

# **Sorption Properties Library (SorpPropLib)**

**Manual**

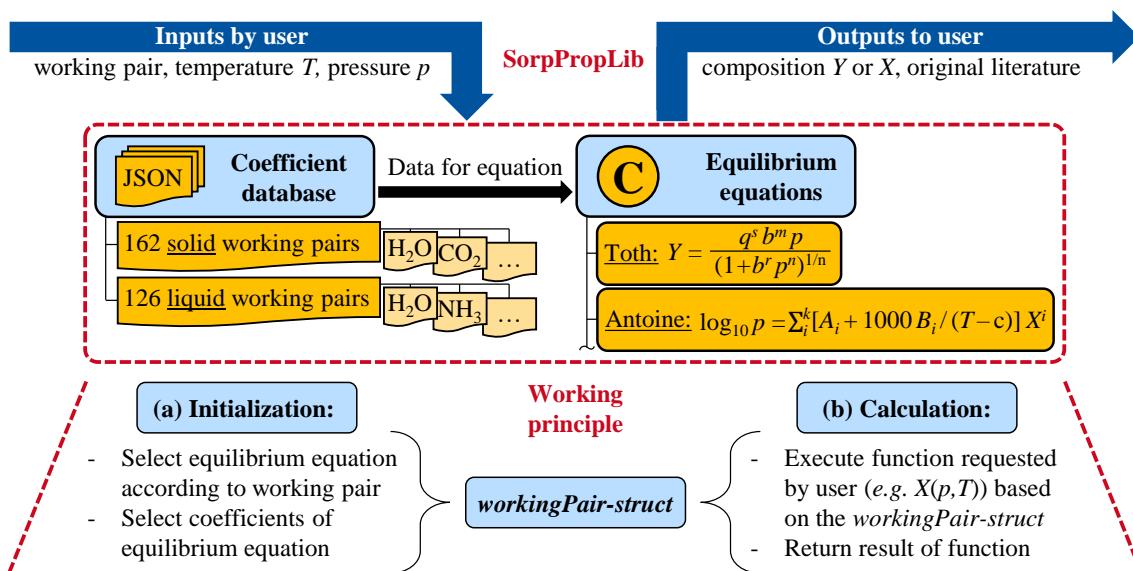
## Summary

Sorption equilibrium data are fundamental to design and develop sorption systems. Currently, some databases exist which contain experimental equilibrium data, e.g., Springer Materials, NIST, Dortmund Data Bank. However, no open-source database exists containing both experimental sorption equilibrium data as well as generalized equilibrium models and the associated coefficients of sorption working pairs.

Here, the sorption property library – SorpPropLib – comes in. SorpPropLib contains generalized equilibrium models, associated coefficients of adsorption and absorption working pairs, and experimentally measured equilibrium data. The working principle of SorpPropLib is explained below.

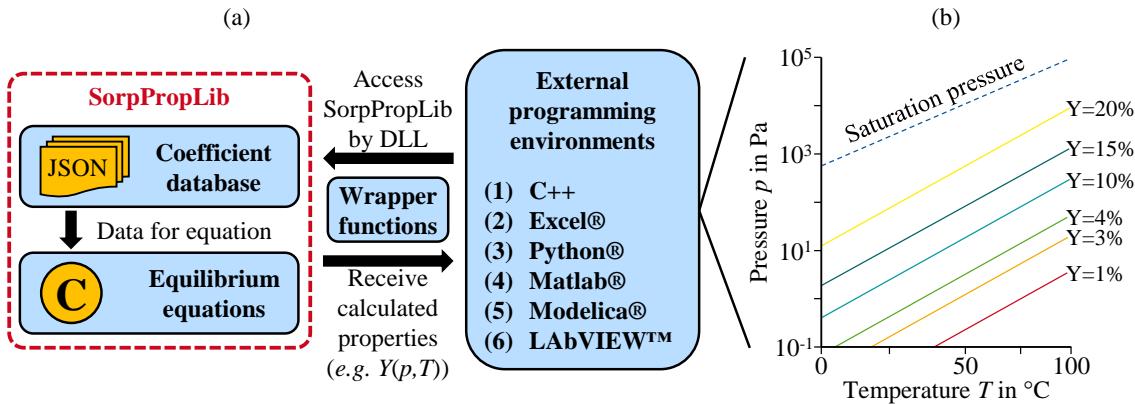
### Working principle of SorpPropLib

The equilibrium models are implemented in *C*, and the coefficients and experimental data are stored text-based in a *JSON database*. First, a sorption work pair object is initialized by specifying a sorption work pair, including the equilibrium and refrigerant model. Then, the user can calculate various sorption equilibrium data using the sorption working pair object. The schematic of the working principle is shown below.



### Integration of SorpPropLib into other programming environments

SorpPropLib can currently be used from 6 programming environments besides the programming language *C*: *C++*, *Python*, *Matlab*, *Modelica*, *LabVIEW*, and *Excel*. For this purpose, SorpPropLib is compiled as a dynamic link library (DLL) and integrated into the programming environments via wrapper functions. In addition, some of the programming environments (e.g., *Python*) contain functions for visualizing equilibrium data and creating or reading out the *JSON database*. The scheme of integrating SorpPropLib into other programming environments is shown below.



## Citing SorpPropLib

The SorpPropLib shall be cited via the following journal article:

Yang, Zhiyao; Gluesenkamp, Kyle R.; Frazzica, Andrea (2021): Equilibrium vapor pressure properties for absorbent and adsorbent materials. In: *International Journal of Refrigeration* 124, pp. 134-166. DOI: 10.1016/j.ijrefrig.2020.12.013.

Furthermore, the following conference paper shall be cited when using the *JSON database*, *C* code, or an interface to the programming environments mentioned before:

Engelpracht, M.; Yang, Z.; Gluesenkamp, K. R.; Turnaoglu, T.; Seiler, J.; Bardow, A. (2020): SorpPropLib: An Open-Source Database for Sorption Equilibrium Properties. In: *ISHPC 2021 proceedings - online pre-conference 2020*, pp. 33-36. International Sorption Heat Pump Conference. Berlin, Germany.

# Contents

<b>Summary</b>	i
<b>1 Usage of SorpPropLib</b>	<b>1</b>
1.1 <i>C/C++</i> and compiling DLL . . . . .	1
1.2 <i>Python</i> . . . . .	2
1.3 <i>Matlab</i> . . . . .	3
1.4 <i>Modelica</i> . . . . .	3
1.5 <i>LabVIEW</i> . . . . .	4
1.6 <i>Excel</i> . . . . .	5
1.7 Known problems . . . . .	6
<b>2 Extension of SorpPropLib</b>	<b>7</b>
2.1 Case 1 – Equilibrium equation already implemented in SorpPropLib . . . . .	7
2.2 Case 2 - Type of equilibrium equation already implemented in Sorp- PropLib . . . . .	8
2.3 Case 3 - Type of equilibrium equation not implemented in SorpPropLib	10
<b>3 Approaches implemented into SorpPropLib</b>	<b>11</b>
3.1 Refrigerants - Vapour Pressure . . . . .	11
3.1.1 VaporPressure_EoS1 . . . . .	11
3.1.2 VaporPressure_EoS2 . . . . .	12
3.1.3 VaporPressure_EoS3 . . . . .	12
3.1.4 VaporPressure_Antoine . . . . .	13
3.1.5 VaporPressure_EoS_Cubic . . . . .	14
3.2 Refrigerants - Saturated liquid density . . . . .	16
3.2.1 SaturatedLiquidDensity_EoS1 . . . . .	16
3.3 Absorption - Conventional . . . . .	16
3.3.1 Antoine . . . . .	17
3.3.2 Dühring . . . . .	17
3.4 Absorption - Activity . . . . .	18
3.4.1 WilsonFixedDl . . . . .	18
3.4.2 WilsonTemperatureDl . . . . .	19
3.4.3 WangChao . . . . .	20
3.4.4 TsubokaKatayama . . . . .	21
3.4.5 Heil . . . . .	21
3.4.6 FloryHuggins . . . . .	22
3.4.7 NRTLFixedDg . . . . .	23
3.4.8 NRTLTemperatureDg . . . . .	23
3.4.9 UniquacFixedDu . . . . .	24
3.4.10 UniquacTemperatureDu . . . . .	25

3.5	Absorption - Mixing . . . . .	25
3.5.1	1pvdw . . . . .	26
3.5.2	2pvdw . . . . .	27
3.5.3	vdbw . . . . .	27
3.6	Adsorption - Surface . . . . .	28
3.6.1	DualSiteSips . . . . .	29
3.6.2	Langmuir . . . . .	29
3.6.3	Toth . . . . .	30
3.7	Adsorption - Surface & Vapor Pressure . . . . .	31
3.7.1	Freundlich . . . . .	31
3.8	Adsorption - Volumetric . . . . .	32
3.8.1	DubininAstakhov . . . . .	32
3.8.2	DubininArctan1 . . . . .	33
<b>4</b>	<b>Refrigerants</b>	<b>35</b>
4.1	1-Butene . . . . .	35
4.1.1	Vapor Pressure - Antoine - ID 1 . . . . .	35
4.1.2	Vapor Pressure - EoS1 - ID 1 . . . . .	36
4.1.3	Vapor Pressure - EoSCubic - ID 1 . . . . .	38
4.1.4	Vapor Pressure - EoSCubic - ID 2 . . . . .	39
4.2	2-Propanol . . . . .	41
4.2.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	41
4.2.2	Saturated Liquid Density - EoS1 - ID 2 . . . . .	43
4.2.3	Vapor Pressure - Antoine - ID 1 . . . . .	44
4.2.4	Vapor Pressure - Antoine - ID 2 . . . . .	46
4.2.5	Vapor Pressure - EoS1 - ID 1 . . . . .	47
4.2.6	Vapor Pressure - EoS1 - ID 2 . . . . .	49
4.2.7	Vapor Pressure - EoSCubic - ID 1 . . . . .	50
4.2.8	Vapor Pressure - EoSCubic - ID 2 . . . . .	52
4.3	Acetone . . . . .	54
4.3.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	54
4.3.2	Vapor Pressure - Antoine - ID 1 . . . . .	56
4.3.3	Vapor Pressure - EoS1 - ID 1 . . . . .	57
4.3.4	Vapor Pressure - EoS Cubic - ID 1 . . . . .	59
4.3.5	Vapor Pressure - EoS Cubic - ID 2 . . . . .	60
4.4	Ammonia . . . . .	62
4.4.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	62
4.4.2	Vapor Pressure - Antoine - ID 1 . . . . .	64
4.4.3	Vapor Pressure - Antoine - ID 2 . . . . .	65
4.4.4	Vapor Pressure - EoS1 - ID 1 . . . . .	67
4.4.5	Vapor Pressure - EoS Cubic - ID 1 . . . . .	68
4.4.6	Vapor Pressure - EoS Cubic - ID 2 . . . . .	70
4.5	Argon . . . . .	72
4.5.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	72
4.5.2	Saturated Liquid Density - EoS1 - ID 2 . . . . .	74
4.5.3	Vapor Pressure - Antoine - ID 1 . . . . .	75

4.5.4	Vapor Pressure - Antoine - ID 2 . . . . .	76
4.5.5	Vapor Pressure - Antoine - ID 3 . . . . .	77
4.5.6	Vapor Pressure - Antoine - ID 4 . . . . .	78
4.5.7	Vapor Pressure - EoS1 - ID 1 . . . . .	79
4.5.8	Vapor Pressure - EoSCubic - ID 1 . . . . .	80
4.5.9	Vapor Pressure - EoSCubic - ID 2 . . . . .	81
4.6	Benzene . . . . .	82
4.6.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	82
4.6.2	Saturated Liquid Density - EoS1 - ID 2 . . . . .	83
4.6.3	Vapor Pressure - Antoine - ID 1 . . . . .	85
4.6.4	Vapor Pressure - Antoine - ID 2 . . . . .	86
4.6.5	Vapor Pressure - Antoine - ID 3 . . . . .	88
4.6.6	Vapor Pressure - Antoine - ID 4 . . . . .	89
4.6.7	Vapor Pressure - EoS1 - ID 1 . . . . .	91
4.6.8	Vapor Pressure - EoS2 - ID 1 . . . . .	92
4.6.9	Vapor Pressure - EoS Cubic - ID 1 . . . . .	94
4.6.10	Vapor Pressure - EoS Cubic - ID 2 . . . . .	95
4.7	Butane . . . . .	97
4.7.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	97
4.7.2	Saturated Liquid Density - EoS1 - ID 2 . . . . .	99
4.7.3	Vapor Pressure - Antoine - ID 1 . . . . .	100
4.7.4	Vapor Pressure - Antoine - ID 2 . . . . .	102
4.7.5	Vapor Pressure - Antoine - ID 3 . . . . .	103
4.7.6	Vapor Pressure - EoS1 - ID 1 . . . . .	105
4.7.7	Vapor Pressure - EoS1 - ID 2 . . . . .	106
4.7.8	Vapor Pressure - EoS Cubic - ID 1 . . . . .	108
4.7.9	Vapor Pressure - EoS Cubic - ID 2 . . . . .	109
4.8	CarbonDioxide . . . . .	111
4.8.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	111
4.8.2	Saturated Liquid Density - EoS1 - ID 2 . . . . .	113
4.8.3	Vapor Pressure - Antoine - ID 1 . . . . .	114
4.8.4	Vapor Pressure - EoS1 - ID 1 . . . . .	116
4.8.5	Vapor Pressure - EoS1 - ID 2 . . . . .	117
4.8.6	Vapor Pressure - EoS Cubic - ID 1 . . . . .	119
4.8.7	Vapor Pressure - EoS Cubic - ID 2 . . . . .	120
4.9	Cyclohexane . . . . .	122
4.9.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	122
4.9.2	Vapor Pressure - Antoine - ID 1 . . . . .	124
4.9.3	Vapor Pressure - Antoine - ID 2 . . . . .	125
4.9.4	Vapor Pressure - Antoine - ID 3 . . . . .	127
4.9.5	Vapor Pressure - Antoine - ID 4 . . . . .	128
4.9.6	Vapor Pressure - EoS1 - ID 1 . . . . .	130
4.9.7	Vapor Pressure - EoS Cubic - ID 1 . . . . .	131
4.9.8	Vapor Pressure - EoS Cubic - ID 2 . . . . .	133
4.10	Cyclohexene . . . . .	135
4.10.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	135

4.10.2 Vapor Pressure - Antoine - ID 1 . . . . .	137
4.11 Ethanol . . . . .	138
4.11.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	138
4.11.2 Saturated Liquid Density - EoS1 - ID 2 . . . . .	140
4.11.3 Vapor Pressure - Antoine - ID 1 . . . . .	141
4.11.4 Vapor Pressure - Antoine - ID 2 . . . . .	143
4.11.5 Vapor Pressure - Antoine - ID 3 . . . . .	144
4.11.6 Vapor Pressure - EoS1 - ID 1 . . . . .	146
4.11.7 Vapor Pressure - EoS1 - ID 2 . . . . .	147
4.11.8 Vapor Pressure - EoS Cubic - ID 1 . . . . .	149
4.11.9 Vapor Pressure - EoS Cubic - ID 2 . . . . .	150
4.12 EthyleneGlycol . . . . .	152
4.12.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	152
4.12.2 Vapor Pressure - Antoine - ID 1 . . . . .	154
4.12.3 Vapor Pressure - EoS1 - ID 1 . . . . .	155
4.12.4 Vapor Pressure - EoS Cubic - ID 1 . . . . .	156
4.12.5 Vapor Pressure - EoS Cubic - ID 2 . . . . .	157
4.13 Helium . . . . .	158
4.13.1 Vapor Pressure - EoS1 - ID 1 . . . . .	158
4.13.2 Vapor Pressure - EoS Cubic - ID 1 . . . . .	159
4.13.3 Vapor Pressure - EoS Cubic - ID 2 . . . . .	160
4.14 Hexane . . . . .	161
4.14.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	161
4.14.2 Vapor Pressure - Antoine - ID 1 . . . . .	162
4.14.3 Vapor Pressure - Antoine - ID 2 . . . . .	164
4.14.4 Vapor Pressure - EoS1 - ID 1 . . . . .	165
4.14.5 Vapor Pressure - EoS Cubic - ID 1 . . . . .	167
4.14.6 Vapor Pressure - EoS Cubic - ID 2 . . . . .	168
4.15 Isobutane . . . . .	170
4.15.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	170
4.15.2 Vapor Pressure - Antoine - ID 1 . . . . .	172
4.15.3 Vapor Pressure - Antoine - ID 2 . . . . .	173
4.15.4 Vapor Pressure - EoS1 - ID 1 . . . . .	175
4.15.5 Vapor Pressure - EoS1 - ID 2 . . . . .	176
4.15.6 Vapor Pressure - EoS Cubic - ID 1 . . . . .	178
4.15.7 Vapor Pressure - EoS Cubic - ID 2 . . . . .	179
4.16 Krypton . . . . .	181
4.16.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	181
4.16.2 Vapor Pressure - Antoine - ID 1 . . . . .	183
4.16.3 Vapor Pressure - EoS1 - ID 1 . . . . .	184
4.16.4 Vapor Pressure - EoS Cubic - ID 1 . . . . .	185
4.16.5 Vapor Pressure - EoS Cubic - ID 2 . . . . .	186
4.17 Methane . . . . .	187
4.17.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	187
4.17.2 Saturated Liquid Density - EoS1 - ID 2 . . . . .	188
4.17.3 Vapor Pressure - Antoine - ID 1 . . . . .	190

4.17.4	Vapor Pressure - Antoine - ID 2 . . . . .	191
4.17.5	Vapor Pressure - Antoine - ID 3 . . . . .	193
4.17.6	Vapor Pressure - Antoine - ID 4 . . . . .	194
4.17.7	Vapor Pressure - EoS1 - ID 1 . . . . .	196
4.17.8	Vapor Pressure - EoS1 - ID 2 . . . . .	197
4.17.9	Vapor Pressure - EoSCubic - ID 1 . . . . .	199
4.17.10	Vapor Pressure - EoSCubic - ID 2 . . . . .	200
4.18	Methanol . . . . .	202
4.18.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	202
4.18.2	Vapor Pressure - Antoine - ID 1 . . . . .	204
4.18.3	Vapor Pressure - Antoine - ID 2 . . . . .	205
4.18.4	Vapor Pressure - Antoine - ID 3 . . . . .	207
4.18.5	Vapor Pressure - EoS1 - ID 1 . . . . .	208
4.18.6	Vapor Pressure - EoS1 - ID 2 . . . . .	210
4.18.7	Vapor Pressure - EoS Cubic - ID 1 . . . . .	211
4.18.8	Vapor Pressure - EoS Cubic - ID 2 . . . . .	213
4.19	Neon . . . . .	215
4.19.1	Vapor Pressure - Antoine - ID 1 . . . . .	215
4.19.2	Vapor Pressure - EoS1 - ID 1 . . . . .	217
4.19.3	Vapor Pressure - EoS Cubic - ID 1 . . . . .	218
4.19.4	Vapor Pressure - EoS Cubic - ID 2 . . . . .	219
4.20	Nitrogen . . . . .	220
4.20.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	220
4.20.2	Saturated Liquid Density - EoS1 - ID 2 . . . . .	222
4.20.3	Vapor Pressure - Antoine - ID 1 . . . . .	223
4.20.4	Vapor Pressure - Antoine - ID 2 . . . . .	225
4.20.5	Vapor Pressure - EoS1 - ID 1 . . . . .	226
4.20.6	Vapor Pressure - EoS1 - ID 2 . . . . .	228
4.20.7	Vapor Pressure - EoS Cubic - ID 1 . . . . .	229
4.20.8	Vapor Pressure - EoS Cubic - ID 2 . . . . .	231
4.21	Oxygen . . . . .	233
4.21.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	233
4.21.2	Vapor Pressure - Antoine - ID 1 . . . . .	235
4.21.3	Vapor Pressure - EoS1 - ID 1 . . . . .	236
4.21.4	Vapor Pressure - EoS Cubic - ID 1 . . . . .	237
4.21.5	Vapor Pressure - EoS Cubic - ID 2 . . . . .	238
4.22	Propane . . . . .	239
4.22.1	Saturated Liquid Density - EoS1 - ID 1 . . . . .	239
4.22.2	Saturated Liquid Density - EoS1 - ID 2 . . . . .	240
4.22.3	Vapor Pressure - Antoine - ID 1 . . . . .	242
4.22.4	Vapor Pressure - Antoine - ID 2 . . . . .	243
4.22.5	Vapor Pressure - Antoine - ID 3 . . . . .	245
4.22.6	Vapor Pressure - EoS1 - ID 1 . . . . .	246
4.22.7	Vapor Pressure - EoS1 - ID 2 . . . . .	248
4.22.8	Vapor Pressure - EoS Cubic - ID 1 . . . . .	249
4.22.9	Vapor Pressure - EoS Cubic - ID 2 . . . . .	251

4.23 Propene . . . . .	253
4.23.1 Vapor Pressure - EoSCubic - ID 1 . . . . .	253
4.24 Propylene . . . . .	255
4.24.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	255
4.24.2 Vapor Pressure - Antoine - ID 1 . . . . .	256
4.24.3 Vapor Pressure - EoS1 - ID 1 . . . . .	258
4.24.4 Vapor Pressure - EoSCubic - ID 1 . . . . .	259
4.25 R-12 . . . . .	261
4.25.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	261
4.25.2 Vapor Pressure - Antoine - ID 1 . . . . .	263
4.25.3 Vapor Pressure - EoS1 - ID 1 . . . . .	264
4.25.4 Vapor Pressure - EoS Cubic - ID 1 . . . . .	266
4.25.5 Vapor Pressure - EoS Cubic - ID 2 . . . . .	267
4.26 R-123 . . . . .	269
4.26.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	269
4.26.2 Vapor Pressure - EoS1 - ID 1 . . . . .	271
4.26.3 Vapor Pressure - EoS Cubic - ID 1 . . . . .	272
4.26.4 Vapor Pressure - EoS Cubic - ID 2 . . . . .	274
4.27 R-1234ze(E) . . . . .	276
4.27.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	276
4.27.2 Vapor Pressure - EoS1 - ID 1 . . . . .	278
4.27.3 Vapor Pressure - EoS Cubic - ID 1 . . . . .	279
4.27.4 Vapor Pressure - EoS Cubic - ID 2 . . . . .	281
4.28 R-125 . . . . .	283
4.28.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	283
4.28.2 Vapor Pressure - EoS1 - ID 1 . . . . .	285
4.28.3 Vapor Pressure - EoS Cubic - ID 1 . . . . .	286
4.28.4 Vapor Pressure - EoS Cubic - ID 2 . . . . .	288
4.29 R-13 B1 . . . . .	290
4.29.1 Vapor Pressure - Antoine - ID 1 . . . . .	290
4.30 R-134a . . . . .	292
4.30.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	292
4.30.2 Vapor Pressure - EoS1 - ID 1 . . . . .	294
4.30.3 Vapor Pressure - EoS Cubic - ID 1 . . . . .	295
4.30.4 Vapor Pressure - EoS Cubic - ID 2 . . . . .	297
4.31 R-142b . . . . .	299
4.31.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	299
4.31.2 Vapor Pressure - EoS3 - ID 1 . . . . .	301
4.31.3 Vapor Pressure - EoS Cubic - ID 1 . . . . .	302
4.31.4 Vapor Pressure - EoS Cubic - ID 2 . . . . .	303
4.32 R-143a . . . . .	304
4.32.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	304
4.32.2 Saturated Liquid Density - EoS1 - ID 2 . . . . .	305
4.32.3 Vapor Pressure - Antoine - ID 1 . . . . .	307
4.32.4 Vapor Pressure - EoS1 - ID 1 . . . . .	308
4.32.5 Vapor Pressure - EoS1 - ID 2 . . . . .	310

4.32.6 Vapor Pressure - EoSCubic - ID 1 . . . . .	311
4.32.7 Vapor Pressure - EoSCubic - ID 2 . . . . .	313
4.33 R-152a . . . . .	315
4.33.1 Vapor Pressure - Antoine - ID 1 . . . . .	315
4.33.2 Vapor Pressure - EoS Cubic - ID 1 . . . . .	317
4.33.3 Vapor Pressure - EoS Cubic - ID 2 . . . . .	318
4.34 R-22 . . . . .	320
4.34.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	320
4.34.2 Saturated Liquid Density - EoS1 - ID 2 . . . . .	322
4.34.3 Vapor Pressure - Antoine - ID 1 . . . . .	323
4.34.4 Vapor Pressure - Antoine - ID 2 . . . . .	325
4.34.5 Vapor Pressure - EoS1 - ID 1 . . . . .	326
4.34.6 Vapor Pressure - EoS1 - ID 2 . . . . .	328
4.34.7 Vapor Pressure - EoS Cubic - ID 1 . . . . .	329
4.34.8 Vapor Pressure - EoS Cubic - ID 2 . . . . .	331
4.35 R-227ea . . . . .	333
4.35.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	333
4.35.2 Vapor Pressure - EoS1 - ID 1 . . . . .	335
4.35.3 Vapor Pressure - EoS Cubic - ID 1 . . . . .	336
4.35.4 Vapor Pressure - EoS Cubic - ID 2 . . . . .	337
4.36 R-23 . . . . .	338
4.36.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	338
4.36.2 Saturated Liquid Density - EoS1 - ID 2 . . . . .	339
4.36.3 Vapor Pressure - Antoine - ID 1 . . . . .	341
4.36.4 Vapor Pressure - EoS1 - ID 1 . . . . .	342
4.36.5 Vapor Pressure - EoS1 - ID 2 . . . . .	344
4.36.6 Vapor Pressure - EoS Cubic - ID 1 . . . . .	345
4.36.7 Vapor Pressure - EoS Cubic - ID 2 . . . . .	347
4.37 R-32 . . . . .	349
4.37.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	349
4.37.2 Vapor Pressure - Antoine - ID 1 . . . . .	351
4.37.3 Vapor Pressure - EoS1 - ID 1 . . . . .	352
4.37.4 Vapor Pressure - EoS1 - ID 2 . . . . .	354
4.37.5 Vapor Pressure - EoS Cubic - ID 1 . . . . .	355
4.37.6 Vapor Pressure - EoS Cubic - ID 2 . . . . .	357
4.38 R-404a . . . . .	359
4.38.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	359
4.39 R-407c . . . . .	361
4.39.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	361
4.39.2 Vapor Pressure - EoS1 - ID 1 . . . . .	362
4.40 R-410a . . . . .	364
4.40.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	364
4.40.2 Vapor Pressure - EoS1 - ID 1 . . . . .	365
4.41 R-507a . . . . .	367
4.41.1 Vapor Pressure - EoS1 - ID 1 . . . . .	367

4.42 TFE . . . . .	368
4.42.1 Vapor Pressure - Antoine - ID 1 . . . . .	368
4.43 THF . . . . .	370
4.43.1 Vapor Pressure - Antoine - ID 1 . . . . .	370
4.44 Toluene . . . . .	371
4.44.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	371
4.44.2 Vapor Pressure - Antoine - ID 1 . . . . .	373
4.44.3 Vapor Pressure - Antoine - ID 2 . . . . .	374
4.44.4 Vapor Pressure - Antoine - ID 3 . . . . .	376
4.44.5 Vapor Pressure - Antoine - ID 4 . . . . .	377
4.44.6 Vapor Pressure - Antoine - ID 5 . . . . .	379
4.44.7 Vapor Pressure - EoS1 - ID 1 . . . . .	380
4.44.8 Vapor Pressure - EoSCubic - ID 1 . . . . .	382
4.44.9 Vapor Pressure - EoSCubic - ID 2 . . . . .	383
4.45 Water . . . . .	385
4.45.1 Saturated Liquid Density - EoS1 - ID 1 . . . . .	385
4.45.2 Saturated Liquid Density - EoS1 - ID 2 . . . . .	387
4.45.3 Vapor Pressure - Antoine - ID 1 . . . . .	388
4.45.4 Vapor Pressure - Antoine - ID 2 . . . . .	390
4.45.5 Vapor Pressure - Antoine - ID 3 . . . . .	391
4.45.6 Vapor Pressure - Antoine - ID 4 . . . . .	393
4.45.7 Vapor Pressure - Antoine - ID 5 . . . . .	394
4.45.8 Vapor Pressure - Antoine - ID 6 . . . . .	396
4.45.9 Vapor Pressure - Antoine - ID 7 . . . . .	397
4.45.10 Vapor Pressure - EoS1 - ID 1 . . . . .	399
4.45.11 Vapor Pressure - EoS1 - ID 2 . . . . .	400
4.45.12 Vapor Pressure - EoS Cubic - ID 1 . . . . .	402
4.45.13 Vapor Pressure - EoS Cubic - ID 2 . . . . .	403
<b>5 Adsorption</b>	<b>406</b>
5.1 1-Butene . . . . .	406
5.1.1 Zeolite pellet 13X . . . . .	406
5.1.1.1 Toth - ID 1 . . . . .	406
5.2 Ammonia . . . . .	408
5.2.1 Zeolite pellet NaX . . . . .	408
5.2.1.1 DubininAstakhov - ID 1 . . . . .	408
5.3 Butane . . . . .	410
5.3.1 Activated carbon powder Maxsorb III . . . . .	410
5.3.1.1 DubininAstakhov - ID 1 . . . . .	410
5.4 CarbonDioxide . . . . .	412
5.4.1 Activated carbon Norit RB 1 . . . . .	412
5.4.1.1 Langmuir - ID 1 . . . . .	412
5.4.2 Activated carbon fiber A-20 . . . . .	414
5.4.2.1 Langmuir - ID 1 . . . . .	414
5.4.2.2 Toth - ID 1 . . . . .	416

5.4.3	Activated carbon powder Maxsorb III . . . . .	418
5.4.3.1	Langmuir - ID 1 . . . . .	418
5.4.3.2	Toth - ID 1 . . . . .	420
5.4.4	Silica gel pellet . . . . .	422
5.4.4.1	Toth - ID 1 . . . . .	422
5.4.5	Zeolite pellet 13X . . . . .	424
5.4.5.1	Toth - ID 1 . . . . .	424
5.4.6	Zeolite pellet 5A . . . . .	426
5.4.6.1	Toth - ID 1 . . . . .	426
5.5	Ethanol . . . . .	428
5.5.1	Activated carbon AP4-60 . . . . .	428
5.5.1.1	DubininAstakhov - ID 1 . . . . .	428
5.5.2	Activated carbon ATO . . . . .	430
5.5.2.1	DubininAstakhov - ID 1 . . . . .	430
5.5.3	Activated carbon COC-L1200 . . . . .	432
5.5.3.1	DubininAstakhov - ID 1 . . . . .	432
5.5.4	Activated carbon FR20 . . . . .	434
5.5.4.1	DubininAstakhov - ID 1 . . . . .	434
5.5.5	Activated carbon SRD 1352/3 . . . . .	436
5.5.5.1	DubininAstakhov - ID 1 . . . . .	436
5.5.6	Activated carbon fiber A-20 . . . . .	438
5.5.6.1	DubininAstakhov - ID 1 . . . . .	438
5.5.7	Activated carbon powder H <sub>2</sub> -treated Maxsorb III . . . . .	440
5.5.7.1	DubininAstakhov - ID 1 . . . . .	440
5.5.8	Activated carbon powder KOH-H <sub>2</sub> -treated Maxsorb III . . . . .	442
5.5.8.1	DubininAstakhov - ID 1 . . . . .	442
5.5.9	Activated carbon powder Maxsorb III . . . . .	444
5.5.9.1	DubininAstakhov - ID 1 . . . . .	444
5.5.9.2	DubininAstakhov - ID 2 . . . . .	446
5.5.10	Mof MIL-101Cr . . . . .	448
5.5.10.1	DubininAstakhov - ID 1 . . . . .	448
5.5.11	Phenol resin composite KOH4-PR . . . . .	450
5.5.11.1	DubininAstakhov - ID 1 . . . . .	450
5.5.12	Phenol resin composite KOH6-PR . . . . .	452
5.5.12.1	DubininAstakhov - ID 1 . . . . .	452
5.5.13	Silica gel composite 19 wt.% LiBr . . . . .	454
5.5.13.1	DubininAstakhov - ID 1 . . . . .	454
5.6	Isobutane . . . . .	456
5.6.1	Mof powder cubtc . . . . .	456
5.6.1.1	DualSiteSips - ID 1 . . . . .	456
5.6.2	Zeolite pellet 13X . . . . .	458
5.6.2.1	Toth - ID 1 . . . . .	458
5.7	Methane . . . . .	460
5.7.1	Activated carbon AX21 . . . . .	460
5.7.1.1	DubininAstakhov - ID 1 . . . . .	460

5.7.2	Activated carbon BPL . . . . .	462
5.7.2.1	DubininAstakhov - ID 1 . . . . .	462
5.7.3	Activated carbon Calgon AC . . . . .	464
5.7.3.1	DubininAstakhov - ID 1 . . . . .	464
5.7.4	Activated carbon F30/470 . . . . .	466
5.7.4.1	DubininAstakhov - ID 1 . . . . .	466
5.7.5	Activated carbon Norit R 1 Extra . . . . .	468
5.7.5.1	DubininAstakhov - ID 1 . . . . .	468
5.7.6	Activated carbon Norit RB 1 . . . . .	470
5.7.6.1	Langmuir - ID 1 . . . . .	470
5.7.7	Activated carbon fiber A-20 . . . . .	472
5.7.7.1	DubininAstakhov - ID 1 . . . . .	472
5.7.8	Activated carbon powder Maxsorb III . . . . .	474
5.7.8.1	DubininAstakhov - ID 1 . . . . .	474
5.7.9	Activated charcoal pellet Chemviron . . . . .	476
5.7.9.1	DubininAstakhov - ID 1 . . . . .	476
5.8	Methanol . . . . .	478
5.8.1	Activated carbon 207C . . . . .	478
5.8.1.1	DubininAstakhov - ID 1 . . . . .	478
5.8.2	Activated carbon 207EA . . . . .	480
5.8.2.1	DubininAstakhov - ID 1 . . . . .	480
5.8.2.2	DubininAstakhov - ID 2 . . . . .	482
5.8.3	Activated carbon A-35 . . . . .	484
5.8.3.1	DubininAstakhov - ID 1 . . . . .	484
5.8.4	Activated carbon AC-35 . . . . .	485
5.8.4.1	DubininAstakhov - ID 1 . . . . .	485
5.8.5	Activated carbon AC-5060 . . . . .	486
5.8.5.1	DubininAstakhov - ID 1 . . . . .	486
5.8.6	Activated carbon ACLH . . . . .	487
5.8.6.1	DubininAstakhov - ID 1 . . . . .	487
5.8.7	Activated carbon BPL . . . . .	488
5.8.7.1	DubininAstakhov - ID 1 . . . . .	488
5.8.8	Activated carbon CarboTech A35/1 . . . . .	489
5.8.8.1	DubininAstakhov - ID 1 . . . . .	489
5.8.9	Activated carbon CarboTech C40/1 . . . . .	491
5.8.9.1	DubininAstakhov - ID 1 . . . . .	491
5.8.10	Activated carbon DEG . . . . .	493
5.8.10.1	DubininAstakhov - ID 1 . . . . .	493
5.8.11	Activated carbon G32-H . . . . .	494
5.8.11.1	DubininAstakhov - ID 1 . . . . .	494
5.8.12	Activated carbon HC-20C . . . . .	496
5.8.12.1	DubininAstakhov - ID 1 . . . . .	496
5.8.13	Activated carbon Norit R 1 Extra . . . . .	498
5.8.13.1	DubininAstakhov - ID 1 . . . . .	498
5.8.14	Activated carbon Norit RB . . . . .	500
5.8.14.1	DubininAstakhov - ID 1 . . . . .	500

5.8.15	Activated carbon Norit RX 3 Extra . . . . .	501
5.8.15.1	DubininAstakhov - ID 1 . . . . .	501
5.8.16	Activated carbon PKST . . . . .	503
5.8.16.1	DubininAstakhov - ID 1 . . . . .	503
5.8.17	Activated carbon RÜTGERS CG1-3 . . . . .	504
5.8.17.1	DubininAstakhov - ID 1 . . . . .	504
5.8.18	Activated carbon WS-480 . . . . .	506
5.8.18.1	DubininAstakhov - ID 1 . . . . .	506
5.8.18.2	DubininAstakhov - ID 2 . . . . .	508
5.8.19	Activated carbon powder Maxsorb III . . . . .	510
5.8.19.1	DubininAstakhov - ID 1 . . . . .	510
5.8.20	Activated charcoal 207E4 . . . . .	512
5.8.20.1	DubininAstakhov - ID 1 . . . . .	512
5.8.21	Activated charcoal Chinese LSZ30 . . . . .	513
5.8.21.1	DubininAstakhov - ID 1 . . . . .	513
5.8.22	Activated charcoal LH . . . . .	514
5.8.22.1	DubininAstakhov - ID 1 . . . . .	514
5.8.23	Activated charcoal Thai MD6070 . . . . .	515
5.8.23.1	DubininAstakhov - ID 1 . . . . .	515
5.9	Nitrogen . . . . .	516
5.9.1	Activated carbon AP4-60 . . . . .	516
5.9.1.1	DubininAstakhov - ID 1 . . . . .	516
5.9.2	Activated carbon ATO . . . . .	518
5.9.2.1	DubininAstakhov - ID 1 . . . . .	518
5.9.3	Activated carbon COC-L1200 . . . . .	520
5.9.3.1	DubininAstakhov - ID 1 . . . . .	520
5.9.4	Activated carbon CarboTech A35/1 . . . . .	522
5.9.4.1	DubininAstakhov - ID 1 . . . . .	522
5.9.5	Activated carbon CarboTech C40/1 . . . . .	524
5.9.5.1	DubininAstakhov - ID 1 . . . . .	524
5.9.6	Activated carbon FR20 . . . . .	526
5.9.6.1	DubininAstakhov - ID 1 . . . . .	526
5.9.7	Activated carbon G32-H . . . . .	528
5.9.7.1	DubininAstakhov - ID 1 . . . . .	528
5.9.8	Activated carbon Norit R 1 Extra . . . . .	530
5.9.8.1	DubininAstakhov - ID 1 . . . . .	530
5.9.9	Activated carbon Norit RX 3 Extra . . . . .	532
5.9.9.1	DubininAstakhov - ID 1 . . . . .	532
5.9.10	Activated carbon RÜTGERS CG1-3 . . . . .	534
5.9.10.1	DubininAstakhov - ID 1 . . . . .	534
5.9.11	Activated carbon SRD 1352/3 . . . . .	536
5.9.11.1	DubininAstakhov - ID 1 . . . . .	536
5.10	Propane . . . . .	538
5.10.1	Activated carbon powder Maxsorb III . . . . .	538
5.10.1.1	DubininAstakhov - ID 1 . . . . .	538

5.10.2	Carbon molecular sieve 4A . . . . .	540
5.10.2.1	DubininAstakhov - ID 1 . . . . .	540
5.10.2.2	Toth - ID 1 . . . . .	542
5.10.3	Mof powder cubtc . . . . .	544
5.10.3.1	DualSiteSips - ID 1 . . . . .	544
5.10.4	Zeolite crystal 5A . . . . .	546
5.10.4.1	DubininAstakhov - ID 1 . . . . .	546
5.10.4.2	Toth - ID 1 . . . . .	548
5.10.5	Zeolite pellet 13X . . . . .	550
5.10.5.1	Toth - ID 1 . . . . .	550
5.10.5.2	Toth - ID 2 . . . . .	552
5.10.6	Zeolite pellet 4A . . . . .	554
5.10.6.1	Langmuir - ID 1 . . . . .	554
5.10.6.2	Toth - ID 1 . . . . .	556
5.10.7	Zeolite pellet 5A . . . . .	558
5.10.7.1	DubininAstakhov - ID 1 . . . . .	558
5.10.7.2	Toth - ID 1 . . . . .	560
5.11	Propylene . . . . .	562
5.11.1	Carbon molecular sieve 4A . . . . .	562
5.11.1.1	DubininAstakhov - ID 1 . . . . .	562
5.11.1.2	Toth - ID 1 . . . . .	564
5.11.2	Mof powder cubtc . . . . .	566
5.11.2.1	DualSiteSips - ID 1 . . . . .	566
5.11.3	Zeolite crystal 5A . . . . .	568
5.11.3.1	DubininAstakhov - ID 1 . . . . .	568
5.11.3.2	Toth - ID 1 . . . . .	570
5.11.4	Zeolite pellet 13X . . . . .	572
5.11.4.1	Toth - ID 1 . . . . .	572
5.11.4.2	Toth - ID 2 . . . . .	574
5.11.5	Zeolite pellet 4A . . . . .	576
5.11.5.1	Toth - ID 1 . . . . .	576
5.11.6	Zeolite pellet 5A . . . . .	578
5.11.6.1	DubininAstakhov - ID 1 . . . . .	578
5.11.6.2	Toth - ID 1 . . . . .	580
5.12	R-1234ze(E) . . . . .	582
5.12.1	Activated carbon powder Maxsorb III . . . . .	582
5.12.1.1	Toth - ID 1 . . . . .	582
5.13	R-134a . . . . .	584
5.13.1	Activated carbon Maxsorb III . . . . .	584
5.13.1.1	DubininAstakhov - ID 1 . . . . .	584
5.13.1.2	DubininAstakhov - ID 2 . . . . .	586
5.13.2	Activated carbon SRD 1352/3 . . . . .	588
5.13.2.1	DubininAstakhov - ID 1 . . . . .	588
5.13.2.2	DubininAstakhov - ID 2 . . . . .	590
5.13.3	Activated carbon granular . . . . .	592
5.13.3.1	DubininAstakhov - ID 1 . . . . .	592

5.13.4	Activated carbon fiber A-20 . . . . .	594
5.13.4.1	DubininAstakhov - ID 1 . . . . .	594
5.13.4.2	DubininAstakhov - ID 2 . . . . .	596
5.13.4.3	DubininAstakhov - ID 3 . . . . .	598
5.13.5	Activated carbon powder Maxsorb III . . . . .	600
5.13.5.1	DubininAstakhov - ID 1 . . . . .	600
5.13.5.2	Toth - ID 1 . . . . .	602
5.13.6	Activated charcoal pellet Chemviron . . . . .	603
5.13.6.1	DubininAstakhov - ID 1 . . . . .	603
5.13.7	Activated charcoal powder Fluka . . . . .	605
5.13.7.1	DubininAstakhov - ID 1 . . . . .	605
5.13.8	Activated charcoal powder Maxsorb . . . . .	607
5.13.8.1	DubininAstakhov - ID 1 . . . . .	607
5.14	R-32 . . . . .	609
5.14.1	Activated carbon fiber A-20 . . . . .	609
5.14.1.1	DubininAstakhov - ID 1 . . . . .	609
5.14.2	Activated carbon powder Maxsorb III . . . . .	611
5.14.2.1	DubininAstakhov - ID 1 . . . . .	611
5.15	R-404a . . . . .	613
5.15.1	Activated carbon AquaSorb 2000 . . . . .	613
5.15.1.1	DubininAstakhov - ID 1 . . . . .	613
5.16	R-407c . . . . .	615
5.16.1	Activated carbon AquaSorb 2000 . . . . .	615
5.16.1.1	DubininAstakhov - ID 1 . . . . .	615
5.17	R-410a . . . . .	617
5.17.1	Activated carbon fiber A-20 . . . . .	617
5.17.1.1	DubininAstakhov - ID 1 . . . . .	617
5.17.2	Activated carbon powder Maxsorb III . . . . .	619
5.17.2.1	DubininAstakhov - ID 1 . . . . .	619
5.17.2.2	DubininAstakhov - ID 2 . . . . .	621
5.18	R-507a . . . . .	623
5.18.1	Activated carbon fiber A-20 . . . . .	623
5.18.1.1	DubininAstakhov - ID 1 . . . . .	623
5.18.2	Activated carbon powder Maxsorb III . . . . .	625
5.18.2.1	DubininAstakhov - ID 1 . . . . .	625
5.18.2.2	DubininAstakhov - ID 2 . . . . .	627
5.19	Water . . . . .	629
5.19.1	Mof powder CPO-27(Ni) . . . . .	629
5.19.1.1	DubininAstakhov - ID 1 . . . . .	629
5.19.2	Polymer PS-I . . . . .	631
5.19.2.1	DubininAstakhov - ID 1 . . . . .	631
5.19.3	Polymer PS-II . . . . .	633
5.19.3.1	DubininAstakhov - ID 1 . . . . .	633
5.19.4	Silica gel pellet . . . . .	635
5.19.4.1	Freundlich - ID 1 . . . . .	635
5.19.4.2	Toth - ID 1 . . . . .	636

5.19.5 Silica gel pellet 123 . . . . .	638
5.19.5.1 DubininArctan1 - ID 1 . . . . .	638
5.19.6 Silica gel pellet 125 . . . . .	640
5.19.6.1 DubininArctan1 - ID 1 . . . . .	640
5.19.7 Silica gel pellet AF-25 . . . . .	642
5.19.7.1 DubininArctan1 - ID 1 . . . . .	642
5.19.8 Silica gel pellet Fuji . . . . .	644
5.19.8.1 DubininArctan1 - ID 1 . . . . .	644
5.19.9 Silica gel pellet Fuji A . . . . .	646
5.19.9.1 Freundlich - ID 1 . . . . .	646
5.19.10 Silica gel pellet Fuji RD . . . . .	648
5.19.10.1 Freundlich - ID 1 . . . . .	648
5.19.10.2 Freundlich - ID 2 . . . . .	649
5.19.10.3 Toth - ID 1 . . . . .	650
5.19.11 Silica gel pellet Fuji RD 2560 . . . . .	651
5.19.11.1 DubininAstakhov - ID 1 . . . . .	651
5.19.12 Silica gel pellet KD A5BW . . . . .	653
5.19.12.1 DubininAstakhov - ID 1 . . . . .	653
5.19.13 Silica gel pellet Mayekawa A++ . . . . .	655
5.19.13.1 DubininAstakhov - ID 1 . . . . .	655
5.19.14 Silica gel pellet Siogel . . . . .	657
5.19.14.1 DubininAstakhov - ID 1 . . . . .	657
5.19.15 Silica gel pellet WS . . . . .	659
5.19.15.1 DubininArctan1 - ID 1 . . . . .	659
5.19.16 Zeolite pellet . . . . .	661
5.19.16.1 DubininAstakhov - ID 1 . . . . .	661
5.19.17 Zeolite pellet 13X . . . . .	662
5.19.17.1 Toth - ID 1 . . . . .	662
5.19.18 Zeolite pellet 5A . . . . .	664
5.19.18.1 Toth - ID 1 . . . . .	664
5.19.19 Zeotype pellet AQSOA-Z01 . . . . .	666
5.19.19.1 DubininAstakhov - ID 1 . . . . .	666
5.19.19.2 DubininAstakhov - ID 2 . . . . .	668
5.19.20 Zeotype pellet AQSOA-Z02 . . . . .	670
5.19.20.1 DubininAstakhov - ID 1 . . . . .	670
5.19.20.2 DubininAstakhov - ID 2 . . . . .	672
5.19.21 Zeotype pellet AQSOA-Z05 . . . . .	674
5.19.21.1 DubininAstakhov - ID 1 . . . . .	674
5.19.22 Zeotype powder ETS-10 . . . . .	676
5.19.22.1 DubininAstakhov - ID 1 . . . . .	676
<b>6 Absorption</b>	<b>678</b>
6.1 2-Propanol . . . . .	678
6.1.1 Ionic liquid [BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	678
6.1.1.1 NrtlFixedDg - ID 1 . . . . .	678
6.1.1.2 UniquacFixedDu - ID 1 . . . . .	680

6.1.1.3	UniquacFixedDu - ID 2 . . . . .	682
6.1.1.4	WilsonFixedDl - ID 1 . . . . .	684
6.1.2	Ionic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	686
6.1.2.1	NrtlFixedDg - ID 1 . . . . .	686
6.1.2.2	UniquacFixedDu - ID 1 . . . . .	688
6.1.2.3	UniquacFixedDu - ID 2 . . . . .	690
6.1.2.4	WilsonFixedDl - ID 1 . . . . .	692
6.2	Acetone . . . . .	694
6.2.1	Ionic liquid [BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	694
6.2.1.1	NrtlFixedDg - ID 1 . . . . .	694
6.2.1.2	UniquacFixedDu - ID 1 . . . . .	696
6.2.1.3	UniquacFixedDu - ID 2 . . . . .	698
6.2.1.4	WilsonFixedDl - ID 1 . . . . .	700
6.2.2	Ionic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	702
6.2.2.1	NrtlFixedDg - ID 1 . . . . .	702
6.2.2.2	UniquacFixedDu - ID 1 . . . . .	704
6.2.2.3	UniquacFixedDu - ID 2 . . . . .	706
6.2.2.4	WilsonFixedDl - ID 1 . . . . .	708
6.2.3	Ionic liquid [MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]- . . . . .	710
6.2.3.1	UniquacFixedDu - ID 1 . . . . .	710
6.3	Benzene . . . . .	712
6.3.1	Inoic liquid [BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	712
6.3.1.1	NrtlTemperatureDg - ID 1 . . . . .	712
6.3.2	Inoic liquid [C <sub>2</sub> H <sub>5</sub> NH]+[C <sub>2</sub> H <sub>5</sub> OC <sub>2</sub> H <sub>4</sub> OSO <sub>3</sub> ]- . . . . .	714
6.3.2.1	NrtlTemperatureDg - ID 1 . . . . .	714
6.3.3	Inoic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	716
6.3.3.1	NrtlTemperatureDg - ID 1 . . . . .	716
6.3.4	Inoic liquid [EMIM]+[C <sub>2</sub> H <sub>5</sub> OSO <sub>3</sub> ]- . . . . .	718
6.3.4.1	NrtlTemperatureDg - ID 1 . . . . .	718
6.3.5	Inoic liquid [MMIM]+[(CFH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	720
6.3.5.1	NrtlTemperatureDg - ID 1 . . . . .	720
6.3.6	Ionic liquid [BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	722
6.3.6.1	UniquacTemperatureDu - ID 1 . . . . .	722
6.3.7	Ionic liquid [C <sub>2</sub> H <sub>5</sub> NH]+[C <sub>2</sub> H <sub>5</sub> OC <sub>2</sub> H <sub>4</sub> OSO <sub>3</sub> ]- . . . . .	724
6.3.7.1	UniquacTemperatureDu - ID 1 . . . . .	724
6.3.8	Ionic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	726
6.3.8.1	UniquacTemperatureDu - ID 1 . . . . .	726
6.3.9	Ionic liquid [EMIM]+[C <sub>2</sub> H <sub>5</sub> OSO <sub>3</sub> ]- . . . . .	728
6.3.9.1	UniquacTemperatureDu - ID 1 . . . . .	728
6.3.10	Ionic liquid [MMIM]+[(CH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	730
6.3.10.1	UniquacTemperatureDu - ID 1 . . . . .	730
6.4	CarbonDioxide . . . . .	732
6.4.1	Ionic liquid [C <sub>10</sub> mim][NTf <sub>2</sub> ] . . . . .	732
6.4.1.1	MixingRule - ID 1 . . . . .	732
6.4.1.2	MixingRule - ID 2 . . . . .	735

6.4.2	Ionic liquid [C4mim][NTf2] . . . . .	738
6.4.2.1	MixingRule - ID 1 . . . . .	738
6.4.2.2	MixingRule - ID 2 . . . . .	741
6.4.3	Ionic liquid [N1,8,8,8][NTf2] . . . . .	744
6.4.3.1	MixingRule - ID 1 . . . . .	744
6.4.3.2	MixingRule - ID 2 . . . . .	747
6.4.4	Ionic liquid [N4,1,1,1][NTf2] . . . . .	750
6.4.4.1	MixingRule - ID 1 . . . . .	750
6.4.4.2	MixingRule - ID 2 . . . . .	753
6.4.5	Ionic liquid [P6,6,6,14][Cl] . . . . .	756
6.4.5.1	MixingRule - ID 1 . . . . .	756
6.4.5.2	MixingRule - ID 2 . . . . .	759
6.4.6	Ionic liquid [P6,6,6,14][NTf2] . . . . .	762
6.4.6.1	MixingRule - ID 1 . . . . .	762
6.4.6.2	MixingRule - ID 2 . . . . .	765
6.4.7	Ionic liquid [Pyrr4,1][NTf2] . . . . .	768
6.4.7.1	MixingRule - ID 1 . . . . .	768
6.4.7.2	MixingRule - ID 2 . . . . .	771
6.5	Cyclohexane . . . . .	774
6.5.1	Inoic liquid [BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	774
6.5.1.1	NrtlTemperatureDg - ID 1 . . . . .	774
6.5.2	Inoic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	776
6.5.2.1	NrtlTemperatureDg - ID 1 . . . . .	776
6.5.3	Inoic liquid [EMIM]+[C <sub>2</sub> H <sub>5</sub> OSO <sub>3</sub> ]- . . . . .	778
6.5.3.1	NrtlTemperatureDg - ID 1 . . . . .	778
6.5.4	Inoic liquid [MMIM]+[(CH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	780
6.5.4.1	NrtlTemperatureDg - ID 1 . . . . .	780
6.5.5	Ionic liquid [BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	782
6.5.5.1	UniquacTemperatureDu - ID 1 . . . . .	782
6.5.6	Ionic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	784
6.5.6.1	UniquacTemperatureDu - ID 1 . . . . .	784
6.5.7	Ionic liquid [EMIM]+[C <sub>2</sub> H <sub>5</sub> OSO <sub>3</sub> ]- . . . . .	786
6.5.7.1	UniquacTemperatureDu - ID 1 . . . . .	786
6.5.8	Ionic liquid [MMIM]+[(CH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	788
6.5.8.1	UniquacTemperatureDu - ID 1 . . . . .	788
6.6	Cyclohexene . . . . .	790
6.6.1	Inoic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	790
6.6.1.1	NrtlTemperatureDg - ID 1 . . . . .	790
6.7	Ethanol . . . . .	792
6.7.1	Ionic liquid [MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]- . . . . .	792
6.7.1.1	UniquacFixedDu - ID 1 . . . . .	792
6.8	Hexane . . . . .	794
6.8.1	Inoic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	794
6.8.1.1	NrtlTemperatureDg - ID 1 . . . . .	794
6.8.2	Ionic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	796
6.8.2.1	UniquacTemperatureDu - ID 1 . . . . .	796

6.9 Isobutane . . . . .	798
6.9.1 Lubricant POE ISO7 . . . . .	798
6.9.1.1 MixingRule - ID 1 . . . . .	798
6.10 Methanol . . . . .	801
6.10.1 Ionic liquid [MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]- . . . . .	801
6.10.1.1 UniquacFixedDu - ID 1 . . . . .	801
6.11 R-12 . . . . .	803
6.11.1 Lubricant AB32 . . . . .	803
6.11.1.1 MixingRule - ID 1 . . . . .	803
6.11.2 Naphthenic . . . . .	805
6.11.2.1 Heil - ID 1 . . . . .	805
6.11.2.2 NRTLFixedDg - ID 1 . . . . .	807
6.11.2.3 TsubokaKatayama - ID 1 . . . . .	809
6.11.2.4 WangChao - ID 1 . . . . .	811
6.11.2.5 WilsonFixedDl - ID 1 . . . . .	813
6.11.3 Paraffinic . . . . .	815
6.11.3.1 Heil - ID 1 . . . . .	815
6.11.3.2 NRTLFixedDg - ID 1 . . . . .	817
6.11.3.3 TsubokaKatayama - ID 1 . . . . .	819
6.11.3.4 UniquacFixedDu - ID 1 . . . . .	821
6.11.3.5 WangChao - ID 1 . . . . .	823
6.11.3.6 WilsonFixedDl - ID 1 . . . . .	825
6.12 R-123 . . . . .	827
6.12.1 Lubricant MO56 . . . . .	827
6.12.1.1 MixingRule - ID 1 . . . . .	827
6.13 R-1234ze(E) . . . . .	829
6.13.1 Lubricant POE . . . . .	829
6.13.1.1 NRTLFixedDg - ID 1 . . . . .	829
6.13.1.2 UniquacFixedDu - ID 1 . . . . .	830
6.13.1.3 WilsonFixedDl - ID 1 . . . . .	831
6.14 R-125 . . . . .	833
6.14.1 Hexadecane . . . . .	833
6.14.1.1 UniquacFixedDu - ID 1 . . . . .	833
6.14.2 Lubricant BAB15 . . . . .	835
6.14.2.1 MixingRule - ID 1 . . . . .	835
6.14.3 Lubricant BAB32 . . . . .	838
6.14.3.1 MixingRule - ID 1 . . . . .	838
6.14.4 Lubricant HAB15 . . . . .	841
6.14.4.1 MixingRule - ID 1 . . . . .	841
6.14.5 Lubricant HAB32 . . . . .	843
6.14.5.1 MixingRule - ID 1 . . . . .	843
6.14.6 Lubricant HC16 . . . . .	845
6.14.6.1 MixingRule - ID 1 . . . . .	845
6.14.7 Lubricant PEB6 . . . . .	847
6.14.7.1 FloryHuggins - ID 1 . . . . .	847

6.14.8 Lubricant PEB . . . . .	849
6.14.8.1 FloryHuggins - ID 1 . . . . .	849
6.14.8.2 MixingRule - ID 1 . . . . .	851
6.14.9 Lubricant PEC9 . . . . .	853
6.14.9.1 FloryHuggins - ID 1 . . . . .	853
6.14.10 Lubricant POE . . . . .	855
6.14.10.1 Heil - ID 1 . . . . .	855
6.14.10.2 NrtlFixedDg - ID 1 . . . . .	857
6.14.10.3 TsubokaKatayama - ID 1 . . . . .	859
6.14.10.4 UniquacFixedDu - ID 1 . . . . .	861
6.14.10.5 WangChao - ID 1 . . . . .	863
6.14.10.6 WilsonFixedDl - ID 1 . . . . .	865
6.14.11 Lubricant POE32 . . . . .	867
6.14.11.1 MixingRule - ID 1 . . . . .	867
6.14.12 Lubricant POE68 . . . . .	869
6.14.12.1 MixingRule - ID 1 . . . . .	869
6.14.13 Pentaerythritol tetrapentanoate ester . . . . .	871
6.14.13.1 FloryHuggins - ID 1 . . . . .	871
6.15 R-13 B1 . . . . .	873
6.15.1 Lubricant AB32 . . . . .	873
6.15.1.1 MixingRule - ID 1 . . . . .	873
6.16 R-134a . . . . .	875
6.16.1 Triegdme . . . . .	875
6.16.1.1 WilsonTemperatureDl - ID 1 . . . . .	875
6.16.2 Hexadecane . . . . .	878
6.16.2.1 UniquacFixedDu - ID 1 . . . . .	878
6.16.3 Lubricant BAB15 . . . . .	880
6.16.3.1 MixingRule - ID 1 . . . . .	880
6.16.4 Lubricant BAB32 . . . . .	883
6.16.4.1 MixingRule - ID 1 . . . . .	883
6.16.5 Lubricant HAB32 . . . . .	886
6.16.5.1 MixingRule - ID 1 . . . . .	886
6.16.6 Lubricant HC13 . . . . .	888
6.16.6.1 MixingRule - ID 1 . . . . .	888
6.16.7 Lubricant HC16 . . . . .	890
6.16.7.1 MixingRule - ID 1 . . . . .	890
6.16.8 Lubricant HC20 . . . . .	893
6.16.8.1 MixingRule - ID 1 . . . . .	893
6.16.9 Lubricant PAG . . . . .	895
6.16.9.1 Heil - ID 1 . . . . .	895
6.16.9.2 NrtlFixedDg - ID 1 . . . . .	897
6.16.9.3 TsubokaKatayama - ID 1 . . . . .	899
6.16.9.4 WangChao - ID 1 . . . . .	901
6.16.9.5 WilsonFixedDl - ID 1 . . . . .	903
6.16.10 Lubricant PEB6 . . . . .	905
6.16.10.1 FloryHuggins - ID 1 . . . . .	905

6.16.11 Lubricant PEB8 . . . . .	907
6.16.11.1 FloryHuggins - ID 1 . . . . .	907
6.16.11.2 MixingRule - ID 1 . . . . .	909
6.16.12 Lubricant PEC9 . . . . .	911
6.16.12.1 FloryHuggins - ID 1 . . . . .	911
6.16.13 Lubricant POE . . . . .	913
6.16.13.1 Heil - ID 1 . . . . .	913
6.16.13.2 Heil - ID 2 . . . . .	915
6.16.13.3 NrtlFixedDg - ID 1 . . . . .	917
6.16.13.4 NrtlFixedDg - ID 2 . . . . .	919
6.16.13.5 TsubokaKatayama - ID 1 . . . . .	921
6.16.13.6 TsubokaKatayama - ID 2 . . . . .	923
6.16.13.7 UniquacFixedDu - ID 1 . . . . .	925
6.16.13.8 UniquacFixedDu - ID 2 . . . . .	927
6.16.13.9 WangChao - ID 1 . . . . .	929
6.16.13.10 WangChao - ID 2 . . . . .	931
6.16.13.11 WilsonFixedDl - ID 1 . . . . .	933
6.16.13.12 WilsonFixedDl - ID 2 . . . . .	935
6.16.14 Lubricant POE Castrol SW 46 . . . . .	937
6.16.14.1 NrtlFixedDg - ID 1 . . . . .	937
6.16.15 Lubricant POE32 . . . . .	938
6.16.15.1 MixingRule - ID 1 . . . . .	938
6.16.16 Lubricant POE68 . . . . .	941
6.16.16.1 MixingRule - ID 1 . . . . .	941
6.16.17 Pentaerythritol tetrapentanoate ester . . . . .	943
6.16.17.1 FloryHuggins - ID 1 . . . . .	943
6.17 R-143a . . . . .	945
6.17.1 Lubricant BAB15 . . . . .	945
6.17.1.1 MixingRule - ID 1 . . . . .	945
6.17.2 Lubricant BAB32 . . . . .	948
6.17.2.1 MixingRule - ID 1 . . . . .	948
6.17.3 Lubricant HAB15 . . . . .	951
6.17.3.1 MixingRule - ID 1 . . . . .	951
6.17.4 Lubricant HC16 . . . . .	953
6.17.4.1 MixingRule - ID 1 . . . . .	953
6.17.5 Lubricant PEB6 . . . . .	955
6.17.5.1 FloryHuggins - ID 1 . . . . .	955
6.17.6 Lubricant PEB8 . . . . .	957
6.17.6.1 FloryHuggins - ID 1 . . . . .	957
6.17.6.2 MixingRule - ID 1 . . . . .	958
6.17.7 Lubricant PEC9 . . . . .	960
6.17.7.1 FloryHuggins - ID 1 . . . . .	960
6.17.8 Pentaerythritol tetrapentanoate ester . . . . .	962
6.17.8.1 FloryHuggins - ID 1 . . . . .	962

6.18 R-152a . . . . .	963
6.18.1 Lubricant HC16 . . . . .	963
6.18.1.1 MixingRule - ID 1 . . . . .	963
6.18.2 Lubricant PEB6 . . . . .	965
6.18.2.1 FloryHuggins - ID 1 . . . . .	965
6.18.3 Lubricant PEB8 . . . . .	967
6.18.3.1 FloryHuggins - ID 1 . . . . .	967
6.18.3.2 MixingRule - ID 1 . . . . .	968
6.18.4 Lubricant PEC9 . . . . .	970
6.18.4.1 FloryHuggins - ID 1 . . . . .	970
6.18.5 Pentaerythritol tetrapentanoate ester . . . . .	972
6.18.5.1 FloryHuggins - ID 1 . . . . .	972
6.19 R-22 . . . . .	973
6.19.1 Lubricant AB32 . . . . .	973
6.19.1.1 MixingRule - ID 1 . . . . .	973
6.19.2 Lubricant POE . . . . .	975
6.19.2.1 Heil - ID 1 . . . . .	975
6.19.2.2 NrtlFixedDg - ID 1 . . . . .	977
6.19.2.3 TsubokaKatayama - ID 1 . . . . .	979
6.19.2.4 UniquacFixedDu - ID 1 . . . . .	981
6.19.2.5 WangChao - ID 1 . . . . .	983
6.19.2.6 WilsonFixedDl - ID 1 . . . . .	985
6.19.3 Lubricant POE Castrol SW 46 . . . . .	987
6.19.3.1 NrtlFixedDg - ID 1 . . . . .	987
6.20 R-23 . . . . .	988
6.20.1 1-phenyloctane . . . . .	988
6.20.1.1 MixingRule - ID 1 . . . . .	988
6.20.1.2 MixingRule - ID 2 . . . . .	991
6.21 R-32 . . . . .	994
6.21.1 R-125 . . . . .	994
6.21.1.1 Heil - ID 1 . . . . .	994
6.21.1.2 NrtlFixedDg - ID 1 . . . . .	996
6.21.1.3 TsubokaKatayama - ID 1 . . . . .	997
6.21.1.4 UniquacFixedDu - ID 1 . . . . .	999
6.21.1.5 WangChao - ID 1 . . . . .	1000
6.21.1.6 WilsonFixedDl - ID 1 . . . . .	1002
6.21.2 Lubricant BAB15 . . . . .	1004
6.21.2.1 MixingRule - ID 1 . . . . .	1004
6.21.3 Lubricant BAB32 . . . . .	1007
6.21.3.1 MixingRule - ID 1 . . . . .	1007
6.21.4 Lubricant HAB32 . . . . .	1010
6.21.4.1 MixingRule - ID 1 . . . . .	1010
6.21.5 Lubricant PEB6 . . . . .	1012
6.21.5.1 FloryHuggins - ID 1 . . . . .	1012
6.21.6 Lubricant PEB8 . . . . .	1014
6.21.6.1 FloryHuggins - ID 1 . . . . .	1014

6.21.6.2 MixingRule - ID 1 . . . . .	1016
6.21.7 Lubricant PEC9 . . . . .	1018
6.21.7.1 FloryHuggins - ID 1 . . . . .	1018
6.21.8 Lubricant POE . . . . .	1020
6.21.8.1 Heil - ID 1 . . . . .	1020
6.21.8.2 NrtlFixedDg - ID 1 . . . . .	1022
6.21.8.3 TsubokaKatayama - ID 1 . . . . .	1024
6.21.8.4 UniquacFixedDu - ID 1 . . . . .	1026
6.21.8.5 WangChao - ID 1 . . . . .	1028
6.21.8.6 WilsonFixedDl - ID 1 . . . . .	1031
6.21.9 Lubricant POE32 . . . . .	1033
6.21.9.1 MixingRule - ID 1 . . . . .	1033
6.21.10 Lubricant POE68 . . . . .	1035
6.21.10.1 MixingRule - ID 1 . . . . .	1035
6.21.11 Pentaerythritol tetrapentanoate ester . . . . .	1037
6.21.11.1 FloryHuggins - ID 1 . . . . .	1037
6.22 TFE . . . . .	1039
6.22.1 Nmp . . . . .	1039
6.22.1.1 Antoine - ID 1 . . . . .	1039
6.23 THF . . . . .	1040
6.23.1 Ionic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	1040
6.23.1.1 UniquacFixedDu - ID 1 . . . . .	1040
6.23.2 Ionic liquid [MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]- . . . . .	1042
6.23.2.1 UniquacFixedDu - ID 1 . . . . .	1042
6.24 Toluene . . . . .	1044
6.24.1 Ionic liquid [C <sub>2</sub> H <sub>5</sub> NH]+[C <sub>2</sub> H <sub>5</sub> OC <sub>2</sub> H <sub>4</sub> OSO <sub>3</sub> ]- . . . . .	1044
6.24.1.1 NrtlTemperatureDg - ID 1 . . . . .	1044
6.24.2 Ionic liquid [C <sub>2</sub> H <sub>5</sub> NH]+[C <sub>2</sub> H <sub>5</sub> OC <sub>2</sub> H <sub>4</sub> OSO <sub>3</sub> ]- . . . . .	1046
6.24.2.1 UniquacTemperatureDu - ID 1 . . . . .	1046
6.25 Water . . . . .	1048
6.25.1 Libr . . . . .	1048
6.25.1.1 Duehring - ID 1 . . . . .	1048
6.25.2 Libr/ch <sub>3</sub> cook ratio 2/1 . . . . .	1050
6.25.2.1 Antoine - ID 1 . . . . .	1050
6.25.3 Libr/h <sub>2</sub> n(ch <sub>2</sub> ) <sub>2</sub> oh ratio 3/5/1 . . . . .	1052
6.25.3.1 Antoine - ID 1 . . . . .	1052
6.25.4 Libr/ho(ch <sub>2</sub> ) <sub>3</sub> oh ratio 3/5/1 . . . . .	1053
6.25.4.1 Antoine - ID 1 . . . . .	1053
6.25.5 Libr/lii-oh(ch <sub>2</sub> ) <sub>3</sub> oh massRatio 174/57/15 . . . . .	1055
6.25.5.1 Antoine - ID 1 . . . . .	1055
6.25.6 Libr/lino <sub>3</sub> massRatio 348/69 . . . . .	1056
6.25.6.1 Antoine - ID 1 . . . . .	1056
6.25.7 Libr/lino <sub>3</sub> /lii/lcl ratio 5/1/1/2 . . . . .	1058
6.25.7.1 Antoine - ID 1 . . . . .	1058
6.25.8 Libr/ch <sub>3</sub> ch(oh)coona ratio 2/1 . . . . .	1060
6.25.8.1 Antoine - ID 1 . . . . .	1060

6.25.9 Naoh-koh-csoh . . . . .	1062
6.25.9.1 Duehring - ID 1 . . . . .	1062
6.25.10 Ionic liquid [BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	1064
6.25.10.1 NrtlFixedDg - ID 1 . . . . .	1064
6.25.10.2 UniquacFixedDu - ID 1 . . . . .	1066
6.25.10.3 UniquacFixedDu - ID 2 . . . . .	1068
6.25.10.4 WilsonFixedDl - ID 1 . . . . .	1070
6.25.11 Ionic liquid [DEMA][OMs] . . . . .	1072
6.25.11.1 NrtlFixedDg - ID 1 . . . . .	1072
6.25.12 Ionic liquid [EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]- . . . . .	1074
6.25.12.1 NrtlFixedDg - ID 1 . . . . .	1074
6.25.12.2 UniquacFixedDu - ID 1 . . . . .	1076
6.25.12.3 UniquacFixedDu - ID 2 . . . . .	1078
6.25.12.4 WilsonFixedDl - ID 1 . . . . .	1080
6.25.13 Ionic liquid [EMIM][OAc] . . . . .	1082
6.25.13.1 NrtlFixedDg - ID 1 . . . . .	1082
6.25.14 Ionic liquid [MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]- . . . . .	1084
6.25.14.1 UniquacFixedDu - ID 1 . . . . .	1084

# 1 Usage of SorpPropLib

SorpPropLib can currently be used from 6 programming environments: *C/C++*, *Python*, *Matlab*, *Modelica*, *LabVIEW*, and *Excel*. The usage of SorpPropLib in the programming environments is briefly explained below.

## 1.1 C/C++ and compiling DLL

The *C* code is in the folder "SorpPropLib\c\_code\". Examples of using the *C* code are in the folder "SorpPropLib\c\_code\src\", with file names beginning with "test\_".

Since the equilibrium models are implemented in *C*, either the *C* code (see examples) or a pre-compiled DLL (see example "test\_workingPair\_DLL.c") can be used directly. The pre-compiled DLLs are in the folder "SorpPropLib\c\_code\lib\". Currently, DLLs are pre-compiled for the following systems/architectures: Windows 32bit, Windows 64bit, and Linux Centos 64bit. If the pre-compiled DLLs are not sufficient, makefiles are available for (1) the *C* compiler from Microsoft Visual Studios and (2) the *C* compiler from MinGW or GNU to compile user-specific DLLs. The makefiles are to be used as follows:

### 1. Makefile for Microsoft Visual Studios:

- a) Replace the contents of the file "makefile" in the folder "SorpPropLib\c\_code\" with the contents of the file "makefile\_MSVS"
- b) Make sure that the variable "BUILD\_RELEASE" in the "makefile" file is set to "YES"
- c) Open the developer prompt for Microsoft Visual Studios
- d) Set the correct architecture (32bit or 64bit) by running the appropriate bat file (see the comment at the beginning of the makefile "makefile\_MSVS"; you may have to adapt the path to your installation folder of Microsoft Visual Studios)
- e) Navigate to the folder "SorpPropLib\c\_code\" (change drive by typing, e.g., "C:" or "D:"; change directory by typing "cd D:\YourPath")
- f) Compile the DLL by executing the command "NMAKE all /C" (if all files are to be rebuilt, use the command "NMAKE all /A /C")
- g) The DLL is saved in the folder "SorpPropLib\c\_code\lib\"

### 2. Makefile for MinGW / GNU:

- a) Replace the content of the file "makefile" in the folder "SorpPropLib\c\_code\" with the content of the file "makefile\_MINGW"
- b) Make sure that the variable "BUILD\_RELEASE" is set to "YES" and the variable "TYPE\_SYSTEM" is set according to the system
- c) Open the command prompt under Windows or the console under Linux
- d) Navigate to the folder "SorpPropLib\c\_code\" (change drive by typing, e.g., "C:" or "D:"; change directory by typing "cd D:\YourPath")
- e) Copy the path to the file "mingw32-make.exe", which corresponds to the required architecture (32bit or 64bit):
  - i. Example for 32bit: "C:\MinGW32bit\bin\mingw32-make.exe"
  - ii. Example for 64bit: "C:\MinGW64bit\bin\mingw32-make.exe"
- f) Compile the DLL by executing the command "'path to correct make.exe' all" (if all files are to be rebuilt, use the command "'path to correct make.exe' all -B")
- g) The DLL is saved in the folder "SorpPropLib\c\_code\lib\"

## 1.2 Python

The *Python* interface is in the folder "SorpPropLib\python\_wrapper\". The required (pre)compiled DLL is to be stored in "SorpPropLib\python\_wrapper\sorpproplib\data\CorrectSystemArchitecture". Examples for using the *Python* interface are in the folder "SorpPropLib\python\_wrapper\", with file names starting with "example\_":

- example\_generate\_json\_file: Generates the JSON database from CSV files in UTF8 format (see chapter 2)
- example\_generate\_content\_list: Generates Excel files in the folder "SorpPropLib" containing all implemented equilibrium approaches for absorption and adsorption work pairs as well as all implemented refrigerant functions
- example\_generate\_manual: Automatically generates LaTeX files in the folder "SorpPropLib\python\_wrapper\sorpproplib\doc\" to compile this manual
- example\_calling\_DLL: Demonstrates all wrapper functions available in *Python*
- example\_generate\_plots: Demonstrates all implemented functions for visualizing equilibrium data

**Important notes:** The *Python* interface was developed using the *Anaconda Python distribution* and using the additional package "CoolProp" to calculate refrigerant properties. Besides, the example files can be executed directly with *Python* because the paths to the DLL and the JSON database are stored as relative paths in the example files.

### 1.3 Matlab

The *Matlab* interface is in the folder "SorpPropLib\matlab\_wrapper\". The required (pre)compiled DLL and the JSON database are to be stored in "SorpPropLib\matlab\_wrapper\data\'CorrectSystemArchitecture''. Examples for using the *Matlab* interface are in the folder "SorpPropLib\matlab\_wrapper\", with file names starting with "minimal\_example\_":

- minimal\_example\_absorption\_activity: Demonstrates all available equilibrium functions of absorption work pairs based on activity coefficients (e.g., Wilson)
- minimal\_example\_absorption\_conventional: Demonstrates all available equilibrium functions of absorption work pairs based on conventional approaches (e.g., Antoine or Dühring)
- minimal\_example\_absorption\_mixing: Demonstrates all available equilibrium functions of absorption work pairs based on mixing rules of cubic equations of state
- minimal\_example\_adsorption\_surface: Demonstrates all available equilibrium functions of adsorption work pairs based on the surface approach (e.g., Toth)
- minimal\_example\_adsorption\_surface\_vapor: Demonstrates all available equilibrium functions of adsorption working pairs based on the surface approach and using the vapor pressure as an additional function argument (e.g., Freundlich)
- minimal\_example\_adsorption\_volumetric: Demonstrates all available equilibrium functions of adsorption working pairs based on the volumetric approach and using the vapor pressure and density of the adsorpt as additional function arguments (e.g., Dubinin-Astakhov)

**Important note:** The example files can be executed directly with *Matlab* since the paths to the DLL and the JSON database are stored as relative paths in the example files.

### 1.4 Modelica

The *Modelica* interface is in the folder "SorpPropLib\modelica\_wrapper\SorpPropLib\". The required (pre)compiled DLL and the JSON database are to be stored under "SorpPropLib\modelica\_wrapper\SorpPropLib\Resources\Library\'CorrectSystemArchitecture'' and "SorpPropLib\modelica\_wrapper\SorpPropLib\Resources\Data" respectively. Examples for using the *Modelica* interface can be found in the *Modelica* library in the packages "SorpPropLib.DirectFunctionCals.Tester" or "SorpPropLib.WorkingPair.Tester":

- Test\_WPair\_refrigerant: Demonstrates all available refrigerant functions
- Test\_WPair\_absorption\_activity: Demonstrates all available equilibrium functions of absorption working pairs based on activity coefficients (e.g., Wilson)

- Test\_WPair\_absorption\_conventional: Demonstrates all available equilibrium functions of absorption work pairs based on conventional approaches (e.g., Antoine or Dühring)
- Test\_WPair\_absorption\_mixing: Demonstrates all available equilibrium functions of absorption working pairs based on mixing rules of cubic equations of state
- Test\_WPair\_adsorption\_surface: Demonstrates all available equilibrium functions of adsorption work pairs starting based on the surface approach (e.g., Toth)
- Test\_WPair\_adsorption\_surface\_vapor: Demonstrates all available equilibrium functions of adsorption working pairs based on the surface approach and using the vapor pressure as an additional function argument (e.g., Freundlich)
- Test\_WPair\_adsorption\_volumetric: Demonstrates all available equilibrium functions of adsorption working pairs based on the volumetric approach and using the vapor pressure and density of the adsorpt as additional function arguments (e.g., Dubinin-Astakhov)

**Important note:** The example files cannot be executed directly in *Modelica* because the path to the JSON database is not specified as a relative path. Therefore, the variable "path\_db" must be adjusted to execute the sample files.

## 1.5 LabVIEW

The *LabVIEW* interface is in the folder "SorpPropLib\labview\_wrapper\". The required (pre)compiled DLL and the JSON database are to be saved under "SorpPropLib\labview\_wrapper\data\". Examples for using the *LabVIEW* interface can be found in the *LabVIEW* project under "SorpPropLib.Examples" or under "SorpPropLib.Sub-libraries.direct\_call.Examples" and "SorpPropLib.Sub-libraries.struct\_call.Examples":

- plot\_isosteric\_chart: Demonstrates how to plot equilibrium data in an isosteric chart.
- Test\_abs\_activity: Demonstrates all available equilibrium functions of absorption work pairs based on activity coefficients (e.g., Wilson)
- Test\_abs\_conventional: Demonstrates all available equilibrium functions of absorption work pairs based on conventional approaches (e.g., Antoine or Dühring)
- Test\_abs\_mixing: Demonstrates all available equilibrium functions of absorption working pairs based on mixing rules of cubic equations of state
- Test\_ads\_surface: Demonstrates all available equilibrium functions of adsorption work pairs starting based on the surface approach (e.g., Toth)

- Test\_ads\_surface\_vapor: Demonstrates all available equilibrium functions of adsorption working pairs based on the surface approach and using the vapor pressure as an additional function argument (e.g., Freundlich)
- Test\_ads\_volumetric: Demonstrates all available equilibrium functions of adsorption working pairs based on the volumetric approach and using the vapor pressure and density of the adsorpt as additional function arguments (e.g., Dubinin-Astakhov)

**Important note:** The example files cannot be executed directly in *LabVIEW* because the path to the JSON database is not specified as a relative path. Therefore, the variable “path\_db” must be adjusted to execute the example files.

## 1.6 Excel

The *Excel* interface is in the folder “SorpPropLib\excel\_wrapper\”. The required (pre)compiled DLL and the JSON database are to be stored under “SorpPropLib\excel\_wrapper\data\”. Examples for using the *Excel* interface can be found in the folder “SorpPropLib\excel\_wrapper\”, with file names starting with “minimal\_example\_”:

- minimal\_example\_dll\_functions: Demonstrates all wrapper functions that are available in *Excel*
- minimal\_example\_isosteric\_chart\_adsorption: Demonstrates how to visualize adsorption equilibrium data in an isosteric chart

**Important note:** The example files cannot be executed directly in *Excel* because the path to the DLL cannot be specified as a relative path but must be hardcoded. Therefore, the path to the DLL must be corrected before executing the *Excel* files:

1. Open the file "DirectFunctionCalls.bas" in the folder "SorpPropLib\excel\_wrapper\vba\", e.g., with Notepad
2. Search and replace all "lib 'Path to DLL'" with "lib 'Corrected path to DLL'"
3. Open an *Excel* example and allow macros
4. If developer tools are not yet activated in *Excel*, activate them under File -> Options -> Customize ribbon -> Check developer tools
5. Open the application "Visual Basic" under Developer tools
6. Delete module "DirectFunctionCalls" and add the module "DirectFunctionCalls" adapted before, which contains the correct path to DLL
7. Recalculate a formula in *Excel* so that all functions are updated

## 1.7 Known problems

The following problems are currently known:

1. *Excel* wrapper is currently just working with *Excel 2016* and not with *Excel 365*.
2. When running wrapper functions that rely on the approach ‘direct function calls’ (e.g., all wrapper functions in *Excel*), RAM is only freed when the programming environment is closed and not when the calculation is finished. However, the error does not occur in the testers of the *C* code. In addition, the error does not occur when wrapper functions based on the approach ‘working pair struct’ (i.e., mainly used in all examples) are executed.
3. Some implemented fits represent the experimental data very poorly:
  - a) This happens mainly for absorption work pairs and in particular for absorption work pairs based on activity coefficients.
  - b) The error is suspected to be in the parameterization of the working pairs or the extracted experimental data since all implemented equilibrium equations have been checked several times and for each equilibrium equations there are fits for work pairs that reproduce experimental data very well
  - c) **Important note:** Check the quality of the equilibrium approach before using it, e.g., with this manual (see chapters 4-6)

## 2 Extension of SorpPropLib

Three cases can be distinguished to extend SorpPropLib with new equilibrium data or equilibrium equations:

1. Equilibrium equation is already implemented in SorpPropLib (for implemented equations, see chapter 3).
2. Equilibrium equation is not yet implemented in SorpPropLib, but the type of the equilibrium model (e.g., adsorption→equilibrium approach based on the volumetric approach, or absorption→equilibrium approach based on activity coefficients) is implemented in SorpPropLib (for implemented types, see subsections of chapter 3).
3. Equilibrium equation and type of equilibrium equation are not yet implemented in SorpPropLib.

The necessary procedure for the three cases is explained below.

### 2.1 Case 1 – Equilibrium equation already implemented in SorpPropLib

If the equilibrium equation already exists in SorpPropLib, the following steps are necessary to add equilibrium data:

1. Add the coefficients of the equilibrium equation and all other necessary data to the correct *Excel* file in the folder "SorpPropLib\python\_wrapper\sorpproplib\data\JSON\equation\_coefficients\xlsx\". The *Excel* files are named after the equilibrium models. When adding data to the *Excel* file, following steps are required:
  - a) Add color code: Black - check of calculated and experimental data is OK; Red - No experimental data available to check; Orange - Fit does not match experimental data well
  - b) Save the *Excel* file as a *CSV* file in **UTF8** format under "SorpPropLib\python\_wrapper\sorpproplib\data\JSON\equation\_coefficients\".
2. If available, add experimental data points and other necessary data to the correct *Excel* files under "SorpPropLib\python\_wrapper\sorpproplib\data\JSON\experimental\_data\abs\xlsx\" or "SorpPropLib\python\_wrapper\sorpproplib\data\JSON\experimental\_data\abs\xlsx\". The *Excel* files are named after the refrigerants. Then, save the *Excel* file as a *CSV* file in **UTF8** format under "SorpPropLib\python\_wrapper\sorpproplib\data\JSON\experimental\_data\abs\"

or "SorpPropLib\python\_wrapper\sorpproplib\data\JSON\experimental\_data\abs\" respectively.

3. Execute the *Python* files "example\_generate\_json\_file", "example\_generate\_content\_list", and "example\_generate\_manual" to update the JSON database, content lists and pages of this manual.
4. Update this manual by compiling the *LaTeX* file "manual.tex", located in the folder "SorpPropLib\python\_wrapper\sorpproplib\doc", twice.

## 2.2 Case 2 - Type of equilibrium equation already implemented in SorpPropLib

If the type of equilibrium equation already exists in SorpPropLib, but not the required equilibrium equation, the following steps are necessary to add equilibrium data:

1. Implement the equilibrium model and all associated inverses / partial derivatives in C (compare equilibrium models of the same type for further information) by performing these steps:
  - a) Insert a new header file of the equilibrium equation, including documentation, in the folder "SorpPropLib\c\_code\incl\". The new header file shall be named by the new equilibrium equation. As a good starting point, copy and adjust a header file of the same type of equilibrium model.
  - b) Insert a new source file of the equilibrium equation, including documentation, in the folder "SorpPropLib\c\_code\src". The new source file shall be named by the new equilibrium approach. As a good starting point, copy and adjust a source file of the same type of equilibrium equation. Whenever possible, implement analytical and no numerical functional forms. If only numerical functional forms a possible, add sound method to determine roots, e.g., the Newton-Raphson method. The Newton-Raphson method has already been used several times within SorpPropLib and you will find, e.g., an implementation in the source file "adsorption\_dualSiteSips.c", function "adsorption\_dualSiteSips\_p\_wT".
  - c) Insert a new source file, including documentation, to test and verify all implementations of the new equilibrium equation in the folder "SorpPropLib\c\_code\src". As a good starting point, copy and adjust a source file of a tester of the same type of equilibrium equation.
2. Add the new equilibrium equation (i.e., all inverses, partial derivatives, ...) to the initialization functions of the refrigerant, adsorption, or absorption struct by performing the corresponding step:
  - a) Refrigerant: The equilibrium equations has to be added by adapting the function "newRefrigerant" in the file "SorpPropLib\c\_code\src\refrigerant.c". As a good starting point, copy and adjust a "else if"-section of a equilibrium model of the same type. Moreover, the header name created in step 1.a) has to be added at the top of the file "refrigerant.c".

- b) Adsorption: The equilibrium equations has to be added by adapting the function "newAdsorption" in the file "SorpPropLib\c\_code\src\adsorption.c". As a good starting point, copy and adjust a "else if"-section of a equilibrium model of the same type. Moreover, the header name created in step 1.a) has to be added at the top of the file "adsorption.c".
  - c) Absorption: The equilibrium equations has to be added by adapting the function "newAbsorption" in the file "SorpPropLib\c\_code\src\absorption.c". As a good starting point, copy and adjust a "else if"-section of a equilibrium model of the same type. Moreover, the header name created in step 1.a) has to be added at the top of the file "absorption.c".
3. Extend the test models of the refrigerant-, adsorption- **or** absorption-struct as well as the workingPair-structs with the new equilibrium equation by performing the corresponding steps:
- a) Refrigerant: The file "SorpPropLib\c\_code\src\test\_refrigerant.c" has to be extended by the new equilibrium equation. As a good starting point, copy and adjust a code block testing an equilibrium equation of the same type within this file. Besides, do not forget to free the allocated memory at the end of this file.
  - b) Adsorption: The file "SorpPropLib\c\_code\src\test\_adsorption.c" has to be extended by the new equilibrium equation. As a good starting point, copy and adjust a code block testing an equilibrium equation of the same type within this file. Besides, do not forget to free the allocated memory at the end of this file.
  - c) Absorption: The file "SorpPropLib\c\_code\src\test\_absorption.c" shall be extended by the new equilibrium equation. As a good starting point, copy and adjust a code block testing an equilibrium equation of the same type within this file. Besides, do not forget to free the allocated memory at the end of this file.
  - d) Working pair: The files "test\_workingPair.c", "test\_workingPair\_staticLibrary.c", and "test\_workingPair\_DLL.c" in the folder "SorpPropLib\c\_code\src\" have to be extended with the new equilibrium model in a similar way as described in the prvious steps a)-c).
4. Adapt the existing makefiles (see chapter 1.1) to execute the C-code by performing these steps:
- a) Add the path to the source file of the new equilibrium equation to the variable "SOURCE\_LIB".
  - b) Add the test file name of the new equilibrium equation to the recipes "test\_refrigerants", "test\_adsorption", **or** "test\_absorption".
  - c) Add a recipe for the test file. As a good starting point, copy and adjust a recipe of a test file for an equilibrium equation of the same type.

5. Compile the DLL of SorpPropLib as you added new functionalities (see chapter 1.1). Replace the old DLL with the new one in all wrappers of SorpPropLib (see sub-chapters of chapter 1).
6. Execute steps 1)-2) of case 1, where the *Excel* file of case 1 is created for the first time. As a good starting point, copy and adjust an *Excel* file of an equilibrium equation of the same type.
7. Add new LaTeX code of the new equilibrium equation to the Python file "SorpPropLib\python\_wrapper\sorpproplib\doc\equation.py" and to the LaTeX file "SorpPropLib\python\_wrapper\sorpproplib\doc\chapter\approaches.tex". As a good starting point, copy and adapt a code block creating the LaTeX strings of an equilibrium model of the same type.
8. Execute steps 3)-4) of case 1.

### 2.3 Case 3 - Type of equilibrium equation not implemented in SorpPropLib

If neither the equilibrium equation nor its type exist in SorpPropLib, the following elaborate steps are necessary to add new equilibrium data:

1. Execute step 1) of case 2.
2. Execute step 2) of case 2, with following special cases are to be taken into account:
  - a) If necessary, new function prototypes for the general functions of adsorption working pairs have to be added to the file "SorpPropLib\c\_code\src\structDefinitions.c". Then, the whole initialization functions of the refrigerant, adsorption, **or** absorption struct hast to be adapted as well.
  - b) Add new low-level functions to directly execute the new equilibrium functions in the file "SorpPropLib\c\_code\src\workingPair.c" **and** all wrappers (e.g., *Python*, *LabVIEW*, *Excel*, *Matlab*, *Modelica*, ...).
3. Execute steps 3) - 8) of case 2.

### 3 Approaches implemented into SorpPropLib

Currently, various generalized equilibrium approaches have been implemented for absorption and adsorption working pairs as well as for the vapor pressure and saturated liquid density of refrigerants. Details of the implemented functions are presented below.

#### 3.1 Refrigerants - Vapour Pressure

Currently, 5 approaches are implemented in SorpPropLib to calculate vapor pressure  $p_{\text{sat}}$  in Pa as a function of temperature  $T$  in K. In addition, the partial derivatives according to the temperature as well as the inverses of the approaches are implemented in SorpPropLib. Details of the approaches are presented below.

##### 3.1.1 VaporPressure\_EoS1

The vapor pressure  $p_{\text{sat}}$  is calculted by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$
$$\xi = 1 - \theta \quad , \text{ and}$$
$$\theta = T/T_{\text{crit}} \quad .$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$T_{\text{crit}}$	K	$p_{\text{ref}}$	Pa	$a_1$	-	$b_1$	-
$a_2$	-	$b_2$	-	$a_3$	-	$b_3$	-
$a_4$	-	$b_4$	-	$a_5$	-	$b_5$	-
$a_6$	-	$b_6$	-	$a_7$	-	$b_7$	-

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p_{\text{sat}})$	K	Uses Newton-Raphson method (start: 253.15 K)

Function	Unit	Implementation
$\frac{\partial p_{\text{sat}}(T)}{\partial T}$	Pa K <sup>-1</sup>	Analytical function

### 3.1.2 VaporPressure\_EoS2

The vapor pressure  $p_{\text{sat}}$  is calculted by:

$$p_{\text{sat}} = p_{\text{ref}} \exp \left( \frac{a_0}{\theta} + \sum_{i=1}^4 a_i \theta^{b_i} + a_5 \xi^{b_5} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T/T_{\text{crit}}}{} \quad .$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$T_{\text{crit}}$	K	$p_{\text{ref}}$	Pa	$a_0$	-	$a_1$	-
$b_1$	-	$a_2$	-	$b_2$	-	$a_3$	-
$b_3$	-	$a_4$	-	$b_4$	-	$a_5$	-
$b_5$	-						

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p_{\text{sat}})$	K	Uses Newton-Raphson method (start: 313.15 K)
$\frac{\partial p_{\text{sat}}(T)}{\partial T}$	Pa K <sup>-1</sup>	Analytical function

### 3.1.3 VaporPressure\_EoS3

The vapor pressure  $p_{\text{sat}}$  is calculted by:

$$p_{\text{sat}} = p_{\text{ref}} \exp \left( \frac{a_0}{T} + \sum_{i=1}^2 a_i T^{b_i} + a_3 \xi^{b_3} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T/T_{\text{crit}}}{} \quad .$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$T_{\text{crit}}$	K	$p_{\text{ref}}$	Pa	$a_0$	-	$a_1$	-
$b_1$	-	$a_2$	-	$b_2$	-	$a_3$	-
$b_3$	-						

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p_{\text{sat}})$	K	Uses Newton-Raphson method (start: 253.15 K)
$\frac{\partial p_{\text{sat}}(T)}{\partial T}$	Pa K <sup>-1</sup>	Analytical function

### 3.1.4 VaporPressure\_Antoine

The vapor pressure  $p_{\text{sat}}$  is calculted by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value
$a$	-	$b$	K	$c$	K

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p_{\text{sat}})$	K	Analytical function
$\frac{\partial p_{\text{sat}}(T)}{\partial T}$	Pa K <sup>-1</sup>	Analytical function

### 3.1.5 VaporPressure\_EoS\_Cubic

When using the Soave-Redlich-Kwong equation of state with custom equation for  $\alpha$  (EoS = -10), the vapor pressure  $p_{\text{sat}}$  is calculted by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \beta_0 + \sum_{i=1}^3 \beta_i \theta^i \quad , \text{ and} \\ \theta &= T_{\text{crit}}/T - T/T_{\text{crit}} \quad . \end{aligned}$$

When using the Soave-Redlich-Kwong equation of state (EoS = -5), the vapor pressure  $p_{\text{sat}}$  is calculted by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

When using the Peng-Robinson equation of state with custom equation for  $\alpha$  (EoS = 5), the vapor pressure  $p_{\text{sat}}$  is calculted by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \beta_0 + \sum_{i=1}^3 \beta_i \theta^i \quad , \text{ and} \\ \theta &= T_{\text{crit}}/T - T/T_{\text{crit}} \quad . \end{aligned}$$

When using the Peng-Robinson equation of state (EoS = 10), the vapor pressure  $p_{\text{sat}}$  is calculted by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

When using the Peng-Robinson-Stryjek-Vera equation of state (EoS = 20), the vapor pressure  $p_{\text{sat}}$  is calculted by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= \kappa_0 + \kappa_1 \left(1 + \sqrt{\frac{T}{T_{\text{crit}}}}\right) (0.7 - \frac{T}{T_{\text{crit}}}) \quad , \text{ and} \\ \kappa_0 &= 0.378893 + 1.4897153\omega - 0.17131848\omega^2 + 0.0196554\omega^3 \quad . \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
EoS	-	$T_{\text{crit}}$	K	$p_{\text{crit}}$	Pa	$\omega$	-
$\kappa_1$	-	$\beta_0$	-	$\beta_1$	-	$\beta_2$	-
$\beta_3$	-						

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p_{\text{sat}})$	K	Uses Newton-Raphson method (start value calculated)
$\frac{\partial p_{\text{sat}}(T)}{\partial T}$	Pa K <sup>-1</sup>	Uses two-point numerical differentiation

## 3.2 Refrigerants - Saturated liquid density

Currently, 1 approach is implemented in SorpPropLib to calculate saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  as a function of temperature  $T$  in K. In addition, the partial derivatives according to the temperature is implemented in SorpPropLib. Details of the approach are presented below.

### 3.2.1 SaturatedLiquidDensity\_EoS1

The saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  is calculated by:

$$\begin{aligned}\rho_{\text{sat}}^{\text{liq}} &= \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with} \\ \Omega &= \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and} \\ \xi &= 1 - \theta, \text{ and} \\ \theta &= T/T_{\text{crit}}.\end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
flag	-	$T_{\text{crit}}$	K	$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	$a_1$	-
$b_1$	-	$a_2$	-	$b_2$	-	$a_3$	-
$b_3$	-	$a_4$	-	$b_4$	-	$a_5$	-
$b_5$	-	$a_6$	-	$b_6$	-	$a_7$	-
$b_7$	-	$a_8$	-	$b_8$	-		-

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$\frac{\partial \rho_{\text{sat}}^{\text{liq}}(T)}{\partial T}$	$\text{kg m}^{-3} \text{K}^{-1}$	Analytical function

## 3.3 Absorption - Conventional

Currently, 2 approaches are implemented in SorpPropLib for conventional absorption working pairs to calculate equilibrium pressure  $p$  in Pa as a function of temperature  $T$  in K and concentration  $X$  in  $\text{kg kg}^{-1}$ . In addition, partial derivatives according to the temperature and concentration as well as the inverses of the approaches are implemented in SorpPropLib. Details of the approaches are presented below.

### 3.3.1 Antoine

The equilibrium pressure  $p$  is calculated by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$c$	K	$d$	Pa	$A_0$	-	$B_0$	K
$A_1$	-	$A_2$	-	$A_3$	-	$A_4$	-
$B_1$	K	$B_2$	K	$B_3$	K	$B_4$	K

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$X(p, T)$	$\text{kg kg}^{-1}$	Uses Newton-Raphson method (start: $0.5 \text{ kg kg}^{-1}$ )
$T(p, X)$	K	Uses Newton-Raphson method (start: $353.15 \text{ K}$ )
$\frac{\partial p(X, T)}{\partial T}$	$\text{Pa K}^{-1}$	Analytical function
$\frac{\partial p(X, T)}{\partial X}$	$\text{Pa kg K}^{-1} \text{kg}^{-1}$	Analytical function
$\frac{\partial X(p, T)}{\partial p}$	$\text{kg Pa}^{-1} \text{kg}^{-1}$	Uses two-point numerical differentiation
$\frac{\partial X(p, T)}{\partial T}$	$\text{kg K}^{-1} \text{kg}^{-1}$	Uses two-point numerical differentiation

### 3.3.2 Dühring

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned} p &= 1/r 10^{C + \frac{D}{T_{\text{ref}}} + \frac{E}{T_{\text{ref}}^2}} \quad , \text{ and} \\ T_{\text{ref}} &= q + \frac{(nT + m - B)}{A} \quad , \text{ and} \\ A &= \sum_{i=0}^3 a_0 X_{\text{cor}}^i \quad , \text{ and} \\ B &= \sum_{i=0}^3 b_0 X_{\text{cor}}^i \quad , \text{ and} \\ X_{\text{cor}} &= 100X \quad . \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$a_0$	-	$a_1$	-	$a_2$	-	$a_3$	-
$b_0$	-	$b_1$	-	$b_2$	-	$b_3$	-
$C$	-	$m$	-	$n$	-	$r$	$\text{Pa}^{-1}$
$D$	K	$E$	$\text{K}^2$	$q$	-		

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$X(p, T)$	$\text{kg kg}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{kg kg}^{-1}$ )
$T(p, X)$	K	Analytical function
$\frac{\partial p(X, T)}{\partial T}$	$\text{Pa K}^{-1}$	Analytical function
$\frac{\partial p(X, T)}{\partial X}$	$\text{Pa kg K}^{-1} \text{kg}^{-1}$	Analytical function
$\frac{\partial X(p, T)}{\partial p}$	$\text{kg Pa}^{-1} \text{kg}^{-1}$	Uses two-point numerical differentiation
$\frac{\partial X(p, T)}{\partial T}$	$\text{kg K}^{-1} \text{kg}^{-1}$	Uses two-point numerical differentiation

## 3.4 Absorption - Activity

Currently, 10 approaches are implemented in SorpPropLib for absorption working pairs based on activity coefficients to calculate equilibrium pressure  $p$  in Pa as a function of temperature  $T$  in K, molar composition in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , and molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ . Details of the approaches are presented below.

### 3.4.1 WilsonFixedDI

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit		Par.	Unit.		Par.	Value		Par.	Value
$\Lambda_{12}^*$ $v_1$	- $m^3 \text{ mol}^{-1}$		$\Lambda_{21}^*$ $v_2$	- $m^3 \text{ mol}^{-1}$		$\Delta\lambda_{12}$	$J \text{ mol}^{-1}$		$\Delta\lambda_{21}$	$J \text{ mol}^{-1}$

Implemented inverse functions and partial derivatives are:

Function		Unit		Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$		$\text{mol mol}^{-1}$		Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.2 WilsonTemperatureDI

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \frac{v_2/v_1}{\exp \left( -\frac{\Delta\lambda_{12}}{RT} \right)} && , \text{ and} \\
 \Lambda_{21} &= \frac{v_1/v_2}{\exp \left( -\frac{\Delta\lambda_{21}}{RT} \right)} && , \text{ and} \\
 \Delta\lambda_{12} &= R(\Delta\lambda_{12,c} + \Delta\lambda_{12,t}(T - c)) && , \text{ and} \\
 \Delta\lambda_{21} &= R(\Delta\lambda_{21,c} + \Delta\lambda_{21,t}(T - c)) && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit		Par.	Unit.		Par.	Value		Par.	Value
$\Delta\lambda_{12,c}$ $v_1$	$K$ $m^3 \text{ mol}^{-1}$		$\Delta\lambda_{21,c}$ $v_2$	$K$ $m^3 \text{ mol}^{-1}$		$\Delta\lambda_{12,t}$	-		$\Delta\lambda_{12,t}$	-

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.3 WangChao

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1 \Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta \lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta \lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + \frac{x_2}{x_1} \exp(-\Delta \lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + \frac{x_1}{x_2} \exp(-\Delta \lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta \lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta \lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= \frac{v_1}{v_2} && , \text{ and} \\
 \rho_{21} &= \frac{v_2}{v_1} && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$\Delta \lambda_{12}$	$\text{J mol}^{-1}$	$\Delta \lambda_{21}$	$\text{J mol}^{-1}$	$v_1$	$\text{m}^3 \text{ mol}^{-1}$	$v_2$	$\text{m}^3 \text{ mol}^{-1}$
$z$	-						

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.4 TsubokaKatayama

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) & , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) & , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) & , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) & , \text{ and} \\
 \rho_{12} &= v_1/v_2 & , \text{ and} \\
 \rho_{21} &= v_2/v_1 & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	$v_1$	$\text{m}^3 \text{mol}^{-1}$	$v_2$	$\text{m}^3 \text{mol}^{-1}$

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.5 Heil

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) & , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) & , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) & , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) & , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT & , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	$v_1$	$\text{m}^3 \text{mol}^{-1}$	$v_2$	$\text{m}^3 \text{mol}^{-1}$

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.6 FloryHuggins

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + \frac{w_1}{T} \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value
$r$	-	$w_0^*$	K	$w_1$	K

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.7 NrtlFixedDg

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) && , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) && , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) && , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT && , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$\alpha_{12}$	-	$\alpha_{21}$	-	$\Delta g_{12}$	$\text{J mol}^{-1}$	$\Delta g_{21}$	$\text{J mol}^{-1}$

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.8 NrtlTemperatureDg

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) && , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) && , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) && , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT && , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT && , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12}T && , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21}T && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$\alpha_{12}$	-	$\alpha_{21}$	-	$a_{12}$	$J \text{ mol}^{-1}$	$a_{21}$	$J \text{ mol}^{-1}$
$b_{12}$	$J \text{ mol}^{-1} K^{-1}$	$b_{21}$	$J \text{ mol}^{-1} K^{-1}$				

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.5 $\text{mol mol}^{-1}$ )

### 3.4.9 UniquacFixedDu

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$\Delta u_{12}$	$J \text{ mol}^{-1}$	$\Delta u_{21}$	$J \text{ mol}^{-1}$	$r_1$	-	$r_2$	-
$q_1$	-	$q_3$	-	$z$	-		

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.6 $\text{mol mol}^{-1}$ )

### 3.4.10 UniquacTemperatureDu

The equilibrium pressure  $p$  is calculated by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par	Value	Par	Value
$a_{12}$	$\text{J mol}^{-1}$	$a_{21}$	$\text{J mol}^{-1}$	$b_{12}$	$\text{J mol}^{-1} \text{K}^{-1}$	$b_{21}$	$\text{J mol}^{-1} \text{K}^{-1}$
$r_1$	-	$r_2$	-	$q_1$	-	$q_2$	-
$z$	-						

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$x_1(p, T, v_1, v_2, p_{\text{sat},1}(T))$	$\text{mol mol}^{-1}$	Uses Newton-Raphson method (start: 0.6 $\text{mol mol}^{-1}$ )

## 3.5 Absorption - Mixing

Currently, 3 approaches are implemented in SorpPropLib for absorption working pairs based on mixing rules to calculate equilibrium pressure  $p$  in Pa as a function

of temperature  $T$  in K and molar composition in the liquid phase  $x$  in mol mol<sup>-1</sup>. Details of the approaches are presented below.

### 3.5.1 1pvdw

The equilibrium pressure  $p$  is calculated iteratively by applying the one-parameter van der Waals mixing rule (MIXING = -5) to cubic equations of state (see Section 3.1.5):

$$\begin{aligned} a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\ b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\ a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\ z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad . \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
EoS	-	Mix	-	$T_{\text{crit},1}$	K	$p_{\text{crit},1}$	Pa
$\omega_1$	-	$\kappa_{1,1}$	-	$\beta_{0,1}$	-	$\beta_{1,1}$	-
$\beta_{2,1}$	-	$\beta_{3,1}$	-	$T_{\text{crit},2}$	K	$p_{\text{crit},2}$	Pa
$\omega_2$	-	$\kappa_{1,2}$	-	$\beta_{0,2}$	-	$\beta_{1,2}$	-
$\beta_{2,2}$	-	$\beta_{3,2}$	-	$k_{12}$	-	$m$	-
$l_{12}$	-	$l_{21}$	-	$t$	-		

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p, x_1)$	K	Uses Newton-Raphson method (start value calculated)
$x_1(p, T)$	K	Uses Newton-Raphson method (start: $x_1 = 0.25\text{mol mol}^{-1}$ , $y_1 = 0.99\text{mol mol}^{-1}$ )
$\frac{\partial p(T, x_1)}{\partial T}$	Pa K <sup>-1</sup>	Uses two-point numerical differentiation
$\frac{\partial p(T, x_1)}{\partial x_1}$	Pa mol mol <sup>-1</sup>	Uses two-point numerical differentiation

### 3.5.2 2pvdw

The equilibrium pressure  $p$  is calculated iteratively by applying the two-parameter van der Waals mixing rule (MIXING = 5) to cubic equations of state (see Section 3.1.5):

$$\begin{aligned} a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\ b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\ a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\ b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\ z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad . \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
EoS	-	Mix	-	$T_{\text{crit},1}$	K	$p_{\text{crit},1}$	Pa
$\omega_1$	-	$\kappa_{1,1}$	-	$\beta_{0,1}$	-	$\beta_{1,1}$	-
$\beta_{2,1}$	-	$\beta_{3,1}$	-	$T_{\text{crit},2}$	K	$p_{\text{crit},2}$	Pa
$\omega_2$	-	$\kappa_{1,2}$	-	$\beta_{0,2}$	-	$\beta_{1,2}$	-
$\beta_{2,2}$	-	$\beta_{3,2}$	-	$k_{12}$	-	$m$	-
$l_{12}$	-	$l_{21}$	-	$t$	-		

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p, x_1)$	K	Uses Newton-Raphson method (start value calculated)
$x_1(p, T)$	K	Uses Newton-Raphson method (start: $x_1 = 0.25 \text{ mol mol}^{-1}$ , $y_1 = 0.99 \text{ mol mol}^{-1}$ )
$\frac{\partial p(T, x_1)}{\partial T}$	$\text{Pa K}^{-1}$	Uses two-point numerical differentiation
$\frac{\partial p(T, x_1)}{\partial x_1}$	$\text{Pa mol mol}^{-1}$	Uses two-point numerical differentiation

### 3.5.3 vdwb

The equilibrium pressure  $p$  is calculated iteratively by applying the modified van der Waals and Berthelot mixing rule (MIXING = 10) to cubic equations of state (see

Section 3.1.5):

$$\begin{aligned}
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} .
 \end{aligned}$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
EoS	-	Mix	-	$T_{\text{crit},1}$	K	$p_{\text{crit},1}$	Pa
$\omega_1$	-	$\kappa_{1,1}$	-	$\beta_{0,1}$	-	$\beta_{1,1}$	-
$\beta_{2,1}$	-	$\beta_{3,1}$	-	$T_{\text{crit},2}$	K	$p_{\text{crit},2}$	Pa
$\omega_2$	-	$\kappa_{1,2}$	-	$\beta_{0,2}$	-	$\beta_{1,2}$	-
$\beta_{2,2}$	-	$\beta_{3,2}$	-	$k_{12}$	-	$m$	-
$l_{12}$	-	$l_{21}$	-	$t$	-		

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$T(p, x_1)$	K	Uses Newton-Raphson method (start value calculated)
$x_1(p, T)$	K	Uses Newton-Raphson method (start: $x_1 = 0.25 \text{ mol mol}^{-1}$ , $y_1 = 0.99 \text{ mol mol}^{-1}$ )
$\frac{\partial p(T, x_1)}{\partial T}$	$\text{Pa K}^{-1}$	Uses two-point numerical differentiation
$\frac{\partial p(T, x_1)}{\partial x_1}$	$\text{Pa mol mol}^{-1}$	Uses two-point numerical differentiation

## 3.6 Adsorption - Surface

Currently, 3 approaches are implemented in SorpPropLib for conventional adsorption working pairs based on the surface approach to calculate equilibrium pressure  $p$  in Pa as a function of temperature  $T$  in K and loading  $w$  in  $\text{kg kg}^{-1}$ . In addition, partial derivatives according to the temperature and concentration as well as the inverses of the approaches are implemented in SorpPropLib. Details of the approaches are presented below.

### 3.6.1 DualSiteSips

The loading  $w$  is calculated by:

$$w = \sum_{i=A}^B w_i \frac{(b_i p)^{1/\eta_i}}{1 + (b_i p)^{1/\eta_i}} \quad , \text{ and}$$

$$b_i = b_{i,0} \exp\left(\frac{Q_i}{RT}\left(1 - \frac{T}{T_0}\right)\right) \quad .$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$b_{A,0}$	$\text{Pa}^{-1}$	$Q_A$	$\text{J mol}^{-1}$	$\eta_A$	-	$w_A$	$\text{kg kg}^{-1}$
$T_0$	K	$b_{B,0}$	$\text{Pa}^{-1}$	$Q_B$	$\text{J mol}^{-1}$	$\eta_B$	-
$w_B$	$\text{kg kg}^{-1}$						

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$p(w, T)$	K	Uses Newton-Raphson method (start: 10000 Pa)
$T(p, w)$	K	Uses Newton-Raphson method (start: 353.15 K)
$\frac{\partial w(p,T)}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p,T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function
$\frac{\partial w(p,T)}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Uses two-point numerical differentiation
$\frac{\partial w(p,T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Uses two-point numerical differentiation

### 3.6.2 Langmuir

The loading  $w$  is calculated by:

$$w = \frac{w_{\text{sat}} K p}{1 + K p} \quad , \text{ and}$$

$$K = K_0 \exp\left(\frac{\Delta H}{RT}\right) \quad .$$

Required coefficients of the equation are:

Par.	Unit		Par.	Unit.		Par.	Value
$\Delta H$	$\text{J mol}^{-1}$		$K_0$	$\text{Pa}^{-1}$		$w_{\text{sat}}$	$\text{kg kg}^{-1}$

---

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$p(w, T)$	K	Analytical function
$T(p, w)$	K	Analytical function
$\frac{\partial w(p, T)}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function
$\frac{\partial w(p, T)}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function

---

### 3.6.3 Toth

The loading  $w$  is calculated by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

Required coefficients of the equation are:

Par.	Unit		Par.	Unit.		Par.	Value		Par.	Value
$b_0$	$\text{Pa}^{-1}$		$m$	-		$Q^*$	K		$w_{\text{sat}}$	$\text{kg kg}^{-1}$
$c$	K		$n_0$	-		$r^*$	-			

---

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$p(w, T)$	K	Analytical function

---

Function	Unit	Implementation
$T(p, w)$	K	Uses Newton-Raphson method (start: 353.15 K)
$\frac{\partial w(p,T)}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p,T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function
$\frac{\partial w(p,T)}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p,T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function

## 3.7 Adsorption - Surface & Vapor Pressure

Currently, 1 approach are implemented in SorpPropLib for conventional adsorption working pairs based on the surface approach to calculate equilibrium pressure  $p$  in Pa as a function of temperature  $T$  in K, loading  $w$  in  $\text{kg kg}^{-1}$ , and vapor pressure  $p_{\text{sat}}$  in Pa. In addition, partial derivatives according to the temperature and concentration as well as the inverses of the approaches are implemented in SorpPropLib. Details of the approaches are presented below.

### 3.7.1 Freundlich

The loading  $w$  is calculated by:

$$w = A (p/p_{\text{sat}})^B \quad , \text{ and}$$

$$A = A_0 + A_1 T + A_2 T^2 + A_3 T^3 \quad , \text{ and}$$

$$B = B_0 + B_1 T + B_2 T^2 + B_3 T^3 \quad .$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$A_0$	$\text{kg kg}^{-1}$	$A_2$	$\text{kg kg}^{-1} \text{K}^{-2}$	$B_0$	-	$B_2$	$\text{K}^{-3}$
$A_1$	$\text{kg kg}^{-1} \text{K}^{-1}$	$A_3$	$\text{kg kg}^{-1} \text{K}^{-3}$	$B_1$	$\text{K}^{-1}$	$B_3$	$\text{K}^{-2}$

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$p(w, T, p_{\text{sat}}(T))$	K	Analytical function
$T(p, w, p_{\text{sat}}(T))$	K	Uses Newton-Raphson method (start: 353.15 K)

Function	Unit	Implementation
$\frac{\partial w(p, T, p_{\text{sat}}(T))}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \frac{\partial p_{\text{sat}}(T)}{\partial T})}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T))}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \frac{\partial p_{\text{sat}}(T)}{\partial T})}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function

## 3.8 Adsorption - Volumetric

Currently, 3 approaches are implemented in SorpPropLib for conventional adsorption working pairs based on the volumetric approach to calculate equilibrium pressure  $p$  in Pa as a function of temperature  $T$  in K, loading  $w$  in  $\text{kg kg}^{-1}$ , vapor pressure  $p_{\text{sat}}$  in Pa, and saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$ . In addition, partial derivatives according to the temperature and concentration as well as the inverses of the approaches are implemented in SorpPropLib. Details of the approaches are presented below.

### 3.8.1 DubininAstakhov

The loading  $w$  is calculated by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
flag	-	$E$	$\text{J mol}^{-1}$	$n$	-	$W_0$	$\text{kg kg}^{-1}$

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$p(w, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))$	K	Analytical function
$T(p, w, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))$	K	Uses Newton-Raphson method (start: 273.15 K)

Function	Unit	Implementation
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T), \partial p_{\text{sat}}(T)/\partial T, \partial \rho_{\text{sat}}^{\text{liq}}(T)/\partial T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T), \partial p_{\text{sat}}(T)/\partial T, \partial \rho_{\text{sat}}^{\text{liq}}(T)/\partial T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function
$W(A, rho_{\text{sat}}^{\text{liq}}(T))$	$\text{m}^3 \text{kg}^{-1}$	Analytical function
$A(W, rho_{\text{sat}}^{\text{liq}}(T))$	$\text{J mol}^{-1}$	Analytical function
$\frac{\partial W(A, rho_{\text{sat}}^{\text{liq}}(T))}{\partial A}$	$\text{mol m}^3 \text{kg}^{-1} \text{J}^{-1}$	Analytical function
$\frac{\partial A(W, rho_{\text{sat}}^{\text{liq}}(T))}{\partial W}$	$\text{kg J mol}^{-1} \text{m}^{-3}$	Analytical function

### 3.8.2 DubininArctan1

The loading  $w$  is calculated by:

$$w = W \rho_{\text{sat}}^{\text{liq}} , \text{ and}$$

$$W = \frac{a}{\Pi} \left( \arctan \left( \frac{A - b}{c} \right) + \frac{\Pi}{2} \right) + d , \text{ and}$$

$$A = RT \ln \left( \frac{p_{\text{sat}}}{p} \right) .$$

Required coefficients of the equation are:

Par.	Unit	Par.	Unit.	Par.	Value	Par.	Value
$a$	$\text{m}^3 \text{kg}^{-1}$	$b$	$\text{J mol}^{-1}$	$c$	$\text{J mol}^{-1}$	$d$	$\text{m}^3 \text{kg}^{-1}$

Implemented inverse functions and partial derivatives are:

Function	Unit	Implementation
$p(w, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))$	K	Analytical function
$T(p, w, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))$	K	Uses Newton-Raphson method (start: 313.15 K)
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T), \partial p_{\text{sat}}(T)/\partial T, \partial \rho_{\text{sat}}^{\text{liq}}(T)/\partial T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T))}{\partial p}$	$\text{kg kg}^{-1} \text{Pa}^{-1}$	Analytical function
$\frac{\partial w(p, T, p_{\text{sat}}(T), \rho_{\text{sat}}^{\text{liq}}(T), \partial p_{\text{sat}}(T)/\partial T, \partial \rho_{\text{sat}}^{\text{liq}}(T)/\partial T)}{\partial T}$	$\text{kg kg}^{-1} \text{K}^{-1}$	Analytical function

Function	Unit	Implementation
$W(A, rho_{\text{sat}}^{\text{liq}}(T))$	$\text{m}^3 \text{ kg}^{-1}$	Analytical function
$A(W, rho_{\text{sat}}^{\text{liq}}(T))$	$\text{J mol}^{-1}$	Analytical function
$\frac{\partial W(A, rho_{\text{sat}}^{\text{liq}}(T))}{\partial A}$	$\text{mol m}^3 \text{ kg}^{-1} \text{ J}^{-1}$	Analytical function
$\frac{\partial A(W, rho_{\text{sat}}^{\text{liq}}(T))}{\partial W}$	$\text{kg J mol}^{-1} \text{ m}^{-3}$	Analytical function

## 4 Refrigerants

### 4.1 1-Butene

#### 4.1.1 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	1-Butene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

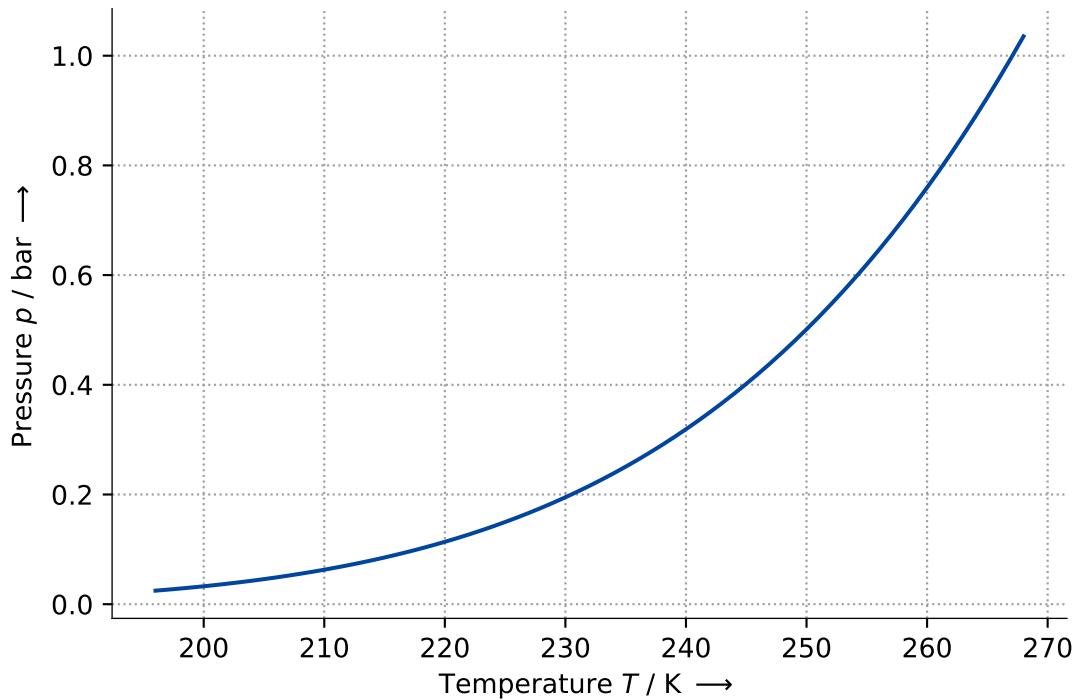
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.246960000e+00	$c$	K	-8.256000000e+00
$b$	K	1.099207000e+03			

#### Validity:

Equation is approximately valid for  $195.7 \text{K} \leq T \leq 269.4 \text{K}$ .

#### Visualization:



#### 4.1.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	1-Butene
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

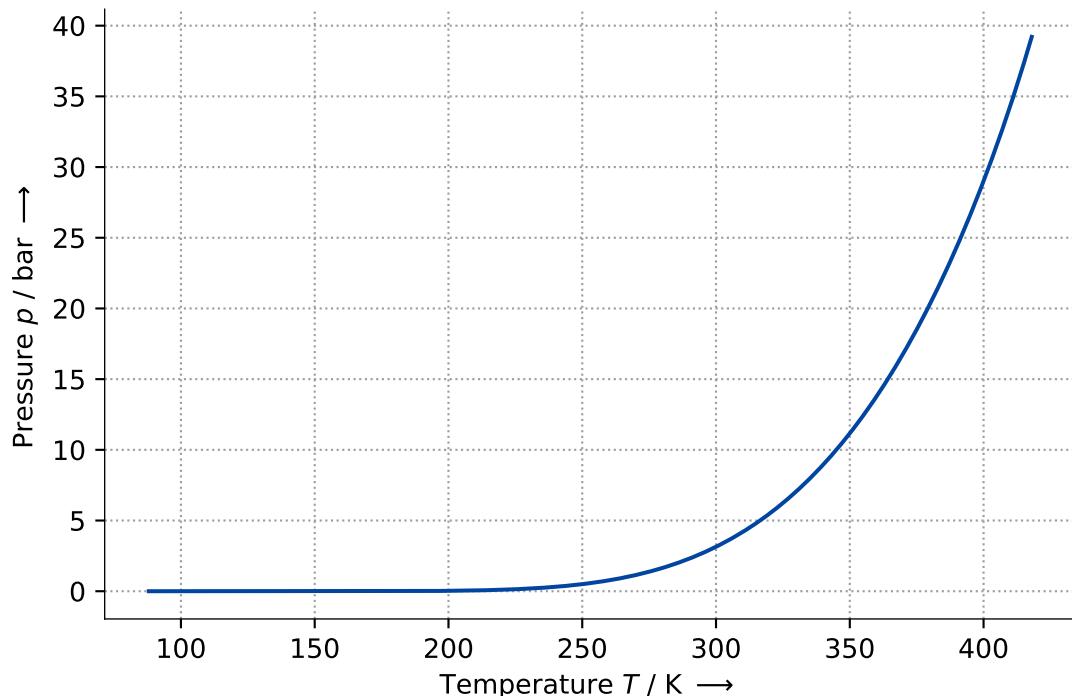
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	4.192900000e+02		$a_4$	-	-2.648450000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	4.006000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.078970000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.878190000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.022560000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $87.8\text{K} \leq T \leq 419.29\text{K}$ .

**Visualization:**

### 4.1.3 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	1-Butene
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

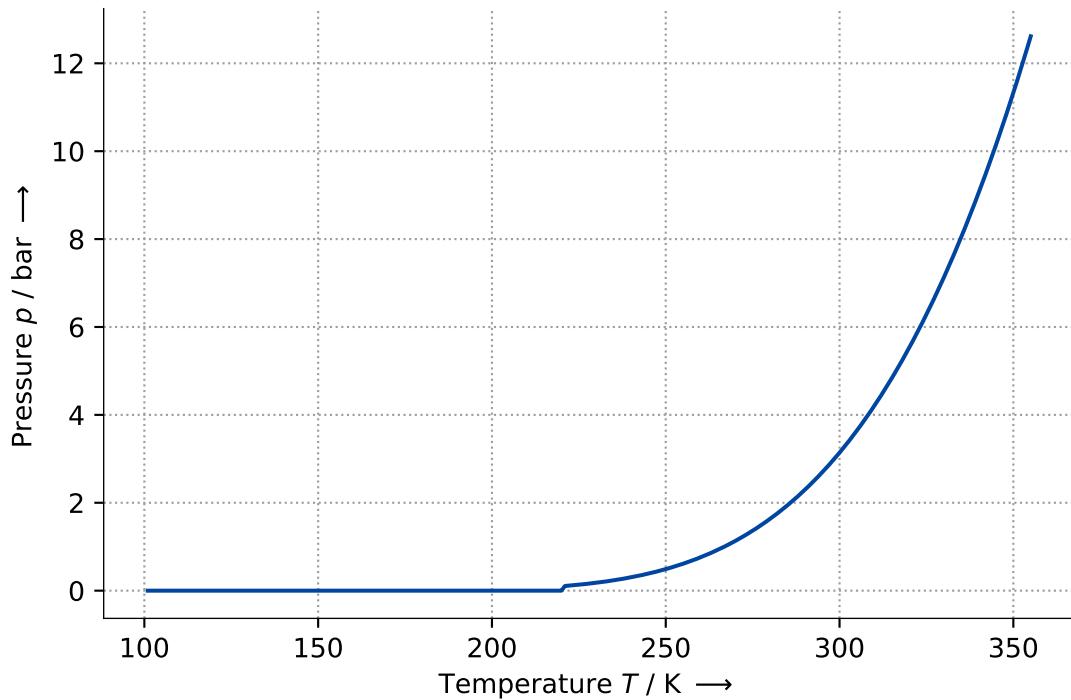
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.192900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.005100000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.920000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $100.97\text{K} \leq T \leq 356.3965\text{K}$ .

#### Visualization:



#### 4.1.4 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	1-Butene
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

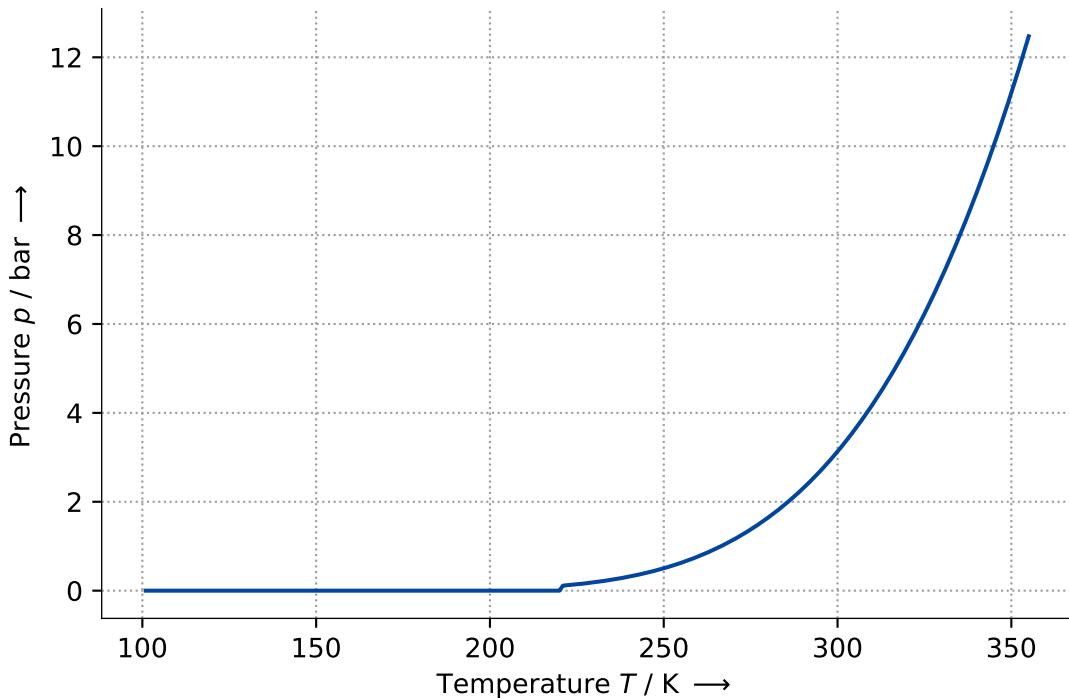
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.192900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.005100000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.920000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $100.97\text{K} \leq T \leq 356.3965\text{K}$ .

### Visualization:



## 4.2 2-Propanol

### 4.2.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	2-Propanol
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Scalabrin, G.; Stringari, P. (2009): A Fundamental Equation of State for 2-propanol (C <sub>3</sub> H <sub>8</sub> O) in the Extended Equation of State Format. In: Journal of Physical and Chemical Reference Data 38 (2), S. 127–170. DOI: 10.1063/1.3112608.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in kg m<sup>-3</sup> is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

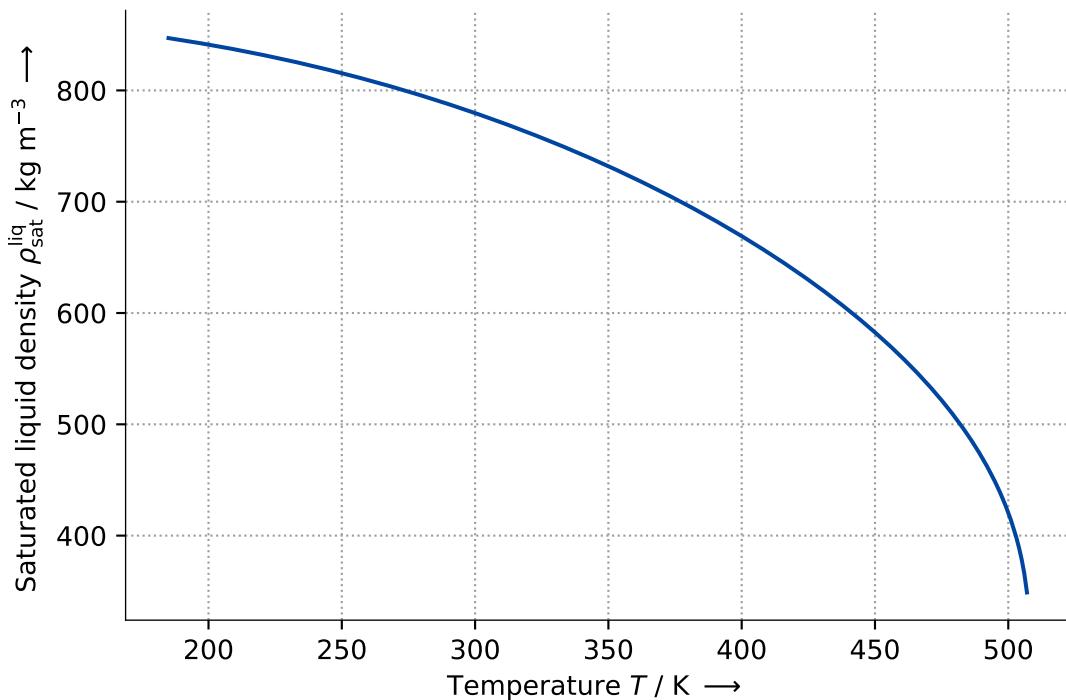
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$b_4$	-	2.030000000e+00
$T_{\text{crit}}$	K	5.083000000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.710000000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	-3.576000000e-02	$a_6$	-	0.000000000e+00
$b_1$	-	3.000000000e-03	$b_6$	-	0.000000000e+00
$a_2$	-	-2.955000000e-03	$a_7$	-	0.000000000e+00
$b_2$	-	2.600000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.445860000e+00	$a_8$	-	0.000000000e+00
$b_3$	-	2.700000000e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-2.547310000e-01			

### Validity:

Equation is approximately valid for  $184.9\text{K} \leq T \leq 508.3\text{K}$ .

### Visualization:



### 4.2.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	2-Propanol
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

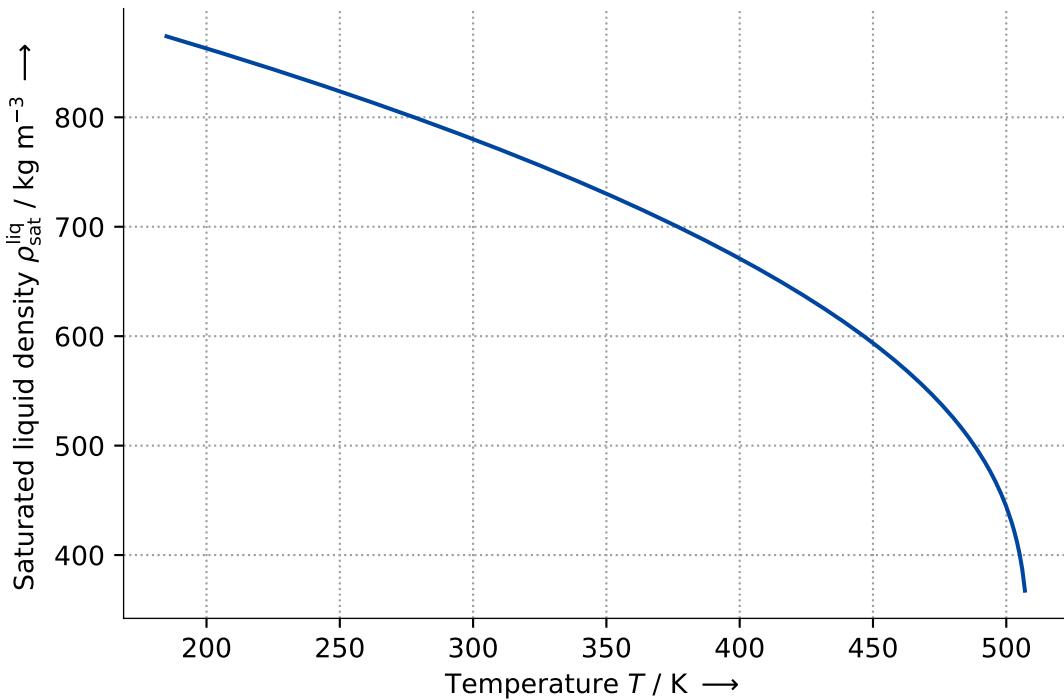
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.082500000e+02	$a_5$	-	-1.396072528e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.730000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	3.171855311e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-2.725620146e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	3.574744322e+00			

#### Validity:

Equation is approximately valid for  $184.9\text{K} \leq T \leq 508.25\text{K}$ .

#### Visualization:



#### 4.2.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	2-Propanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

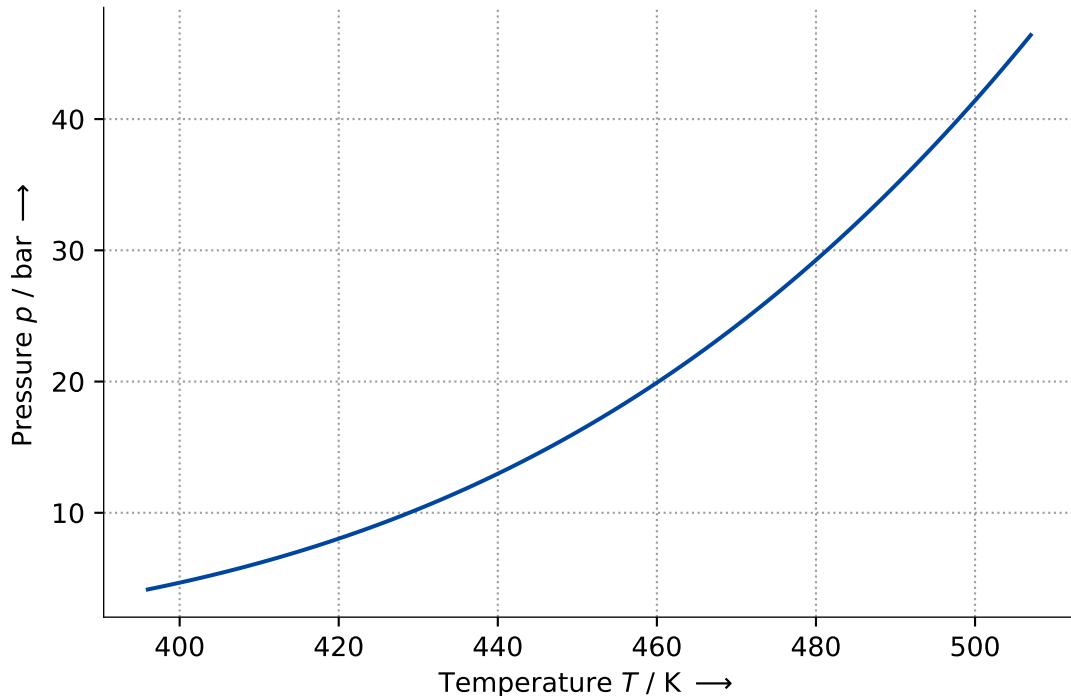
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.577950000e+00	$c$	K	-8.747400000e+01
$b$	K	1.221423000e+03			

##### Validity:

Equation is approximately valid for  $395.1\text{K} \leq T \leq 508.24\text{K}$ .

**Visualization:**



#### 4.2.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	2-Propanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

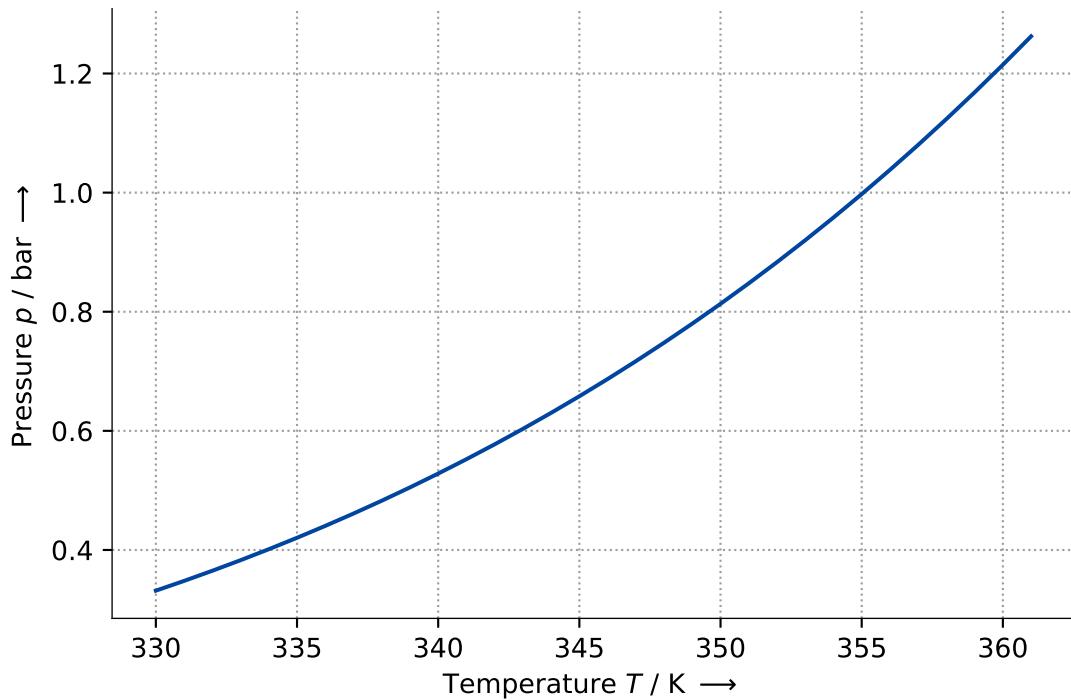
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.861000000e+00	$c$	K	-7.581400000e+01
$b$	K	1.357427000e+03			

#### Validity:

Equation is approximately valid for  $329.92\text{K} \leq T \leq 362.41\text{K}$ .

#### Visualization:



#### 4.2.5 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	2-Propanol
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Scalabrin, G.; Stringari, P. (2009): A Fundamental Equation of State for 2-propanol (C <sub>3</sub> H <sub>8</sub> O) in the Extended Equation of State Format. In: Journal of Physical and Chemical Reference Data 38 (2), S. 127–170. DOI: 10.1063/1.3112608.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

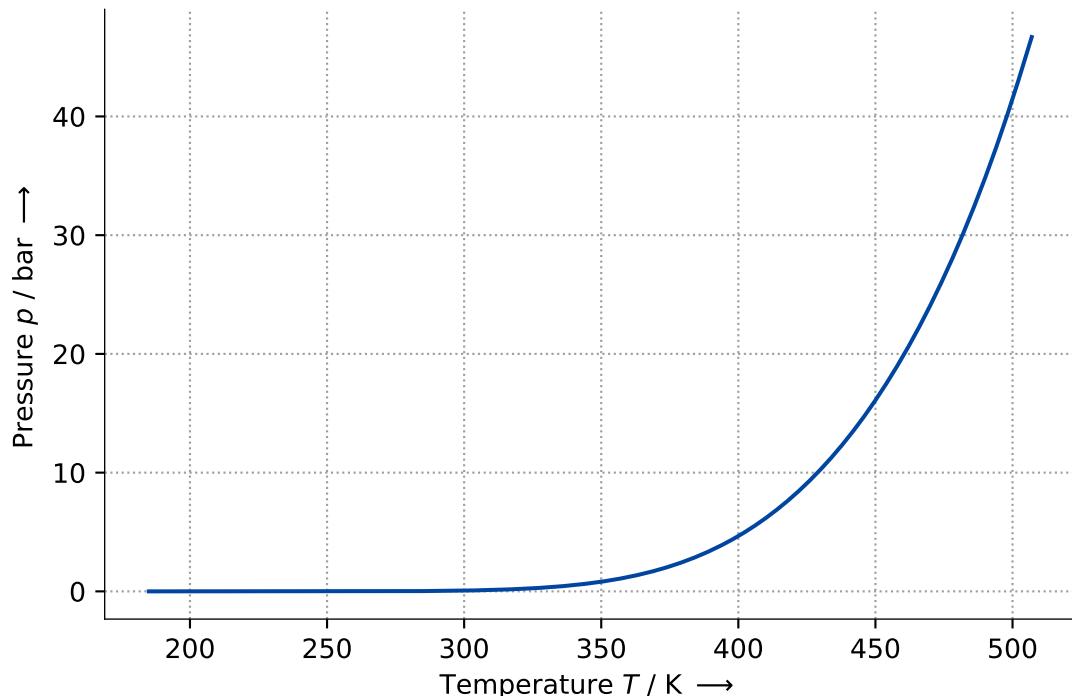
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.083000000e+02	$a_4$	-	2.043260000e+01
$p_{\text{crit}}$	Pa	4.764000000e+06	$b_4$	-	4.510000000e+00
$a_1$	-	-1.899130000e+01	$a_5$	-	-1.538320000e+01
$b_1$	-	1.100000000e+00	$b_5$	-	7.340000000e+00
$a_2$	-	1.289860000e+01	$a_6$	-	0.000000000e+00
$b_2$	-	1.270000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.674990000e+01	$a_7$	-	0.000000000e+00
$b_3$	-	2.890000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $184.9\text{K} \leq T \leq 508.3\text{K}$ .

**Visualization:**



#### 4.2.6 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	2-Propanol
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

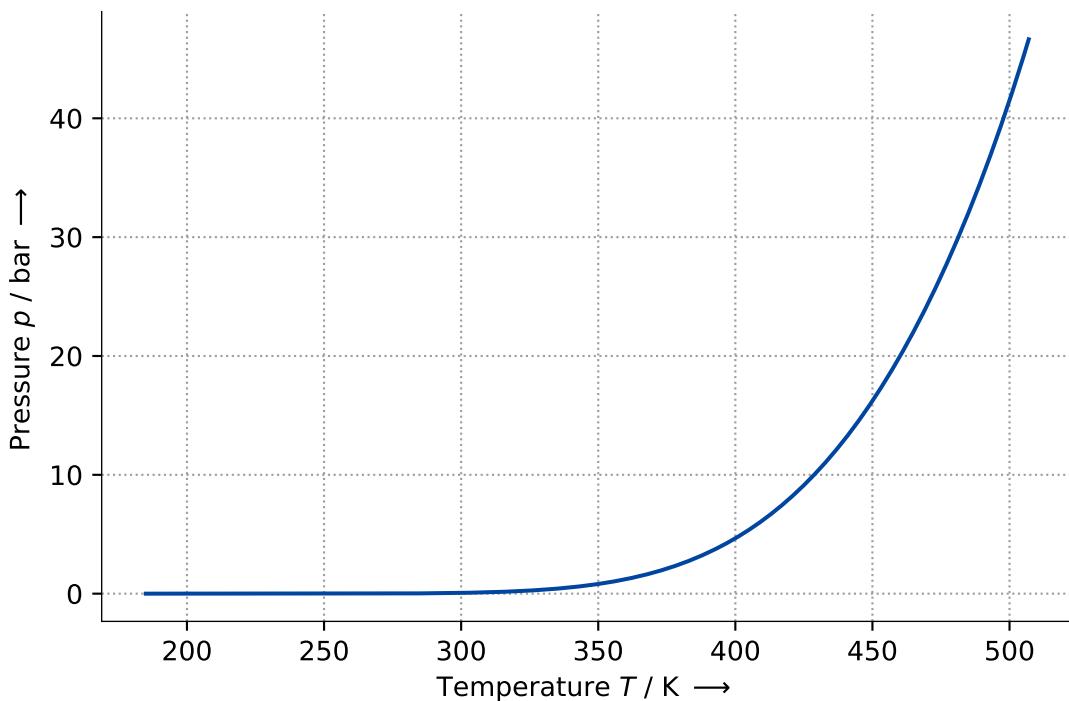
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.082500000e+02	$a_4$	-	6.924800000e-01
$p_{\text{crit}}$	Pa	4.762000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-8.447370000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.174020000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-6.978760000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $184.9\text{K} \leq T \leq 508.25\text{K}$ .

#### Visualization:



#### 4.2.7 Vapor Pressure - EoS Cubic - ID 1

<b>Name:</b>	2-Propanol
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

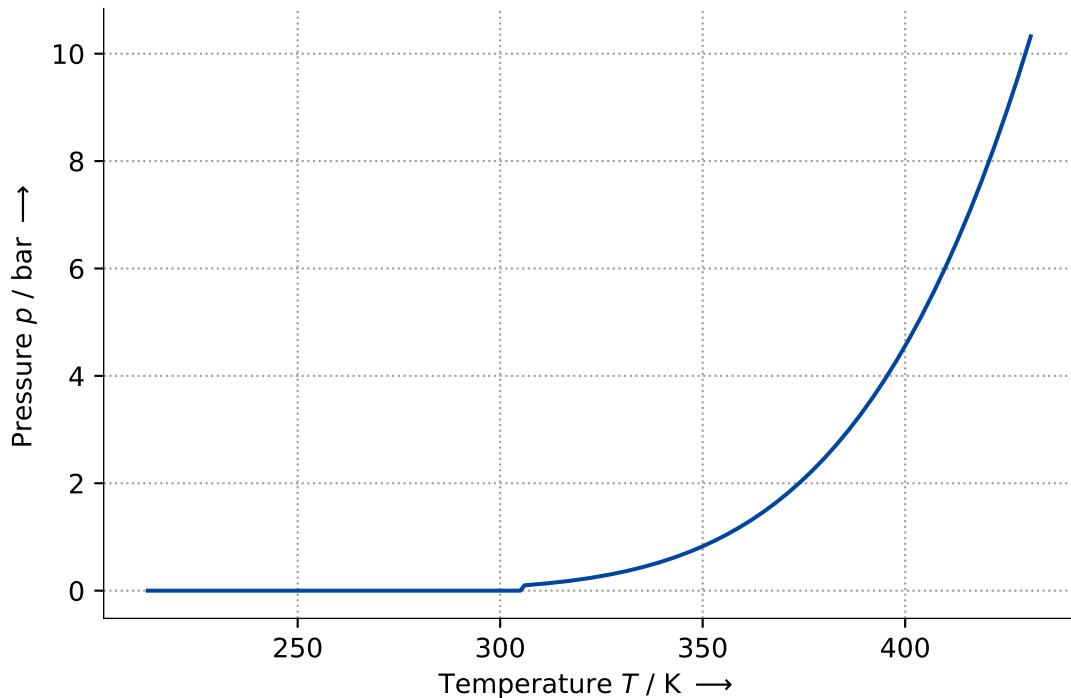
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.090000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.900000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	6.668700000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $212.635\text{K} \leq T \leq 432.65\text{K}$ .

### Visualization:



#### 4.2.8 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	2-Propanol
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

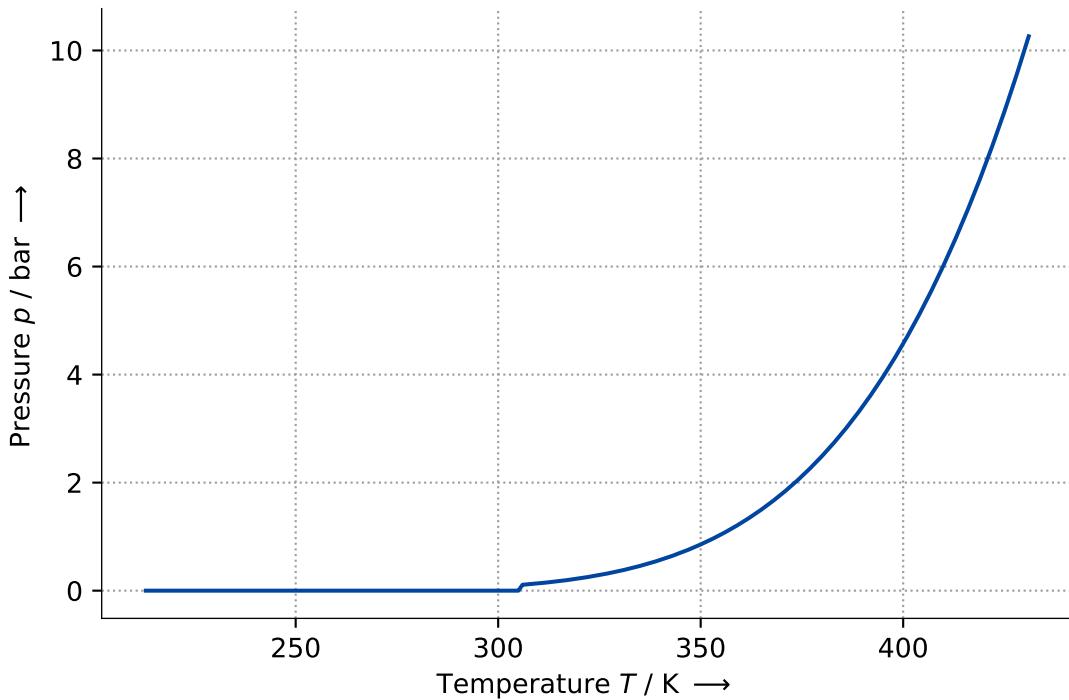
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.090000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.900000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	6.668700000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $212.635\text{K} \leq T \leq 432.65\text{K}$ .

### Visualization:



## 4.3 Acetone

### 4.3.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Acetone
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

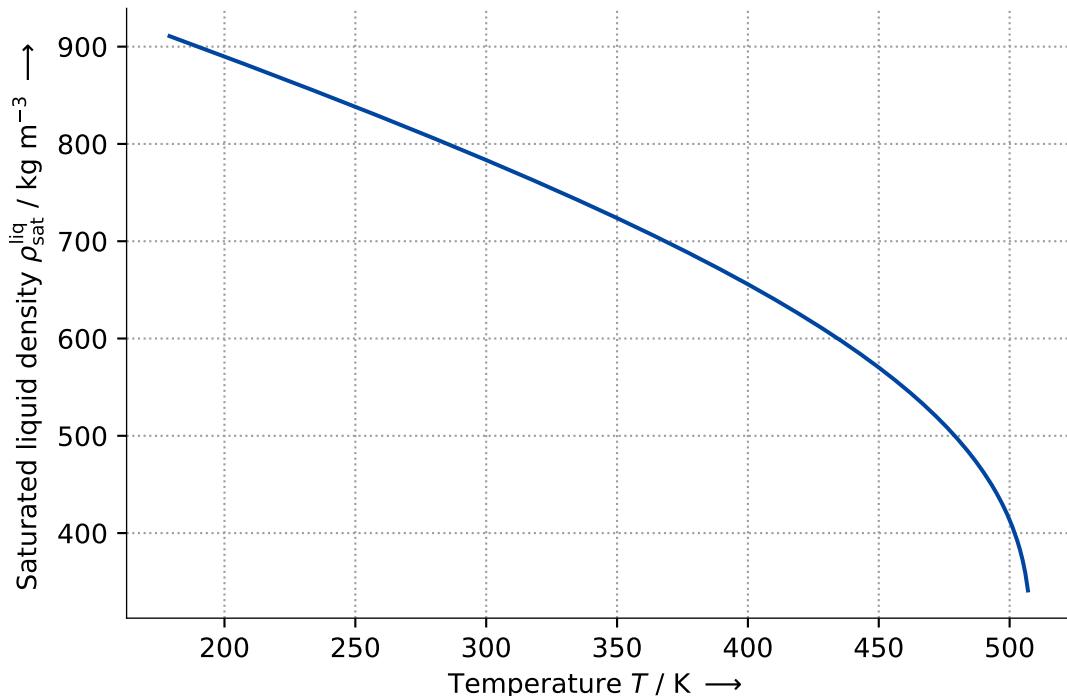
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.081000000e+02	$a_5$	-	9.269839416e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.740000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.997744525e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	7.618321168e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-7.436492701e-01			

### Validity:

Equation is approximately valid for  $178.5\text{K} \leq T \leq 508.1\text{K}$ .

### Visualization:



### 4.3.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Acetone
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

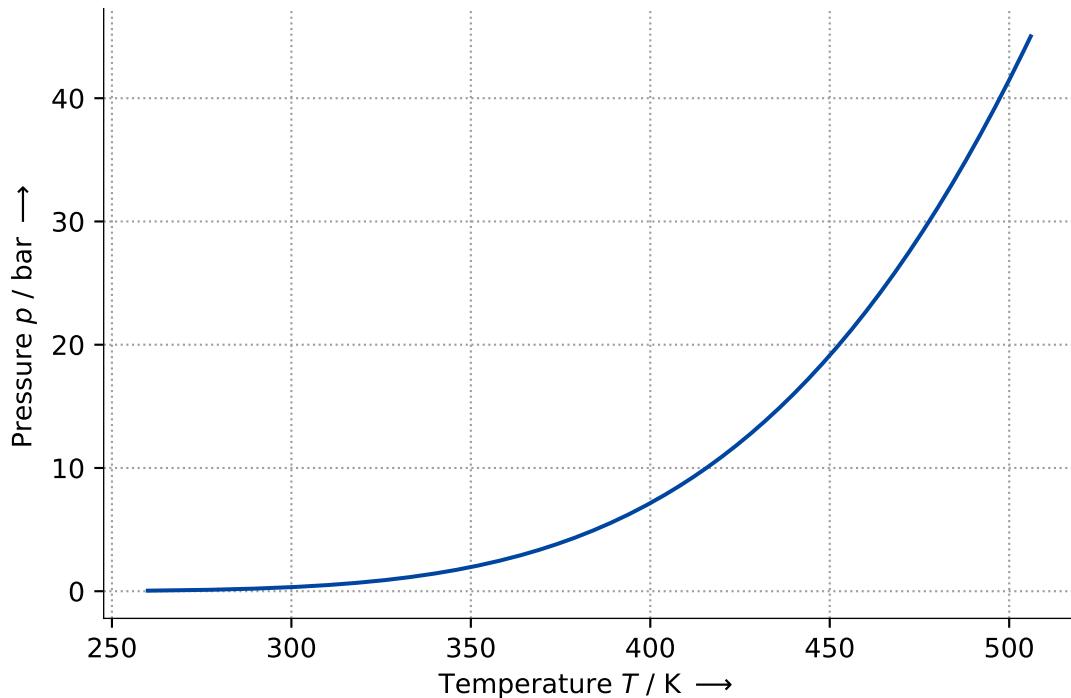
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.424480000e+00	$c$	K	-3.244500000e+01
$b$	K	1.312253000e+03			

#### Validity:

Equation is approximately valid for  $259.16\text{K} \leq T \leq 507.6\text{K}$ .

#### Visualization:



#### 4.3.3 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Acetone
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

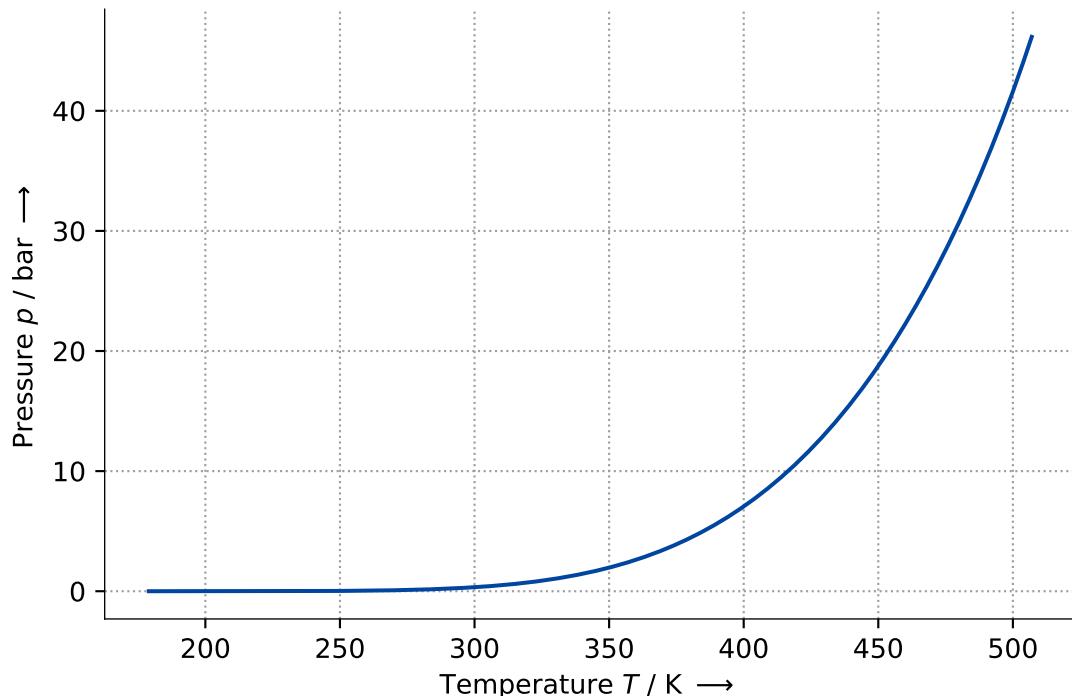
Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	5.081000000e+02		$a_4$	-	-2.901620000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	4.692000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.670330000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.964690000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.443800000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $178.5\text{K} \leq T \leq 508.1\text{K}$ .

**Visualization:**



#### 4.3.4 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Acetone
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

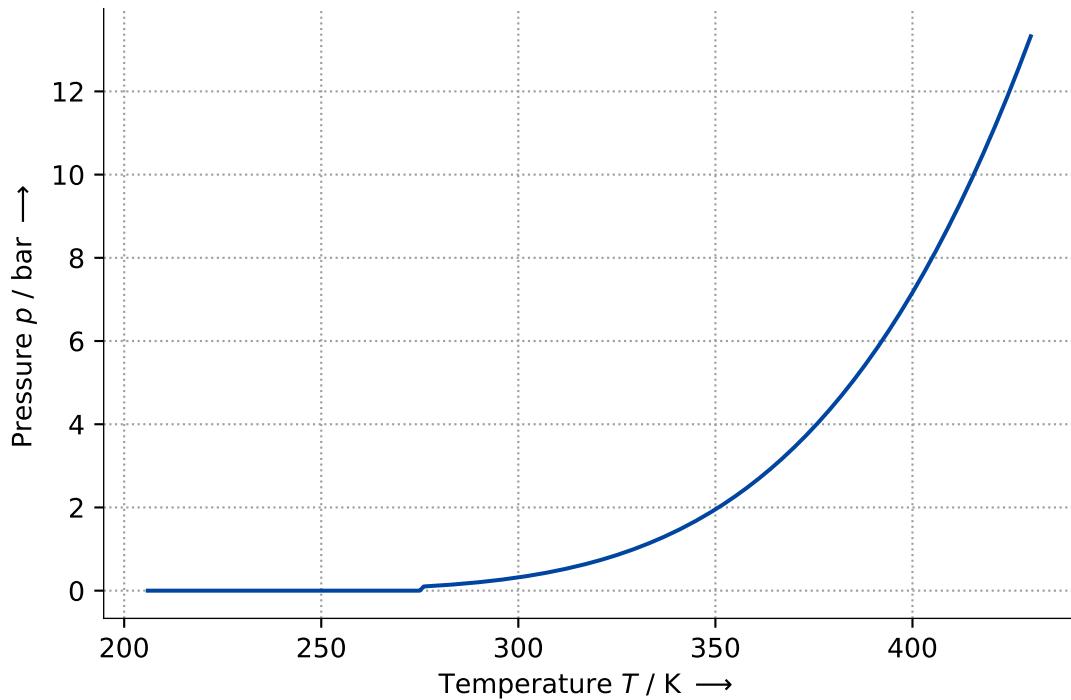
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.081000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.692400000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.071000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $205.275\text{K} \leq T \leq 431.885\text{K}$ .

#### Visualization:



#### 4.3.5 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	Acetone
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

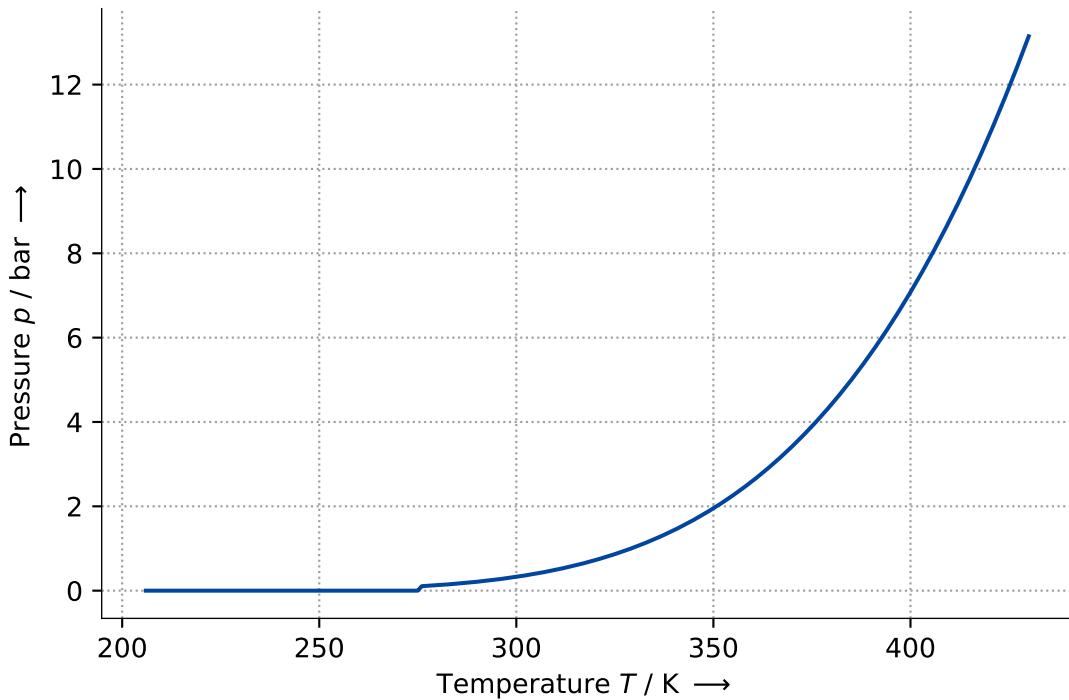
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.081000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.692400000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.071000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $205.275\text{K} \leq T \leq 431.885\text{K}$ .

### Visualization:



## 4.4 Ammonia

### 4.4.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Ammonia
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

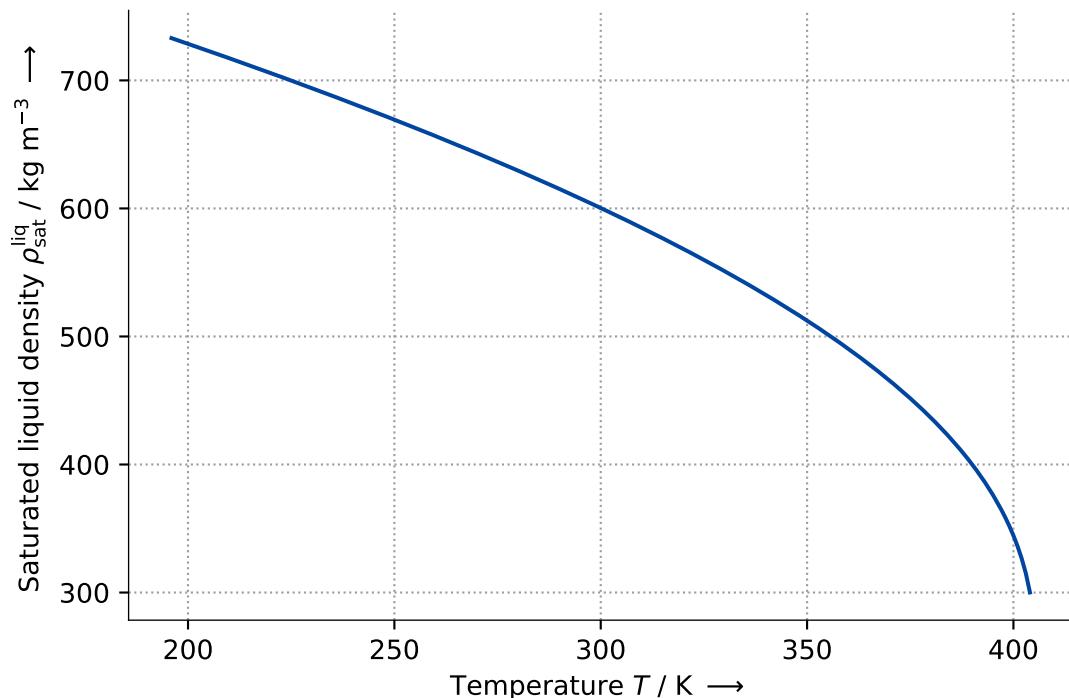
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	4.055000000e+02	$a_5$	-	-2.842031111e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.250000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.363223556e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-1.400120000e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	1.142634667e+00			

**Validity:**

Equation is approximately valid for  $195.49\text{K} \leq T \leq 405.5\text{K}$ .

**Visualization:**

#### 4.4.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Ammonia
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

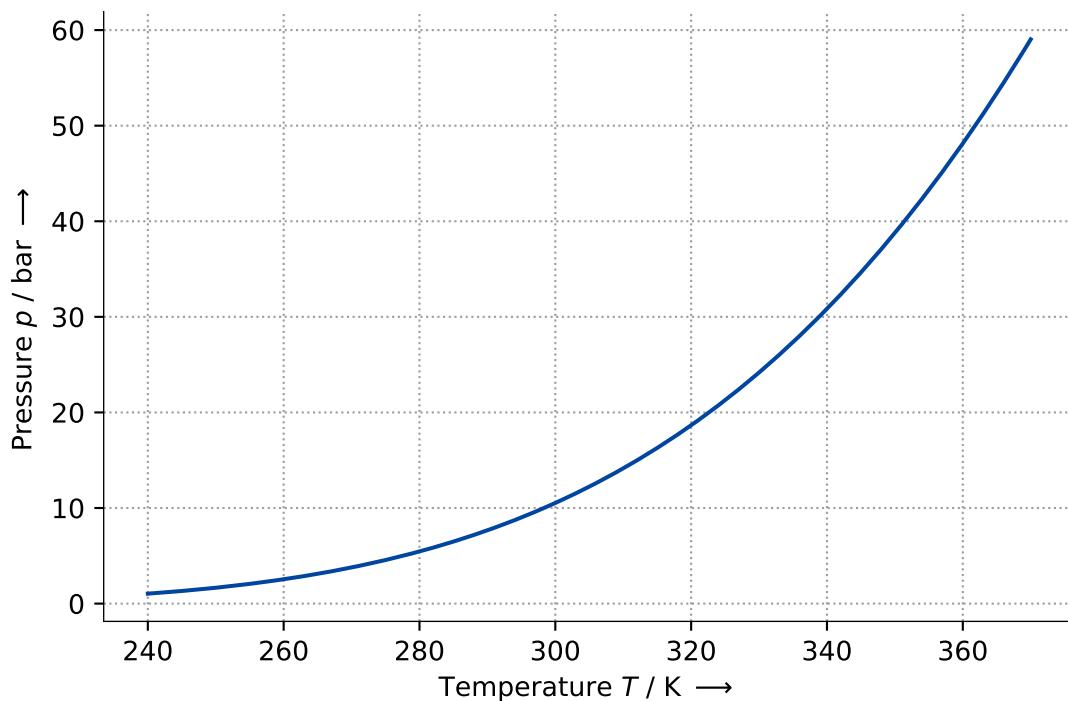
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.868860000e+00	$c$	K	-1.040900000e+01
$b$	K	1.113928000e+03			

#### Validity:

Equation is approximately valid for  $239.6 \text{K} \leq T \leq 371.5 \text{K}$ .

#### Visualization:



#### 4.4.3 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Ammonia
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

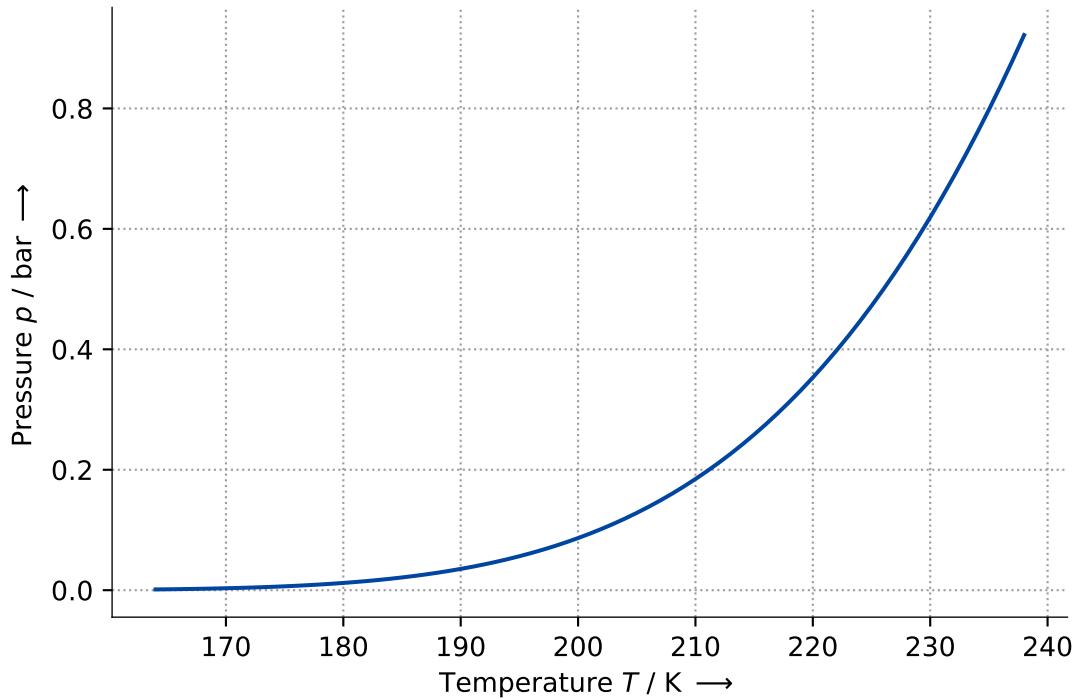
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.187570000e+00	$c$	K	-8.078000000e+01
$b$	K	5.067130000e+02			

#### Validity:

Equation is approximately valid for  $164.0\text{K} \leq T \leq 239.6\text{K}$ .

**Visualization:**



#### 4.4.4 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Ammonia
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

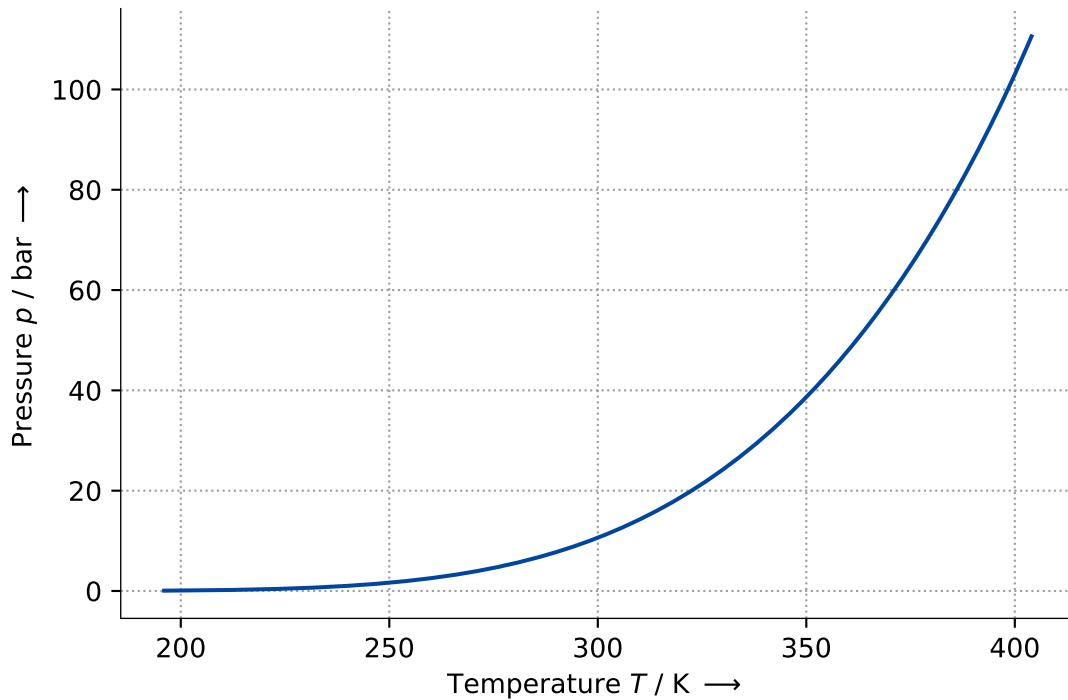
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	4.055000000e+02	$a_4$	-	-1.968840000e+00
$p_{\text{crit}}$	Pa	1.135900000e+07	$b_4$	-	5.000000000e+00
$a_1$	-	-7.302740000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.646380000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.016060000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $195.49\text{K} \leq T \leq 405.5\text{K}$ .

#### Visualization:



#### 4.4.5 Vapor Pressure - EoS Cubic - ID 1

<b>Name:</b>	Ammonia
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{T/T_{\text{crit}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

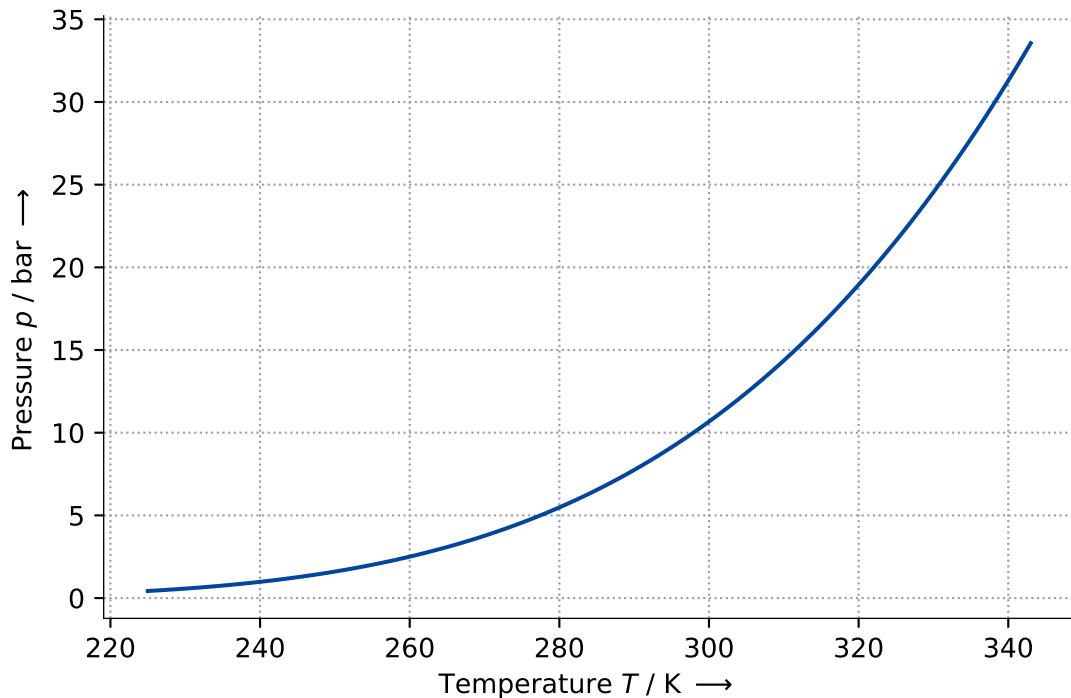
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.055600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	1.136300000e+07	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.560000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $224.8135\text{K} \leq T \leq 344.726\text{K}$ .

### Visualization:



#### 4.4.6 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	Ammonia
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

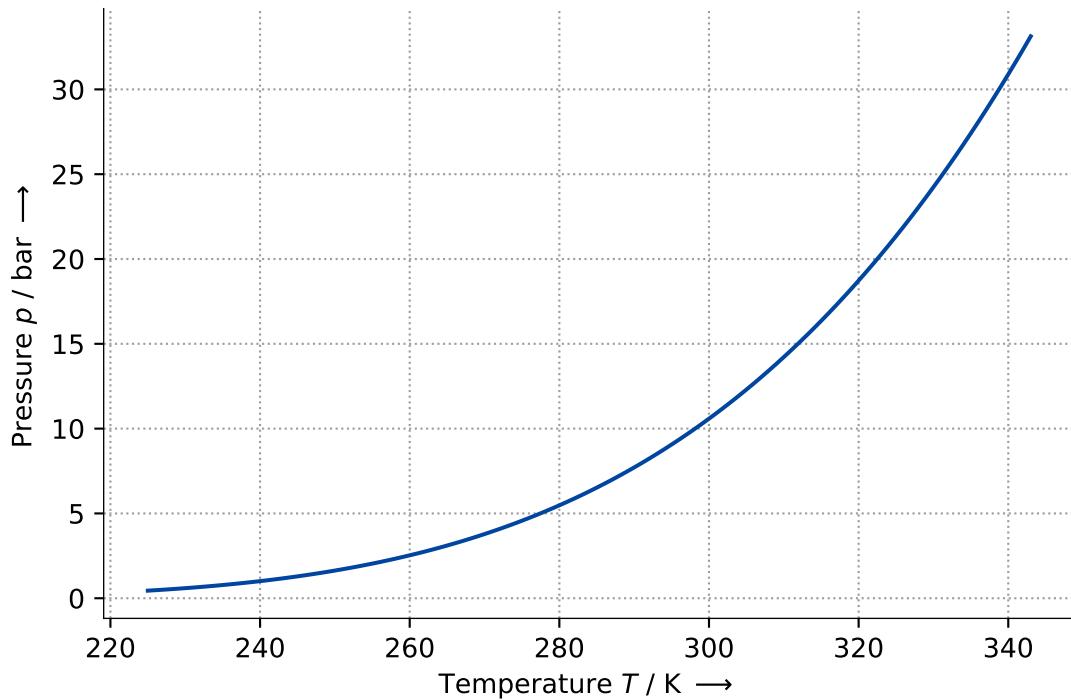
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.055600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	1.136300000e+07	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.560000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $224.8135\text{K} \leq T \leq 344.726\text{K}$ .

### Visualization:



## 4.5 Argon

### 4.5.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Argon
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Tegeler, Ch.; Span, Roland; Wagner, Wolfgang (1999): A New Equation of State for Argon Covering the Fluid Region for Temperatures From the Melting Line to 700 K at Pressures up to 1000 MPa. In: Journal of Physical and Chemical Reference Data 28 (3), S. 779–850. DOI: 10.1063/1.556037.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$b_4$	-	4.000000000e+00
$T_{\text{crit}}$	K	1.506870000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	kg m <sup>-3</sup>	5.356000000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.500426200e+00	$a_6$	-	0.000000000e+00
$b_1$	-	3.340000000e-01	$b_6$	-	0.000000000e+00
$a_2$	-	-3.138129000e-01	$a_7$	-	0.000000000e+00
$b_2$	-	6.666666667e-01	$b_7$	-	0.000000000e+00
$a_3$	-	8.646162200e-02	$a_8$	-	0.000000000e+00
$b_3$	-	2.333333333e+00	$b_8$	-	0.000000000e+00
$a_4$	-	-4.147752500e-02			

### Validity:

Equation is approximately valid for  $83.806\text{K} \leq T \leq 150.687\text{K}$ .

### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

### 4.5.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Argon
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	1.506900000e+02	$a_5$	-	2.236354478e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.360000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.670586754e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	5.555796642e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-2.977630597e-02			

#### Validity:

Equation is approximately valid for  $83.806\text{K} \leq T \leq 150.69\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

### 4.5.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Argon
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.295550000e+00	$c$	K	-2.223300000e+01
$b$	K	2.152400000e+02			

#### Validity:

Equation is approximately valid for  $83.78\text{K} \leq T \leq 150.72\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

#### 4.5.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Argon
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.469030000e+00	$c$	K	2.215600000e+01
$b$	K	4.810120000e+02			

#### Validity:

Equation is approximately valid for  $114.4 \text{K} \leq T \leq 150.31 \text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

#### 4.5.5 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Argon
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.971710000e+00	$c$	K	4.981900000e+01
$b$	K	6.589820000e+02			

#### Validity:

Equation is approximately valid for  $129.33\text{K} \leq T \leq 147.4\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

#### 4.5.6 Vapor Pressure - Antoine - ID 4

<b>Name:</b>	Argon
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	4
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.734790000e+00	$c$	K	-6.083000000e+00
$b$	K	3.026830000e+02			

#### Validity:

Equation is approximately valid for  $90.94 \text{K} \leq T \leq 101.48 \text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

#### 4.5.7 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Argon
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	1.506900000e+02	$a_4$	-	-1.523120000e+00
$p_{\text{crit}}$	Pa	4.863000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-5.928010000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.219820000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-5.396700000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $83.806\text{K} \leq T \leq 150.69\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

#### 4.5.8 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Argon
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.506900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.863000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	-2.190000000e-03	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $96.3769\text{K} \leq T \leq 128.0865\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

#### 4.5.9 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Argon
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.506900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.863000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	-2.190000000e-03	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $96.3769\text{K} \leq T \leq 128.0865\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Argon'. Thus, data cannot be visualized!

## 4.6 Benzene

### 4.6.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Benzene
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Goodwin, Robert D. (1988): Benzene Thermophysical Properties from 279 to 900 K at Pressures to 1000 Bar. In: Journal of Physical and Chemical Reference Data 17 (4), S. 1541–1636. DOI: 10.1063/1.555813.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

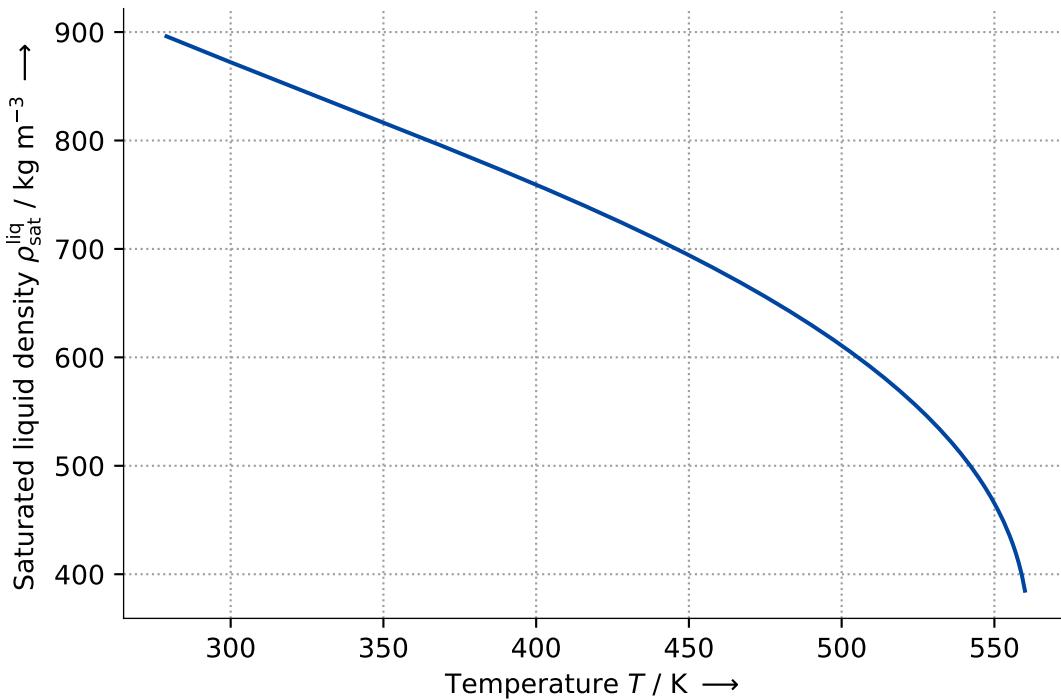
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	2.000000000e+00
$T_{\text{crit}}$	K	5.617500000e+02	$a_5$	-	2.092670400e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	3.046290000e+02	$b_5$	-	3.000000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.960018200e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.062881200e+00	$a_8$	-	0.000000000e+00
$b_3$	-	1.000000000e+00	$b_8$	-	0.000000000e+00
$a_4$	-	-1.585664000e+00			

#### Validity:

Equation is approximately valid for  $278.67\text{K} \leq T \leq 561.75\text{K}$ .

#### Visualization:



#### 4.6.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Benzene
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

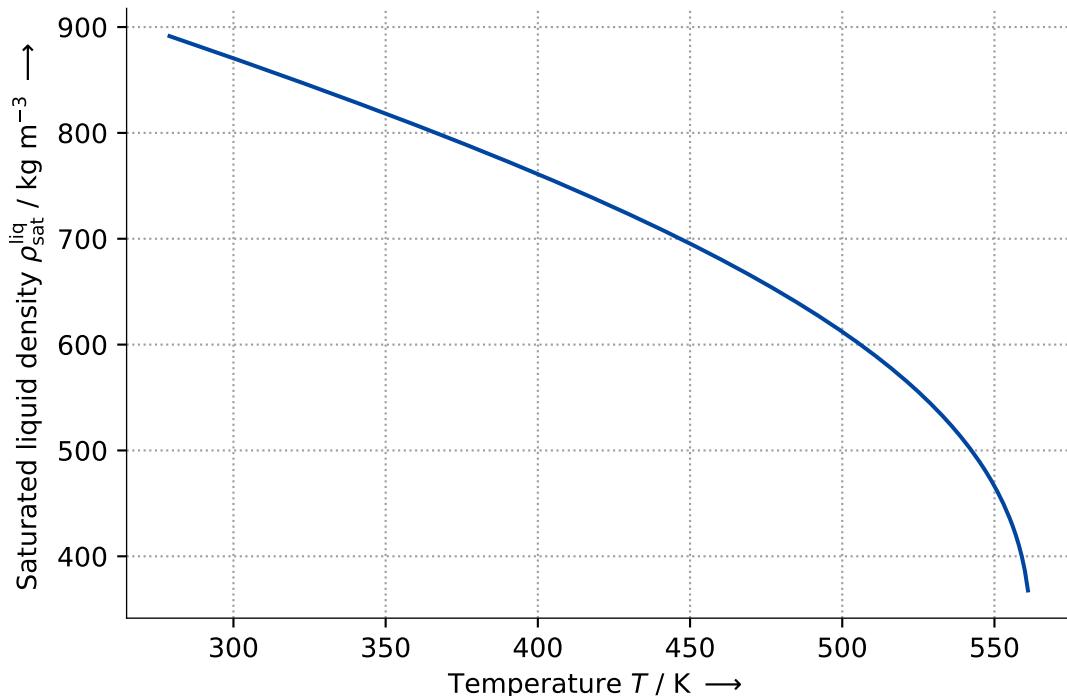
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.620100000e+02	$a_5$	-	1.534623856e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	3.060000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.641941503e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.737248366e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-2.169890523e+00			

---

### Validity:

Equation is approximately valid for  $278.67\text{K} \leq T \leq 562.01\text{K}$ .

### Visualization:



#### 4.6.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

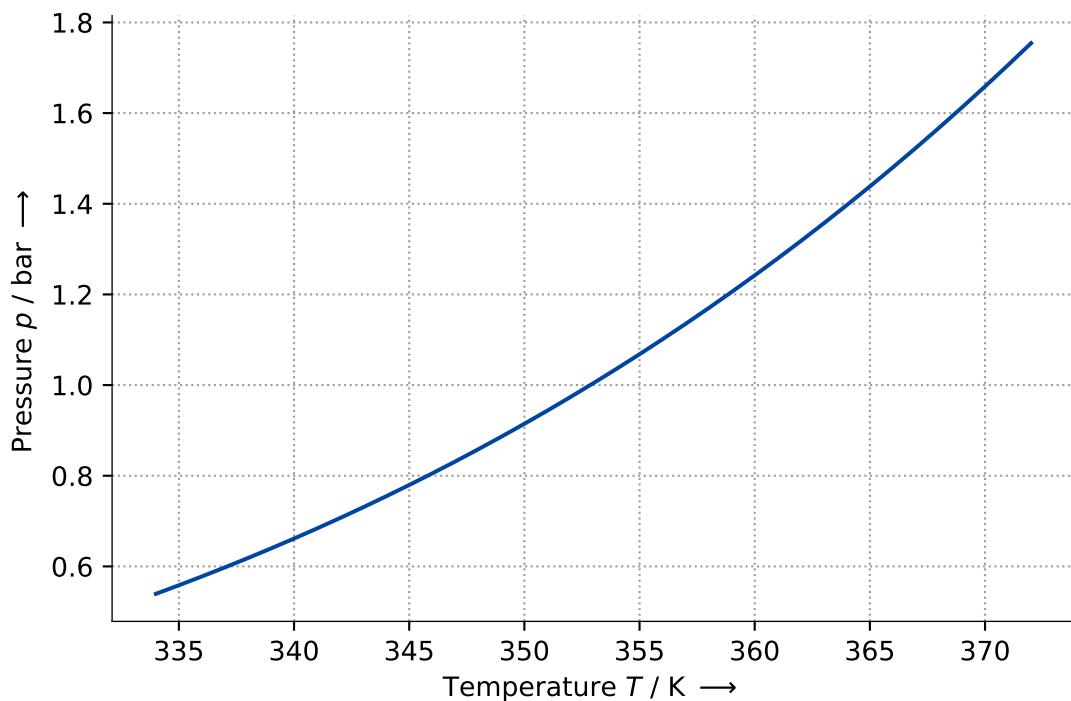
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.725830000e+00	$c$	K	-1.461000000e+00
$b$	K	1.660652000e+03			

#### Validity:

Equation is approximately valid for  $333.4 \text{K} \leq T \leq 373.5 \text{K}$ .

#### Visualization:



#### 4.6.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

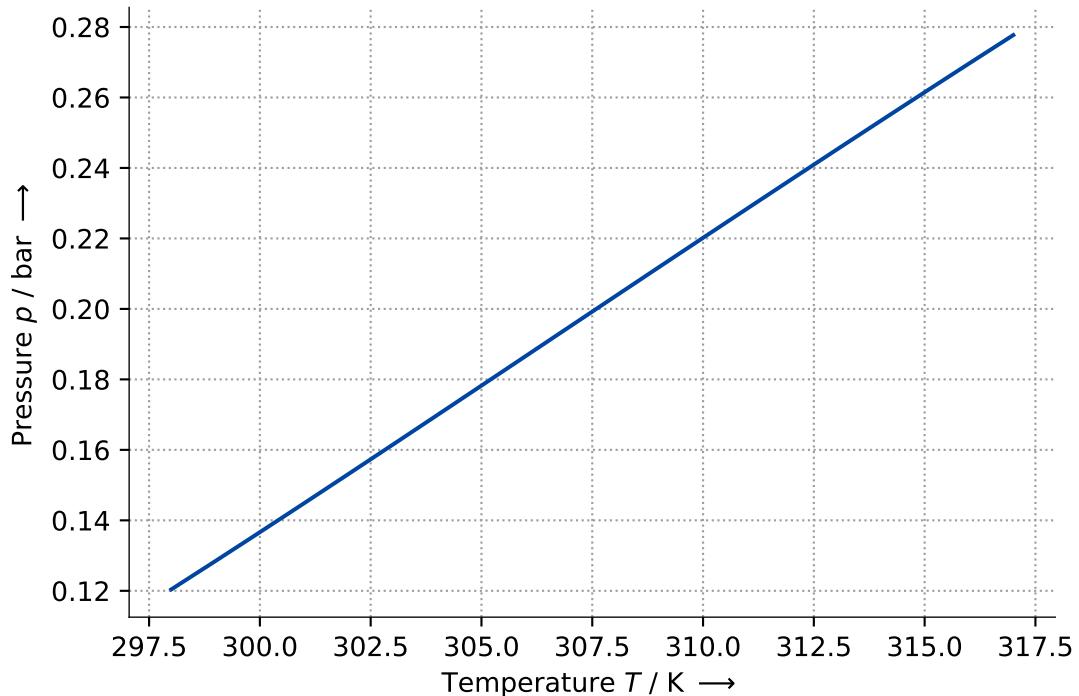
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	1.459100000e-01	$c$	K	-2.612360000e+02
$b$	K	3.916500000e+01			

#### Validity:

Equation is approximately valid for  $297.9\text{K} \leq T \leq 318.0\text{K}$ .

**Visualization:**



#### 4.6.5 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

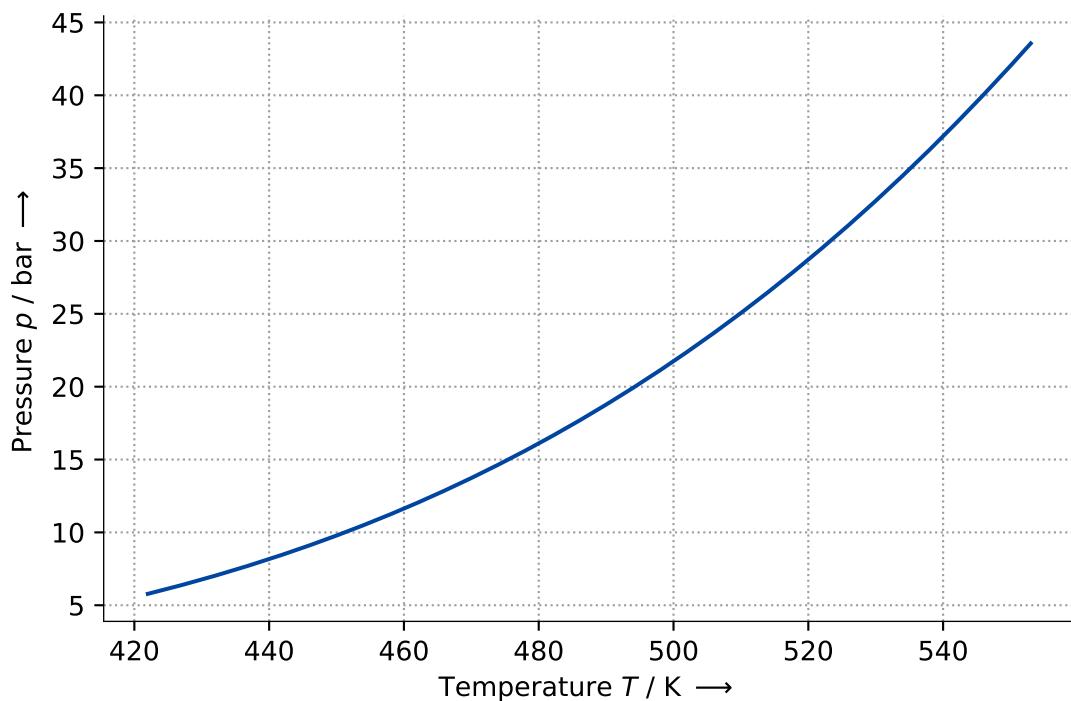
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.603620000e+00	$c$	K	2.080600000e+01
$b$	K	1.701073000e+03			

#### Validity:

Equation is approximately valid for  $421.56\text{K} \leq T \leq 554.8\text{K}$ .

#### Visualization:



#### 4.6.6 Vapor Pressure - Antoine - ID 4

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	4
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

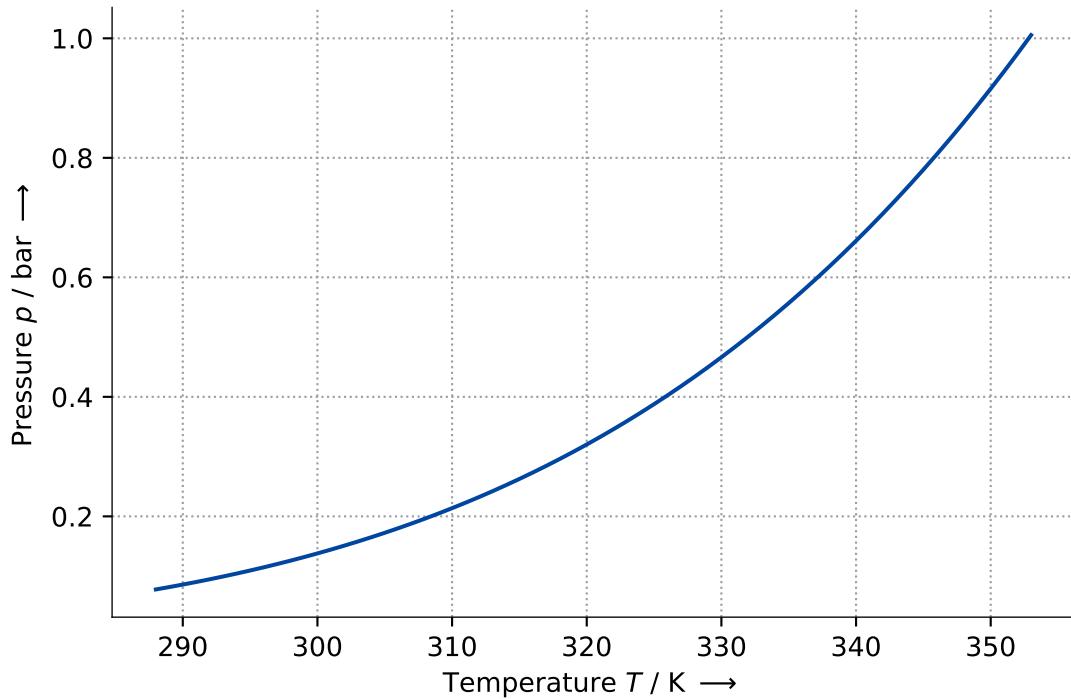
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.018140000e+00	$c$	K	-5.322600000e+01
$b$	K	1.203835000e+03			

#### Validity:

Equation is approximately valid for  $287.7\text{K} \leq T \leq 354.07\text{K}$ .

**Visualization:**



#### 4.6.7 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

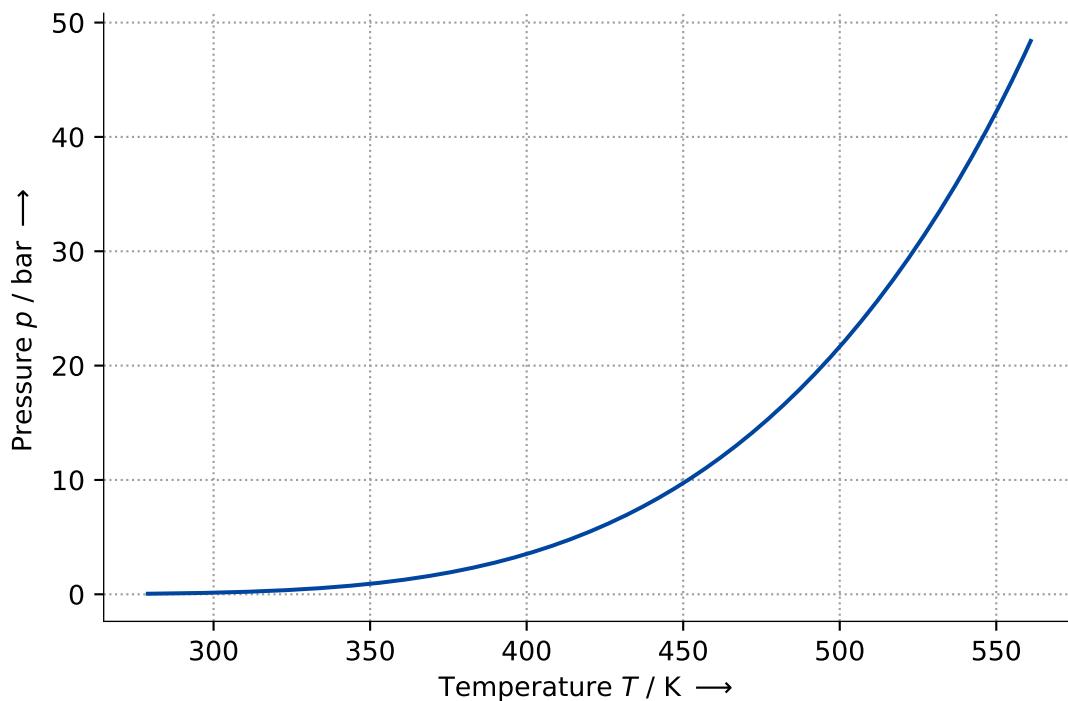
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.620100000e+02	$a_4$	-	-3.151790000e+00
$p_{\text{crit}}$	Pa	4.901000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.114510000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.839810000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.251580000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $278.67\text{K} \leq T \leq 562.01\text{K}$ .

#### Visualization:



#### 4.6.8 Vapor Pressure - EoS2 - ID 1

---

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_EoS2
<b>ID:</b>	1
<b>Reference:</b>	Goodwin, Robert D. (1988): Benzene Thermophysical Properties from 279 to 900 K at Pressures to 1000 Bar. In: Journal of Physical and Chemical Reference Data 17 (4), S. 1541–1636. DOI: 10.1063/1.555813.
<b>Comment:</b>	None

---

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{ref}} \exp \left( \frac{a_0}{\theta} + \sum_{i=1}^4 a_i \theta^{b_i} + a_5 \xi^{b_5} \right) , \text{ and}$$

$$\xi = 1 - \theta , \text{ and}$$

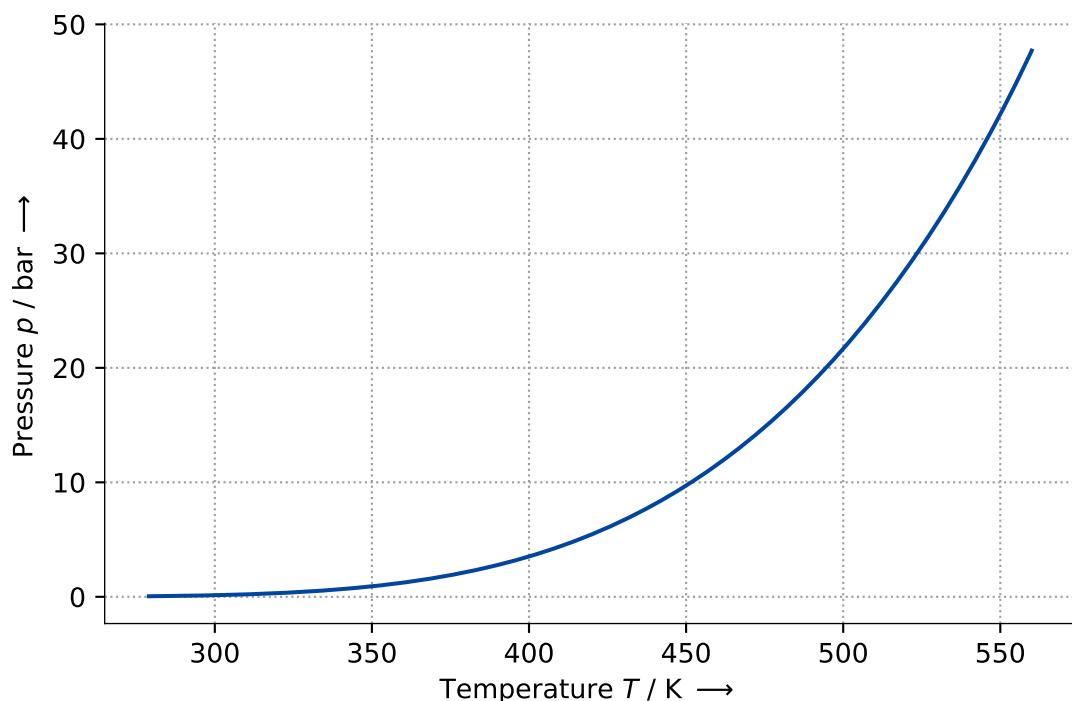
$$\theta = \frac{T}{T_{\text{crit}}} .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.617500000e+02	$a_3$	-	2.020859327e+01
$p_{\text{ref}}$	Pa	1.000000000e+05	$b_3$	-	2.000000000e+00
$a_0$	-	-1.065537528e+01	$a_4$	-	-7.219556515e+00
$a_1$	-	2.394191237e+01	$b_4$	-	3.000000000e+00
$b_1$	-	0.000000000e+00	$a_5$	-	4.847283265e+00
$a_2$	-	-2.238871476e+01	$b_5$	-	1.700000000e+00
$b_2$	-	1.000000000e+00			

**Validity:**

Equation is approximately valid for  $278.67\text{K} \leq T \leq 561.75\text{K}$ .

**Visualization:**

#### 4.6.9 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

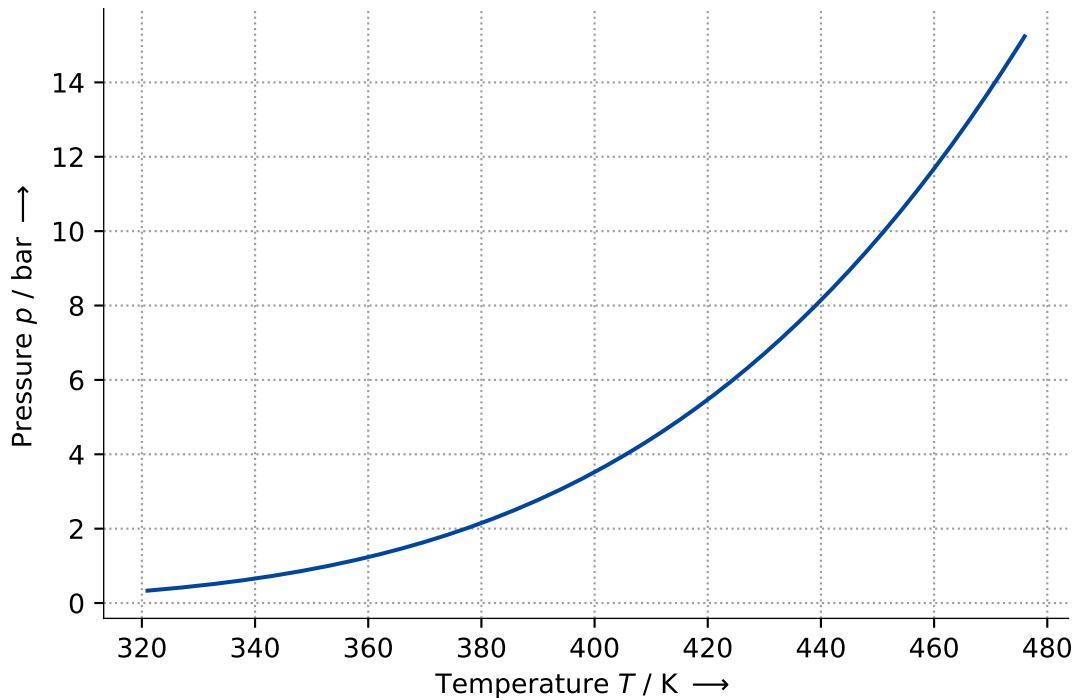
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.620200000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.907300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.110000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $320.4705\text{K} \leq T \leq 477.717\text{K}$ .

#### Visualization:



#### 4.6.10 Vapor Pressure - EoS Cubic - ID 2

---

<b>Name:</b>	Benzene
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

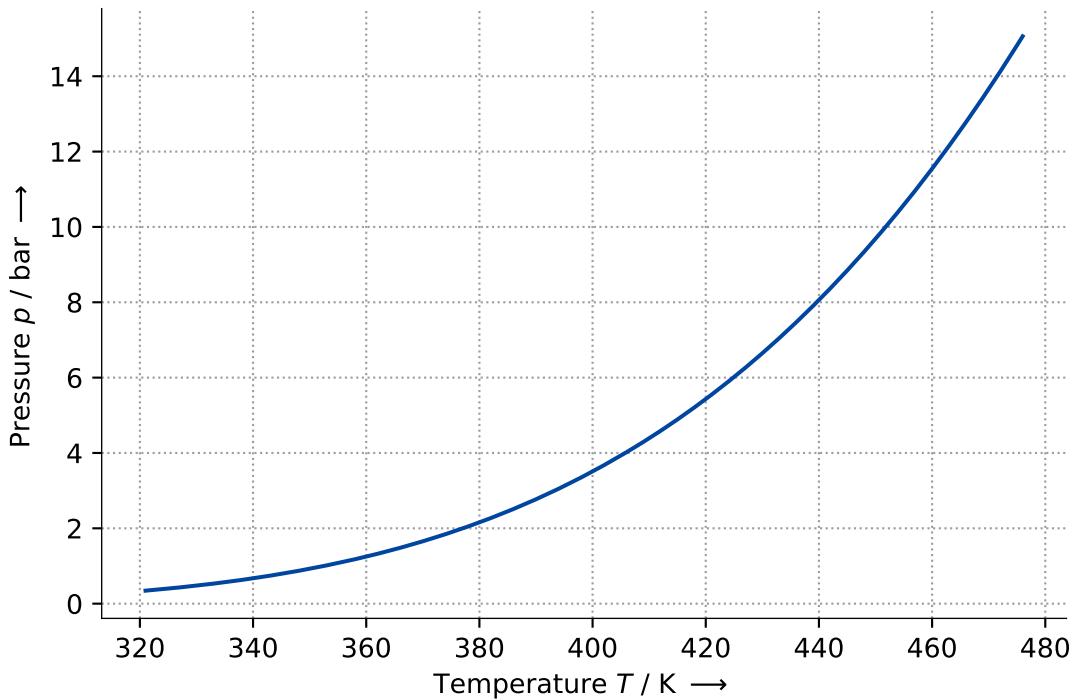
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.620200000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.907300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.110000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $320.4705\text{K} \leq T \leq 477.717\text{K}$ .

### Visualization:



## 4.7 Butane

### 4.7.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Butane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Bücker, D.; Wagner, W. (2006): Reference Equations of State for the Thermodynamic Properties of Fluid Phase n-Butane and Isobutane. In: Journal of Physical and Chemical Reference Data 35 (2), S. 929–1019. DOI: 10.1063/1.1901687.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

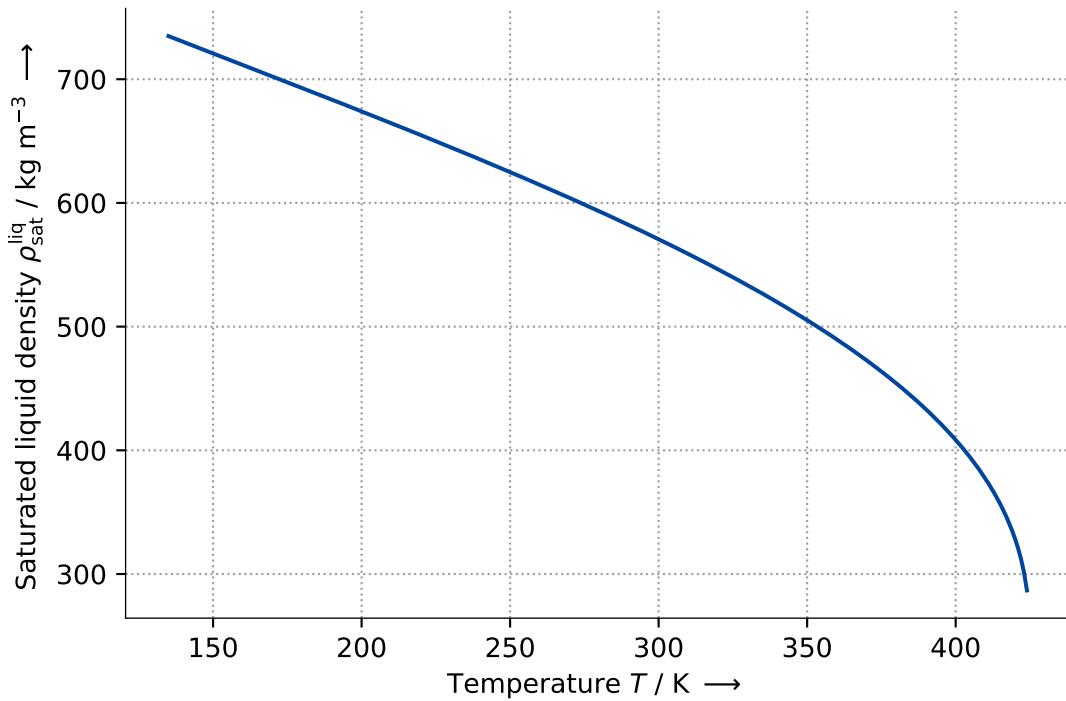
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.500000000e+00
$T_{\text{crit}}$	K	4.251250000e+02	$a_5$	-	3.043375580e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.280000000e+02	$b_5$	-	3.000000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.978745150e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.450000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	8.567995100e-01	$a_8$	-	0.000000000e+00
$b_3$	-	1.000000000e+00	$b_8$	-	0.000000000e+00
$a_4$	-	-3.418718870e-01			

---

### Validity:

Equation is approximately valid for  $134.9\text{K} \leq T \leq 425.125\text{K}$ .

### Visualization:



### 4.7.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Butane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

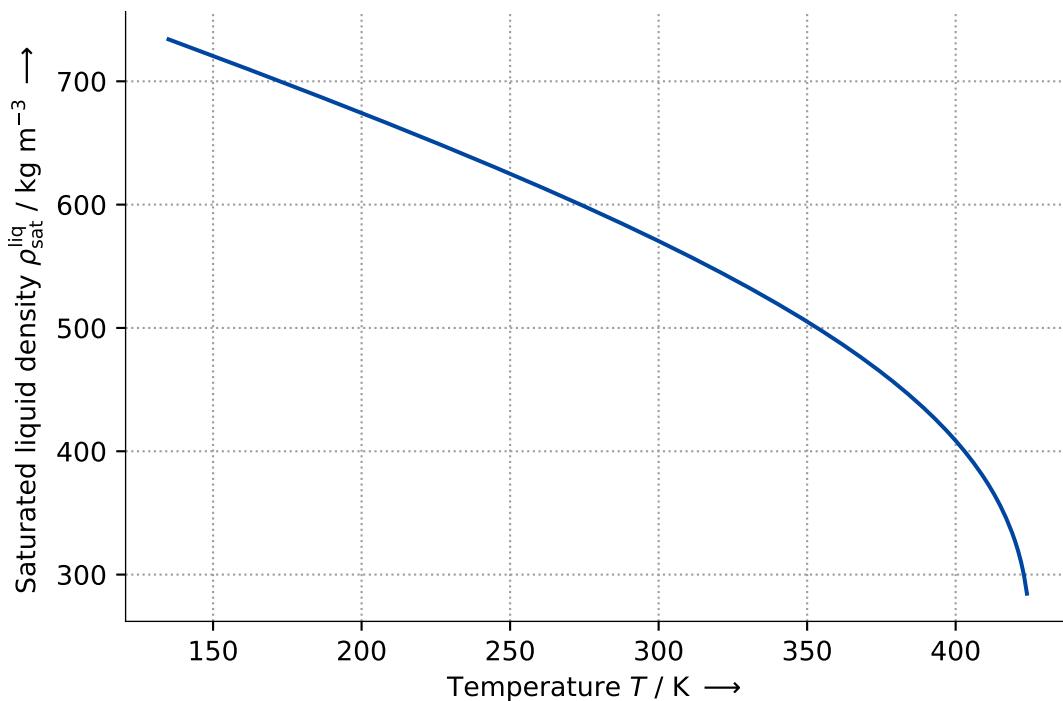
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	4.251300000e+02	$a_5$	-	1.205646930e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.280000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.836397368e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.082646491e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.393101754e+00			

#### Validity:

Equation is approximately valid for  $134.9\text{K} \leq T \leq 425.13\text{K}$ .

#### Visualization:



#### 4.7.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Butane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

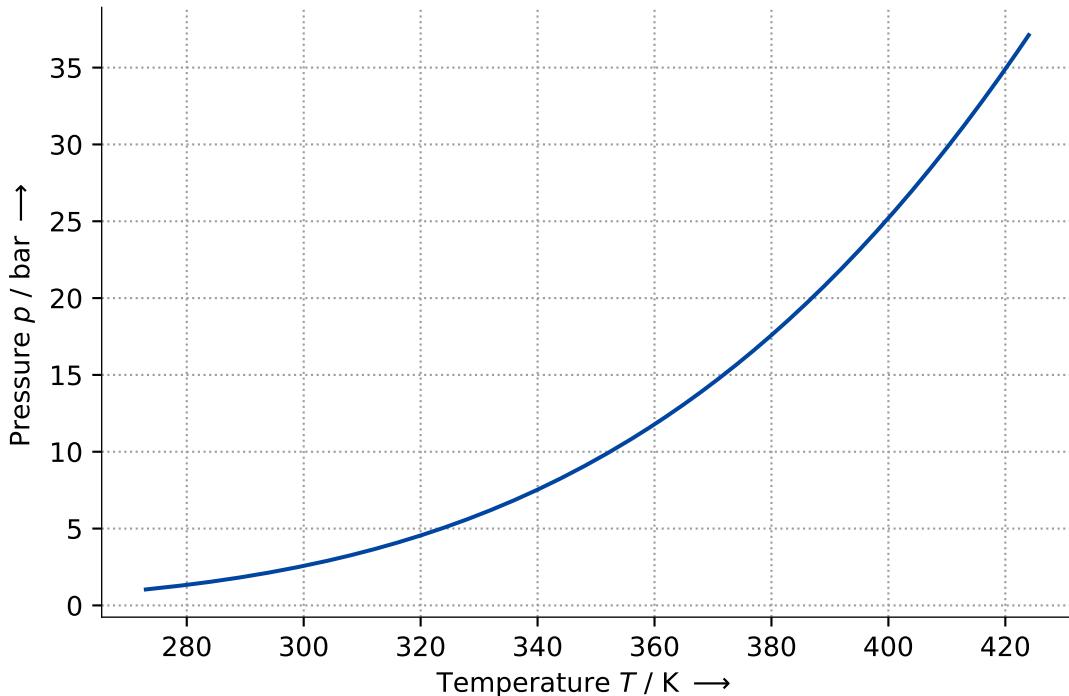
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.355760000e+00	$c$	K	-2.071000000e+00
$b$	K	1.175581000e+03			

#### Validity:

Equation is approximately valid for  $272.66\text{K} \leq T \leq 425.0\text{K}$ .

**Visualization:**



#### 4.7.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Butane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

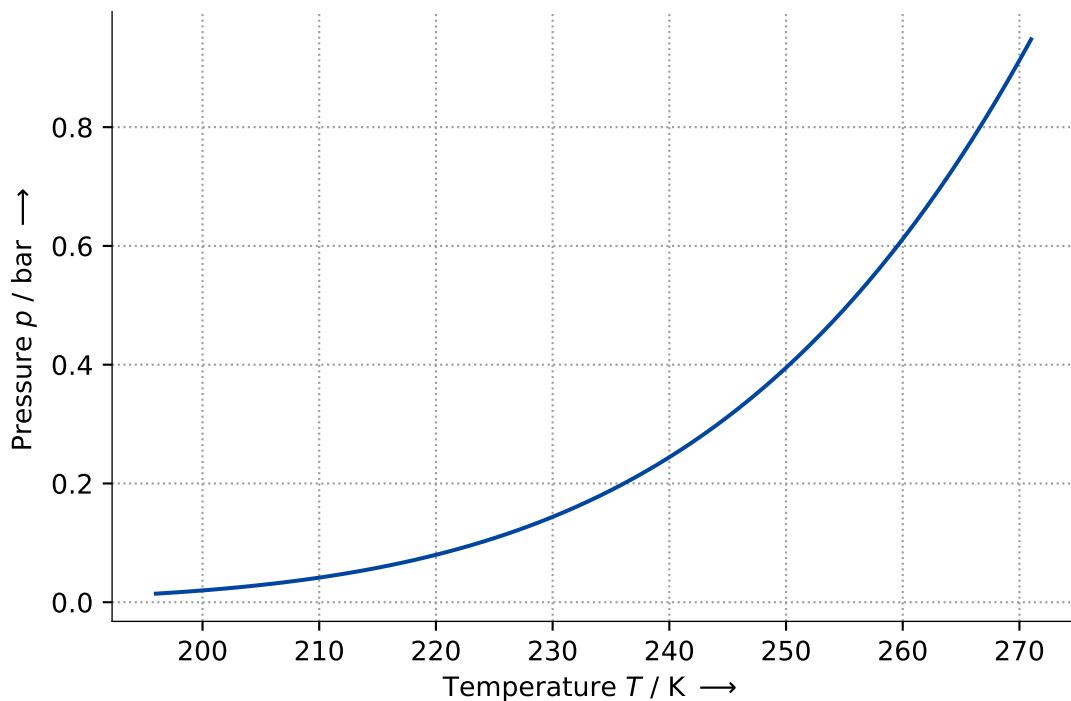
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.850020000e+00	$c$	K	-3.614600000e+01
$b$	K	9.096500000e+02			

#### Validity:

Equation is approximately valid for  $195.11\text{K} \leq T \leq 272.81\text{K}$ .

#### Visualization:



#### 4.7.5 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Butane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

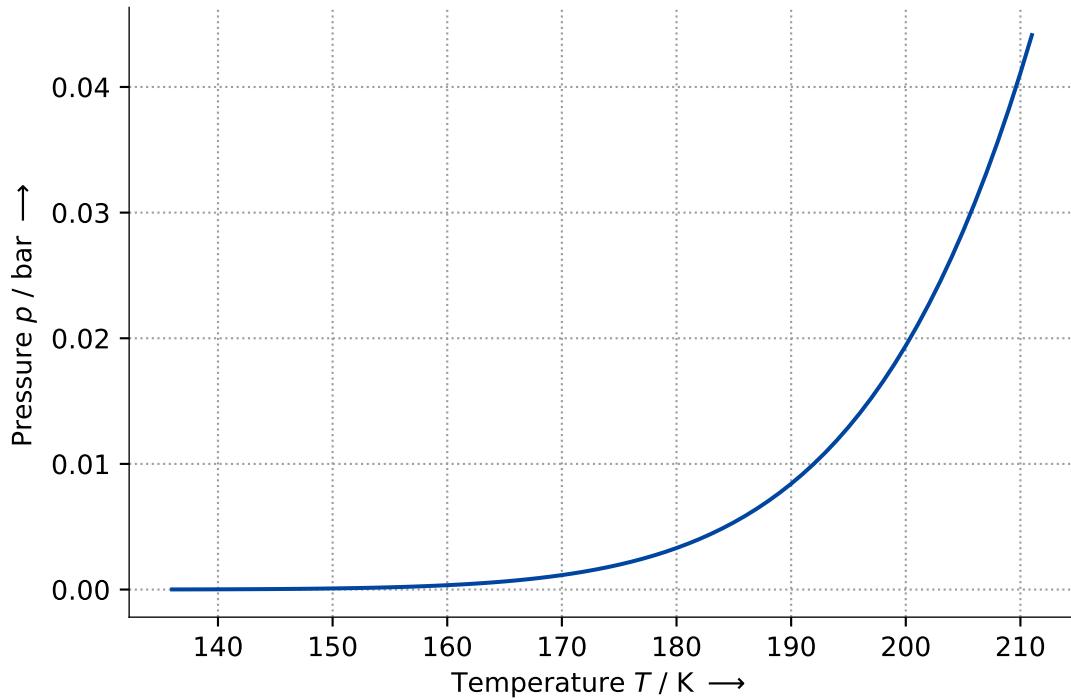
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.708120000e+00	$c$	K	-1.301300000e+01
$b$	K	1.200475000e+03			

#### Validity:

Equation is approximately valid for  $135.42\text{K} \leq T \leq 212.89\text{K}$ .

**Visualization:**



#### 4.7.6 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Butane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Bücker, D.; Wagner, W. (2006): Reference Equations of State for the Thermodynamic Properties of Fluid Phase n-Butane and Isobutane. In: Journal of Physical and Chemical Reference Data 35 (2), S. 929–1019. DOI: 10.1063/1.1901687.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

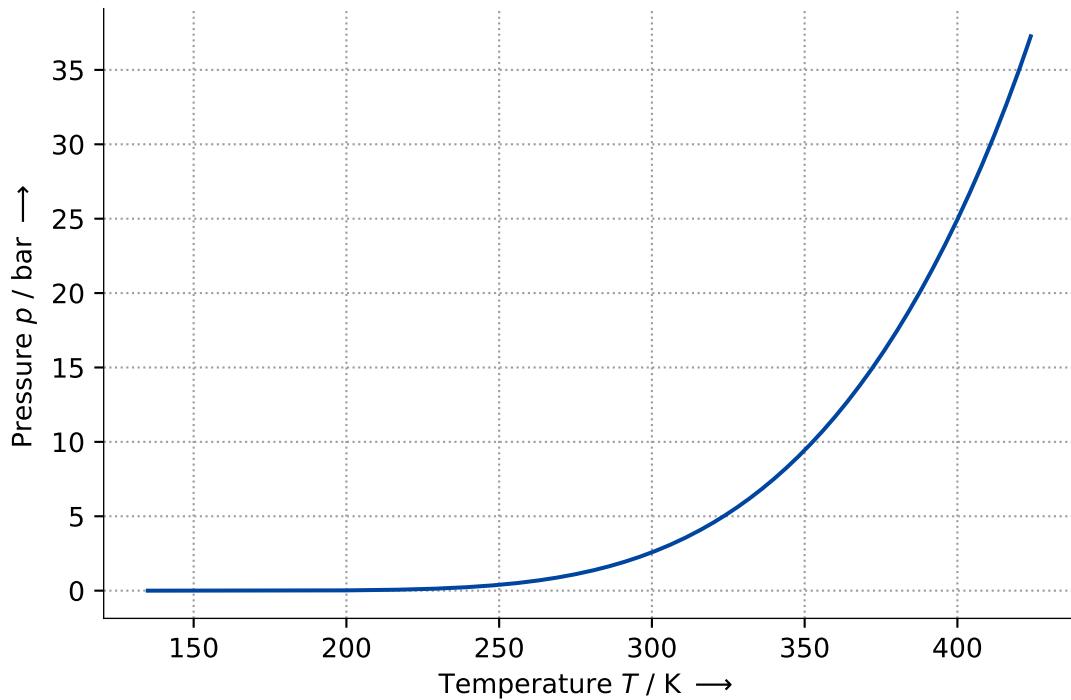
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	4.251250000e+02	$a_4$	-	-2.822411300e+00
$p_{\text{crit}}$	Pa	3.796000000e+06	$b_4$	-	4.500000000e+00
$a_1$	-	-7.176169030e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.536353360e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.075328690e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $134.9 \text{K} \leq T \leq 425.125 \text{K}$ .

#### Visualization:



#### 4.7.7 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Butane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

The parameters of the equation are:

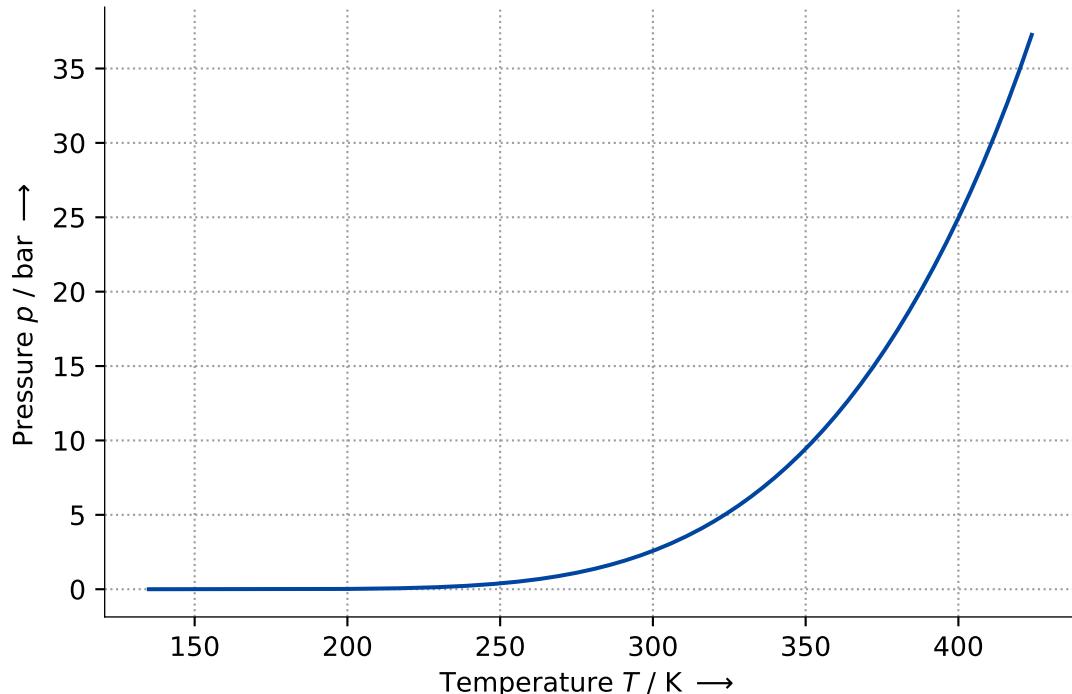
Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	4.251300000e+02		$a_4$	-	-2.319750000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	3.796000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.085620000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.793350000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.000030000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $134.9\text{K} \leq T \leq 425.13\text{K}$ .

**Visualization:**



#### 4.7.8 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Butane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

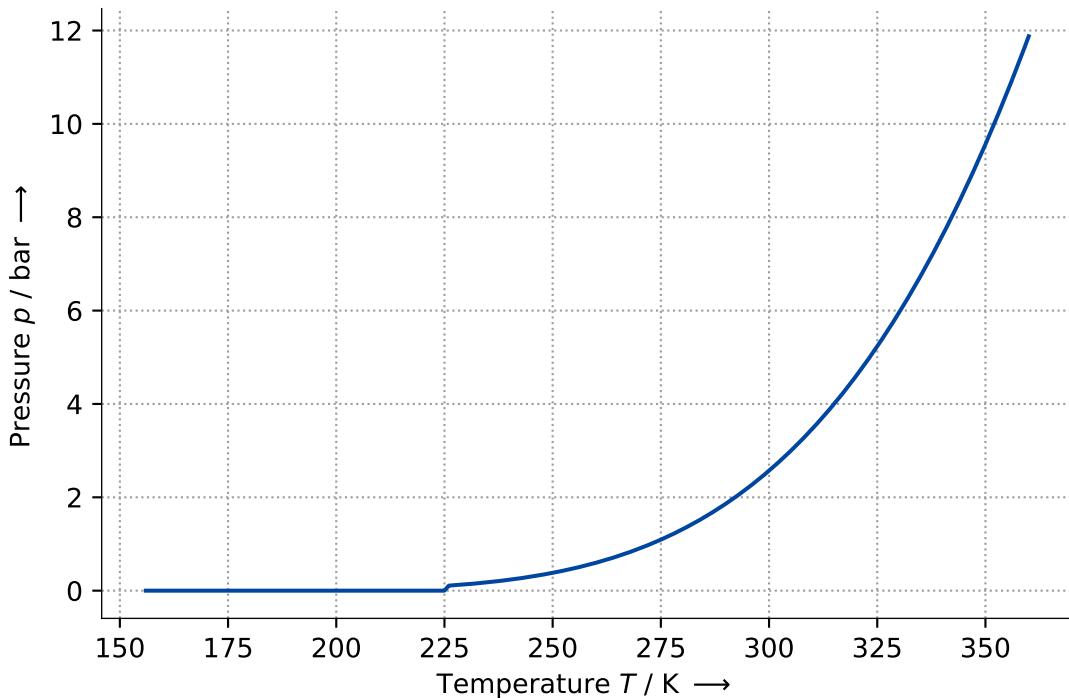
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.251300000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.796000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.010000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $155.135\text{K} \leq T \leq 361.3605\text{K}$ .

#### Visualization:



#### 4.7.9 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	Butane
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

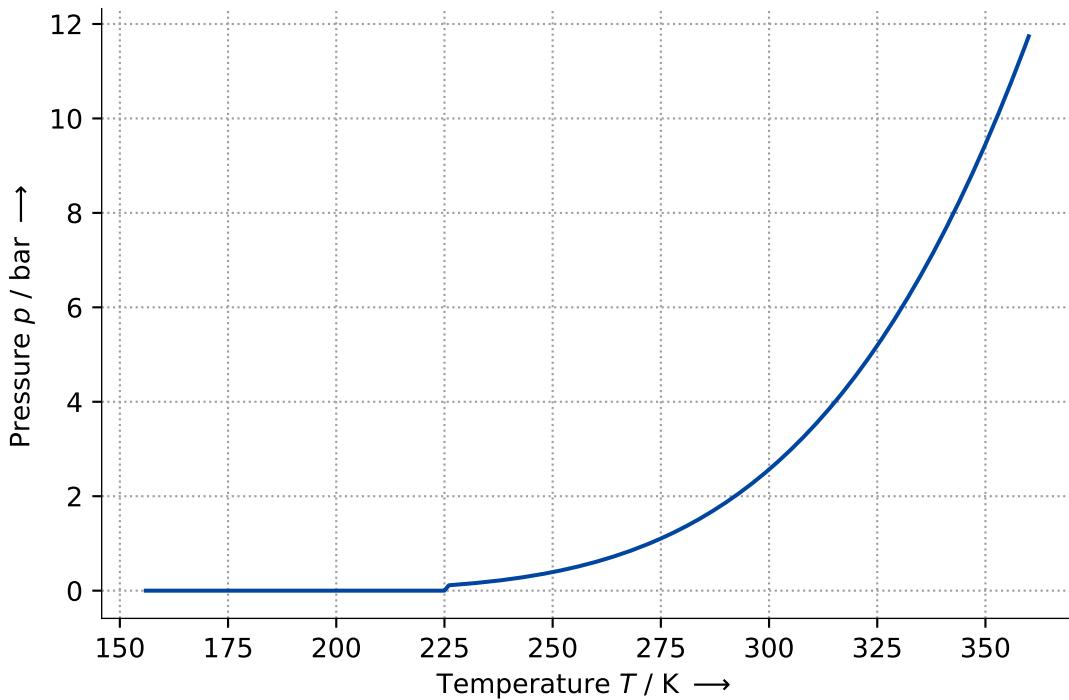
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.251300000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.796000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.010000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $155.135\text{K} \leq T \leq 361.3605\text{K}$ .

### Visualization:



## 4.8 CarbonDioxide

### 4.8.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	CarbonDioxide
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Span, Roland; Wagner, Wolfgang (1996): A New Equation of State for Carbon Dioxide Covering the Fluid Region from the Triple-Point Temperature to 1100 K at Pressures up to 800 MPa. In: Journal of Physical and Chemical Reference Data 25 (6), S. 1509–1596. DOI: 10.1063/1.555991.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

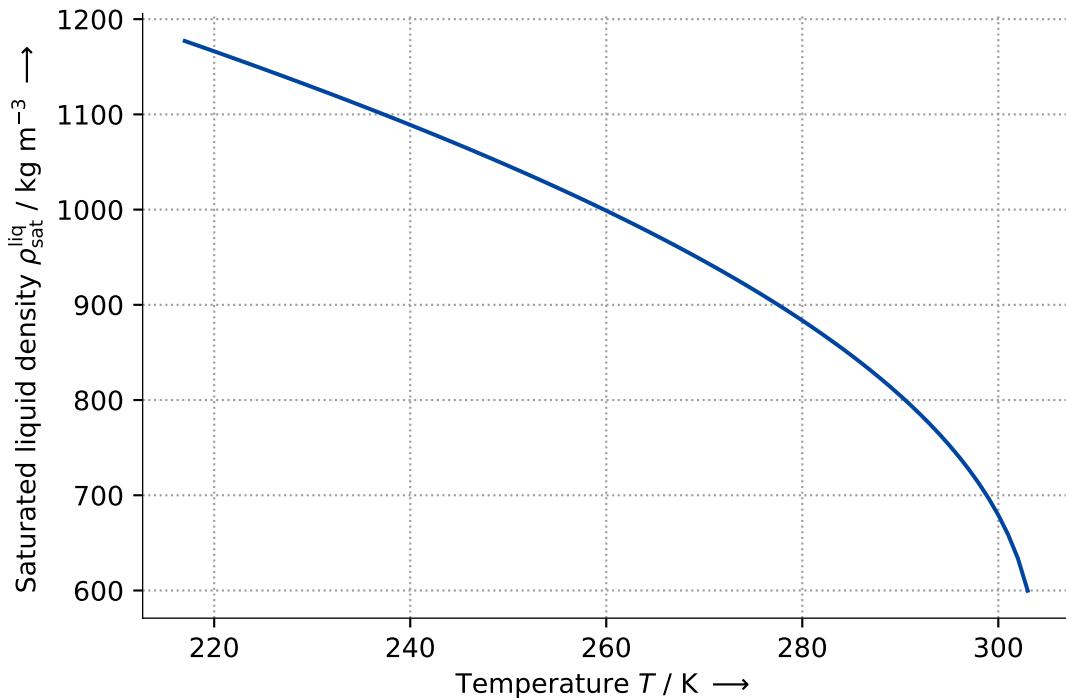
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$b_4$	-	1.833333333e+00
$T_{\text{crit}}$	K	3.041282000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.676000000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.924510800e+00	$a_6$	-	0.000000000e+00
$b_1$	-	3.400000000e-01	$b_6$	-	0.000000000e+00
$a_2$	-	-6.238555500e-01	$a_7$	-	0.000000000e+00
$b_2$	-	5.000000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-3.273112700e-01	$a_8$	-	0.000000000e+00
$b_3$	-	1.666666667e+00	$b_8$	-	0.000000000e+00
$a_4$	-	3.924514200e-01			

---

### Validity:

Equation is approximately valid for  $216.59\text{K} \leq T \leq 304.1282\text{K}$ .

### Visualization:



### 4.8.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	CarbonDioxide
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

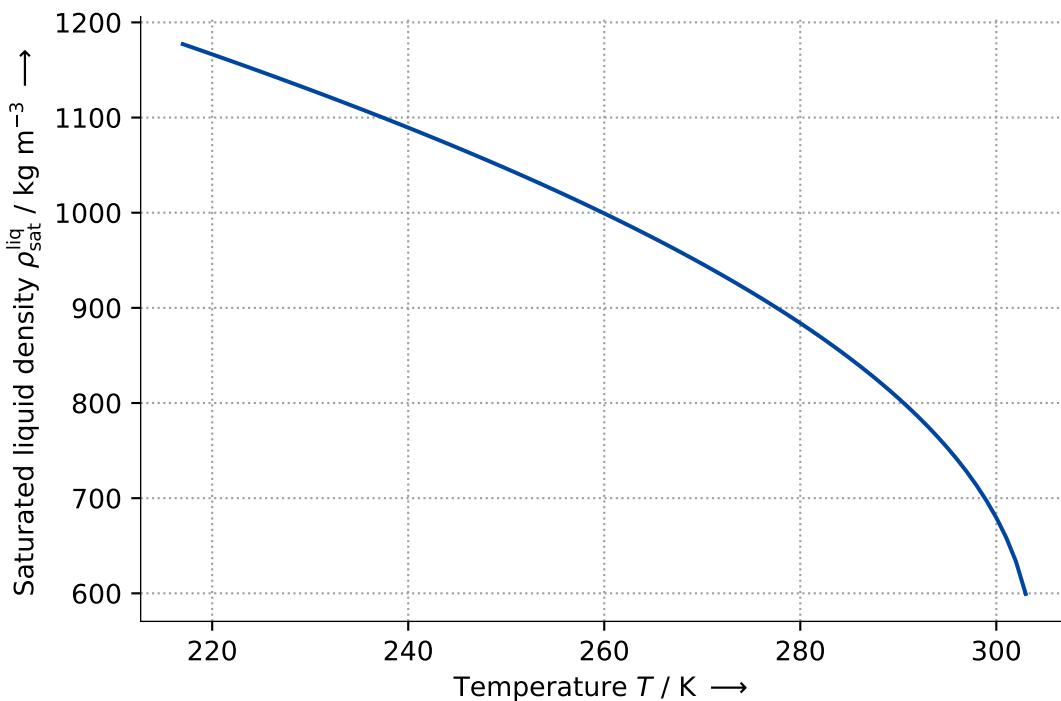
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.041300000e+02	$a_5$	-	8.102948718e-02
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.680000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.918531410e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	3.633354701e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	3.612213675e-01			

#### Validity:

Equation is approximately valid for  $216.59\text{K} \leq T \leq 304.13\text{K}$ .

#### Visualization:



#### 4.8.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	CarbonDioxide
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

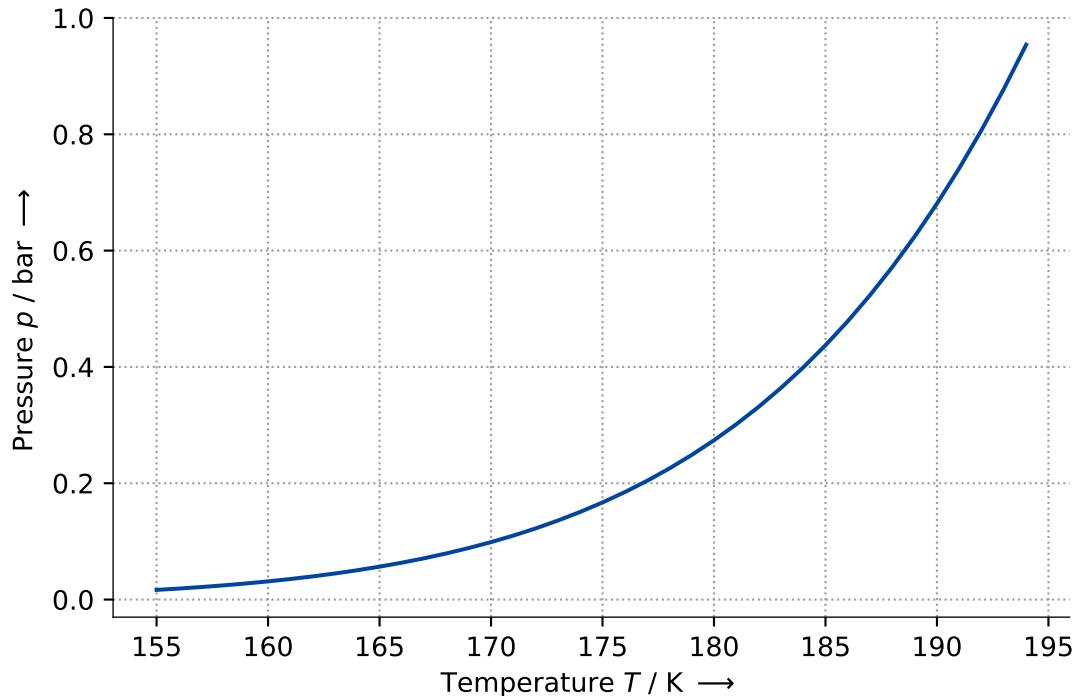
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	6.812280000e+00	$c$	K	-3.494000000e+00
$b$	K	1.301679000e+03			

##### Validity:

Equation is approximately valid for  $154.26\text{K} \leq T \leq 195.89\text{K}$ .

**Visualization:**



#### 4.8.4 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	CarbonDioxide
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Span, Roland; Wagner, Wolfgang (1996): A New Equation of State for Carbon Dioxide Covering the Fluid Region from the Triple-Point Temperature to 1100 K at Pressures up to 800 MPa. In: Journal of Physical and Chemical Reference Data 25 (6), S. 1509–1596. DOI: 10.1063/1.555991.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

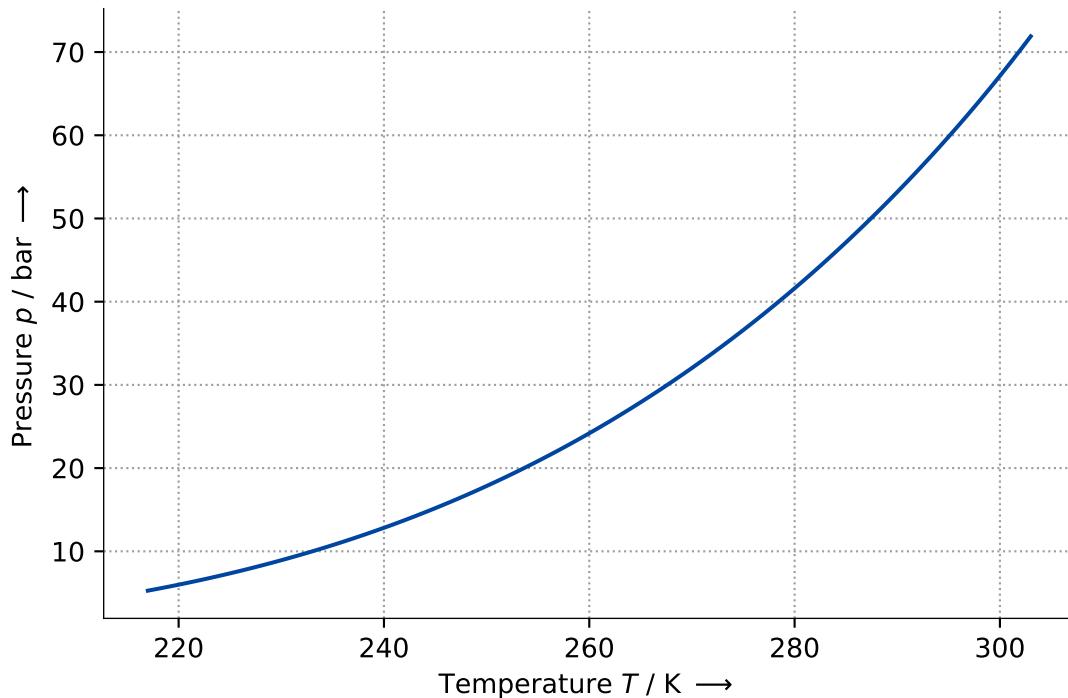
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.041282000e+02	$a_4$	-	-3.299563400e+00
$p_{\text{crit}}$	Pa	7.377300000e+06	$b_4$	-	4.000000000e+00
$a_1$	-	-7.060208700e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.939121800e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.646359700e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $216.59\text{K} \leq T \leq 304.1282\text{K}$ .

#### Visualization:



#### 4.8.5 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	CarbonDioxide
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

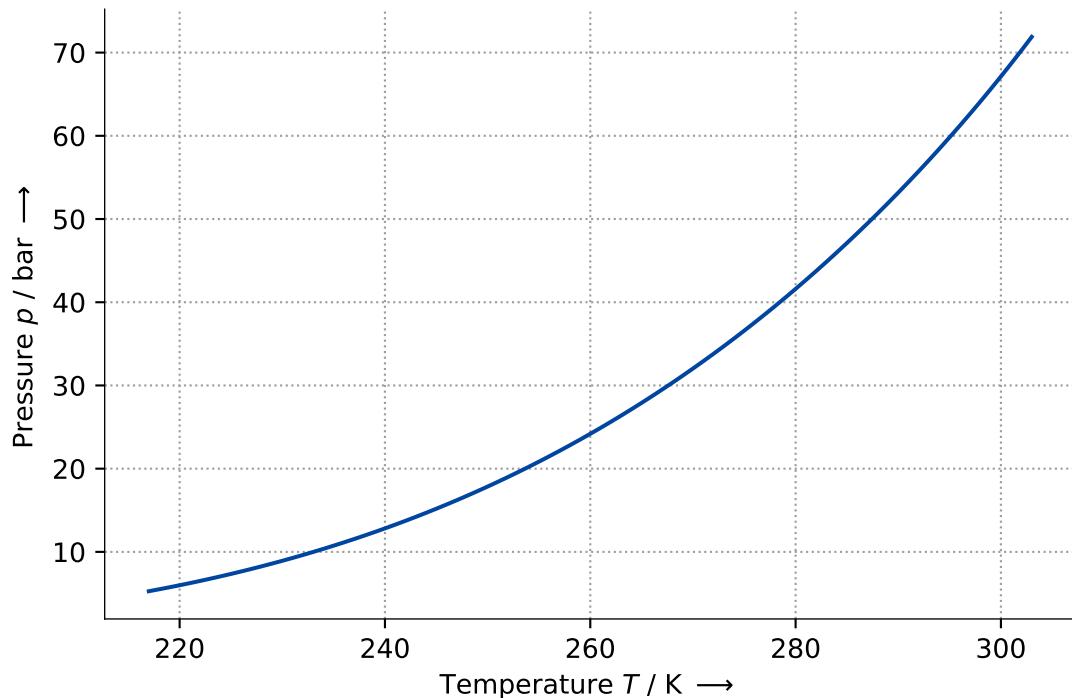
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	3.041300000e+02		$a_4$	-	-2.348530000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	7.377000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.029160000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.539370000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.283300000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $216.59\text{K} \leq T \leq 304.13\text{K}$ .

**Visualization:**

#### 4.8.6 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	CarbonDioxide
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

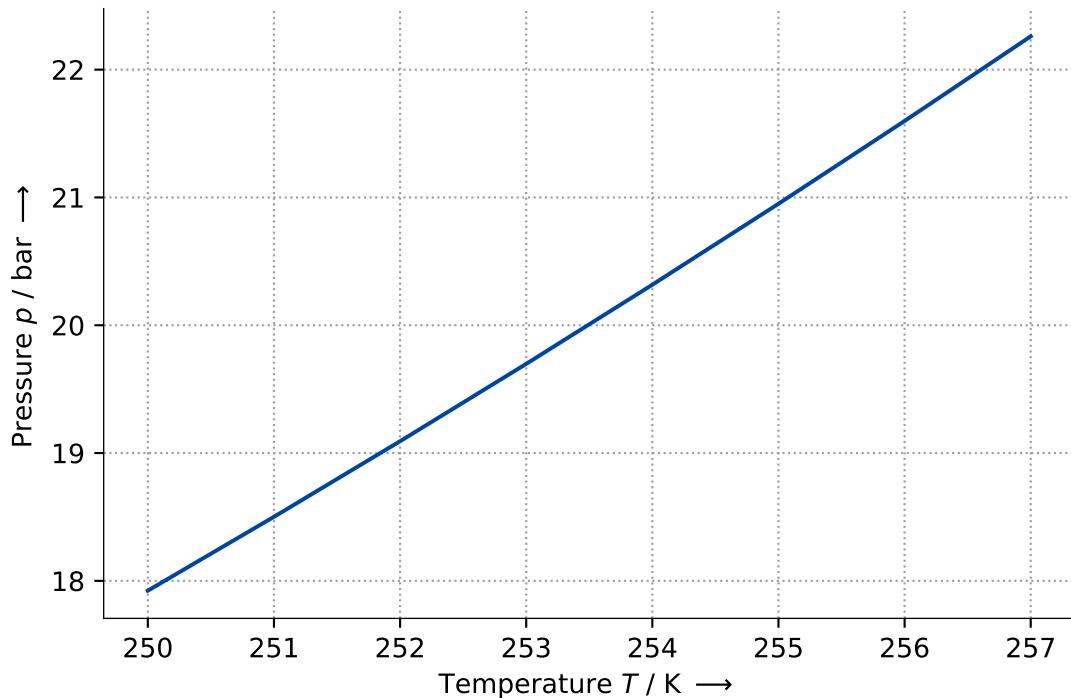
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.041300000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	7.377300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.239400000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $249.0785\text{K} \leq T \leq 258.5105\text{K}$ .

#### Visualization:



#### 4.8.7 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	CarbonDioxide
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

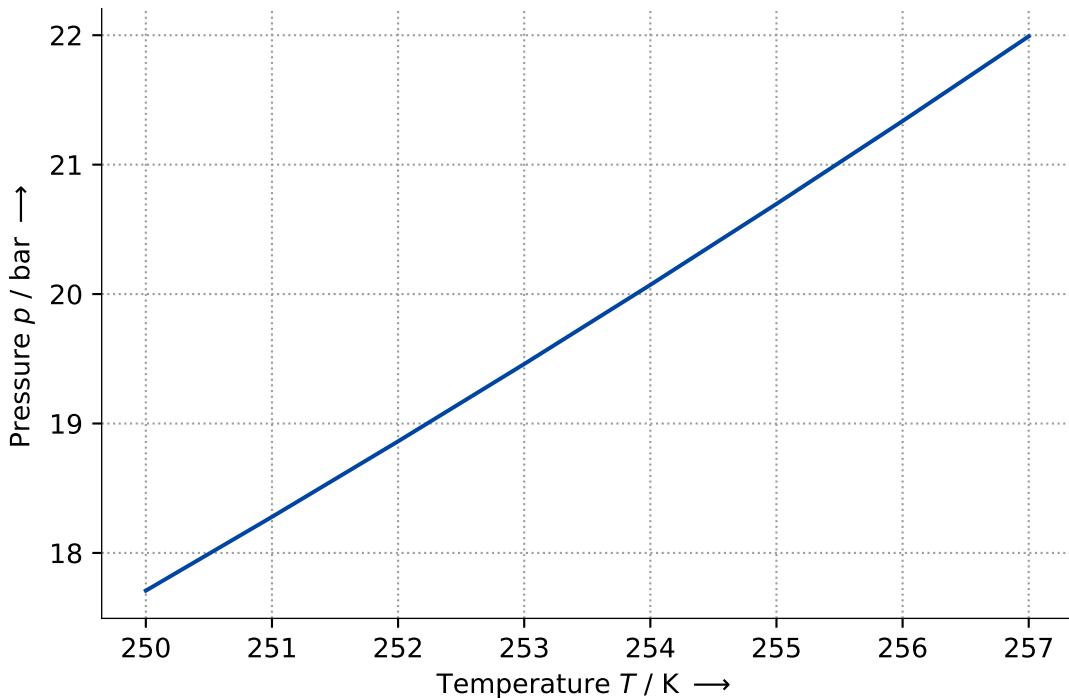
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.041300000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	7.377300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.239400000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $249.0785\text{K} \leq T \leq 258.5105\text{K}$ .

### Visualization:



## 4.9 Cyclohexane

### 4.9.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

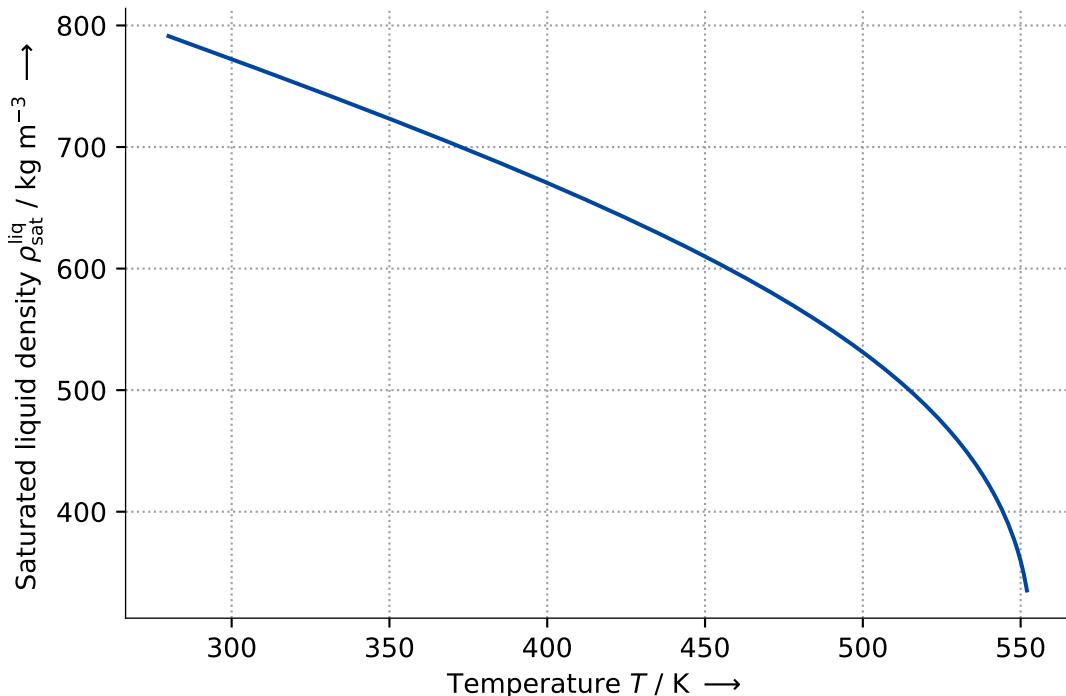
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.536000000e+02	$a_5$	-	2.988509524e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.730000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.369678022e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	3.108960073e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-4.619653114e+00			

**Validity:**

Equation is approximately valid for  $279.86\text{K} \leq T \leq 553.6\text{K}$ .

**Visualization:**

#### 4.9.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

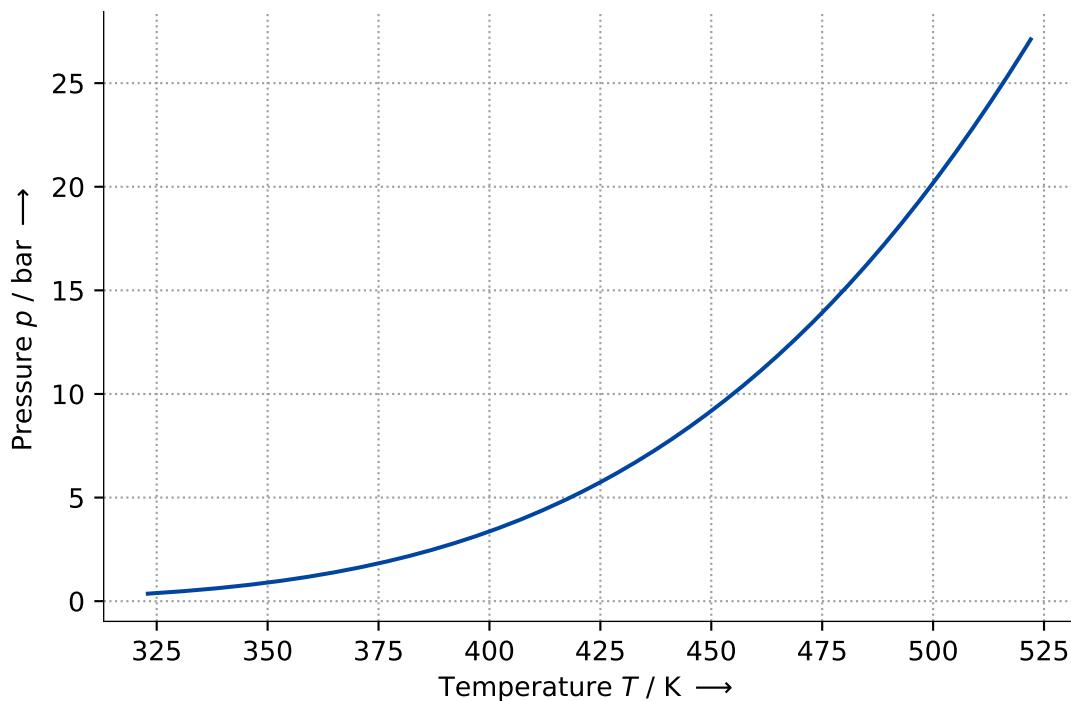
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.139830000e+00	$c$	K	-3.558100000e+01
$b$	K	1.316554000e+03			

#### Validity:

Equation is approximately valid for  $323.0\text{K} \leq T \leq 523.0\text{K}$ .

#### Visualization:



#### 4.9.3 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

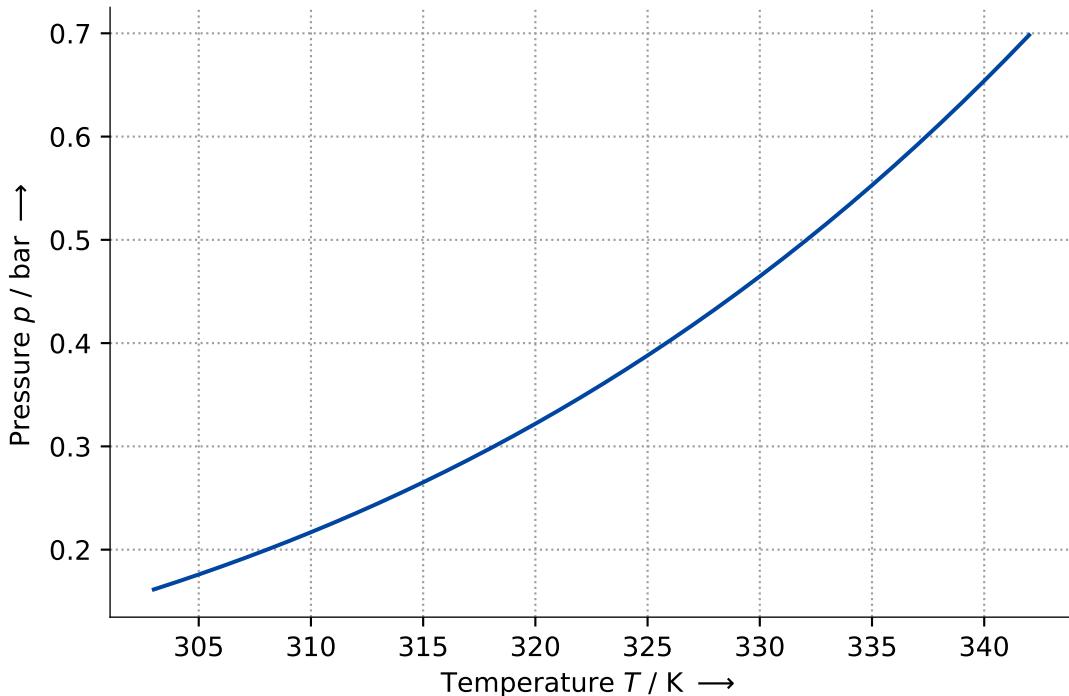
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.992000000e+00	$c$	K	-4.862100000e+01
$b$	K	1.216930000e+03			

#### Validity:

Equation is approximately valid for  $303.0\text{K} \leq T \leq 343.0\text{K}$ .

**Visualization:**



#### 4.9.4 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

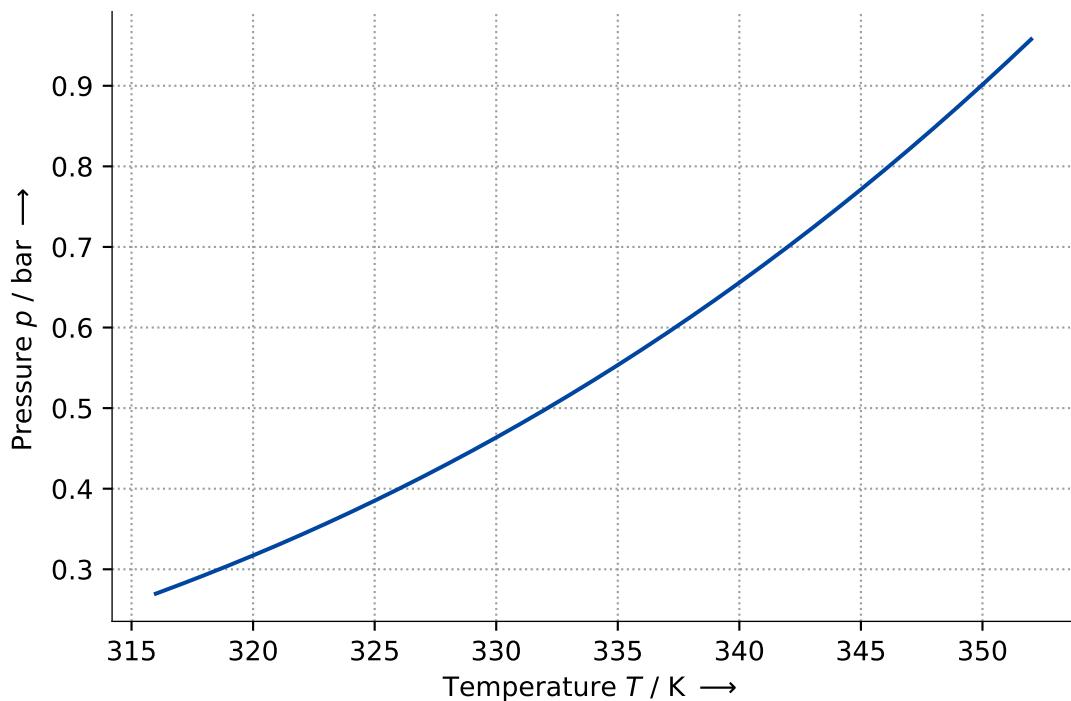
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.171250000e+00	$c$	K	-1.072900000e+02
$b$	K	7.806370000e+02			

**Validity:**

Equation is approximately valid for  $315.7 \text{K} \leq T \leq 353.9 \text{K}$ .

**Visualization:**



#### 4.9.5 Vapor Pressure - Antoine - ID 4

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	4
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

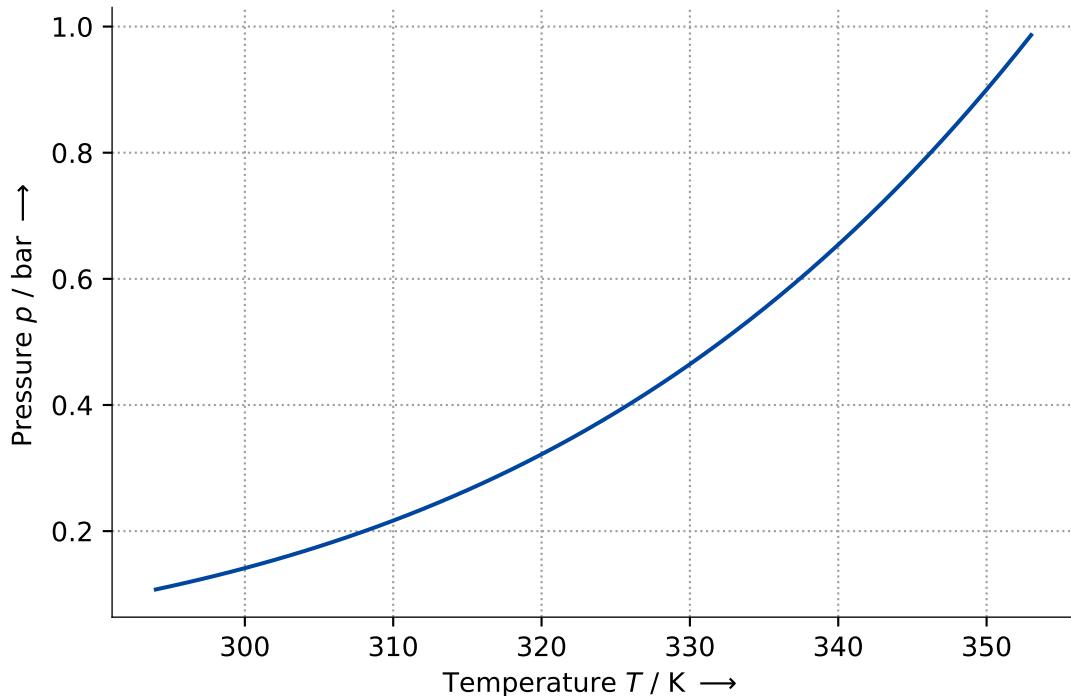
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.969880000e+00	$c$	K	-5.028700000e+01
$b$	K	1.203526000e+03			

##### Validity:

Equation is approximately valid for  $293.06\text{K} \leq T \leq 354.73\text{K}$ .

**Visualization:**



#### 4.9.6 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

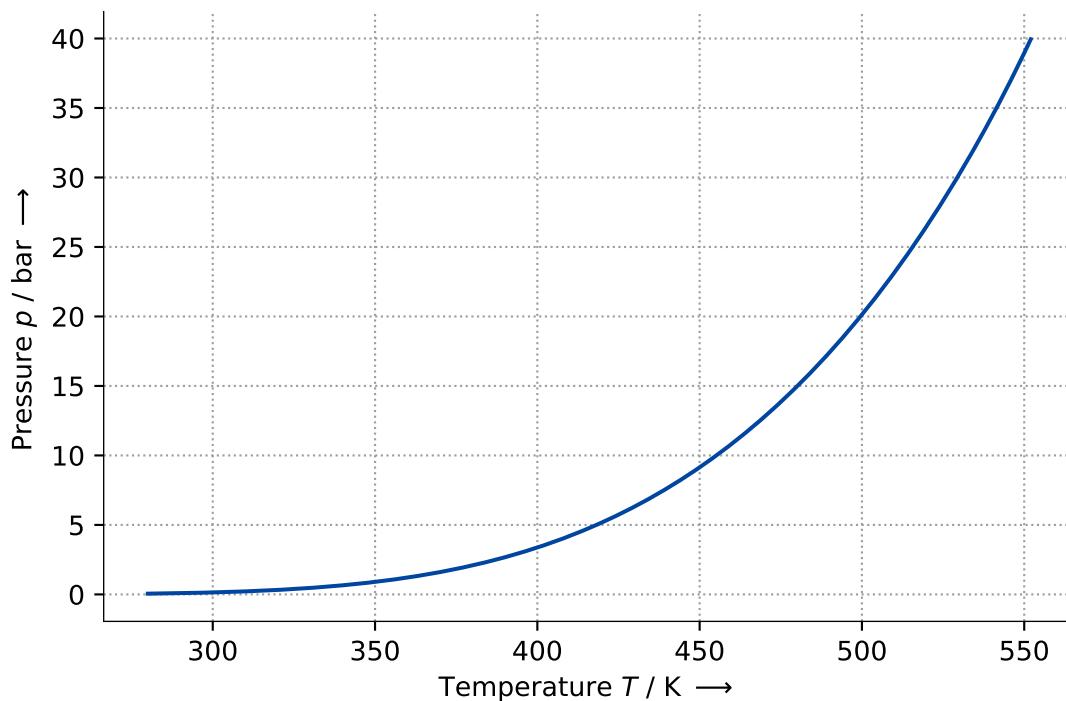
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.536000000e+02	$a_4$	-	-3.260950000e+00
$p_{\text{crit}}$	Pa	4.075000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.009790000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.574750000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.968200000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $279.86\text{K} \leq T \leq 553.6\text{K}$ .

#### Visualization:



#### 4.9.7 Vapor Pressure - EoS Cubic - ID 1

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

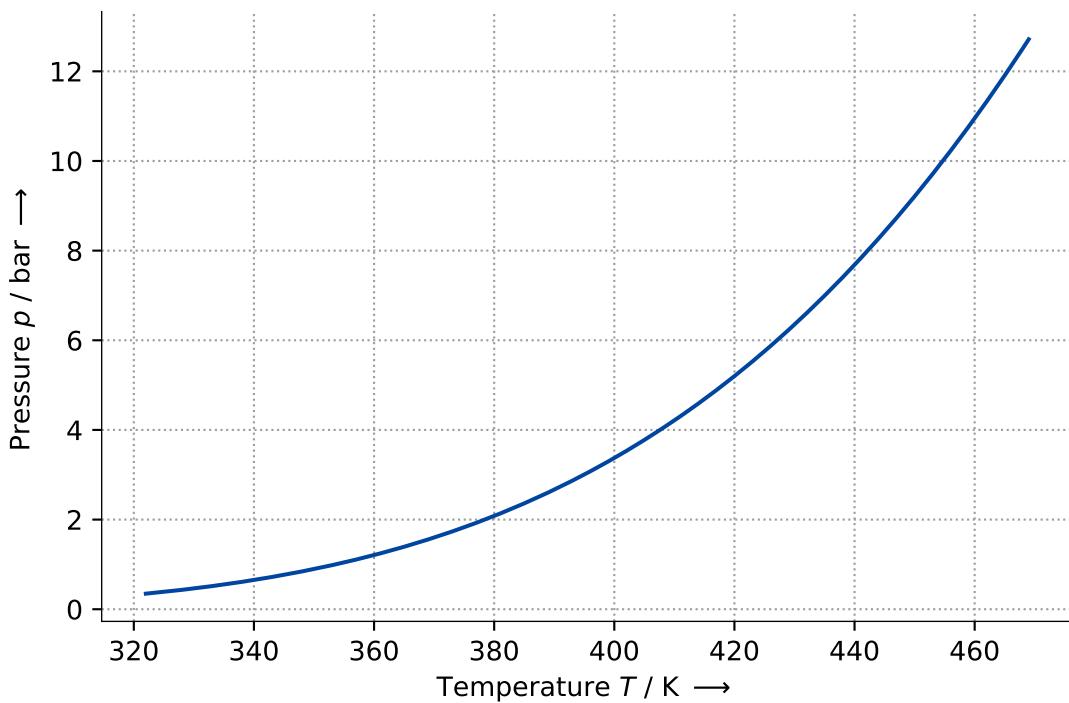
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.536000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.080500000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.096000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $321.839\text{K} \leq T \leq 470.56\text{K}$ .

### Visualization:



#### 4.9.8 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	Cyclohexane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

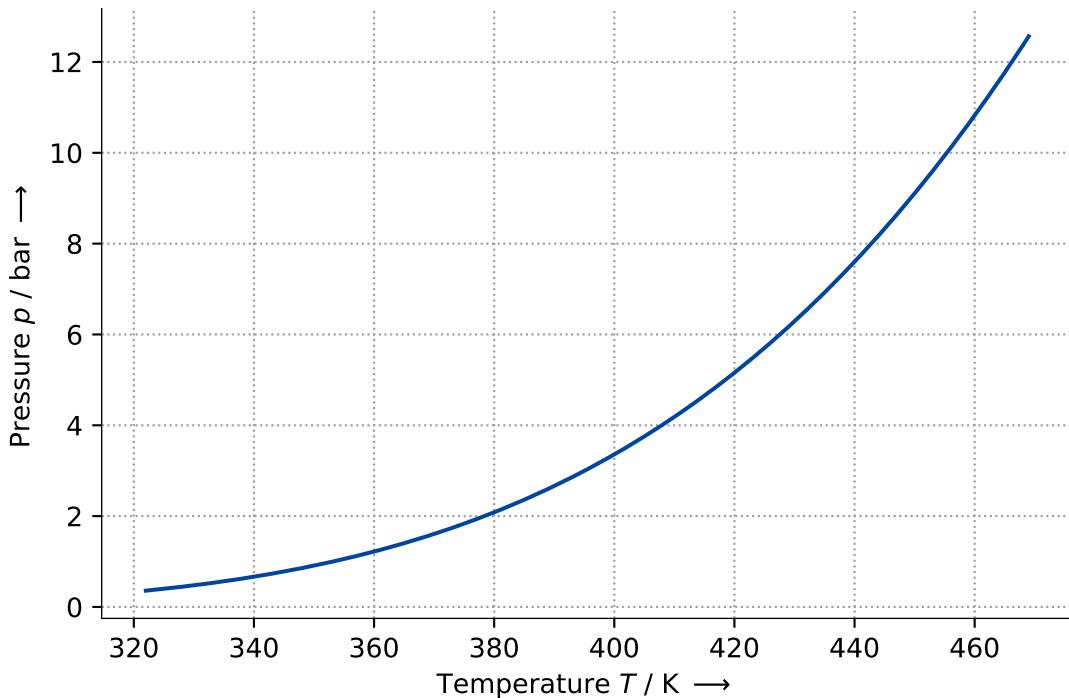
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.536000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.080500000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.096000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $321.839\text{K} \leq T \leq 470.56\text{K}$ .

### Visualization:



## 4.10 Cyclohexene

### 4.10.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Cyclohexene
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

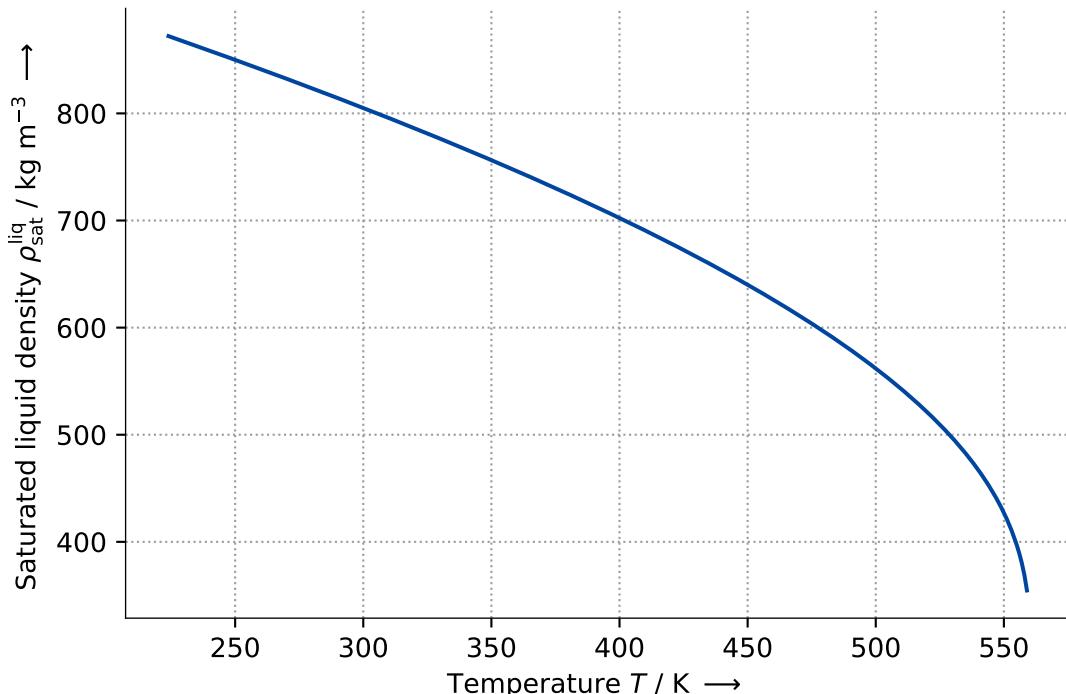
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.604500000e+02	$a_5$	-	-4.102241135e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.820000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.126200709e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-5.617524823e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	1.535502128e+00			

**Validity:**

Equation is approximately valid for  $223.15\text{K} \leq T \leq 560.45\text{K}$ .

**Visualization:**

#### 4.10.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Cyclohexene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

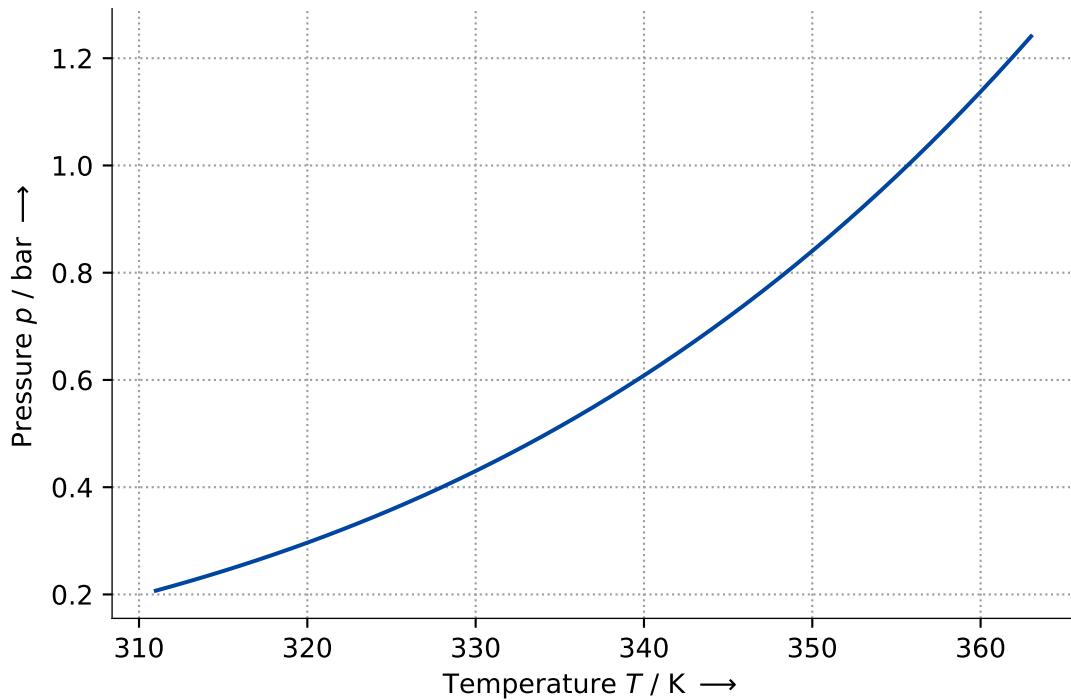
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.997300000e+00	$c$	K	-4.99800000e+01
$b$	K	1.221900000e+03			

#### Validity:

Equation is approximately valid for  $310.02\text{K} \leq T \leq 364.53\text{K}$ .

#### Visualization:



## 4.11 Ethanol

### 4.11.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Ethanol
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Schroeder, J. A.; Penoncello, S. G.; Schroeder, J. S. (2014): A Fundamental Equation of State for Ethanol. In: Journal of Physical and Chemical Reference Data 43 (4), S. 43102. DOI: 10.1063/1.4895394.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

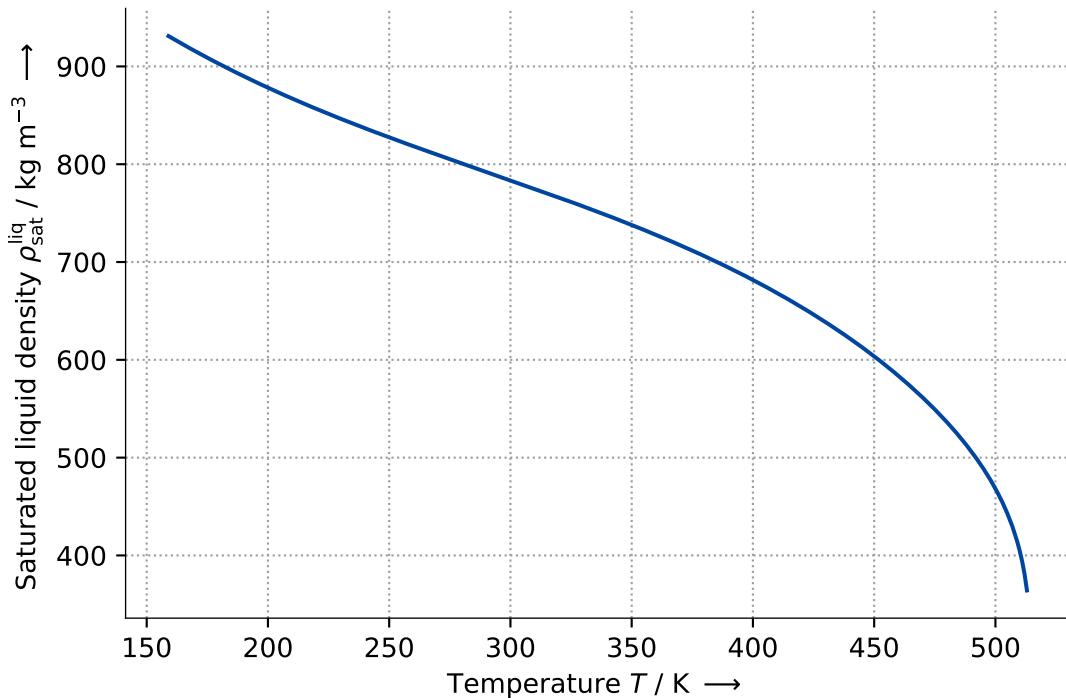
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.100000000e+00
$T_{\text{crit}}$	K	5.147100000e+02	$a_5$	-	-1.654590000e+01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.731951000e+02	$b_5$	-	1.500000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	3.642940000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	3.300000000e+00
$a_2$	-	9.009210000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	5.000000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-2.316680000e+01	$a_8$	-	0.000000000e+00
$b_3$	-	8.000000000e-01	$b_8$	-	0.000000000e+00
$a_4$	-	3.090920000e+01			

---

### Validity:

Equation is approximately valid for  $159.0\text{K} \leq T \leq 514.71\text{K}$ .

### Visualization:



#### 4.11.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Ethanol
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

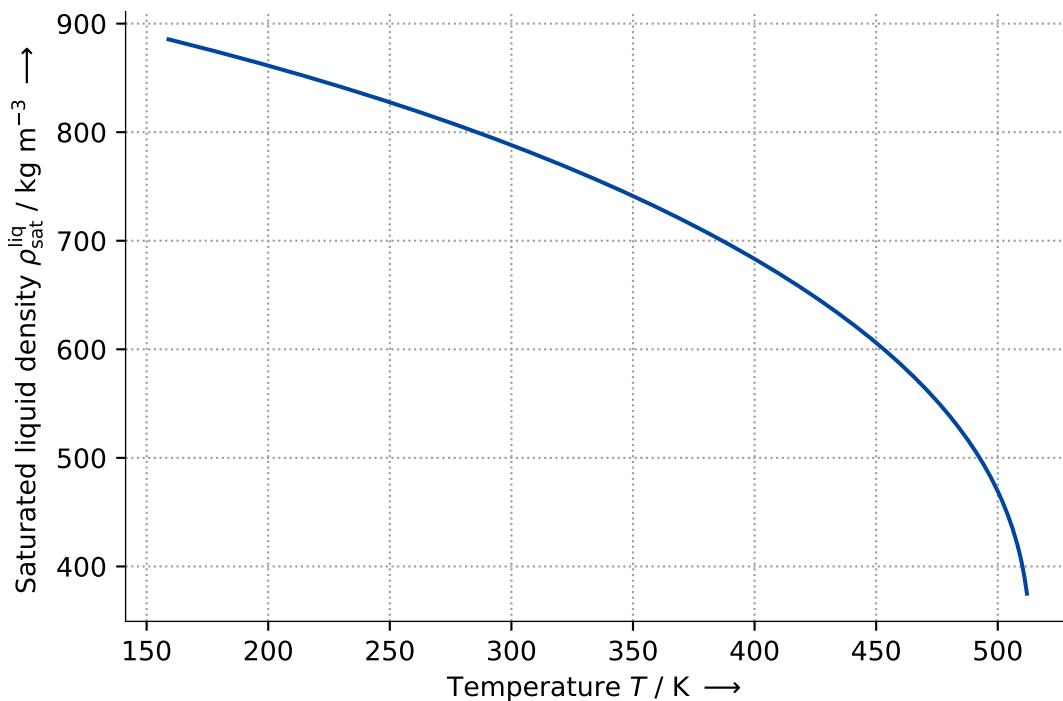
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.139000000e+02	$a_5$	-	-1.593705839e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.760000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.732186131e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-1.504979927e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	2.833717153e+00			

#### Validity:

Equation is approximately valid for  $159.0\text{K} \leq T \leq 513.9\text{K}$ .

#### Visualization:



#### 4.11.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Ethanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

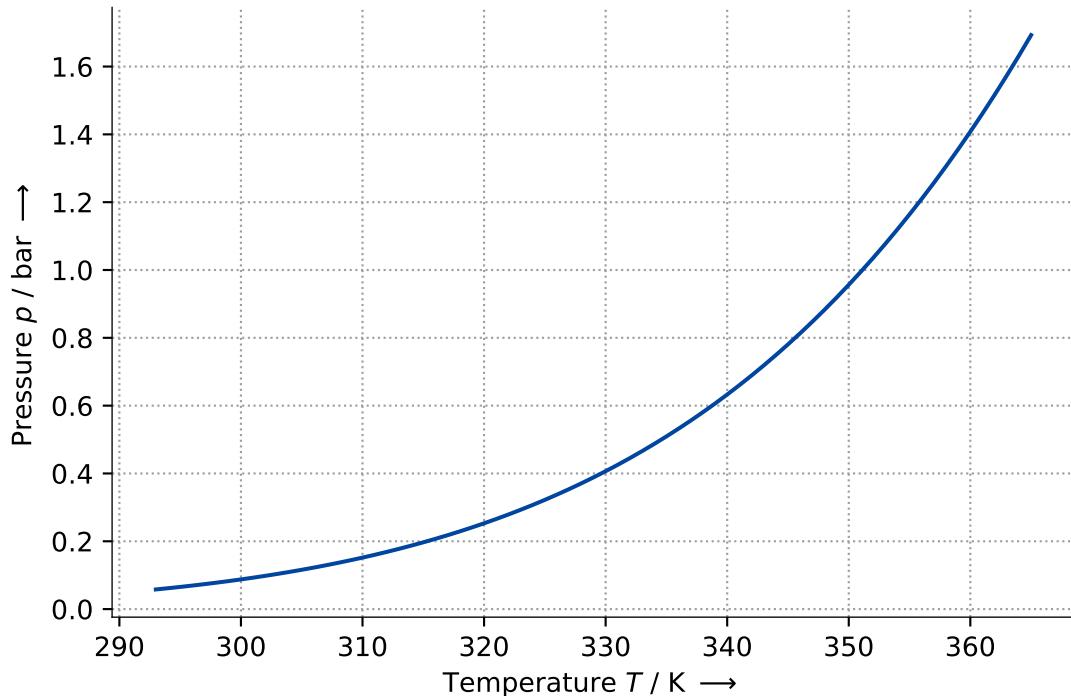
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.246770000e+00	$c$	K	-4.642400000e+01
$b$	K	1.598673000e+03			

##### Validity:

Equation is approximately valid for  $292.77\text{K} \leq T \leq 366.63\text{K}$ .

**Visualization:**



#### 4.11.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Ethanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

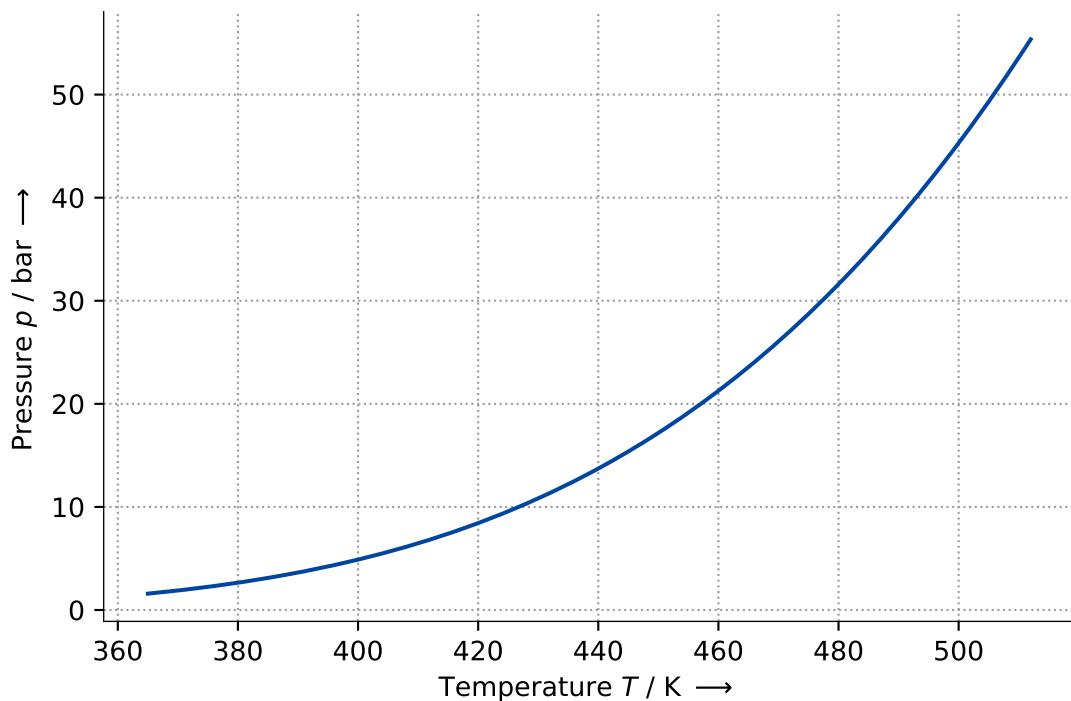
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.925310000e+00	$c$	K	-6.181900000e+01
$b$	K	1.432526000e+03			

#### Validity:

Equation is approximately valid for  $364.8 \text{K} \leq T \leq 513.91 \text{K}$ .

#### Visualization:



#### 4.11.5 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Ethanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

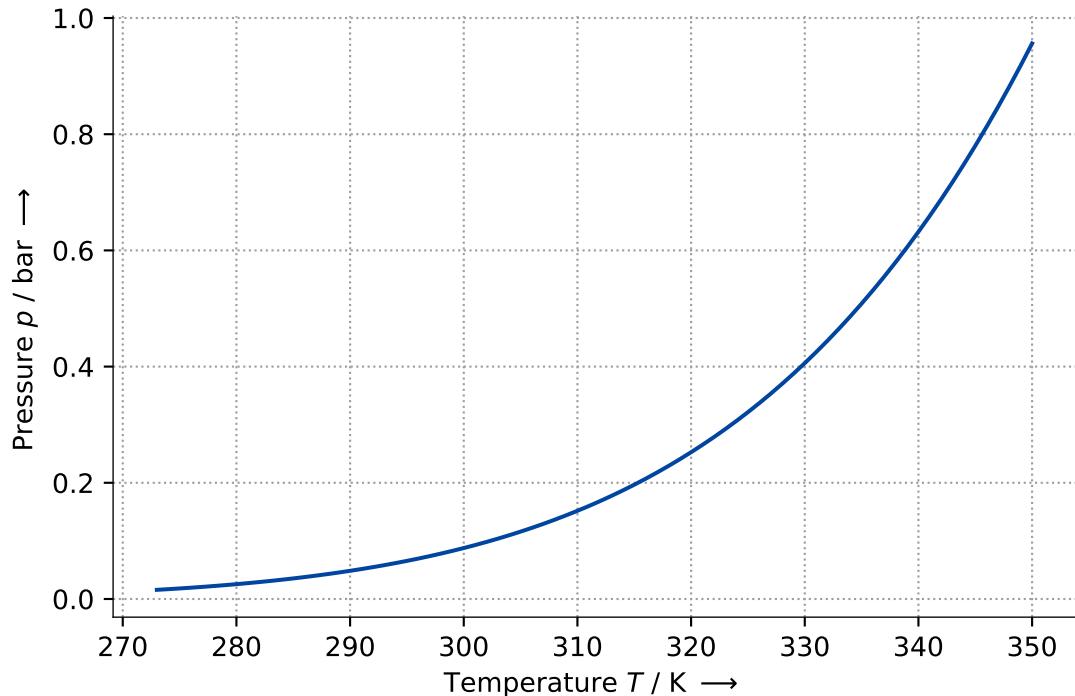
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.372290000e+00	$c$	K	-4.019100000e+01
$b$	K	1.670409000e+03			

#### Validity:

Equation is approximately valid for  $273.0\text{K} \leq T \leq 351.7\text{K}$ .

**Visualization:**



#### 4.11.6 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Ethanol
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Schroeder, J. A.; Penoncello, S. G.; Schroeder, J. S. (2014): A Fundamental Equation of State for Ethanol. In: Journal of Physical and Chemical Reference Data 43 (4), S. 43102. DOI: 10.1063/1.4895394.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

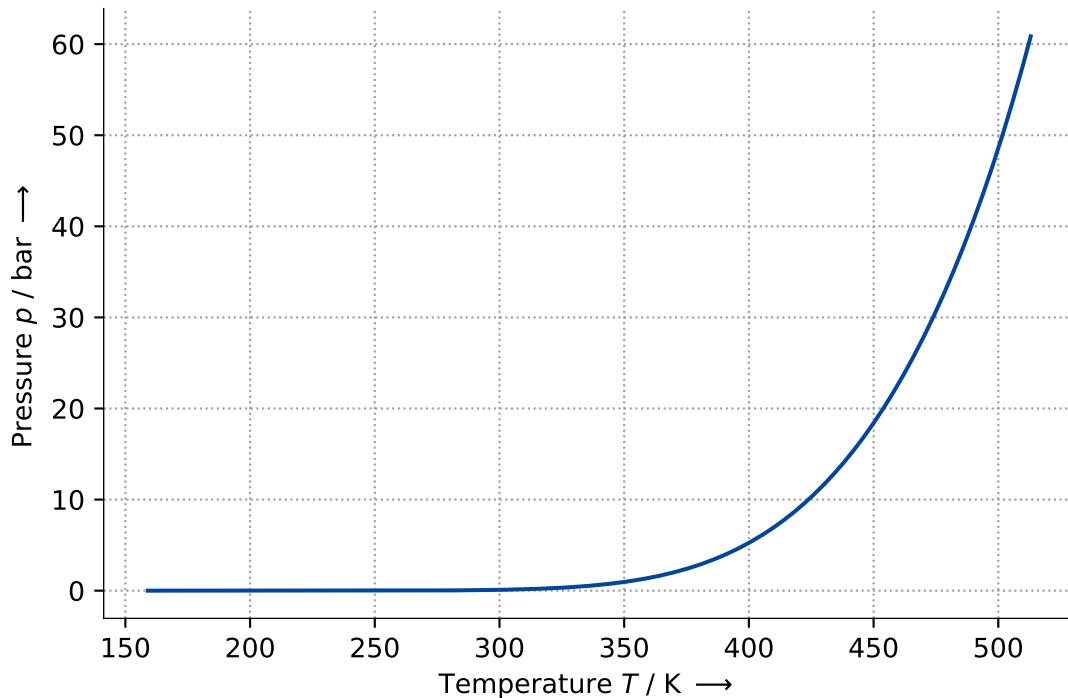
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.147100000e+02	$a_4$	-	5.313600000e+01
$p_{\text{crit}}$	Pa	6.268000000e+06	$b_4$	-	3.700000000e+00
$a_1$	-	-8.941610000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.617610000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-5.114280000e+01	$a_7$	-	0.000000000e+00
$b_3$	-	3.400000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $159.0\text{K} \leq T \leq 514.71\text{K}$ .

#### Visualization:



#### 4.11.7 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Ethanol
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

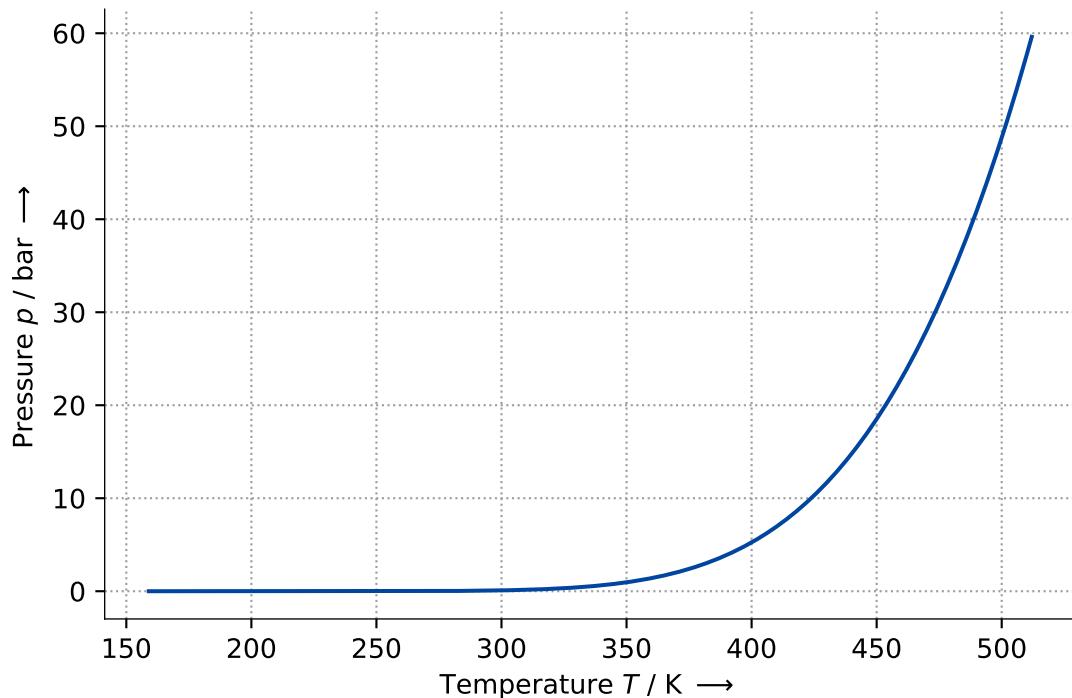
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	5.139000000e+02		$a_4$	-	-2.598600000e-01

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	6.148000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-8.338010000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	8.719000000e-02	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-3.305780000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $159.0\text{K} \leq T \leq 513.9\text{K}$ .

**Visualization:**

#### 4.11.8 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Ethanol
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

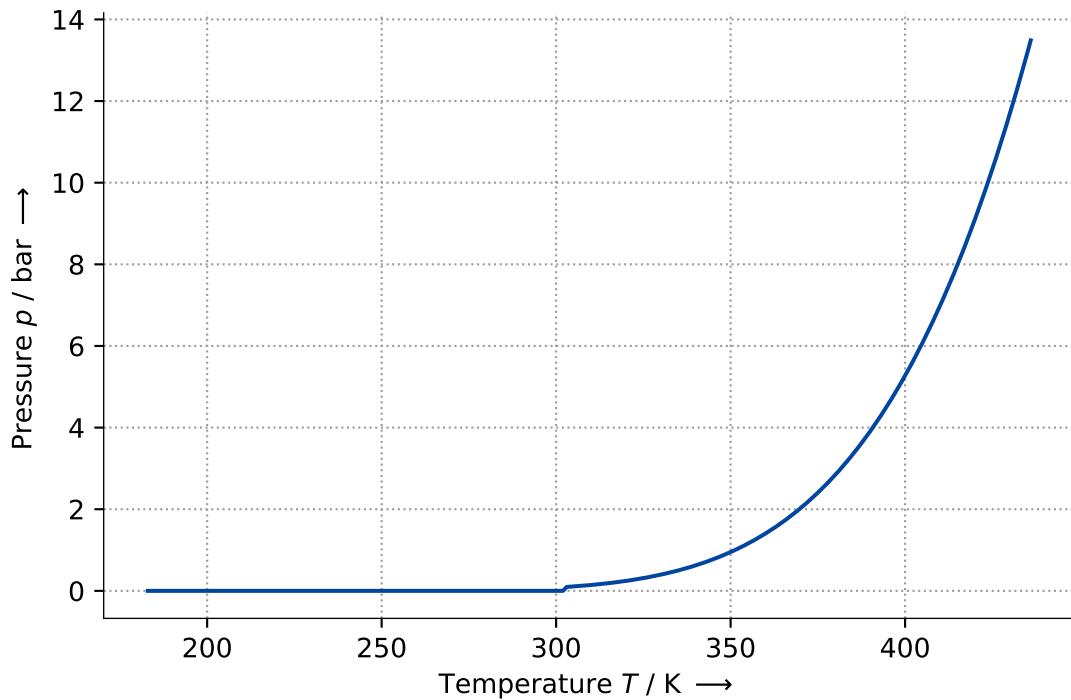
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.147100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	6.268000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	6.460000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $182.85\text{K} \leq T \leq 437.5035\text{K}$ .

#### Visualization:



#### 4.11.9 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Ethanol
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

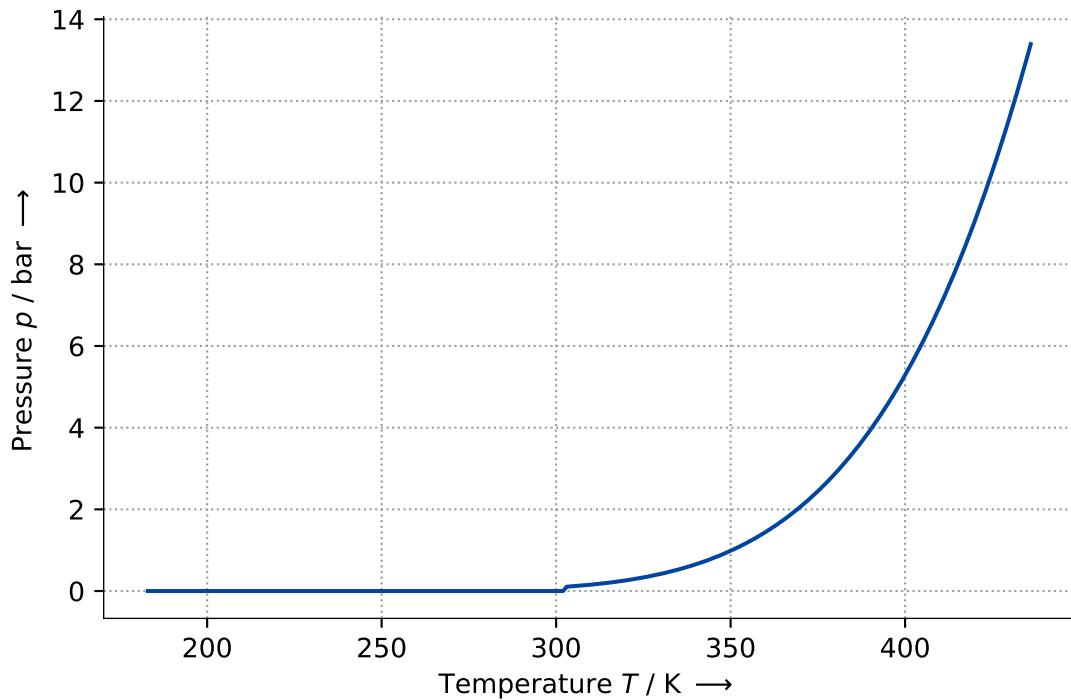
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.147100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	6.268000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	6.460000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $182.85\text{K} \leq T \leq 437.5035\text{K}$ .

### Visualization:



## 4.12 EthyleneGlycol

### 4.12.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	EthyleneGlycol
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	7.191500000e+02	$a_5$	-	-2.046264000e+00
$\rho_{\text{ref}}$	kg m <sup>-3</sup>	3.250000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	4.017209539e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-4.228480308e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	5.203231077e+00			

**Validity:**

Equation is approximately valid for  $260.6 \text{K} \leq T \leq 719.15 \text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'EthyleneGlycol'. Thus, data cannot be visualized!

#### 4.12.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	EthyleneGlycol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.970120000e+00	$c$	K	-8.499600000e+01
$b$	K	1.914951000e+03			

#### Validity:

Equation is approximately valid for  $323.0\text{K} \leq T \leq 473.0\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'EthyleneGlycol'. Thus, data cannot be visualized!

### 4.12.3 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	EthyleneGlycol
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	7.191500000e+02	$a_4$	-	-1.656600000e+00
$p_{\text{crit}}$	Pa	8.200000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.855750000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.067620000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-5.142710000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $260.6K \leq T \leq 719.15K$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'EthyleneGlycol'. Thus, data cannot be visualized!

#### 4.12.4 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	EthyleneGlycol
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	7.190000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	1.050900000e+07	$\beta_2$	-	0.000000000e+00
$\omega$	-	6.190000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $299.69\text{K} \leq T \leq 611.15\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'EthyleneGlycol'. Thus, data cannot be visualized!

#### 4.12.5 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	EthyleneGlycol
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	7.190000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	1.050900000e+07	$\beta_2$	-	0.000000000e+00
$\omega$	-	6.190000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $299.69\text{K} \leq T \leq 611.15\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'EthyleneGlycol'. Thus, data cannot be visualized!

## 4.13 Helium

### 4.13.1 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Helium
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.200000000e+00	$a_4$	-	8.835000000e-02
$p_{\text{crit}}$	Pa	2.270000000e+05	$b_4$	-	5.000000000e+00
$a_1$	-	-4.068560000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.043790000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	1.115940000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $2.1768\text{K} \leq T \leq 5.2\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Helium'. Thus, data cannot be visualized!

### 4.13.2 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Helium
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v-b} - \frac{a}{v(v+b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3}-1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.195300000e+00	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.283200000e+05	$\beta_2$	-	0.000000000e+00
$\omega$	-	-3.836000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $2.50332\text{K} \leq T \leq 4.416005\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Helium'. Thus, data cannot be visualized!

### 4.13.3 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Helium
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.195300000e+00	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.283200000e+05	$\beta_2$	-	0.000000000e+00
$\omega$	-	-3.836000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $2.50332\text{K} \leq T \leq 4.416005\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Helium'. Thus, data cannot be visualized!

## 4.14 Hexane

### 4.14.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Hexane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

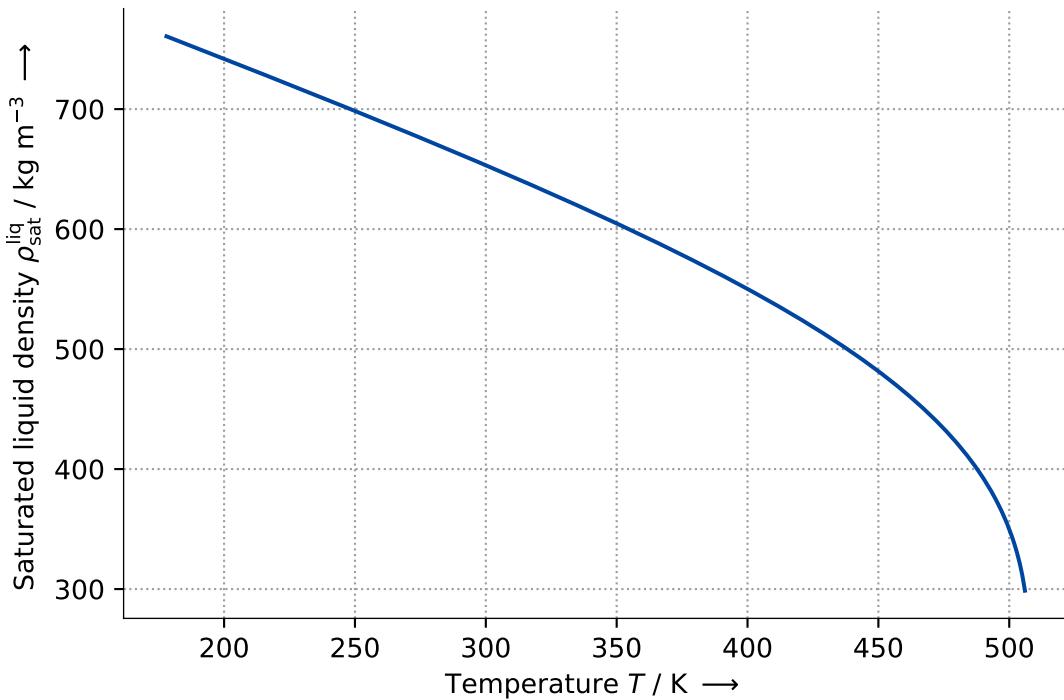
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.077900000e+02	$a_5$	-	1.544865022e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.230000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.409838565e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	3.940484305e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.270801794e+00			

#### Validity:

Equation is approximately valid for  $177.83\text{K} \leq T \leq 507.79\text{K}$ .

#### Visualization:



#### 4.14.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Hexane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

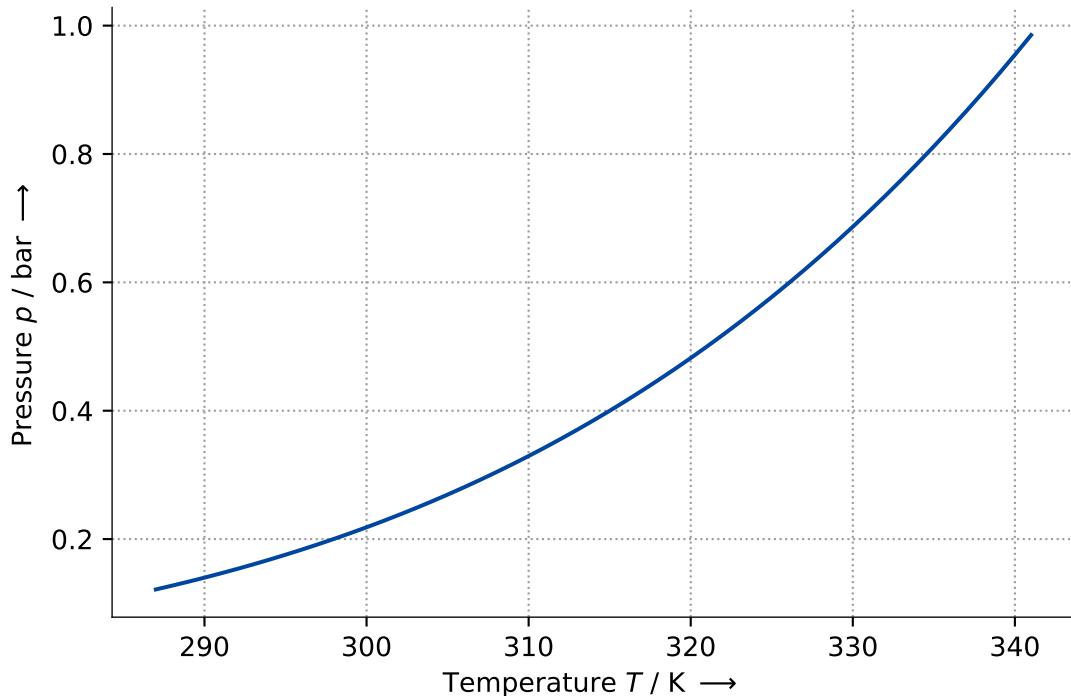
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.002660000e+00	$c$	K	-4.878400000e+01
$b$	K	1.171530000e+03			

#### Validity:

Equation is approximately valid for  $286.18\text{K} \leq T \leq 342.69\text{K}$ .

**Visualization:**



#### 4.14.3 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Hexane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

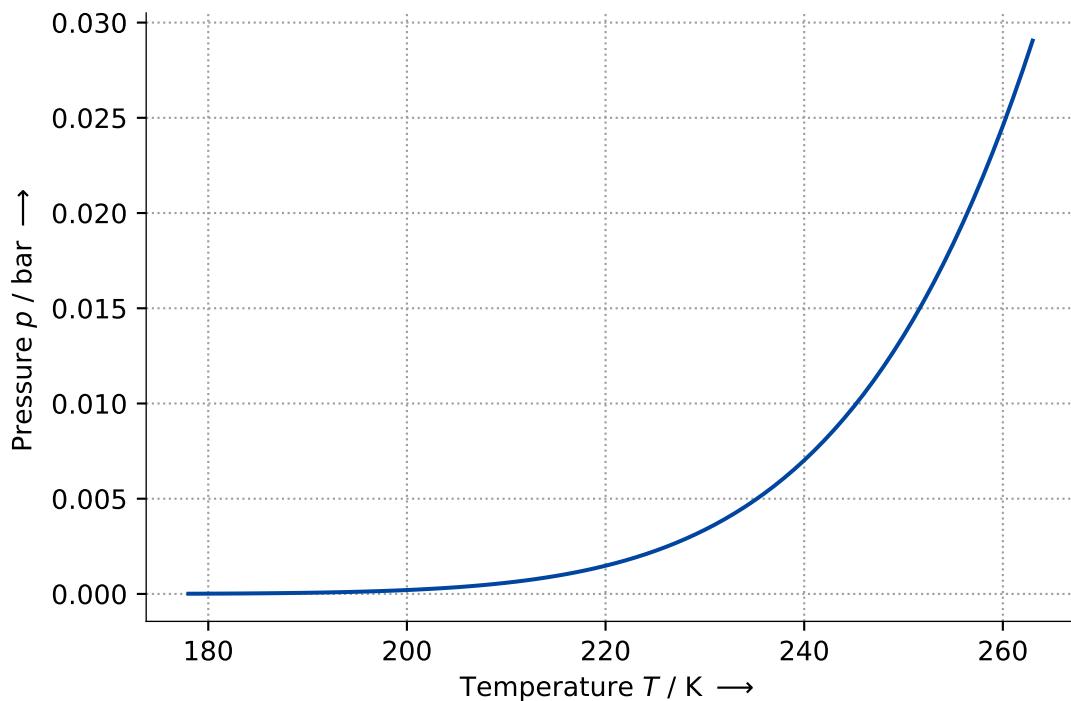
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.456040000e+00	$c$	K	-5.389300000e+01
$b$	K	1.044038000e+03			

#### Validity:

Equation is approximately valid for  $177.7 \text{K} \leq T \leq 264.93 \text{K}$ .

#### Visualization:



#### 4.14.4 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Hexane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

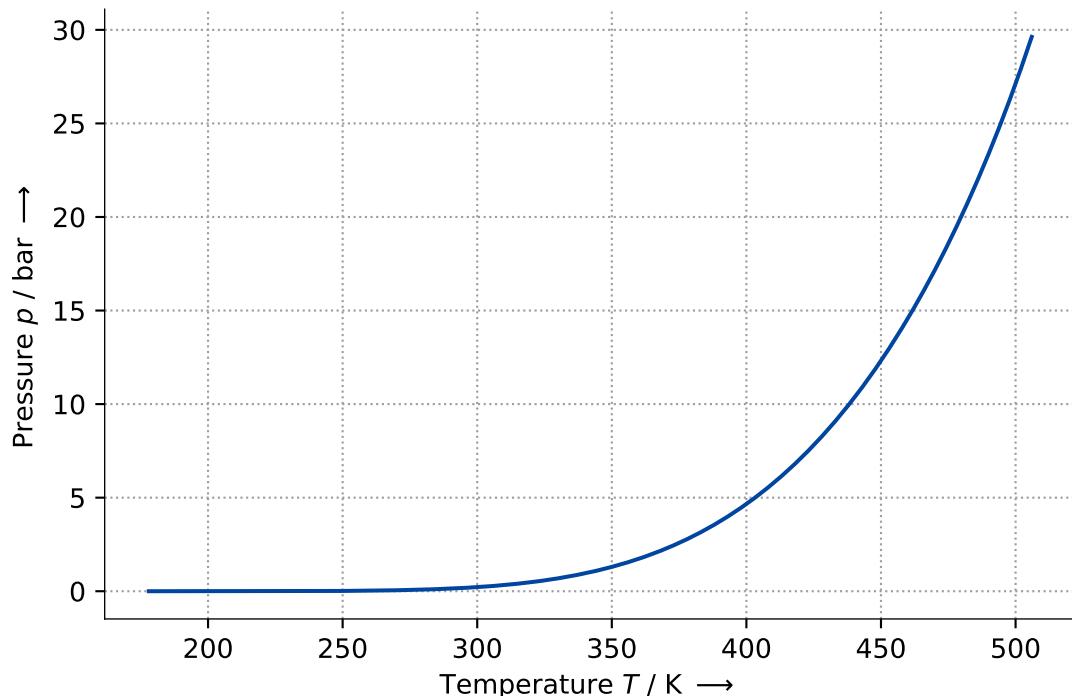
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	5.077900000e+02		$a_4$	-	-2.828240000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	3.042000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.610750000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.005270000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.741580000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $177.83\text{K} \leq T \leq 507.79\text{K}$ .

**Visualization:**

#### 4.14.5 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Hexane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

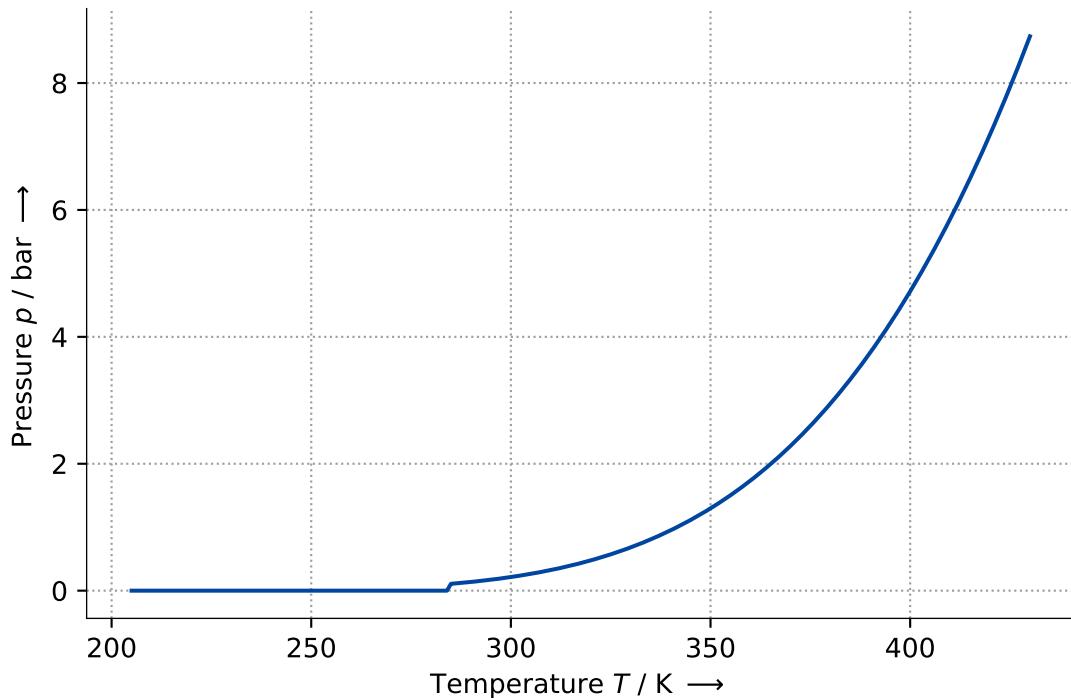
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.078200000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.044100000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.000000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $204.5045\text{K} \leq T \leq 431.647\text{K}$ .

#### Visualization:



#### 4.14.6 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	Hexane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

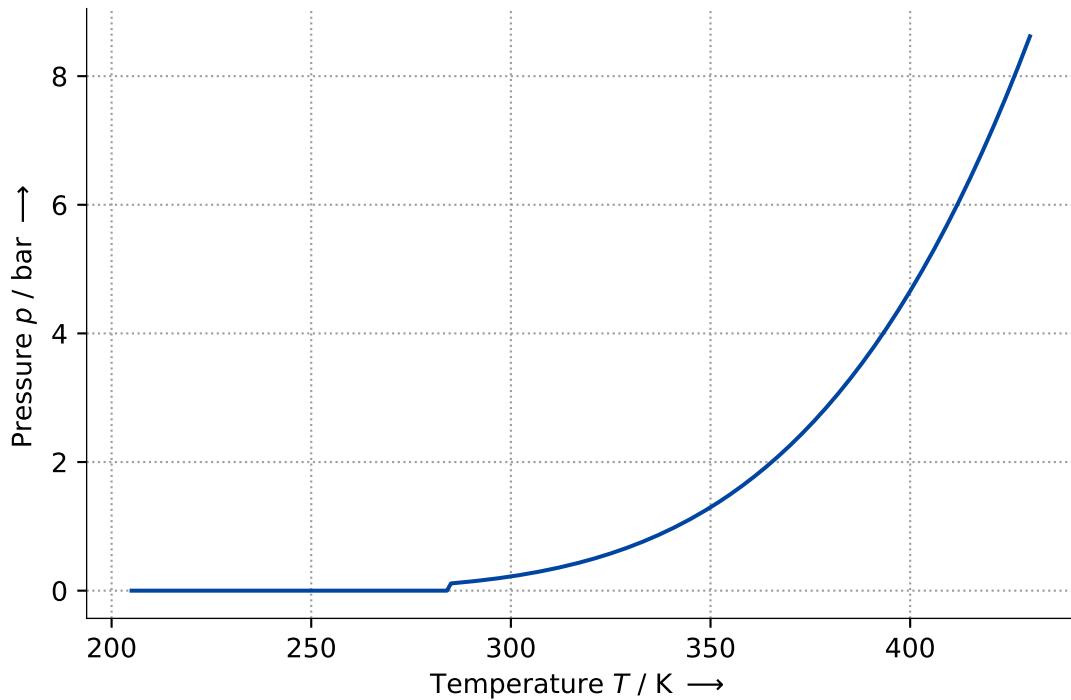
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.078200000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.044100000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.000000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $204.5045\text{K} \leq T \leq 431.647\text{K}$ .

### Visualization:



## 4.15 Isobutane

### 4.15.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Isobutane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Miyamoto, H.; Watanabe, K. (2002): A Thermodynamic Property Model for Fluid-Phase Isobutane. In: International Journal of Thermophysics 23 (2), S. 477–499. DOI: 10.1023/A:1015161519954.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

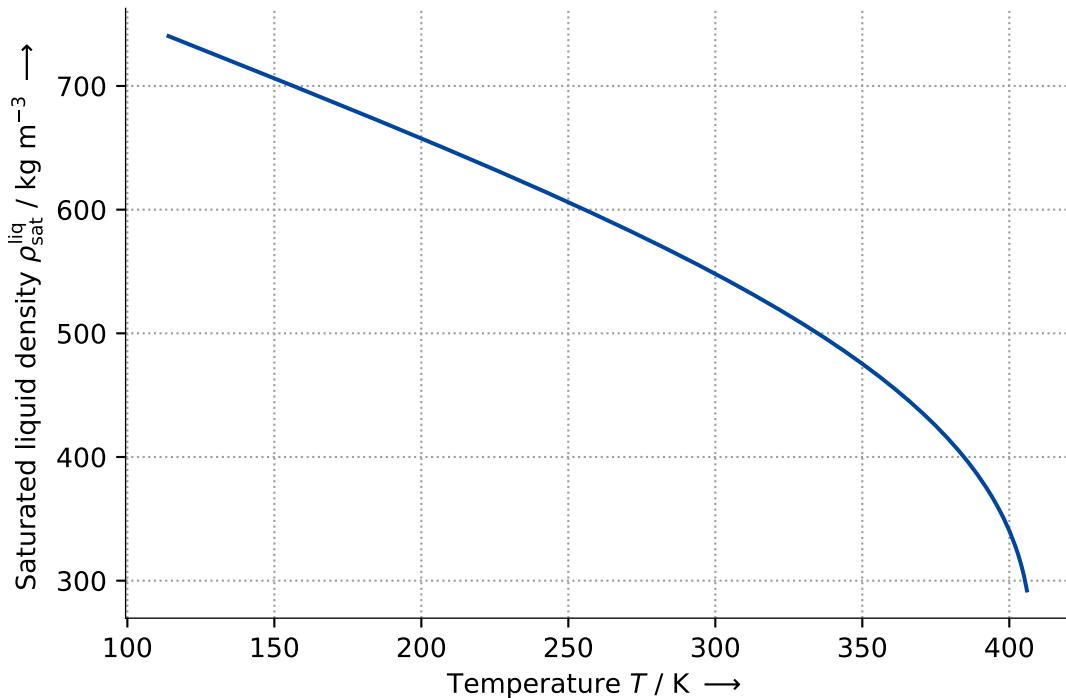
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$b_4$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.078170000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.243600000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.605620000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	3.300000000e-01	$b_6$	-	0.000000000e+00
$a_2$	-	-2.374095000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	1.000000000e+00	$b_7$	-	0.000000000e+00
$a_3$	-	2.098763000e+00	$a_8$	-	0.000000000e+00
$b_3$	-	1.100000000e+00	$b_8$	-	0.000000000e+00
$a_4$	-	0.000000000e+00			

---

### Validity:

Equation is approximately valid for  $113.73\text{K} \leq T \leq 407.817\text{K}$ .

### Visualization:



#### 4.15.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Isobutane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

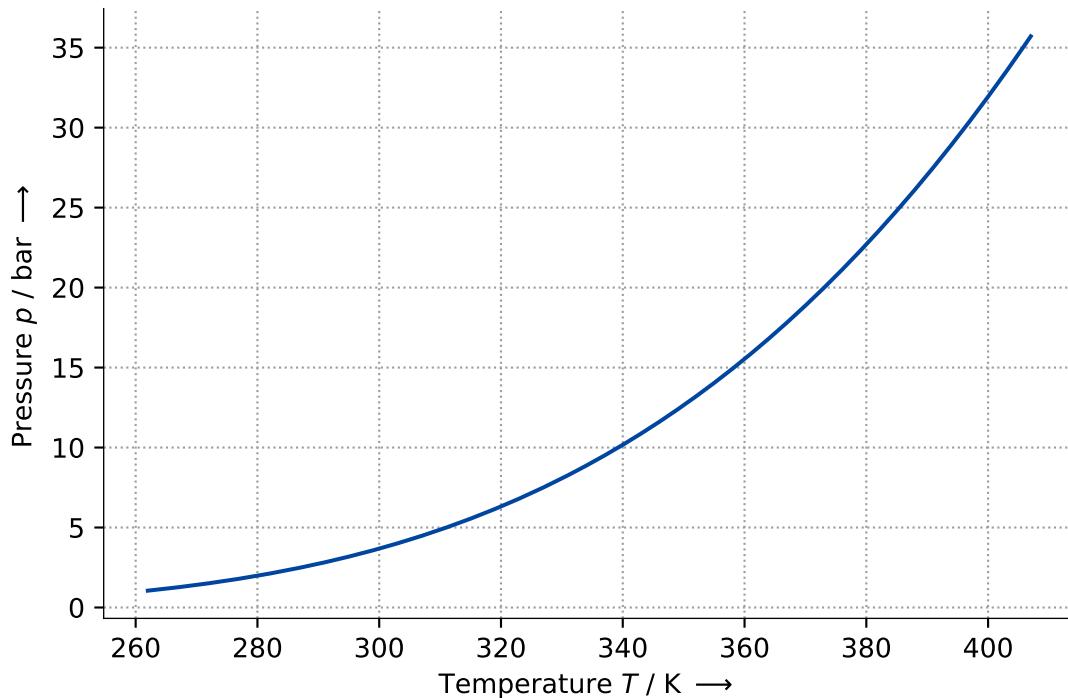
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.328100000e+00	$c$	K	9.180000000e-01
$b$	K	1.132108000e+03			

#### Validity:

Equation is approximately valid for  $261.31\text{K} \leq T \leq 408.12\text{K}$ .

#### Visualization:



#### 4.15.3 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Isobutane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

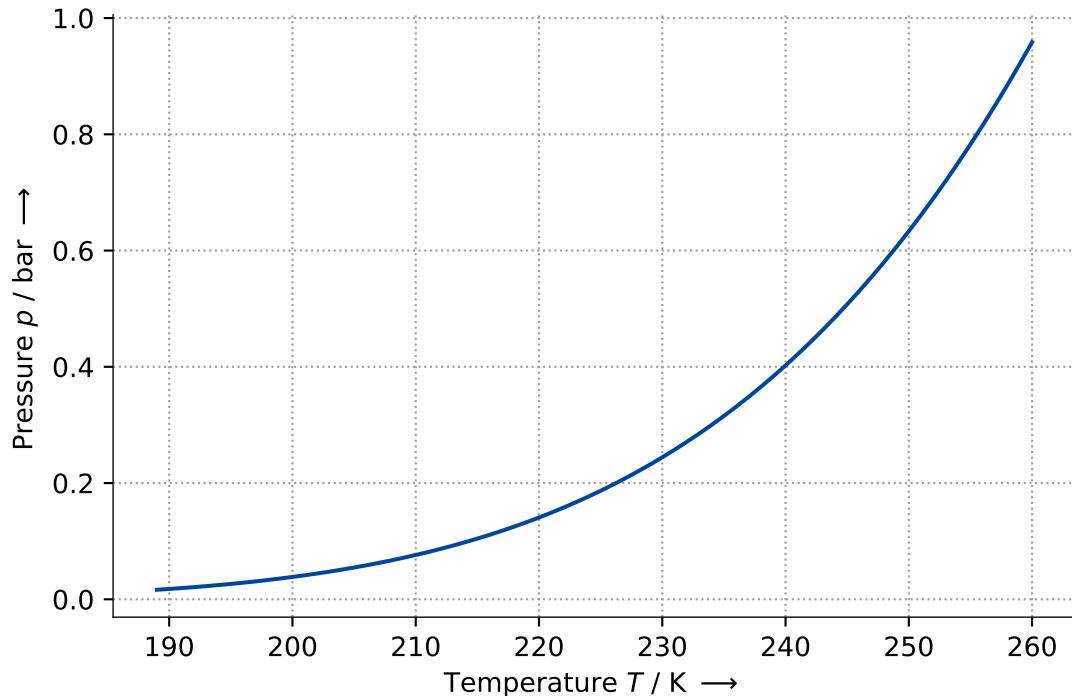
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.944170000e+00	$c$	K	-2.980800000e+01
$b$	K	9.121410000e+02			

#### Validity:

Equation is approximately valid for  $188.06\text{K} \leq T \leq 261.54\text{K}$ .

**Visualization:**



#### 4.15.4 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Isobutane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Bücker, D.; Wagner, W. (2006): Reference Equations of State for the Thermodynamic Properties of Fluid Phase n-Butane and Isobutane. In: Journal of Physical and Chemical Reference Data 35 (2), S. 929–1019. DOI: 10.1063/1.1901687.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

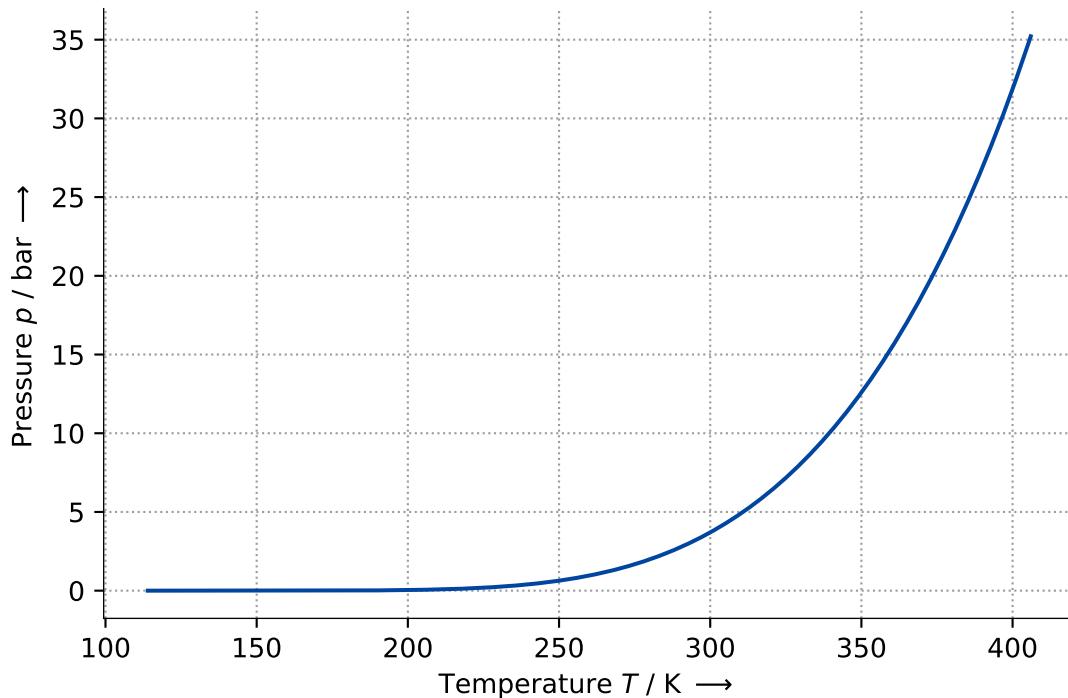
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	4.078100000e+02	$a_4$	-	-2.561909940e+00
$p_{\text{crit}}$	Pa	3.629000000e+06	$b_4$	-	4.500000000e+00
$a_1$	-	-6.850931030e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.365431980e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.325426910e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $113.73\text{K} \leq T \leq 407.81\text{K}$ .

#### Visualization:



#### 4.15.5 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Isobutane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Miyamoto, H.; Watanabe, K. (2002): A Thermodynamic Property Model for Fluid-Phase Isobutane. In: International Journal of Thermophysics 23 (2), S. 477–499. DOI: 10.1023/A:1015161519954.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

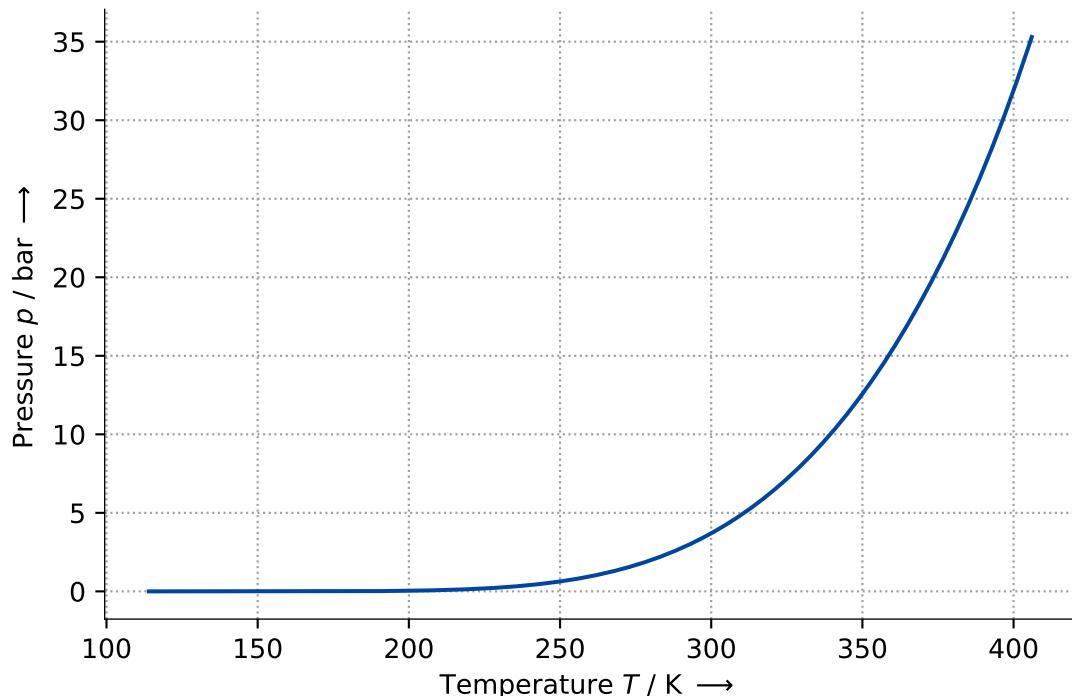
$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	4.078170000e+02	$a_4$	-	-2.191970000e+00
$p_{\text{crit}}$	Pa	3.640000000e+06	$b_4$	-	4.500000000e+00
$a_1$	-	-6.995565000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.754758000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.833831000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $113.73\text{K} \leq T \leq 407.817\text{K}$ .

**Visualization:**

#### 4.15.6 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Isobutane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

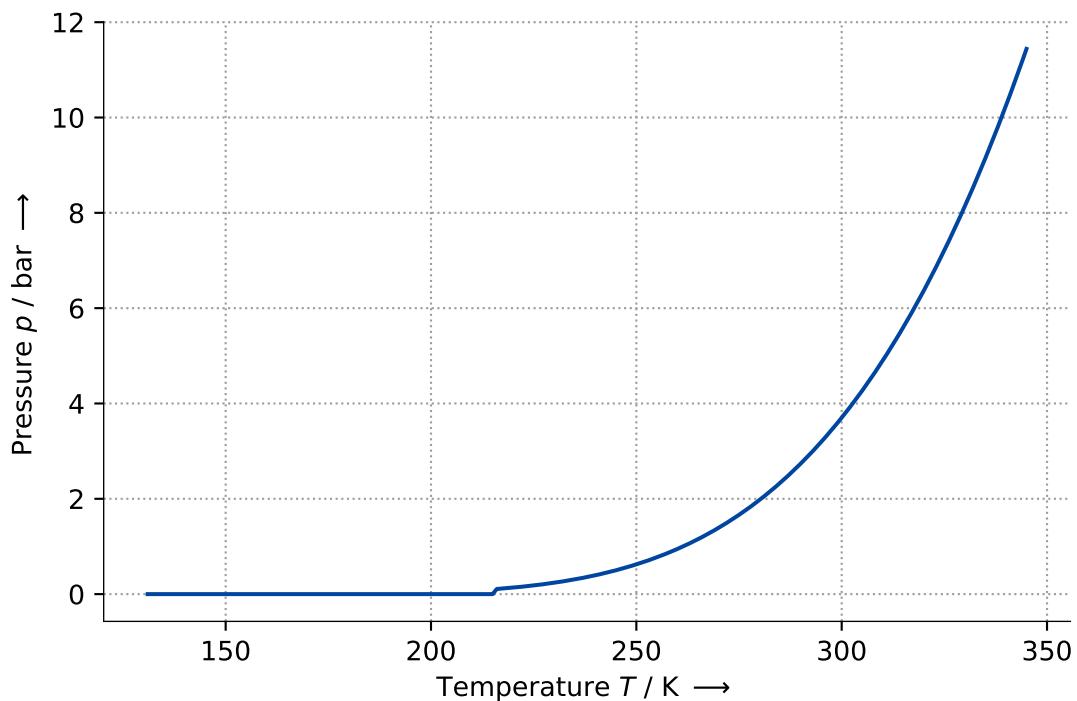
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.078100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.629000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.840000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $130.7895\text{K} \leq T \leq 346.6385\text{K}$ .

#### Visualization:



#### 4.15.7 Vapor Pressure - EoS Cubic - ID 2

---

<b>Name:</b>	Isobutane
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

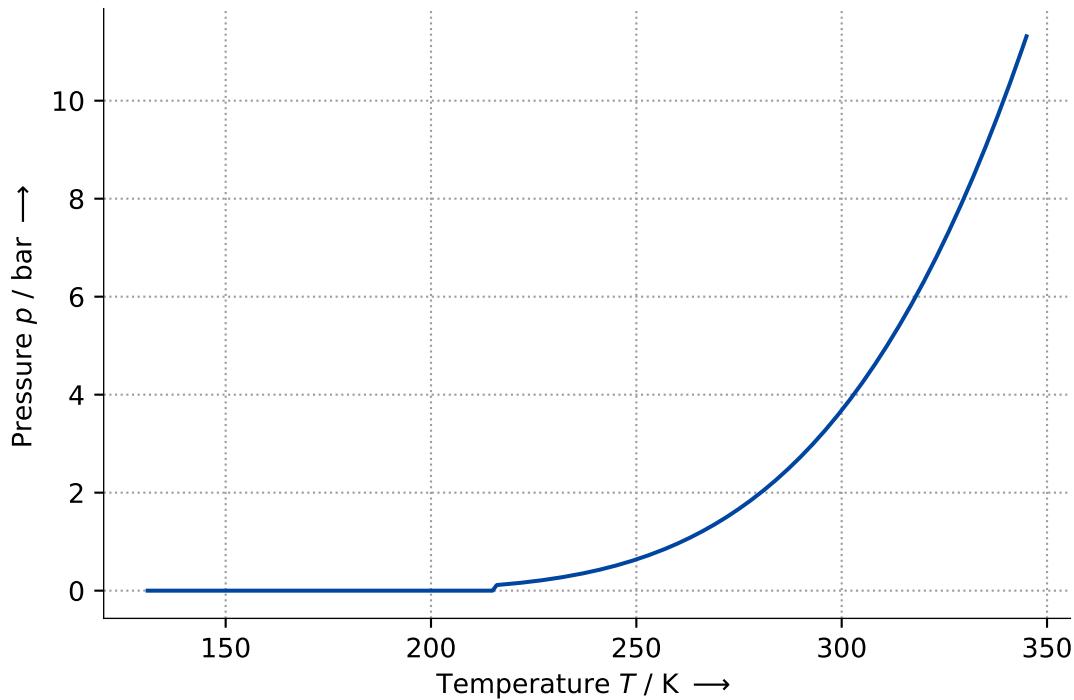
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.078100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.629000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.840000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $130.7895\text{K} \leq T \leq 346.6385\text{K}$ .

### Visualization:



## 4.16 Krypton

### 4.16.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Krypton
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	2.094800000e+02	$a_5$	-	1.963675824e-01
$\rho_{\text{ref}}$	kg m <sup>-3</sup>	9.100000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.771438462e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	3.763043956e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	1.437058242e-01			

**Validity:**

Equation is approximately valid for  $115.78\text{K} \leq T \leq 209.48\text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'Krypton'. Thus, data cannot be visualized!

#### 4.16.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Krypton
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.206400000e+00	$c$	K	8.855000000e+00
$b$	K	5.390040000e+02			

#### Validity:

Equation is approximately valid for  $126.68\text{K} \leq T \leq 208.0\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Krypton'. Thus, data cannot be visualized!

## 4.16.3 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Krypton
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.200000000e+00	$a_4$	-	-1.300120000e+00
$p_{\text{crit}}$	Pa	2.270000000e+05	$b_4$	-	5.000000000e+00
$a_1$	-	-5.983960000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.343340000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-6.652100000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $115.78\text{K} \leq T \leq 5.2\text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'Krypton'. Thus, data cannot be visualized!

#### 4.16.4 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Krypton
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	2.094800000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	5.525000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	-8.940000000e-04	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $133.147\text{K} \leq T \leq 178.058\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Krypton'. Thus, data cannot be visualized!

#### 4.16.5 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Krypton
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	2.094800000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	5.525000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	-8.940000000e-04	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $133.147\text{K} \leq T \leq 178.058\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Krypton'. Thus, data cannot be visualized!

## 4.17 Methane

### 4.17.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Methane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Setzmann, U.; Wagner, W. (1991): A New Equation of State and Tables of Thermodynamic Properties for Methane Covering the Range from the Melting Line to 625 K at Pressures up to 100 MPa. In: Journal of Physical and Chemical Reference Data 20 (6), S. 1061–1155. DOI: 10.1063/1.555898.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\begin{aligned}\rho_{\text{sat}}^{\text{liq}} &= \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with} \\ \Omega &= \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and} \\ \xi &= 1 - \theta, \text{ and} \\ \theta &= T/T_{\text{crit}}.\end{aligned}$$

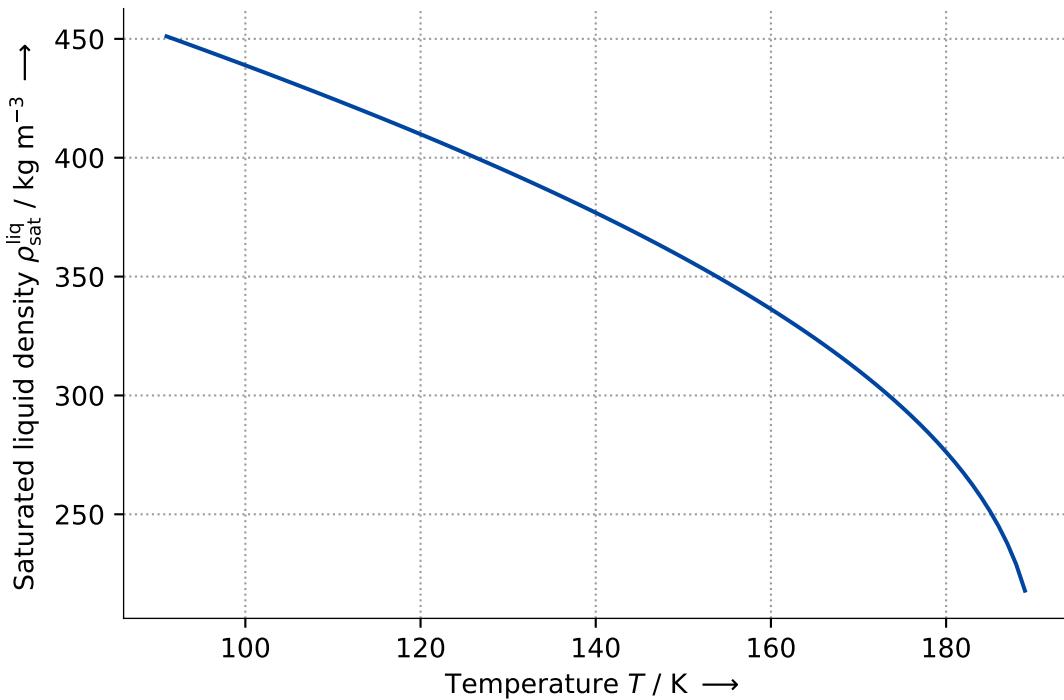
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$b_4$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.905640000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	1.626600000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.990638900e+00	$a_6$	-	0.000000000e+00
$b_1$	-	3.540000000e-01	$b_6$	-	0.000000000e+00
$a_2$	-	-7.875619700e-01	$a_7$	-	0.000000000e+00
$b_2$	-	5.000000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	3.697672300e-02	$a_8$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_8$	-	0.000000000e+00
$a_4$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $90.694\text{K} \leq T \leq 190.564\text{K}$ .

#### Visualization:



#### 4.17.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Methane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

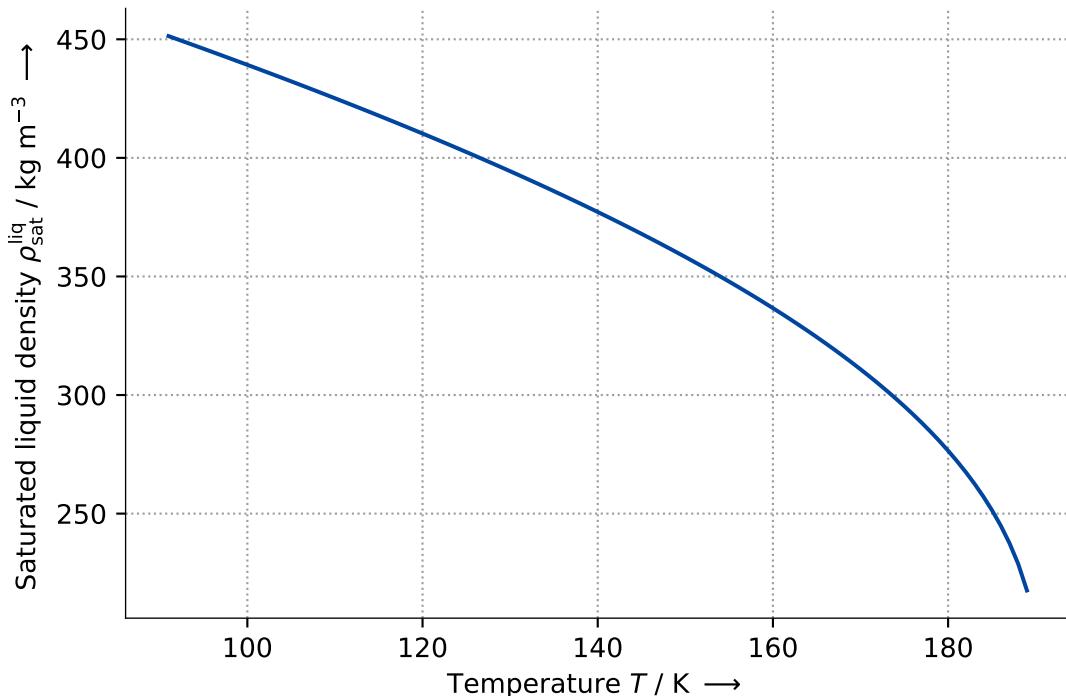
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	1.905600000e+02	$a_5$	-	4.292723926e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	1.630000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.643309203e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	7.938392638e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-4.515766871e-01			

**Validity:**

Equation is approximately valid for  $90.694\text{K} \leq T \leq 190.56\text{K}$ .

**Visualization:**

#### 4.17.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

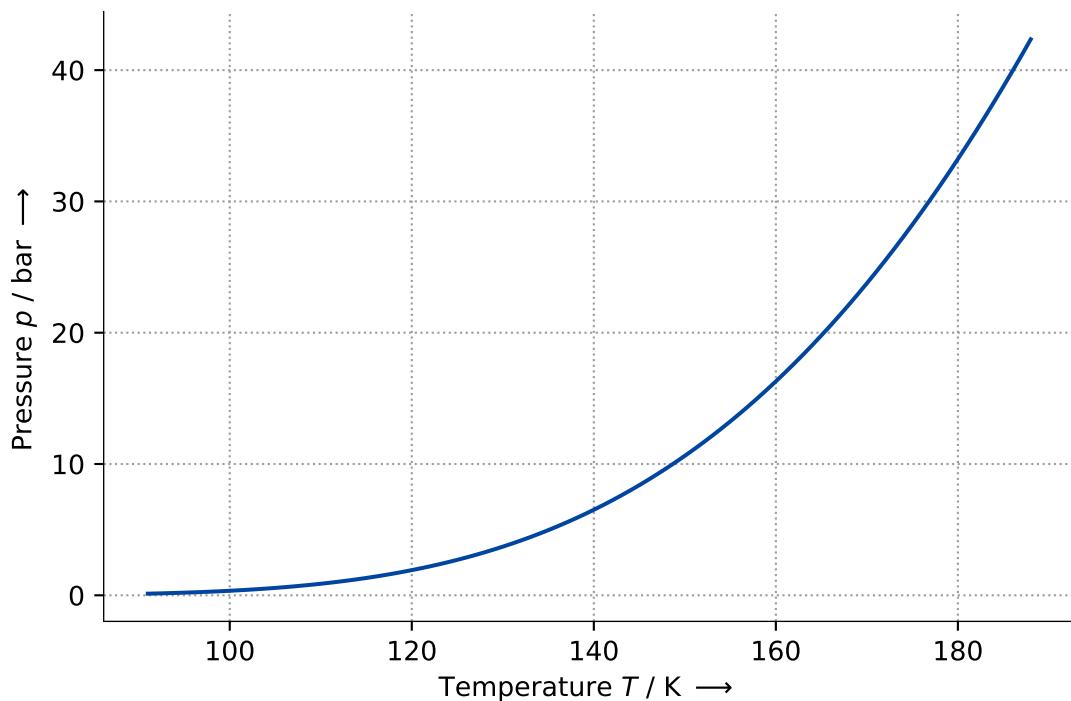
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.989500000e+00	$c$	K	-4.900000000e-01
$b$	K	4.430280000e+02			

#### Validity:

Equation is approximately valid for  $90.99\text{K} \leq T \leq 189.99\text{K}$ .

#### Visualization:



#### 4.17.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

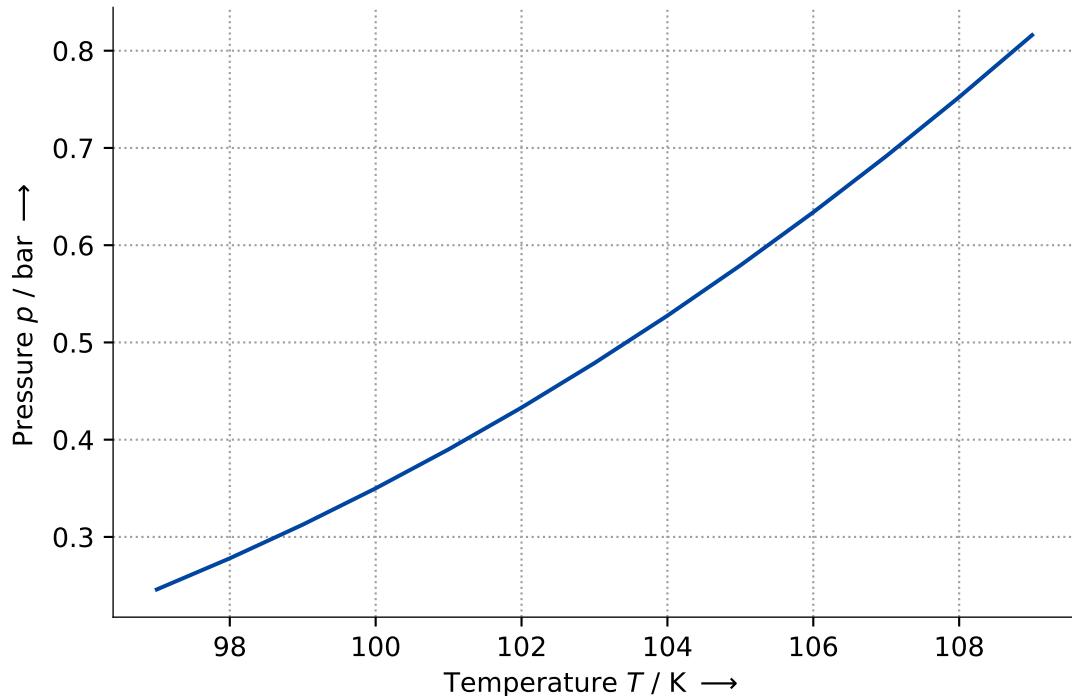
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	2.002530000e+00	$c$	K	-4.882300000e+01
$b$	K	1.258190000e+02			

#### Validity:

Equation is approximately valid for  $96.89\text{K} \leq T \leq 110.19\text{K}$ .

**Visualization:**



#### 4.17.5 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

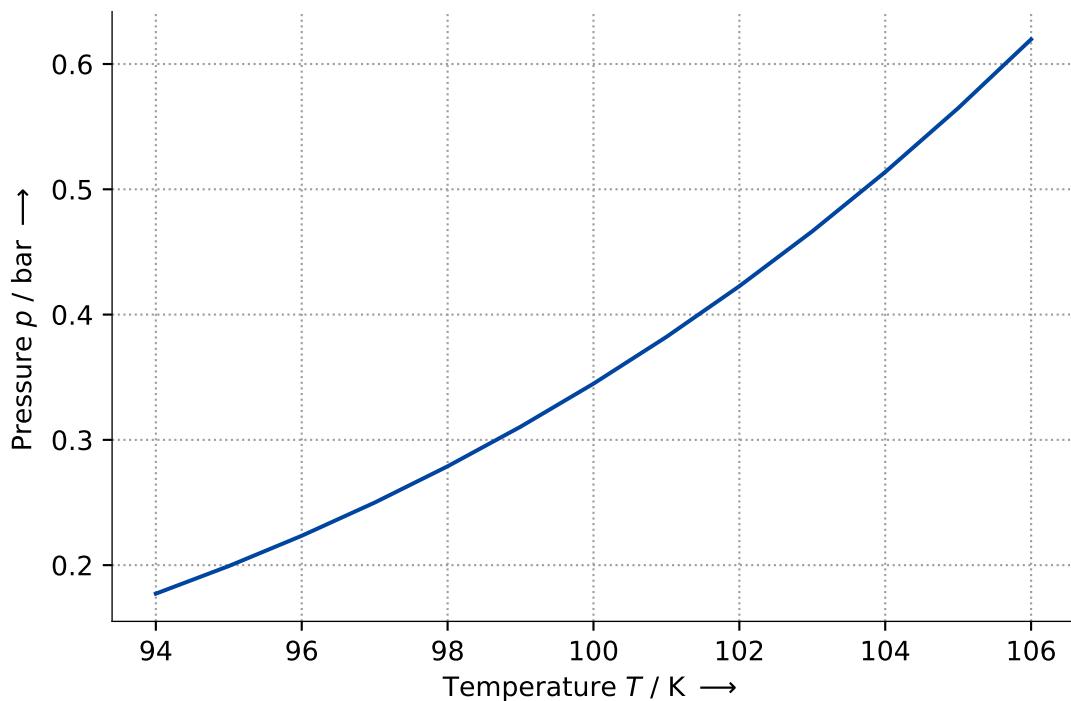
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.802350000e+00	$c$	K	-5.479000000e+00
$b$	K	4.031060000e+02			

#### Validity:

Equation is approximately valid for  $93.04 \text{K} \leq T \leq 107.84 \text{K}$ .

#### Visualization:



#### 4.17.6 Vapor Pressure - Antoine - ID 4

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	4
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

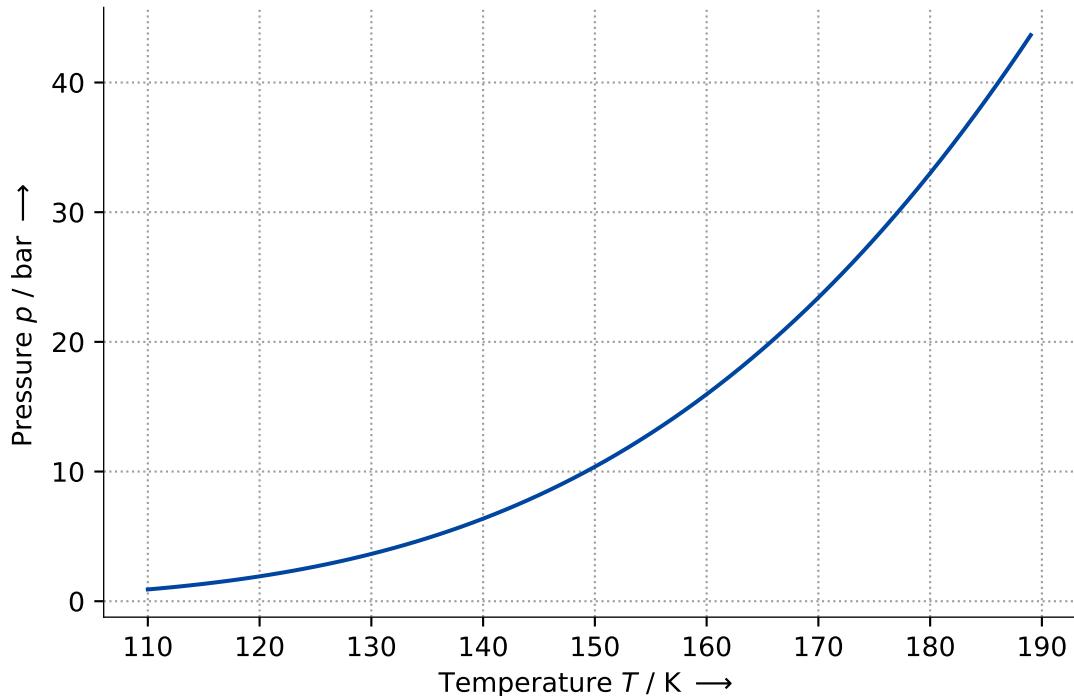
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.220610000e+00	$c$	K	1.122300000e+01
$b$	K	5.166890000e+02			

#### Validity:

Equation is approximately valid for  $110.0\text{K} \leq T \leq 190.5\text{K}$ .

**Visualization:**



#### 4.17.7 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Setzmann, U.; Wagner, W. (1991): A New Equation of State and Tables of Thermodynamic Properties for Methane Covering the Range from the Melting Line to 625 K at Pressures up to 100 MPa. In: Journal of Physical and Chemical Reference Data 20 (6), S. 1061–1155. DOI: 10.1063/1.555898.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

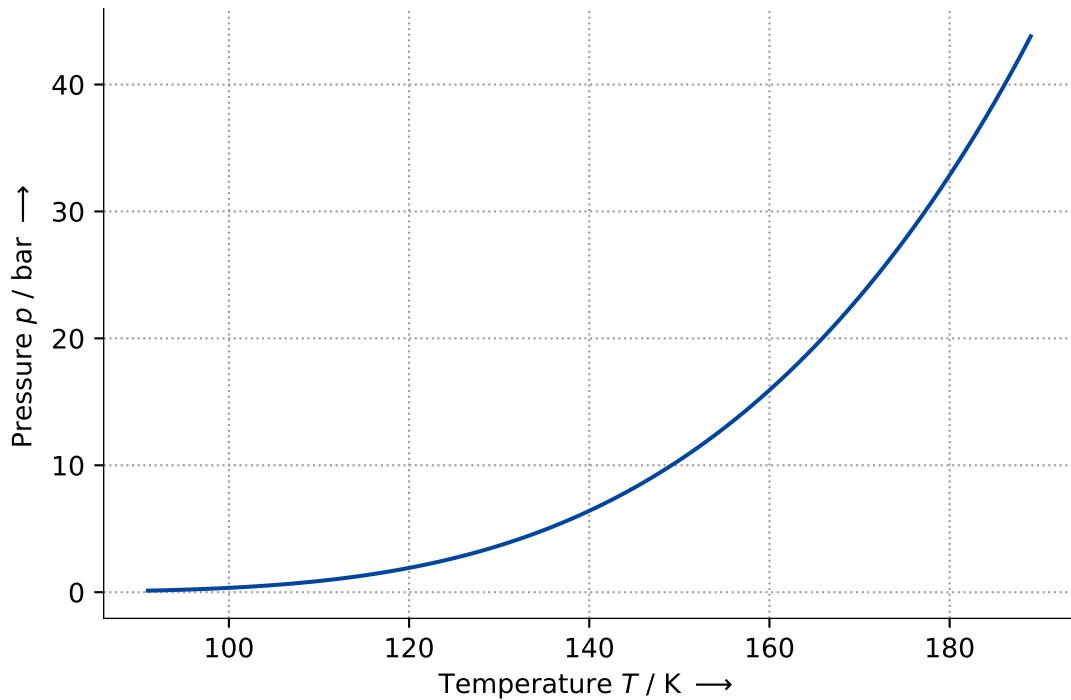
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	1.905640000e+02	$a_4$	-	-1.443048000e+00
$p_{\text{crit}}$	Pa	4.599200000e+06	$b_4$	-	4.500000000e+00
$a_1$	-	-6.036219000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.409353000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-4.945199000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $90.694\text{K} \leq T \leq 190.564\text{K}$ .

#### Visualization:



#### 4.17.8 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

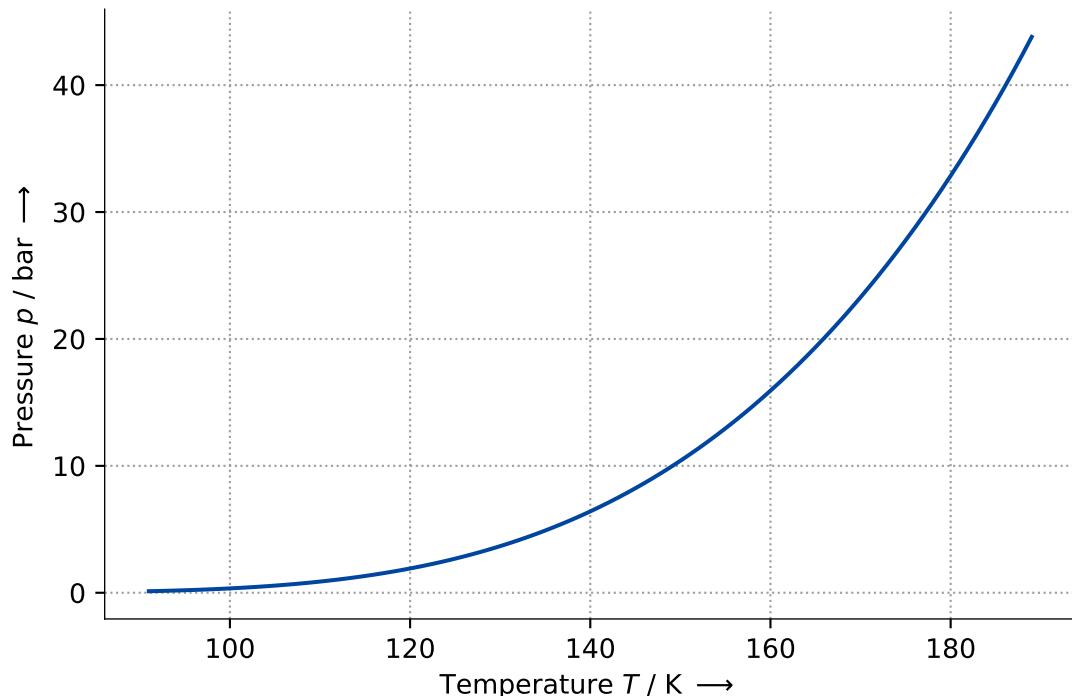
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	1.905600000e+02		$a_4$	-	-1.376480000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	4.599000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-6.023880000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.268130000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-5.694800000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $90.694\text{K} \leq T \leq 190.56\text{K}$ .

**Visualization:**

#### 4.17.9 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

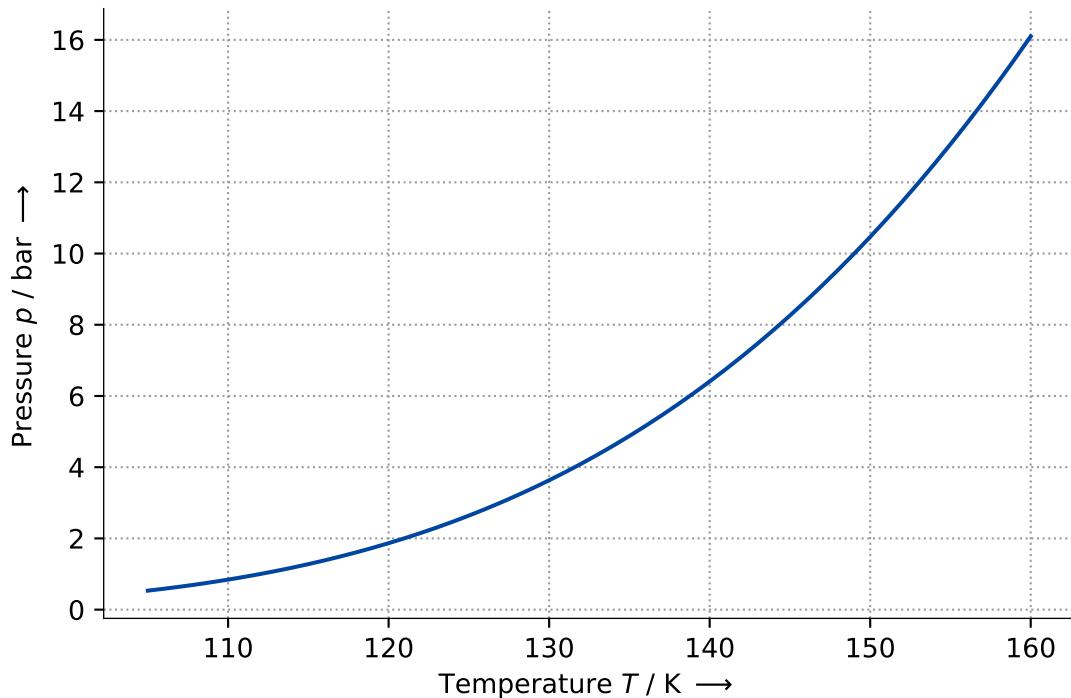
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.905600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.599200000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.142000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $104.2981\text{K} \leq T \leq 161.976\text{K}$ .

#### Visualization:



#### 4.17.10 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Methane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

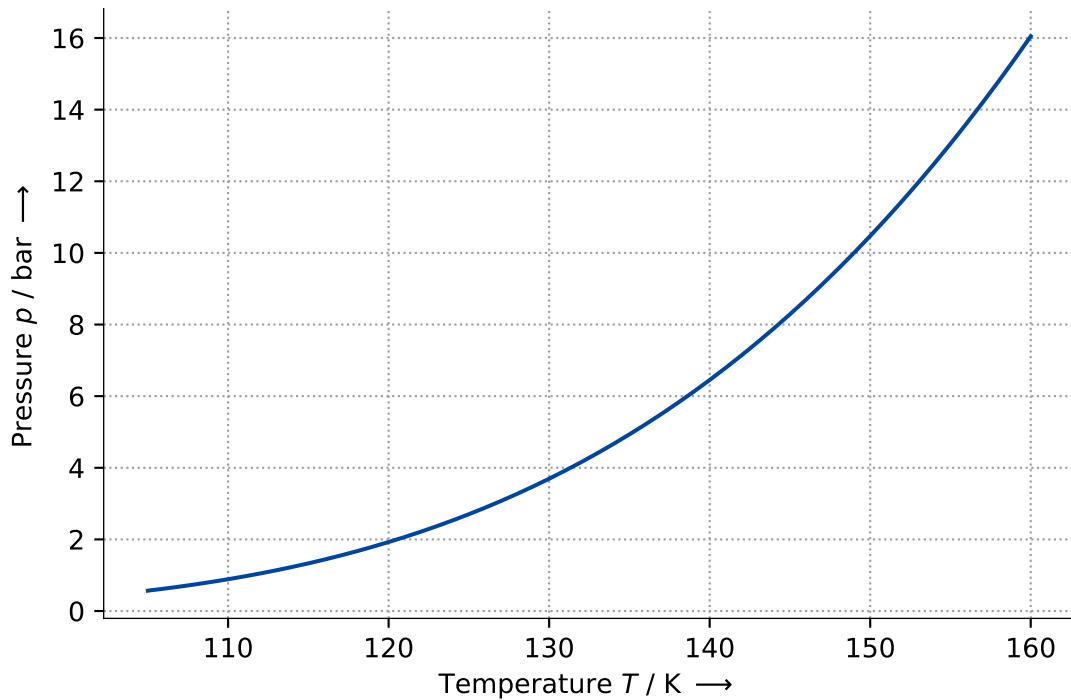
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.905600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.599200000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.142000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $104.2981\text{K} \leq T \leq 161.976\text{K}$ .

### Visualization:



## 4.18 Methanol

### 4.18.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Methanol
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

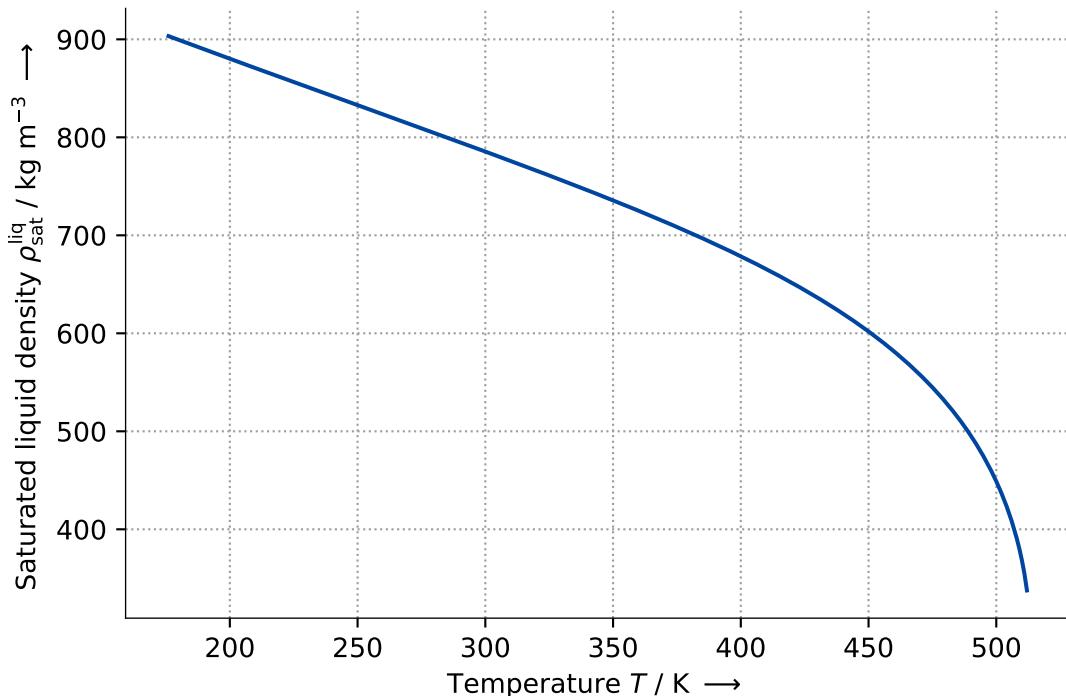
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.133800000e+02	$a_5$	-	6.843041135e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.820000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	5.842592199e-01	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	8.006268794e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.257337695e+01			

**Validity:**

Equation is approximately valid for  $175.61\text{K} \leq T \leq 513.38\text{K}$ .

**Visualization:**

#### 4.18.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Methanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

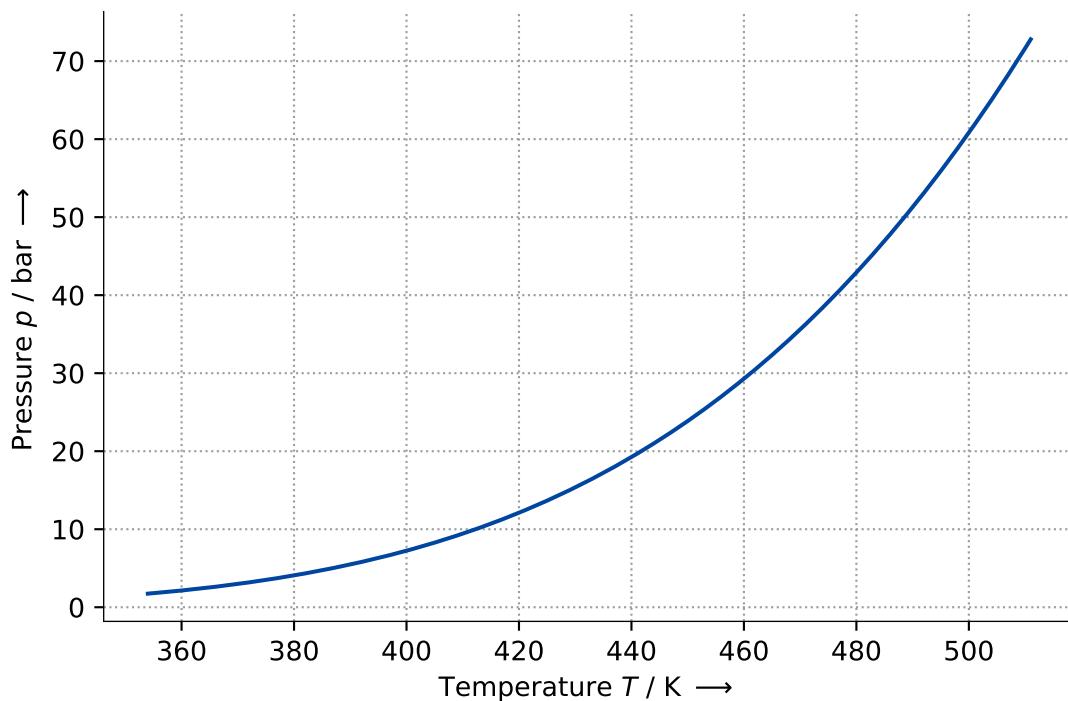
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.158530000e+00	$c$	K	-3.484600000e+01
$b$	K	1.569613000e+03			

**Validity:**

Equation is approximately valid for  $353.5 \text{K} \leq T \leq 512.63 \text{K}$ .

**Visualization:**



#### 4.18.3 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Methanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

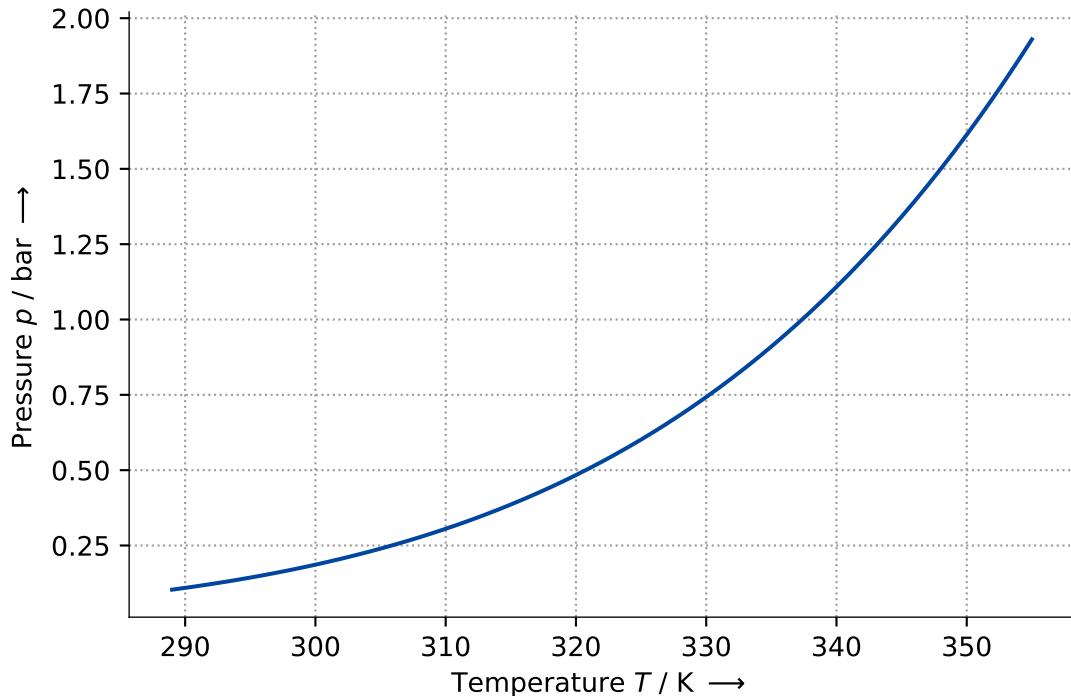
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.204090000e+00	$c$	K	-3.350000000e+01
$b$	K	1.581341000e+03			

#### Validity:

Equation is approximately valid for  $288.1\text{K} \leq T \leq 356.83\text{K}$ .

**Visualization:**



#### 4.18.4 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Methanol
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

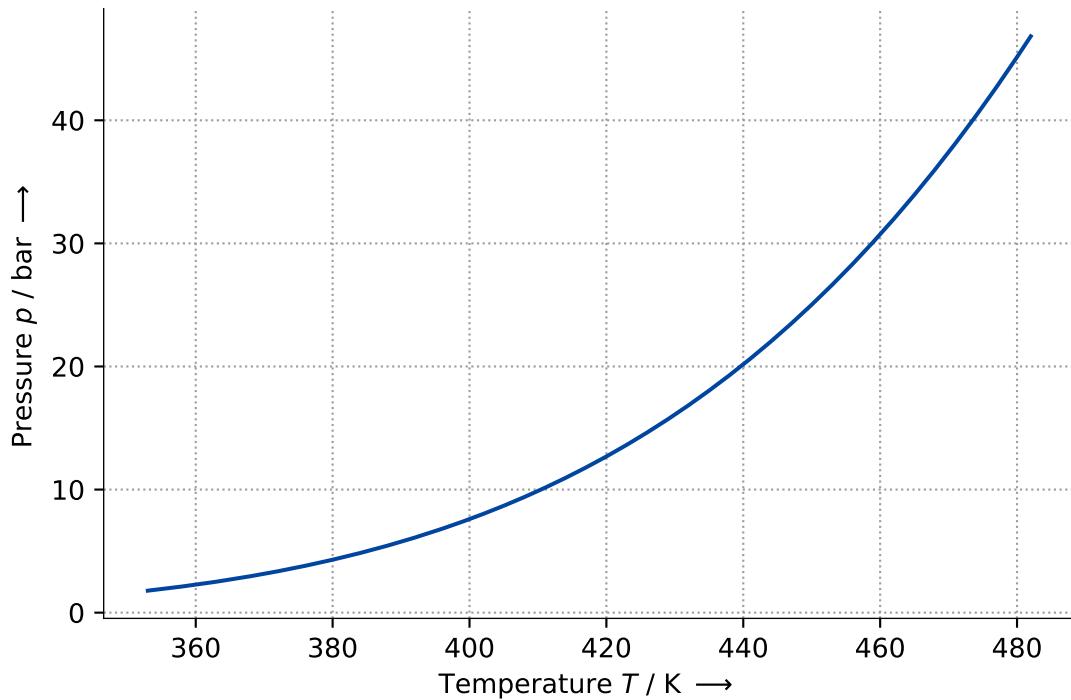
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.313010000e+00	$c$	K	-2.172800000e+01
$b$	K	1.676569000e+03			

**Validity:**

Equation is approximately valid for  $353.0\text{K} \leq T \leq 483.0\text{K}$ .

**Visualization:**



#### 4.18.5 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Methanol
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Kume, D.; Sakoda, N.; Uematsu, M.: An Equation of State for Thermodynamic Properties for Methanol.
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

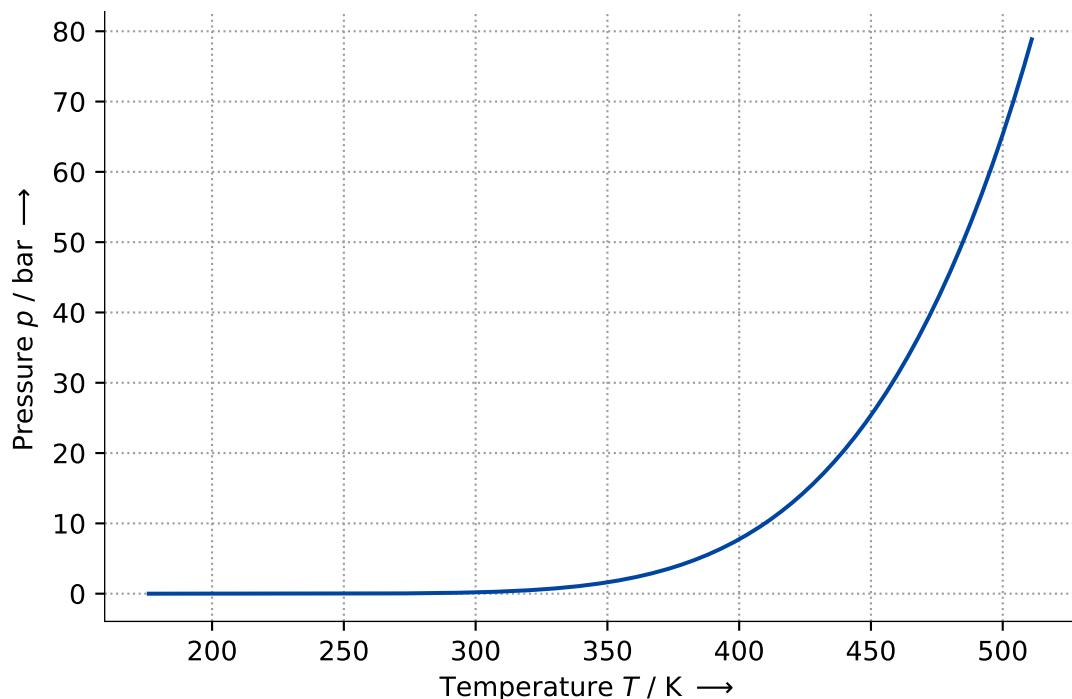
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.126000000e+02	$a_4$	-	-1.504411100e+00
$p_{\text{crit}}$	Pa	8.103500000e+06	$b_4$	-	3.500000000e+00

Par.	Unit	Value	Par.	Unit	Value
$a_1$	-	-8.857024700e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.407244700e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.645250100e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $175.61\text{K} \leq T \leq 512.6\text{K}$ .

**Visualization:**

## 4.18.6 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Methanol
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

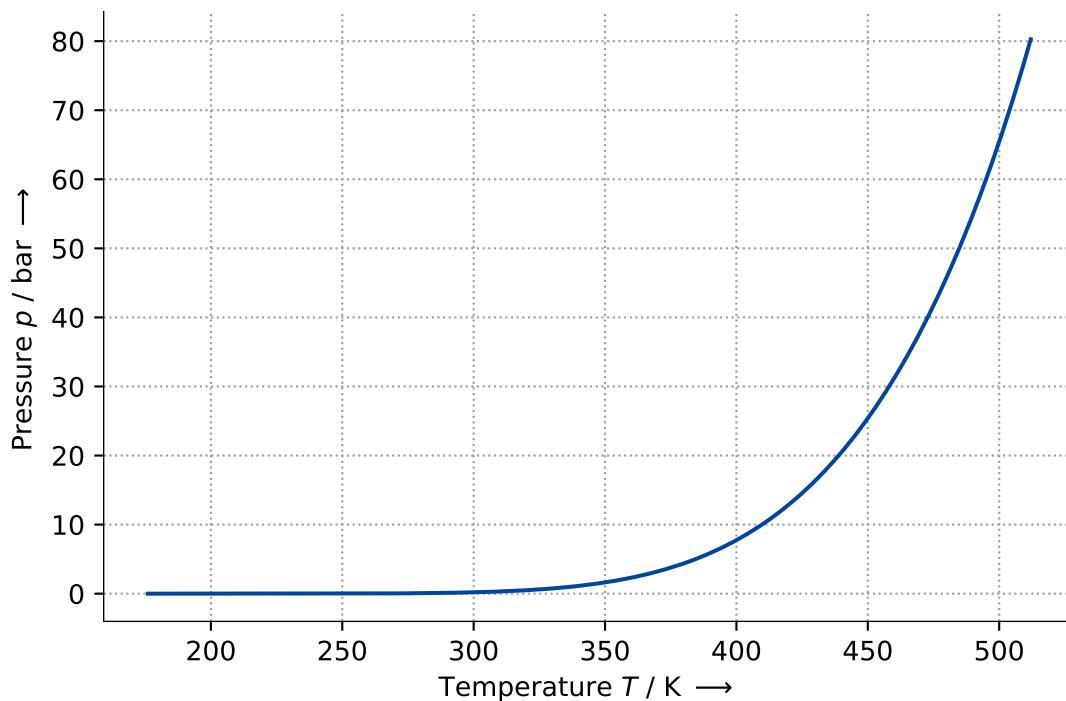
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	5.133800000e+02	$a_4$	-	7.066900000e-01
$p_{\text{crit}}$	Pa	8.216000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-8.729630000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.458600000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.784490000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $175.61\text{K} \leq T \leq 513.38\text{K}$ .

**Visualization:**



#### 4.18.7 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Methanol
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

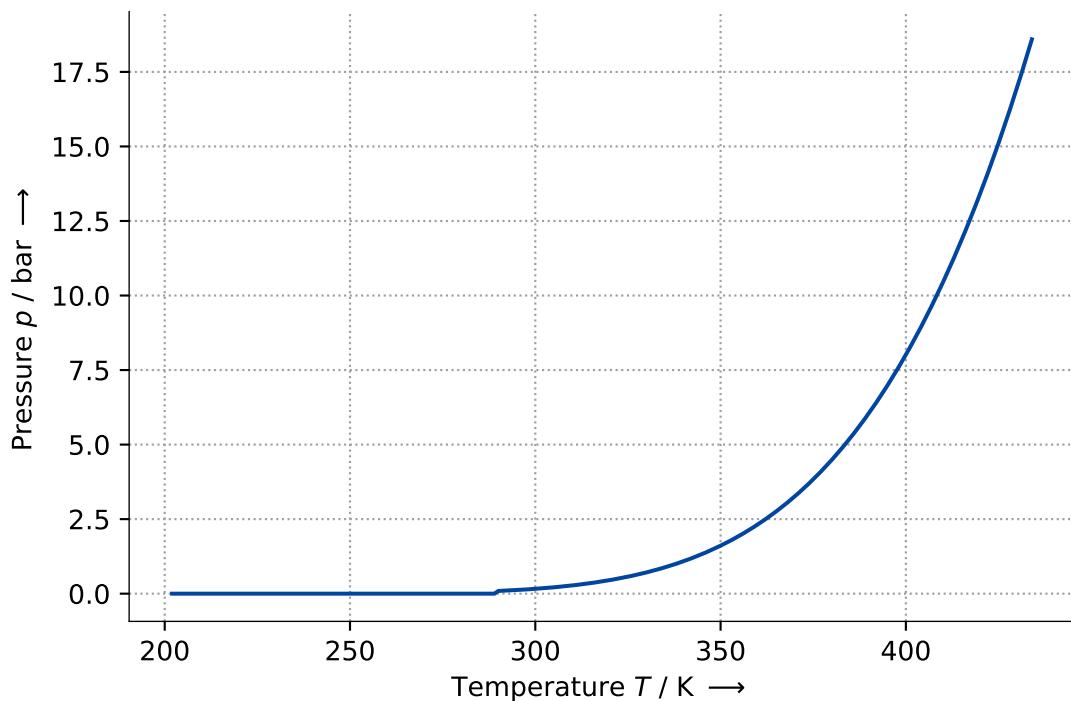
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.126000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	8.103500000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	5.625000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $201.9515\text{K} \leq T \leq 435.71\text{K}$ .

### Visualization:



#### 4.18.8 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	Methanol
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

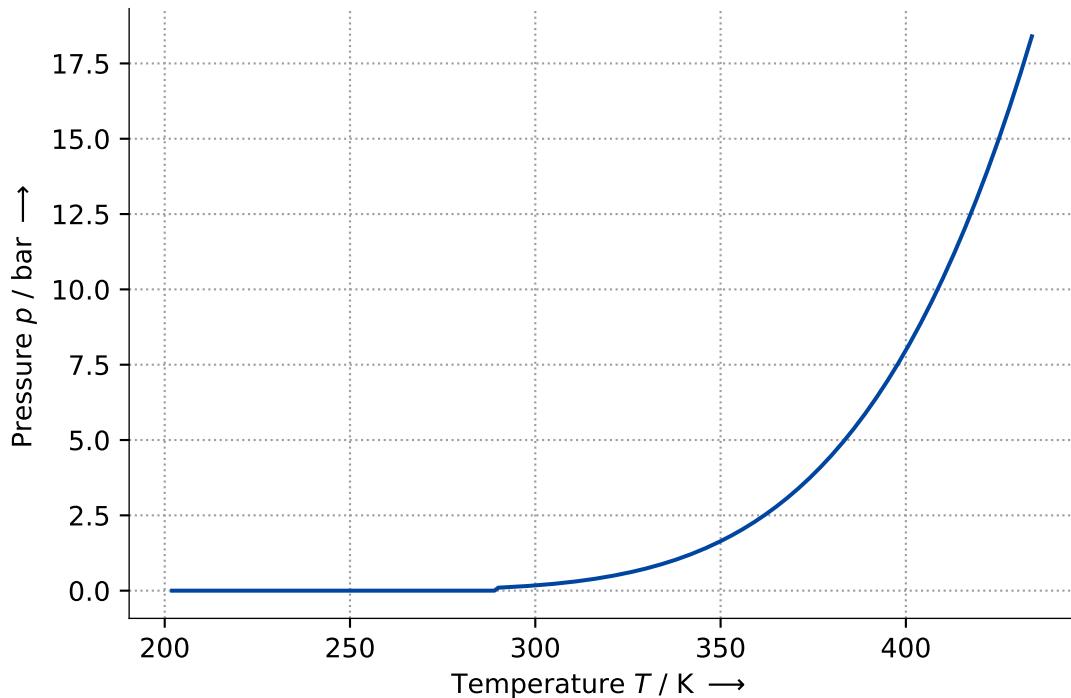
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.126000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	8.103500000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	5.625000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $201.9515\text{K} \leq T \leq 435.71\text{K}$ .

### Visualization:



## 4.19 Neon

### 4.19.1 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Neon
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.756410000e+00	$c$	K	-1.503000000e+00
$b$	K	9.559900000e+01			

Par.	Unit	Value		Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $15.9\text{K} \leq T \leq 27.0\text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'Neon'. Thus, data cannot be visualized!

#### 4.19.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Neon
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	4.449000000e+01	$a_4$	-	-1.198510000e+00
$p_{\text{crit}}$	Pa	2.679000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-5.742380000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.088600000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-5.896000000e-02	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $24.556\text{K} \leq T \leq 44.49\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Neon'. Thus, data cannot be visualized!

### 4.19.3 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Neon
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.440000000e+01	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.661600000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	-3.550000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $28.2394\text{K} \leq T \leq 37.74\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Neon'. Thus, data cannot be visualized!

#### 4.19.4 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Neon
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.440000000e+01	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.661600000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	-3.550000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $28.2394\text{K} \leq T \leq 37.74\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Neon'. Thus, data cannot be visualized!

## 4.20 Nitrogen

### 4.20.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Nitrogen
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Span, Roland; Lemmon, Eric W.; Jacobsen, Richard T.; Wagner, Wolfgang; Yokozeki, Akimichi (2000): A Reference Equation of State for the Thermodynamic Properties of Nitrogen for Temperatures from 63.151 to 1000 K and Pressures to 2200 MPa. In: Journal of Physical and Chemical Reference Data 29 (6), S. 1361–1433. DOI: 10.1063/1.1349047.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

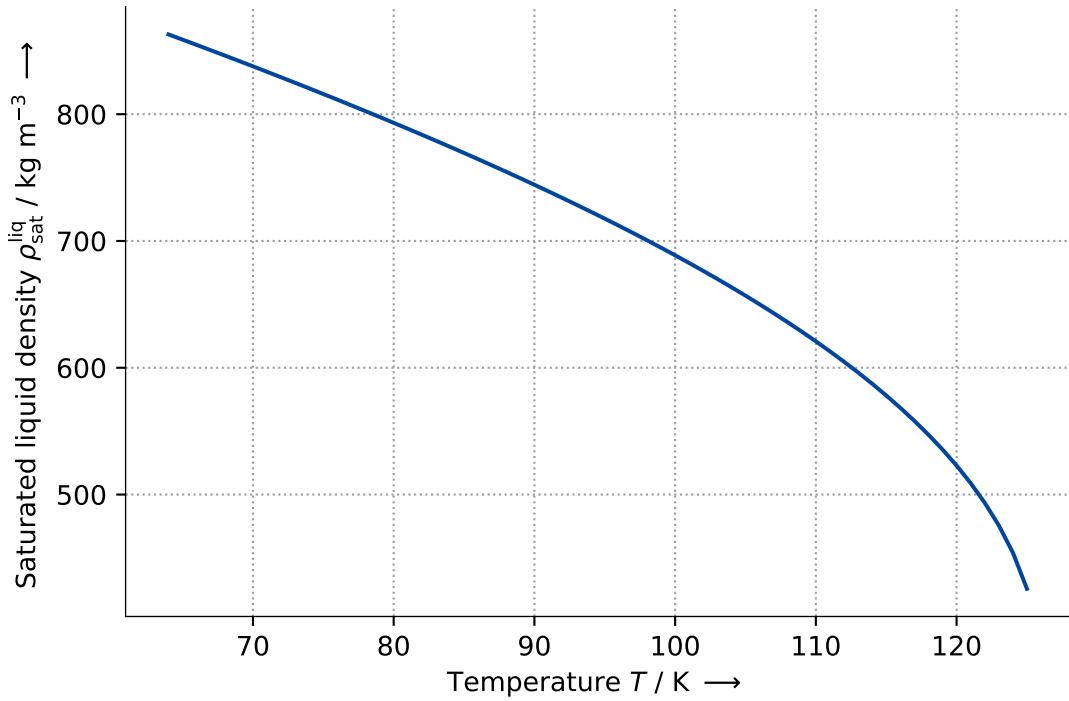
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$b_4$	-	5.833333333e+00
$T_{\text{crit}}$	K	1.261920000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	3.130000000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.486542370e+00	$a_6$	-	0.000000000e+00
$b_1$	-	3.294000000e-01	$b_6$	-	0.000000000e+00
$a_2$	-	-2.804760660e-01	$a_7$	-	0.000000000e+00
$b_2$	-	6.666666667e-01	$b_7$	-	0.000000000e+00
$a_3$	-	8.941430850e-02	$a_8$	-	0.000000000e+00
$b_3$	-	2.666666667e+00	$b_8$	-	0.000000000e+00
$a_4$	-	-1.198798660e-01			

#### Validity:

Equation is approximately valid for  $63.151\text{K} \leq T \leq 126.192\text{K}$ .

## Visualization:



#### 4.20.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Nitrogen
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

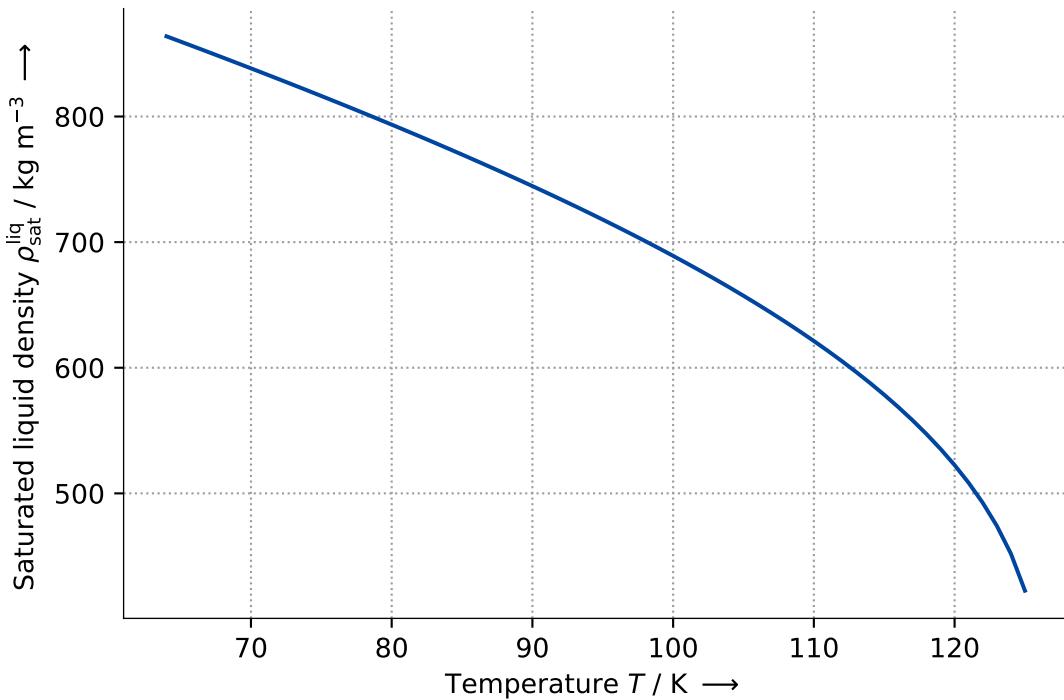
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	1.261900000e+02	$a_5$	-	1.244762939e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	3.130000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.504544409e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.575880831e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.790635463e+00			

##### Validity:

Equation is approximately valid for  $63.151\text{K} \leq T \leq 126.19\text{K}$ .

##### Visualization:



#### 4.20.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Nitrogen
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

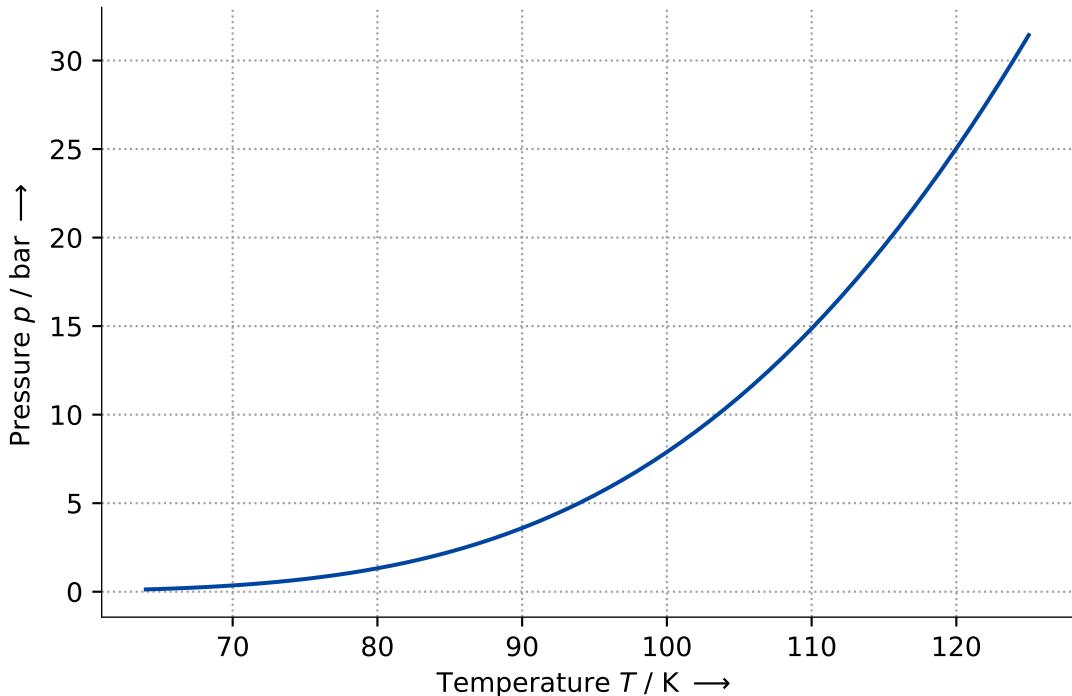
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.736200000e+00	$c$	K	-6.788000000e+00
$b$	K	2.646510000e+02			

#### Validity:

Equation is approximately valid for  $63.14\text{K} \leq T \leq 126.0\text{K}$ .

**Visualization:**



#### 4.20.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Nitrogen
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

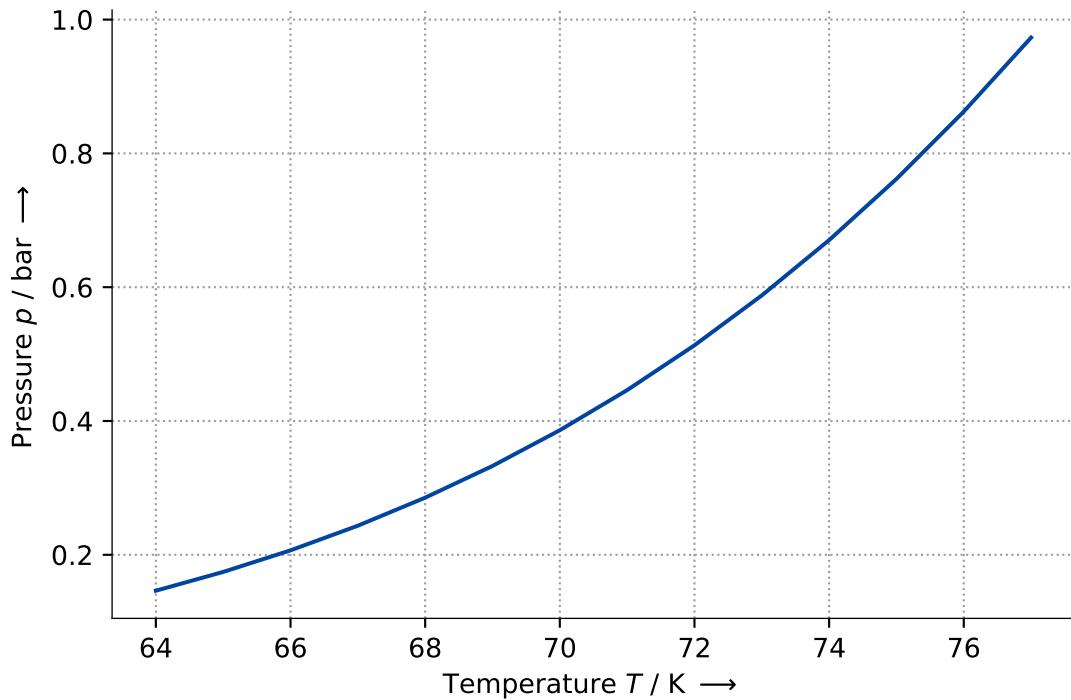
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.637920000e+00	$c$	K	-6.344000000e+00
$b$	K	2.578770000e+02			

**Validity:**

Equation is approximately valid for  $63.14\text{K} \leq T \leq 78.0\text{K}$ .

**Visualization:**



#### 4.20.5 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Nitrogen
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Span, Roland; Lemmon, Eric W.; Jacobsen, Richard T.; Wagner, Wolfgang; Yokozeki, Akimichi (2000): A Reference Equation of State for the Thermodynamic Properties of Nitrogen for Temperatures from 63.151 to 1000 K and Pressures to 2200 MPa. In: Journal of Physical and Chemical Reference Data 29 (6), S. 1361–1433. DOI: 10.1063/1.1349047.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

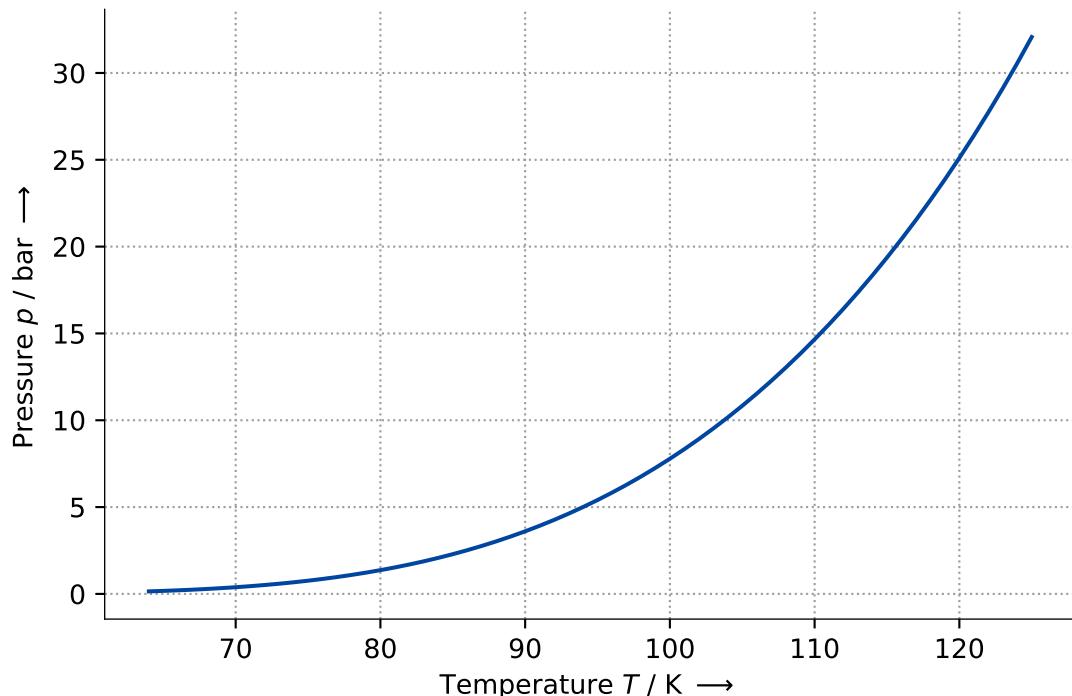
$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	1.261920000e+02	$a_4$	-	-1.775705640e+00
$p_{\text{crit}}$	Pa	3.395800000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-6.124452840e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.263272200e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-7.659100820e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $63.151\text{K} \leq T \leq 126.192\text{K}$ .

**Visualization:**

## 4.20.6 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Nitrogen
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

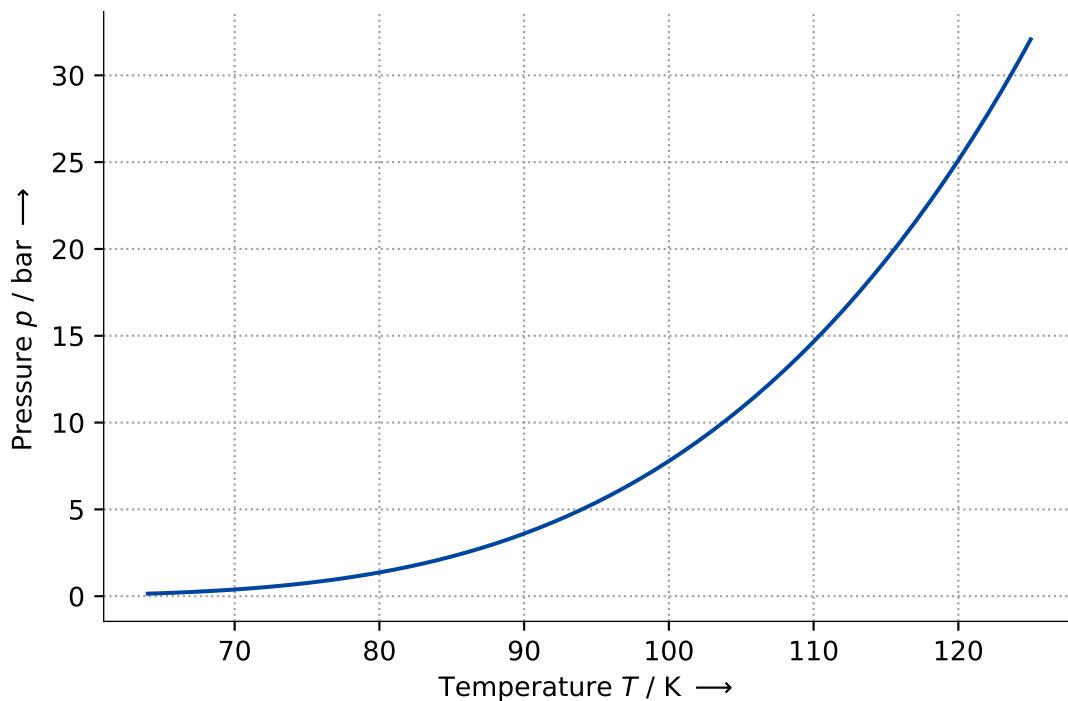
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	1.261900000e+02	$a_4$	-	-1.781730000e+00
$p_{\text{crit}}$	Pa	3.396000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-6.124980000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.264990000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-7.676500000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $63.151\text{K} \leq T \leq 126.19\text{K}$ .

**Visualization:**



#### 4.20.7 Vapor Pressure - EoS Cubic - ID 1

---

<b>Name:</b>	Nitrogen
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

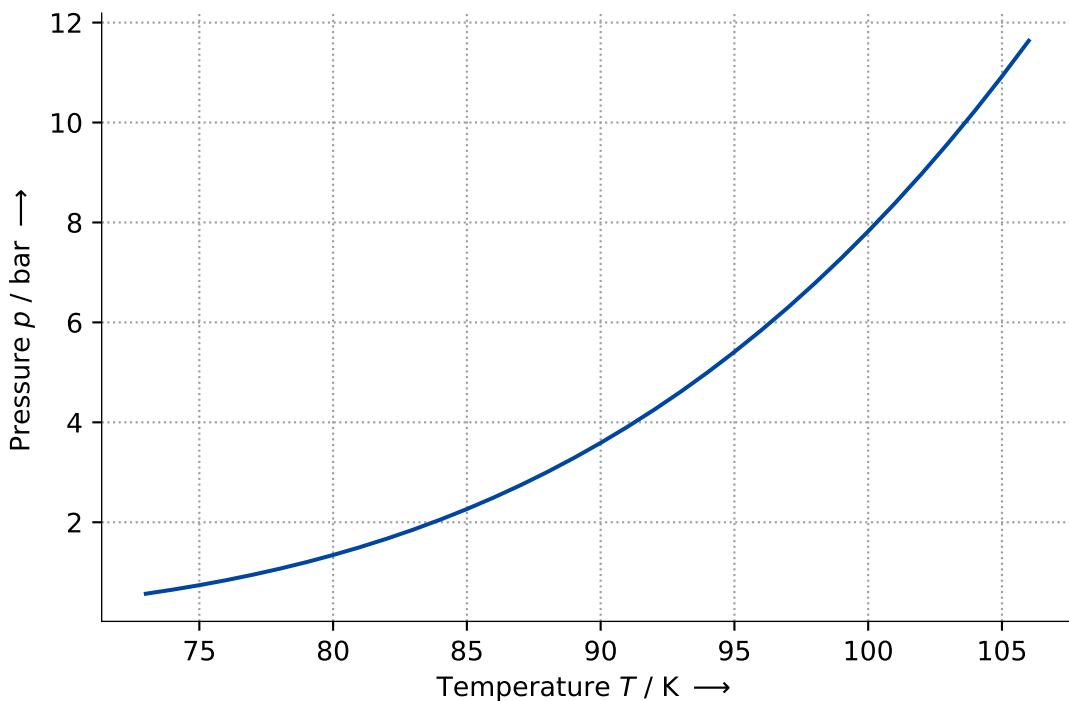
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.261900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.395800000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.720000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $72.62365\text{K} \leq T \leq 107.2615\text{K}$ .

### Visualization:



#### 4.20.8 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Nitrogen
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

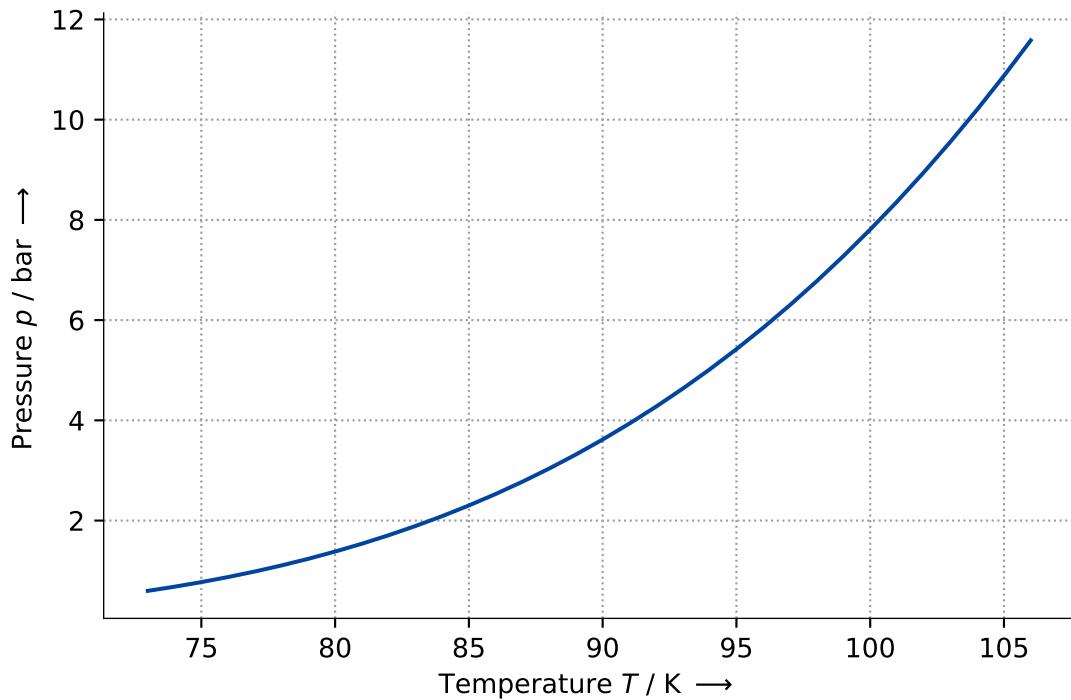
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.261900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.395800000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.720000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $72.62365\text{K} \leq T \leq 107.2615\text{K}$ .

### Visualization:



## 4.21 Oxygen

### 4.21.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Oxygen
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	1.546000000e+02	$a_5$	-	8.728112412e-01
$\rho_{\text{ref}}$	kg m <sup>-3</sup>	4.270000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.752629508e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	9.279569087e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-9.747983607e-01			

**Validity:**

Equation is approximately valid for  $54.361\text{K} \leq T \leq 154.6\text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'Oxygen'. Thus, data cannot be visualized!

#### 4.21.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Oxygen
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.952300000e+00	$c$	K	-4.144000000e+00
$b$	K	3.400240000e+02			

#### Validity:

Equation is approximately valid for  $54.36 \text{K} \leq T \leq 154.33 \text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Oxygen'. Thus, data cannot be visualized!

### 4.21.3 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Oxygen
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	1.546000000e+02	$a_4$	-	-1.612880000e+00
$p_{\text{crit}}$	Pa	5.046000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-6.051480000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.235060000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-6.288300000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $54.361\text{K} \leq T \leq 154.6\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Oxygen'. Thus, data cannot be visualized!

#### 4.21.4 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Oxygen
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.545800000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	5.043000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.220000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $62.51515\text{K} \leq T \leq 131.393\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Oxygen'. Thus, data cannot be visualized!

#### 4.21.5 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Oxygen
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	1.545800000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	5.043000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.220000000e-02	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $62.51515\text{K} \leq T \leq 131.393\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Oxygen'. Thus, data cannot be visualized!

## 4.22 Propane

### 4.22.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Propane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; McLinden, Mark O.; Wagner, Wolfgang (2009): Thermodynamic Properties of Propane. III. A Reference Equation of State for Temperatures from the Melting Line to 650 K and Pressures up to 1000 MPa. In: J. Chem. Eng. Data 54 (12), S. 3141–3180. DOI: 10.1021/je900217v.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\begin{aligned}\rho_{\text{sat}}^{\text{liq}} &= \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with} \\ \Omega &= \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and} \\ \xi &= 1 - \theta, \text{ and} \\ \theta &= T/T_{\text{crit}}.\end{aligned}$$

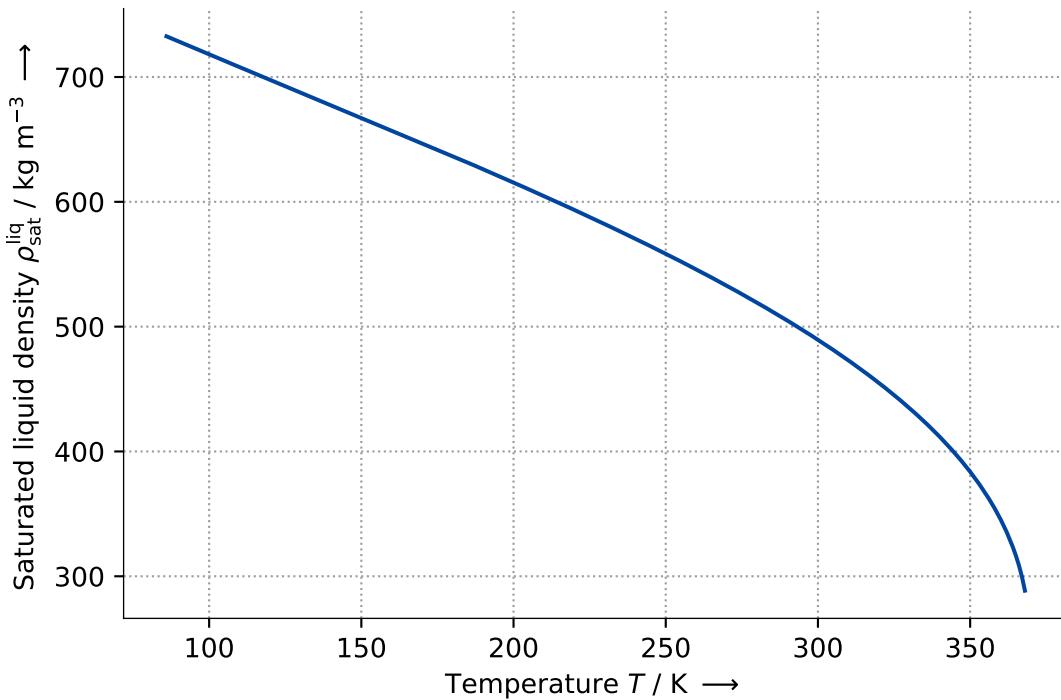
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	2.600000000e+00
$T_{\text{crit}}$	K	3.698900000e+02	$a_5$	-	8.397300000e-02
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.204850000e+02	$b_5$	-	7.200000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.822050000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.450000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	6.580200000e-01	$a_8$	-	0.000000000e+00
$b_3$	-	7.400000000e-01	$b_8$	-	0.000000000e+00
$a_4$	-	2.110900000e-01			

#### Validity:

Equation is approximately valid for  $85.525\text{K} \leq T \leq 369.89\text{K}$ .

#### Visualization:



#### 4.22.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Propane
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

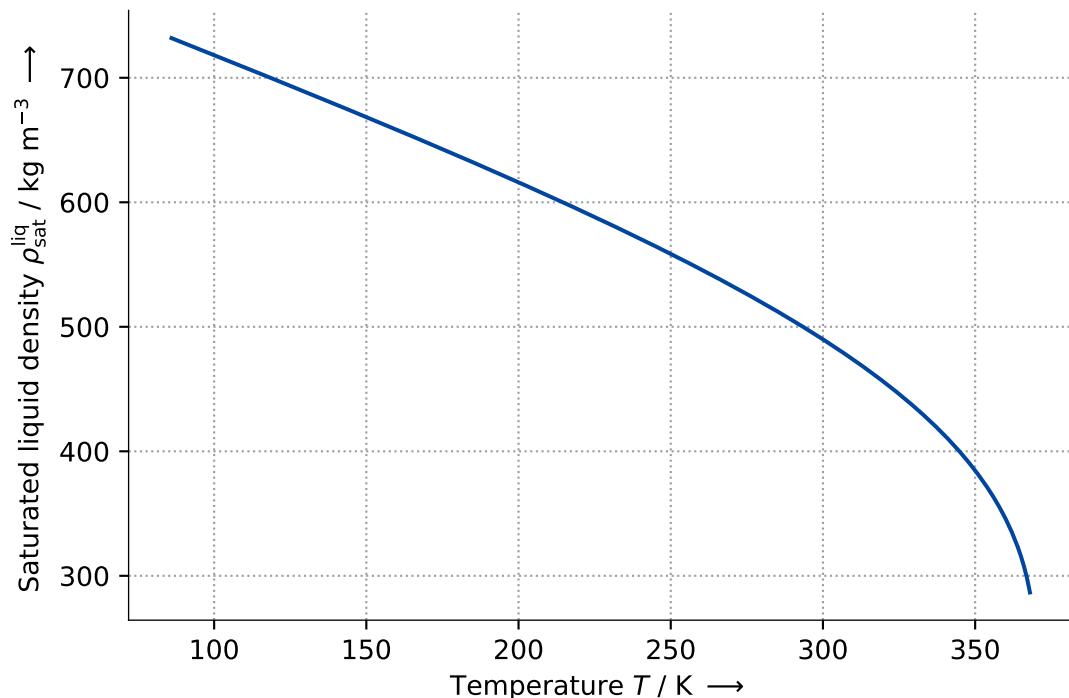
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.698200000e+02	$a_5$	-	1.482017195e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.210000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.688905430e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.466864706e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.952962896e+00			

**Validity:**

Equation is approximately valid for  $85.525\text{K} \leq T \leq 369.82\text{K}$ .

**Visualization:**

#### 4.22.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Propane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

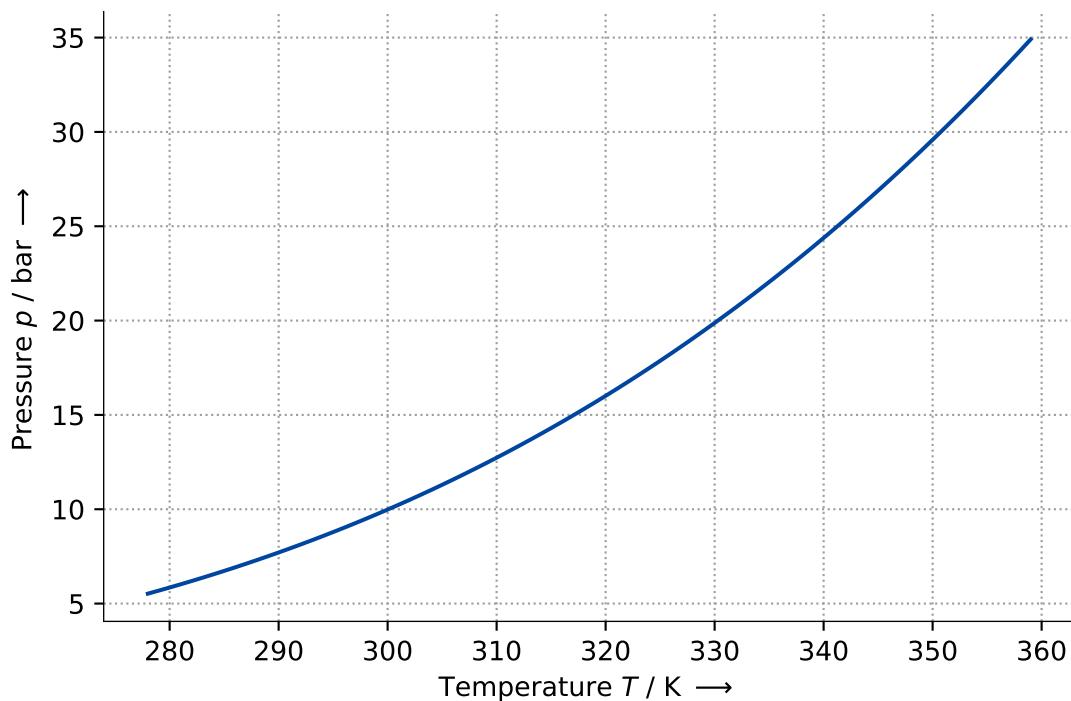
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.536780000e+00	$c$	K	2.490600000e+01
$b$	K	1.149360000e+03			

#### Validity:

Equation is approximately valid for  $277.6 \text{K} \leq T \leq 360.8 \text{K}$ .

#### Visualization:



#### 4.22.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Propane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

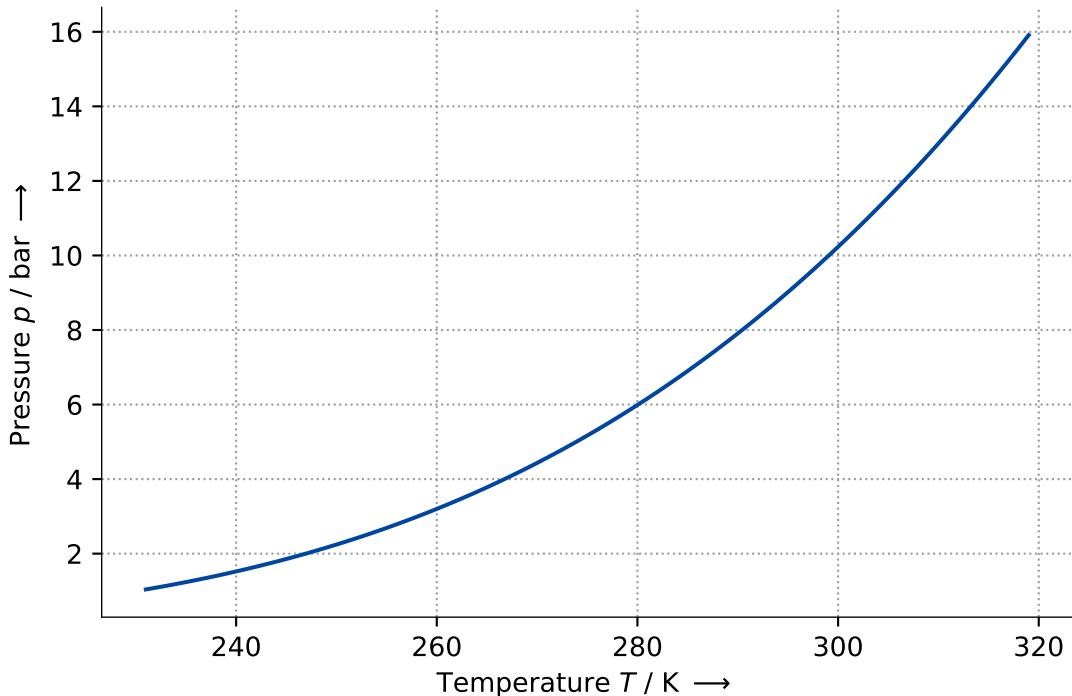
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.982920000e+00	$c$	K	-2.441700000e+01
$b$	K	8.192960000e+02			

#### Validity:

Equation is approximately valid for  $230.6\text{K} \leq T \leq 320.7\text{K}$ .

**Visualization:**



#### 4.22.5 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Propane
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

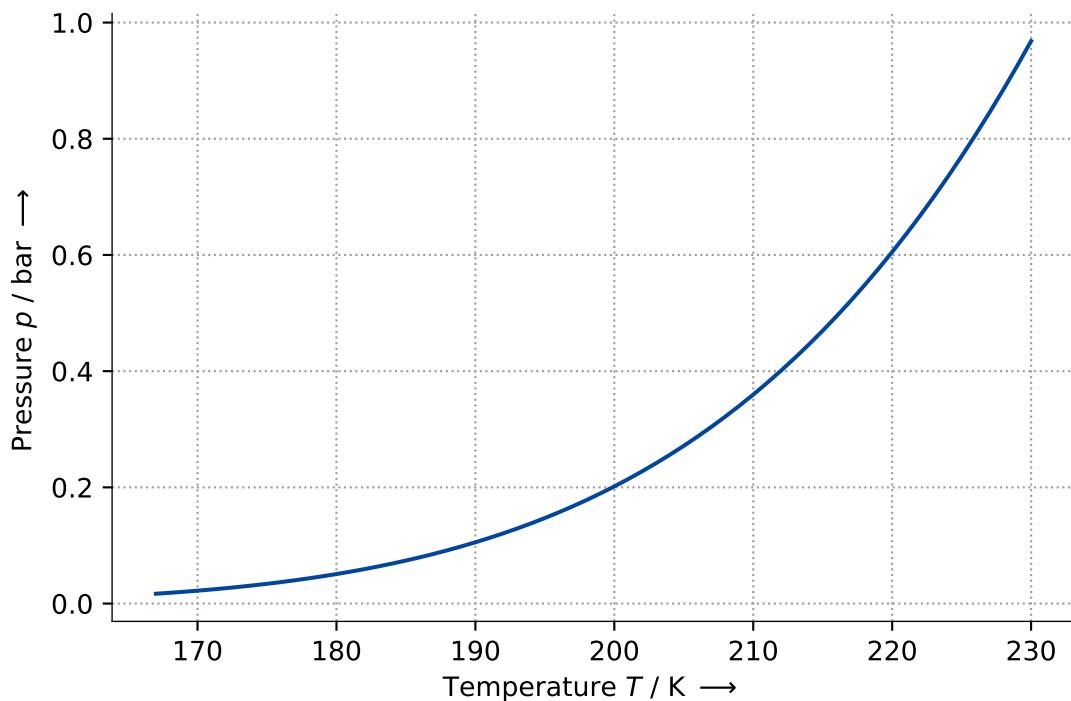
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.011580000e+00	$c$	K	-2.276300000e+01
$b$	K	8.342600000e+02			

#### Validity:

Equation is approximately valid for  $166.02\text{K} \leq T \leq 231.41\text{K}$ .

#### Visualization:



#### 4.22.6 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Propane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; McLinden, Mark O.; Wagner, Wolfgang (2009): Thermodynamic Properties of Propane. III. A Reference Equation of State for Temperatures from the Melting Line to 650 K and Pressures up to 1000 MPa. In: J. Chem. Eng. Data 54 (12), S. 3141–3180. DOI: 10.1021/je900217v.
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

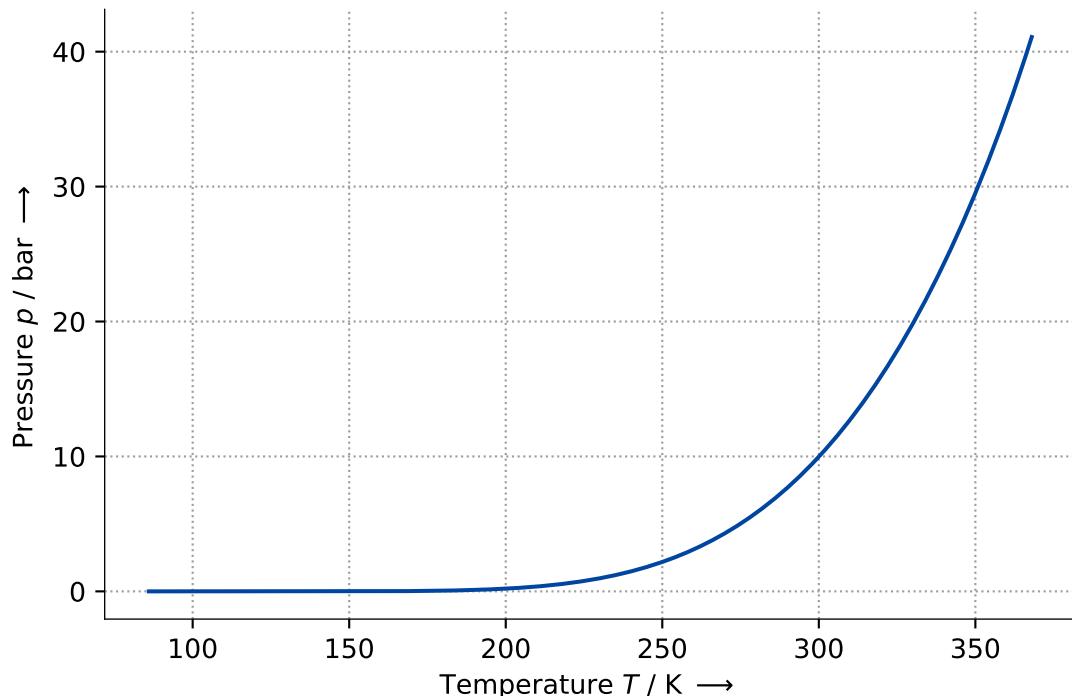
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.698900000e+02	$a_4$	-	-3.187600000e+00
$p_{\text{crit}}$	Pa	4.251200000e+06	$b_4$	-	4.800000000e+00
$a_1$	-	-6.772200000e+00	$a_5$	-	9.493700000e-01
$b_1$	-	1.000000000e+00	$b_5$	-	6.200000000e+00
$a_2$	-	1.693800000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.334100000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.200000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $85.525\text{K} \leq T \leq 369.89\text{K}$ .

**Visualization:**



## 4.22.7 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Propane
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

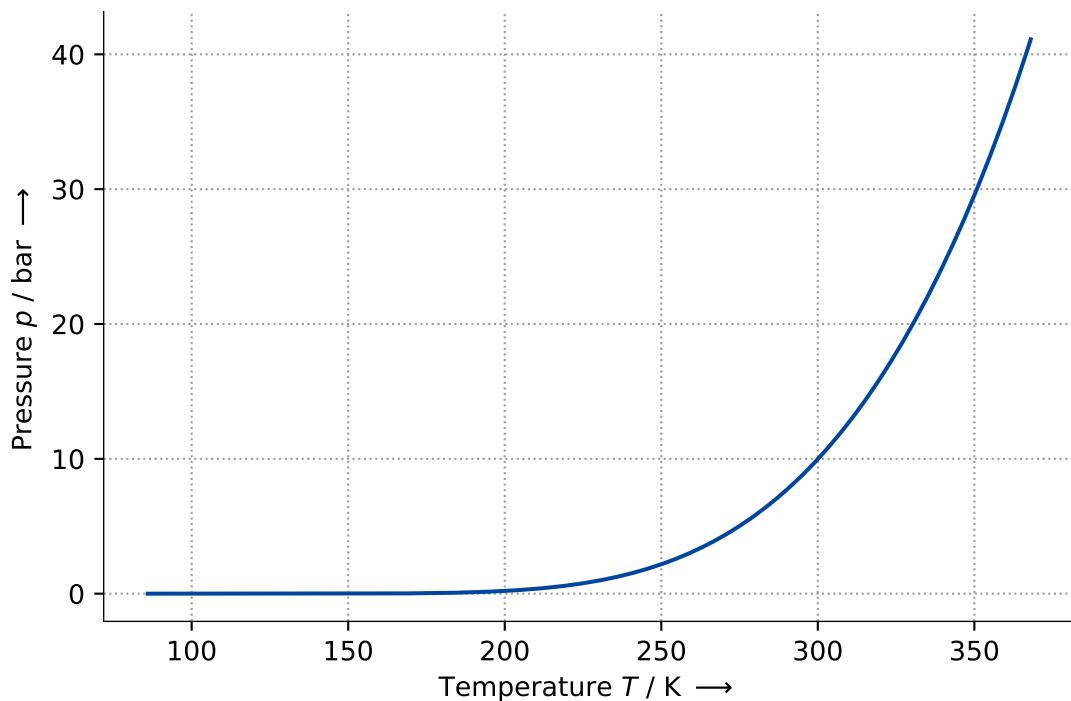
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.698200000e+02	$a_4$	-	-2.568270000e+00
$p_{\text{crit}}$	Pa	4.248000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-6.714800000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.383880000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.309650000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $85.525\text{K} \leq T \leq 369.82\text{K}$ .

**Visualization:**



#### 4.22.8 Vapor Pressure - EoS Cubic - ID 1

---

<b>Name:</b>	Propane
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

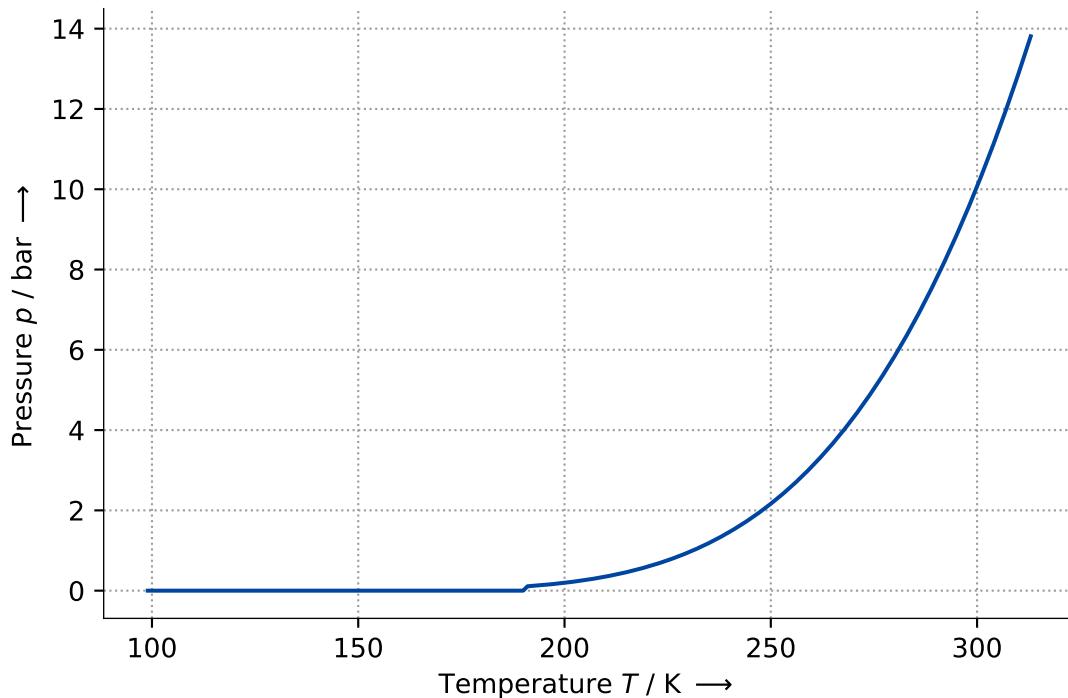
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.698900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.251200000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.521000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $98.35375\text{K} \leq T \leq 314.4065\text{K}$ .

### Visualization:



#### 4.22.9 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Propane
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

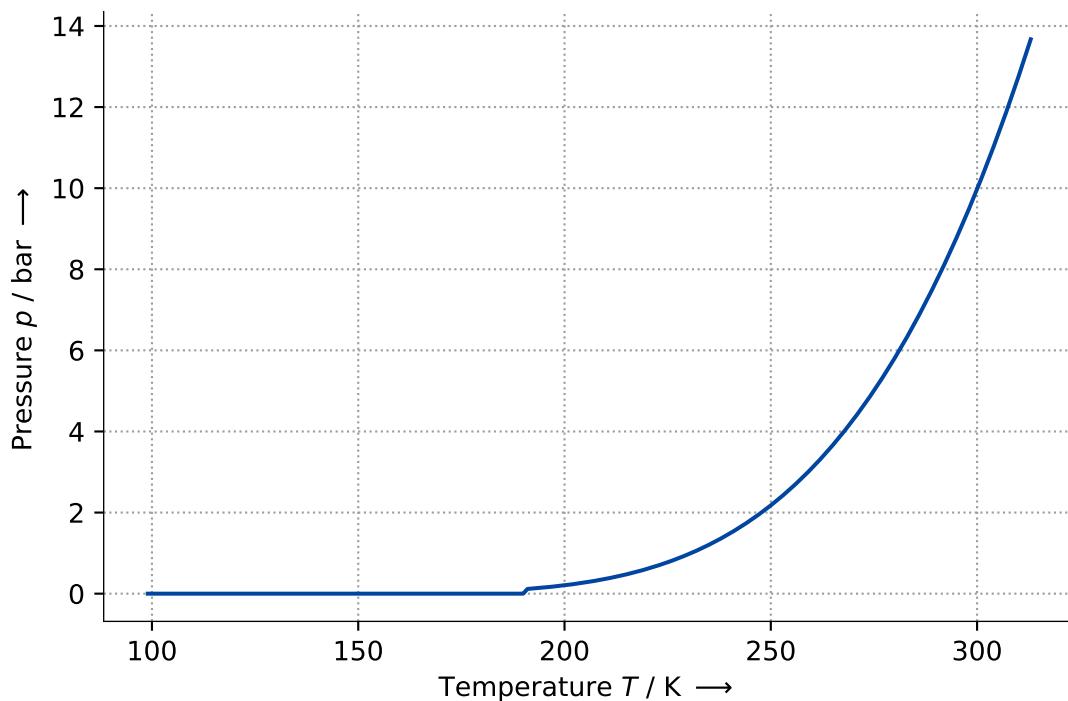
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.698900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.251200000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.521000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $98.35375\text{K} \leq T \leq 314.4065\text{K}$ .

### Visualization:



## 4.23 Propene

### 4.23.1 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Propene
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.642100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.555000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.460000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $101.14595\text{K} \leq T \leq 309.5785\text{K}$ .

### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'Propene'. Thus, data cannot be visualized!

## 4.24 Propylene

### 4.24.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Propylene
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

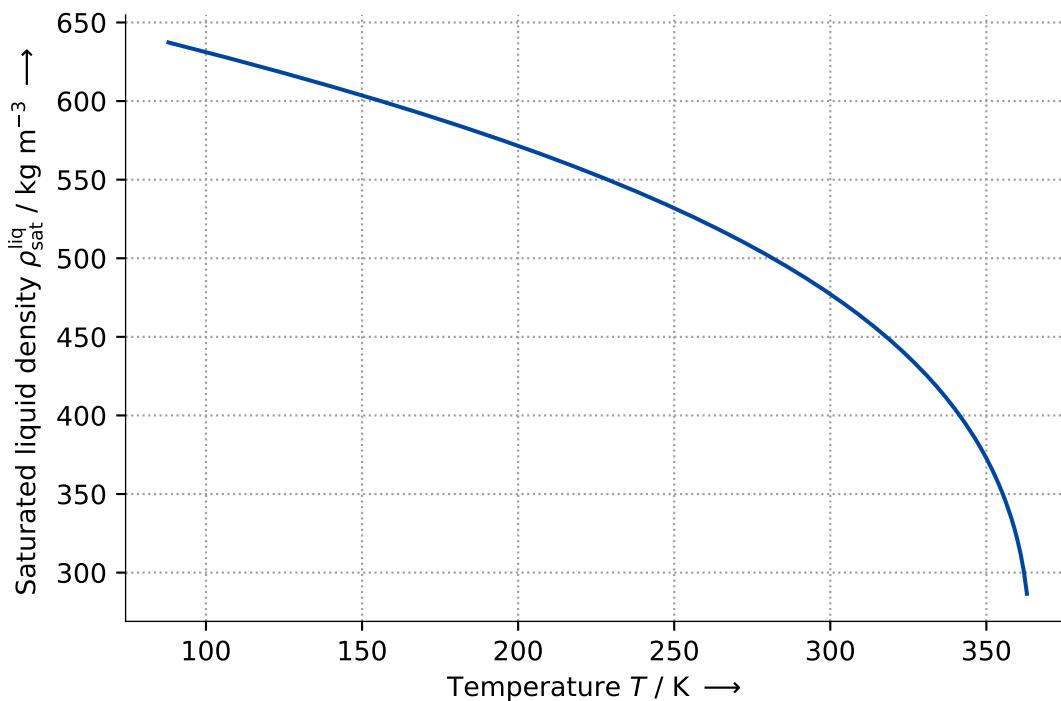
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.642100000e+02	$a_5$	-	7.932532847e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.300000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.622817826e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.409465652e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.876542609e+00			

#### Validity:

Equation is approximately valid for  $87.953\text{K} \leq T \leq 364.21\text{K}$ .

#### Visualization:



#### 4.24.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Propylene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

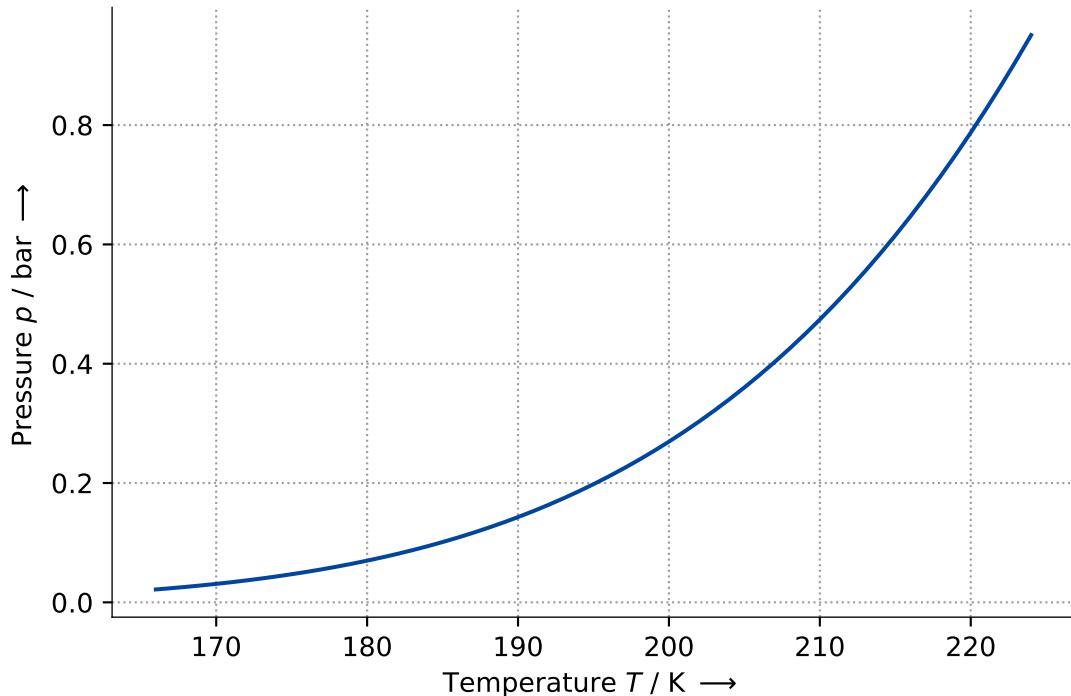
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.974880000e+00	$c$	K	-2.488400000e+01
$b$	K	7.958190000e+02			

#### Validity:

Equation is approximately valid for  $165.81\text{K} \leq T \leq 225.98\text{K}$ .

**Visualization:**



## 4.24.3 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Propylene
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

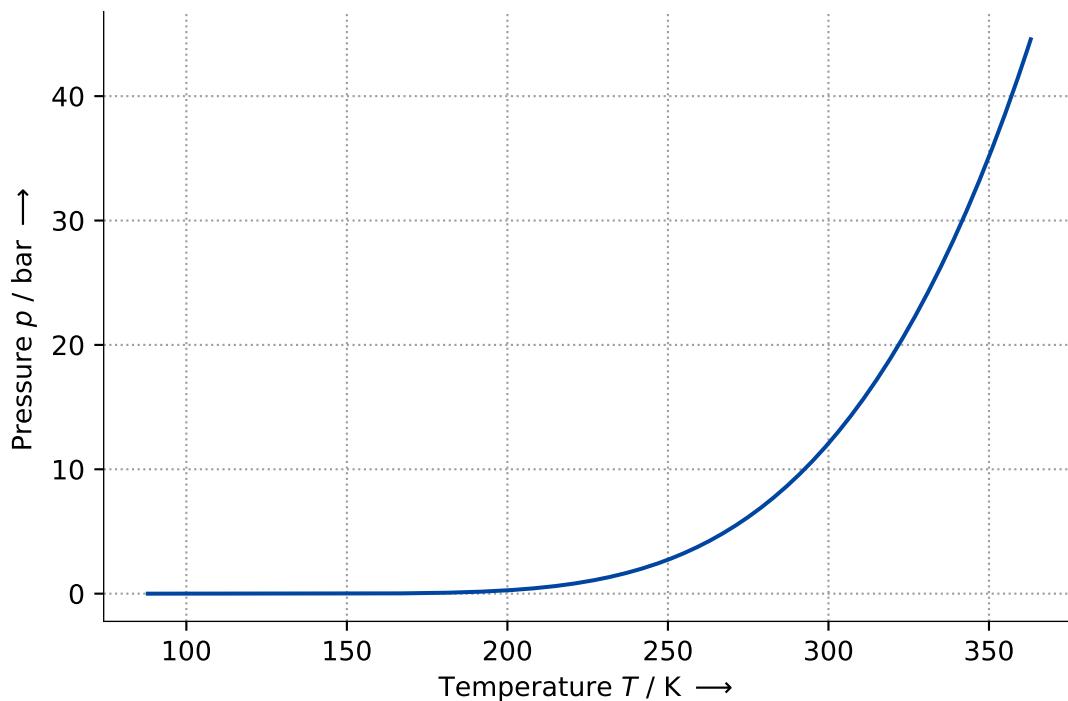
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.642100000e+02	$a_4$	-	-3.371390000e+00
$p_{\text{crit}}$	Pa	4.555000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-6.599710000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.106470000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-8.499900000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $87.953\text{K} \leq T \leq 364.21\text{K}$ .

**Visualization:**



#### 4.24.4 Vapor Pressure - EoS Cubic - ID 1

<b>Name:</b>	Propylene
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

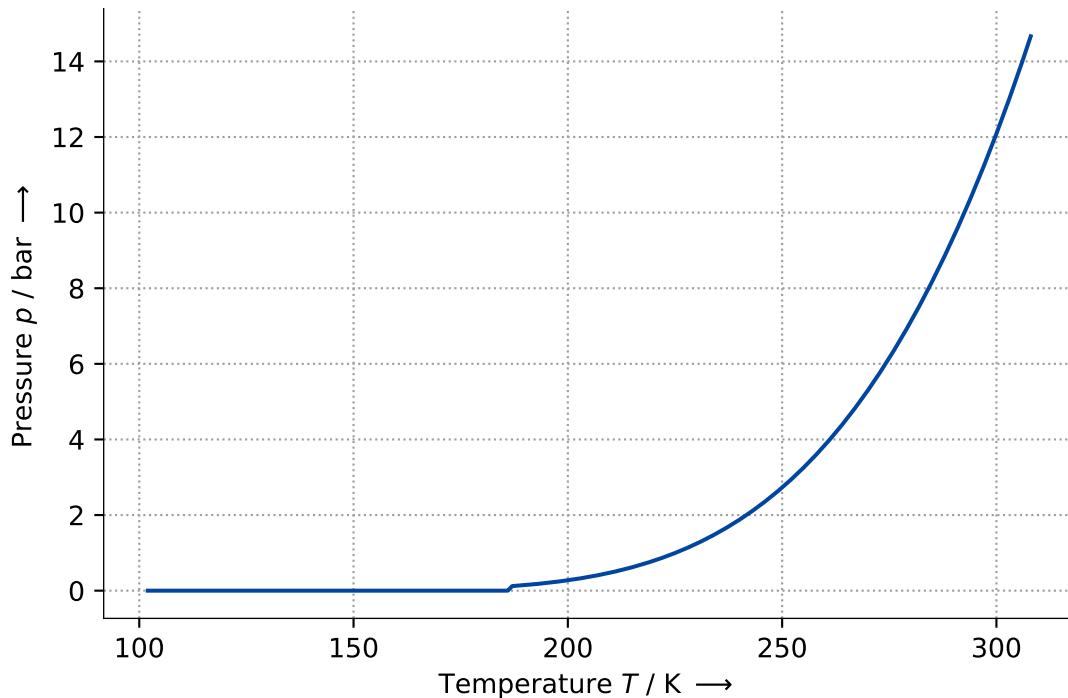
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.642100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.555000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.460000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $101.14595\text{K} \leq T \leq 309.5785\text{K}$ .

### Visualization:



## 4.25 R-12

### 4.25.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-12
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

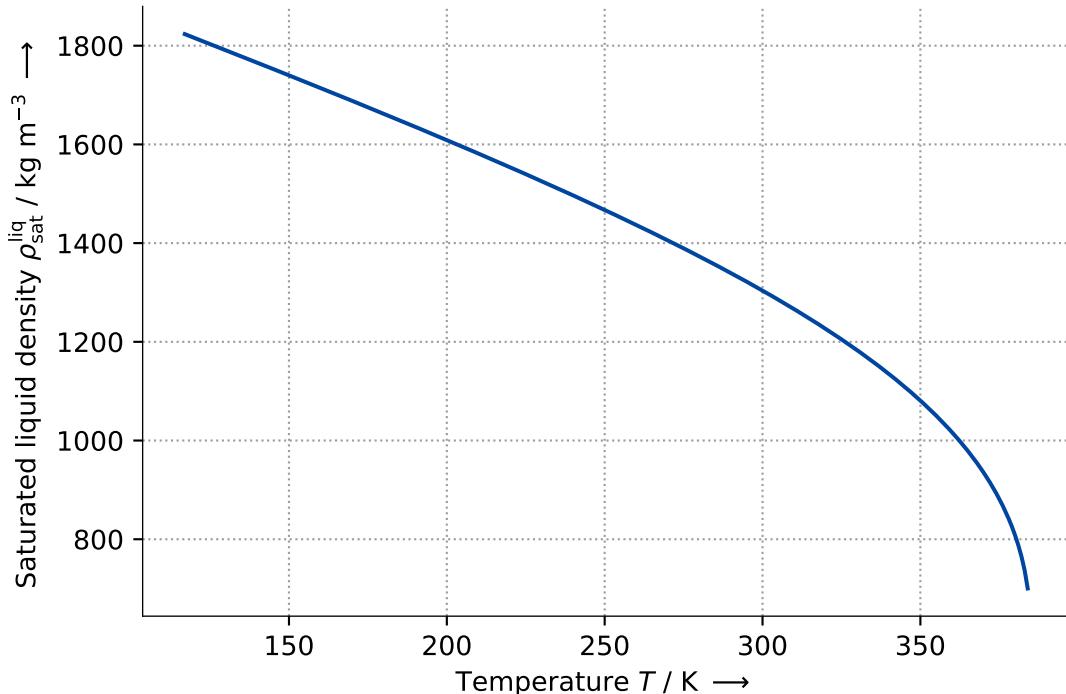
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.851200000e+02	$a_5$	-	1.700945841e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.650000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.619186903e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.760933805e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-2.343916460e+00			

**Validity:**

Equation is approximately valid for  $116.1\text{K} \leq T \leq 385.12\text{K}$ .

**Visualization:**

#### 4.25.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	R-12
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

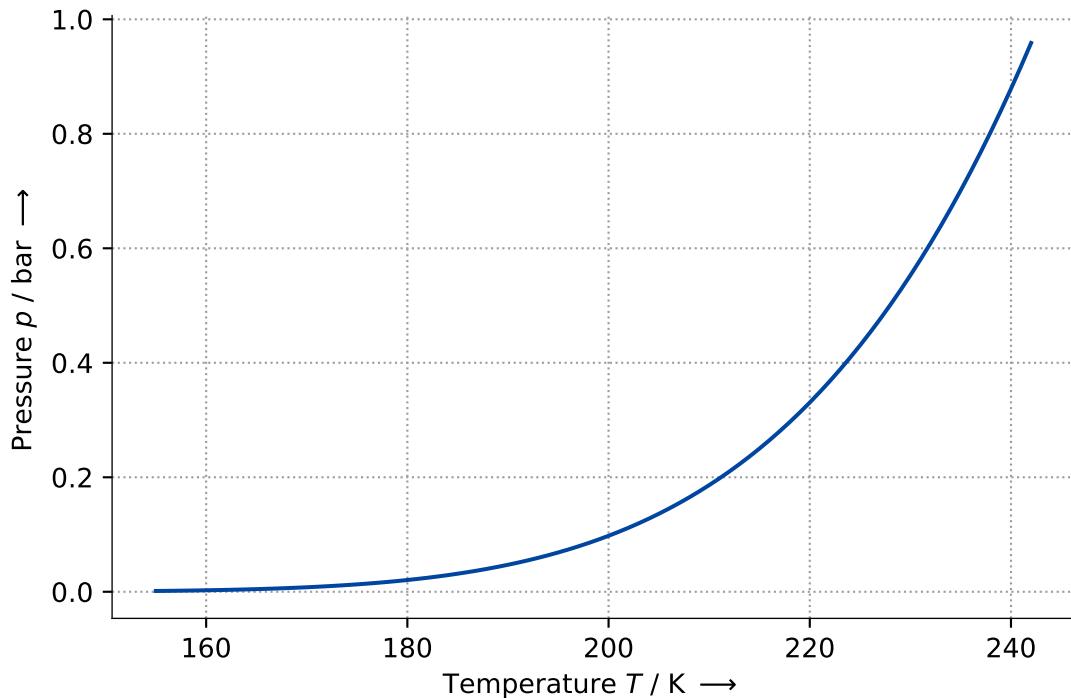
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.811090000e+00	$c$	K	-3.777300000e+01
$b$	K	7.820720000e+02			

#### Validity:

Equation is approximately valid for  $154.7 \text{K} \leq T \leq 243.4 \text{K}$ .

#### Visualization:



#### 4.25.3 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-12
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

The parameters of the equation are:

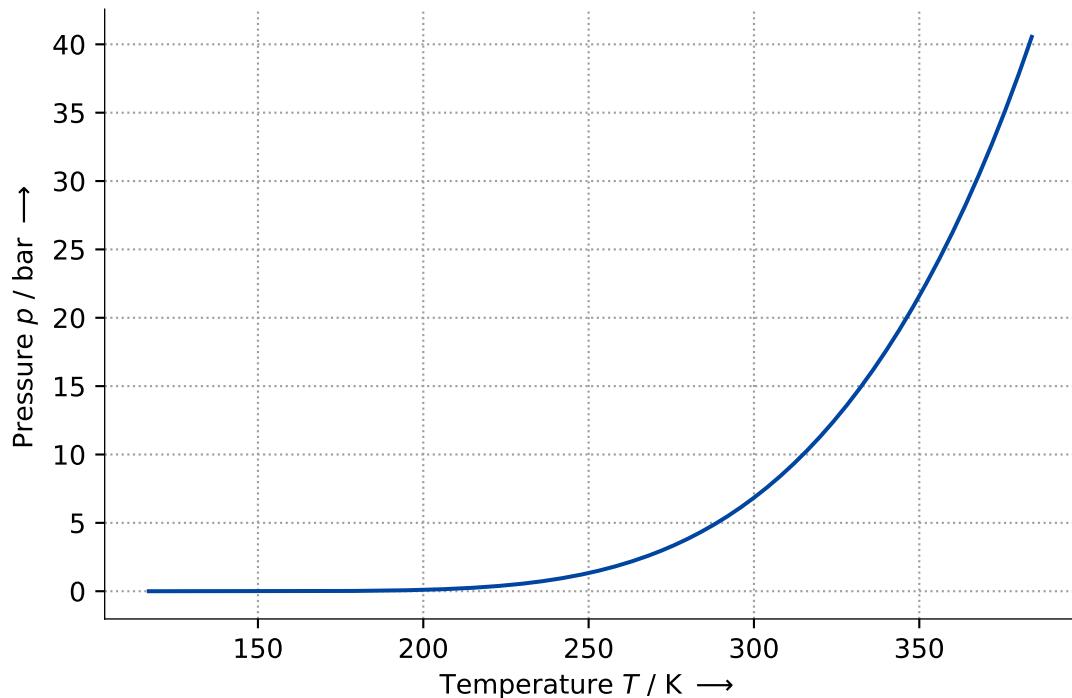
Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	3.851200000e+02		$a_4$	-	-2.582820000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	4.136000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-6.920850000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.626150000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.739390000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $116.1\text{K} \leq T \leq 385.12\text{K}$ .

**Visualization:**



#### 4.25.4 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	R-12
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

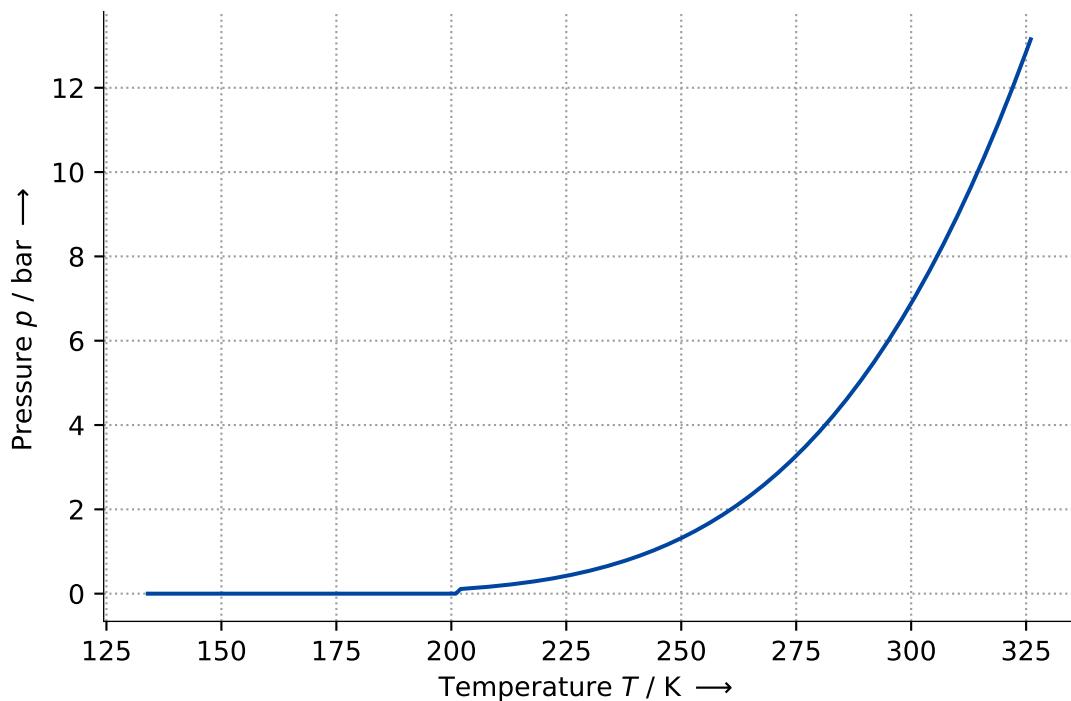
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.851200000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.136100000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.794800000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $133.515\text{K} \leq T \leq 327.352\text{K}$ .

#### Visualization:



#### 4.25.5 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	R-12
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

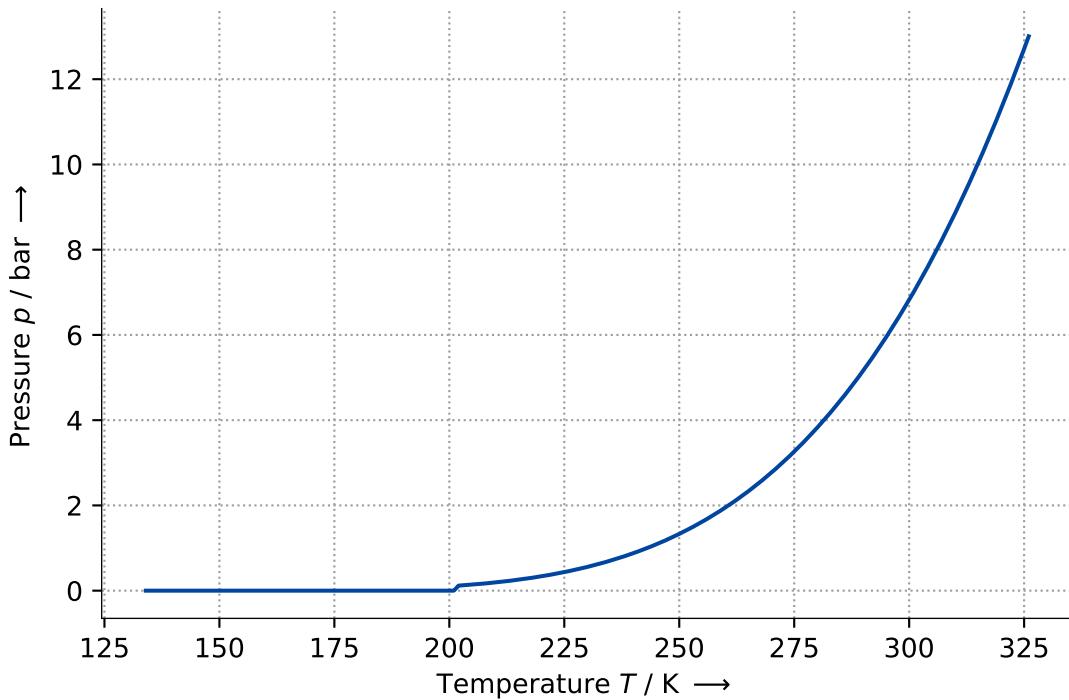
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.851200000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.136100000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	1.794800000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $133.515\text{K} \leq T \leq 327.352\text{K}$ .

### Visualization:



## 4.26 R-123

### 4.26.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-123
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Younglove, Ben A.; McLinden, Mark O. (1994): An International Standard Equation of State for the Thermodynamic Properties of Refrigerant 123 (2,2-Dichloro-1,1,1-Trifluoroethane). In: Journal of Physical and Chemical Reference Data 23 (5), S. 731–779. DOI: 10.1063/1.555950.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

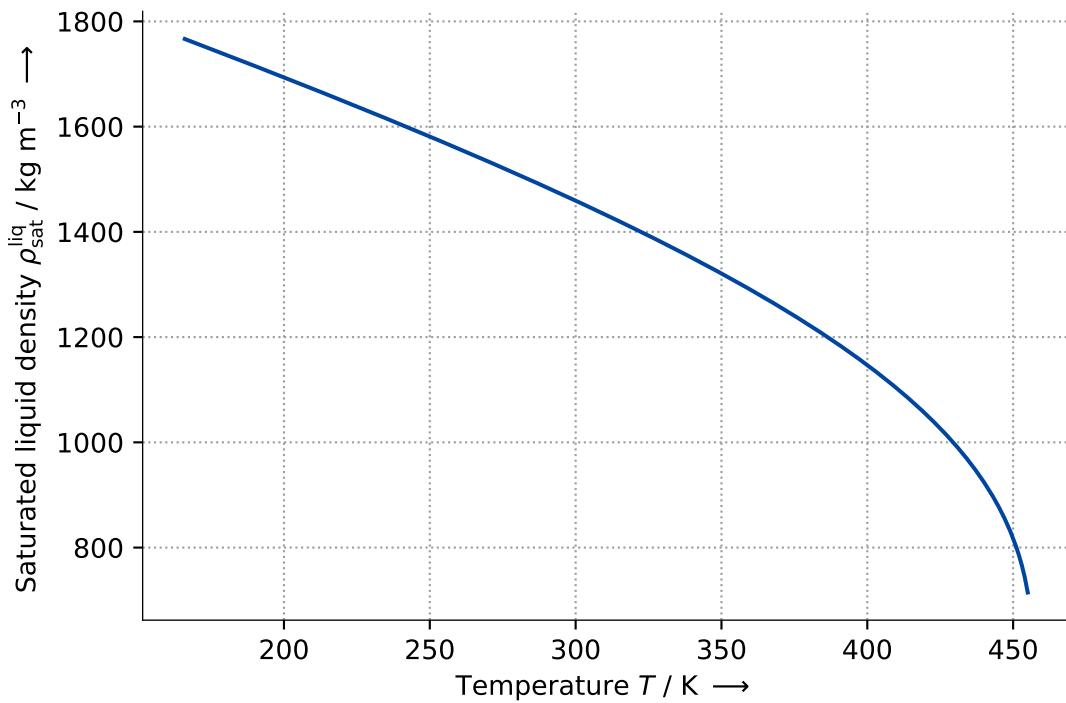
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	4.568310000e+02	$a_5$	-	9.536980230e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.500000518e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.032125410e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.550000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	6.151386150e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-7.803093750e-01			

### Validity:

Equation is approximately valid for  $166.0\text{K} \leq T \leq 456.831\text{K}$ .

### Visualization:



#### 4.26.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-123
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Younglove, Ben A.; McLinden, Mark O. (1994): An International Standard Equation of State for the Thermodynamic Properties of Refrigerant 123 (2,2-Dichloro-1,1,1-Trifluoroethane). In: Journal of Physical and Chemical Reference Data 23 (5), S. 731–779. DOI: 10.1063/1.555950.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

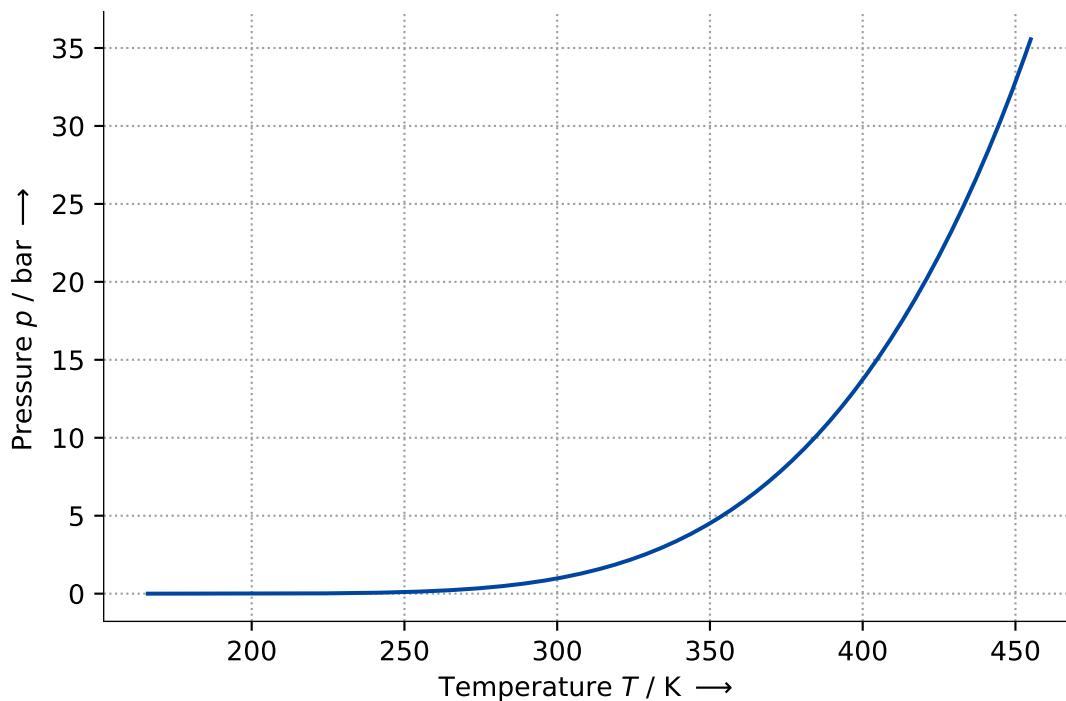
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	4.568310000e+02	$a_4$	-	-3.194718270e+00
$p_{\text{crit}}$	Pa	3.661800000e+06	$b_4$	-	4.000000000e+00
$a_1$	-	-7.447552680e+00	$a_5$	-	-1.299823160e+00
$b_1$	-	1.000000000e+00	$b_5$	-	6.500000000e+00
$a_2$	-	2.222058280e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.900077220e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $166.0\text{K} \leq T \leq 456.83\text{K}$ .

#### Visualization:



#### 4.26.3 Vapor Pressure - EoS Cubic - ID 1

<b>Name:</b>	R-123
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

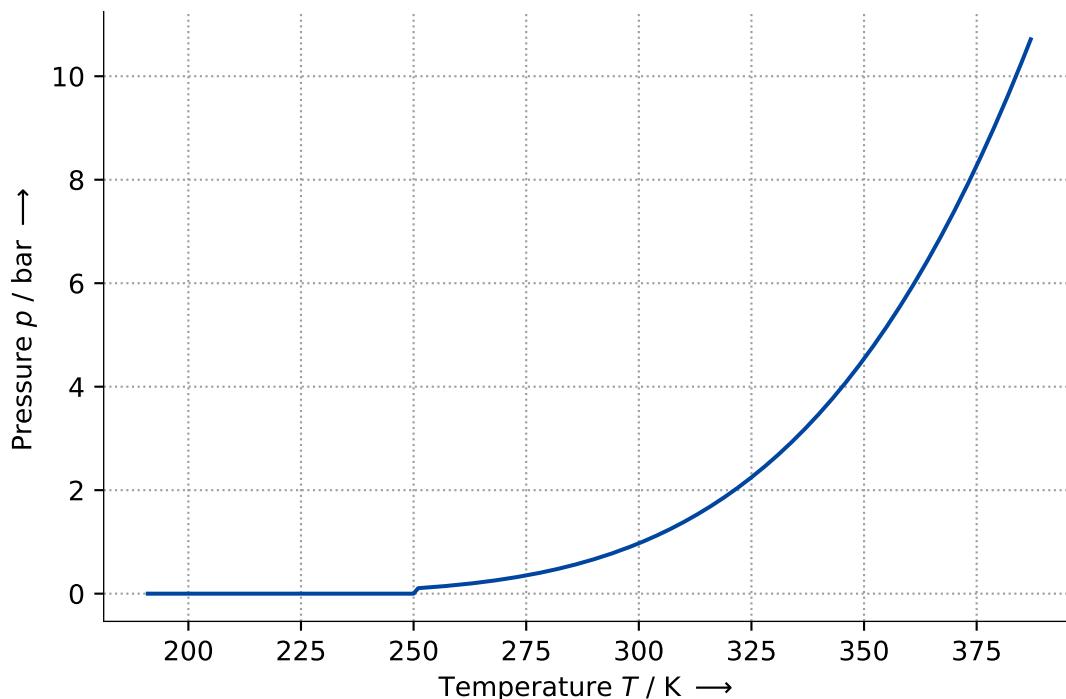
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.568300000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.661800000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.819200000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $190.9\text{K} \leq T \leq 388.3055\text{K}$ .

### Visualization:



#### 4.26.4 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	R-123
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

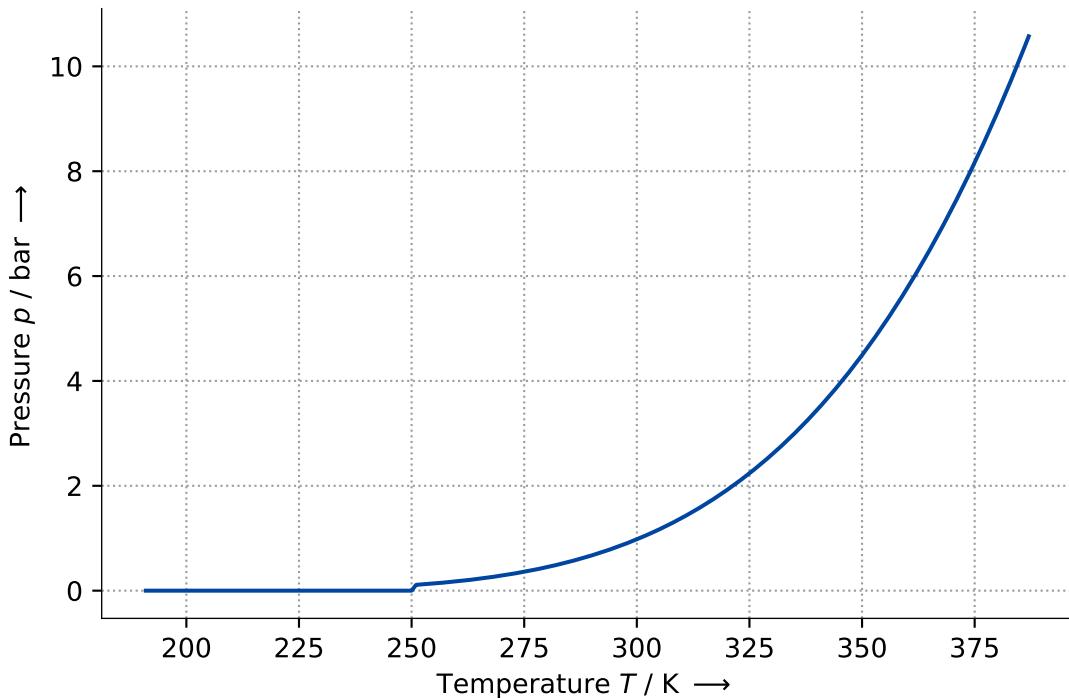
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.568300000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.661800000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.819200000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $190.9\text{K} \leq T \leq 388.3055\text{K}$ .

### Visualization:



## 4.27 R-1234ze(E)

### 4.27.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-1234ze(E)
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Thol, Monika; Lemmon, Eric W. (2016): Equation of State for the Thermodynamic Properties of trans-1,3,3,3-Tetrafluoropropene [R-1234ze(E)]. In: Int J Thermophys 37 (3), S. 3710. DOI: 10.1007/s10765-016-2040-6.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

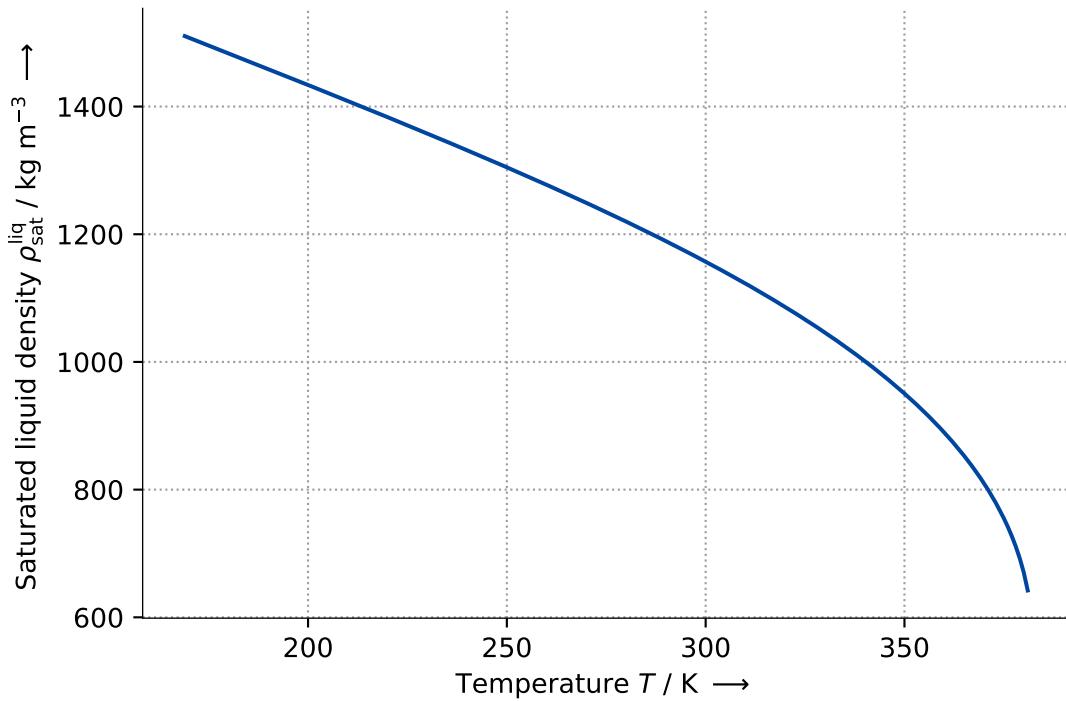
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.250000000e+00
$T_{\text{crit}}$	K	3.825130000e+02	$a_5$	-	1.309600000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.892380000e+02	$b_5$	-	1.900000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.191300000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	2.700000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	2.245600000e+00	$a_8$	-	0.000000000e+00
$b_3$	-	7.000000000e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.774700000e+00			

---

### Validity:

Equation is approximately valid for  $169.0\text{K} \leq T \leq 382.513\text{K}$ .

### Visualization:



#### 4.27.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-1234ze(E)
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Thol, Monika; Lemmon, Eric W. (2016): Equation of State for the Thermodynamic Properties of trans-1,3,3,3-Tetrafluoropropene [R-1234ze(E)]. In: Int J Thermophys 37 (3), S. 3710. DOI: 10.1007/s10765-016-2040-6.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T/T_{\text{crit}}}{.}$$

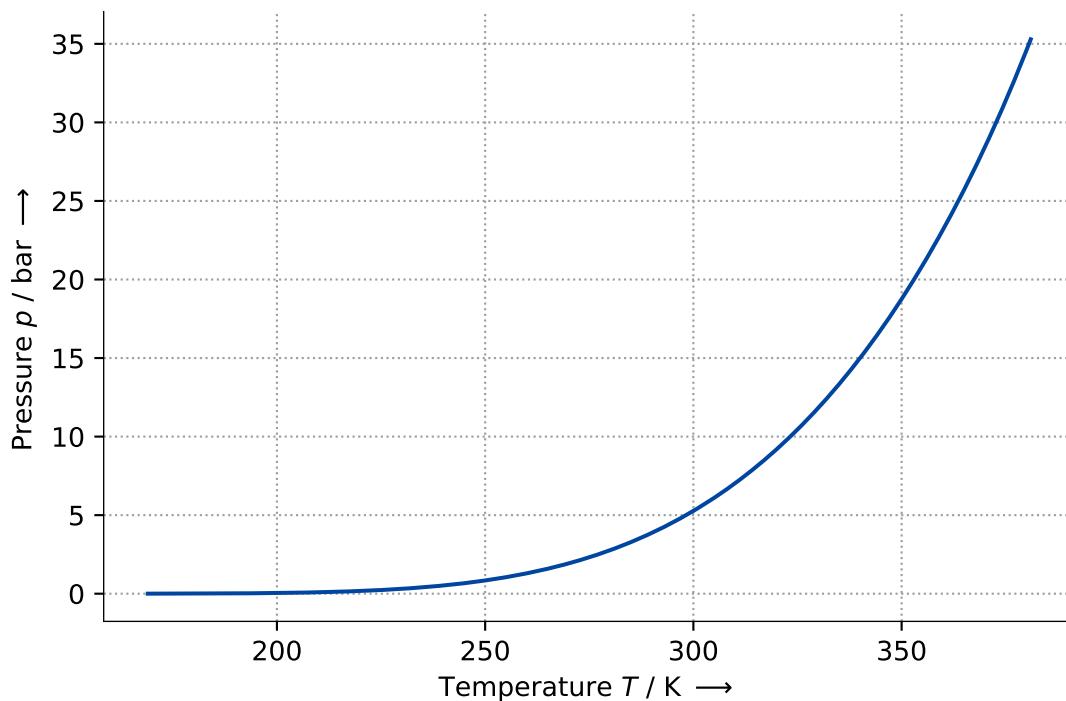
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.825130000e+02	$a_4$	-	-4.123800000e+00
$p_{\text{crit}}$	Pa	3.634900000e+06	$b_4$	-	4.600000000e+00
$a_1$	-	-7.588800000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.969600000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.082700000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.200000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $169.0\text{K} \leq T \leq 382.513\text{K}$ .

#### Visualization:



#### 4.27.3 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	R-1234ze(E)
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

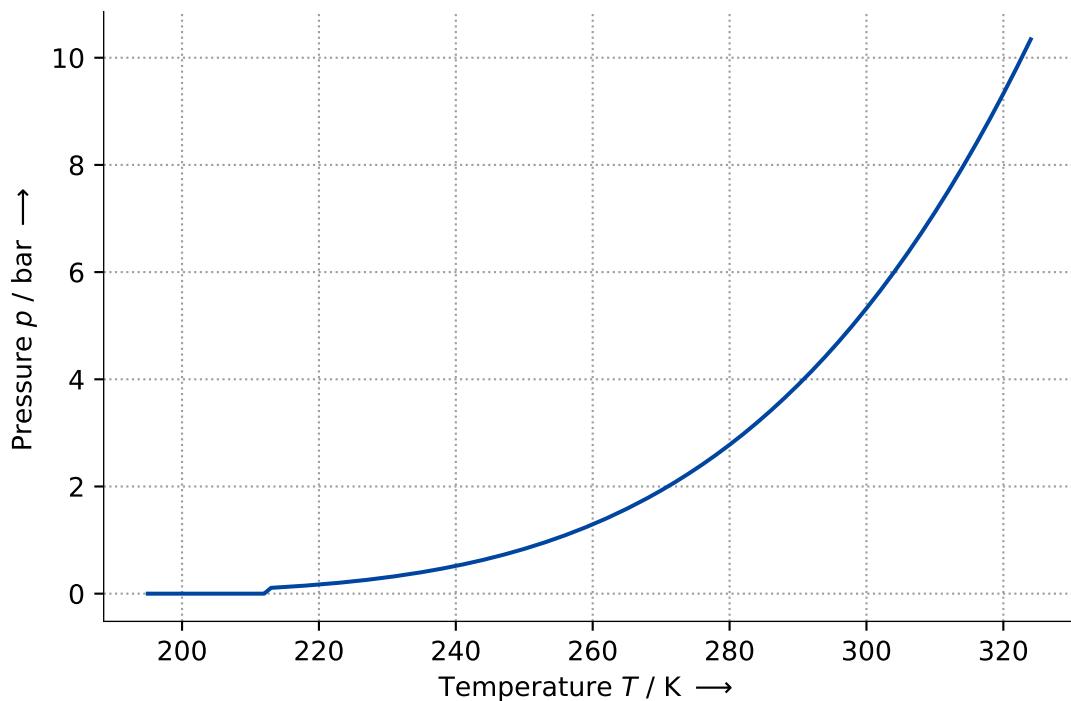
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.825100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.634900000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.130000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $194.35\text{K} \leq T \leq 325.1335\text{K}$ .

### Visualization:



#### 4.27.4 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	R-1234ze(E)
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

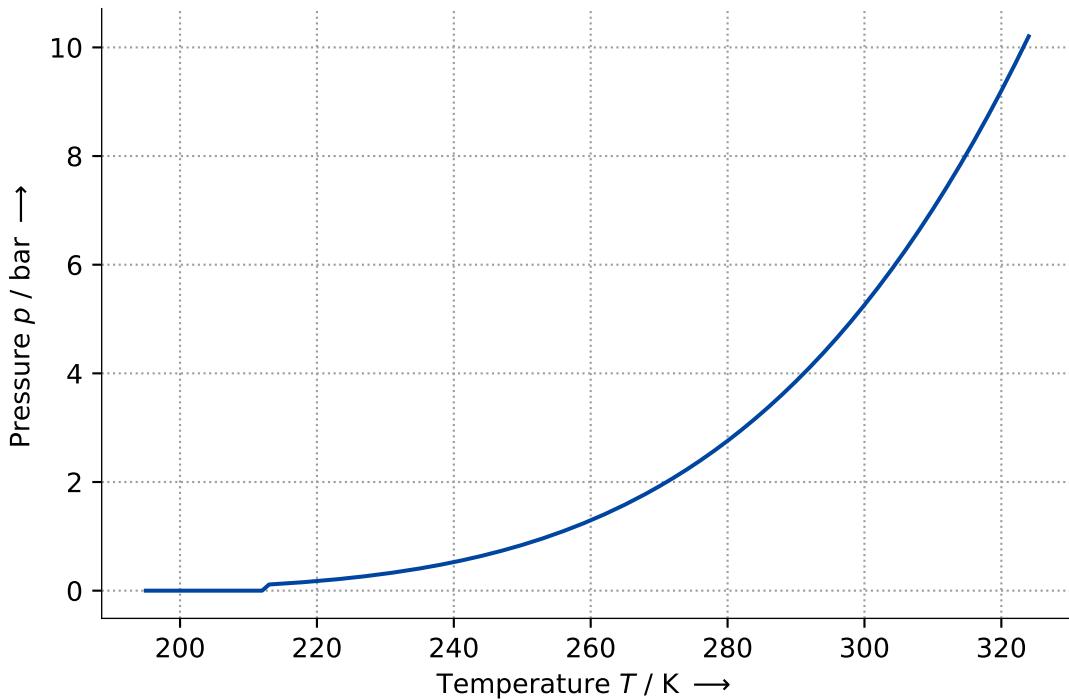
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.825100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.634900000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.130000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $194.35\text{K} \leq T \leq 325.1335\text{K}$ .

### Visualization:



## 4.28 R-125

### 4.28.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-125
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; Jacobsen, Richard T. (2005): A New Functional Form and New Fitting Techniques for Equations of State with Application to Pentafluoroethane (HFC-125). In: Journal of Physical and Chemical Reference Data 34 (1), S. 69–108. DOI: 10.1063/1.1797813.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

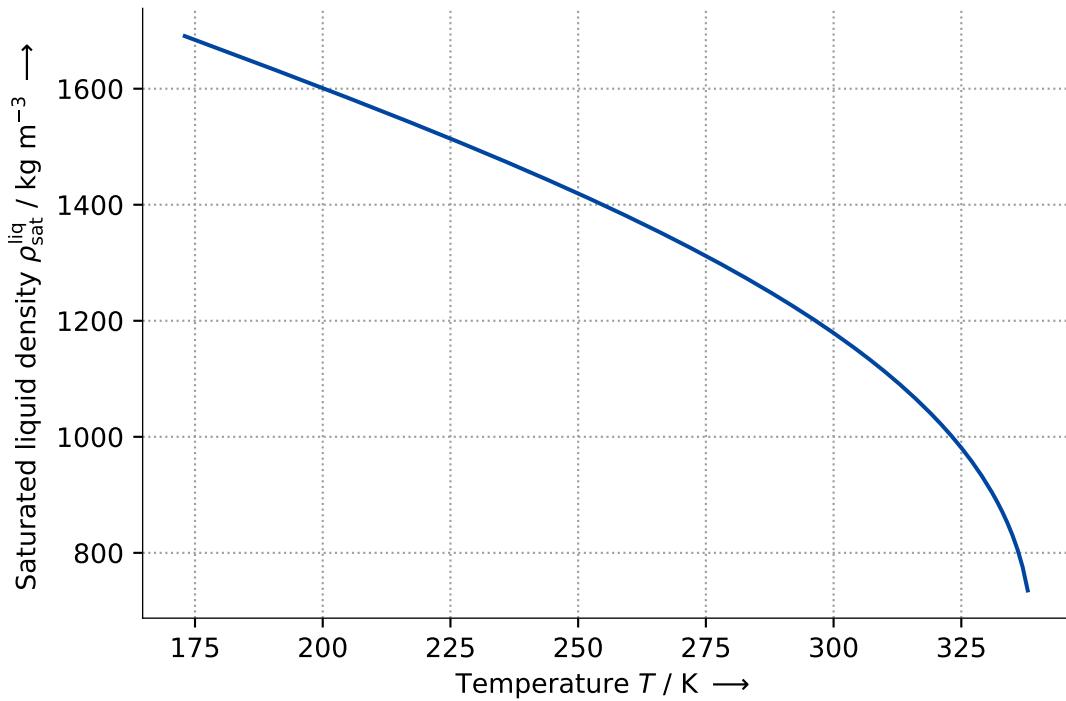
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	2.900000000e+00
$T_{\text{crit}}$	K	3.391730000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.735755800e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.668400000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	8.841500000e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.000000000e-01	$b_8$	-	0.000000000e+00
$a_4$	-	4.438300000e-01			

---

### Validity:

Equation is approximately valid for  $172.52\text{K} \leq T \leq 339.173\text{K}$ .

### Visualization:



#### 4.28.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-125
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; Jacobsen, Richard T. (2005): A New Functional Form and New Fitting Techniques for Equations of State with Application to Pentafluoroethane (HFC-125). In: Journal of Physical and Chemical Reference Data 34 (1), S. 69–108. DOI: 10.1063/1.1797813.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T/T_{\text{crit}}}{T/T_{\text{crit}}} \quad .$$

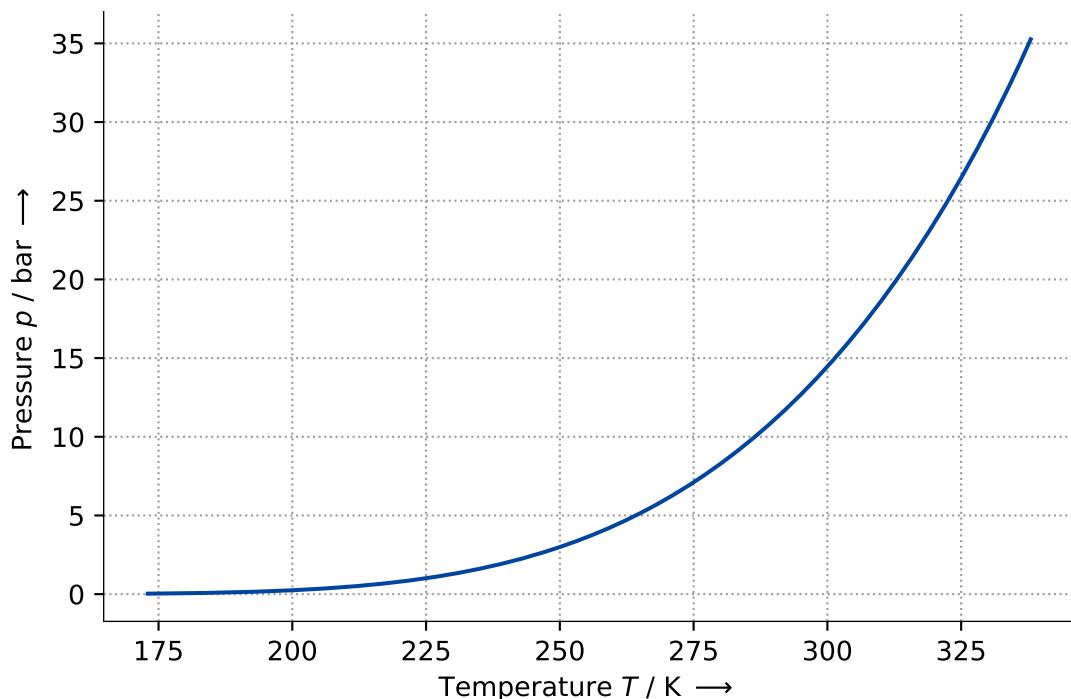
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.391730000e+02	$a_4$	-	-3.448000000e+00
$p_{\text{crit}}$	Pa	3.617700000e+06	$b_4$	-	4.600000000e+00
$a_1$	-	-7.529500000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.902600000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.296600000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.300000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $172.52\text{K} \leq T \leq 339.173\text{K}$ .

#### Visualization:



#### 4.28.3 Vapor Pressure - EoS Cubic - ID 1

---

<b>Name:</b>	R-125
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

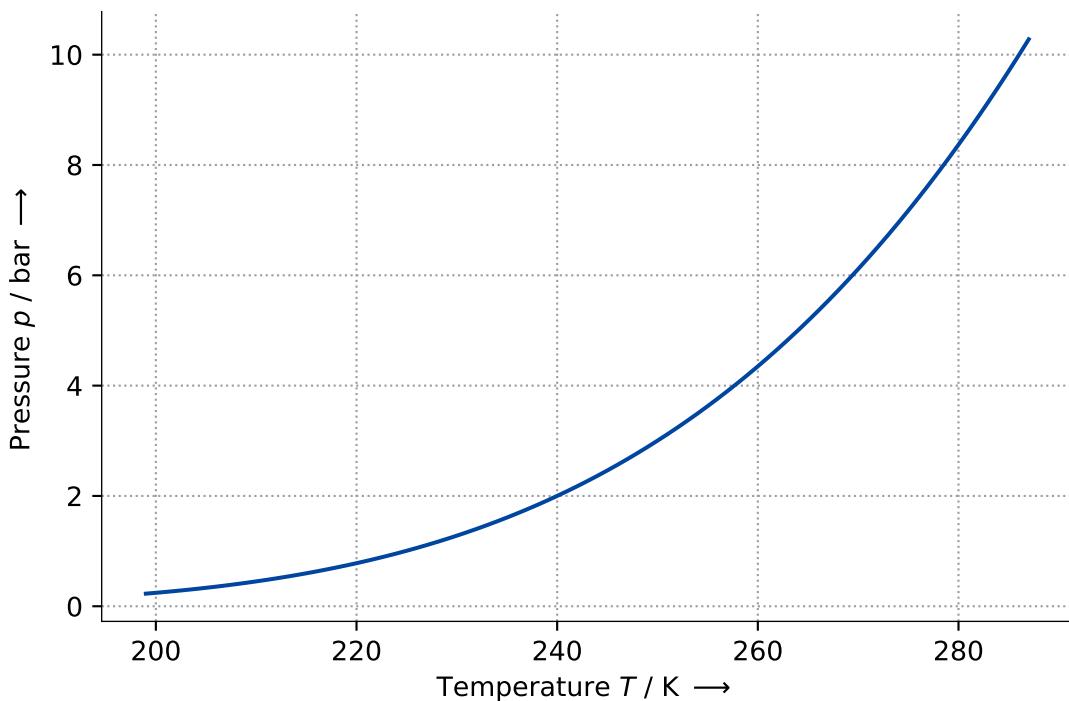
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.391700000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.617700000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.052000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $198.398\text{K} \leq T \leq 288.2945\text{K}$ .

### Visualization:



#### 4.28.4 Vapor Pressure - EoS Cubic - ID 2

---

<b>Name:</b>	R-125
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

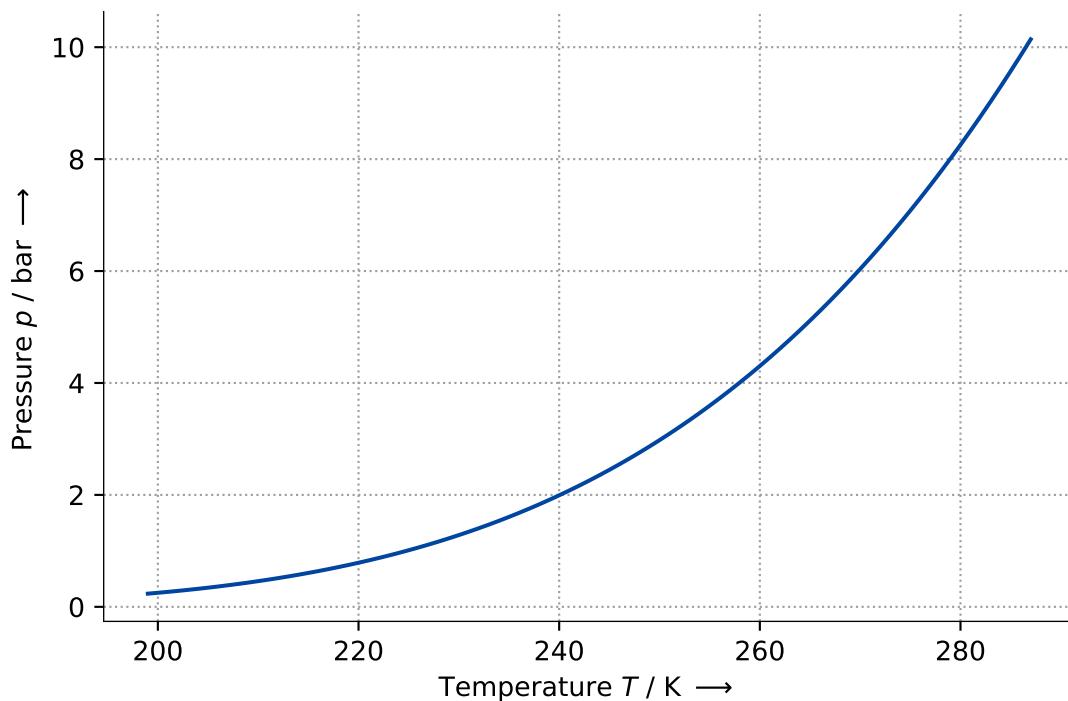
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.391700000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.617700000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.052000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $198.398\text{K} \leq T \leq 288.2945\text{K}$ .

### Visualization:



## 4.29 R-13 B1

### 4.29.1 Vapor Pressure - Antoine - ID 1

Name:	R-13 B1
Equation:	VaporPressure_Antoine
ID:	1
Reference:	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
Comment:	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

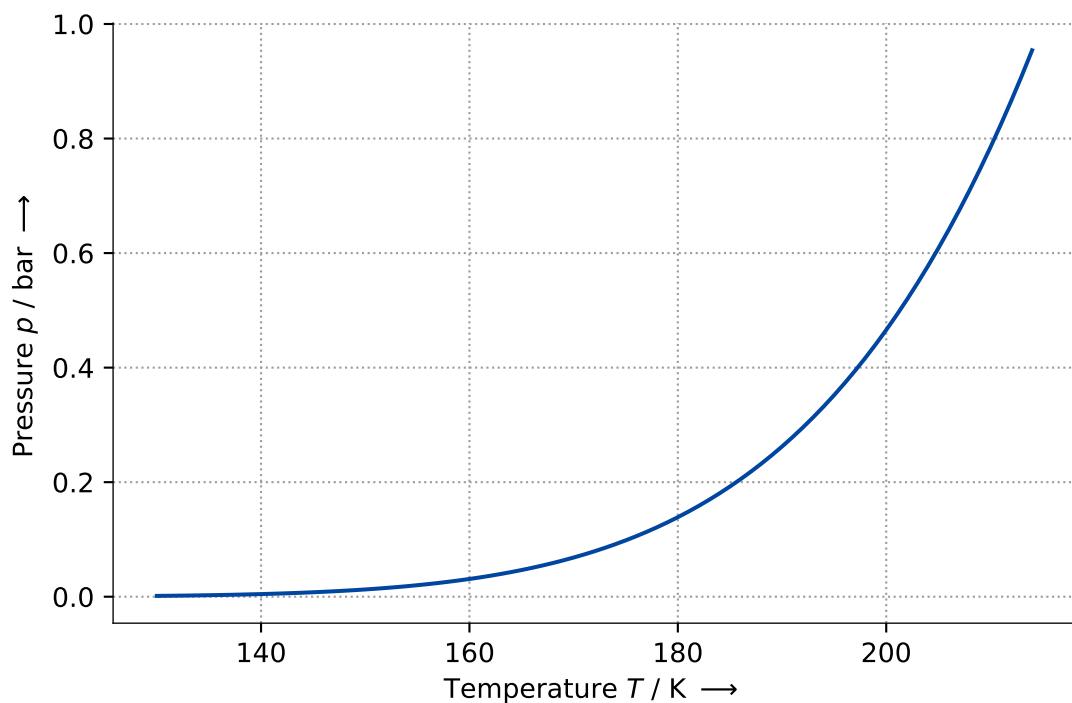
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.585520000e+00	$c$	K	7.086000000e+00
$b$	K	1.018310000e+03			

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $129.5\text{K} \leq T \leq 215.4\text{K}$ .

**Visualization:**

## 4.30 R-134a

### 4.30.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-134a
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Tillner-Roth, Reiner; Baehr, Hans Dieter (1994): An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluoroethane (HFC-134a) for Temperatures from 170 K to 455 K and Pressures up to 70 MPa. In: Journal of Physical and Chemical Reference Data 23 (5), S. 657–729. DOI: 10.1063/1.555958.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

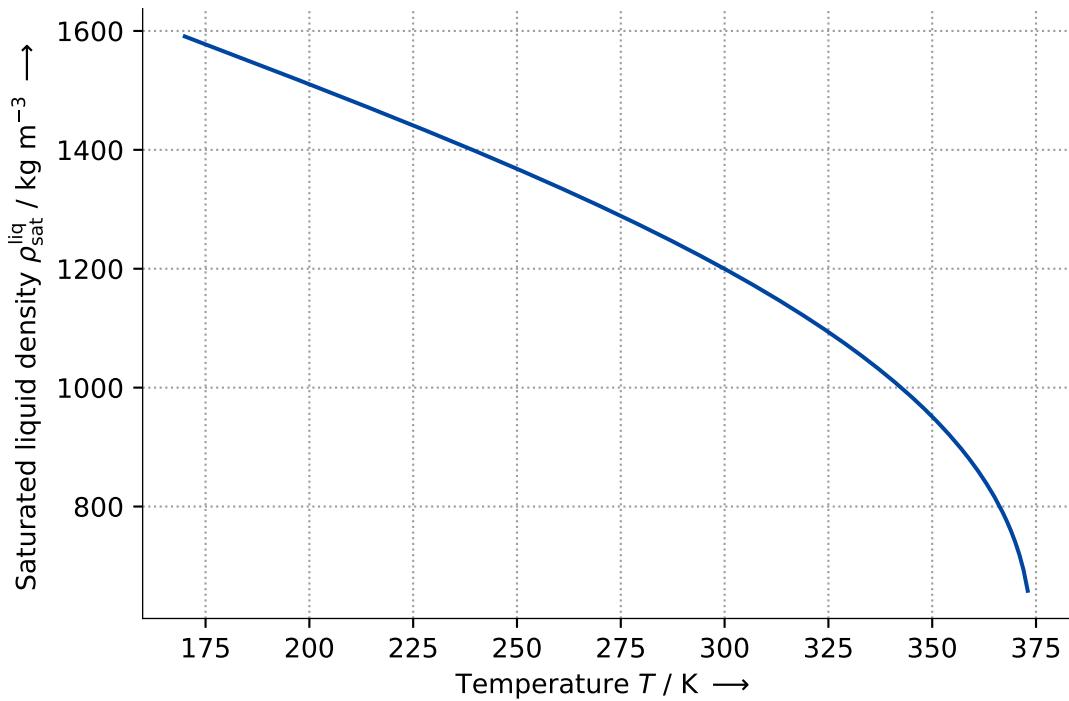
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	3.333333333e+00
$T_{\text{crit}}$	K	3.741800000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_1$	-	5.182000000e+02	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	8.841300000e+02	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	4.858400000e+02	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	1.932900000e+02			

#### Validity:

Equation is approximately valid for  $169.85\text{K} \leq T \leq 374.18\text{K}$ .

**Visualization:**



## 4.30.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-134a
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Tillner-Roth, Reiner; Baehr, Hans Dieter (1994): An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluoroethane (HFC-134a) for Temperatures from 170 K to 455 K and Pressures up to 70 MPa. In: Journal of Physical and Chemical Reference Data 23 (5), S. 657–729. DOI: 10.1063/1.555958.
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

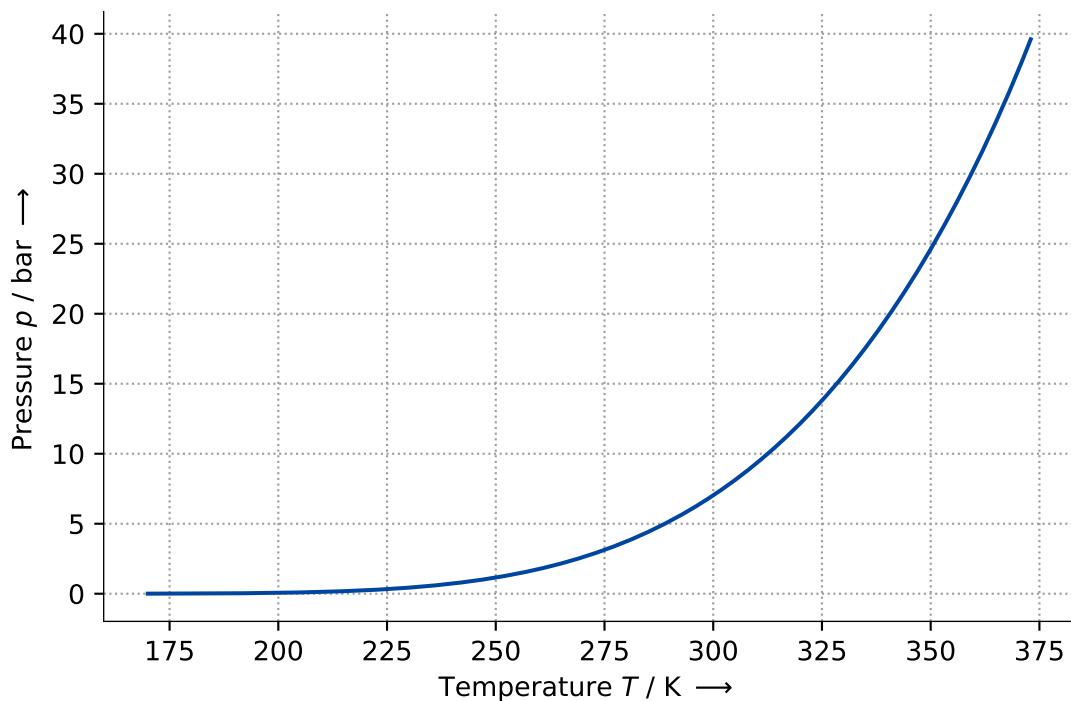
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.741800000e+02	$a_4$	-	-3.583758000e+00
$p_{\text{crit}}$	Pa	4.056290000e+06	$b_4$	-	4.000000000e+00
$a_1$	-	-7.686556000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.311791000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.039554000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $169.85\text{K} \leq T \leq 374.18\text{K}$ .

**Visualization:**



#### 4.30.3 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	R-134a
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

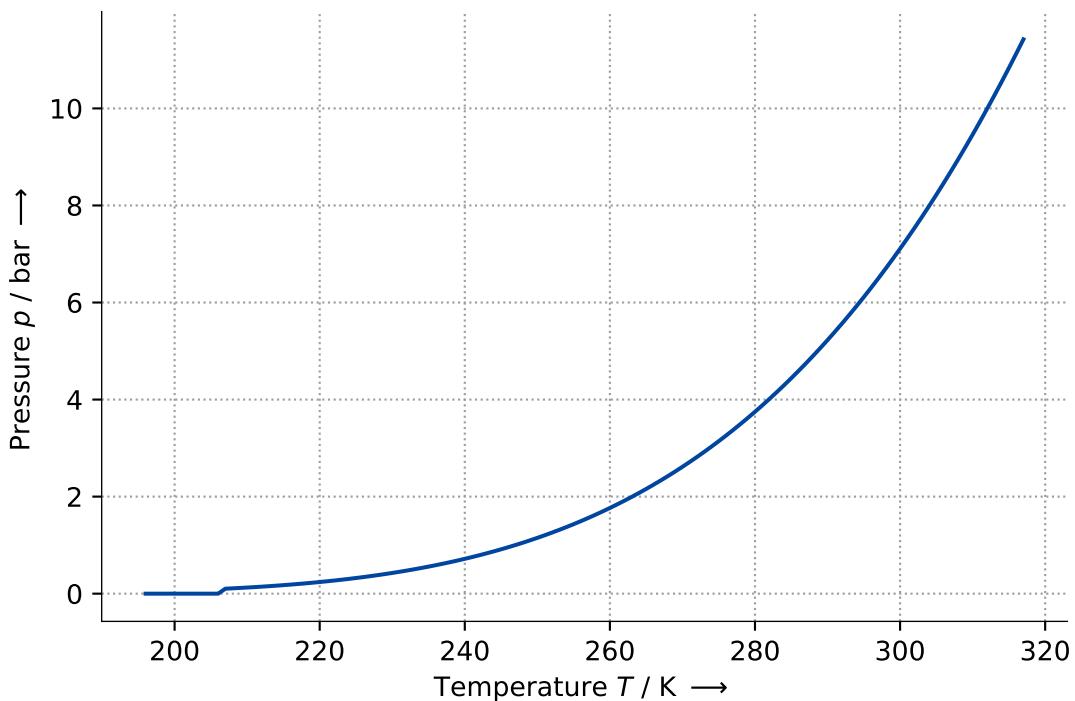
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.742100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.059300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.268400000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $195.3275\text{K} \leq T \leq 318.0785\text{K}$ .

### Visualization:



#### 4.30.4 Vapor Pressure - EoSCubic - ID 2

---

<b>Name:</b>	R-134a
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

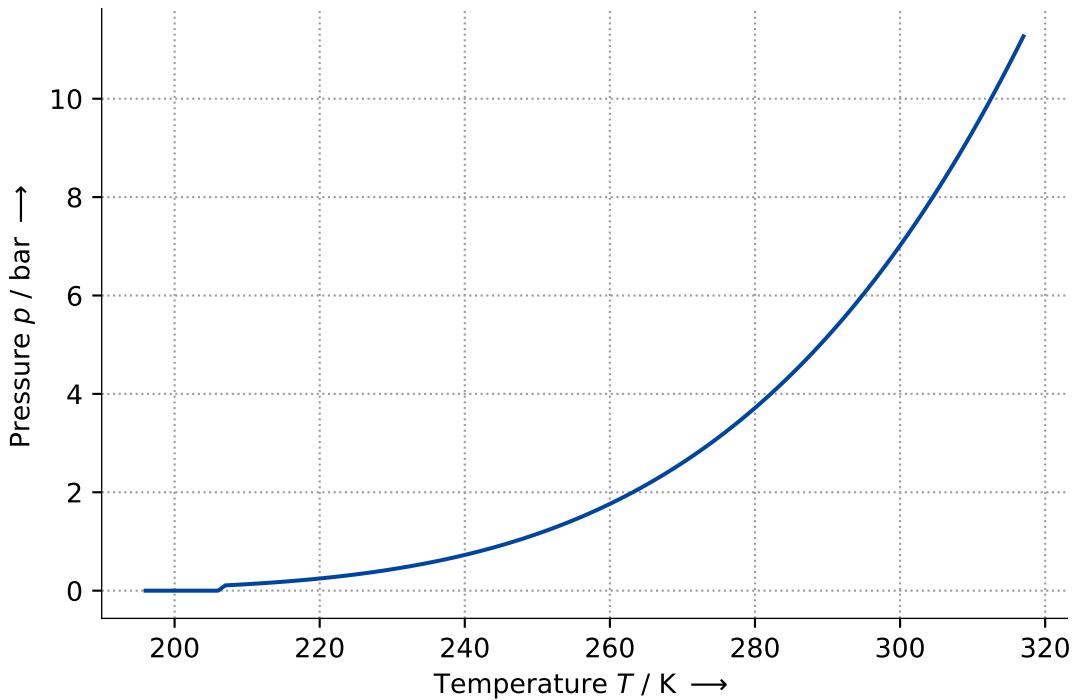
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.742100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.059300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.268400000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $195.3275\text{K} \leq T \leq 318.0785\text{K}$ .

### Visualization:



## 4.31 R-142b

### 4.31.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-142b
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	McLinden, M. O.: Physical Properties of Alternatives to the Fully Halogenated Chlorofluorocarbons.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	4.102500000e+02	$a_5$	-	7.113558700e+00
$\rho_{\text{ref}}$	kg m <sup>-3</sup>	4.350000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	-2.767150000e-01	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.014727500e+01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.391714200e+01			

**Validity:**

Equation is approximately valid for  $142.72\text{K} \leq T \leq 410.25\text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'R-142b'. Thus, data cannot be visualized!

## 4.31.2 Vapor Pressure - EoS3 - ID 1

<b>Name:</b>	R-142b
<b>Equation:</b>	VaporPressure_EoS3
<b>ID:</b>	1
<b>Reference:</b>	McLinden, M. O.: Physical Properties of Alternatives to the Fully Halogenated Chlorofluorocarbons.
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{ref}} \exp \left( \frac{a_0}{T} + \sum_{i=1}^2 a_i T^{b_i} + a_3 \xi^{b_3} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T/T_{\text{crit}}}{.}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	4.102500000e+02	$a_2$	-	-1.012149000e-03
$p_{\text{ref}}$	Pa	1.000000000e+03	$b_2$	-	1.000000000e+00
$a_0$	-	-3.382422000e+03	$a_3$	-	3.224924000e+00
$a_1$	-	1.701384000e+01	$b_3$	-	1.500000000e+00
$b_1$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $142.72\text{K} \leq T \leq 410.25\text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'R-142b'. Thus, data cannot be visualized!

### 4.31.3 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	R-142b
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.102600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.055000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.321000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $164.128\text{K} \leq T \leq 348.721\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'R-142b'. Thus, data cannot be visualized!

#### 4.31.4 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	R-142b
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	4.102600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.055000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.321000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $164.128\text{K} \leq T \leq 348.721\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'R-142b'. Thus, data cannot be visualized!

## 4.32 R-143a

### 4.32.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-143a
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; Jacobsen, Richard T. (2000): An International Standard Formulation for the Thermodynamic Properties of 1,1,1-Trifluoroethane (HFC-143a) for Temperatures From 161 to 450 K and Pressures to 50 MPa. In: Journal of Physical and Chemical Reference Data 29 (4), S. 521–552. DOI: 10.1063/1.1318909.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\begin{aligned}\rho_{\text{sat}}^{\text{liq}} &= \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with} \\ \Omega &= \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and} \\ \xi &= 1 - \theta, \text{ and} \\ \theta &= T/T_{\text{crit}}.\end{aligned}$$

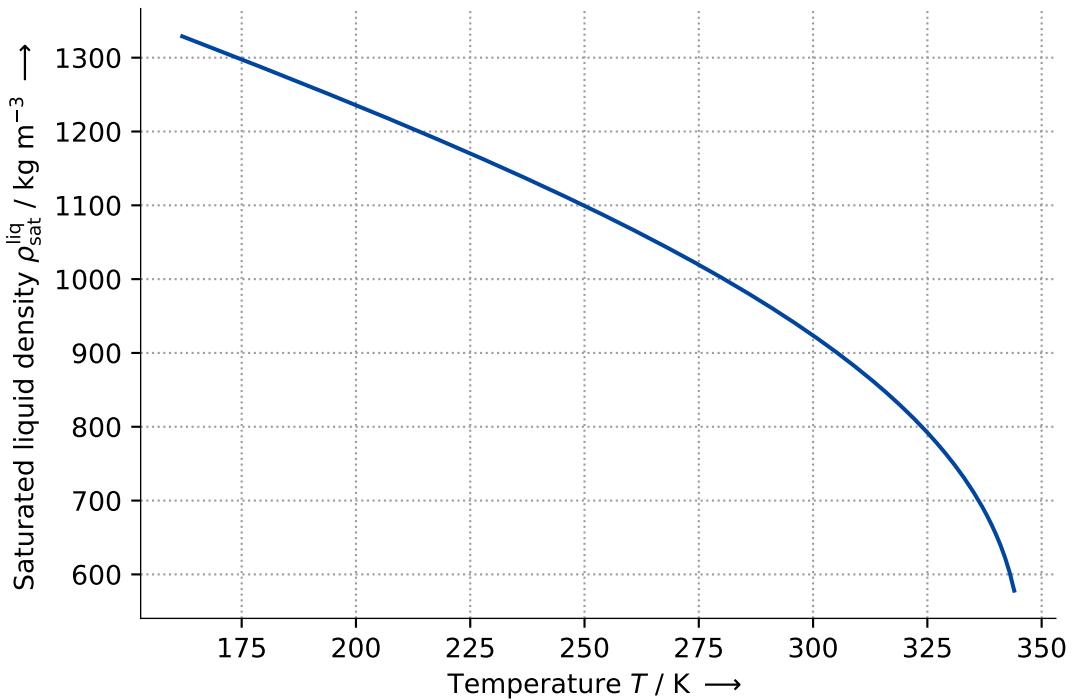
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	2.666666667e+00
$T_{\text{crit}}$	K	3.458570000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.309949380e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.795000000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	8.709000000e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	3.116000000e-01			

#### Validity:

Equation is approximately valid for  $161.34\text{K} \leq T \leq 345.857\text{K}$ .

#### Visualization:



#### 4.32.2 Saturated Liquid Density - EoS1 - ID 2

---

<b>Name:</b>	R-143a
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

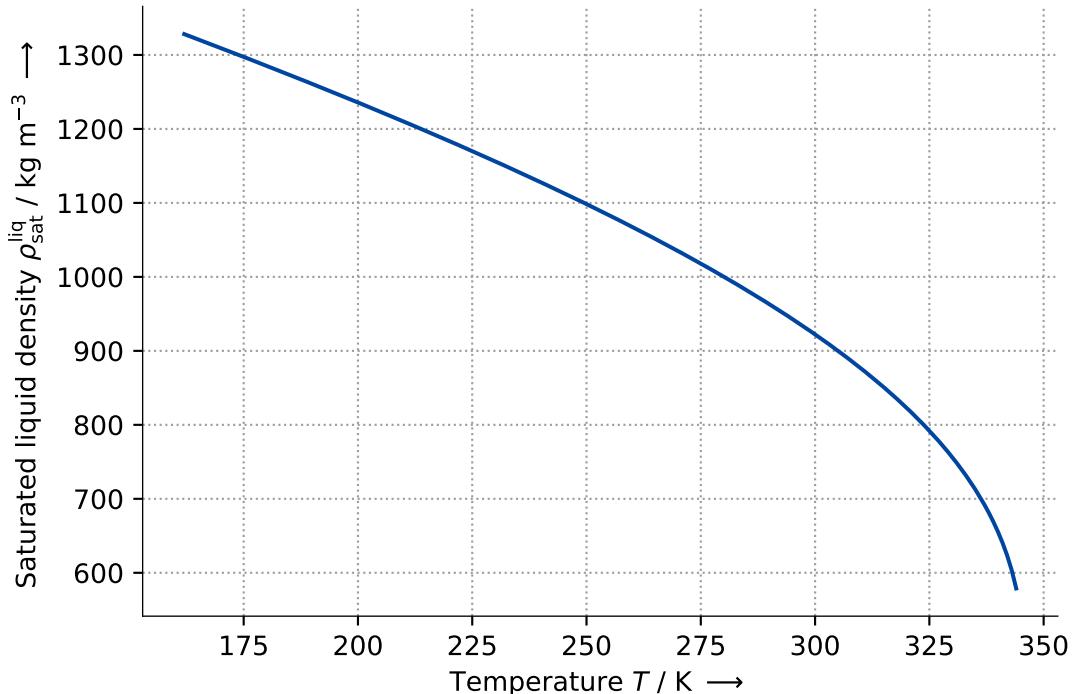
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.458600000e+02	$a_5$	-	5.060540603e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.310000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.064521114e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	3.698689095e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-6.395081207e-02			

**Validity:**

Equation is approximately valid for  $161.34\text{K} \leq T \leq 345.86\text{K}$ .

**Visualization:**

### 4.32.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	R-143a
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

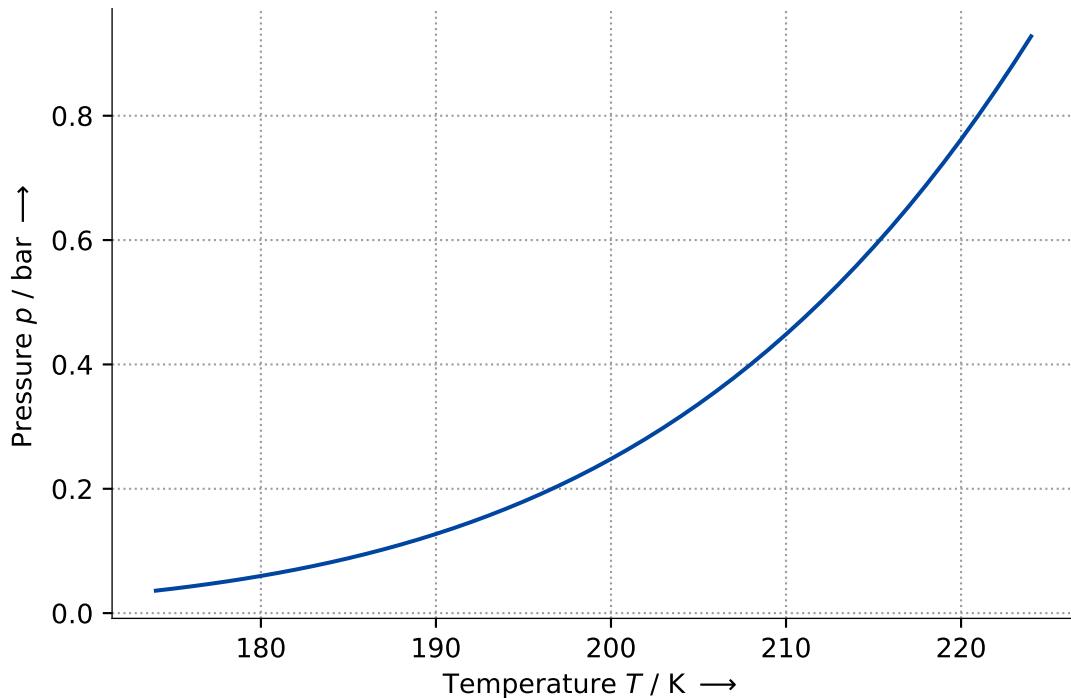
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.024230000e+00	$c$	K	-3.009300000e+01
$b$	K	7.866450000e+02			

#### Validity:

Equation is approximately valid for  $173.6\text{K} \leq T \leq 225.78\text{K}$ .

#### Visualization:



#### 4.32.4 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-143a
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; Jacobsen, Richard T. (2000): An International Standard Formulation for the Thermodynamic Properties of 1,1,1-Trifluoroethane (HFC-143a) for Temperatures From 161 to 450 K and Pressures to 50 MPa. In: Journal of Physical and Chemical Reference Data 29 (4), S. 521–552. DOI: 10.1063/1.1318909.
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

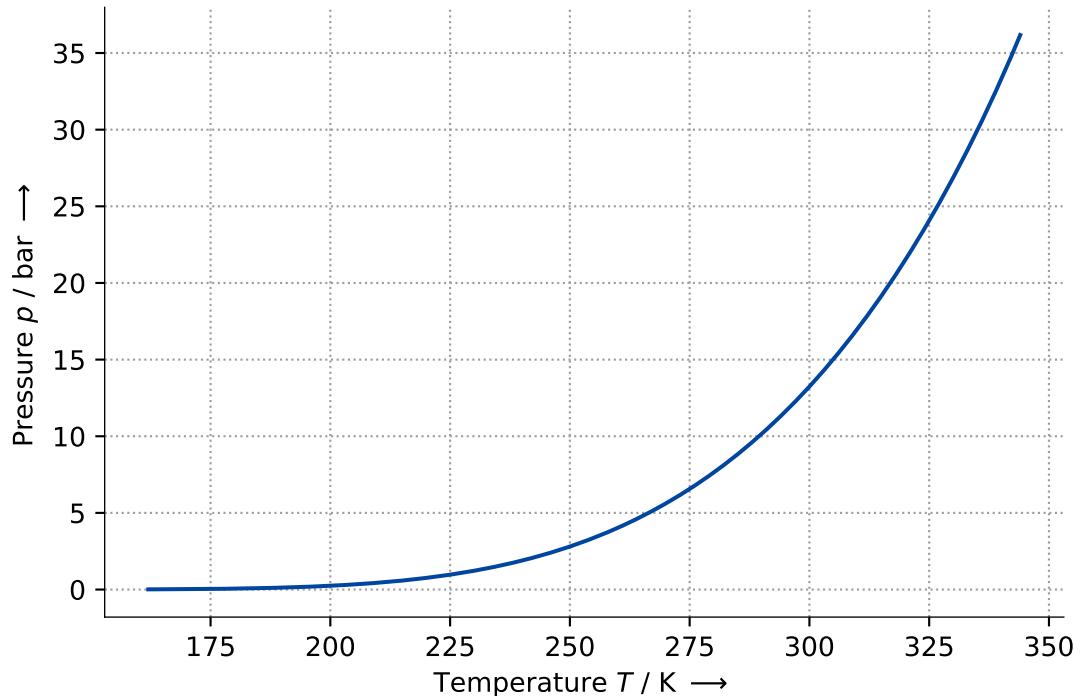
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.458570000e+02	$a_4$	-	-2.053200000e+00
$p_{\text{crit}}$	Pa	3.761000000e+06	$b_4$	-	3.500000000e+00
$a_1$	-	-7.352600000e+00	$a_5$	-	-1.735400000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	5.500000000e+00
$a_2$	-	1.916200000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.220300000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $161.34\text{K} \leq T \leq 345.857\text{K}$ .

**Visualization:**



## 4.32.5 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	R-143a
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

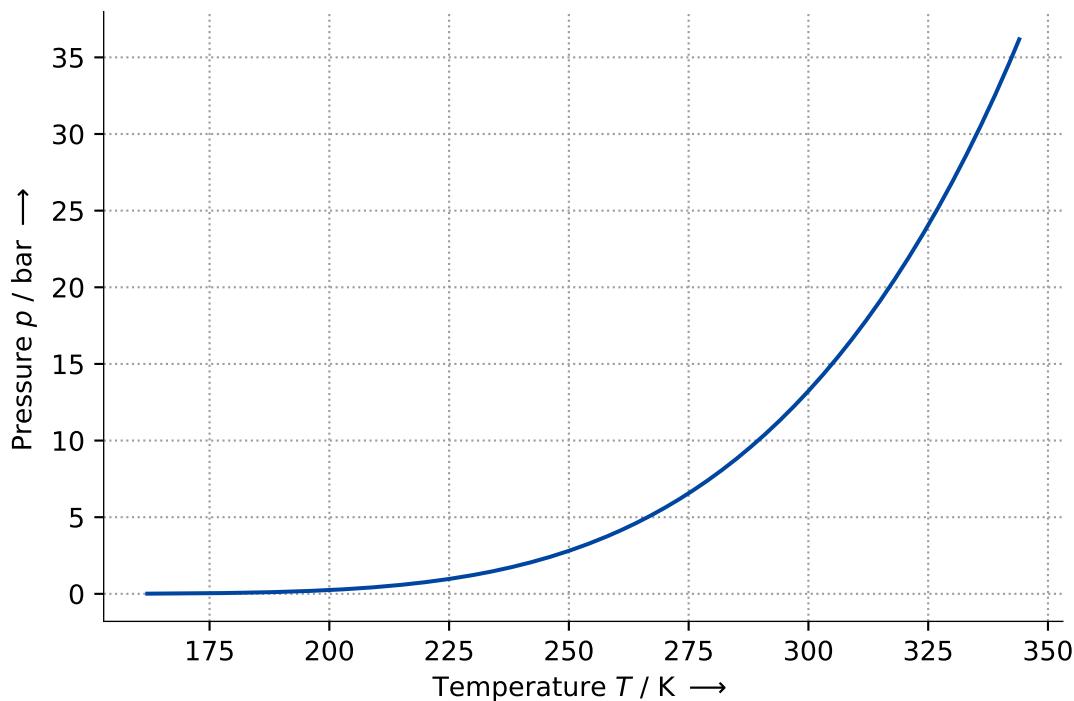
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.458600000e+02	$a_4$	-	-2.984130000e+00
$p_{\text{crit}}$	Pa	3.762000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.359950000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.712030000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.018790000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $161.34\text{K} \leq T \leq 345.86\text{K}$ .

**Visualization:**



#### 4.32.6 Vapor Pressure - EoS Cubic - ID 1

---

<b>Name:</b>	R-143a
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

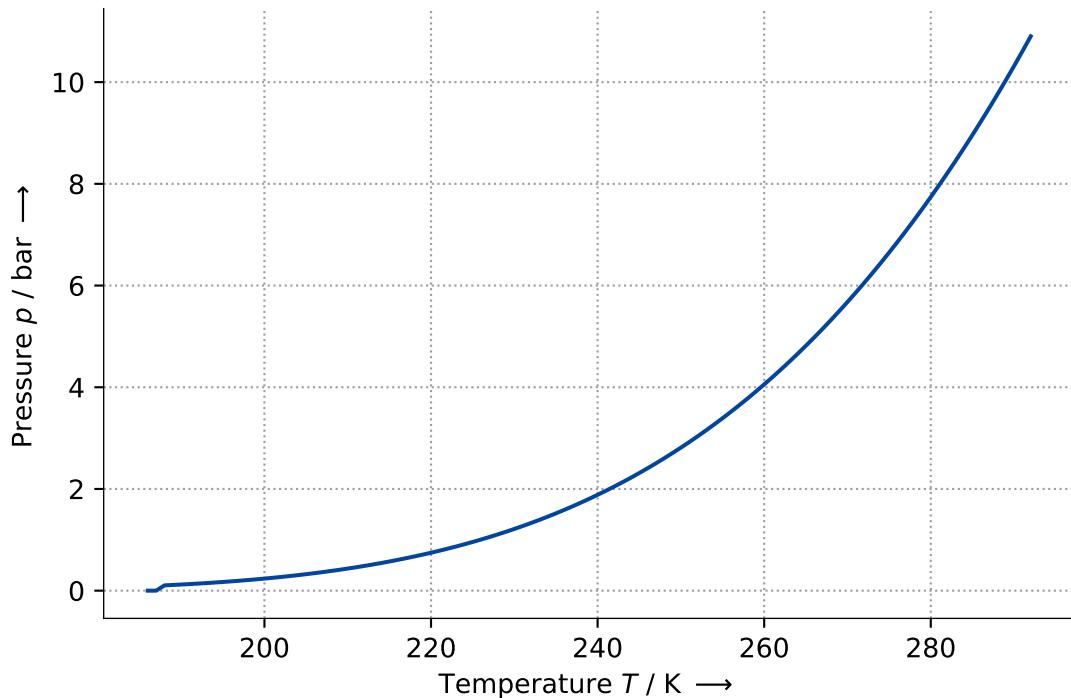
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.458600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.761000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.615000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $185.541\text{K} \leq T \leq 293.981\text{K}$ .

### Visualization:



#### 4.32.7 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	R-143a
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

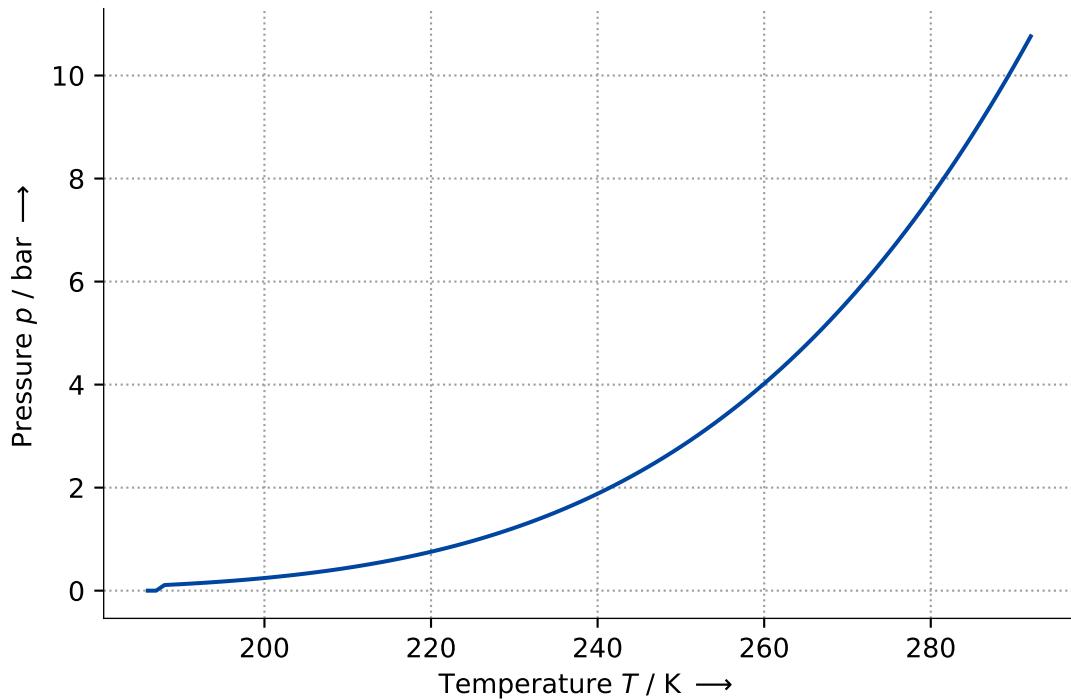
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.458600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	3.761000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.615000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $185.541\text{K} \leq T \leq 293.981\text{K}$ .

### Visualization:



## 4.33 R-152a

### 4.33.1 Vapor Pressure - Antoine - ID 1

Name:	R-152a
Equation:	VaporPressure_Antoine
ID:	1
Reference:	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
Comment:	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

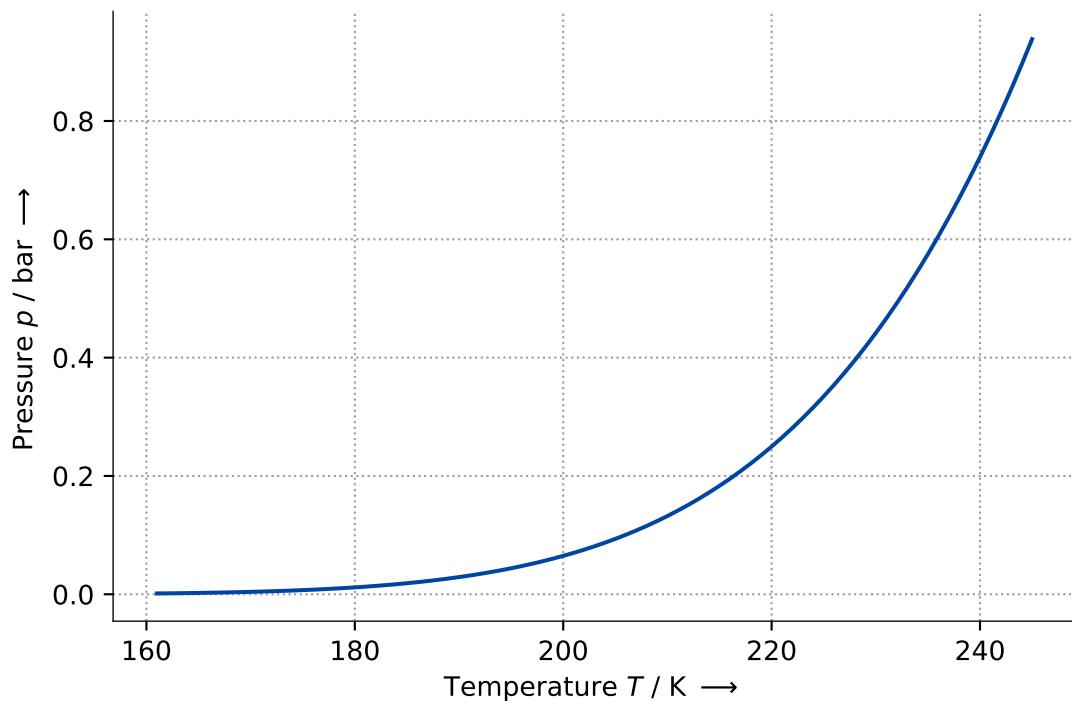
Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.234060000e+00	$c$	K	-3.471400000e+01
$b$	K	8.961710000e+02			

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $160.7\text{K} \leq T \leq 246.7\text{K}$ .

**Visualization:**



### 4.33.2 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	R-152a
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

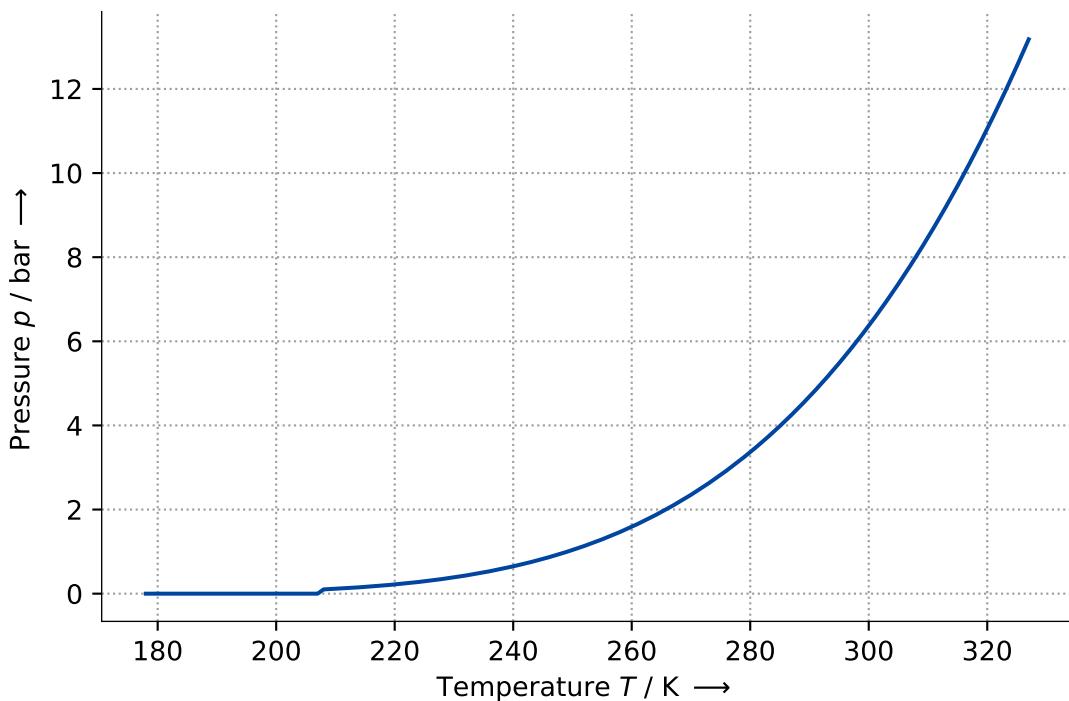
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.864100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.516800000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.752100000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $177.744\text{K} \leq T \leq 328.4485\text{K}$ .

#### Visualization:



#### 4.33.3 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	R-152a
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

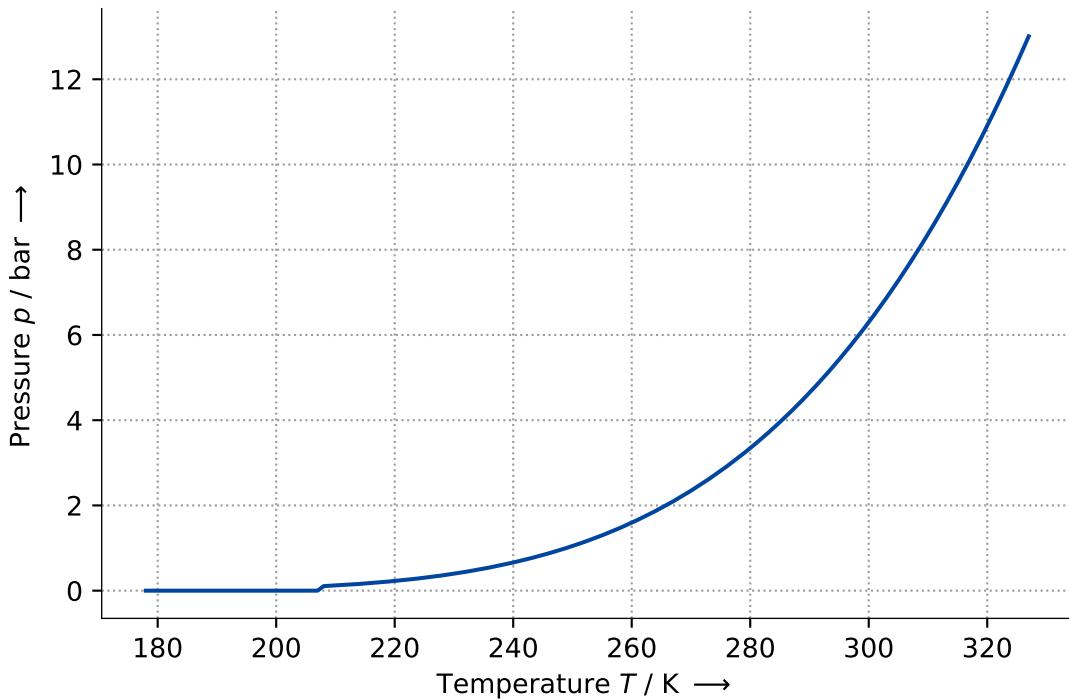
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.864100000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.516800000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.752100000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $177.744\text{K} \leq T \leq 328.4485\text{K}$ .

### Visualization:



## 4.34 R-22

### 4.34.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-22
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Wagner, W.; Marx, V.; Pruss, A. (1993): A new equation of state for chlorodifluoromethane (R22) covering the entire fluid region from 116 K to 550 K at pressures up to 200 MPa. In: International Journal of Refrigeration 16 (6), S. 373–389. DOI: 10.1016/0140-7007(93)90055-D.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

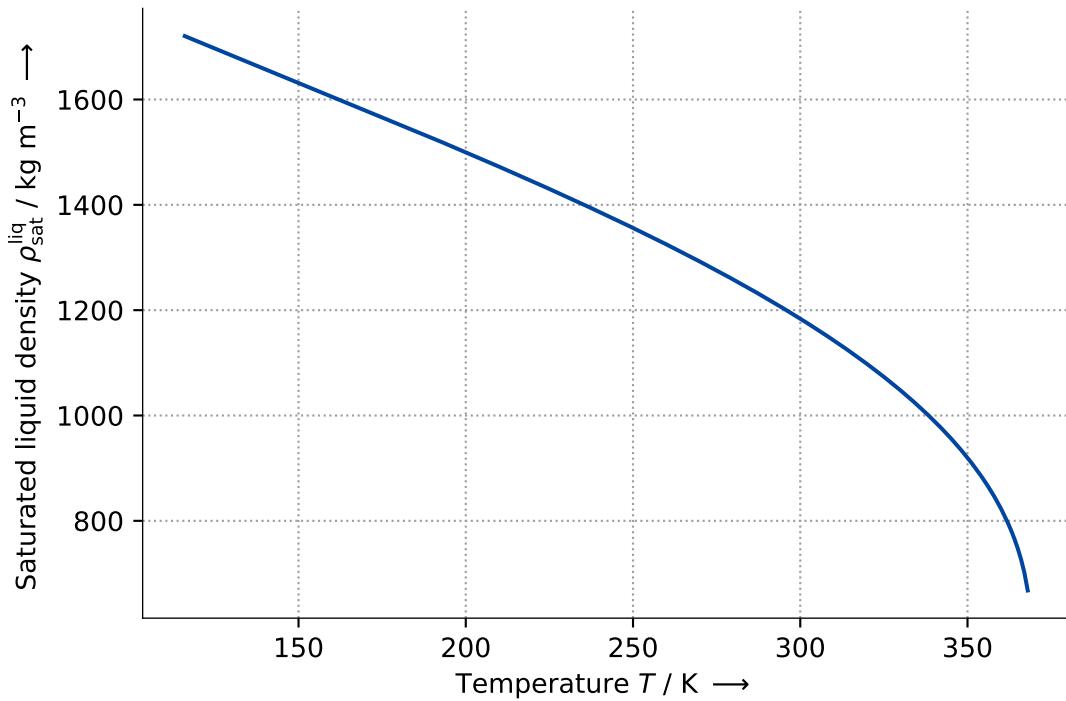
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.666666667e+00
$T_{\text{crit}}$	K	3.692800000e+02	$a_5$	-	2.038181240e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.200000000e+02	$b_5$	-	4.000000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.759600330e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	7.853631550e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	1.888700410e-01			

### Validity:

Equation is approximately valid for  $115.73\text{K} \leq T \leq 369.28\text{K}$ .

### Visualization:



#### 4.34.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	R-22
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

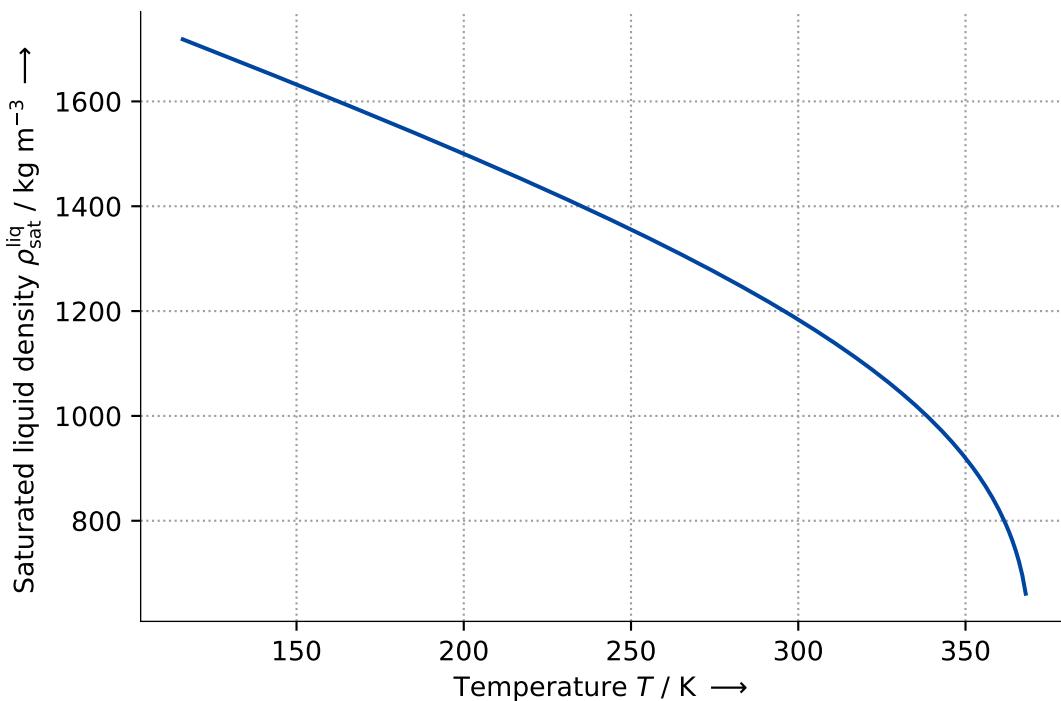
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.692800000e+02	$a_5$	-	1.694242308e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.200000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.738698269e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	1.681093461e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-2.261796539e+00			

#### Validity:

Equation is approximately valid for  $115.73\text{K} \leq T \leq 369.28\text{K}$ .

#### Visualization:



#### 4.34.3 Vapor Pressure - Antoine - ID 1

Name:	R-22
Equation:	VaporPressure_Antoine
ID:	1
Reference:	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
Comment:	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

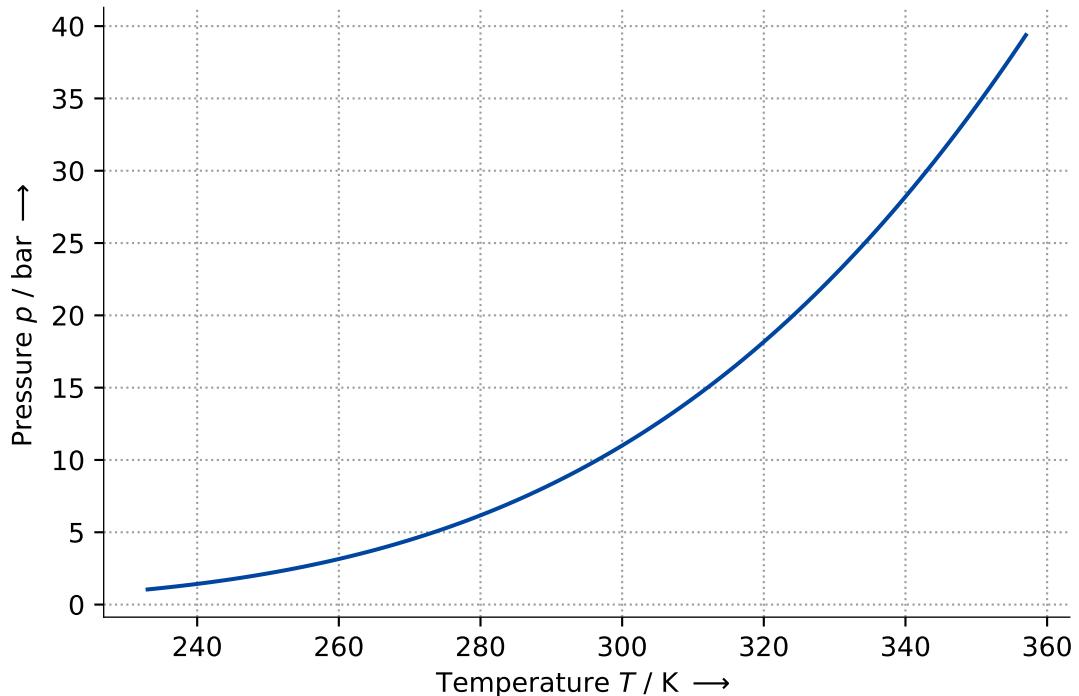
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.365670000e+00	$c$	K	-1.496400000e+01
$b$	K	9.475770000e+02			

##### Validity:

Equation is approximately valid for  $232.4\text{K} \leq T \leq 358.5\text{K}$ .

**Visualization:**



#### 4.34.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	R-22
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

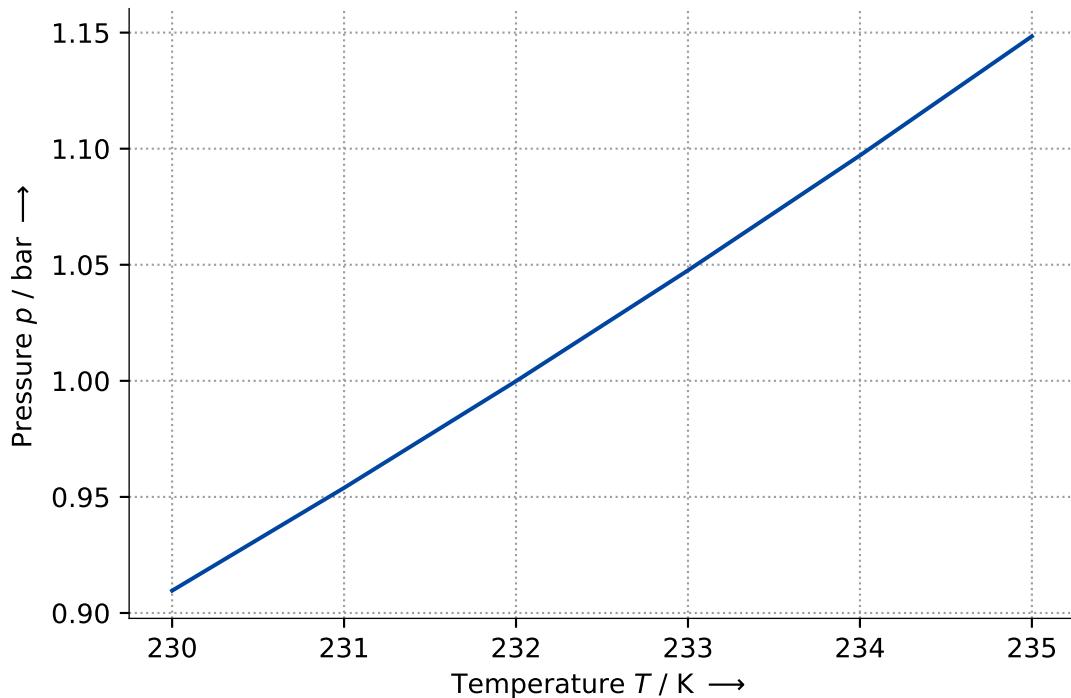
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.176930000e+00	$c$	K	-2.666700000e+01
$b$	K	8.576730000e+02			

**Validity:**

Equation is approximately valid for  $229.6\text{K} \leq T \leq 236.4\text{K}$ .

**Visualization:**



#### 4.34.5 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-22
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Wagner, W.; Marx, V.; Pruss, A. (1993): A new equation of state for chlorodifluoromethane (R22) covering the entire fluid region from 116 K to 550 K at pressures up to 200 MPa. In: International Journal of Refrigeration 16 (6), S. 373–389. DOI: 10.1016/0140-7007(93)90055-D.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

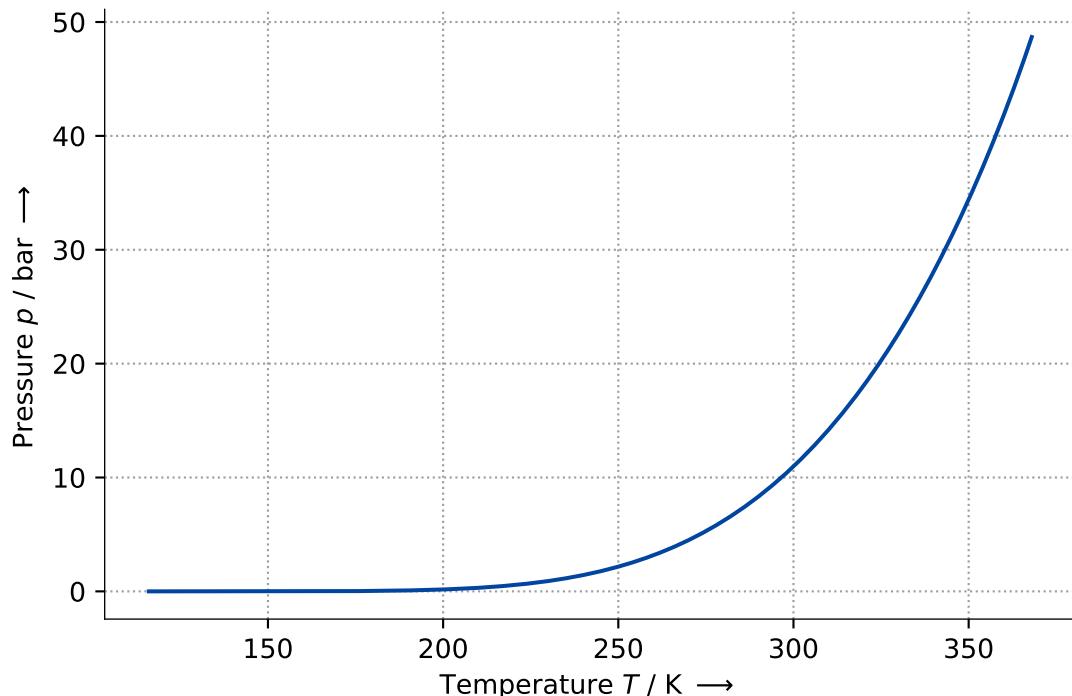
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.692800000e+02	$a_4$	-	-3.259731820e+00
$p_{\text{crit}}$	Pa	4.988500000e+06	$b_4$	-	4.500000000e+00
$a_1$	-	-7.149993690e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.221537540e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.923902010e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.000000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $115.73\text{K} \leq T \leq 369.28\text{K}$ .

**Visualization:**



## 4.34.6 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	R-22
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

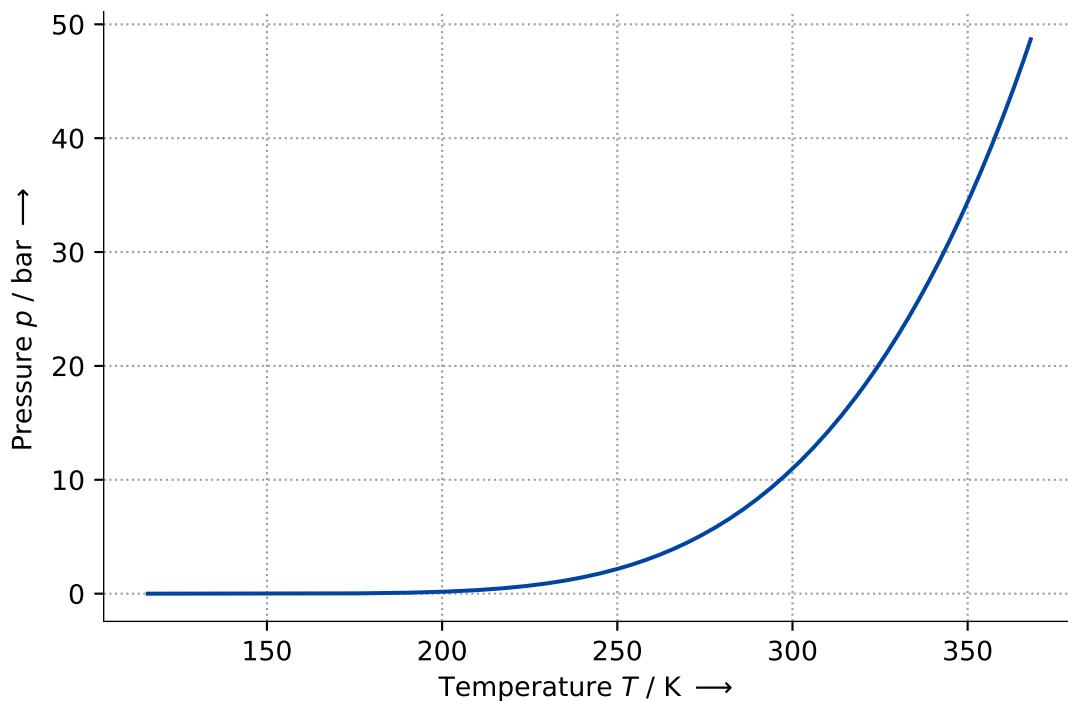
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.692800000e+02	$a_4$	-	-2.731230000e+00
$p_{\text{crit}}$	Pa	4.988000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.092100000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.619050000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.012210000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $115.73\text{K} \leq T \leq 369.28\text{K}$ .

**Visualization:**



#### 4.34.7 Vapor Pressure - EoS Cubic - ID 1

<b>Name:</b>	R-22
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

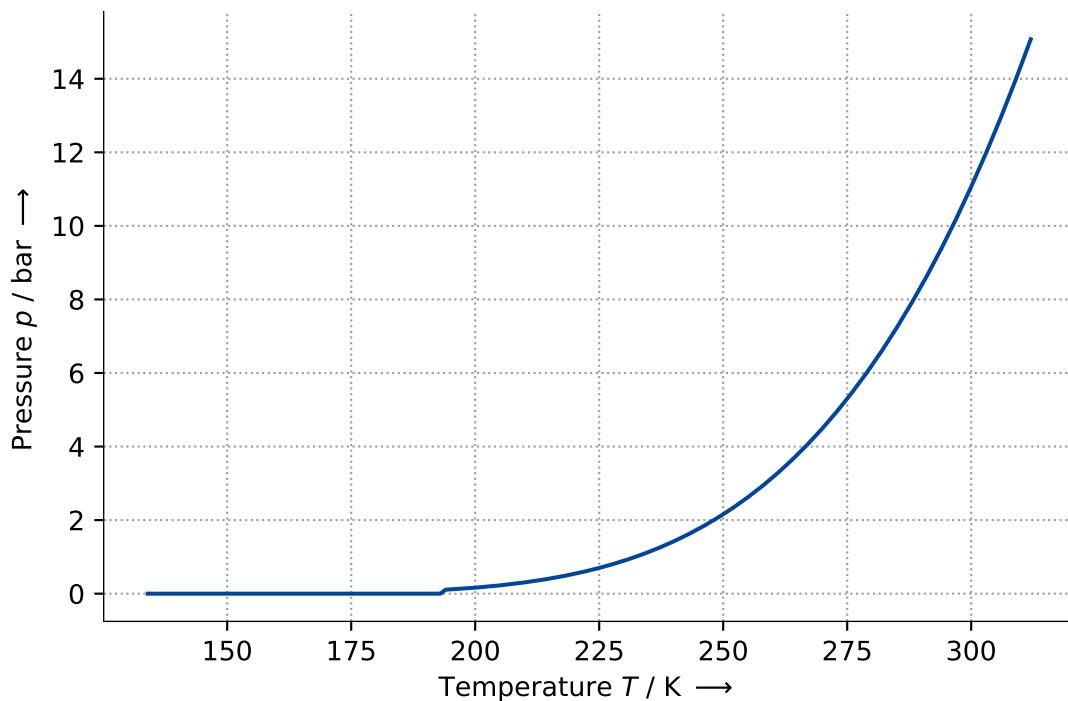
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.693000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.990000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.208200000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $133.0895\text{K} \leq T \leq 313.905\text{K}$ .

### Visualization:



#### 4.34.8 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	R-22
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

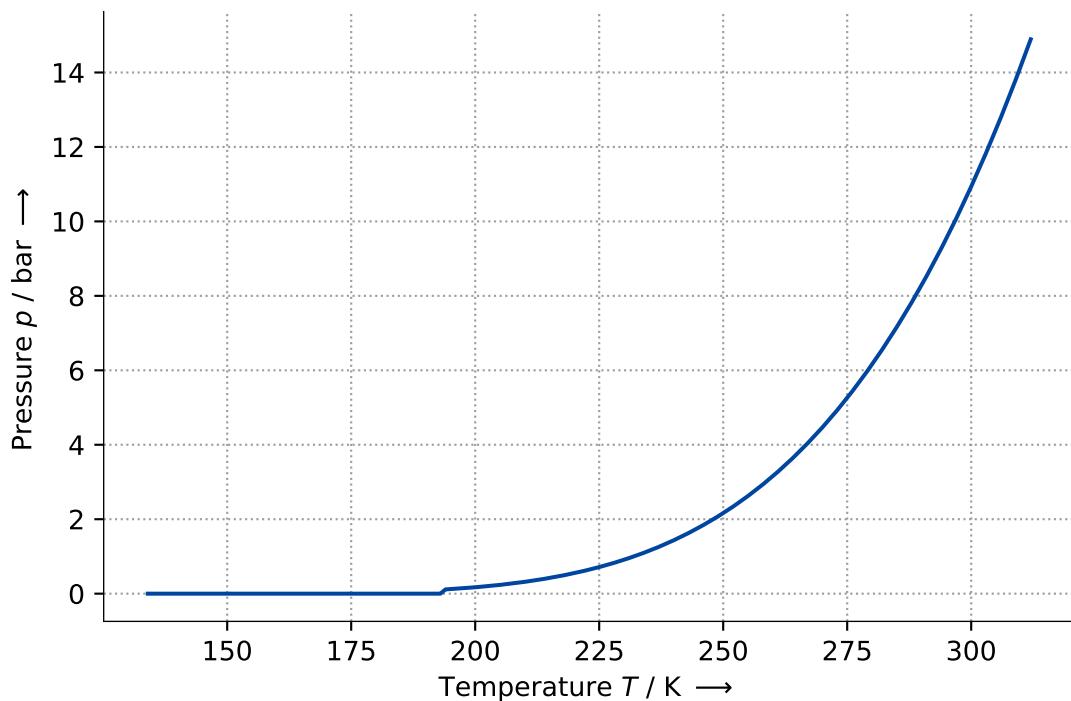
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.693000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.990000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.208200000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $133.0895\text{K} \leq T \leq 313.905\text{K}$ .

### Visualization:



## 4.35 R-227ea

### 4.35.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-227ea
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; Span, Roland (2015): Thermodynamic Properties of R-227ea, R-365mfc, R-115, and R-13I1. In: J. Chem. Eng. Data 60 (12), S. 3745–3758. DOI: 10.1021/acs.jced.5b00684.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	4.400000000e-01
$T_{\text{crit}}$	K	3.749000000e+02	$a_5$	-	2.078400000e+00
$\rho_{\text{ref}}$	kg m <sup>-3</sup>	5.942548500e+02	$b_5$	-	6.000000000e-01
$a_1$	-	1.000000000e+00	$a_6$	-	2.170100000e-01
$b_1$	-	0.000000000e+00	$b_6$	-	2.750000000e+00
$a_2$	-	-2.992600000e-01	$a_7$	-	0.000000000e+00
$b_2$	-	1.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	2.802500000e+00	$a_8$	-	0.000000000e+00
$b_3$	-	3.000000000e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.960200000e+00			

**Validity:**

Equation is approximately valid for  $146.35 \text{K} \leq T \leq 374.9 \text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'R-227ea'. Thus, data cannot be visualized!

## 4.35.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-227ea
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, Eric W.; Span, Roland (2015): Thermodynamic Properties of R-227ea, R-365mfc, R-115, and R-13I1. In: J. Chem. Eng. Data 60 (12), S. 3745–3758. DOI: 10.1021/acs.jced.5b00684.
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.749000000e+02	$a_4$	-	-5.744400000e+00
$p_{\text{crit}}$	Pa	2.925000000e+06	$b_4$	-	4.800000000e+00
$a_1$	-	-7.796100000e+00	$a_5$	-	2.398200000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	6.200000000e+00
$a_2$	-	2.136600000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.602300000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.200000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $146.35\text{K} \leq T \leq 374.9\text{K}$ .

**Visualization:**

No adsorption or absorption working pair exists, which uses refrigerant 'R-227ea'. Thus, data cannot be visualized!

### 4.35.3 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	R-227ea
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.749000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.925000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.570000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $168.3025\text{K} \leq T \leq 318.665\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'R-227ea'. Thus, data cannot be visualized!

#### 4.35.4 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	R-227ea
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v-b} - \frac{a}{v(v+b) + b(v-b)} \quad , \text{ and} \\ a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\left(T/T_{\text{crit}}\right)}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.749000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.925000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.570000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $168.3025\text{K} \leq T \leq 318.665\text{K}$ .

#### Visualization:

No adsorption or absorption working pair exists, which uses refrigerant 'R-227ea'. Thus, data cannot be visualized!

## 4.36 R-23

### 4.36.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-23
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Penoncello, Steven G.; Lemmon, Eric W.; Jacobsen, Richard T.; Shan, Zhengjun (2003): A Fundamental Equation for Trifluoromethane (R-23). In: Journal of Physical and Chemical Reference Data 32 (4), S. 1473–1499. DOI: 10.1063/1.1559671.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

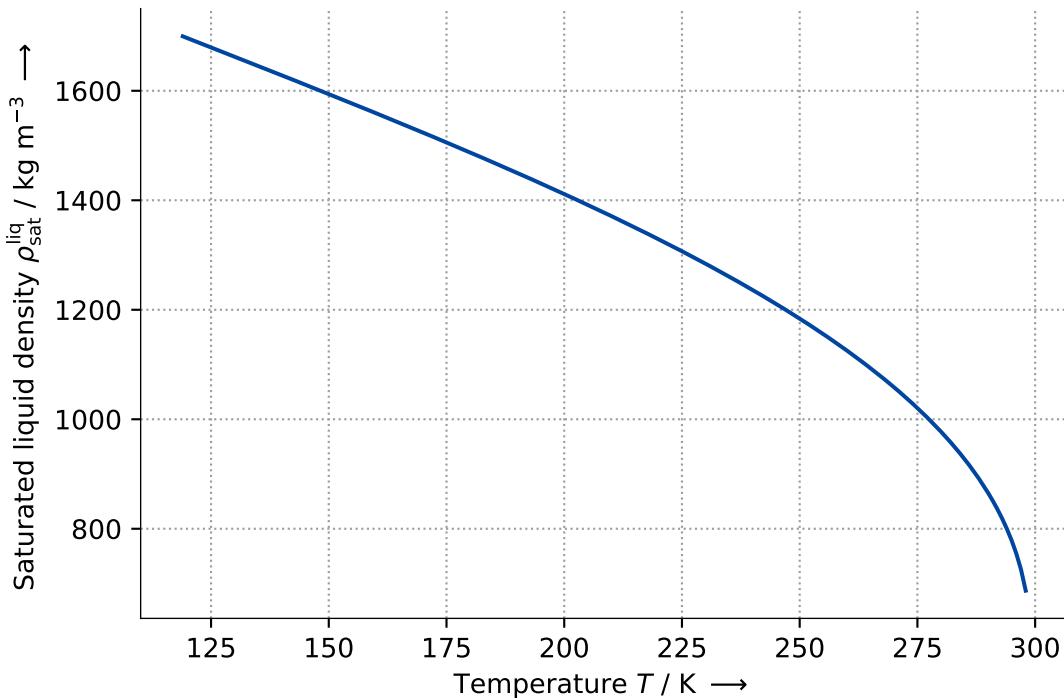
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	3.100000000e+00
$T_{\text{crit}}$	K	2.992930000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.264752000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.263600000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.700000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	4.700700000e-01	$a_8$	-	0.000000000e+00
$b_3$	-	9.400000000e-01	$b_8$	-	0.000000000e+00
$a_4$	-	2.866000000e-01			

#### Validity:

Equation is approximately valid for  $118.02\text{K} \leq T \leq 299.293\text{K}$ .

#### Visualization:



#### 4.36.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	R-23
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

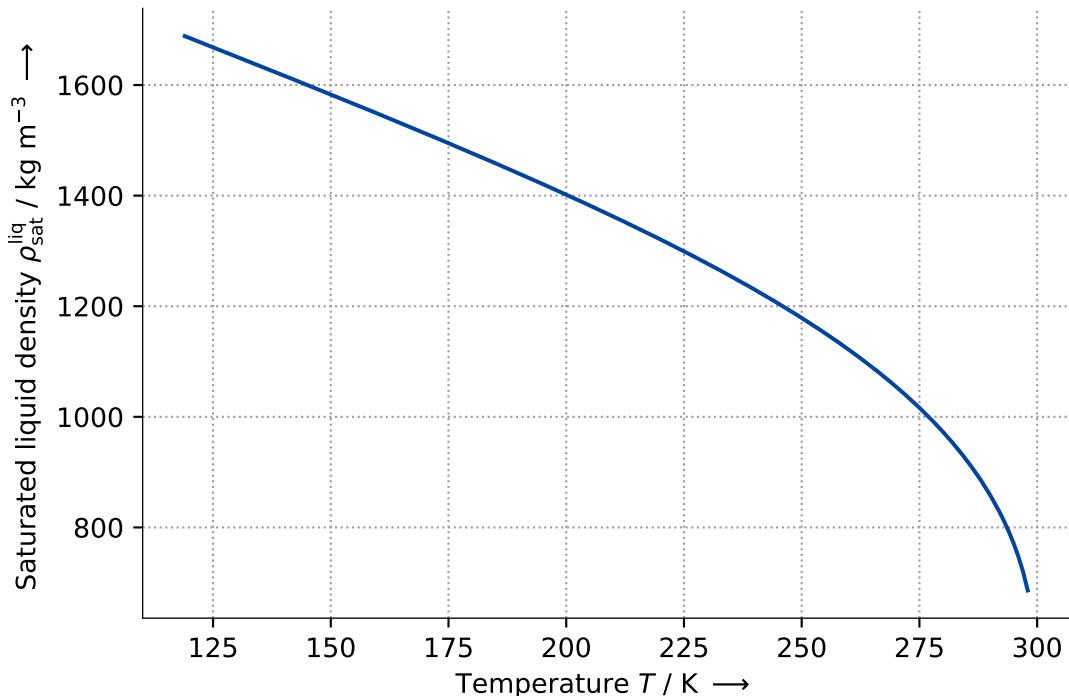
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	2.997500000e+02	$a_5$	-	3.470938213e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.260000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.217400380e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	4.115744107e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-5.830380608e+00			

**Validity:**

Equation is approximately valid for  $118.02\text{K} \leq T \leq 299.75\text{K}$ .

**Visualization:**

#### 4.36.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	R-23
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

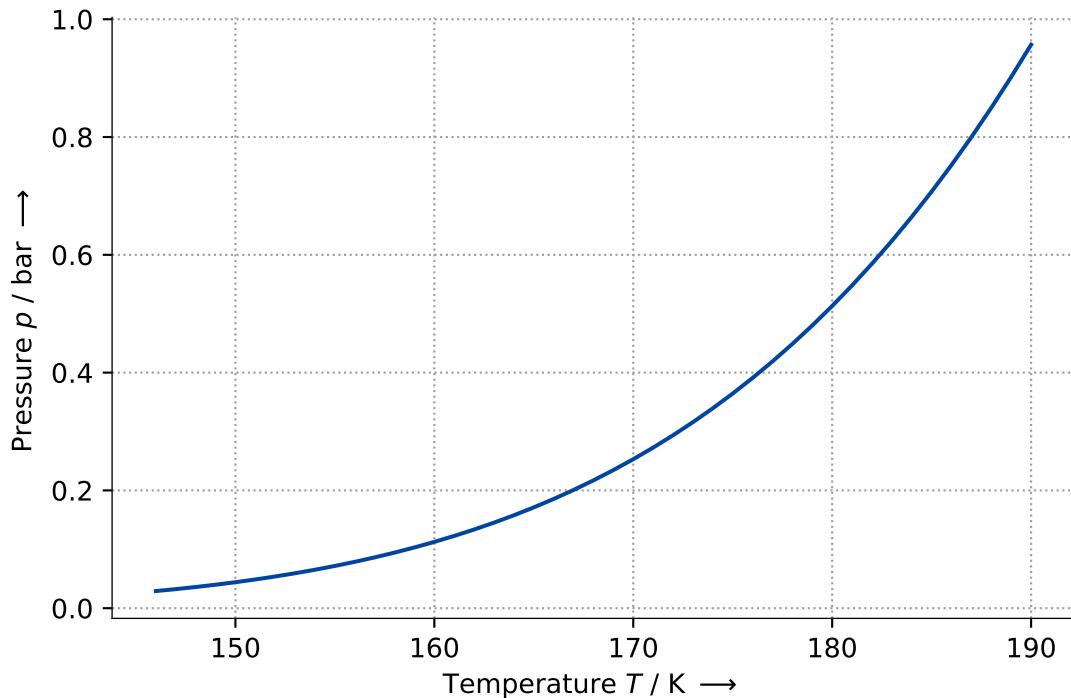
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.255480000e+00	$c$	K	-2.201300000e+01
$b$	K	7.180890000e+02			

**Validity:**

Equation is approximately valid for  $145.36\text{K} \leq T \leq 191.19\text{K}$ .

**Visualization:**



#### 4.36.4 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-23
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Penoncello, Steven G.; Lemmon, Eric W.; Jacobsen, Richard T.; Shan, Zhengjun (2003): A Fundamental Equation for Trifluoromethane (R-23). In: Journal of Physical and Chemical Reference Data 32 (4), S. 1473–1499. DOI: 10.1063/1.1559671.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

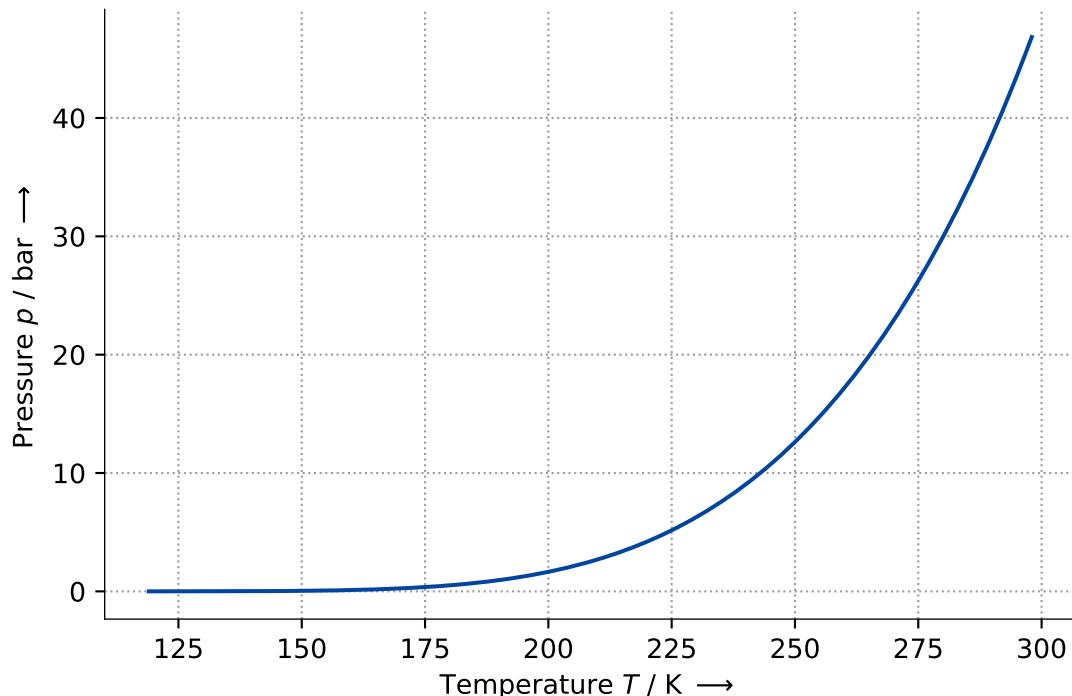
$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	2.992930000e+02	$a_4$	-	-3.199100000e+00
$p_{\text{crit}}$	Pa	4.832000000e+06	$b_4$	-	3.900000000e+00
$a_1$	-	-7.263100000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.314000000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-7.850700000e-01	$a_7$	-	0.000000000e+00
$b_3$	-	2.400000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $118.02\text{K} \leq T \leq 299.293\text{K}$ .

**Visualization:**

## 4.36.5 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	R-23
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

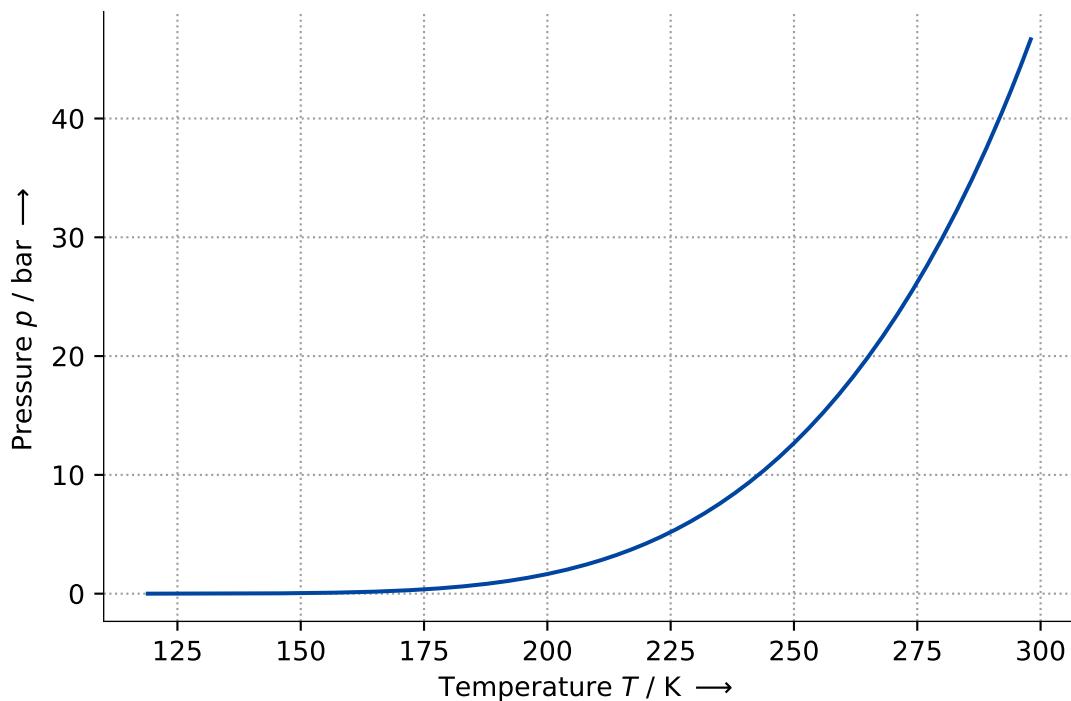
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	2.997500000e+02	$a_4$	-	-1.431780000e+00
$p_{\text{crit}}$	Pa	4.869000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.382160000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.962340000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.683920000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $118.02\text{K} \leq T \leq 299.75\text{K}$ .

**Visualization:**



#### 4.36.6 Vapor Pressure - EoS Cubic - ID 1

<b>Name:</b>	R-23
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

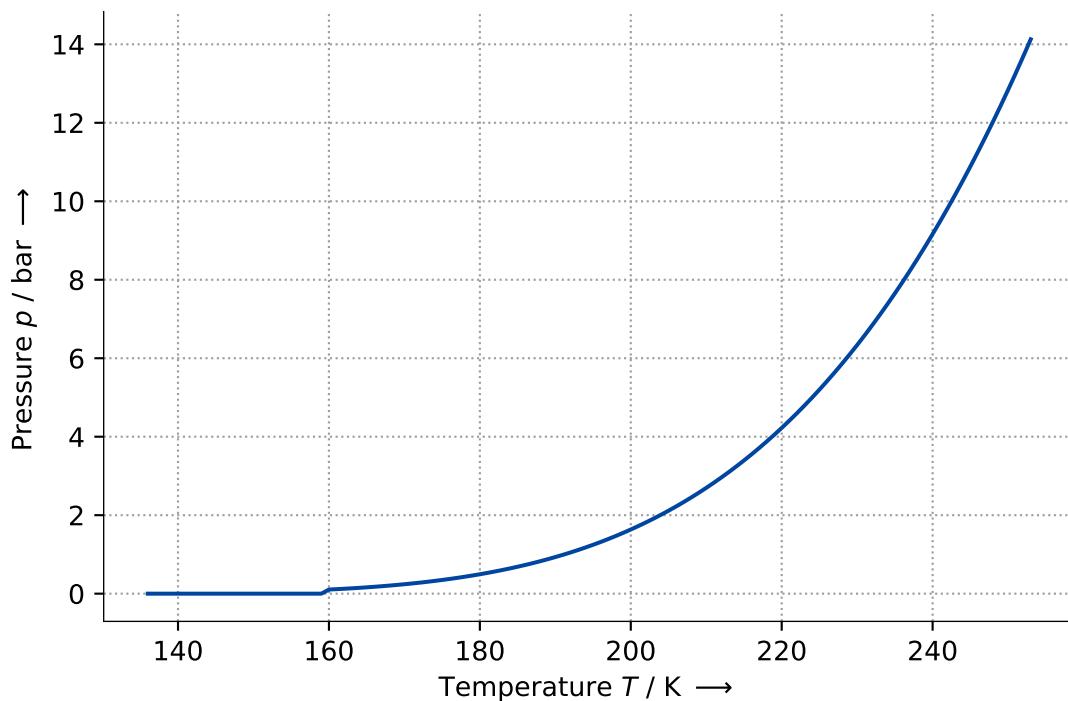
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	2.992900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.832000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.630000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $135.723\text{K} \leq T \leq 254.3965\text{K}$ .

### Visualization:



#### 4.36.7 Vapor Pressure - EoS Cubic - ID 2

<b>Name:</b>	R-23
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

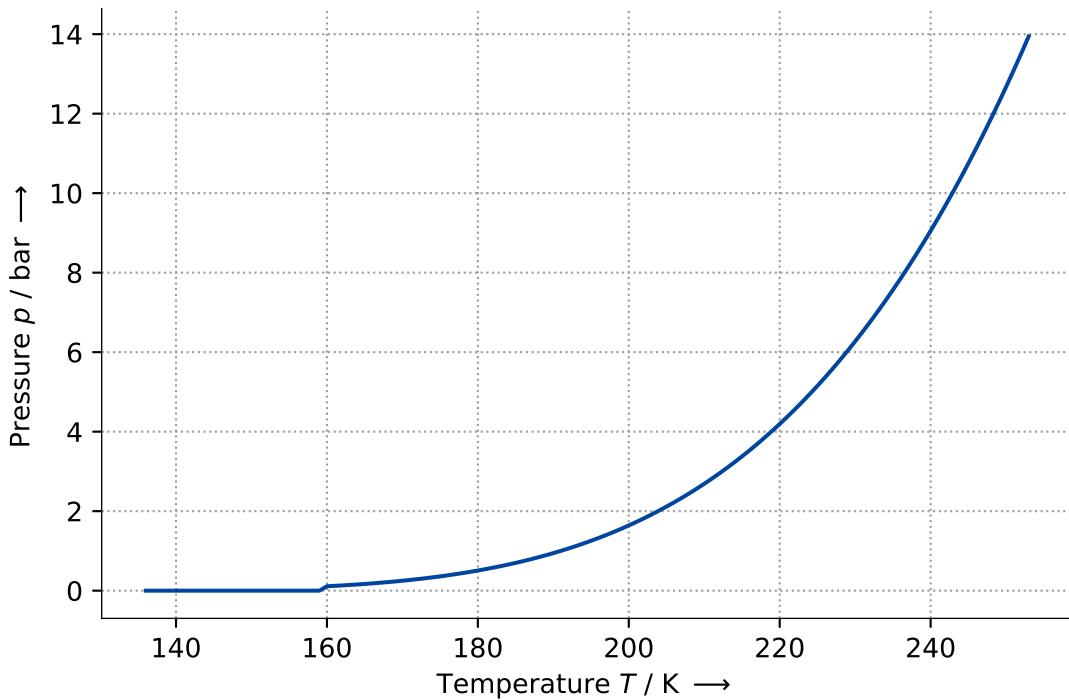
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	2.992900000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.832000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.630000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $135.723\text{K} \leq T \leq 254.3965\text{K}$ .

### Visualization:



## 4.37 R-32

### 4.37.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-32
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

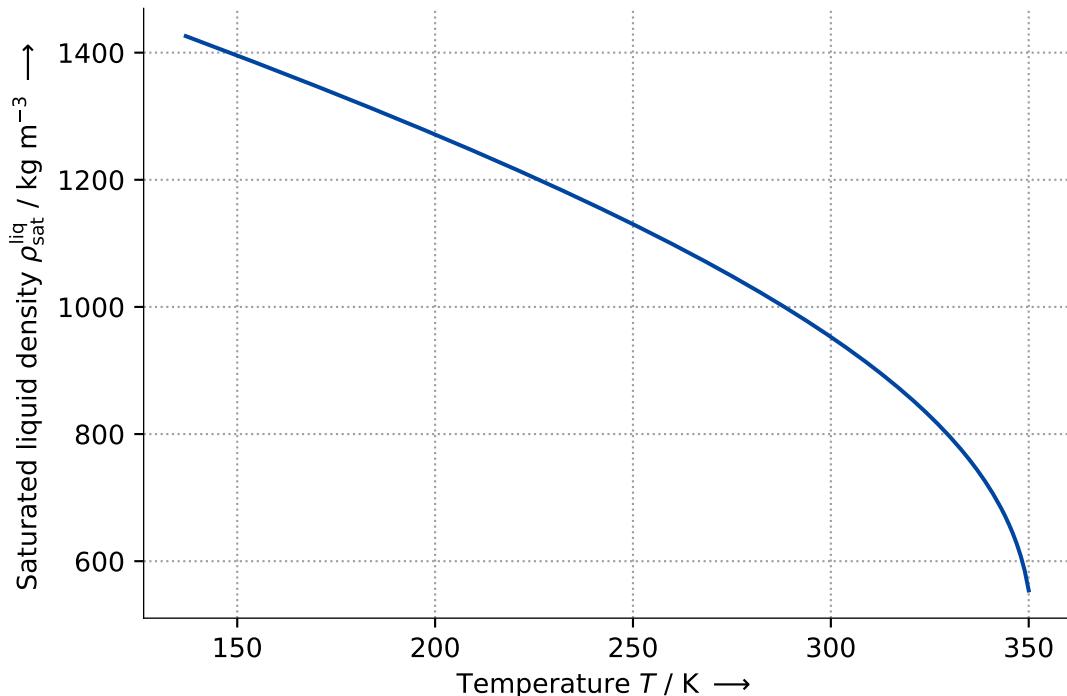
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.512600000e+02	$a_5$	-	5.416509434e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.240000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.111498349e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	5.287551887e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.201009434e-01			

**Validity:**

Equation is approximately valid for  $136.34\text{K} \leq T \leq 351.26\text{K}$ .

**Visualization:**

#### 4.37.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	R-32
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

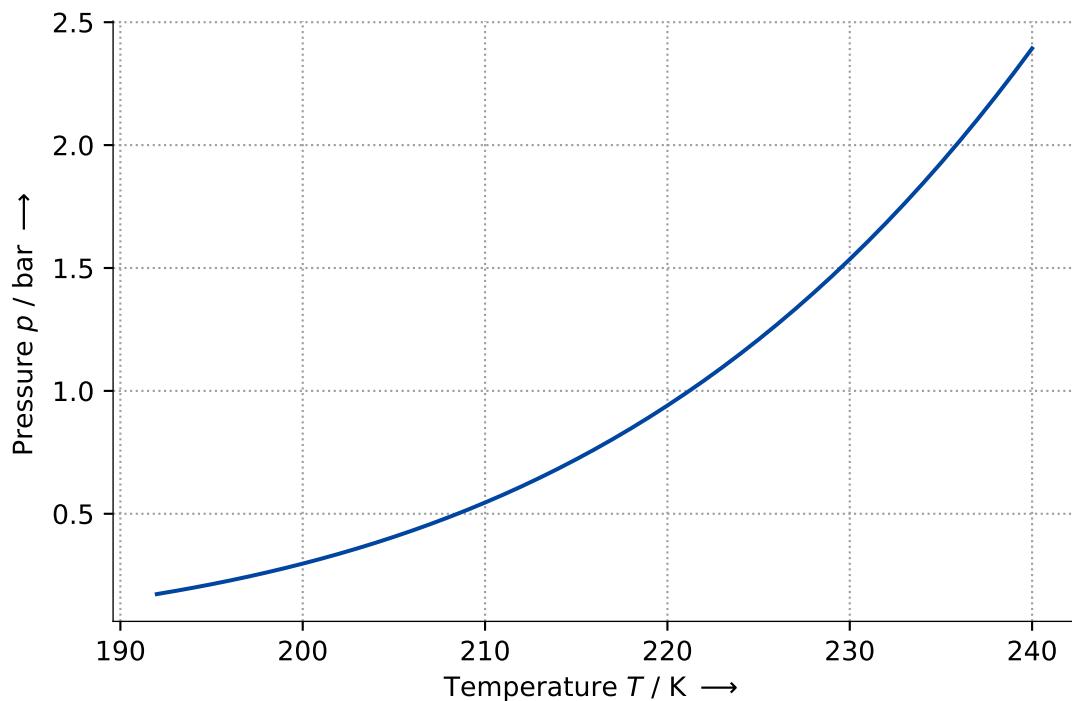
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.262240000e+00	$c$	K	-2.855400000e+01
$b$	K	8.210920000e+02			

**Validity:**

Equation is approximately valid for  $191.19\text{K} \leq T \leq 241.33\text{K}$ .

**Visualization:**



#### 4.37.3 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-32
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Weber, L. A.; Silva, A. M. (1994): Measurements of the Vapor Pressures of Difluoromethane, 1-Chloro-1,2,2,2-tetrafluoroethane, and Pentafluoroethane. In: J. Chem. Eng. Data 39 (4), S. 808–812. DOI: 10.1021/je00016a038.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

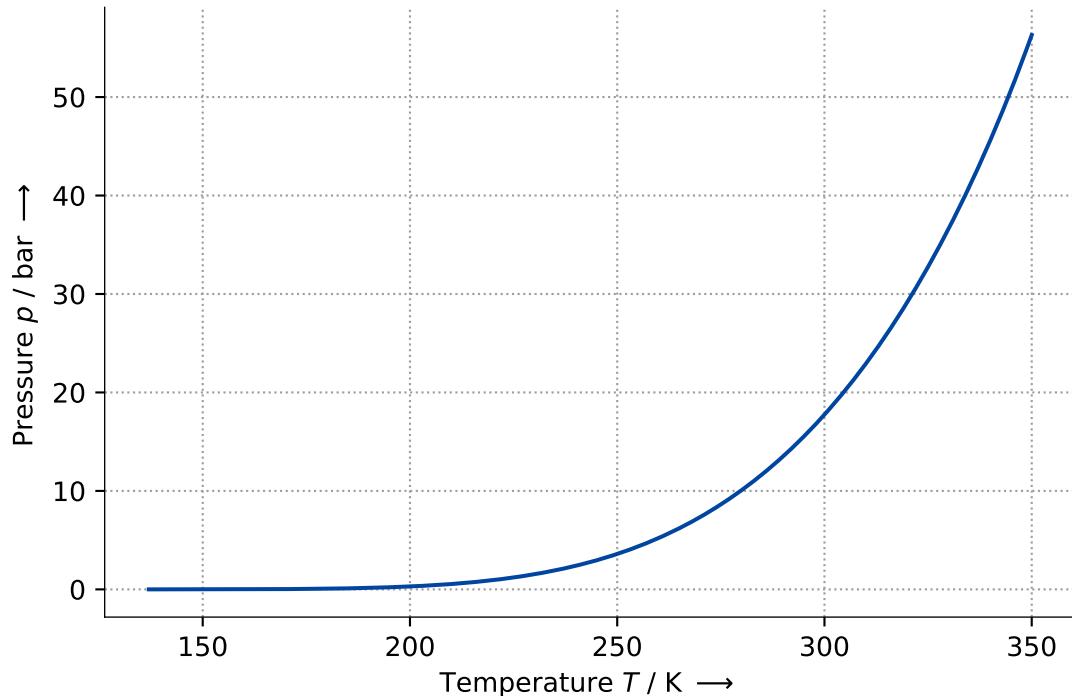
$$\theta = T/T_{\text{crit}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.513600000e+02	$a_4$	-	-2.617090000e+00
$p_{\text{crit}}$	Pa	5.793100000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.461490000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.736870000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-1.986560000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $136.34\text{K} \leq T \leq 351.36\text{K}$ .

**Visualization:**

## 4.37.4 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	R-32
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

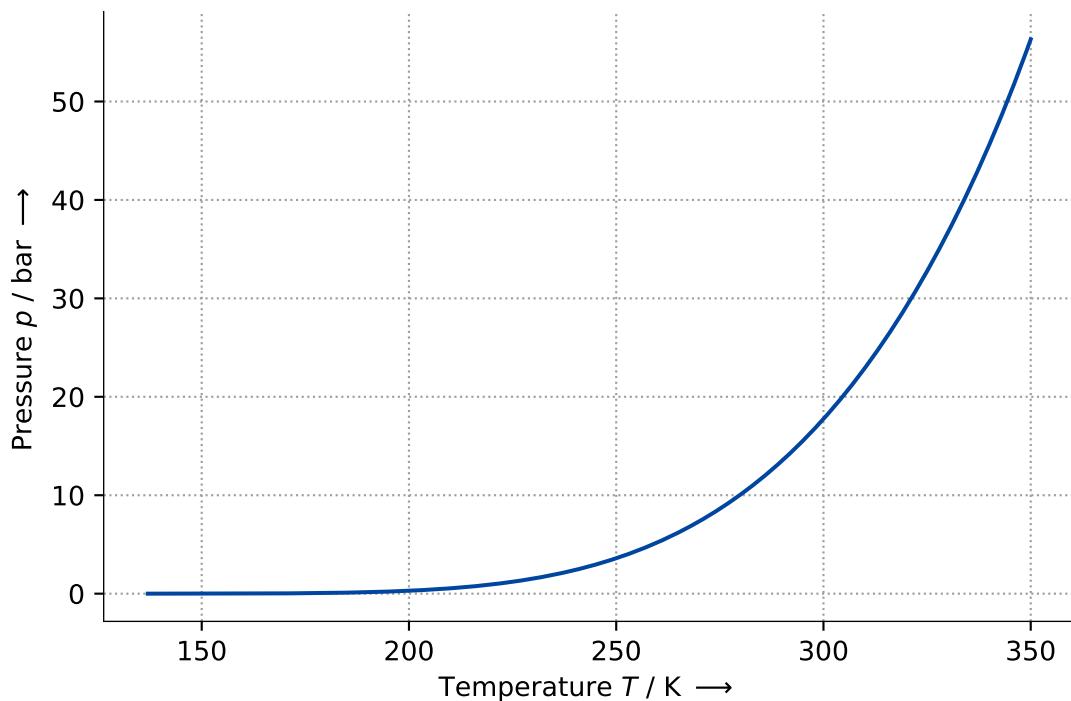
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.512600000e+02	$a_4$	-	-2.621470000e+00
$p_{\text{crit}}$	Pa	5.783000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.470270000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.755950000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.014290000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $136.34\text{K} \leq T \leq 351.26\text{K}$ .

**Visualization:**



#### 4.37.5 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	R-32
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} , \text{ and} \\
 a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 .
 \end{aligned}$$

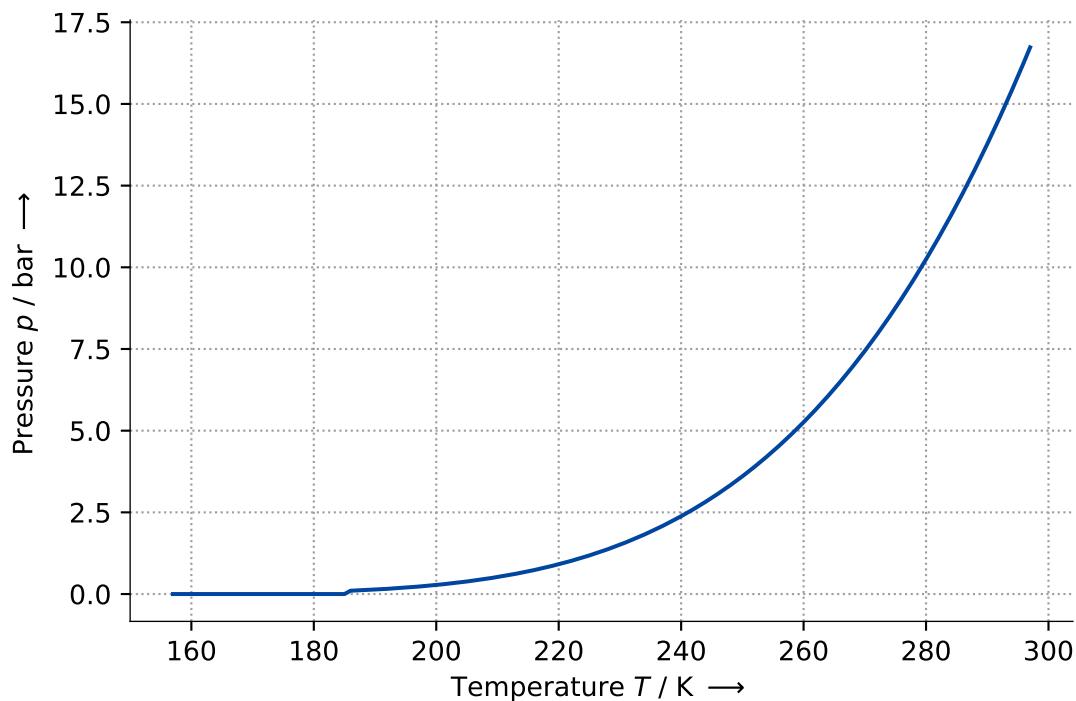
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.512600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	5.782000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.769000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $156.791\text{K} \leq T \leq 298.571\text{K}$ .

### Visualization:



#### 4.37.6 Vapor Pressure - EoS Cubic - ID 2

---

<b>Name:</b>	R-32
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

---

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

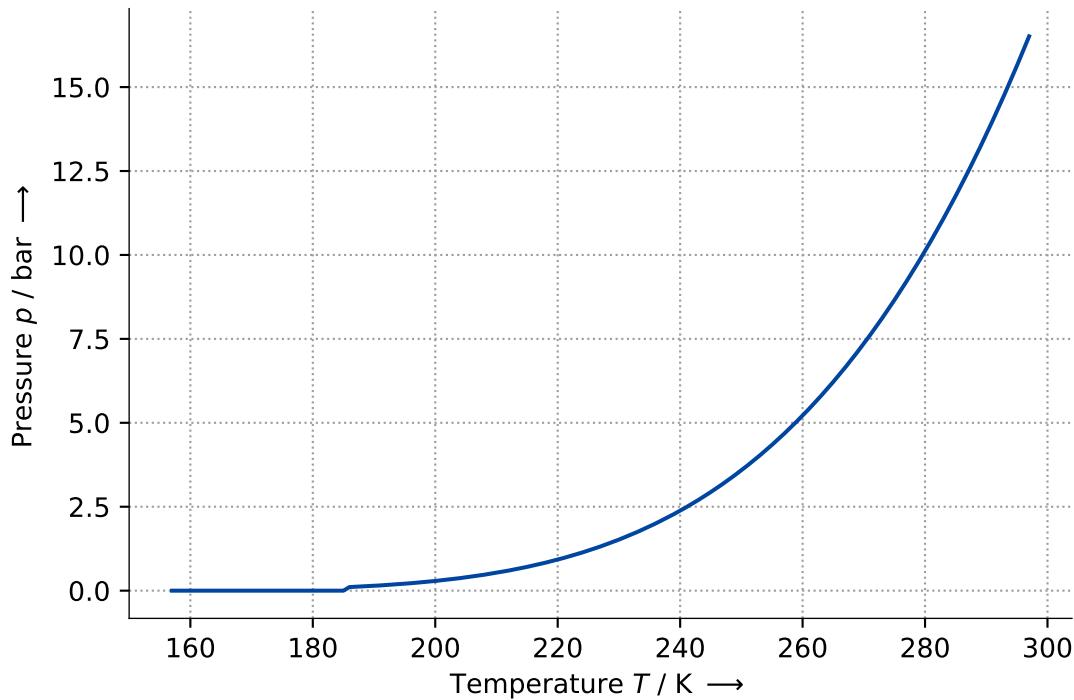
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	3.512600000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	5.782000000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.769000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $156.791\text{K} \leq T \leq 298.571\text{K}$ .

### Visualization:



## 4.38 R-404a

### 4.38.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-404a
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Online: <a href="https://www.freon.com/en/-/media/files/freon/freon-410a-si-thermodynamic-properties.pdf?rev=6b72bfaa299142d697540982b88a56eb">https://www.freon.com/en/-/media/files/freon/freon-410a-si-thermodynamic-properties.pdf?rev=6b72bfaa299142d697540982b88a56eb</a>
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

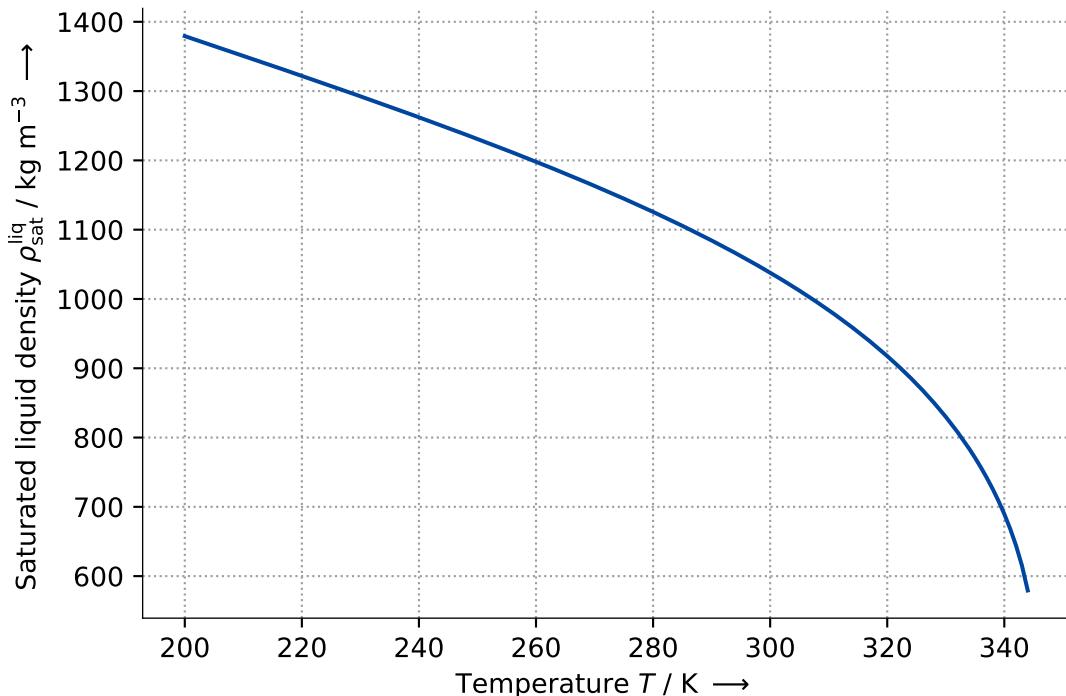
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.452200000e+02	$a_5$	-	7.614200000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.845000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000200000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.930000000e-01	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	9.082900000e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-1.378100000e+01			

**Validity:**

Equation is approximately valid for  $200.0\text{K} \leq T \leq 345.22\text{K}$ .

**Visualization:**

## 4.39 R-407c

### 4.39.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-407c
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Online: <a href="https://www.freon.com/en/-/media/files/freon/freon-410a-si-thermodynamic-properties.pdf?rev=6b72bfaa299142d697540982b88a56eb">https://www.freon.com/en/-/media/files/freon/freon-410a-si-thermodynamic-properties.pdf?rev=6b72bfaa299142d697540982b88a56eb</a>
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

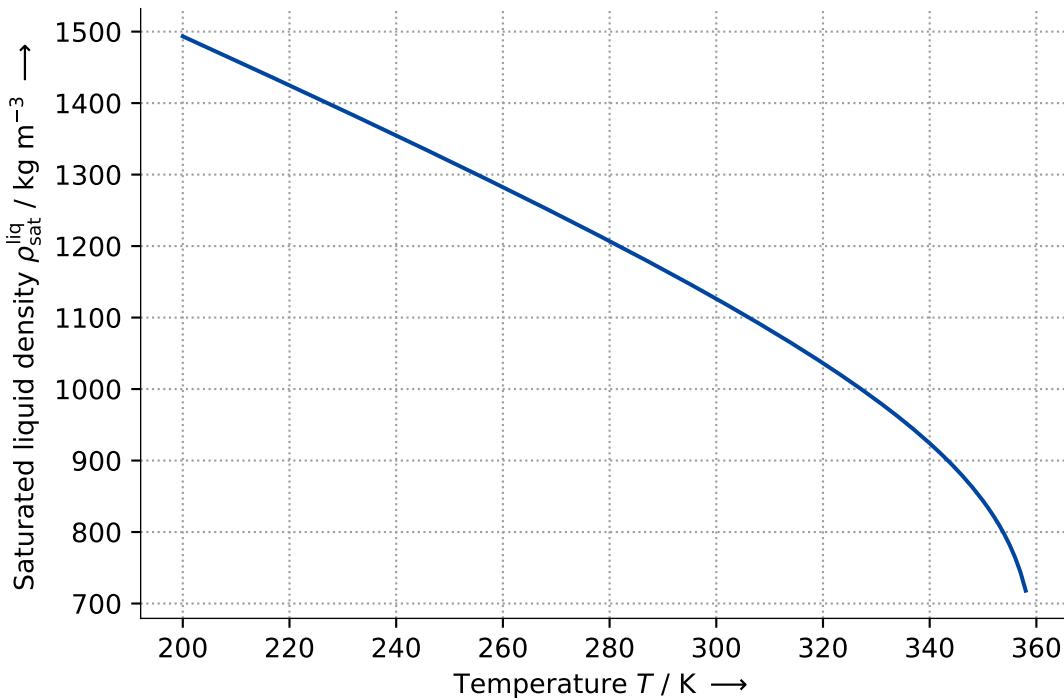
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.598900000e+02	$a_5$	-	0.000000000e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	5.273000000e+02	$b_5$	-	0.000000000e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	2.350274000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-2.029024000e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	2.746460000e+00			

#### Validity:

Equation is approximately valid for  $200.0\text{K} \leq T \leq 359.89\text{K}$ .

#### Visualization:



#### 4.39.2 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-407c
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W. (2003): Pseudo-Pure Fluid Equations of State for the Refrigerant Blends R-410A, R-404A, R-507A, and R-407C. In: International Journal of Thermophysics 24 (4), S. 991–1006. DOI: 10.1023/A:1025048800563.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

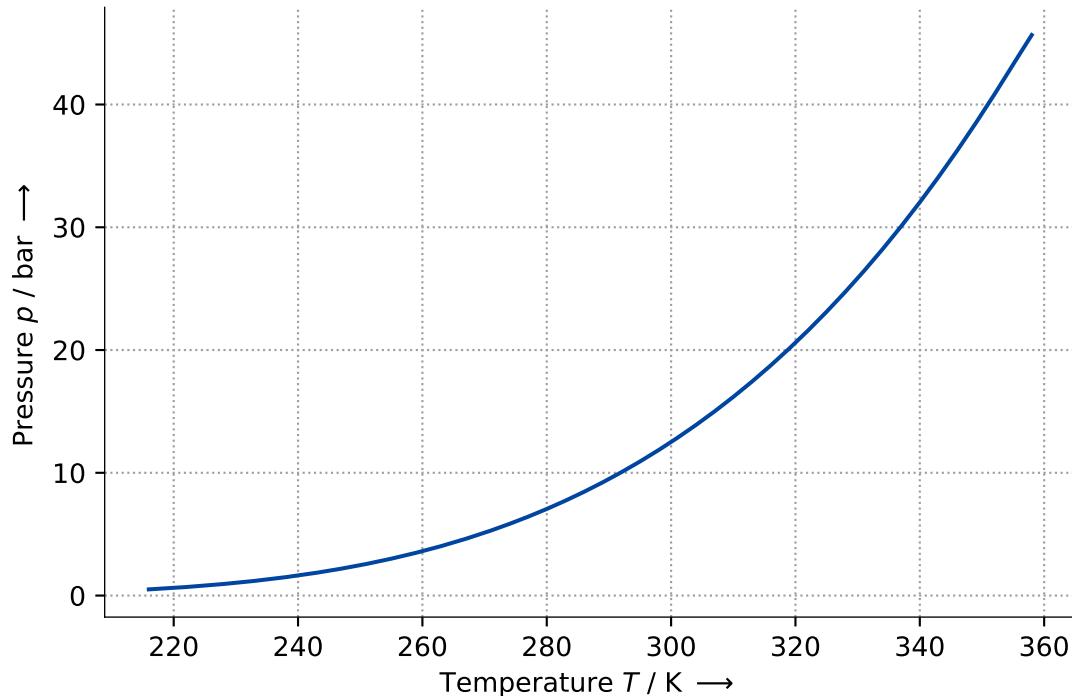
$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.593450000e+02	$a_4$	-	-2.510900000e+00
$p_{\text{crit}}$	Pa	4.631700000e+06	$b_4$	-	4.700000000e+00
$a_1$	-	4.872200000e-01	$a_5$	-	0.000000000e+00
$b_1$	-	5.400000000e-01	$b_5$	-	0.000000000e+00
$a_2$	-	-6.695900000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	9.250000000e-01	$b_6$	-	0.000000000e+00
$a_3$	-	-1.416500000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.700000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $215.607\text{K} \leq T \leq 359.345\text{K}$ .

**Visualization:**

## 4.40 R-410a

### 4.40.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	R-410a
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Online: <a href="https://www.freon.com/en/-/media/files/freon/freon-410a-si-thermodynamic-properties.pdf?rev=6b72bfaa299142d697540982b88a56eb">https://www.freon.com/en/-/media/files/freon/freon-410a-si-thermodynamic-properties.pdf?rev=6b72bfaa299142d697540982b88a56eb</a>
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

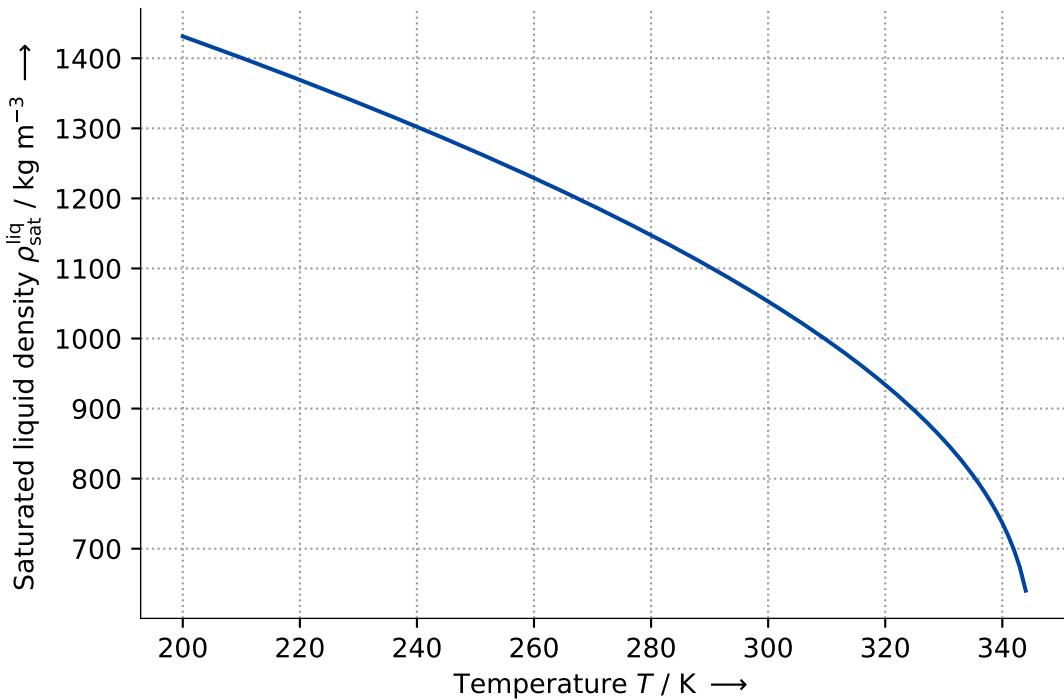
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	3.452800000e+02	$a_5$	-	-7.171684000e-01
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	4.889000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.984734000e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.333333333e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-1.767593000e-01	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	1.819972000e+00			

#### Validity:

Equation is approximately valid for  $200.0\text{K} \leq T \leq 345.28\text{K}$ .

#### Visualization:



#### 4.40.2 Vapor Pressure - EoS1 - ID 1

---

<b>Name:</b>	R-410a
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W. (2003): Pseudo-Pure Fluid Equations of State for the Refrigerant Blends R-410A, R-404A, R-507A, and R-407C. In: International Journal of Thermophysics 24 (4), S. 991–1006. DOI: 10.1023/A:1025048800563.
<b>Comment:</b>	None

---

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

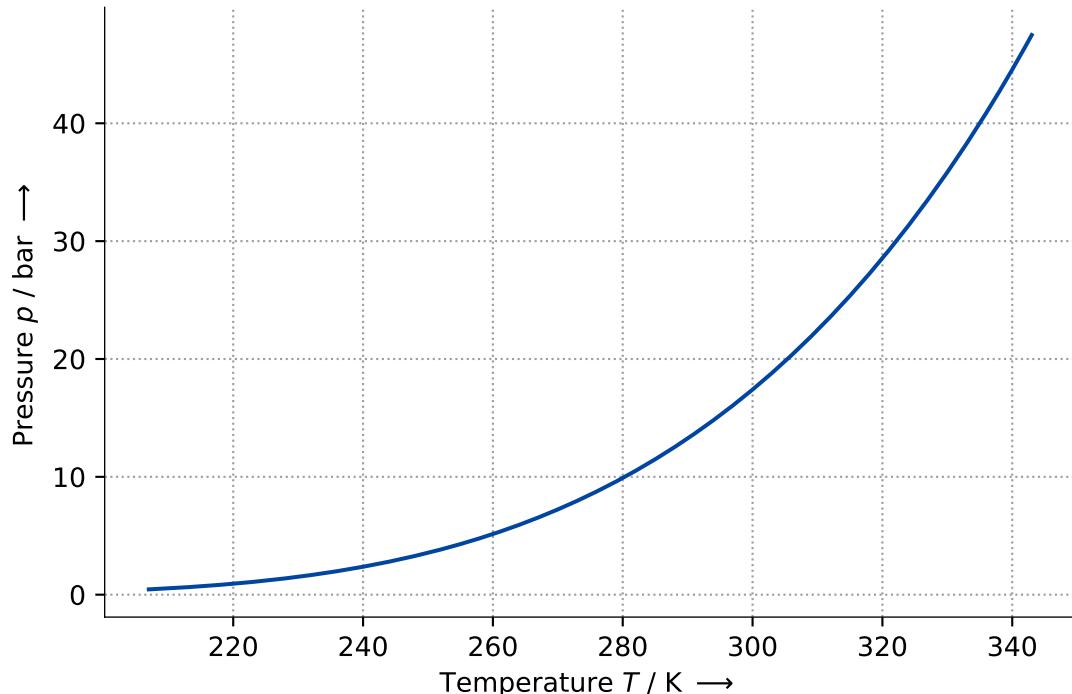
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.444940000e+02	$a_4$	-	-2.802200000e+00
$p_{\text{crit}}$	Pa	4.901200000e+06	$b_4$	-	4.900000000e+00
$a_1$	-	-7.281800000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.509300000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.800000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-3.269500000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.400000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $206.6964\text{K} \leq T \leq 344.494\text{K}$ .

**Visualization:**



## 4.41 R-507a

### 4.41.1 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	R-507a
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W. (2003): Pseudo-Pure Fluid Equations of State for the Refrigerant Blends R-410A, R-404A, R-507A, and R-407C. In: International Journal of Thermophysics 24 (4), S. 991–1006. DOI: 10.1023/A:1025048800563.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

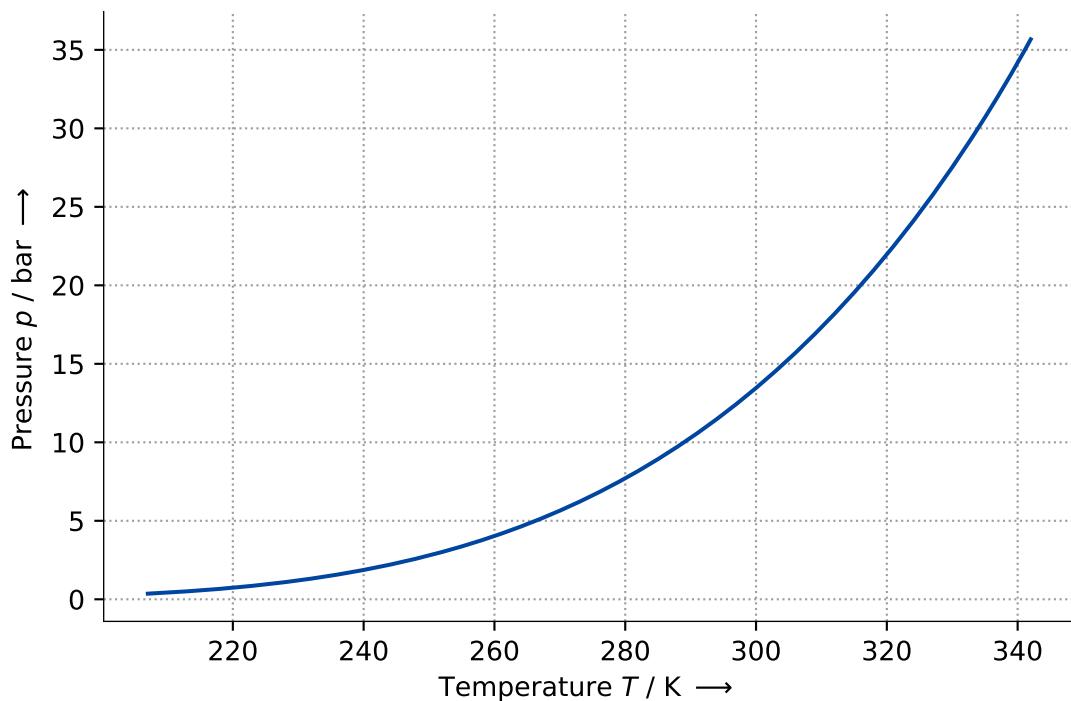
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	3.437650000e+02	$a_4$	-	-3.776300000e+00
$p_{\text{crit}}$	Pa	3.704900000e+06	$b_4$	-	4.600000000e+00
$a_1$	-	-7.485300000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.011500000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.014100000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.200000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $206.259\text{K} \leq T \leq 343.765\text{K}$ .

#### Visualization:



## 4.42 TFE

### 4.42.1 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	TFE
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

The parameters of the equation are:

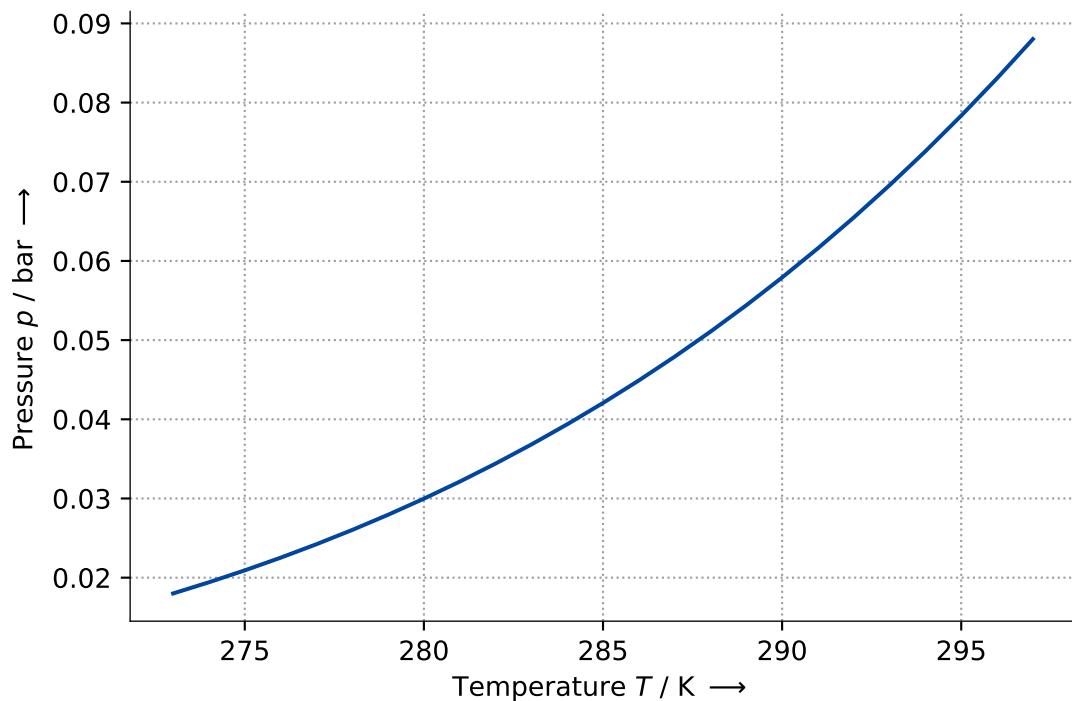
Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.569460000e+00	$c$	K	-1.119320000e+02
$b$	K	8.559210000e+02			

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $272.8\text{K} \leq T \leq 298.6\text{K}$ .

**Visualization:**



## 4.43 THF

### 4.43.1 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	THF
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

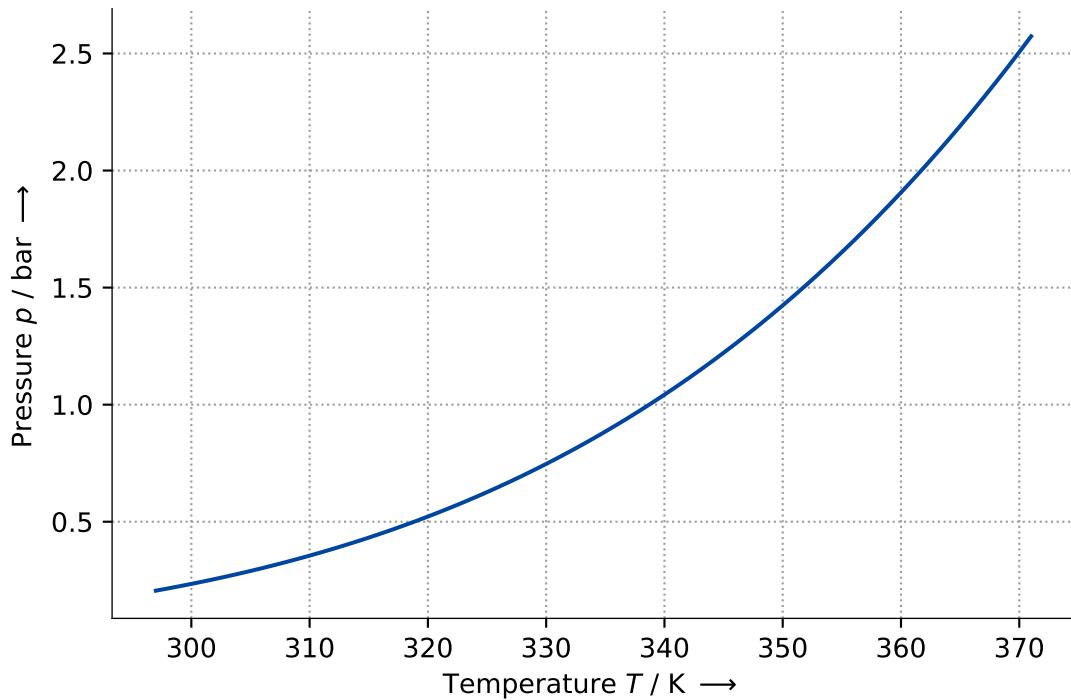
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.121180000e+00	$c$	K	-4.681800000e+01
$b$	K	1.202942000e+03			

#### Validity:

Equation is approximately valid for  $296.29\text{K} \leq T \leq 372.8\text{K}$ .

#### Visualization:



## 4.44 Toluene

### 4.44.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Toluene
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

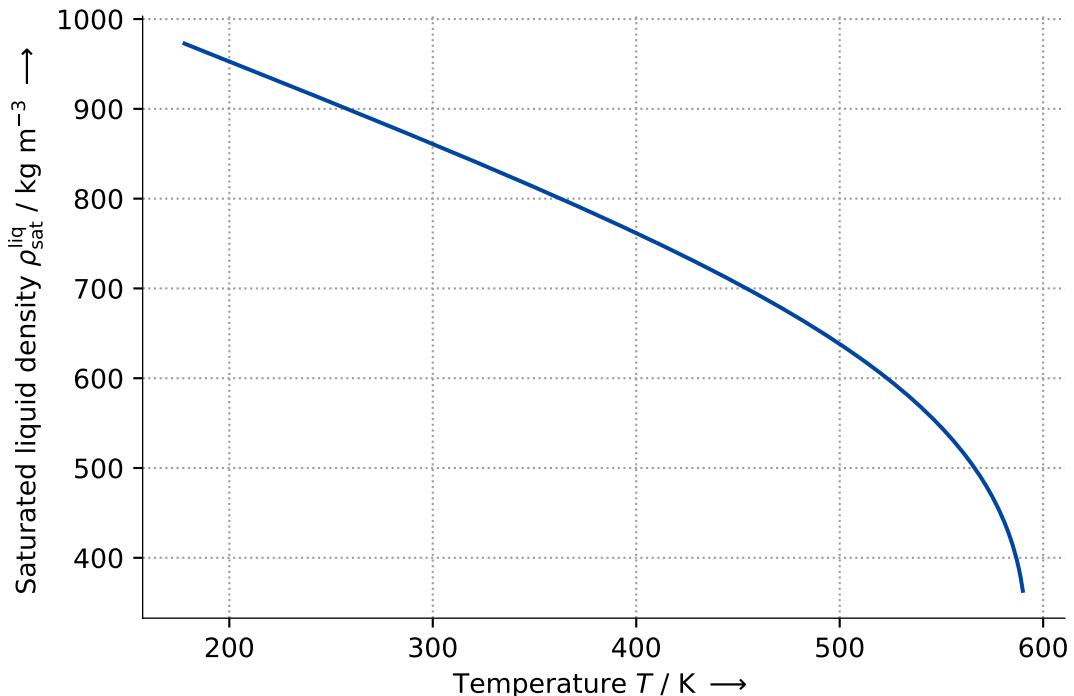
$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	5.917500000e+02	$a_5$	-	2.732445548e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	2.920000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	1.505422945e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	2.873821233e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-4.228919520e+00			

**Validity:**

Equation is approximately valid for  $178.0\text{K} \leq T \leq 591.75\text{K}$ .

**Visualization:**

#### 4.44.2 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

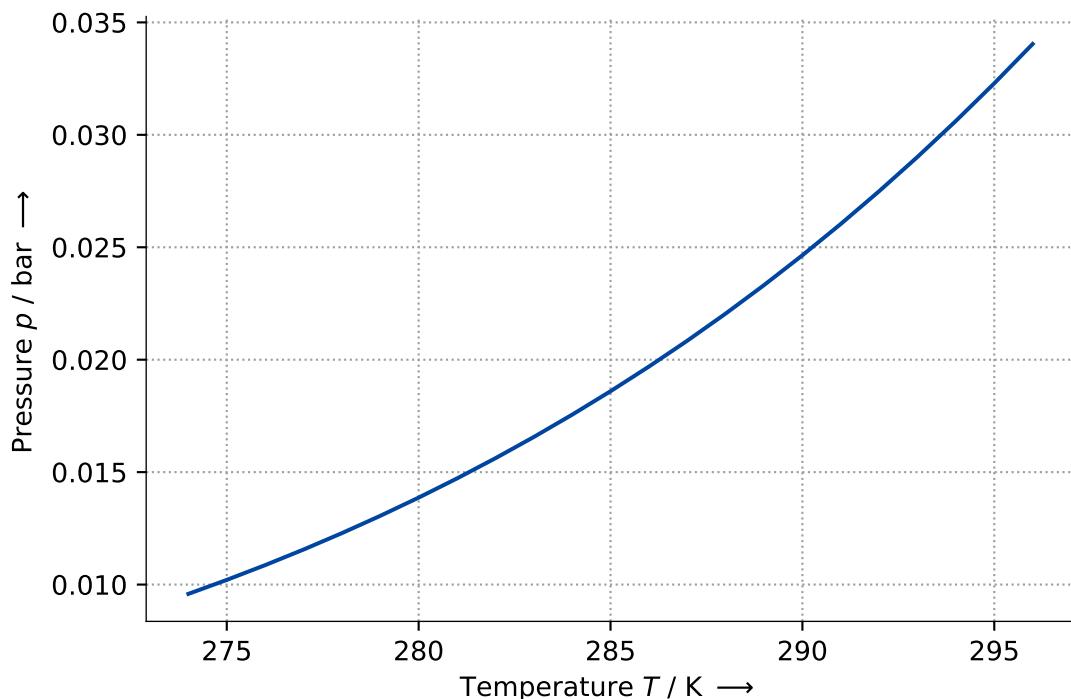
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.236790000e+00	$c$	K	-4.595700000e+01
$b$	K	1.426448000e+03			

#### Validity:

Equation is approximately valid for  $273.13\text{K} \leq T \leq 297.89\text{K}$ .

#### Visualization:



#### 4.44.3 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

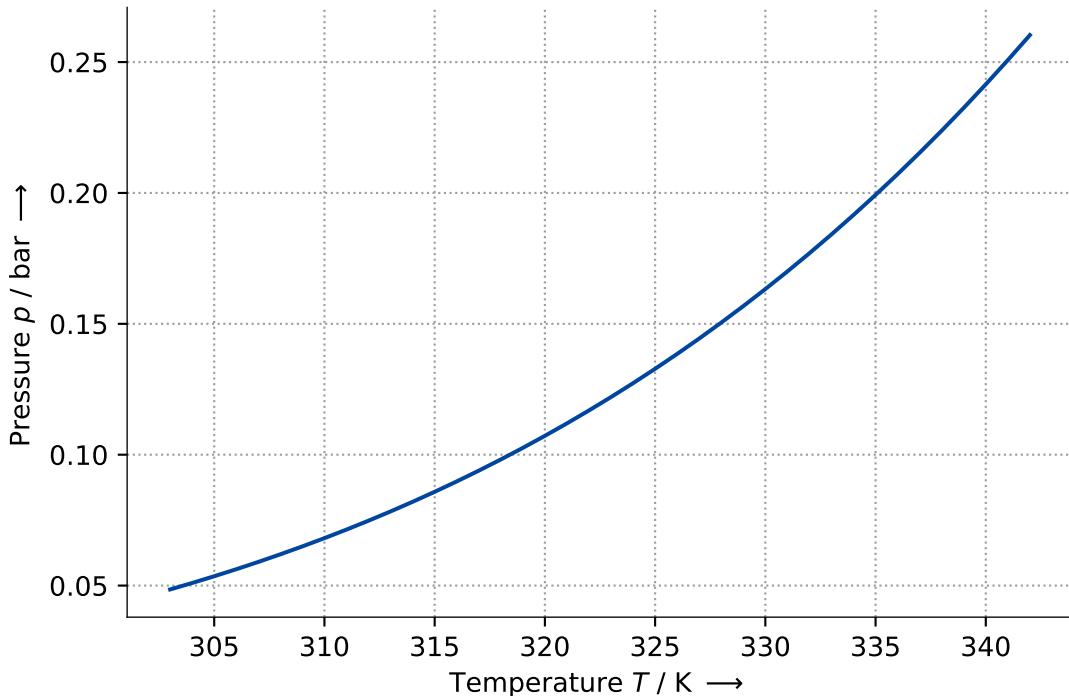
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.082450000e+00	$c$	K	-5.350800000e+01
$b$	K	1.346382000e+03			

#### Validity:

Equation is approximately valid for  $303.0\text{K} \leq T \leq 343.0\text{K}$ .

**Visualization:**



#### 4.44.4 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

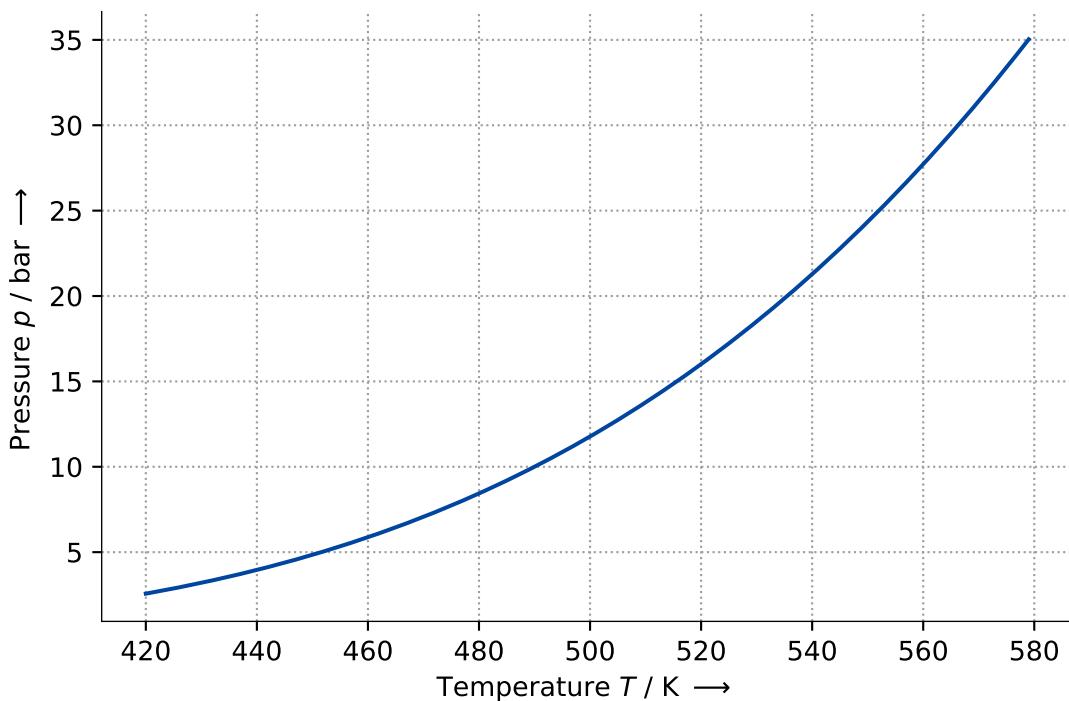
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.544360000e+00	$c$	K	3.940000000e-01
$b$	K	1.738123000e+03			

**Validity:**

Equation is approximately valid for  $420.0\text{K} \leq T \leq 580.0\text{K}$ .

**Visualization:**



#### 4.44.5 Vapor Pressure - Antoine - ID 4

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	4
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

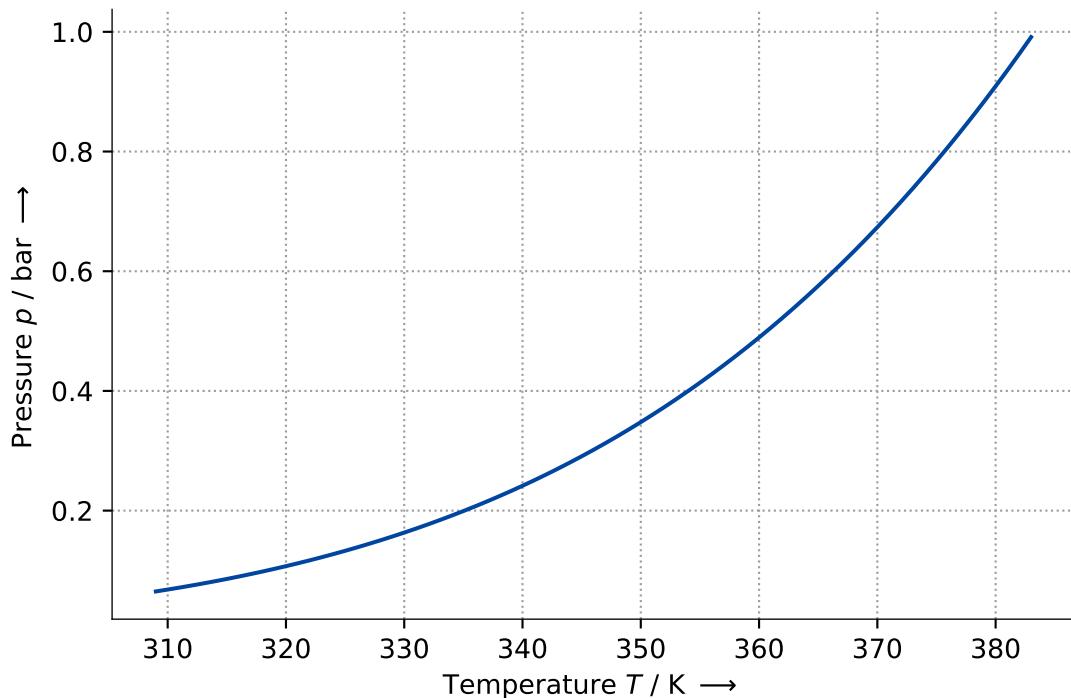
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.078270000e+00	$c$	K	-5.377300000e+01
$b$	K	1.343943000e+03			

#### Validity:

Equation is approximately valid for  $308.52\text{K} \leq T \leq 384.66\text{K}$ .

**Visualization:**



#### 4.44.6 Vapor Pressure - Antoine - ID 5

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	5
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

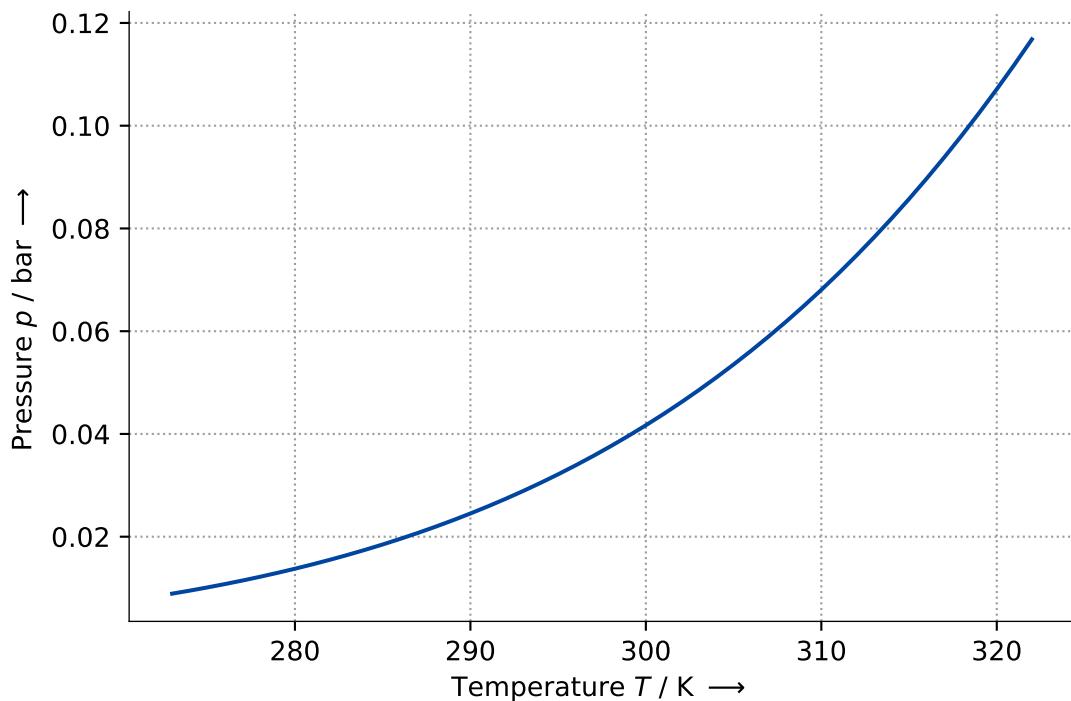
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.141570000e+00	$c$	K	-5.050700000e+01
$b$	K	1.377578000e+03			

#### Validity:

Equation is approximately valid for  $273.0\text{K} \leq T \leq 323.0\text{K}$ .

#### Visualization:



#### 4.44.7 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

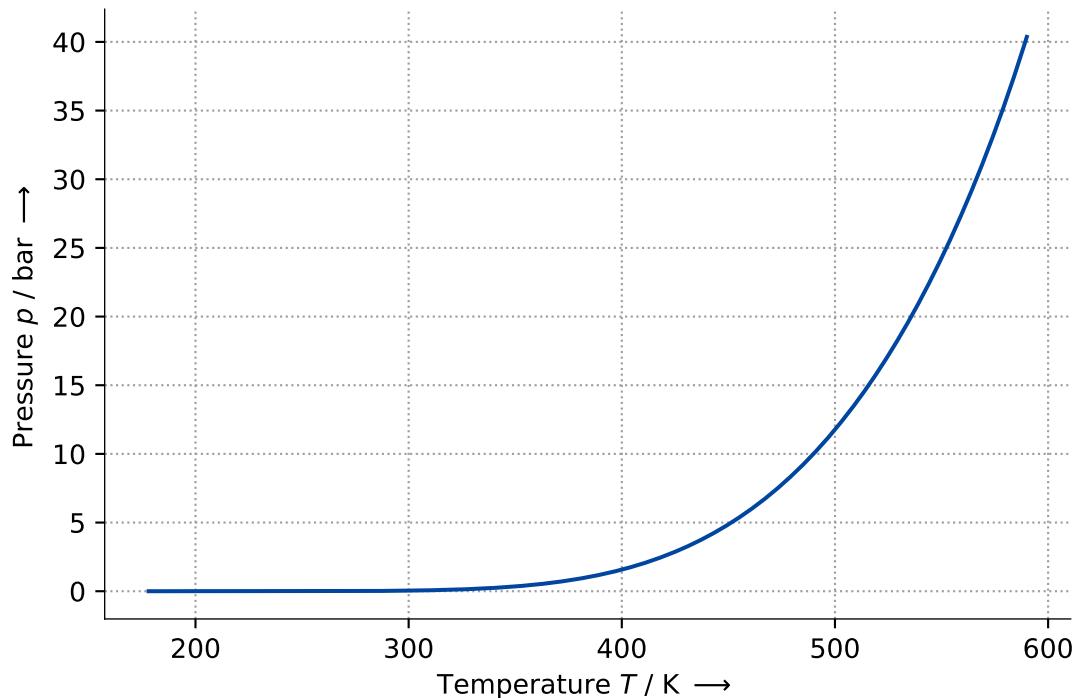
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	5.917500000e+02		$a_4$	-	-2.850420000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	4.126000000e+06	$b_4$	-	5.000000000e+00
$a_1$	-	-7.500510000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	2.089390000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.563680000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $178.0\text{K} \leq T \leq 591.75\text{K}$ .

**Visualization:**

#### 4.44.8 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

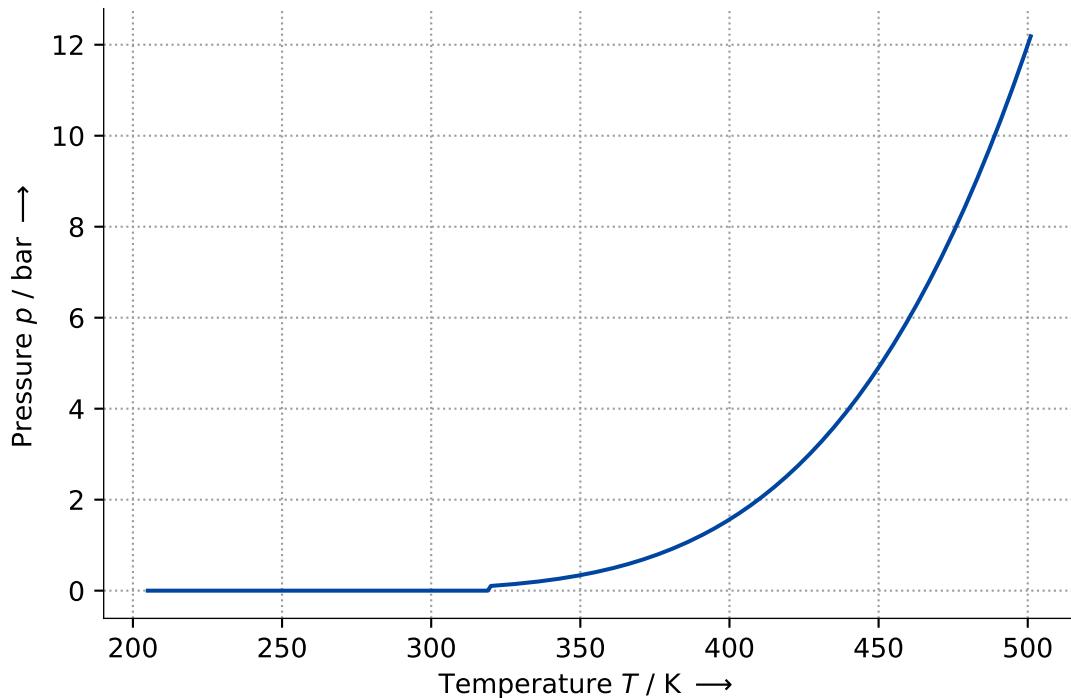
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.917500000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.126300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.657000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

#### Validity:

Equation is approximately valid for  $204.7\text{K} \leq T \leq 502.9875\text{K}$ .

#### Visualization:



#### 4.44.9 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Toluene
<b>Equation:</b>	VaporPressure_EoS Cubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

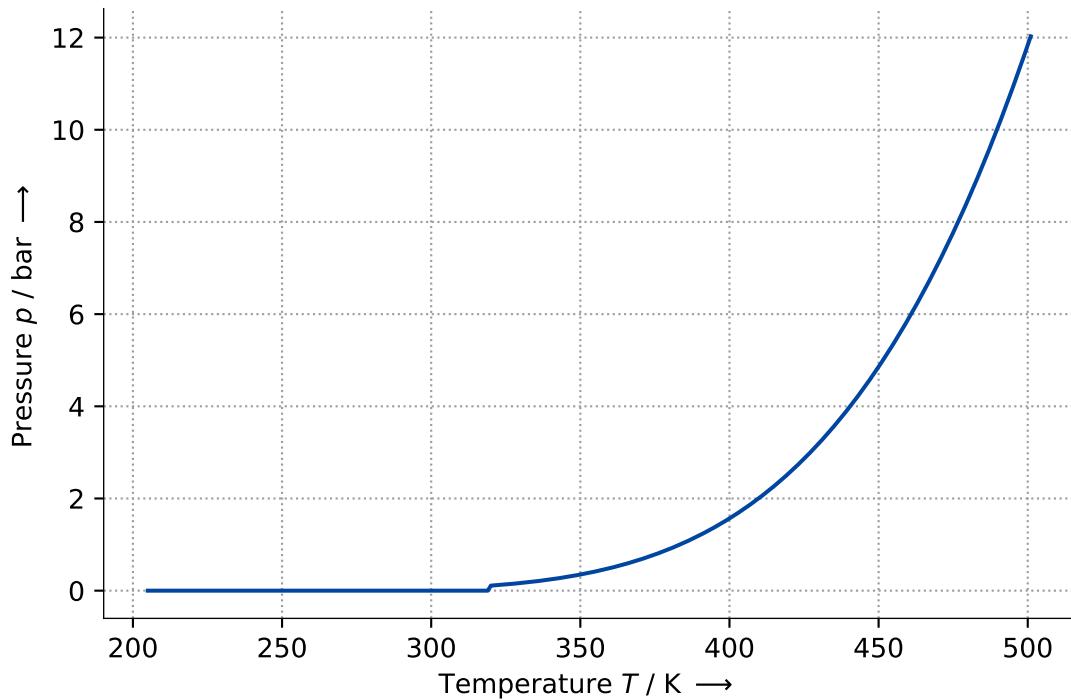
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	5.917500000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	4.126300000e+06	$\beta_2$	-	0.000000000e+00
$\omega$	-	2.657000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $204.7\text{K} \leq T \leq 502.9875\text{K}$ .

### Visualization:



## 4.45 Water

### 4.45.1 Saturated Liquid Density - EoS1 - ID 1

<b>Name:</b>	Water
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Wagner, W.; Prufs, A. (2002): The IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use. In: Journal of Physical and Chemical Reference Data 31 (2), S. 387–535. DOI: 10.1063/1.1461829.
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

The parameters of the equation are:

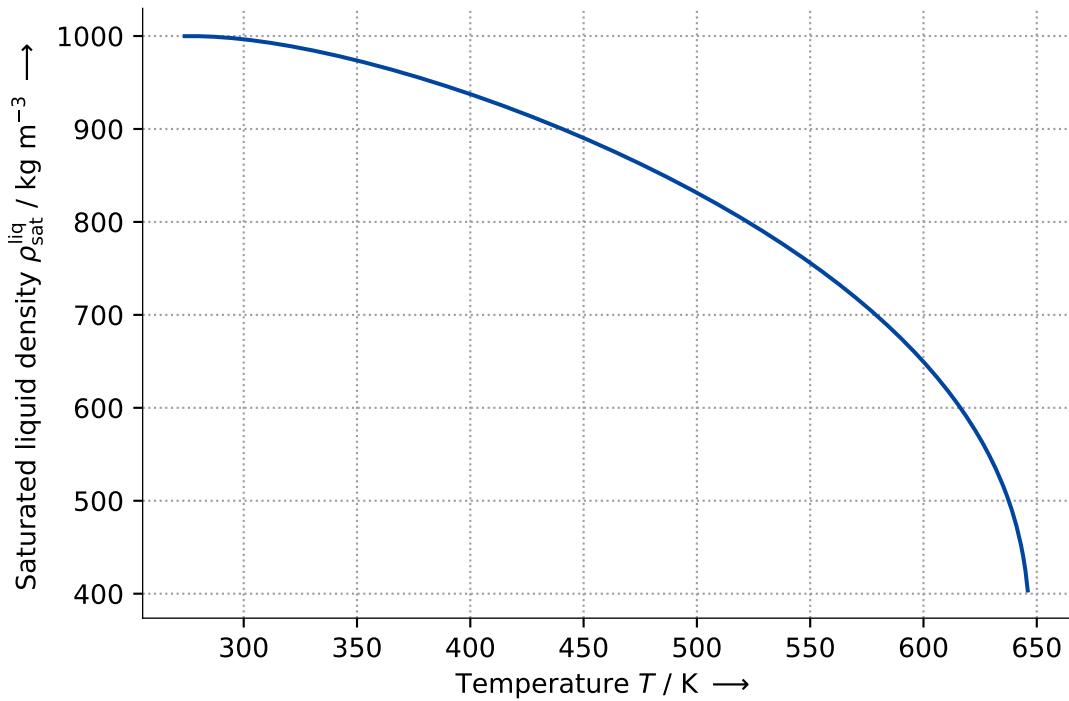
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.666666667e+00
$T_{\text{crit}}$	K	6.470960000e+02	$a_5$	-	-1.754934790e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	3.220000000e+02	$b_5$	-	5.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	-4.551703520e+01
$b_1$	-	0.000000000e+00	$b_6$	-	1.433333333e+01
$a_2$	-	1.992740640e+00	$a_7$	-	-6.746944500e+05
$b_2$	-	3.333333333e-01	$b_7$	-	3.666666667e+01
$a_3$	-	1.099653420e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	-5.108393030e-01			

---

### Validity:

Equation is approximately valid for  $273.16\text{K} \leq T \leq 647.096\text{K}$ .

### Visualization:



#### 4.45.2 Saturated Liquid Density - EoS1 - ID 2

<b>Name:</b>	Water
<b>Equation:</b>	SaturatedLiquidDensity_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Saturated liquid density  $\rho_{\text{sat}}^{\text{liq}}$  in  $\text{kg m}^{-3}$  is calculated depending on temperature  $T$  in K by:

$$\rho_{\text{sat}}^{\text{liq}} = \begin{cases} \rho_{\text{ref}} \exp(\Omega) & \text{if flag} < 0 \\ \rho_{\text{ref}} \Omega & \text{else} \end{cases}, \text{ with}$$

$$\Omega = \sum_{i=1}^8 a_i \xi^{b_i}, \text{ and}$$

$$\xi = 1 - \theta, \text{ and}$$

$$\theta = T/T_{\text{crit}}.$$

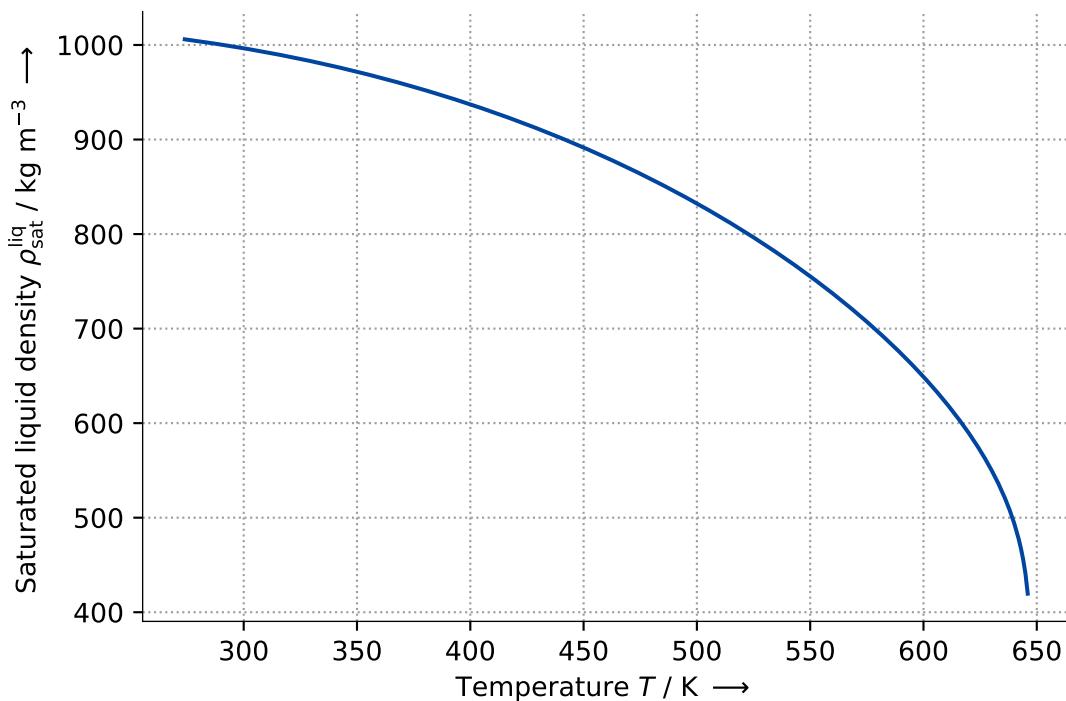
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$b_4$	-	1.000000000e+00
$T_{\text{crit}}$	K	6.471000000e+02	$a_5$	-	-7.701282609e+00
$\rho_{\text{ref}}$	$\text{kg m}^{-3}$	3.220000000e+02	$b_5$	-	1.333333333e+00
$a_1$	-	1.000000000e+00	$a_6$	-	0.000000000e+00
$b_1$	-	0.000000000e+00	$b_6$	-	0.000000000e+00
$a_2$	-	3.397587888e+00	$a_7$	-	0.000000000e+00
$b_2$	-	3.500000000e-01	$b_7$	-	0.000000000e+00
$a_3$	-	-5.631147516e+00	$a_8$	-	0.000000000e+00
$b_3$	-	6.666666667e-01	$b_8$	-	0.000000000e+00
$a_4$	-	1.199986242e+01			

#### Validity:

Equation is approximately valid for  $273.16\text{K} \leq T \leq 647.1\text{K}$ .

#### Visualization:



#### 4.45.3 Vapor Pressure - Antoine - ID 1

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	1
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

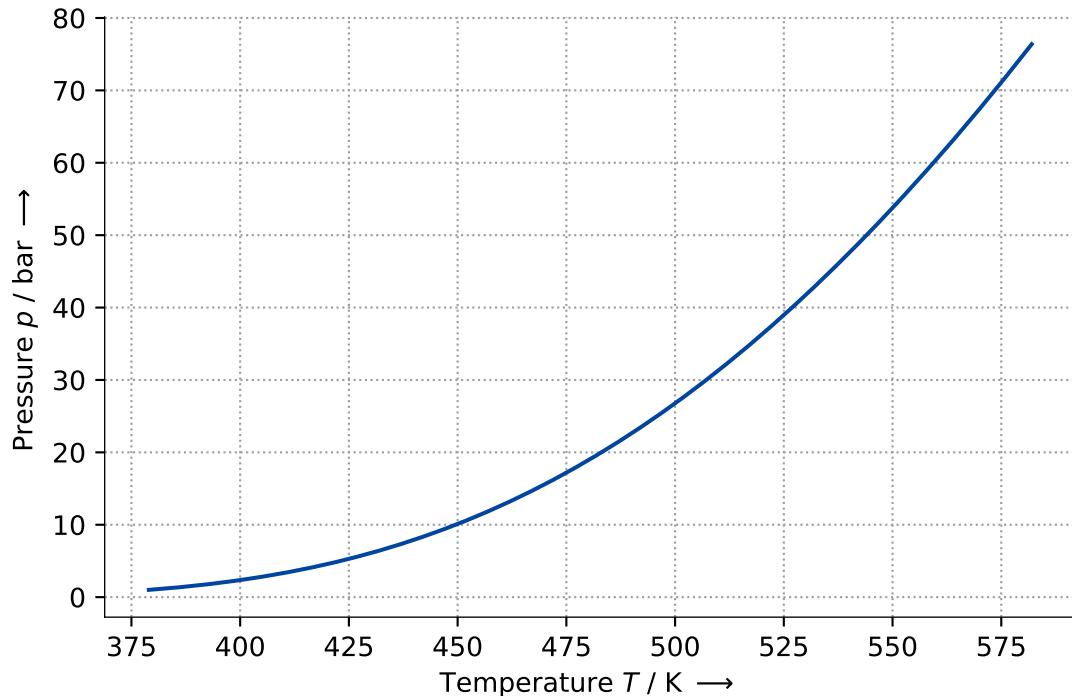
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	3.559590000e+00	$c$	K	-1.980430000e+02
$b$	K	6.437480000e+02			

#### Validity:

Equation is approximately valid for  $379.0\text{K} \leq T \leq 583.0\text{K}$ .

**Visualization:**



#### 4.45.4 Vapor Pressure - Antoine - ID 2

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	2
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

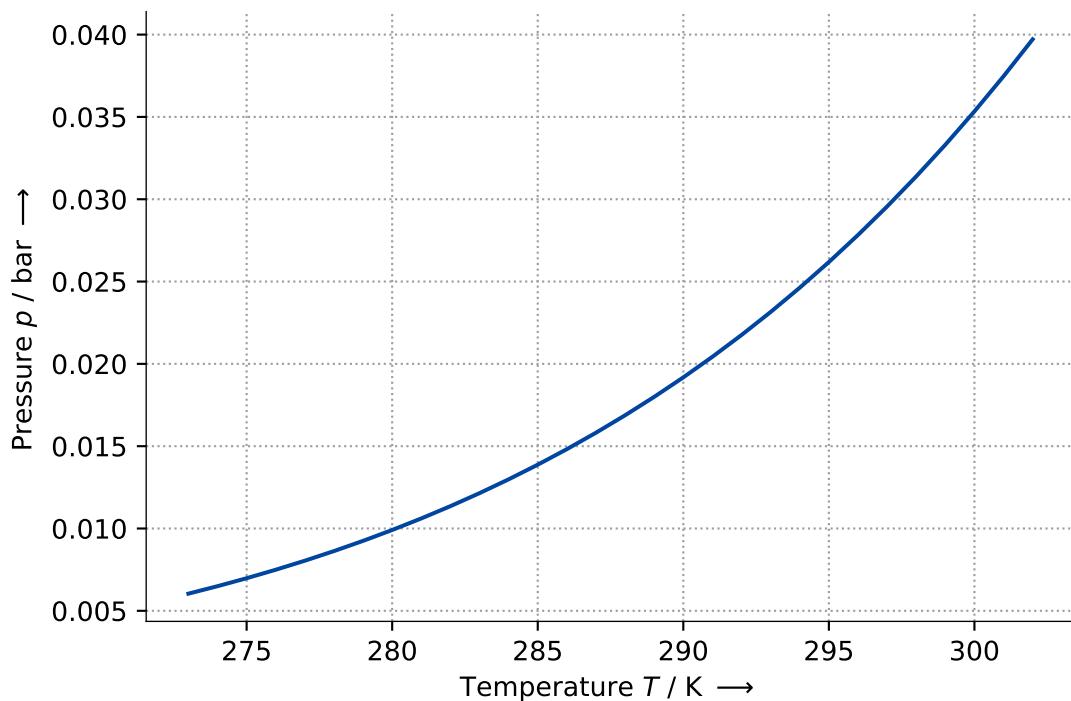
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.402210000e+00	$c$	K	-3.173700000e+01
$b$	K	1.838675000e+03			

#### Validity:

Equation is approximately valid for  $273.0\text{K} \leq T \leq 303.0\text{K}$ .

#### Visualization:



#### 4.45.5 Vapor Pressure - Antoine - ID 3

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	3
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

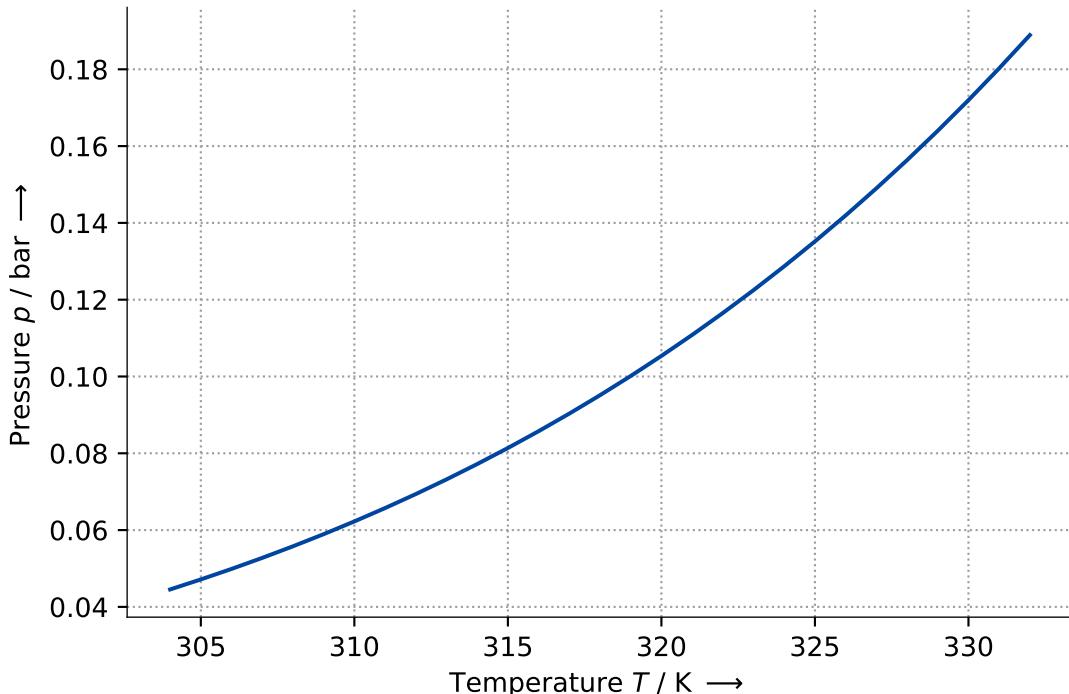
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.203890000e+00	$c$	K	-3.948500000e+01
$b$	K	1.733926000e+03			

#### Validity:

Equation is approximately valid for  $304.0\text{K} \leq T \leq 333.0\text{K}$ .

**Visualization:**



#### 4.45.6 Vapor Pressure - Antoine - ID 4

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	4
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

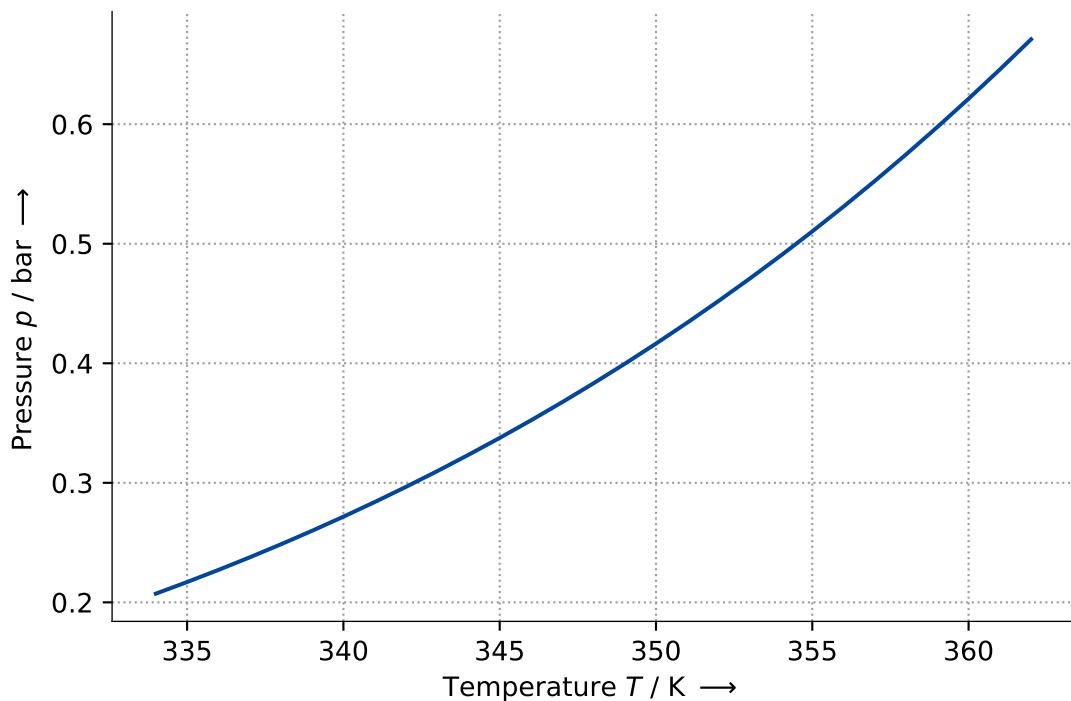
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.076800000e+00	$c$	K	-4.585400000e+01
$b$	K	1.659793000e+03			

#### Validity:

Equation is approximately valid for  $334.0\text{K} \leq T \leq 363.0\text{K}$ .

#### Visualization:



#### 4.45.7 Vapor Pressure - Antoine - ID 5

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	5
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

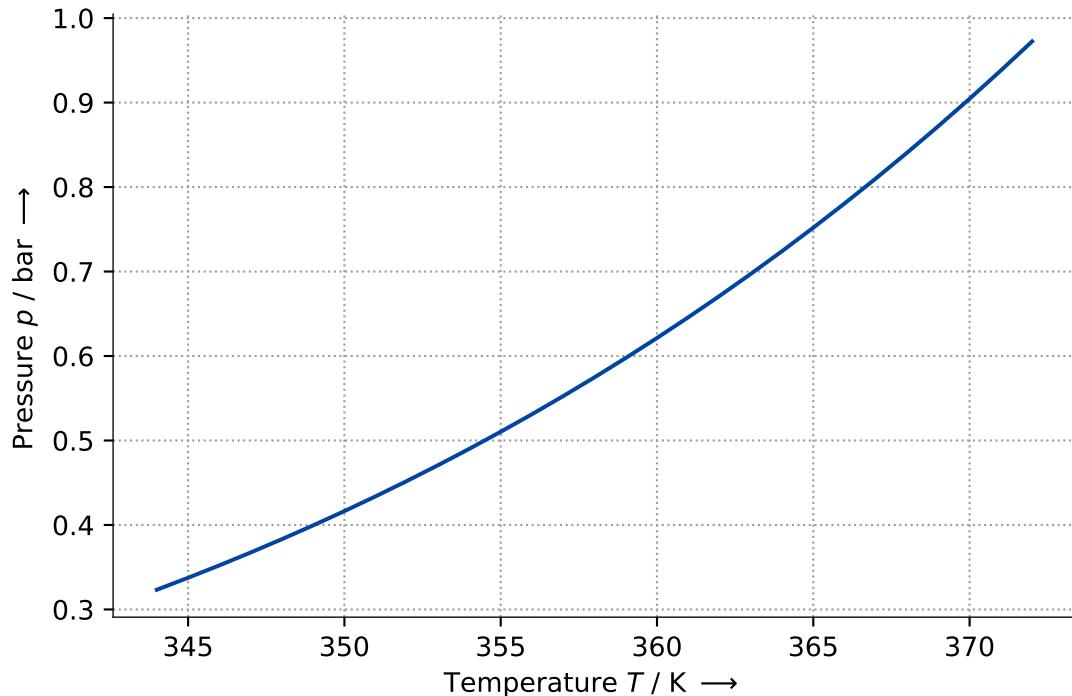
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	5.083540000e+00	$c$	K	-4.562200000e+01
$b$	K	1.663125000e+03			

#### Validity:

Equation is approximately valid for  $344.0\text{K} \leq T \leq 373.0\text{K}$ .

**Visualization:**



#### 4.45.8 Vapor Pressure - Antoine - ID 6

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	6
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

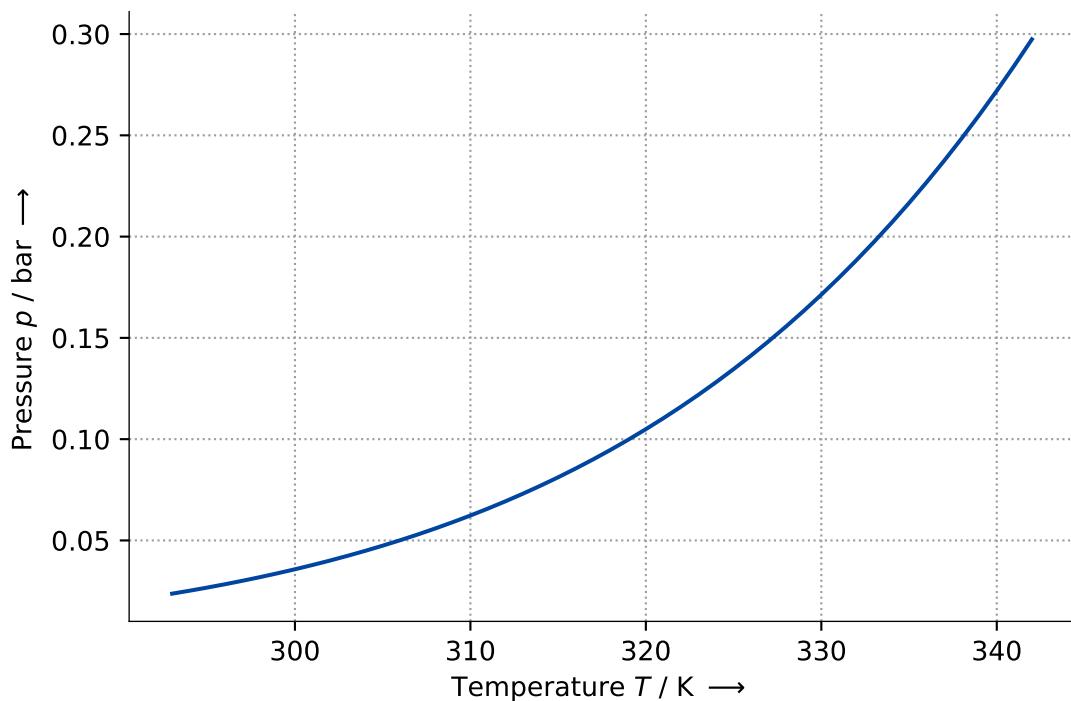
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	6.209630000e+00	$c$	K	7.559000000e+00
$b$	K	2.354731000e+03			

#### Validity:

Equation is approximately valid for  $293.0\text{K} \leq T \leq 343.0\text{K}$ .

#### Visualization:



#### 4.45.9 Vapor Pressure - Antoine - ID 7

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_Antoine
<b>ID:</b>	7
<b>Reference:</b>	P.J. Linstrom and W.G. Mallard, Eds., NIST Chemistry Web-Book, NIST Standard Reference Database Number 69, National Institute of Standards and Technology, Gaithersburg MD, 20899, <a href="https://doi.org/10.18434/T4D303">https://doi.org/10.18434/T4D303</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}}/100000 = 10^{a-b/T+c}$$

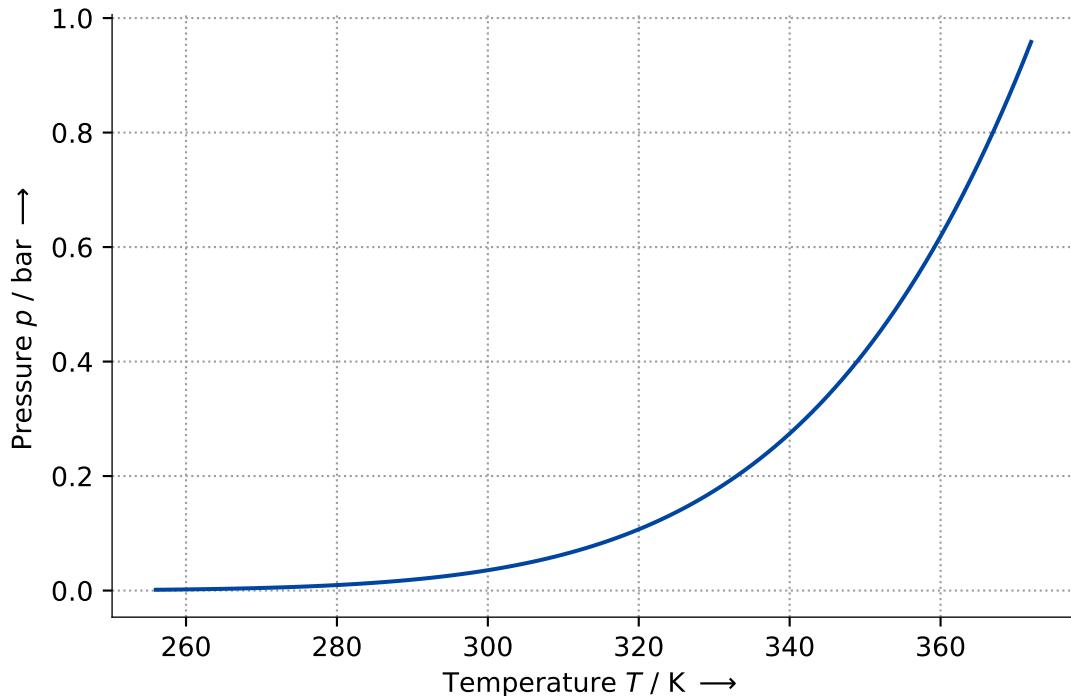
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	-	4.654300000e+00	$c$	K	-6.484800000e+01
$b$	K	1.435264000e+03			

#### Validity:

Equation is approximately valid for  $255.9\text{K} \leq T \leq 373.0\text{K}$ .

**Visualization:**



#### 4.45.10 Vapor Pressure - EoS1 - ID 1

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	1
<b>Reference:</b>	Wagner, W.; Prüß, A. (2002): The IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use. In: Journal of Physical and Chemical Reference Data 31 (2), S. 387–535. DOI: 10.1063/1.1461829.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = \frac{T}{T_{\text{crit}}} \quad .$$

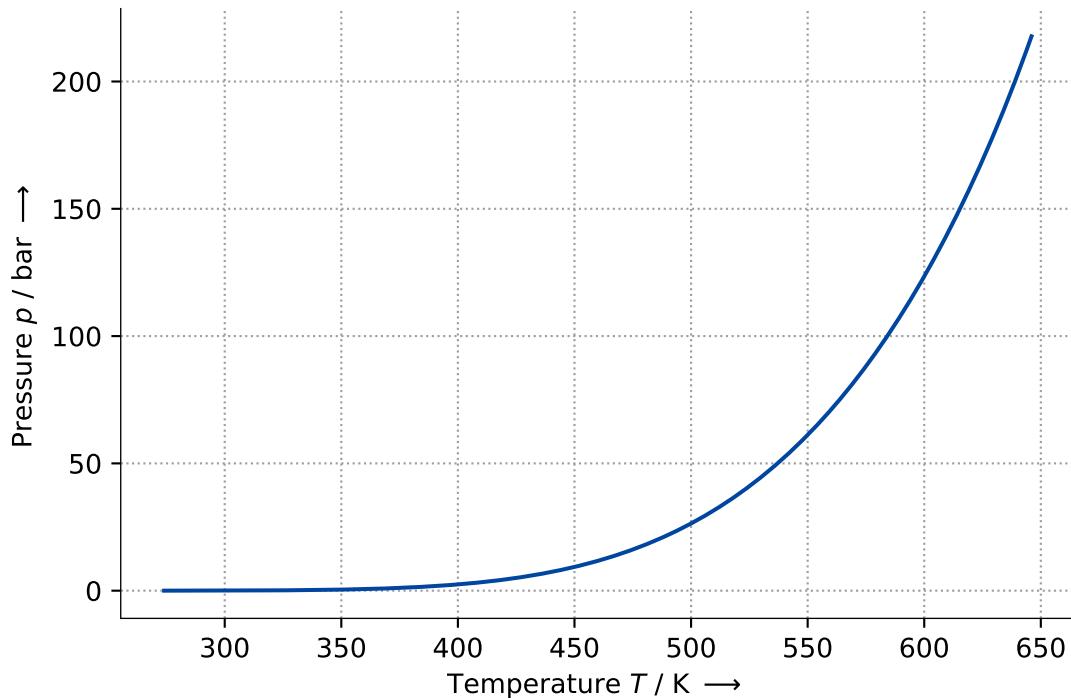
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit}}$	K	6.470960000e+02	$a_4$	-	2.268074110e+01
$p_{\text{crit}}$	Pa	2.206400000e+07	$b_4$	-	3.500000000e+00
$a_1$	-	-7.859517830e+00	$a_5$	-	-1.596187190e+01
$b_1$	-	1.000000000e+00	$b_5$	-	4.000000000e+00
$a_2$	-	1.844082590e+00	$a_6$	-	1.801225020e+00
$b_2$	-	1.500000000e+00	$b_6$	-	7.500000000e+00
$a_3$	-	-1.178664970e+01	$a_7$	-	0.000000000e+00
$b_3$	-	3.000000000e+00	$b_7$	-	0.000000000e+00

#### Validity:

Equation is approximately valid for  $273.16\text{K} \leq T \leq 647.096\text{K}$ .

#### Visualization:



#### 4.45.11 Vapor Pressure - EoS1 - ID 2

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_EoS1
<b>ID:</b>	2
<b>Reference:</b>	Verein Deutscher Ingenieure (2010): VDI Heat Atlas. 2. Ed. Heidelberg: Springer. Online: <a href="http://dx.doi.org/10.1007/978-3-540-77877-6">http://dx.doi.org/10.1007/978-3-540-77877-6</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K by:

$$p_{\text{sat}} = p_{\text{crit}} \exp \left( \frac{1}{\theta} \sum_{i=1}^7 a_i \xi^{b_i} \right) \quad , \text{ and}$$

$$\xi = 1 - \theta \quad , \text{ and}$$

$$\theta = T/T_{\text{crit}} \quad .$$

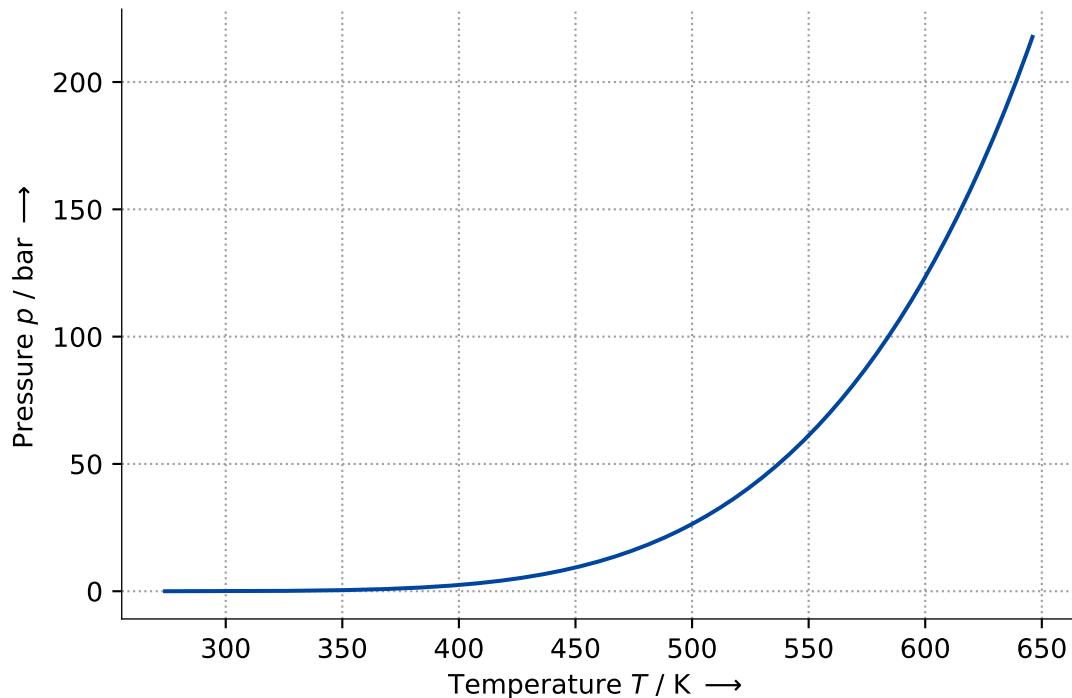
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$T_{\text{crit}}$	K	6.471000000e+02		$a_4$	-	-2.064720000e+00

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit}}$	Pa	2.206400000e+07	$b_4$	-	5.000000000e+00
$a_1$	-	-7.869750000e+00	$a_5$	-	0.000000000e+00
$b_1$	-	1.000000000e+00	$b_5$	-	0.000000000e+00
$a_2$	-	1.905610000e+00	$a_6$	-	0.000000000e+00
$b_2$	-	1.500000000e+00	$b_6$	-	0.000000000e+00
$a_3$	-	-2.308910000e+00	$a_7$	-	0.000000000e+00
$b_3$	-	2.500000000e+00	$b_7$	-	0.000000000e+00

**Validity:**

Equation is approximately valid for  $273.16\text{K} \leq T \leq 647.1\text{K}$ .

**Visualization:**

## 4.45.12 Vapor Pressure - EoSCubic - ID 1

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	1
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned} p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\ a &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha \quad , \text{ and} \\ b &= 0.08664 R \frac{T_{\text{crit}}}{p_{\text{crit}}} \quad , \text{ and} \\ \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 \quad , \text{ and} \\ \kappa &= 0.48508 + 1.55171\omega - 0.15613\omega^2 \quad . \end{aligned}$$

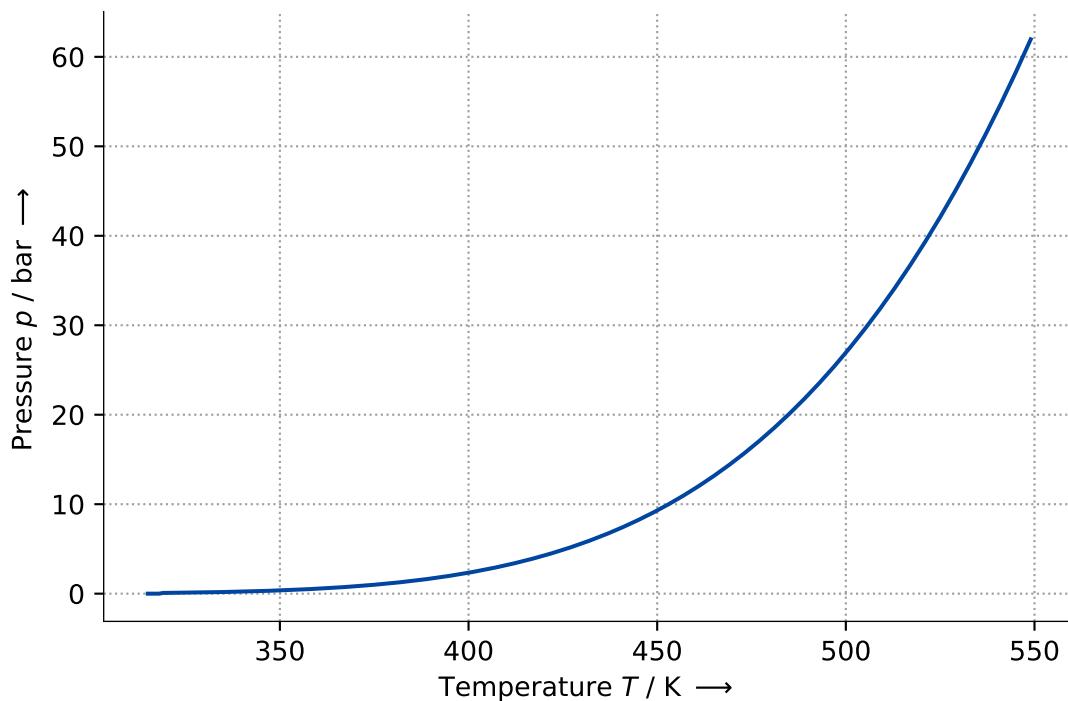
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	6.471000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.206400000e+07	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.443000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $314.134\text{K} \leq T \leq 550.035\text{K}$ .

**Visualization:**



#### 4.45.13 Vapor Pressure - EoSCubic - ID 2

<b>Name:</b>	Water
<b>Equation:</b>	VaporPressure_EoSCubic
<b>ID:</b>	2
<b>Reference:</b>	Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. (2018): NIST Standard Reference Database 23. Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology. Online: <a href="https://www.nist.gov/srd/refprop">https://www.nist.gov/srd/refprop</a> .
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients

of vapor and liquid phase are equal. Cubic equation of state is given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= 0.45724 \frac{(RT_{\text{crit}})^2}{p_{\text{crit}}} \alpha , \text{ and} \\
 b &= 0.07780 R \frac{T_{\text{crit}}}{p_{\text{crit}}} , \text{ and} \\
 \alpha &= \left(1 + \kappa \left(1 - \sqrt{\frac{T}{T_{\text{crit}}}}\right)\right)^2 , \text{ and} \\
 \kappa &= 0.37464 + 1.54226\omega - 0.26992\omega^2 .
 \end{aligned}$$

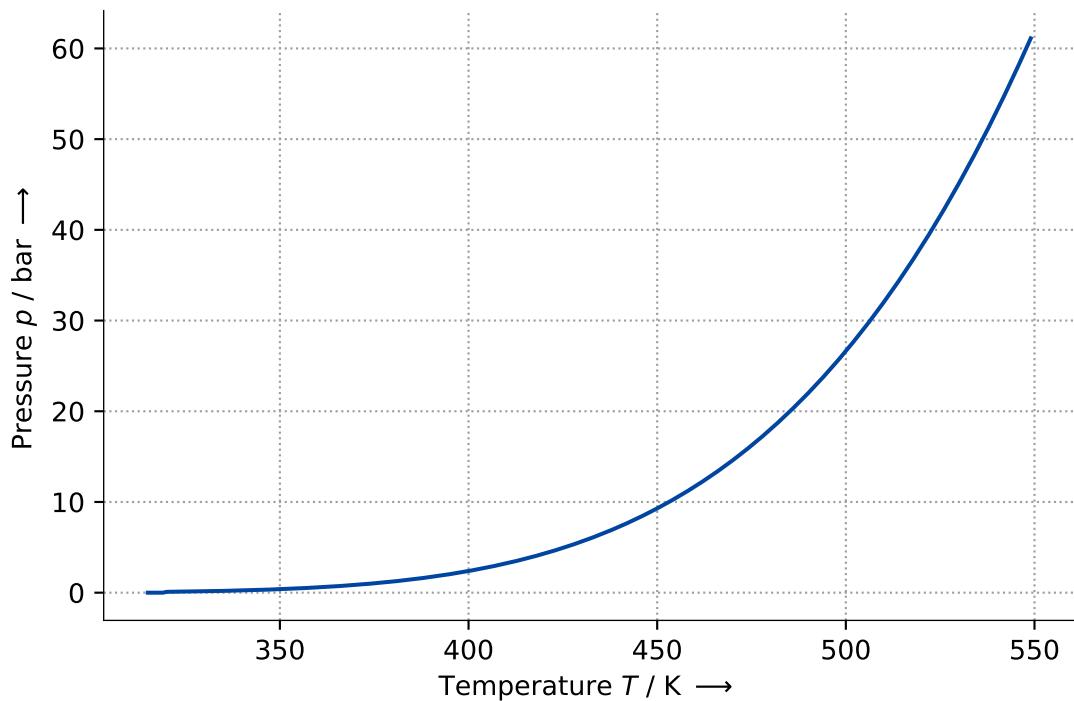
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	$\beta_0$	-	0.000000000e+00
$T_{\text{crit}}$	K	6.471000000e+02	$\beta_1$	-	0.000000000e+00
$p_{\text{crit}}$	Pa	2.206400000e+07	$\beta_2$	-	0.000000000e+00
$\omega$	-	3.443000000e-01	$\beta_3$	-	0.000000000e+00
$\kappa_1$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $314.134\text{K} \leq T \leq 550.035\text{K}$ .

### Visualization:



## 5 Adsorption

### 5.1 1-Butene

#### 5.1.1 Zeolite pellet 13X

##### 5.1.1.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	1-Butene
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Lamia, Nabil; Wolff, Luc; Leflaive, Philibert; Leinekugel-Le-Cocq, Damien; Sá Gomes, Pedro; Grande, Carlos A.; Rodrigues, Alírio E. (2008): Equilibrium and Fixed Bed Adsorption of 1-Butene, Propylene and Propane Over 13X Zeolite Pellets. In: Separation Science and Technology 43 (5), S. 1124–1156. DOI: 10.1080/01496390801888136.
<b>Comment:</b>	None

Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.001
Diameter of pore	mm	0.0000005
Diameter of extrudate	mm	0.8
Porosity of pellet	-	0.395
Pellet density	kg m <sup>-3</sup>	1357

Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature

$T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	2.500000000e-10	$Q^*$	K	6.542816114e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.178310000e-01
$n_0$	-	4.520000000e-01			

### Validity:

Equation is approximately valid for  $0.0\text{Pa} \leq p \leq 110050.0\text{Pa}$ ,  $333.0\text{K} \leq T \leq 393.0\text{K}$ , and  $0.0\text{kg kg}^{-1} \leq w \leq 0.1155866\text{kg kg}^{-1}$ .

### Visualization:

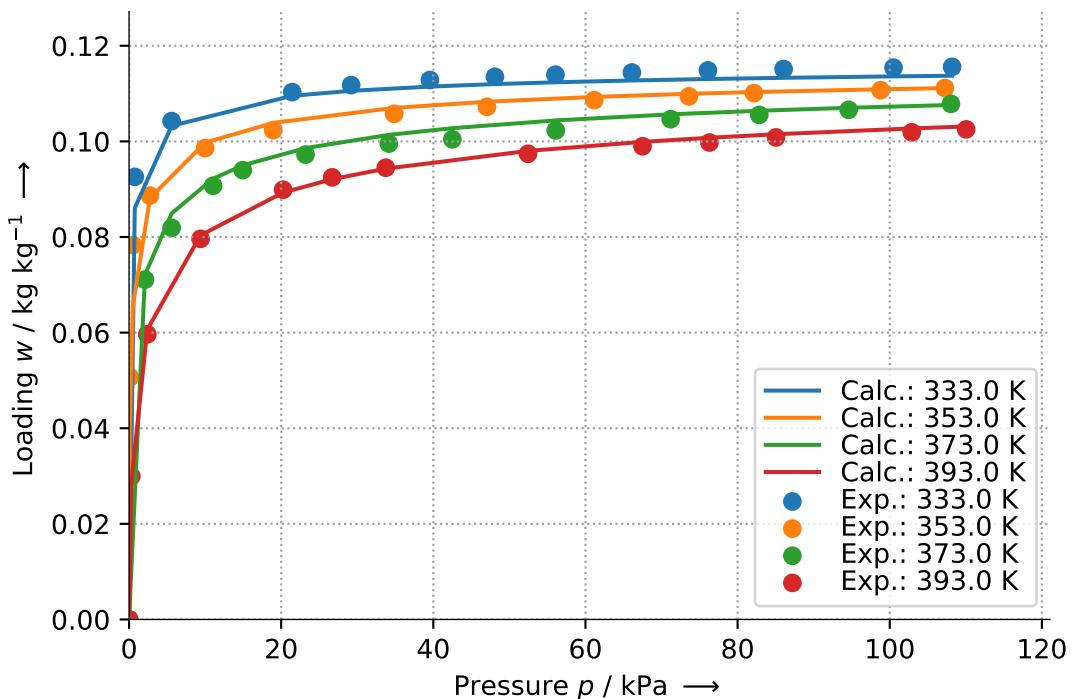
To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: NoSaturatedLiquidDensity - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 50
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.85%.



## 5.2 Ammonia

### 5.2.1 Zeolite pellet NaX

#### 5.2.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	NaX
<b>Refrigerant:</b>	Ammonia
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Sun, L. M.; Feng, Y.; Pons, M. (1997): Numerical investigation of adsorptive heat pump systems with thermal wave heat regeneration under uniform-pressure conditions. In: International Journal of Heat and Mass Transfer 40 (2), S. 281–293. DOI: 10.1016/0017-9310(96)00113-5.
<b>Comment:</b>	See original literature: Vapor pressure in Pa is given by $p_{\text{sat}} = 23.0272 - 2748.39 / T$ .

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in

K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W\rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\mathcal{A}/E)^n), \text{ and}$$

$$\mathcal{A} = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.000000000e+00
E	J mol <sup>-1</sup>	1.899487468e+04	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	2.220000000e-04

### Validity:

No data on validity available!

### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 5.3 Butane

### 5.3.1 Activated carbon powder Maxsorb III

#### 5.3.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	Butane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; Chakraborty, Anutosh; Koyama, Shigeru; Yoon, Seong-Ho; Mochida, Isao; Kumja, M. et al. (2008): Isotherms and thermodynamics for the adsorption of n -butane on pitch based activated carbon. In: International Journal of Heat and Mass Transfer 51 (7-8), S. 1582–1589. DOI: 10.1016/j.ijheatmasstransfer.2007.07.031.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002008
Diameter of pellet	mm	0.072
Surface area	$\text{m}^2 \text{g}^{-1}$	3140
Pore volume	$\text{mm}^3 \text{g}^{-1}$	2.01
Bulk density	$\text{kg m}^{-3}$	310

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n) , \text{ and}$$

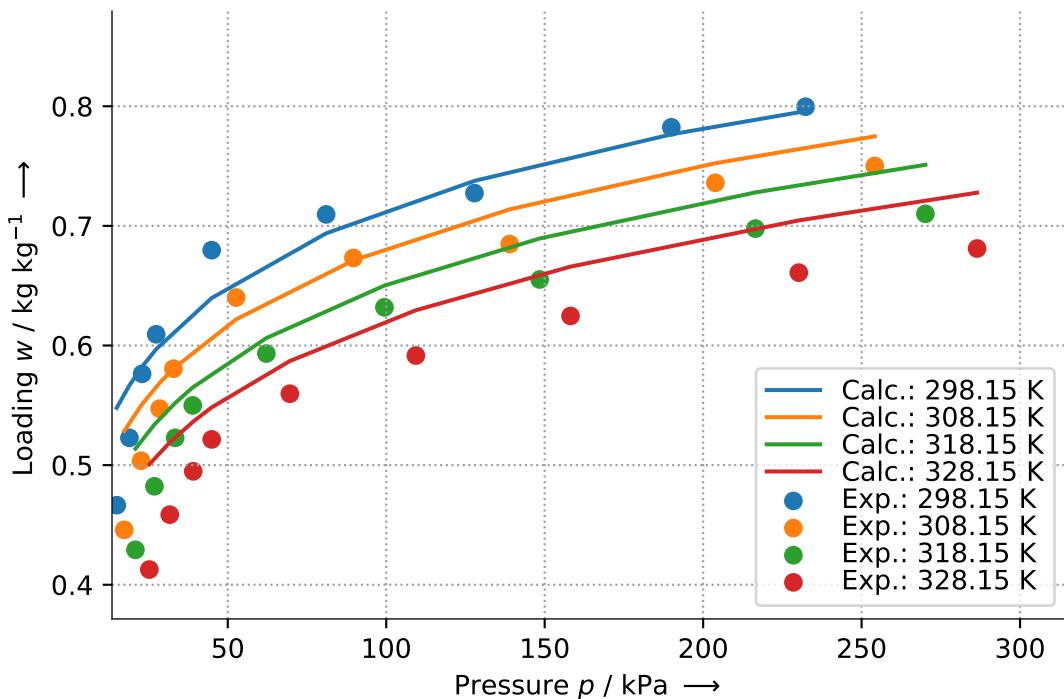
$$A = RT \ln(p_{\text{sat}}/p) .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$n$	-	1.050000000e+00
$E$	J mol <sup>-1</sup>	1.743600000e+04	$W_0$	kg kg <sup>-1</sup>	8.000000000e-01

**Validity:**

Equation is approximately valid for  $14970.0\text{Pa} \leq p \leq 286440.0\text{Pa}$ ,  $298.15\text{K} \leq T \leq 328.15\text{K}$ , and  $0.4127\text{kg kg}^{-1} \leq w \leq 0.7996\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.01

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.18%.

## 5.4 CarbonDioxide

### 5.4.1 Activated carbon Norit RB 1

#### 5.4.1.1 Langmuir - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit RB 1
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Langmuir
<b>ID:</b>	1
<b>Reference:</b>	van der Vaart, Rick; HUISKES, CINDY; Bosch, Hans; Reith, Tom (2000): Single and Mixed Gas Adsorption Equilibria of Carbon Dioxide/Methane on Activated Carbon. In: Adsorption 6 (4), S. 311–323. DOI: 10.1023/A:1026560915422.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} K p}{1 + K p} \quad , \text{ and}$$

$$K = K_0 \exp\left(\frac{\Delta H}{R T}\right) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta H$	$\text{J mol}^{-1}$	2.35000000e+04	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	3.494354300e-01
$K_0$	$\text{Pa}^{-1}$	3.22000000e-10			

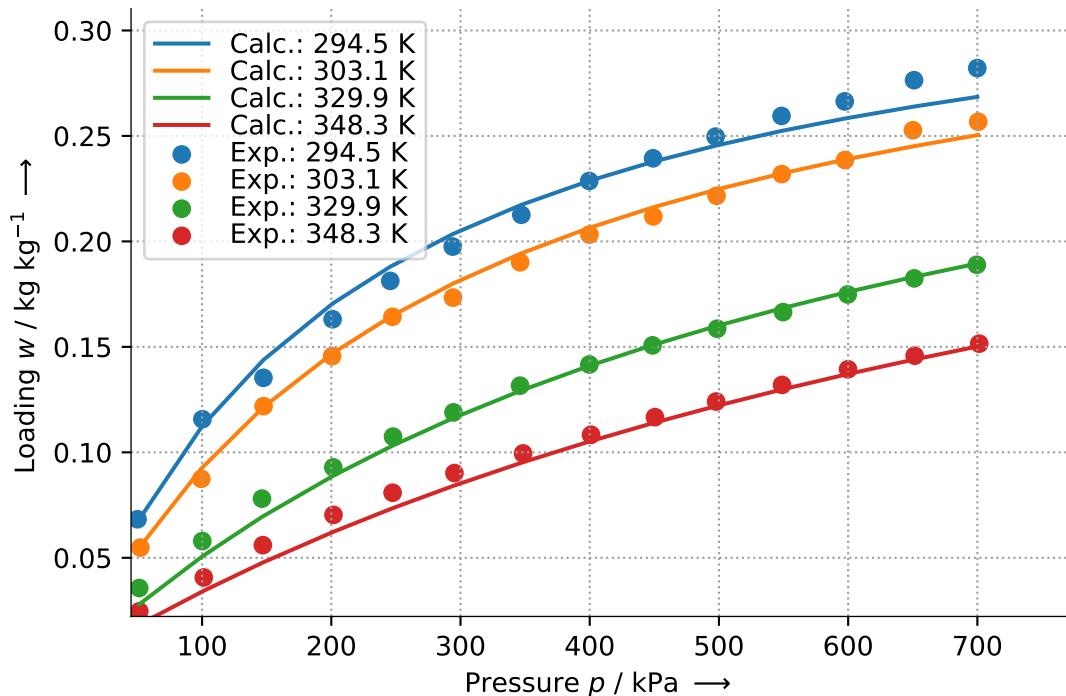
#### Validity:

Equation is approximately valid for  $50048.9\text{Pa} \leq p \leq 701434.0\text{Pa}$ ,  $294.5\text{K} \leq T \leq 348.3\text{K}$ , and  $0.0246555\text{kg kg}^{-1} \leq w \leq 0.282155\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.06%.

### 5.4.2 Activated carbon fiber A-20

#### 5.4.2.1 Langmuir - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Langmuir
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; Jribi, Skander; Koyama, Shigeru; El-Sharkawy, Ibrahim I. (2011): Carbon Dioxide Adsorption Isotherms on Activated Carbons. In: J. Chem. Eng. Data 56 (5), S. 1974–1981. DOI: 10.1021/je100973t.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000216
Surface area	$\text{m}^2 \text{g}^{-1}$	2000
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.03

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} K p}{1 + K p}, \text{ and}$$

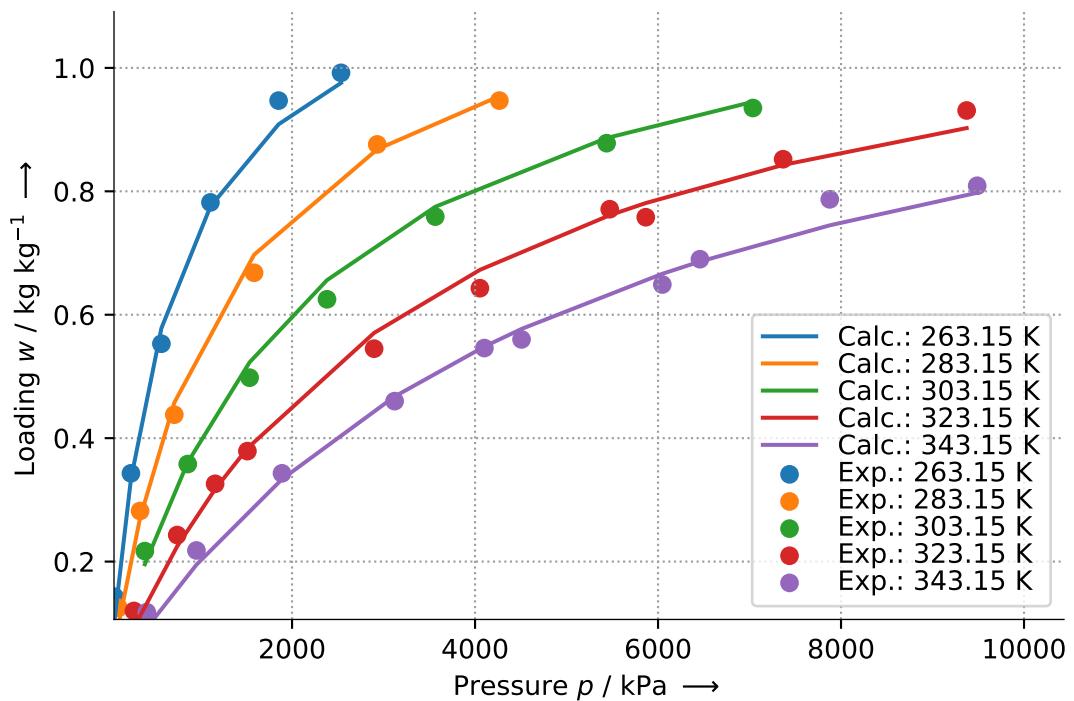
$$K = K_0 \exp\left(\frac{\Delta H}{R T}\right).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta H$	$\text{J mol}^{-1}$	1.941000000e+04	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.220000000e+00
$K_0$	$\text{Pa}^{-1}$	2.210000000e-10			

#### Validity:

Equation is approximately valid for  $60000.0 \text{ Pa} \leq p \leq 9488000.0 \text{ Pa}$ ,  $263.15 \text{ K} \leq T \leq 343.15 \text{ K}$ , and  $0.118 \text{ kg kg}^{-1} \leq w \leq 0.992 \text{ kg kg}^{-1}$ .



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % → 0 Pa <  $p$  < 1000000 Pa: 0.2
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.21%.

### 5.4.2.2 Toth - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; Jribi, Skander; Koyama, Shigeru; El-Sharkawy, Ibrahim I. (2011): Carbon Dioxide Adsorption Isotherms on Activated Carbons. In: J. Chem. Eng. Data 56 (5), S. 1974–1981. DOI: 10.1021/je100973t.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.00000216
Surface area	$\text{m}^2 \text{g}^{-1}$	2000
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.03

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

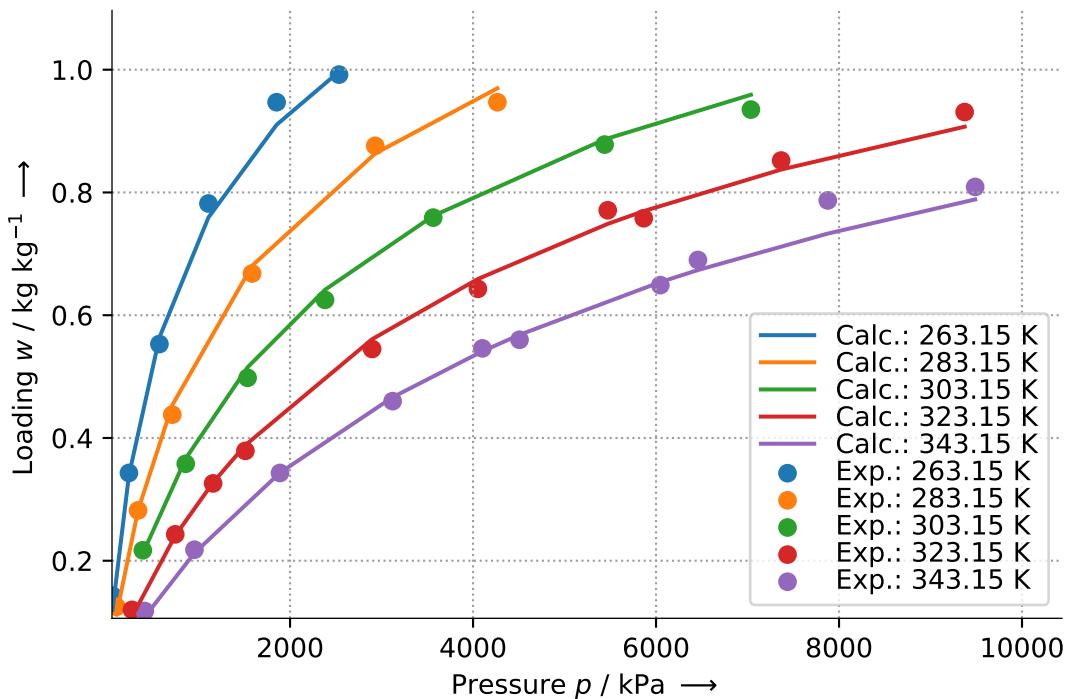
$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	2.550000000e-10	$Q^*$	K	2.312837387e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.560000000e+00
$n_0$	-	6.960000000e-01			

**Validity:**

Equation is approximately valid for  $60000.0\text{Pa} \leq p \leq 9488000.0\text{Pa}$ ,  $263.15\text{K} \leq T \leq 343.15\text{K}$ , and  $0.118\text{kg kg}^{-1} \leq w \leq 0.992\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % →  $0 \text{ Pa} < p < 1000000 \text{ Pa}$ : 0.2
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.94%.

### 5.4.3 Activated carbon powder Maxsorb III

#### 5.4.3.1 Langmuir - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Langmuir
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; Jribi, Skander; Koyama, Shigeru; El-Sharkawy, Ibrahim I. (2011): Carbon Dioxide Adsorption Isotherms on Activated Carbons. In: J. Chem. Eng. Data 56 (5), S. 1974–1981. DOI: 10.1021/je100973t.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3150
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} K p}{1 + K p}, \text{ and}$$

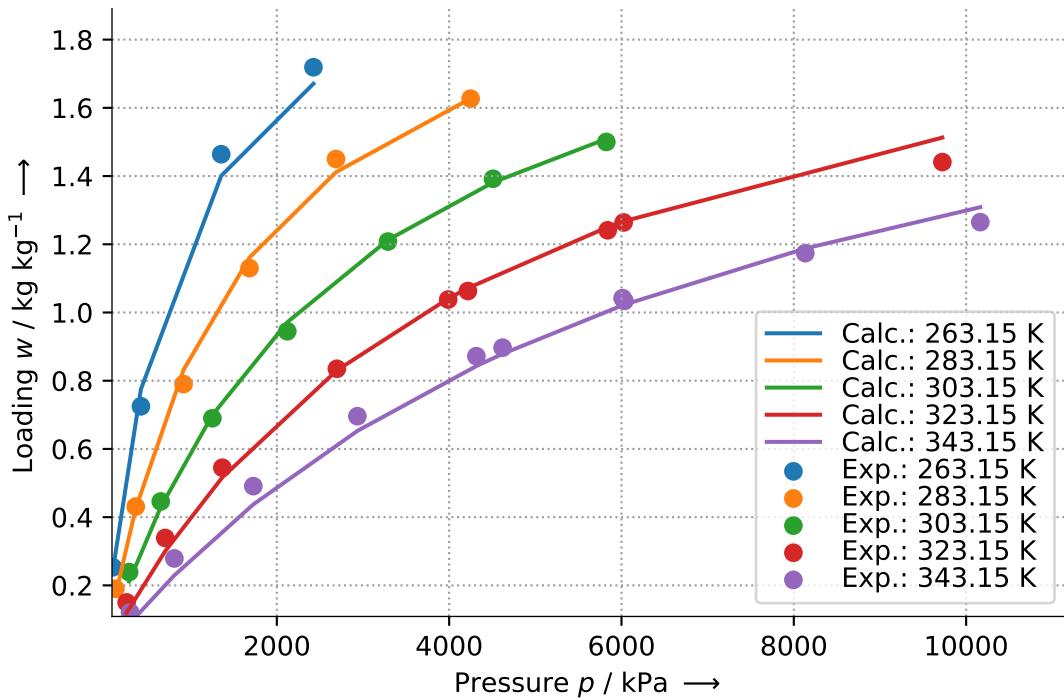
$$K = K_0 \exp\left(\frac{\Delta H}{R T}\right).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta H$	$\text{J mol}^{-1}$	2.056000000e+04	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	2.210000000e+00
$K_0$	$\text{Pa}^{-1}$	1.060000000e-10			

#### Validity:

Equation is approximately valid for  $97000.0 \text{ Pa} \leq p \leq 10164000.0 \text{ Pa}$ ,  $263.15 \text{ K} \leq T \leq 343.15 \text{ K}$ , and  $0.121 \text{ kg kg}^{-1} \leq w \leq 1.719 \text{ kg kg}^{-1}$ .



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % → 0 Pa <  $p$  < 1000000 Pa: 0.2
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.97%.

### 5.4.3.2 Toth - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; Jribi, Skander; Koyama, Shigeru; El-Sharkawy, Ibrahim I. (2011): Carbon Dioxide Adsorption Isotherms on Activated Carbons. In: J. Chem. Eng. Data 56 (5), S. 1974–1981. DOI: 10.1021/je100973t.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3150
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.07

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

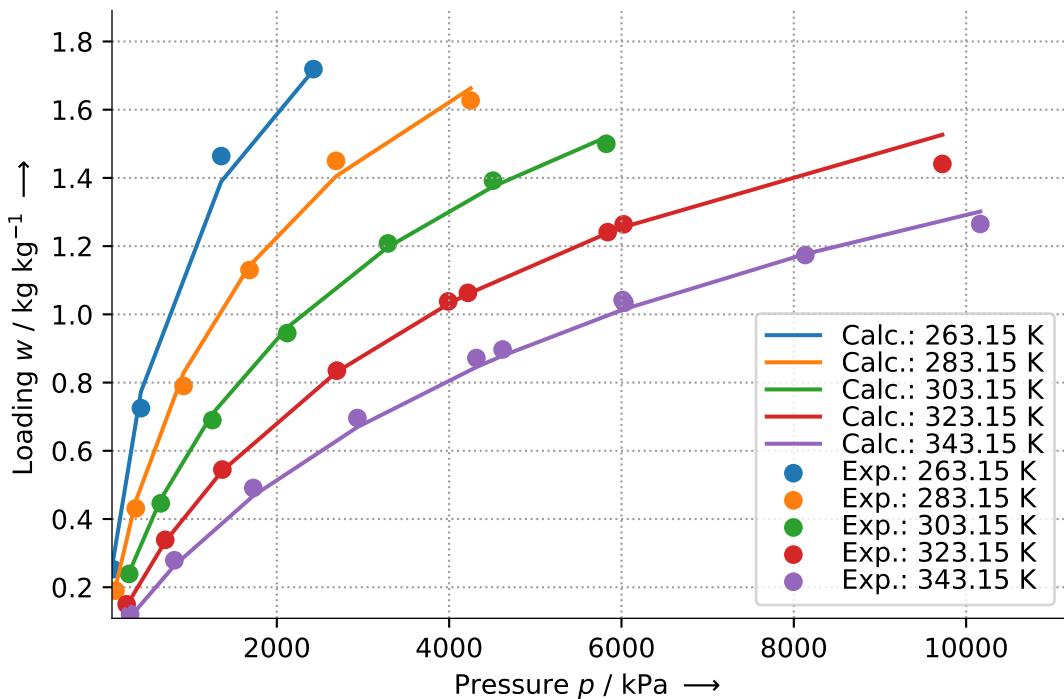
$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	1.170000000e-10	$Q^*$	K	2.449947872e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	3.060000000e+00
$n_0$	-	6.640000000e-01			

**Validity:**

Equation is approximately valid for  $97000.0\text{Pa} \leq p \leq 10164000.0\text{Pa}$ ,  $263.15\text{K} \leq T \leq 343.15\text{K}$ , and  $0.121\text{kg kg}^{-1} \leq w \leq 1.719\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % →  $0 \text{ Pa} < p < 1000000 \text{ Pa}$ : 0.2
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.79%.

#### 5.4.4 Silica gel pellet

##### 5.4.4.1 Toth - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Wang, Yu; LeVan, M. Douglas (2009): Adsorption Equilibrium of Carbon Dioxide and Water Vapor on Zeolites 5A and 13X and Silica Gel. Pure Components. In: J. Chem. Eng. Data 54 (10), S. 2839–2844. DOI: 10.1021/je800900a.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$\begin{aligned} w &= \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}} \quad , \text{ and} \\ b &= b_0 \exp \left( \frac{Q^*}{T} \right) \quad , \text{ and} \\ n &= n_0 + c/T \quad , \text{ and} \\ r &= \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases} . \end{aligned}$$

The parameters of the equation are:

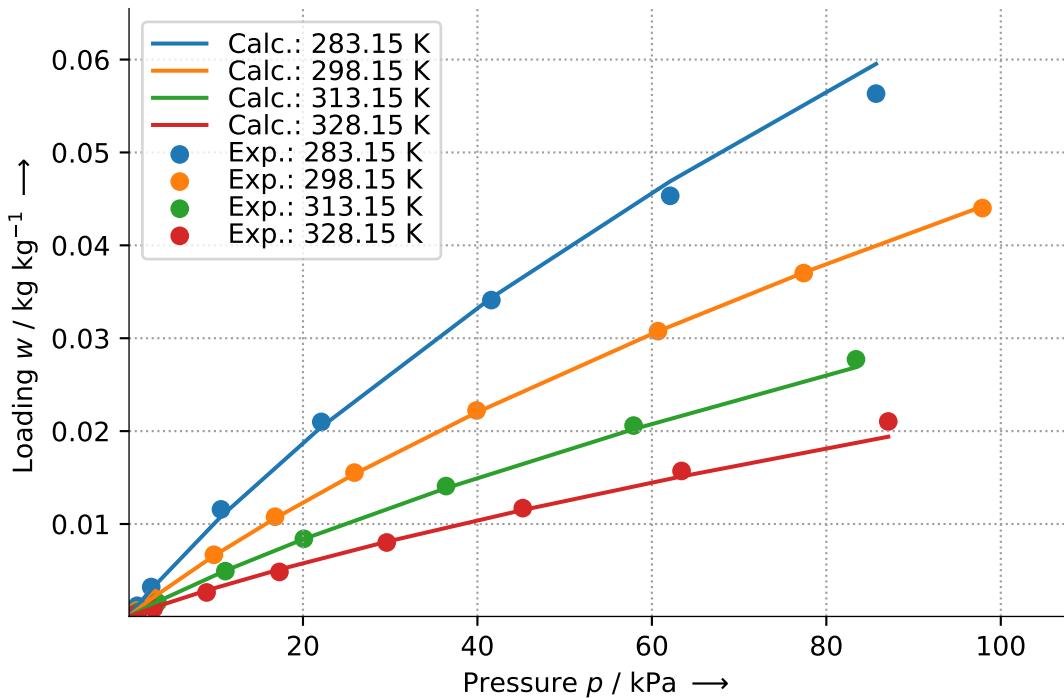
Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	5.164000000e-10	$Q^*$	K	2.330000000e+03
$c$	K	2.386000000e+02	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	6.543472909e-01
$n_0$	-	-3.053000000e-01			

#### Validity:

Equation is approximately valid for  $67.2\text{Pa} \leq p \leq 97900.0\text{Pa}$ ,  $283.15\text{K} \leq T \leq 328.15\text{K}$ , and  $5.28108e-05\text{kg kg}^{-1} \leq w \leq 0.05633152\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, relative, in % →  $0.067 \text{ Pa} < p < 13300 \text{ Pa}$ : 0.25
- Temperature, absolute, in K → 0.3

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.49%.

### 5.4.5 Zeolite pellet 13X

#### 5.4.5.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Wang, Yu; LeVan, M. Douglas (2009): Adsorption Equilibrium of Carbon Dioxide and Water Vapor on Zeolites 5A and 13X and Silica Gel. Pure Components. In: J. Chem. Eng. Data 54 (10), S. 2839–2844. DOI: 10.1021/je800900a.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$\begin{aligned} w &= \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}} \quad , \text{ and} \\ b &= b_0 \exp \left( \frac{Q^*}{T} \right) \quad , \text{ and} \\ n &= n_0 + c/T \quad , \text{ and} \\ r &= \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases} . \end{aligned}$$

The parameters of the equation are:

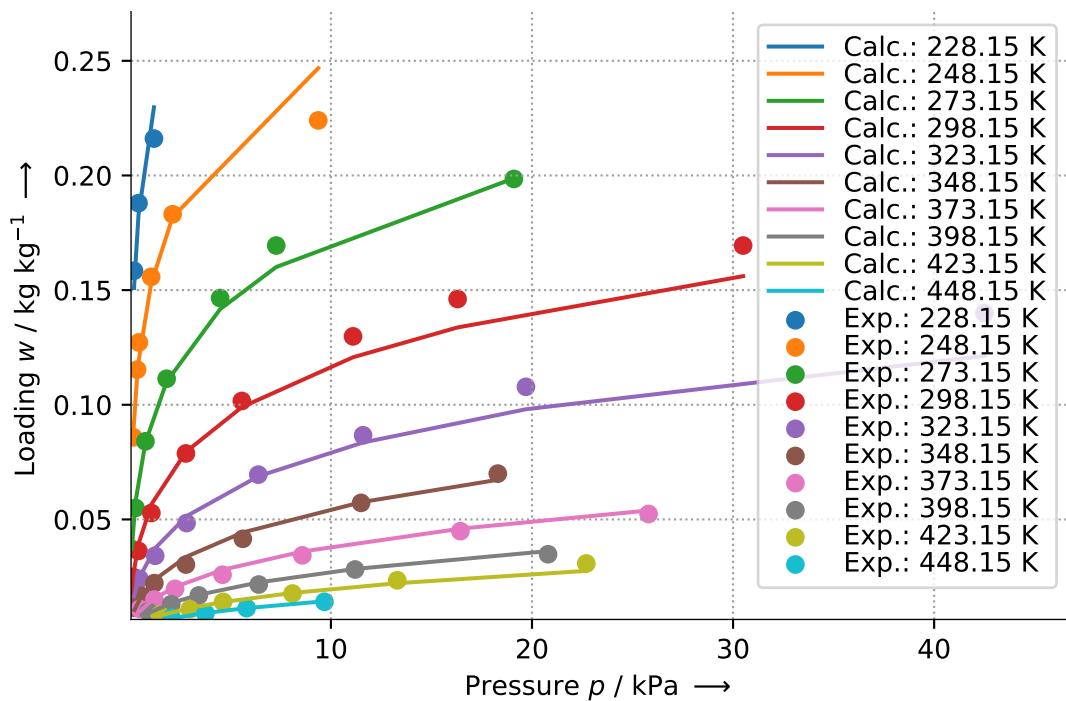
Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	4.884000000e-07	$Q^*$	K	2.991000000e+03
$c$	K	3.805000000e+01	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	5.865230047e-01
$n_0$	-	7.487000000e-02			

#### Validity:

Equation is approximately valid for  $98.2\text{Pa} \leq p \leq 42500.0\text{Pa}$ ,  $228.15\text{K} \leq T \leq 448.15\text{K}$ , and  $0.007085449\text{kg kg}^{-1} \leq w \leq 0.21608419\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, relative, in % →  $0.067 \text{ Pa} < p < 13300 \text{ Pa}$ : 0.25
- Temperature, absolute, in K → 0.3

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.53%.

### 5.4.6 Zeolite pellet 5A

#### 5.4.6.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Wang, Yu; LeVan, M. Douglas (2009): Adsorption Equilibrium of Carbon Dioxide and Water Vapor on Zeolites 5A and 13X and Silica Gel. Pure Components. In: J. Chem. Eng. Data 54 (10), S. 2839–2844. DOI: 10.1021/je800900a.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

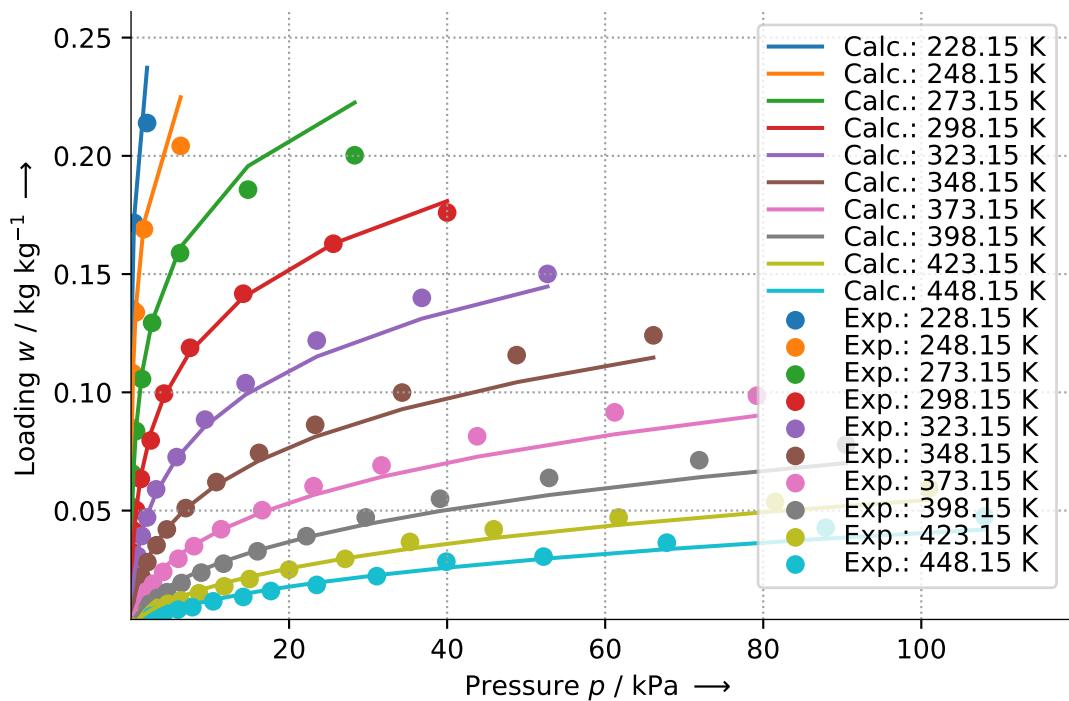
Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	6.761000000e-11	$Q^*$	K	5.625000000e+03
$c$	K	-2.002000000e+01	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	6.427951671e-01
$n_0$	-	2.700000000e-01			

#### Validity:

Equation is approximately valid for  $5.3\text{Pa} \leq p \leq 108000.0\text{Pa}$ ,  $228.15\text{K} \leq T \leq 448.15\text{K}$ , and  $0.0044009\text{kg kg}^{-1} \leq w \leq 0.21388374\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, relative, in % →  $0.067 \text{ Pa} < p < 13300 \text{ Pa}$ : 0.25
- Temperature, absolute, in K → 0.3

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.71%.

## 5.5 Ethanol

### 5.5.1 Activated carbon AP4-60

#### 5.5.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	AP4-60
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.000000128
Diameter of pellet	mm	4
Surface area	$\text{m}^2 \text{g}^{-1}$	1428
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.47

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

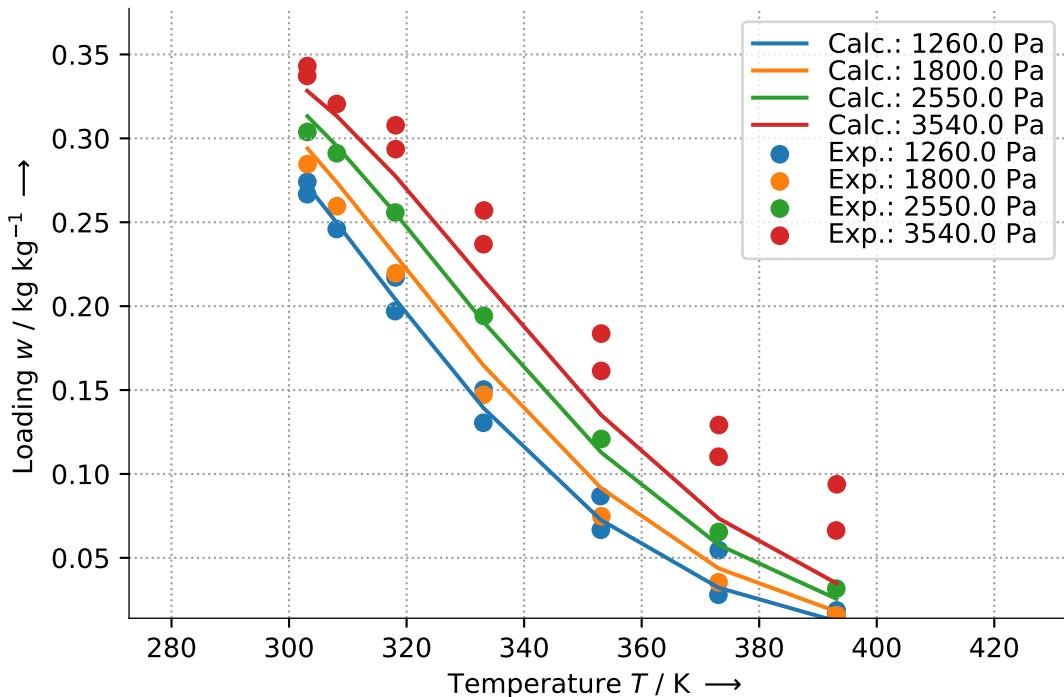
$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.000000000e+00
$E$	$\text{J mol}^{-1}$	1.060000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.500000000e-04

**Validity:**

Equation is approximately valid for  $1260.0\text{Pa} \leq p \leq 3540.0\text{Pa}$ ,  $303.083\text{K} \leq T \leq 393.173\text{K}$ , and  $0.01557\text{kg kg}^{-1} \leq w \leq 0.33722\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 420

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 14.32%.

### 5.5.2 Activated carbon ATO

#### 5.5.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	ATO
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000118
Diameter of pellet	mm	0.25-0.6
Surface area	$\text{m}^2 \text{g}^{-1}$	1745
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.64

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

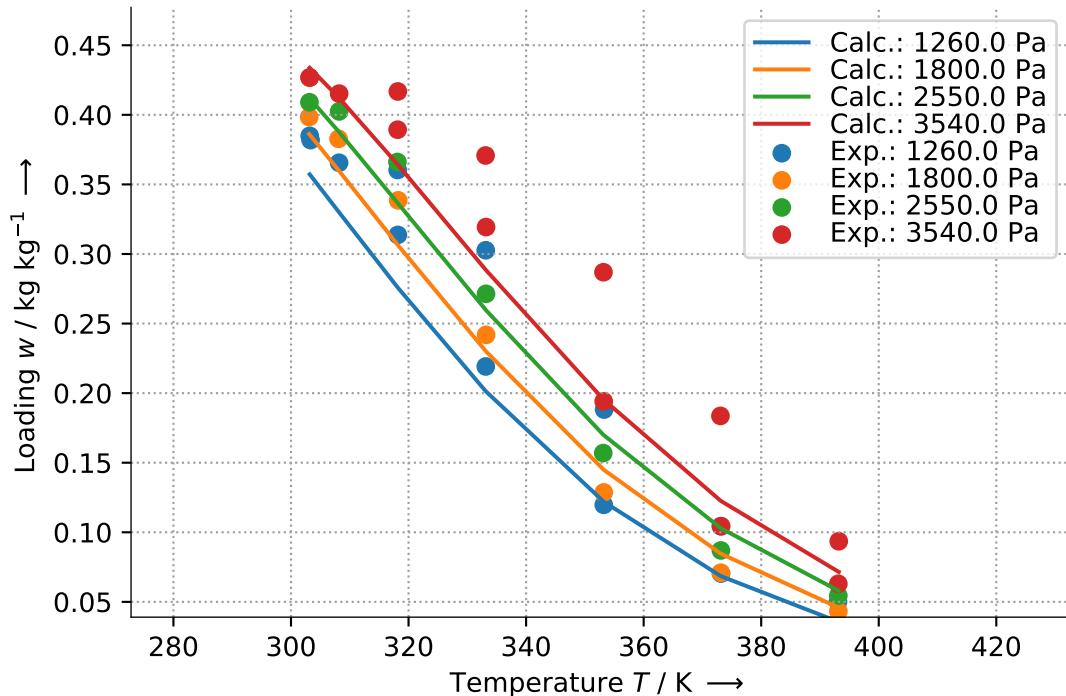
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.700000000e+00
$E$	$\text{J mol}^{-1}$	1.120000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	6.100000000e-04

#### Validity:

Equation is approximately valid for  $1260.0 \text{Pa} \leq p \leq 3540.0 \text{Pa}$ ,  $303.097 \text{K} \leq T \leq$

393.127K, and  $0.04335\text{kg kg}^{-1} \leq w \leq 0.42683\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 420

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 12.57%.

### 5.5.3 Activated carbon COC-L1200

#### 5.5.3.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	COC-L1200
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000118
Diameter of pellet	mm	0.42-1
Surface area	$\text{m}^2 \text{g}^{-1}$	1412
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.49

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

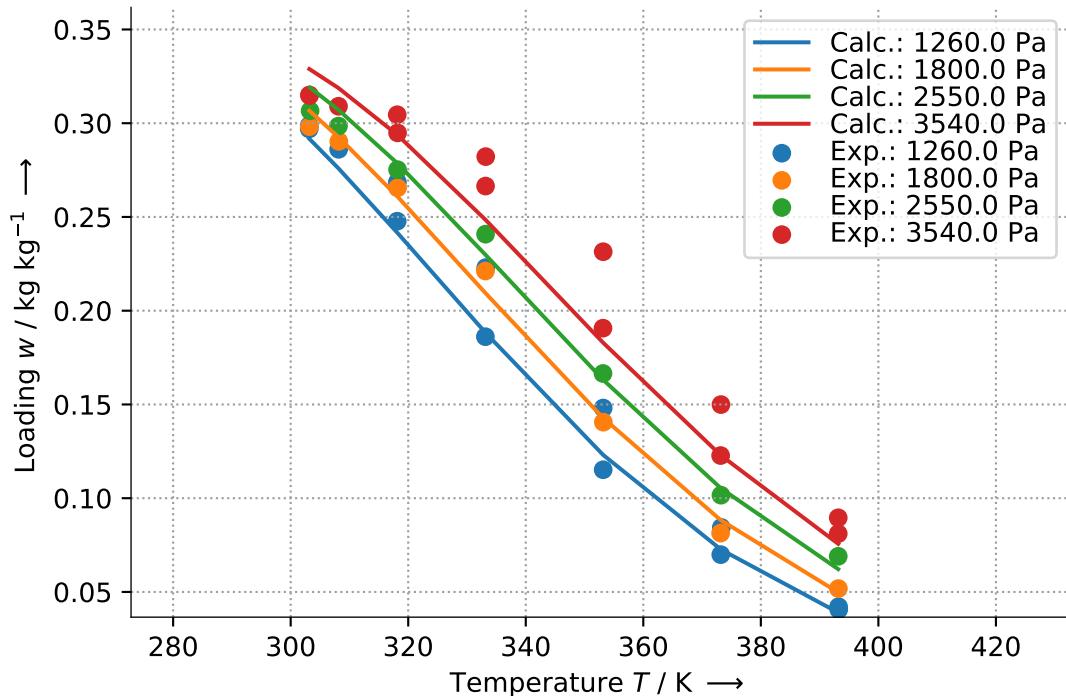
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.000000000e+00
$E$	$\text{J mol}^{-1}$	1.330000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.400000000e-04

#### Validity:

Equation is approximately valid for  $1260.0 \text{Pa} \leq p \leq 3540.0 \text{Pa}$ ,  $303.154 \text{K} \leq T \leq$

393.227K, and  $0.04213\text{kg kg}^{-1} \leq w \leq 0.31477\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 420

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.1%.

### 5.5.4 Activated carbon FR20

#### 5.5.4.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	FR20
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000118
Diameter of pellet	mm	0.01
Surface area	$\text{m}^2 \text{g}^{-1}$	2180
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.75

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

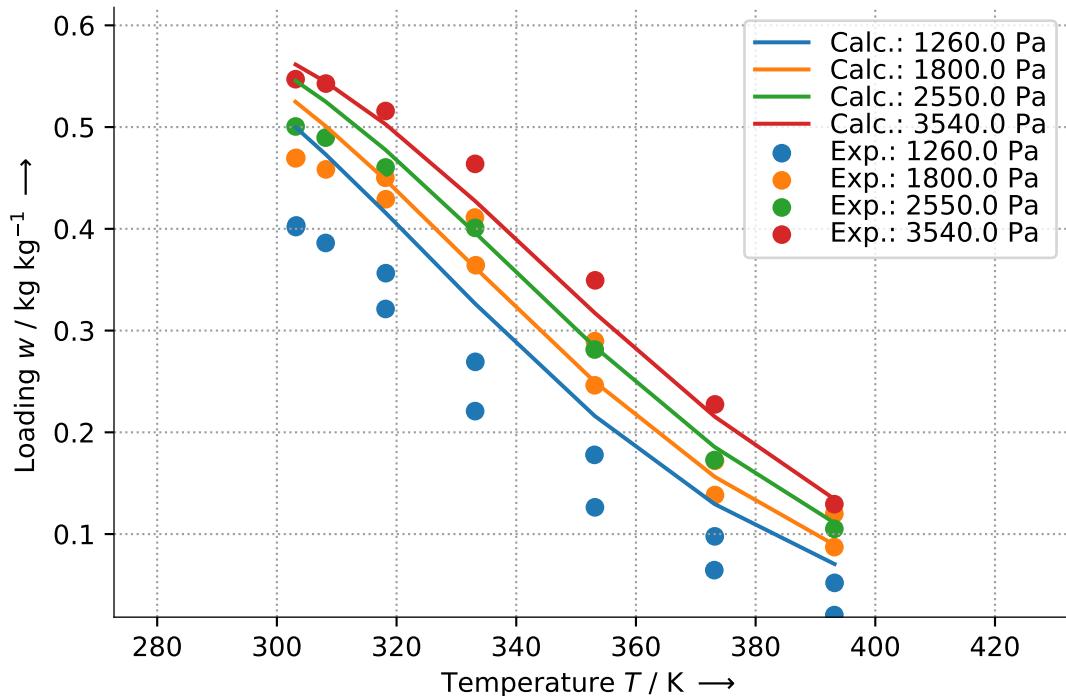
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.000000000e+00
E	$\text{J mol}^{-1}$	1.350000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	7.500000000e-04

#### Validity:

Equation is approximately valid for  $1260.0 \text{Pa} \leq p \leq 3540.0 \text{Pa}$ ,  $3303.129 \text{K} \leq T \leq$

393.156K, and  $0.02038\text{kg kg}^{-1} \leq w \leq 0.54707\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 420

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 21.91%.

### 5.5.5 Activated carbon SRD 1352/3

#### 5.5.5.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	SRD 1352/3
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000112
Diameter of pellet	mm	0.5-2
Surface area	$\text{m}^2 \text{g}^{-1}$	2613
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.65

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

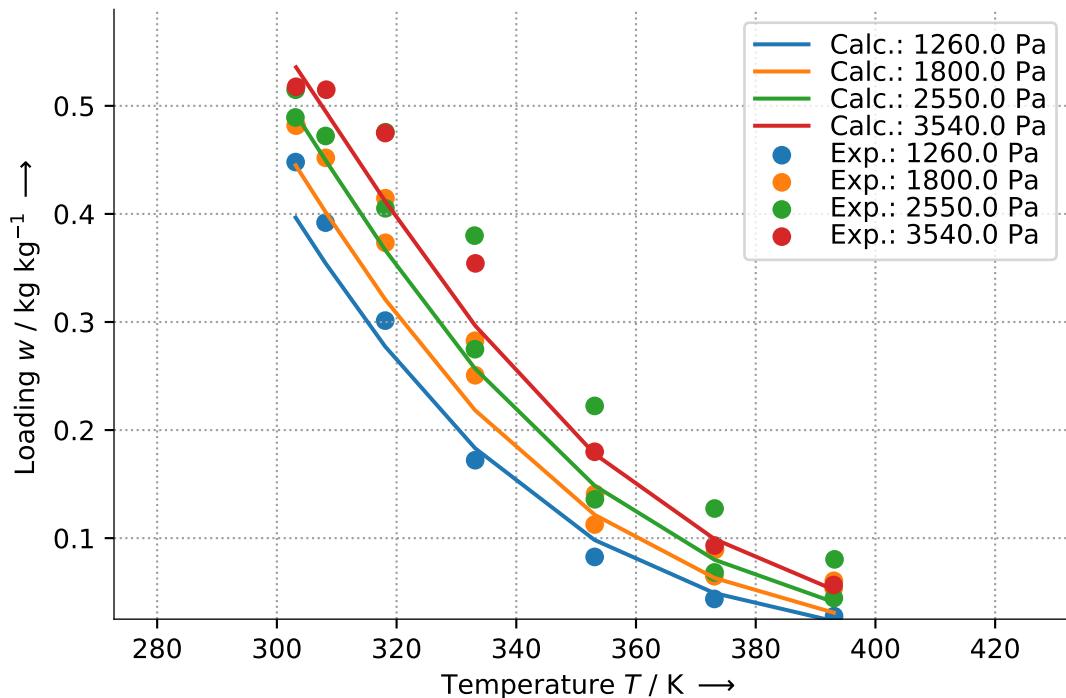
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.500000000e+00
$E$	$\text{J mol}^{-1}$	8.780000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	8.200000000e-04

#### Validity:

Equation is approximately valid for  $1260.0 \text{Pa} \leq p \leq 3540.0 \text{Pa}$ ,  $303.1 \text{K} \leq T \leq$

393.167K, and  $0.02782\text{kg kg}^{-1} \leq w \leq 0.51764\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 420

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 15.38%.

### 5.5.6 Activated carbon fiber A-20

#### 5.5.6.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; El-Sharkawy, Ibrahim I.; Chakraborty, Anutosh; Koyama, Shigeru; Yoon, Seong-Ho; Ng, Kim Choon (2006): Adsorption Rate of Ethanol on Activated Carbon Fiber. In: J. Chem. Eng. Data 51 (5), S. 1587–1592. DOI: 10.1021/je060071z.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	2.16E-08
Surface area	$\text{m}^2 \text{g}^{-1}$	1930
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.028

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

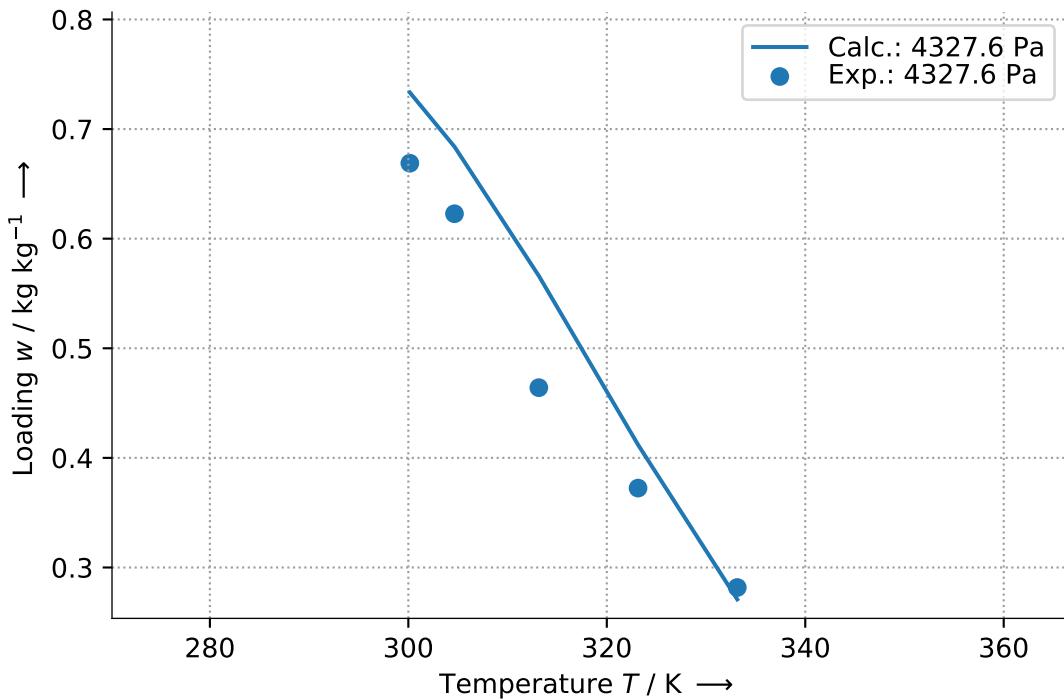
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.000000000e+00
E	$\text{J mol}^{-1}$	6.347102960e+03	$W_0$	$\text{kg kg}^{-1}$	7.970000000e-01

#### Validity:

Equation is approximately valid for  $7885.869802 \text{Pa} \leq p \leq 7885.869802 \text{Pa}$ ,  $300.15 \text{K} \leq$



$T \leq 333.15\text{K}$ , and  $0.281740845\text{kg kg}^{-1} \leq w \leq 0.668876056\text{kg kg}^{-1}$ .

### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Loading, absolute, in  $\text{kg kg}^{-1}$  → 0.0000001

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 11.18%.

### 5.5.7 Activated carbon powder H2-treated Maxsorb III

#### 5.5.7.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	H2-treated Maxsorb III
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Uddin, Kutub; El-Sharkawy, Ibrahim I.; Miyazaki, Takahiko; Saha, Bidyut Baran; Koyama, Shigeru; Kil, Hyun-Sig et al. (2014): Adsorption characteristics of ethanol onto functional activated carbons with controlled oxygen content. In: Applied Thermal Engineering 72 (2), S. 211–218. DOI: 10.1016/j.applthermaleng.2014.03.062.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	3029
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.73

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

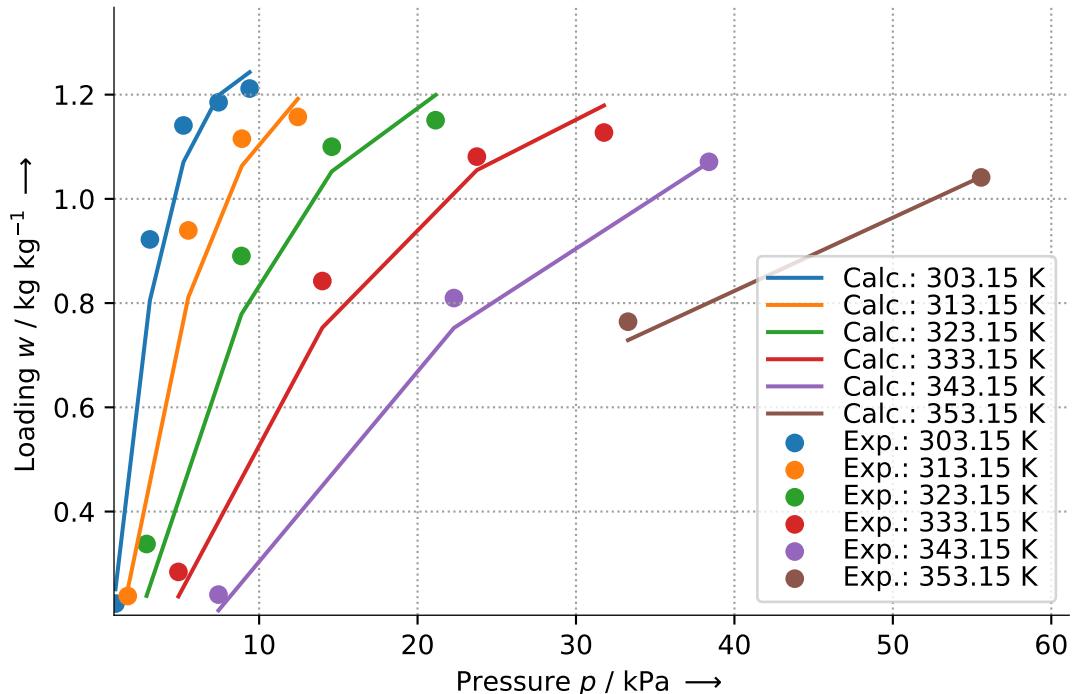
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.900000000e+00
E	$\text{J mol}^{-1}$	4.780000000e+03	$W_0$	$\text{kg kg}^{-1}$	1.250000000e+00

#### Validity:

Equation is approximately valid for  $932.7\text{Pa} \leq p \leq 55573.2\text{Pa}$ ,  $303.15\text{K} \leq T \leq$

353.15K, and  $0.22339\text{kg kg}^{-1} \leq w \leq 1.2117\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.76%.

### 5.5.8 Activated carbon powder KOH-H<sub>2</sub>-treated Maxsorb III

#### 5.5.8.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	KOH-H <sub>2</sub> -treated Maxsorb III
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Uddin, Kutub; El-Sharkawy, Ibrahim I.; Miyazaki, Takahiko; Saha, Bidyut Baran; Koyama, Shigeru; Kil, Hyun-Sig et al. (2014): Adsorption characteristics of ethanol onto functional activated carbons with controlled oxygen content. In: Applied Thermal Engineering 72 (2), S. 211–218. DOI: 10.1016/j.applthermaleng.2014.03.062.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	2992
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	1.65

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

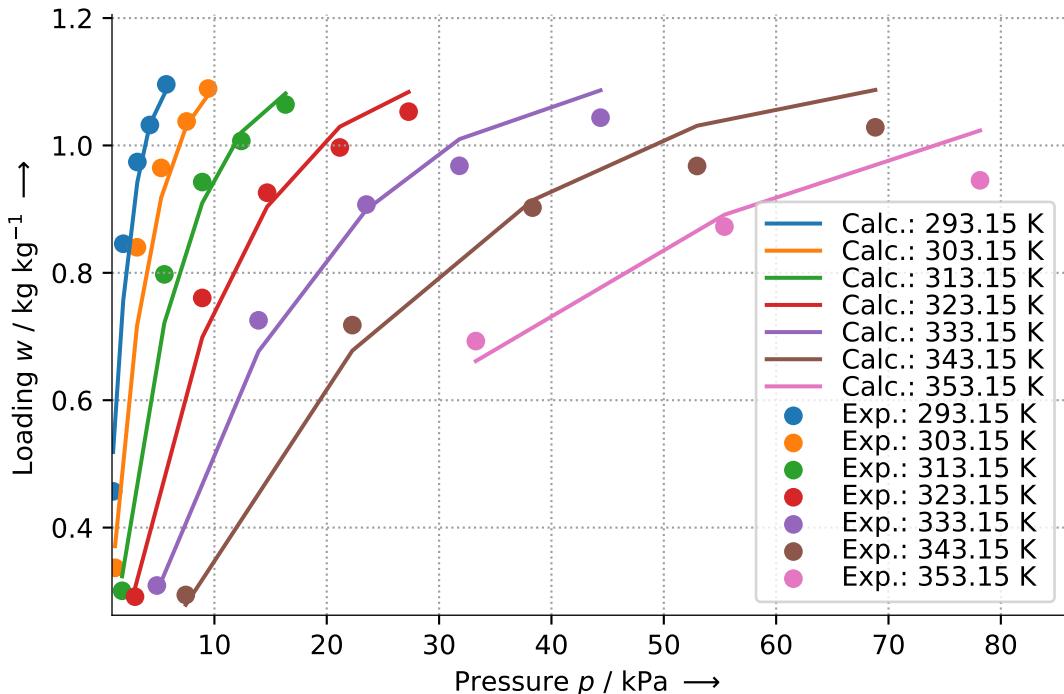
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.600000000e+00
E	J mol <sup>-1</sup>	5.331000000e+03	W <sub>0</sub>	kg kg <sup>-1</sup>	1.090000000e+00

#### Validity:

Equation is approximately valid for 984.1Pa ≤  $p$  ≤ 78150.2Pa, 293.15K ≤  $T$  ≤

353.15K, and  $0.29155\text{kg kg}^{-1} \leq w \leq 1.09586\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.93%.

### 5.5.9 Activated carbon powder Maxsorb III

#### 5.5.9.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Uddin, Kutub; El-Sharkawy, Ibrahim I.; Miyazaki, Takahiko; Saha, Bidyut Baran; Koyama, Shigeru; Kil, Hyun-Sig et al. (2014): Adsorption characteristics of ethanol onto functional activated carbons with controlled oxygen content. In: Applied Thermal Engineering 72 (2), S. 211–218. DOI: 10.1016/j.applthermaleng.2014.03.062.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	3045
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

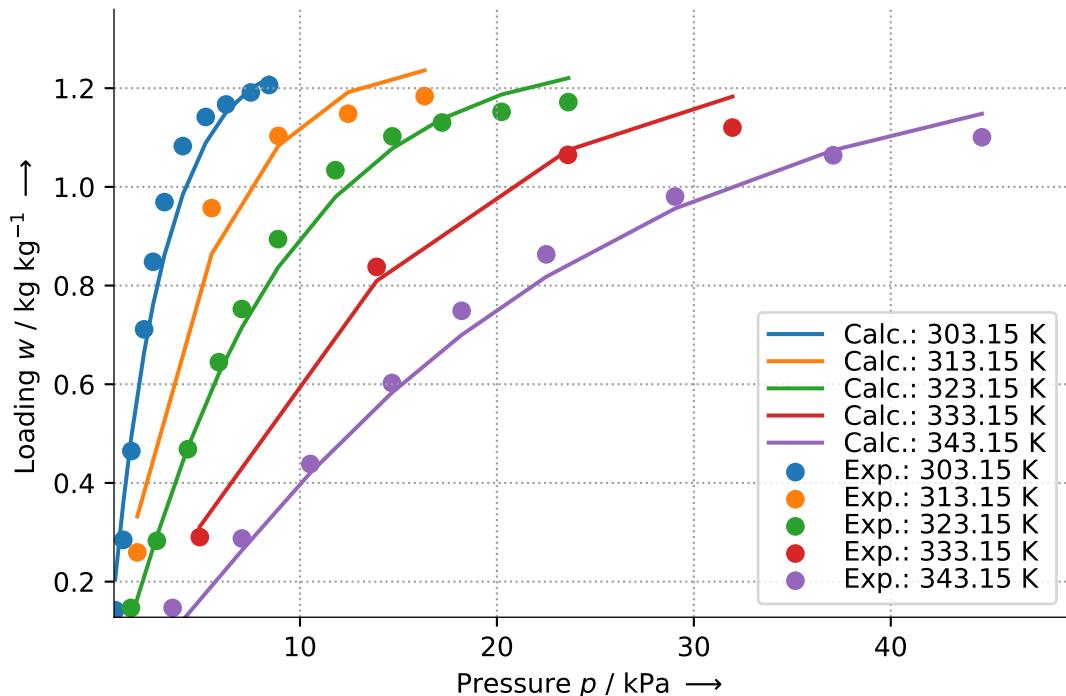
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.900000000e+00
E	$\text{J mol}^{-1}$	5.265000000e+03	$W_0$	$\text{kg kg}^{-1}$	1.240000000e+00

#### Validity:

Equation is approximately valid for  $617.2\text{Pa} \leq p \leq 44631.4\text{Pa}$ ,  $303.15\text{K} \leq T \leq$

343.15K, and  $0.14203\text{kg kg}^{-1} \leq w \leq 1.202639\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.63%.

### 5.5.9.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	El-Sharkawy, I. I.; Saha, B. B.; Koyama, S.; He, J.; Ng, K. C.; Yap, C. (2008): Experimental investigation on activated carbon–ethanol pair for solar powered adsorption cooling applications. In: International Journal of Refrigeration 31 (8), S. 1407–1413. DOI: 10.1016/j.ijrefrig.2008.03.012.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\mathcal{A}/E)^n) \quad , \text{ and}$$

$$\mathcal{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

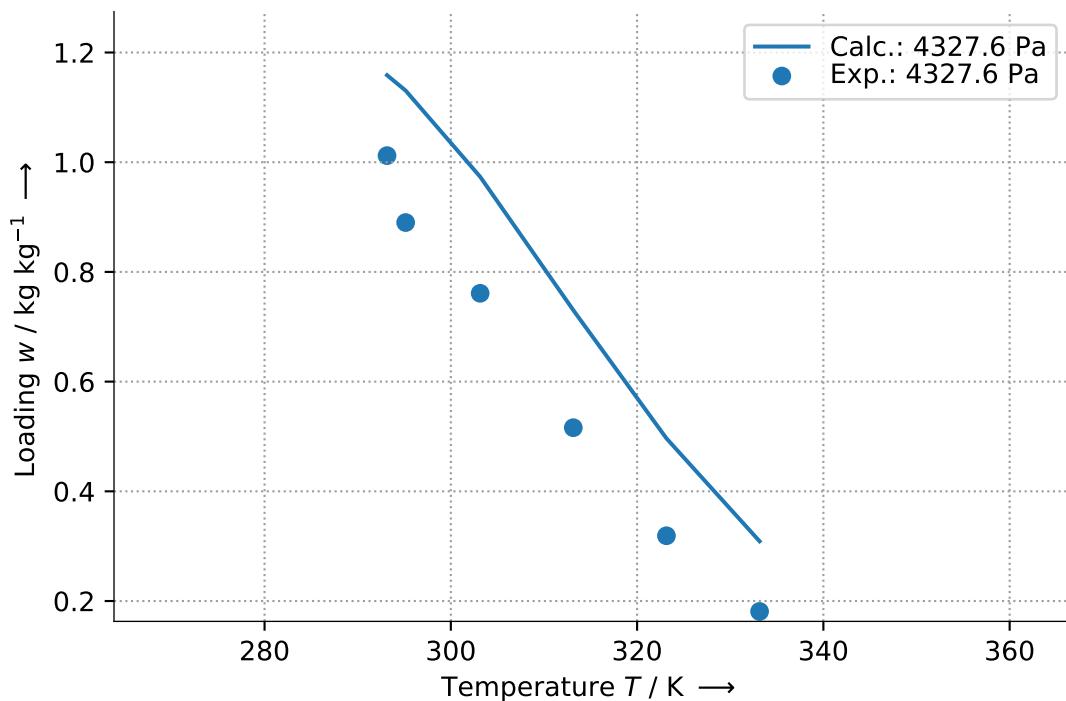
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$n$	-	1.750000000e+00
$E$	$\text{J mol}^{-1}$	5.538000000e+03	$W_0$	$\text{kg kg}^{-1}$	1.200000000e+00

#### Validity:

Equation is approximately valid for  $7885.869802\text{Pa} \leq p \leq 7885.869802\text{Pa}$ ,  $293.15\text{K} \leq T \leq 333.15\text{K}$ , and  $0.181\text{kg kg}^{-1} \leq w \leq 1.0012\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Loading, absolute, in  $\text{kg kg}^{-1}$  → 0.000001

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 39.55%.

### 5.5.10 Mof MIL-101Cr

#### 5.5.10.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	mof
<b>Subtype:</b>	MIL-101Cr
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rezk, Ahmed; AL-Dadah, Raya; Mahmoud, Saad; El-sayed, Ahmed (2013): Investigation of Ethanol/metal organic frameworks for low temperature adsorption cooling applications. In: Applied Energy 112, S. 1025–1031. DOI: 10.1016/j.apenergy.2013.06.041.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.603300000e+00
E	$\text{J mol}^{-1}$	6.527400000e+03	$W_0$	$\text{kg kg}^{-1}$	1.100500000e+00

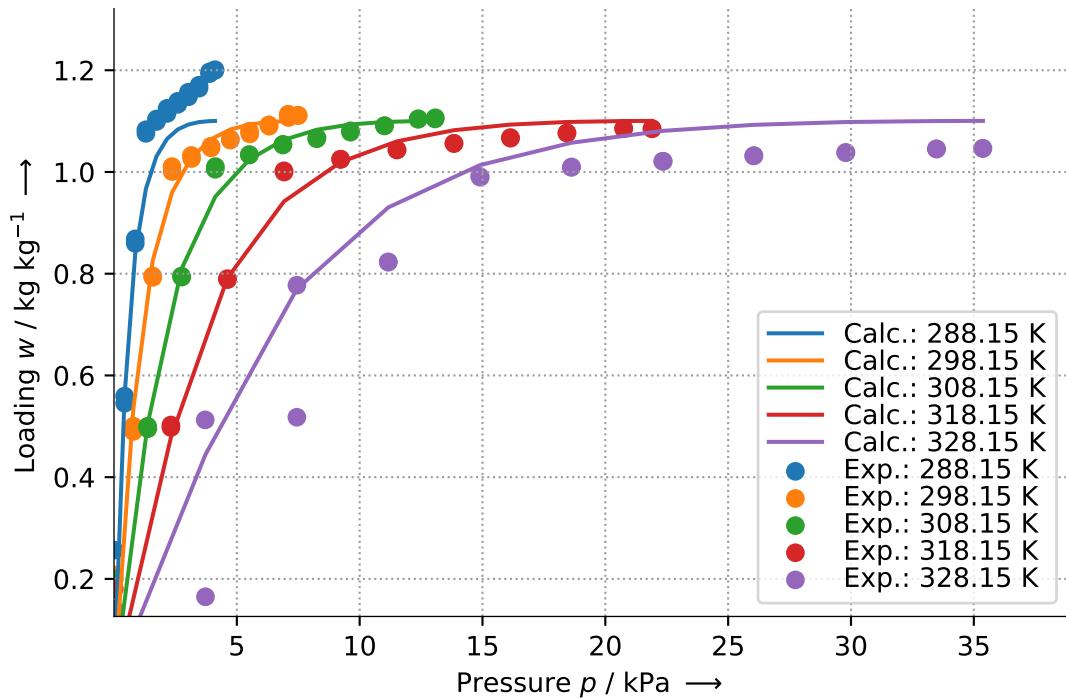
#### Validity:

Equation is approximately valid for  $288.15\text{K} \leq T \leq 328.15\text{K}$ , and  $0.14018\text{kg kg}^{-1} \leq w \leq 1.20106\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.17%.

### 5.5.11 Phenol resin composite KOH4-PR

#### 5.5.11.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	phenol resin composite
<b>Subtype:</b>	KOH4-PR
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	El-Sharkawy, Ibrahim I.; Uddin, Kutub; Miyazaki, Takahiko; Baran Saha, Bidyut; Koyama, Shigeru; Kil, Hyun-Sig et al. (2015): Adsorption of ethanol onto phenol resin based adsorbents for developing next generation cooling systems. In: International Journal of Heat and Mass Transfer 81, S. 171–178. DOI: 10.1016/j.ijheatmasstransfer.2014.10.012.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000125
Surface area	$\text{m}^2 \text{g}^{-1}$	3060
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.9

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\text{A}/\text{E})^n), \text{ and}$$

$$\text{A} = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

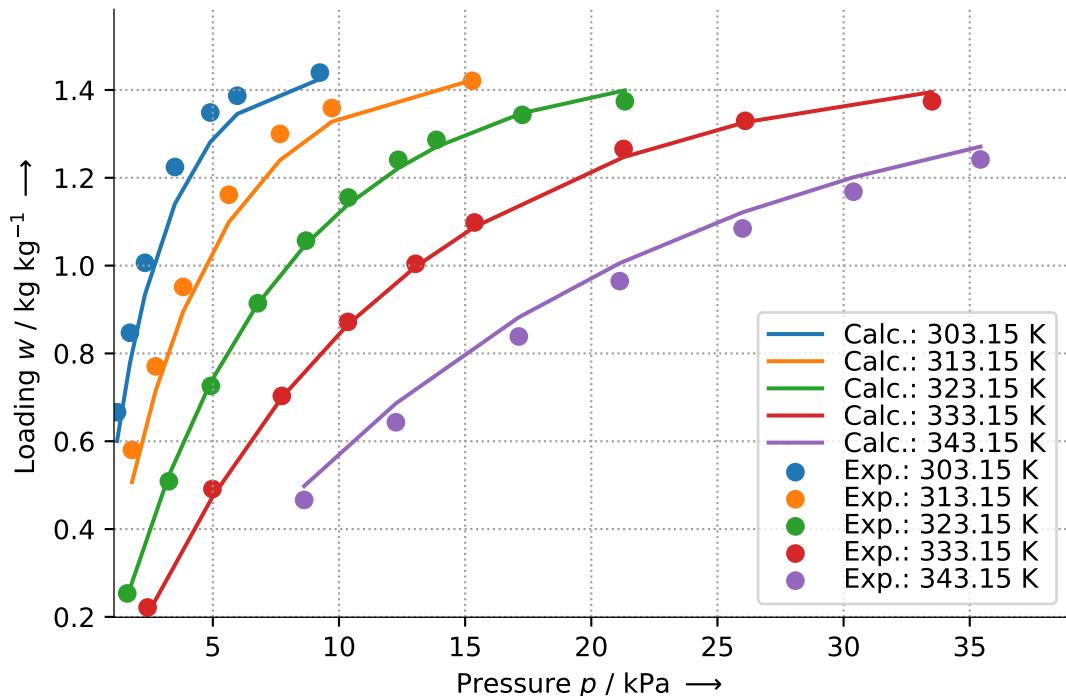
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.000000000e+00
E	$\text{J mol}^{-1}$	5.896960000e+03	$W_0$	$\text{kg kg}^{-1}$	1.430000000e+00

#### Validity:

Equation is approximately valid for  $1202.5 \text{Pa} \leq p \leq 35425.5 \text{Pa}$ ,  $303.15 \text{K} \leq T \leq$

343.15K, and  $0.22135\text{kg kg}^{-1} \leq w \leq 1.43957\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.52%.

### 5.5.12 Phenol resin composite KOH6-PR

#### 5.5.12.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	phenol resin composite
<b>Subtype:</b>	KOH6-PR
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	El-Sharkawy, Ibrahim I.; Uddin, Kutub; Miyazaki, Takahiko; Baran Saha, Bidyut; Koyama, Shigeru; Kil, Hyun-Sig et al. (2015): Adsorption of ethanol onto phenol resin based adsorbents for developing next generation cooling systems. In: International Journal of Heat and Mass Transfer 81, S. 171–178. DOI: 10.1016/j.ijheatmasstransfer.2014.10.012.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000178
Surface area	$\text{m}^2 \text{g}^{-1}$	2910
Pore volume	$\text{mm}^3 \text{g}^{-1}$	2.53

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\text{A}/\text{E})^n), \text{ and}$$

$$\text{A} = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

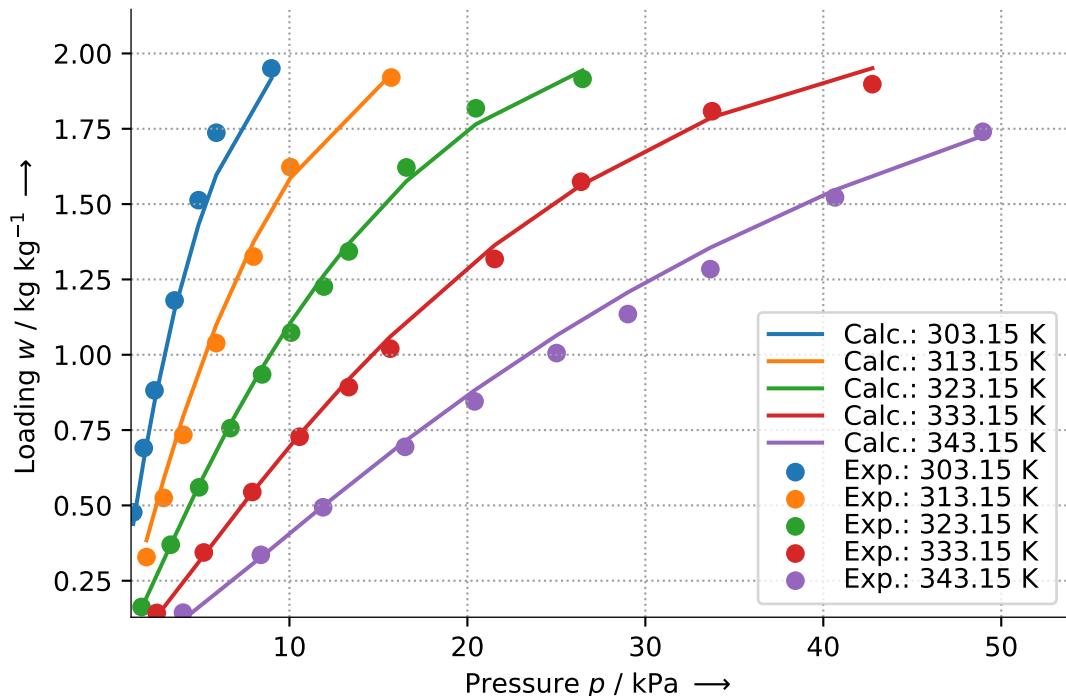
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.500000000e+00
E	$\text{J mol}^{-1}$	4.146300000e+03	$W_0$	$\text{kg kg}^{-1}$	1.980000000e+00

#### Validity:

Equation is approximately valid for  $1221.5 \text{Pa} \leq p \leq 48959.6 \text{Pa}$ ,  $303.15 \text{K} \leq T \leq$

343.15K, and  $0.14319\text{kg kg}^{-1} \leq w \leq 1.95043\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.1%.

### 5.5.13 Silica gel composite 19 wt.% LiBr

#### 5.5.13.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	silica gel composite
<b>Subtype:</b>	19 wt.% LiBr
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000344
Diameter of pellet	mm	0.7-0.85
Surface area	$\text{m}^2 \text{g}^{-1}$	181
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.73
Porosity of pellet	-	0.73

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

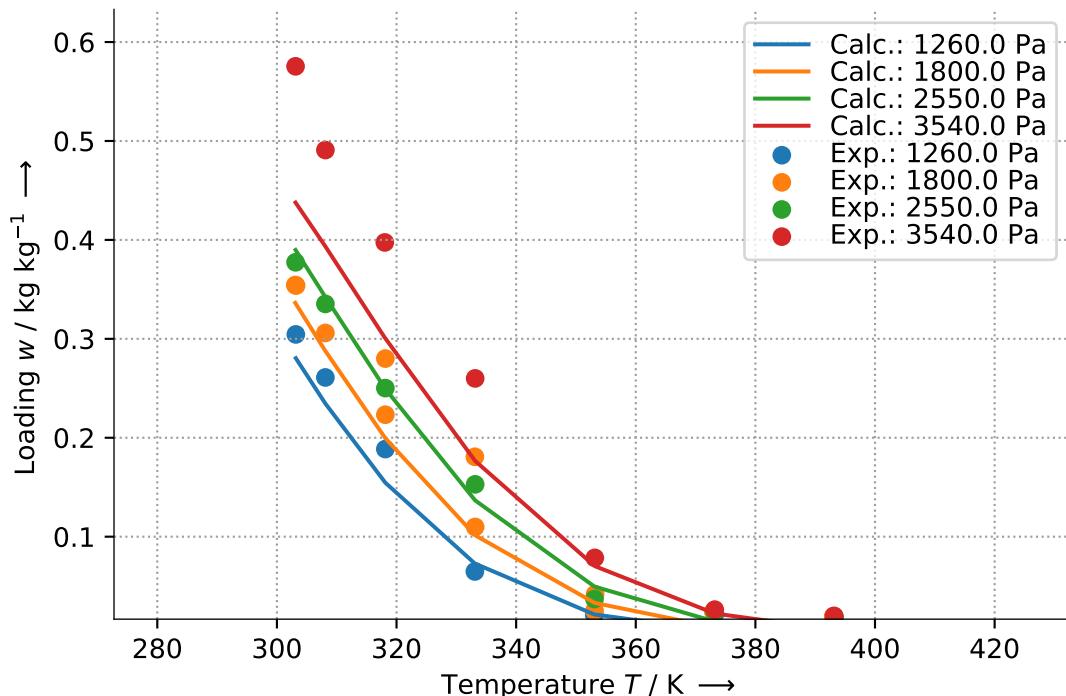
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.800000000e+00
E	$\text{J mol}^{-1}$	6.900000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	6.800000000e-04

#### Validity:

Equation is approximately valid for  $1260.0 \text{Pa} \leq p \leq 2540.0 \text{Pa}$ ,  $303.116 \text{K} \leq T \leq$

393.225K, and  $0.01848\text{kg kg}^{-1} \leq w \leq 0.57547\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 420

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 31.19%.

## 5.6 Isobutane

### 5.6.1 Mof powder cubtc

#### 5.6.1.1 DualSiteSips - ID 1

<b>Sorbent:</b>	mof powder
<b>Subtype:</b>	cubtc
<b>Refrigerant:</b>	Isobutane
<b>Equation:</b>	DualSiteSips
<b>ID:</b>	1
<b>Reference:</b>	Lamia, Nabil; Jorge, Miguel; Granato, Miguel A.; Almeida Paz, Filipe A.; Chevreau, Hubert; Rodrigues, Alírio E. (2009): Adsorption of propane, propylene and isobutane on a metal–organic framework. Molecular simulation and experiment. In: Chemical Engineering Science 64 (14), S. 3246–3259. DOI: 10.1016/j.ces.2009.04.010.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.0016
Surface area	$\text{m}^2 \text{g}^{-1}$	1500-2100
Bulk density	$\text{kg m}^{-3}$	350

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \sum_{i=A}^B w_i \frac{(b_i p)^{1/\eta_i}}{1 + (b_i p)^{1/\eta_i}} \quad , \text{ and}$$

$$b_i = b_{i,0} \exp \left( \frac{Q_i}{RT} \left( 1 - \frac{T}{T_0} \right) \right) \quad .$$

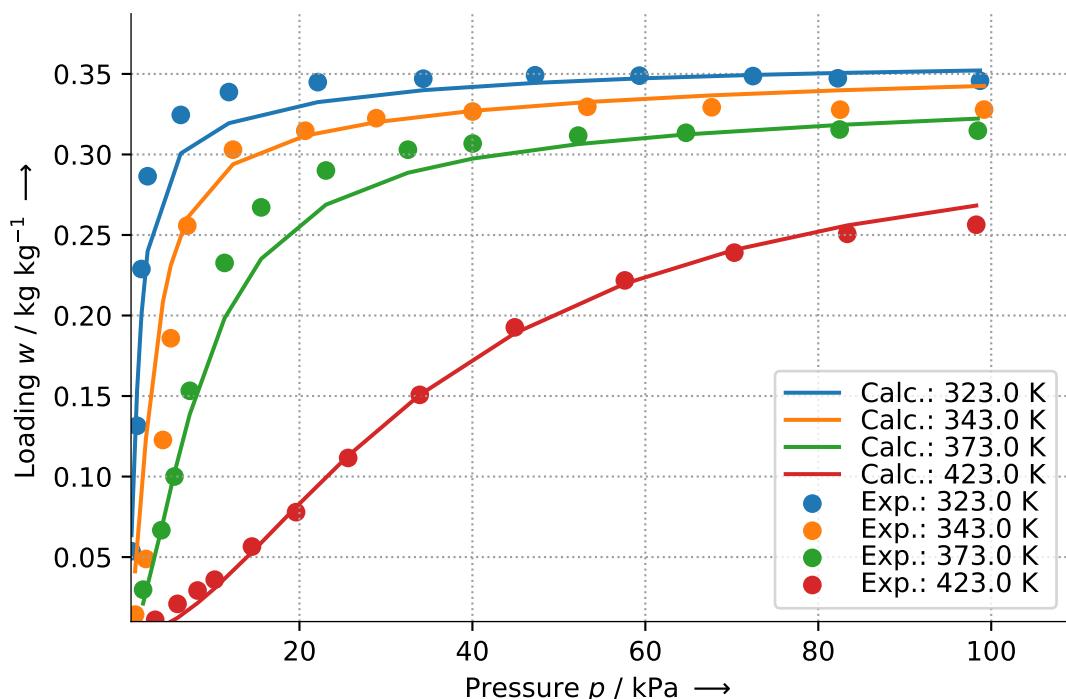
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_{A,0}$	$\text{Pa}^{-1}$	8.200000000e-04	$b_{B,0}$	$\text{Pa}^{-1}$	6.000000000e-05
$Q_A$	$\text{J mol}^{-1}$	3.790000000e+04	$Q_B$	$\text{J mol}^{-1}$	4.080000000e+04

Par.	Unit	Value	Par.	Unit	Value
$\eta_A$	-	5.500000000e-01	$\eta_B$	-	1.000000000e+00
$w_A$	kg kg <sup>-1</sup>	2.975744000e-01	$w_B$	kg kg <sup>-1</sup>	6.393200000e-02
$T_0$	K	3.230000000e+02			

**Validity:**

Equation is approximately valid for  $581.5\text{Pa} \leq p \leq 99177.0\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.011061398\text{kg kg}^{-1} \leq w \leq 0.349172174\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 50
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 15.25%.

## 5.6.2 Zeolite pellet 13X

### 5.6.2.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	Isobutane
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Lamia, Nabil; Wolff, Luc; Leflaive, Philibert; Sá Gomes, Pedro; Grande, Carlos A.; Rodrigues, Alírio E. (2007): Propane/Propylene Separation by Simulated Moving Bed I. Adsorption of Propane, Propylene and Isobutane in Pellets of 13X Zeolite. In: Separation Science and Technology 42 (12), S. 2539–2566. DOI: 10.1080/01496390701515219.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.001
Diameter of pore	mm	0.0000005
Diameter of extrudate	mm	0.8
Porosity of pellet	-	0.395
Pellet density	kg m <sup>-3</sup>	1357

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

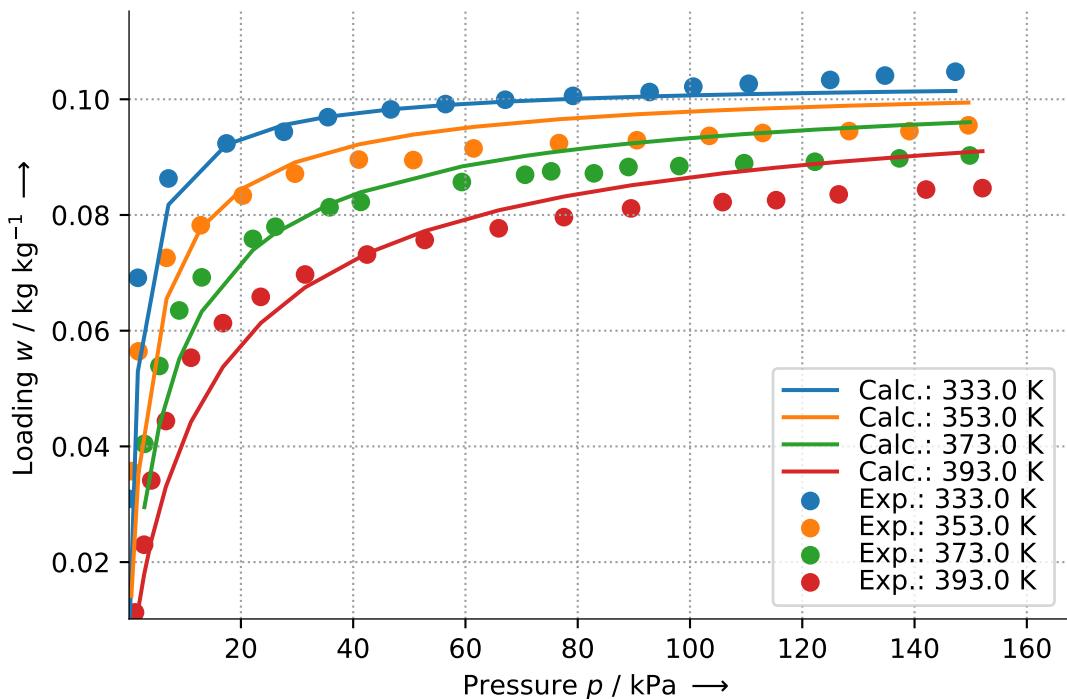
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	2.500000000e-10	$Q^*$	K	5.003329970e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.034536000e-01
$n_0$	-	8.480000000e-01			

**Validity:**

Equation is approximately valid for  $171.9\text{Pa} \leq p \leq 152632.0\text{Pa}$ ,  $333.0\text{K} \leq T \leq 393.0\text{K}$ , and  $0.005888137\text{kg kg}^{-1} \leq w \leq 0.104210322\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 50
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.81%.

## 5.7 Methane

### 5.7.1 Activated carbon AX21

#### 5.7.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	AX21
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^2$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	3106
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	1.29

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n) , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.260000000e+00
$E$	J mol <sup>-1</sup>	5.464100000e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	1.080000000e-03

**Validity:**

Equation is approximately valid for 233.0K  $\leq T \leq$  333.0K.

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.7.2 Activated carbon BPL

#### 5.7.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	BPL
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^{\frac{2}{3}}$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

**Properties of sorbent:**

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	1150
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	0.43

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.540000000e+00
E	J mol <sup>-1</sup>	7.040000000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	3.600000000e-04

Par.	Unit	Value		Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $273.0\text{K} \leq T \leq 333.0\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.7.3 Activated carbon Calgon AC

#### 5.7.3.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Calgon AC
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^{\frac{2}{3}}$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

**Properties of sorbent:**

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	1250
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	0.72

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.410000000e+00
E	J mol <sup>-1</sup>	8.955100000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	3.090000000e-04

Par.	Unit	Value		Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $293.0\text{K} \leq T \leq 313.0\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 5.7.4 Activated carbon F30/470

### 5.7.4.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	F30/470
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^{\frac{2}{3}}$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	994
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	0.39

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.810000000e+00
E	J mol <sup>-1</sup>	7.742900000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	3.890000000e-04

Par.	Unit	Value		Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $303.0\text{K} \leq T \leq 343.0\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.7.5 Activated carbon Norit R 1 Extra

#### 5.7.5.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit R 1 Extra
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^{\frac{2}{3}}$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	1450
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	0.47

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.730000000e+00
E	J mol <sup>-1</sup>	7.500000000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	4.300000000e-04

Par.	Unit	Value		Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $273.0\text{K} \leq T \leq 323.0\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.7.6 Activated carbon Norit RB 1

#### 5.7.6.1 Langmuir - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit RB 1
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	Langmuir
<b>ID:</b>	1
<b>Reference:</b>	van der Vaart, Rick; HUISKES, CINDY; Bosch, Hans; Reith, Tom (2000): Single and Mixed Gas Adsorption Equilibria of Carbon Dioxide/Methane on Activated Carbon. In: Adsorption 6 (4), S. 311–323. DOI: 10.1023/A:1026560915422.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} K p}{1 + K p} \quad , \text{ and}$$

$$K = K_0 \exp\left(\frac{\Delta H}{R T}\right) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta H$	$\text{J mol}^{-1}$	1.950000000e+04	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	7.716442500e-02
$K_0$	$\text{Pa}^{-1}$	1.170000000e-09			

#### Validity:

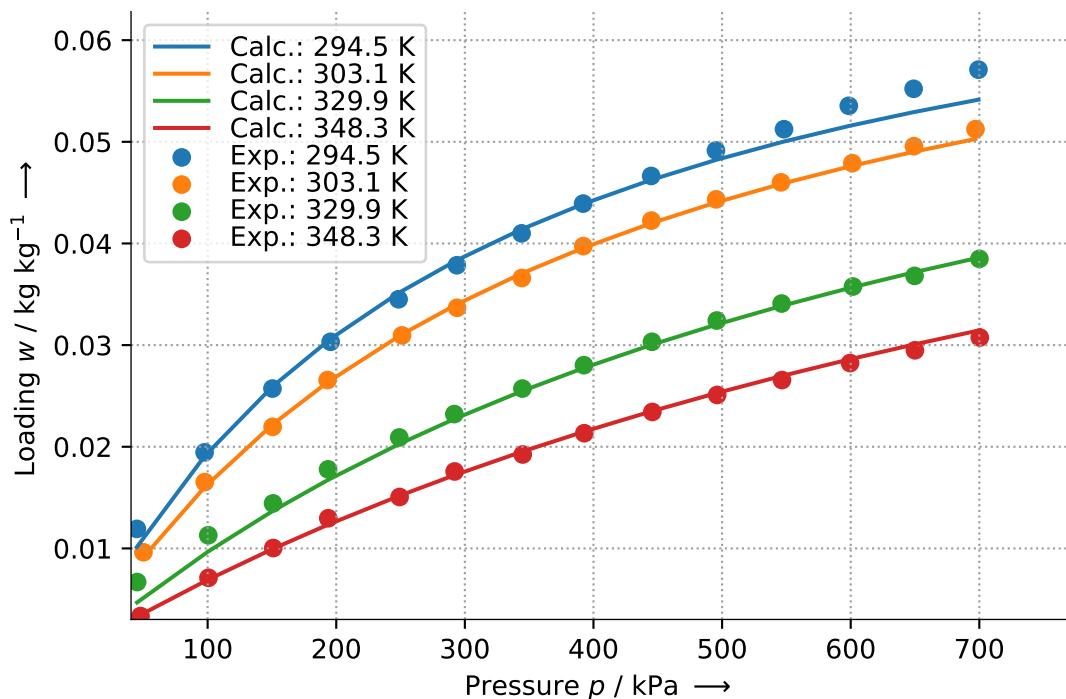
Equation is approximately valid for  $44955.8\text{Pa} \leq p \leq 700365.0\text{Pa}$ ,  $294.5\text{K} \leq T \leq 348.3\text{K}$ , and  $0.00334641\text{kg kg}^{-1} \leq w \leq 0.057098\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:



- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.68%.

### 5.7.7 Activated carbon fiber A-20

#### 5.7.7.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^{\frac{2}{3}}$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

**Properties of sorbent:**

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	2206
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	1.01

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.510000000e+00
E	J mol <sup>-1</sup>	6.198400000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	7.170000000e-04

Par.	Unit	Value		Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $278.0\text{K} \leq T \leq 348.0\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.7.8 Activated carbon powder Maxsorb III

#### 5.7.8.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^{\frac{1}{2}}$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.072
Surface area	$\text{m}^2 \text{g}^{-1}$	3276
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.79
Solid density	$\text{kg m}^{-3}$	2246

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) , \text{ and}$$

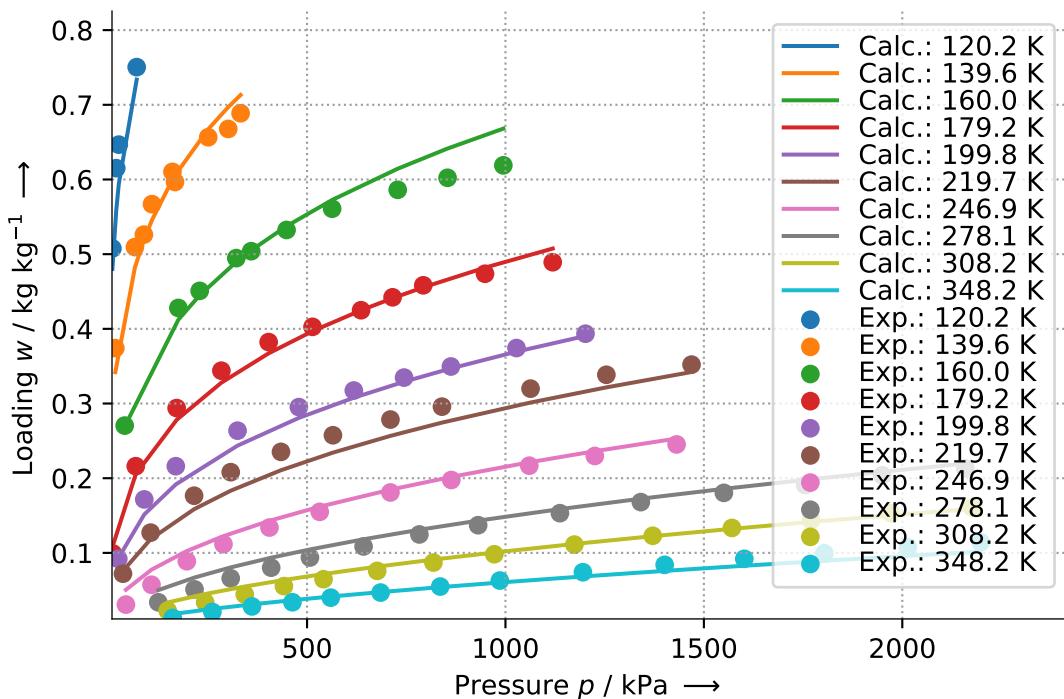
$$A = RT \ln(p_{\text{sat}}/p) .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.050000000e+00
$E$	J mol <sup>-1</sup>	4.757300000e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	2.193000000e-03

**Validity:**

Equation is approximately valid for  $9470.0\text{Pa} \leq p \leq 2197470.0\text{Pa}$ ,  $120.2\text{K} \leq T \leq 348.2\text{K}$ , and  $0.01285\text{kg kg}^{-1} \leq w \leq 0.75044\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.99%.

### 5.7.9 Activated charcoal pellet Chemviron

#### 5.7.9.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal pellet
<b>Subtype:</b>	Chemviron
<b>Refrigerant:</b>	Methane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Rahman, Kazi Afzalur; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2012): On thermodynamics of methane+carbonaceous materials adsorption. In: International Journal of Heat and Mass Transfer 55 (4), S. 565–573. DOI: 10.1016/j.ijheatmasstransfer.2011.10.056.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt (i.e., $1/\rho_{\text{adsorpt}} = 2.3677e-3 * \exp(0.0043 * (T - 111.67))$ in kg/m <sup>3</sup> ) and vapor pressure (i.e., $p_{\text{sat}} = p_{\text{crit}} * (T / T_{\text{crit}})^{\frac{2}{3}}$ in Pa if $T > T_{\text{crit}}$ ) are required; inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	945
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	0.51

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.860000000e+00
E	J mol <sup>-1</sup>	8.684100000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	4.070000000e-04

Par.	Unit	Value		Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $278.0\text{K} \leq T \leq 348.0\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 5.8 Methanol

### 5.8.1 Activated carbon 207C

#### 5.8.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	207C
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Zhao, Yongling; Hu, Eric; Blazewicz, Antoni (2012): A comparison of three adsorption equations and sensitivity study of parameter uncertainty effects on adsorption refrigeration thermal performance estimation. In: Heat Mass Transfer 48 (2), S. 217–226. DOI: 10.1007/s00231-011-0875-8.
<b>Comment:</b>	None

**Properties of sorbent:**

Property data of sorbent and subtype does not exist.

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

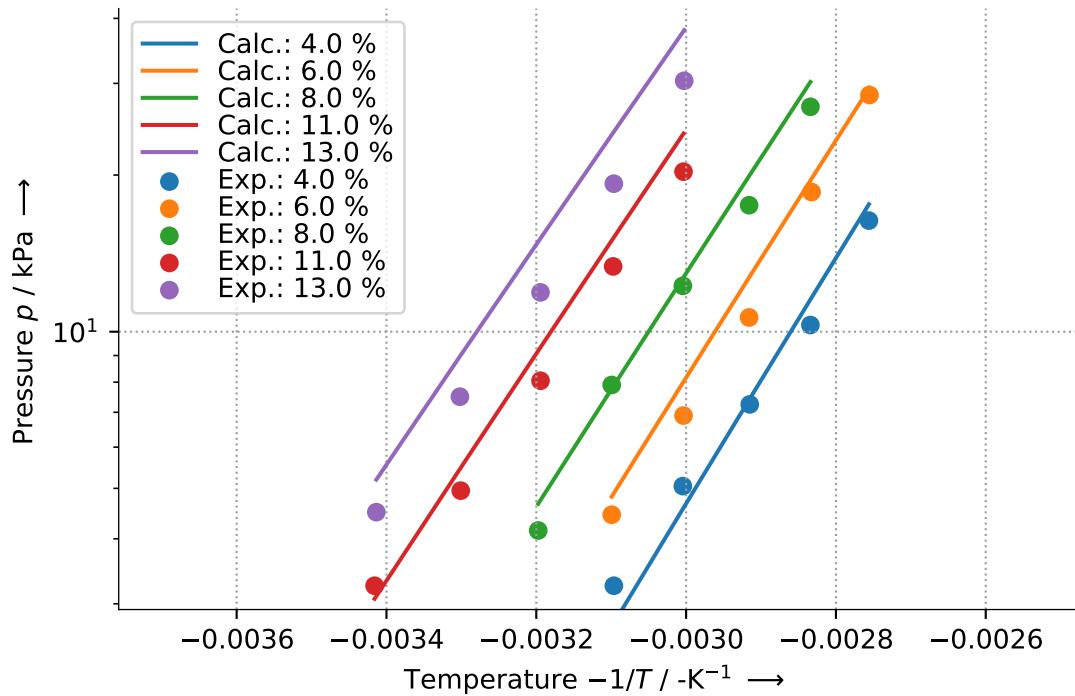
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.720000000e+00
E	$\text{J mol}^{-1}$	6.843588840e+03	$W_0$	$\text{kg kg}^{-1}$	1.500000000e-01

**Validity:**

Equation is approximately valid for  $3250.0\text{Pa} \leq p \leq 30350.0\text{Pa}$ ,  $292.75\text{K} \leq T \leq 362.95\text{K}$ , and  $0.04\text{kg kg}^{-1} \leq w \leq 0.13\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 12.79%.

## 5.8.2 Activated carbon 207EA

### 5.8.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	207EA
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Zhao, Yongling; Hu, Eric; Blazewicz, Antoni (2012): A comparison of three adsorption equations and sensitivity study of parameter uncertainty effects on adsorption refrigeration thermal performance estimation. In: Heat Mass Transfer 48 (2), S. 217–226. DOI: 10.1007/s00231-011-0875-8.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.080000000e+00
E	$\text{J mol}^{-1}$	6.900405946e+03	$W_0$	$\text{kg kg}^{-1}$	2.800000000e-01

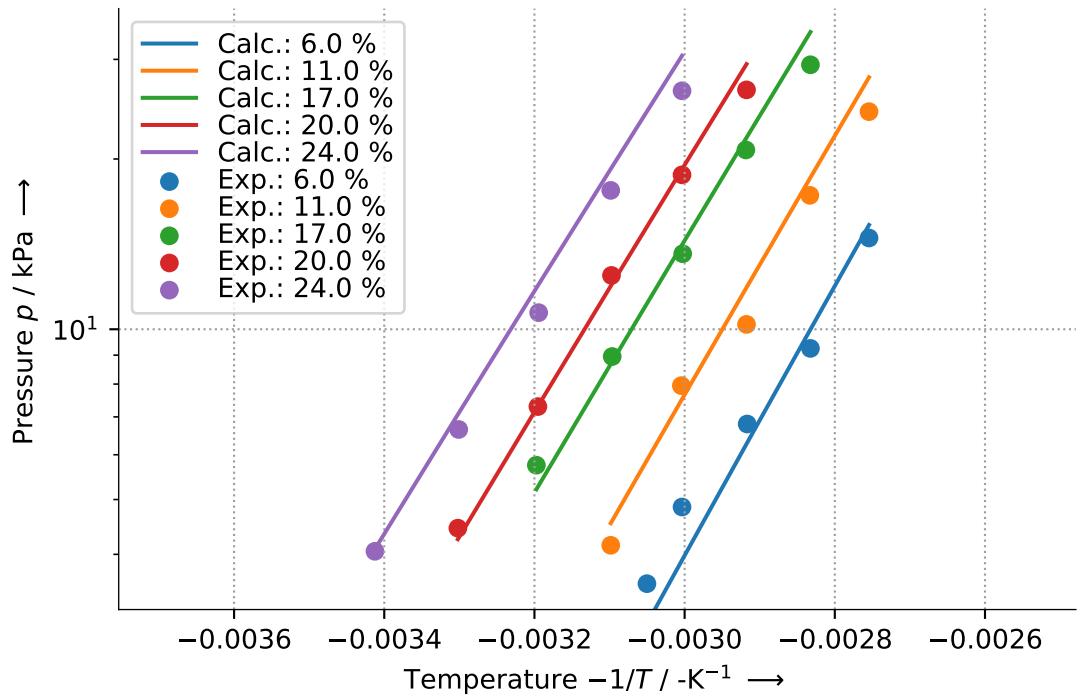
#### Validity:

Equation is approximately valid for  $3550.0\text{Pa} \leq p \leq 29350.0\text{Pa}$ ,  $293.05\text{K} \leq T \leq 363.05\text{K}$ , and  $3550.0\text{kg kg}^{-1} \leq w \leq 29350.0\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.38%.

### 5.8.2.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	207EA
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Wu, Jun W.; Madani, S. Hadi; Biggs, Mark J.; Phillip, Pendleton; Lei, Chen; Hu, Eric J. (2015): Characterizations of Activated Carbon–Methanol Adsorption Pair Including the Heat of Adsorptions. In: J. Chem. Eng. Data 60 (6), S. 1727–1731. DOI: 10.1021/je501113y.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of extrudate	mm	0.004
Length of extrudate	mm	0.01
Surface area	$\text{m}^2 \text{g}^{-1}$	951
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.663

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

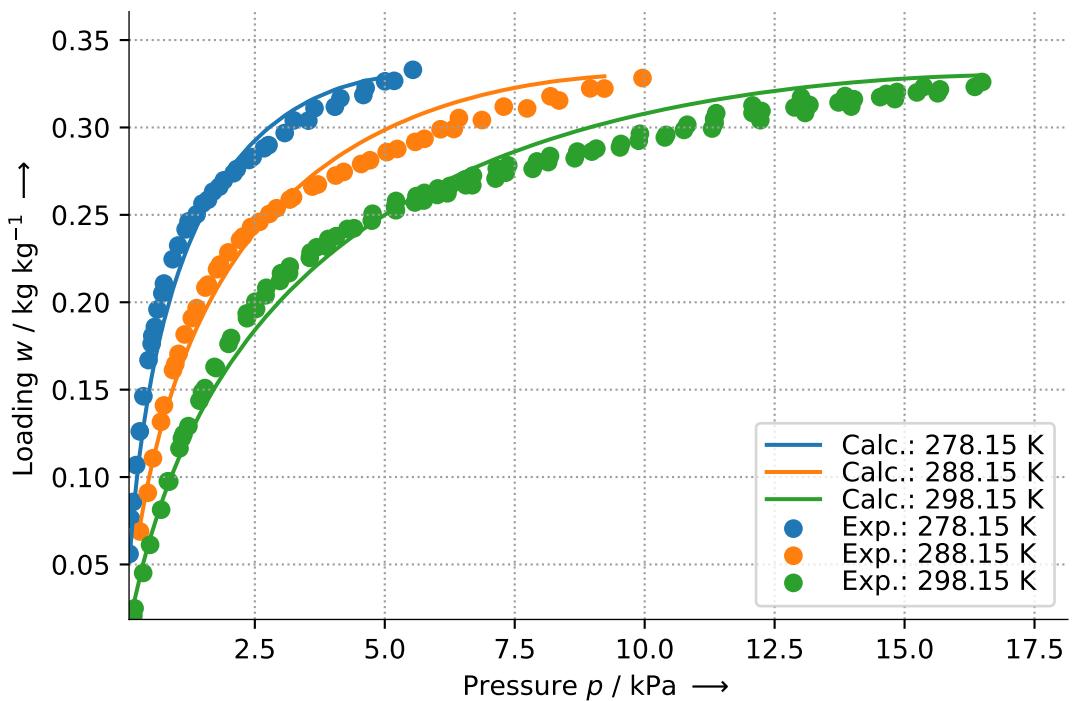
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.655000000e+00
E	$\text{J mol}^{-1}$	6.571233270e+03	$W_0$	$\text{kg kg}^{-1}$	3.300000000e-01

#### Validity:

Equation is approximately valid for  $89.0\text{Pa} \leq p \leq 16492.4\text{Pa}$ ,  $278.15\text{K} \leq T \leq$



298.15K, and  $0.020588\text{kg kg}^{-1} \leq w \leq 0.332976\text{kg kg}^{-1}$ .

### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.44%.

### 5.8.3 Activated carbon A-35

#### 5.8.3.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	A-35
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Passos, E.; Meunier, F.; Gianola, J. C. (1986): Thermodynamic performance improvement of an intermittent solar-powered refrigeration cycle using adsorption of methanol on activated carbon. In: Journal of Heat Recovery Systems 6 (3), S. 259–264. DOI: 10.1016/0198-7593(86)90010-X.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	2.150000000e+00
$E$	$\text{J mol}^{-1}$	7.100000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.270000000e-04

#### Validity:

Equation is approximately valid for  $263.15\text{K} \leq T \leq 393.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.4 Activated carbon AC-35

#### 5.8.4.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	AC-35
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Douss, N.; Meunier, F. (1988): Effect of operating temperatures on the coefficient of performance of active carbon-methanol systems. In: Heat Recovery Systems and CHP 8 (5), S. 383–392. DOI: 10.1016/0890-4332(88)90042-7.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	1.5

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	2.150000000e+00
$E$	$\text{J mol}^{-1}$	7.075211599e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.250000000e-04

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.5 Activated carbon AC-5060

#### 5.8.5.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	AC-5060
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Alghoul, M. A.; Sulaiman, M. Y.; Sopian, K.; Azmi, B. Z. (2009): Performance of a dual-purpose solar continuous adsorption system. In: Renewable Energy 34 (3), S. 920–927. DOI: 10.1016/j.renene.2008.05.037.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Bulk density	kg m <sup>-3</sup>	760

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.599000000e+00
$E$	J mol <sup>-1</sup>	7.072573618e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	3.630000000e-04

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.6 Activated carbon ACLH

#### 5.8.6.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	ACLH
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Douss, N.; Meunier, F. (1988): Effect of operating temperatures on the coefficient of performance of active carbon-methanol systems. In: Heat Recovery Systems and CHP 8 (5), S. 383–392. DOI: 10.1016/0890-4332(88)90042-7.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pellet	mm	1.5

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.321000000e+00
$E$	$\text{J mol}^{-1}$	4.335225274e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	8.600000000e-04

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.7 Activated carbon BPL

#### 5.8.7.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	BPL
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Passos, E.; Meunier, F.; Gianola, J. C. (1986): Thermodynamic performance improvement of an intermittent solar-powered refrigeration cycle using adsorption of methanol on activated carbon. In: Journal of Heat Recovery Systems 6 (3), S. 259–264. DOI: 10.1016/0198-7593(86)90010-X.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.450000000e+00
$E$	$\text{J mol}^{-1}$	6.700000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.140000000e-04

#### Validity:

Equation is approximately valid for  $311.15\text{K} \leq T \leq 400.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 5.8.8 Activated carbon CarboTech A35/1

### 5.8.8.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	CarboTech A35/1
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{ g}^{-1}$	1414
Porosity of pellet	-	0.88
Bulk density	$\text{kg m}^{-3}$	330
Solid density	$\text{kg m}^{-3}$	2191

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\text{A}/\text{E})^n) \quad , \text{ and}$$

$$\text{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

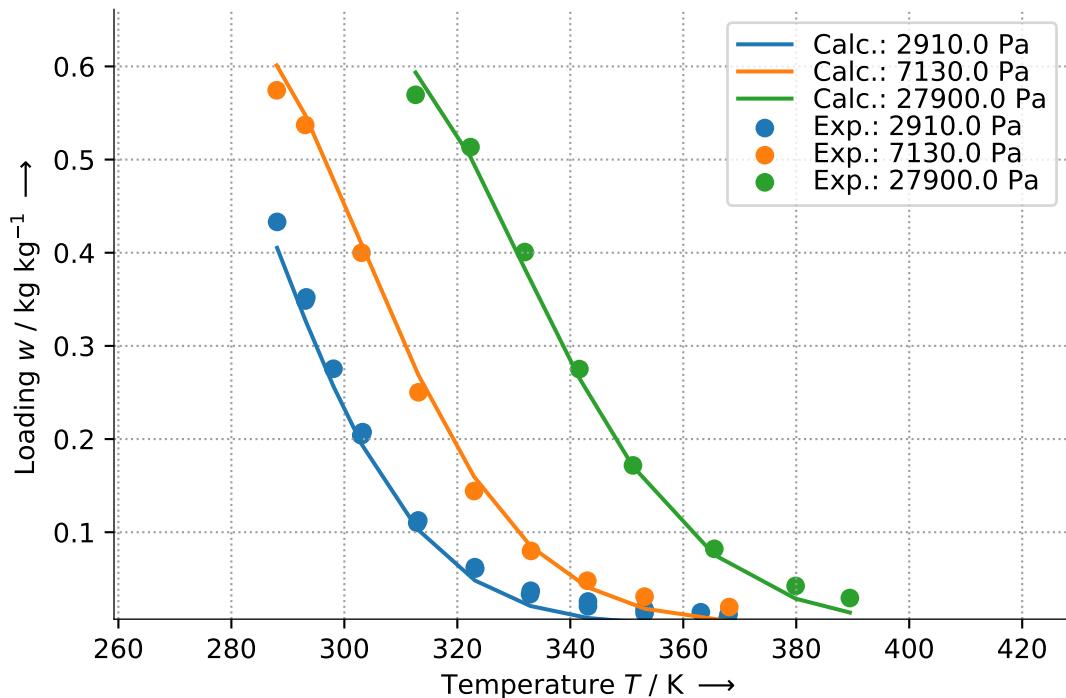
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.760000000e+00
E	$\text{J mol}^{-1}$	4.686334274e+03	$W_0$	$\text{m}^3 \text{ kg}^{-1}$	7.860000000e-04

#### Validity:

Equation is approximately valid for  $2910.0 \text{ Pa} \leq p \leq 27900.0 \text{ Pa}$ ,  $288.099 \text{ K} \leq T \leq$

367.842K, and  $0.007435\text{kg kg}^{-1} \leq w \leq 0.574349\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 28.57%.

### 5.8.9 Activated carbon CarboTech C40/1

#### 5.8.9.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	CarboTech C40/1
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{ g}^{-1}$	1288
Porosity of pellet	-	0.82
Bulk density	$\text{kg m}^{-3}$	380
Solid density	$\text{kg m}^{-3}$	2142

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

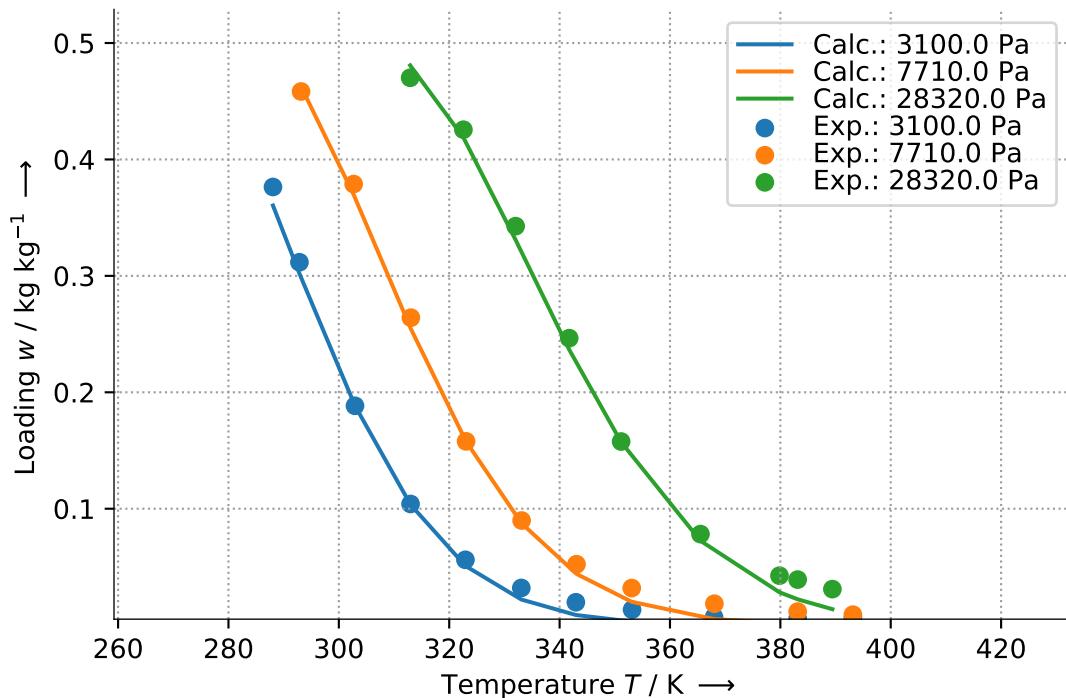
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.850000000e+00
E	$\text{J mol}^{-1}$	4.985780554e+03	$W_0$	$\text{m}^3 \text{ kg}^{-1}$	6.330000000e-04

#### Validity:

Equation is approximately valid for  $3100.0 \text{ Pa} \leq p \leq 28320.0 \text{ Pa}$ ,  $288.067 \text{ K} \leq T \leq$

393.144K, and  $0.005724\text{kg kg}^{-1} \leq w \leq 0.470143\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 31.51%.

### 5.8.10 Activated carbon DEG

#### 5.8.10.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	DEG
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Passos, E.; Meunier, F.; Gianola, J. C. (1986): Thermodynamic performance improvement of an intermittent solar-powered refrigeration cycle using adsorption of methanol on activated carbon. In: Journal of Heat Recovery Systems 6 (3), S. 259–264. DOI: 10.1016/0198-7593(86)90010-X.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.310000000e+00
$E$	$\text{J mol}^{-1}$	5.625000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	5.340000000e-04

#### Validity:

Equation is approximately valid for  $327.15\text{K} \leq T \leq 361.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.11 Activated carbon G32-H

#### 5.8.11.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	G32-H
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{ g}^{-1}$	921
Porosity of pellet	-	0.77
Bulk density	$\text{kg m}^{-3}$	370
Solid density	$\text{kg m}^{-3}$	2174

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\text{A}/\text{E})^n) \quad , \text{ and}$$

$$\text{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

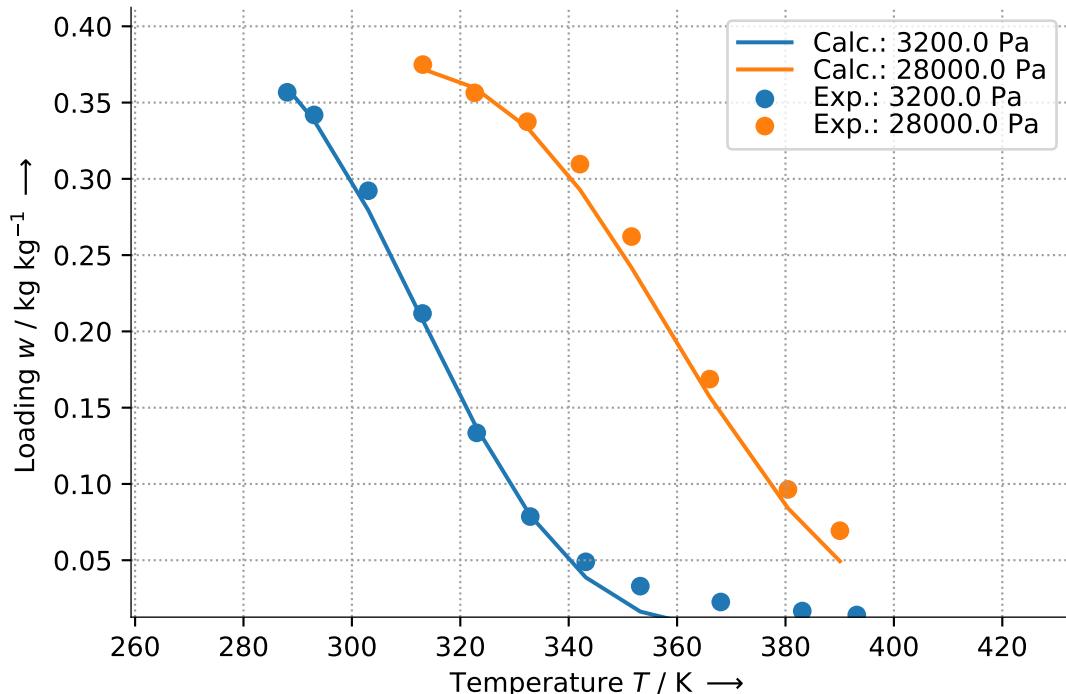
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.590000000e+00
E	$\text{J mol}^{-1}$	7.687435041e+03	$W_0$	$\text{m}^3 \text{ kg}^{-1}$	4.820000000e-04

#### Validity:

Equation is approximately valid for  $3200.0 \text{ Pa} \leq p \leq 28000.0 \text{ Pa}$ ,  $288.06 \text{ K} \leq T \leq$

393.15K, and  $0.014091\text{kg kg}^{-1} \leq w \leq 0.374907\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 22.59%.

### 5.8.12 Activated carbon HC-20C

#### 5.8.12.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	HC-20C
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	El-Sharkawy, I. I.; Hassan, M.; Saha, B. B.; Koyama, S.; Nasr, M. M. (2009): Study on adsorption of methanol onto carbon based adsorbents. In: International Journal of Refrigeration 32 (7), S. 1579–1586. DOI: 10.1016/j.ijrefrig.2009.06.011.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.000000000e+00
E	$\text{J mol}^{-1}$	4.790785223e+03	$W_0$	$\text{kg kg}^{-1}$	7.050000000e-01

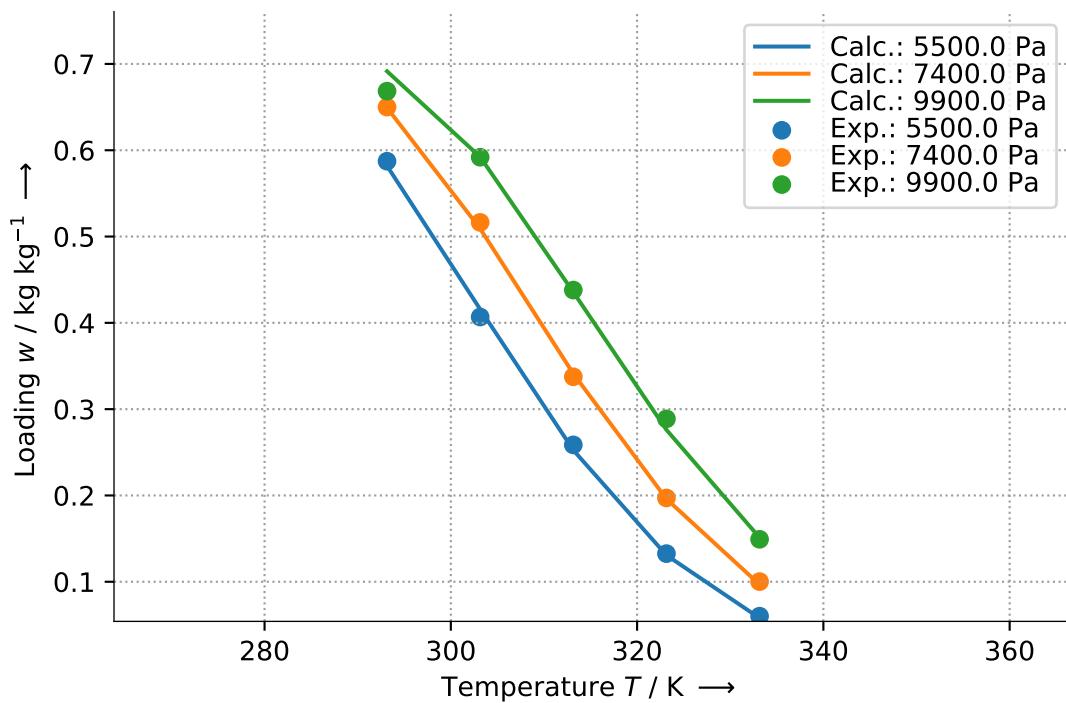
#### Validity:

Equation is approximately valid for  $5500.0\text{Pa} \leq p \leq 9900.0\text{Pa}$ ,  $293.15\text{K} \leq T \leq 333.15\text{K}$ , and  $0.0601\text{kg kg}^{-1} \leq w \leq 0.6685\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.79%.

### 5.8.13 Activated carbon Norit R 1 Extra

#### 5.8.13.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit R 1 Extra
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{ g}^{-1}$	1045
Porosity of pellet	-	0.87
Bulk density	$\text{kg m}^{-3}$	370
Solid density	$\text{kg m}^{-3}$	2139

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

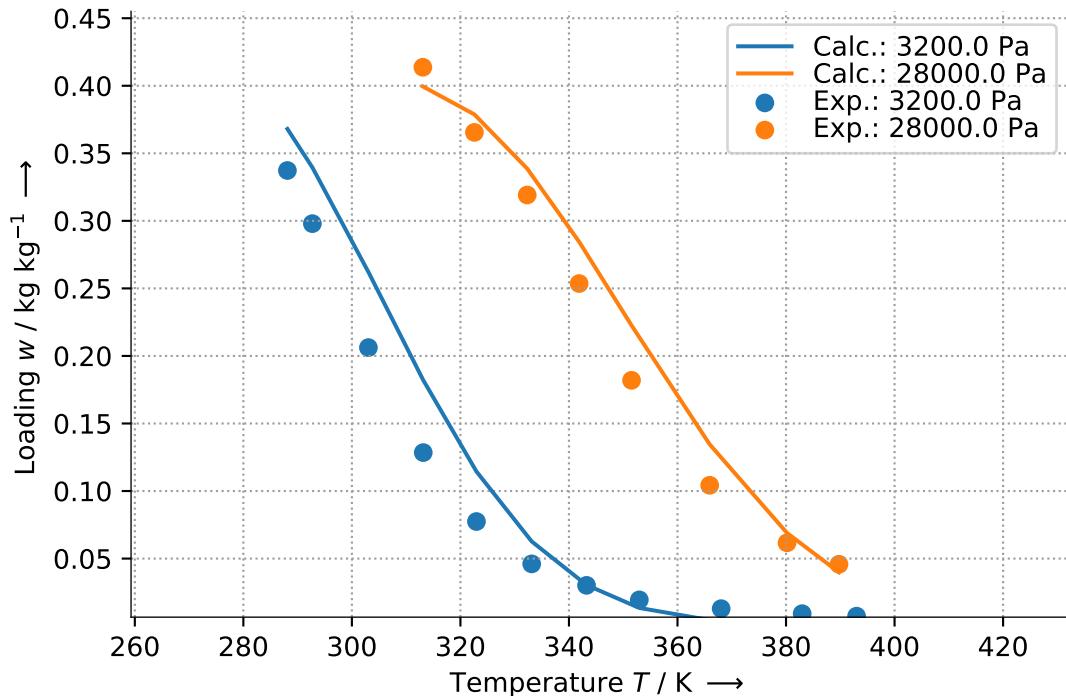
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.270000000e+00
E	$\text{J mol}^{-1}$	6.951221886e+03	$W_0$	$\text{m}^3 \text{ kg}^{-1}$	5.190000000e-04

#### Validity:

Equation is approximately valid for  $3200.0 \text{ Pa} \leq p \leq 28000.0 \text{ Pa}$ ,  $288.117 \text{ K} \leq T \leq$

393.003K, and  $0.007376\text{kg kg}^{-1} \leq w \leq 0.4137\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 30.45%.

### 5.8.14 Activated carbon Norit RB

#### 5.8.14.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit RB
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Passos, E.; Meunier, F.; Gianola, J. C. (1986): Thermodynamic performance improvement of an intermittent solar-powered refrigeration cycle using adsorption of methanol on activated carbon. In: Journal of Heat Recovery Systems 6 (3), S. 259–264. DOI: 10.1016/0198-7593(86)90010-X.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.000000000e+00
E	$\text{J mol}^{-1}$	7.800000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.150000000e-04

#### Validity:

Equation is approximately valid for  $293.15\text{K} \leq T \leq 293.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.15 Activated carbon Norit RX 3 Extra

#### 5.8.15.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit RX 3 Extra
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{ g}^{-1}$	1111
Porosity of pellet	-	0.75
Bulk density	$\text{kg m}^{-3}$	370
Solid density	$\text{kg m}^{-3}$	2169

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

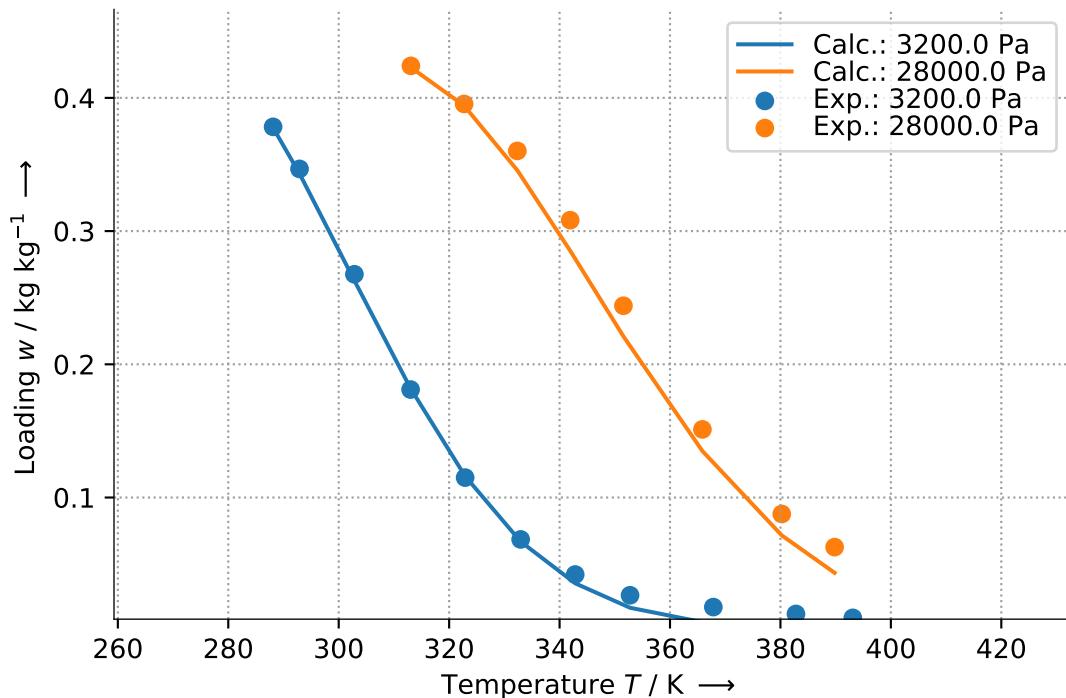
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.060000000e+00
E	$\text{J mol}^{-1}$	6.755624733e+03	$W_0$	$\text{m}^3 \text{ kg}^{-1}$	5.510000000e-04

#### Validity:

Equation is approximately valid for  $3200.0 \text{ Pa} \leq p \leq 28000.0 \text{ Pa}$ ,  $288.117 \text{ K} \leq T \leq$

393.106K, and  $0.00966\text{kg kg}^{-1} \leq w \leq 0.424025\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 21.0%.

### 5.8.16 Activated carbon PKST

#### 5.8.16.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	PKST
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Passos, E.; Meunier, F.; Gianola, J. C. (1986): Thermodynamic performance improvement of an intermittent solar-powered refrigeration cycle using adsorption of methanol on activated carbon. In: Journal of Heat Recovery Systems 6 (3), S. 259–264. DOI: 10.1016/0198-7593(86)90010-X.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	2.000000000e+00
E	$\text{J mol}^{-1}$	8.500000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	2.580000000e-04

#### Validity:

Equation is approximately valid for  $364.15\text{K} \leq T \leq 364.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.17 Activated carbon RÜTGERS CG1-3

#### 5.8.17.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	RÜTGERS CG1-3
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{ g}^{-1}$	1009
Porosity of pellet	-	0.84
Bulk density	$\text{kg m}^{-3}$	420
Solid density	$\text{kg m}^{-3}$	2259

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\text{A}/\text{E})^n) \quad , \text{ and}$$

$$\text{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

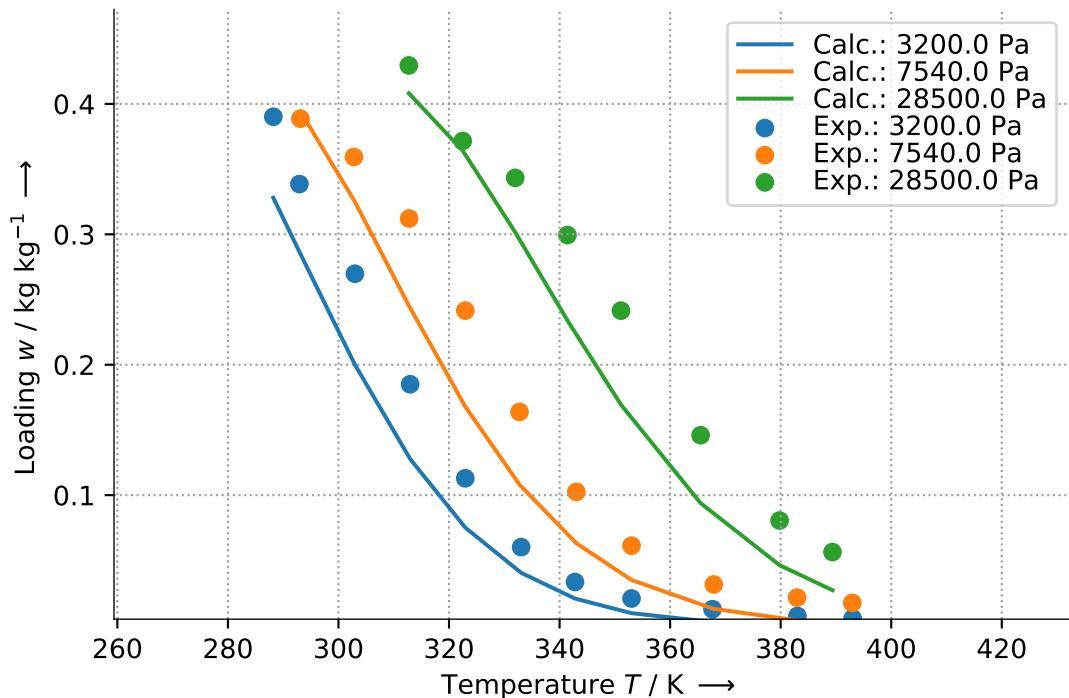
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.800000000e+00
E	$\text{J mol}^{-1}$	5.705847581e+03	$W_0$	$\text{m}^3 \text{ kg}^{-1}$	5.350000000e-04

#### Validity:

Equation is approximately valid for  $3200.0 \text{ Pa} \leq p \leq 28500.0 \text{ Pa}$ ,  $288.212 \text{ K} \leq T \leq$

393.016K, and  $0.00548\text{kg kg}^{-1} \leq w \leq 0.429505\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 38.65%.

### 5.8.18 Activated carbon WS-480

#### 5.8.18.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	WS-480
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Zhao, Yongling; Hu, Eric; Blazewicz, Antoni (2012): A comparison of three adsorption equations and sensitivity study of parameter uncertainty effects on adsorption refrigeration thermal performance estimation. In: Heat Mass Transfer 48 (2), S. 217–226. DOI: 10.1007/s00231-011-0875-8.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.780000000e+00
E	$\text{J mol}^{-1}$	5.654187748e+03	$W_0$	$\text{kg kg}^{-1}$	2.700000000e-01

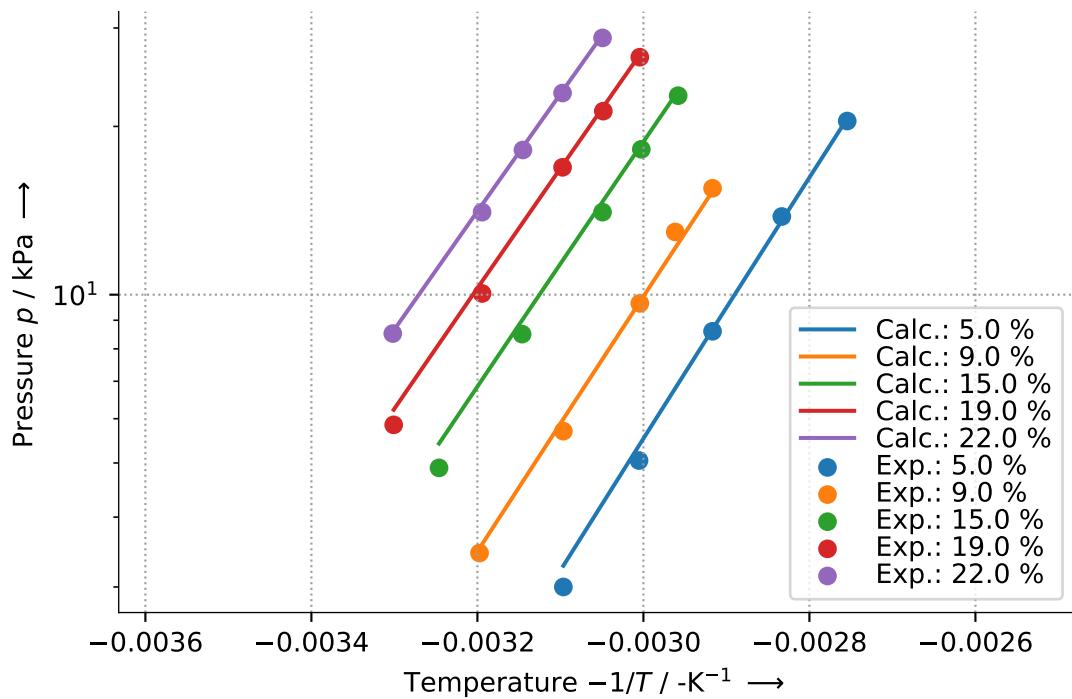
#### Validity:

Equation is approximately valid for  $3000.0\text{Pa} \leq p \leq 28800.0\text{Pa}$ ,  $302.85\text{K} \leq T \leq 363.05\text{K}$ , and  $0.05\text{kg kg}^{-1} \leq w \leq 0.22\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.26%.

### 5.8.18.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	WS-480
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Wu, Jun W.; Madani, S. Hadi; Biggs, Mark J.; Phillip, Pendleton; Lei, Chen; Hu, Eric J. (2015): Characterizations of Activated Carbon–Methanol Adsorption Pair Including the Heat of Adsorptions. In: J. Chem. Eng. Data 60 (6), S. 1727–1731. DOI: 10.1021/je501113y.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.004
Surface area	$\text{m}^2 \text{g}^{-1}$	1231
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.464

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

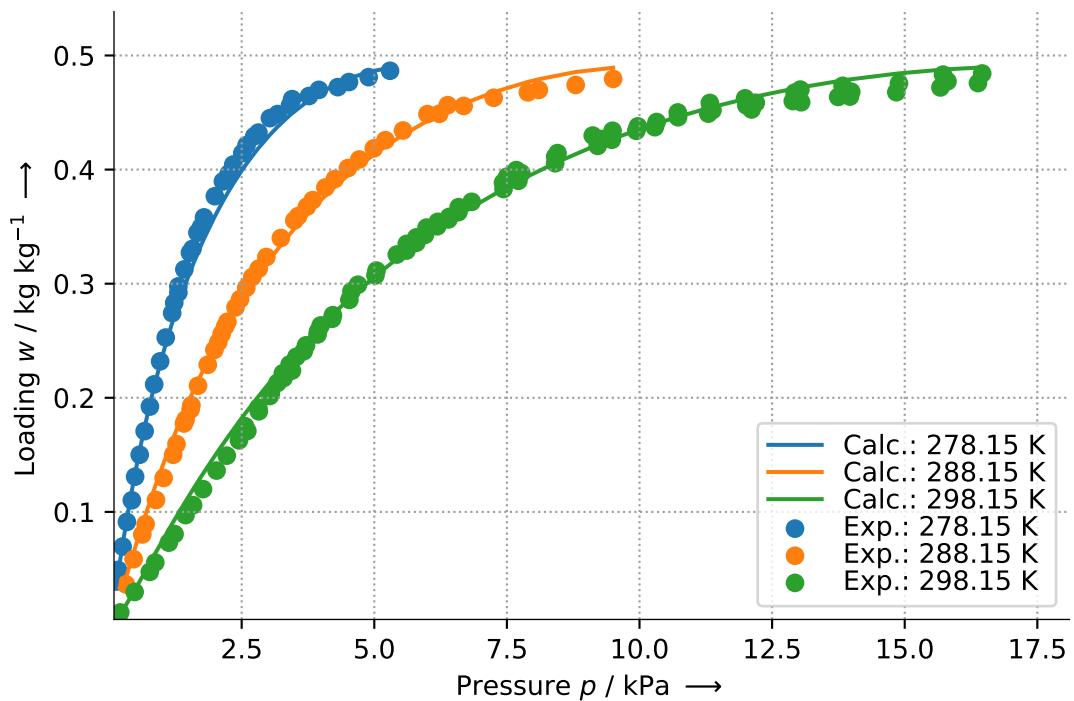
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.650000000e+00
E	$\text{J mol}^{-1}$	4.776748192e+03	$W_0$	$\text{kg kg}^{-1}$	4.900000000e-01

#### Validity:

Equation is approximately valid for  $103.3\text{Pa} \leq p \leq 16460.1\text{Pa}$ ,  $278.15\text{K} \leq T \leq 298.15\text{K}$ , and  $0.006367\text{kg kg}^{-1} \leq w \leq 0.486595\text{kg kg}^{-1}$ .



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.56%.

### 5.8.19 Activated carbon powder Maxsorb III

#### 5.8.19.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	El-Sharkawy, I. I.; Hassan, M.; Saha, B. B.; Koyama, S.; Nasr, M. M. (2009): Study on adsorption of methanol onto carbon based adsorbents. In: International Journal of Refrigeration 32 (7), S. 1579–1586. DOI: 10.1016/j.ijrefrig.2009.06.011.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{ g}^{-1}$	3150

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\mathcal{A}/E)^n) \quad , \text{ and}$$

$$\mathcal{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

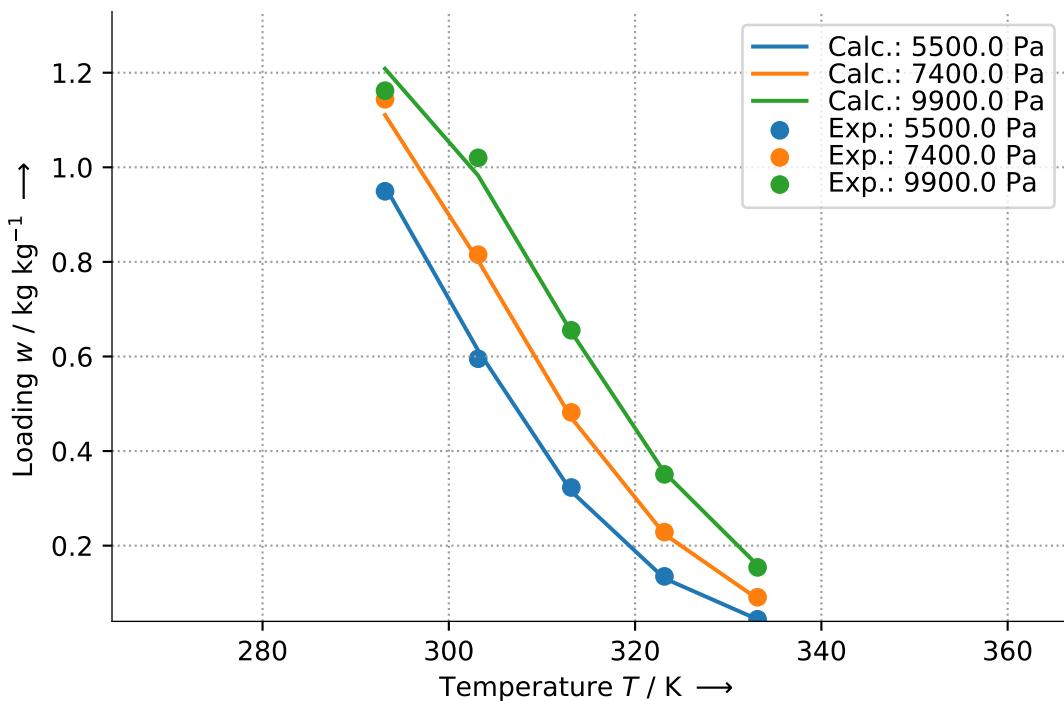
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$n$	-	2.000000000e+00
$E$	$\text{J mol}^{-1}$	4.145845866e+03	$W_0$	$\text{kg kg}^{-1}$	1.240000000e+00

#### Validity:

Equation is approximately valid for  $5500.0 \text{ Pa} \leq p \leq 9900.0 \text{ Pa}$ ,  $293.15 \text{ K} \leq T \leq 333.15 \text{ K}$ , and  $0.0443 \text{ kg kg}^{-1} \leq w \leq 1.162 \text{ kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.32%.

### 5.8.20 Activated charcoal 207E4

#### 5.8.20.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal
<b>Subtype:</b>	207E4
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Jing, Hu; Exell, R.H.B. (1994): Simulation and sensitivity analysis of an intermittent solar-powered charcoal/methanol refrigerator. In: Renewable Energy 4 (1), S. 133–149. DOI: 10.1016/0960-1481(94)90076-0.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\mathcal{A}/E)^n) \quad , \text{ and}$$

$$\mathcal{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.340000000e+00
$E$	$\text{J mol}^{-1}$	5.947289608e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	3.654600000e-04

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.21 Activated charcoal Chinese LSZ30

#### 5.8.21.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal
<b>Subtype:</b>	Chinese LSZ30
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Jing, Hu; Exell, R.H.B. (1994): Simulation and sensitivity analysis of an intermittent solar-powered charcoal/methanol refrigerator. In: Renewable Energy 4 (1), S. 133–149. DOI: 10.1016/0960-1481(94)90076-0.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\mathcal{A}/E)^n) \quad , \text{ and}$$

$$\mathcal{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.260000000e+00
$E$	$\text{J mol}^{-1}$	4.941131407e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.050000000e-04

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.22 Activated charcoal LH

#### 5.8.22.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal
<b>Subtype:</b>	LH
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Jing, Hu; Exell, R.H.B. (1994): Simulation and sensitivity analysis of an intermittent solar-powered charcoal/methanol refrigerator. In: Renewable Energy 4 (1), S. 133–149. DOI: 10.1016/0960-1481(94)90076-0.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\mathcal{A}/E)^n) \quad , \text{ and}$$

$$\mathcal{A} = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.321000000e+00
$E$	$\text{J mol}^{-1}$	4.335225274e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	8.600000000e-04

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.8.23 Activated charcoal Thai MD6070

#### 5.8.23.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal
<b>Subtype:</b>	Thai MD6070
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Jing, Hu; Exell, R.H.B. (1994): Simulation and sensitivity analysis of an intermittent solar-powered charcoal/methanol refrigerator. In: Renewable Energy 4 (1), S. 133–149. DOI: 10.1016/0960-1481(94)90076-0.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.120000000e+00
$E$	$\text{J mol}^{-1}$	4.402306290e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	9.880000000e-04

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 5.9 Nitrogen

### 5.9.1 Activated carbon AP4-60

#### 5.9.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	AP4-60
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.000000128
Diameter of pellet	mm	4
Surface area	$\text{m}^2 \text{g}^{-1}$	1428
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.47

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.500000000e+00
E	$\text{J mol}^{-1}$	1.890000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.400000000e-04

**Validity:**

Equation is approximately valid for  $214.7065231\text{Pa} \leq p \leq 96174.92104\text{Pa}$ ,  $77.0\text{K} \leq T \leq 77.0\text{K}$ , and  $0.33211935\text{kg kg}^{-1} \leq w \leq 0.572771423\text{kg kg}^{-1}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.2 Activated carbon ATO

#### 5.9.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	ATO
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000118
Diameter of pellet	mm	0.25-0.6
Surface area	$\text{m}^2 \text{g}^{-1}$	1745
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.64

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.400000000e+00
E	$\text{J mol}^{-1}$	2.090000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	6.300000000e-04

#### Validity:

Equation is approximately valid for  $350.7197052\text{Pa} \leq p \leq 96538.27054\text{Pa}$ ,  $77.0\text{K} \leq$

$T \leq 77.0\text{K}$ , and  $0.298480609\text{kg kg}^{-1} \leq w \leq 0.425572633\text{kg kg}^{-1}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.3 Activated carbon COC-L1200

#### 5.9.3.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	COC-L1200
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000118
Diameter of pellet	mm	0.42-1
Surface area	$\text{m}^2 \text{g}^{-1}$	1412
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.49

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.400000000e+00
E	$\text{J mol}^{-1}$	2.390000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	5.200000000e-04

#### Validity:

Equation is approximately valid for  $350.7197052\text{Pa} \leq p \leq 96538.27054\text{Pa}$ ,  $77.0\text{K} \leq$

$T \leq 77.0\text{K}$ , and  $0.298480609\text{kg kg}^{-1} \leq w \leq 0.425572633\text{kg kg}^{-1}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.4 Activated carbon CarboTech A35/1

#### 5.9.4.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	CarboTech A35/1
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	1414
Porosity of pellet	-	0.88
Bulk density	$\text{kg m}^{-3}$	330
Solid density	$\text{kg m}^{-3}$	2191

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.200000000e+00
E	$\text{J mol}^{-1}$	4.119000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	7.720000000e-04

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.5 Activated carbon CarboTech C40/1

#### 5.9.5.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	CarboTech C40/1
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	1288
Porosity of pellet	-	0.82
Bulk density	$\text{kg m}^{-3}$	380
Solid density	$\text{kg m}^{-3}$	2142

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.100000000e+00
E	$\text{J mol}^{-1}$	4.366000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	6.950000000e-04

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.6 Activated carbon FR20

#### 5.9.6.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	FR20
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000118
Diameter of pellet	mm	0.01
Surface area	$\text{m}^2 \text{g}^{-1}$	2180
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.75

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.600000000e+00
E	$\text{J mol}^{-1}$	2.030000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	7.400000000e-04

#### Validity:

Equation is approximately valid for  $78.69334105 \text{Pa} \leq p \leq 94770.09918 \text{Pa}$ ,  $77.0 \text{K} \leq$

$T \leq 77.0\text{K}$ , and  $0.345194915\text{kg kg}^{-1} \leq w \leq 0.612861598\text{kg kg}^{-1}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.7 Activated carbon G32-H

#### 5.9.7.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	G32-H
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	921
Porosity of pellet	-	0.77
Bulk density	$\text{kg m}^{-3}$	370
Solid density	$\text{kg m}^{-3}$	2174

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.700000000e+00
$E$	$\text{J mol}^{-1}$	6.486000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.690000000e-04

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 5.9.8 Activated carbon Norit R 1 Extra

### 5.9.8.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit R 1 Extra
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	1045
Porosity of pellet	-	0.87
Bulk density	$\text{kg m}^{-3}$	370
Solid density	$\text{kg m}^{-3}$	2139

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.400000000e+00
E	$\text{J mol}^{-1}$	6.161000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	5.300000000e-04

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.9 Activated carbon Norit RX 3 Extra

#### 5.9.9.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Norit RX 3 Extra
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	1111
Porosity of pellet	-	0.75
Bulk density	$\text{kg m}^{-3}$	370
Solid density	$\text{kg m}^{-3}$	2169

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.200000000e+00
E	$\text{J mol}^{-1}$	6.119000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	5.760000000e-04

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.10 Activated carbon RÜTGERS CG1-3

#### 5.9.10.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	RÜTGERS CG1-3
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Henninger, S. K.; Schicktanz, M.; Hügenell, P.P.C.; Sievers, H.; Henning, H.-M. (2012): Evaluation of methanol adsorption on activated carbons for thermally driven chillers part I. Thermophysical characterisation. In: International Journal of Refrigeration 35 (3), S. 543–553. DOI: 10.1016/j.ijrefrig.2011.10.004.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	1009
Porosity of pellet	-	0.84
Bulk density	$\text{kg m}^{-3}$	420
Solid density	$\text{kg m}^{-3}$	2259

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.200000000e+00
$E$	$\text{J mol}^{-1}$	5.059000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	5.450000000e-04

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.9.11 Activated carbon SRD 1352/3

#### 5.9.11.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	SRD 1352/3
<b>Refrigerant:</b>	Nitrogen
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Brancato, V.; Fazzica, A.; Sapienza, A.; Gordeeva, L.; Freni, A. (2015): Ethanol adsorption onto carbonaceous and composite adsorbents for adsorptive cooling system. In: Energy 84, S. 177–185. DOI: 10.1016/j.energy.2015.02.077.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000112
Diameter of pellet	mm	0.5-2
Surface area	$\text{m}^2 \text{g}^{-1}$	2613
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.65

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.700000000e+00
E	$\text{J mol}^{-1}$	1.890000000e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	7.800000000e-04

#### Validity:

Equation is approximately valid for  $123.3833866\text{Pa} \leq p \leq 96246.81372\text{Pa}$ ,  $77.0\text{K} \leq$

$T \leq 77.0\text{K}$ , and  $0.395659195\text{kg kg}^{-1} \leq w \leq 0.813818229\text{kg kg}^{-1}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 5.10 Propane

### 5.10.1 Activated carbon powder Maxsorb III

#### 5.10.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Loh, Wai Soong; Ismail, Azhar Bin; Xi, Baojuan; Ng, Kim Choon; Chun, Won Gee (2012): Adsorption Isotherms and Isosteric Enthalpy of Adsorption for Assorted Refrigerants on Activated Carbons. In: J. Chem. Eng. Data 57 (10), S. 2766–2773. DOI: 10.1021/je3008099.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3150
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

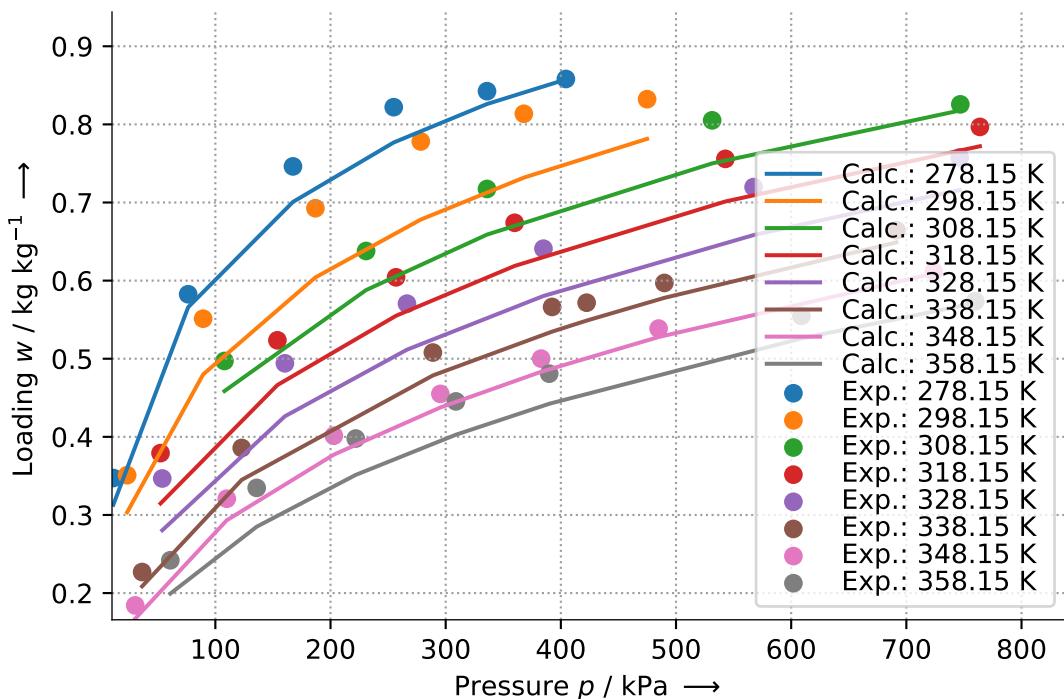
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.220000000e+00
E	$\text{J mol}^{-1}$	8.577900000e+03	$W_0$	$\text{kg kg}^{-1}$	9.000000000e-01

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $11406.0\text{Pa} \leq p \leq 763858.0\text{Pa}$ ,  $278.15\text{K} \leq T \leq 358.15\text{K}$ , and  $0.184246\text{kg kg}^{-1} \leq w \leq 0.858129\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % →  $0 \text{ Pa} < p < 5 \text{ MPa}$ : 0.1
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.75%.

### 5.10.2 Carbon molecular sieve 4A

#### 5.10.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	carbon molecular sieve
<b>Subtype:</b>	4A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Silva, Viviana M.T.M.; Gigola, Carlos; Rodrigues, Alirio E. (2003): Adsorption of propane and propylene onto carbon molecular sieve. In: Carbon 41 (13), S. 2533–2545. DOI: 10.1016/S0008-6223(03)00304-X.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0003
Diameter of pellet	mm	1.1
Length of extrudate	mm	2.3-5
Porosity of pellet	-	0.315
Pellet density	kg m <sup>-3</sup>	900

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

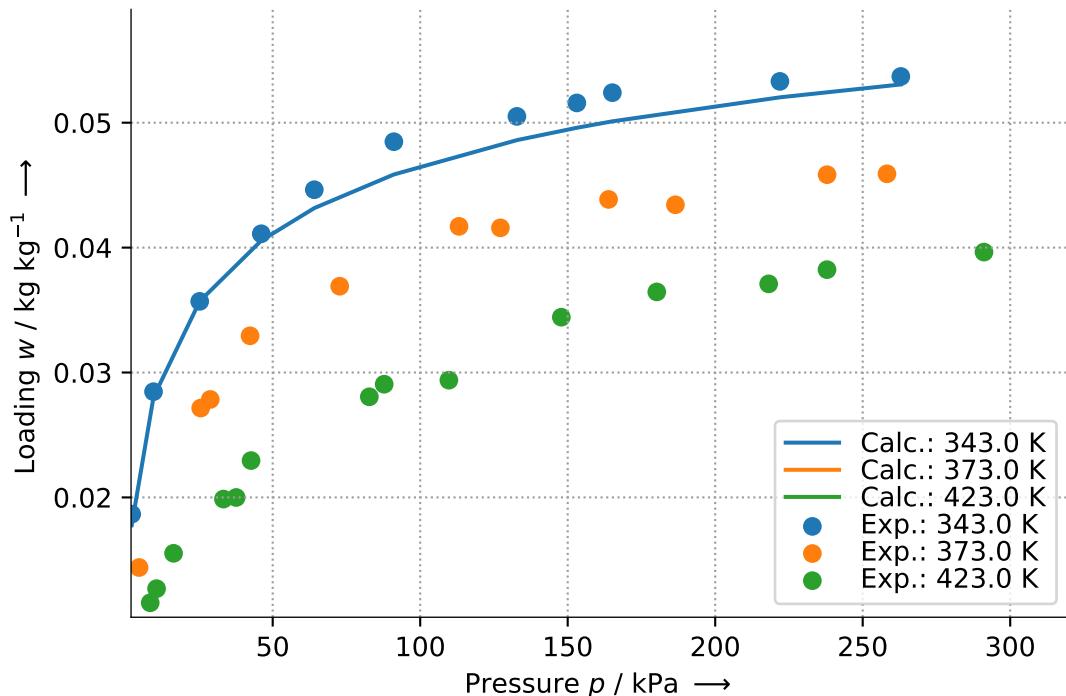
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.000000000e+00
E	J mol <sup>-1</sup>	1.823000000e+04	W <sub>0</sub>	kg kg <sup>-1</sup>	6.028470000e-02

#### Validity:

Equation is approximately valid for  $1834.0 \text{Pa} \leq p \leq 290732.0 \text{Pa}$ ,  $343.0 \text{K} \leq T \leq$

423.0K, and  $0.011958156\text{kg kg}^{-1} \leq w \leq 0.053757018\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 500
- Temperature, absolute, in K → 0.5

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.9%.

## 5.10.2.2 Toth - ID 1

<b>Sorbent:</b>	carbon molecular sieve
<b>Subtype:</b>	4A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Silva, Viviana M.T.M.; Gigola, Carlos; Rodrigues, Alirio E. (2003): Adsorption of propane and propylene onto carbon molecular sieve. In: Carbon 41 (13), S. 2533–2545. DOI: 10.1016/S0008-6223(03)00304-X.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.0003
Diameter of pellet	mm	1.1
Length of extrudate	mm	2.3-5
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	0.31
Porosity of pellet	-	0.315
Pellet density	kg m <sup>-3</sup>	900

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

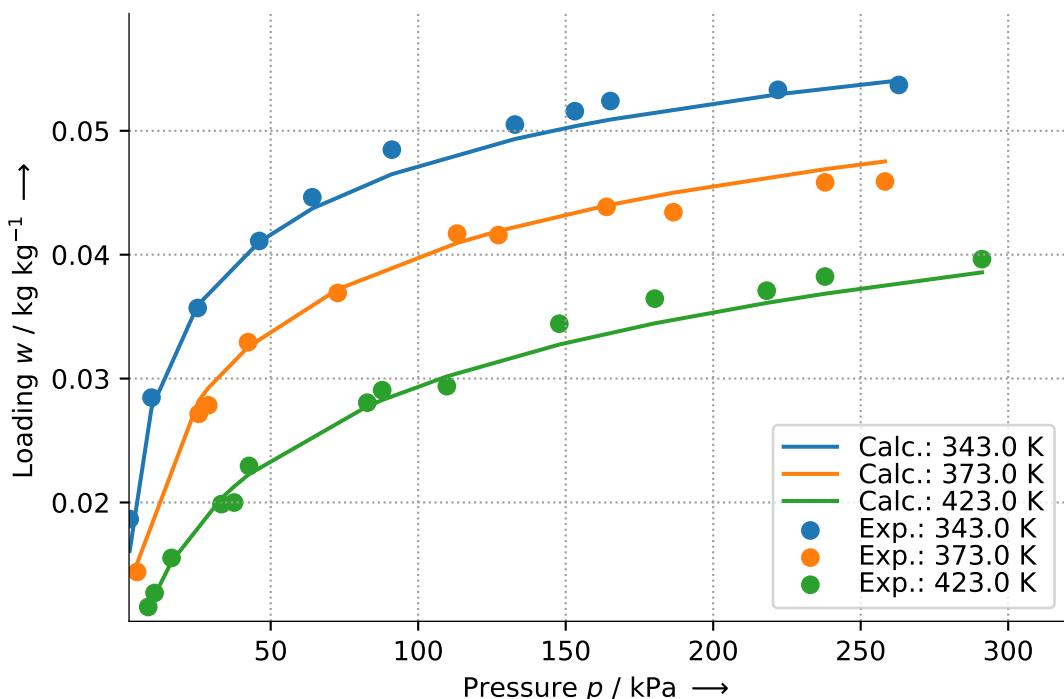
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	Pa <sup>-1</sup>	1.547670750e-03	$Q^*$	K	1.378321189e+03
$c$	K	0.000000000e+00	$r^*$	-	1.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$m$	-	2.808988764e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	7.747842900e-02
$n_0$	-	3.560000000e-01			

**Validity:**

Equation is approximately valid for  $2205.0 \text{ Pa} \leq p \leq 291114.0 \text{ Pa}$ ,  $343.0 \text{ K} \leq T \leq 423.0 \text{ K}$ , and  $0.011563997 \text{ kg kg}^{-1} \leq w \leq 0.053701768 \text{ kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 500
- Temperature, absolute, in K → 0.5

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.92%.

### 5.10.3 Mof powder cubtc

#### 5.10.3.1 DualSiteSips - ID 1

<b>Sorbent:</b>	mof powder
<b>Subtype:</b>	cubtc
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	DualSiteSips
<b>ID:</b>	1
<b>Reference:</b>	Lamia, Nabil; Jorge, Miguel; Granato, Miguel A.; Almeida Paz, Filipe A.; Chevreau, Hubert; Rodrigues, Alírio E. (2009): Adsorption of propane, propylene and isobutane on a metal-organic framework. Molecular simulation and experiment. In: Chemical Engineering Science 64 (14), S. 3246–3259. DOI: 10.1016/j.ces.2009.04.010.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.0016
Surface area	$\text{m}^2 \text{g}^{-1}$	1500-2100
Bulk density	$\text{kg m}^{-3}$	350

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \sum_{i=A}^B w_i \frac{(b_i p)^{1/\eta_i}}{1 + (b_i p)^{1/\eta_i}} \quad , \text{ and}$$

$$b_i = b_{i,0} \exp\left(\frac{Q_i}{RT}\left(1 - \frac{T}{T_0}\right)\right) \quad .$$

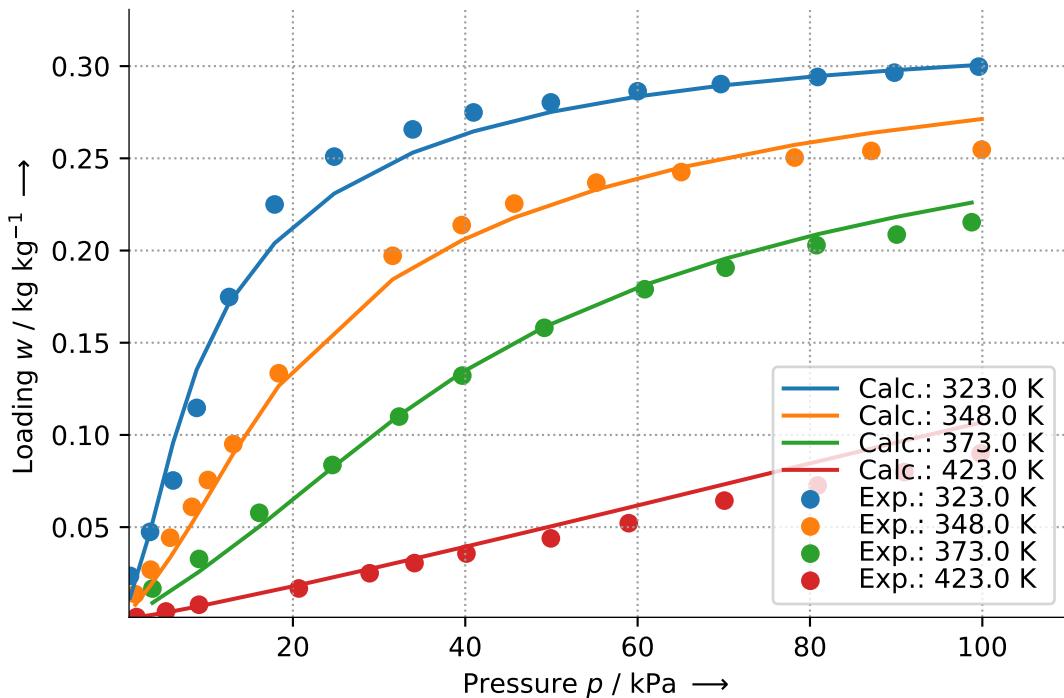
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_{A,0}$	$\text{Pa}^{-1}$	7.000000000e-05	$b_{B,0}$	$\text{Pa}^{-1}$	1.600000000e-04
$Q_A$	$\text{J mol}^{-1}$	2.870000000e+04	$Q_B$	$\text{J mol}^{-1}$	3.410000000e+04
$\eta_A$	-	8.200000000e-01	$\eta_B$	-	3.200000000e-01
$w_A$	$\text{kg kg}^{-1}$	2.738423700e-01	$w_B$	$\text{kg kg}^{-1}$	5.027058000e-02

Par.	Unit	Value	Par.	Unit	Value
$T_0$	K	3.230000000e+02			

**Validity:**

Equation is approximately valid for  $1095.9\text{Pa} \leq p \leq 99931.5\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.001212227\text{kg kg}^{-1} \leq w \leq 0.299726427\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 50
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.42%.

#### 5.10.4 Zeolite crystal 5A

##### 5.10.4.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeolite crystal
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.001

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

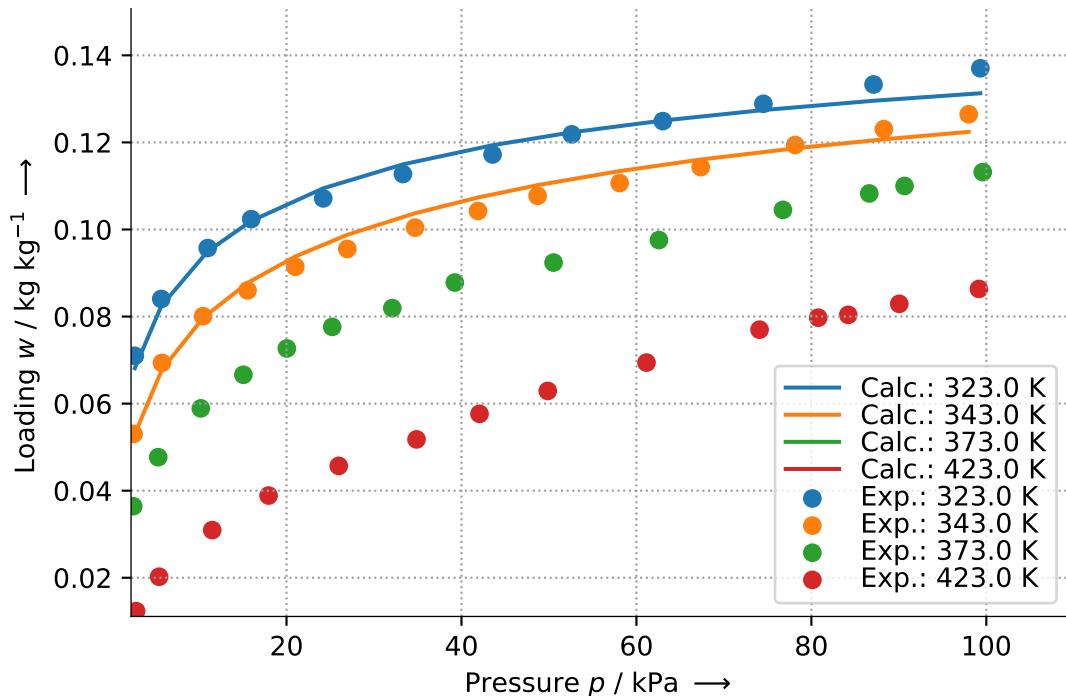
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.240000000e+00
E	$\text{J mol}^{-1}$	1.940000000e+04	$W_0$	$\text{kg kg}^{-1}$	1.486170000e-01

#### Validity:

Equation is approximately valid for  $2450.0\text{Pa} \leq p \leq 99391.0\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.011807775\text{kg kg}^{-1} \leq w \leq 0.137102049\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.0%.

## 5.10.4.2 Toth - ID 1

<b>Sorbent:</b>	zeolite crystal
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.001
Diameter of pore	mm	0.00005
Diameter of pellet	mm	1.65-2.5
Porosity of pellet	-	0.35
Pellet density	$\text{kg m}^{-3}$	1130
Solid density	$\text{kg m}^{-3}$	1740

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

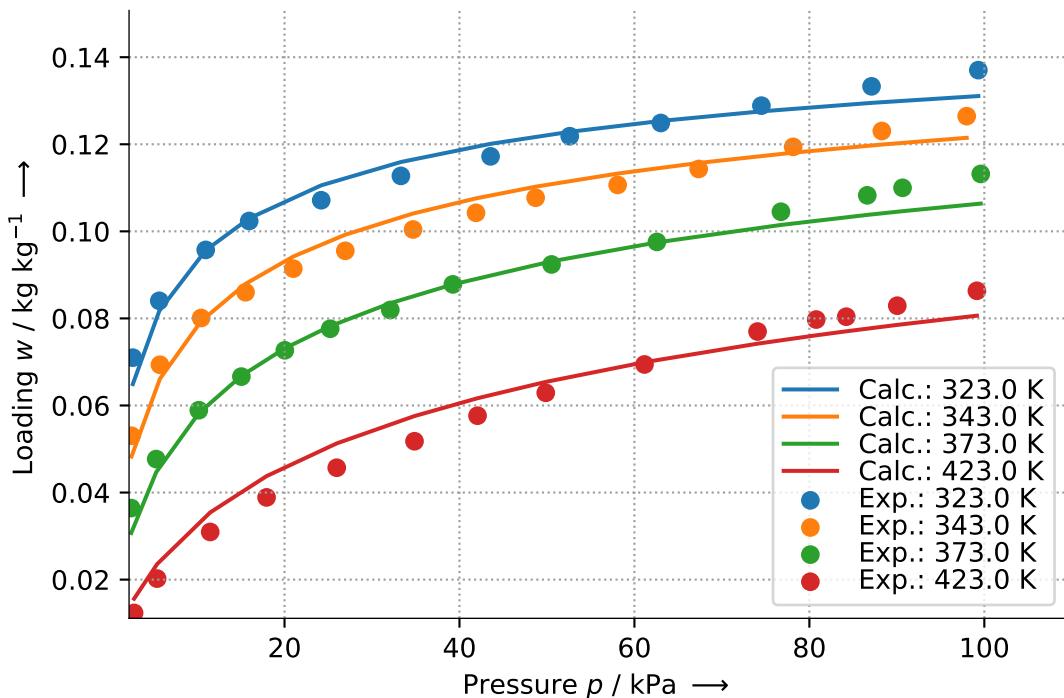
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	1.792538349e-04	$Q^*$	K	1.828139797e+03
$c$	K	0.000000000e+00	$r^*$	-	1.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$m$	-	2.173913043e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.605130800e-01
$n_0$	-	4.600000000e-01			

**Validity:**

Equation is approximately valid for  $2475.3\text{Pa} \leq p \leq 99591.1\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.012344073\text{kg kg}^{-1} \leq w \leq 0.137030546\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.61%.

### 5.10.5 Zeolite pellet 13X

#### 5.10.5.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Da Silva, Francisco A.; Rodrigues, Alírio E. (1999): Adsorption Equilibria and Kinetics for Propylene and Propane over 13X and 4A Zeolite Pellets. In: Ind. Eng. Chem. Res. 38 (5), S. 2051–2057. DOI: 10.1021/ie980640z.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.002
Diameter of pellet	mm	0.79
Diameter of extrudate	mm	1.5-1.9
Length of extrudate	mm	4-7
Porosity of pellet	-	0.39
Bulk density	kg m <sup>-3</sup>	630-680
Pellet density	kg m <sup>-3</sup>	1358
Solid density	kg m <sup>-3</sup>	2234

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

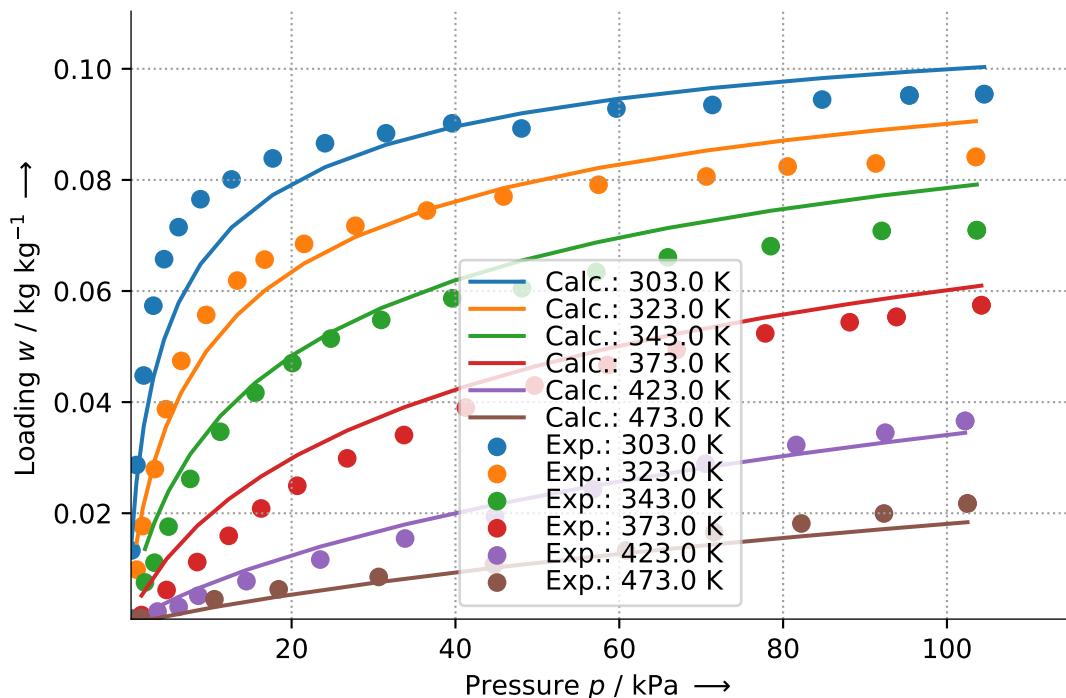
$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	3.500000000e-10	$Q^*$	K	4.300000000e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.181799600e-01
$n_0$	-	5.800000000e-01			

**Validity:**

Equation is approximately valid for  $444.1\text{Pa} \leq p \leq 104549.7\text{Pa}$ ,  $303.0\text{K} \leq T \leq 473.0\text{K}$ , and  $0.001047304\text{kg kg}^{-1} \leq w \leq 0.095440019\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 29.53%.

## 5.10.5.2 Toth - ID 2

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	Toth
<b>ID:</b>	2
<b>Reference:</b>	Lamia, Nabil; Wolff, Luc; Leflaive, Philibert; Sá Gomes, Pedro; Grande, Carlos A.; Rodrigues, Alírio E. (2007): Propane/Propylene Separation by Simulated Moving Bed I. Adsorption of Propane, Propylene and Isobutane in Pellets of 13X Zeolite. In: Separation Science and Technology 42 (12), S. 2539–2566. DOI: 10.1080/01496390701515219.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.001
Diameter of pore	mm	0.0000005
Diameter of extrudate	mm	0.8
Porosity of pellet	-	0.395
Pellet density	kg m <sup>-3</sup>	1357

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

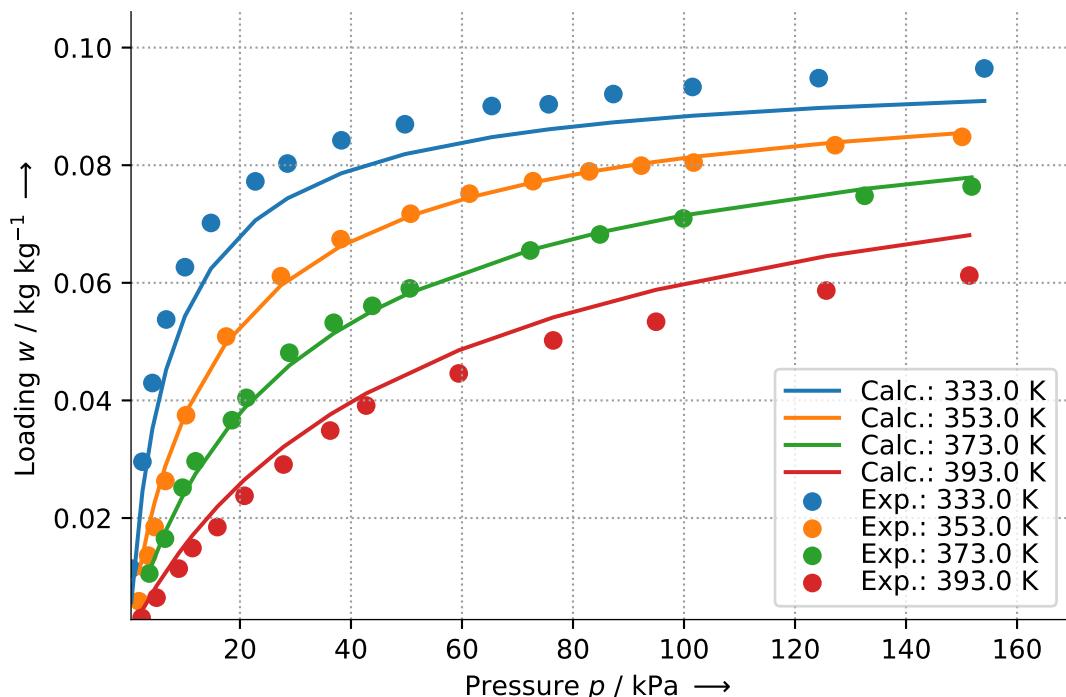
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$b_0$	Pa <sup>-1</sup>	2.500000000e-10		$Q^*$	K	4.438049901e+03

Par.	Unit	Value	Par.	Unit	Value
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	9.701340000e-02
$n_0$	-	8.920000000e-01			

**Validity:**

Equation is approximately valid for  $367.8\text{Pa} \leq p \leq 154298.9\text{Pa}$ ,  $333.0\text{K} \leq T \leq 393.0\text{K}$ , and  $0.002644938\text{kg kg}^{-1} \leq w \leq 0.096698106\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 50
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 9.77%.

### 5.10.6 Zeolite pellet 4A

#### 5.10.6.1 Langmuir - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	4A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	Langmuir
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2003): Propane-propylene binary adsorption on zeolite 4A. In: Adsorption 9 (4), S. 321–329. DOI: 10.1023/A:1026223914143.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} K p}{1 + K p} \quad , \text{ and}$$

$$K = K_0 \exp\left(\frac{\Delta H}{R T}\right) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta H$	$\text{J mol}^{-1}$	1.621460000e+04	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	7.727999250e-02
$K_0$	$\text{Pa}^{-1}$	4.220000000e-08			

#### Validity:

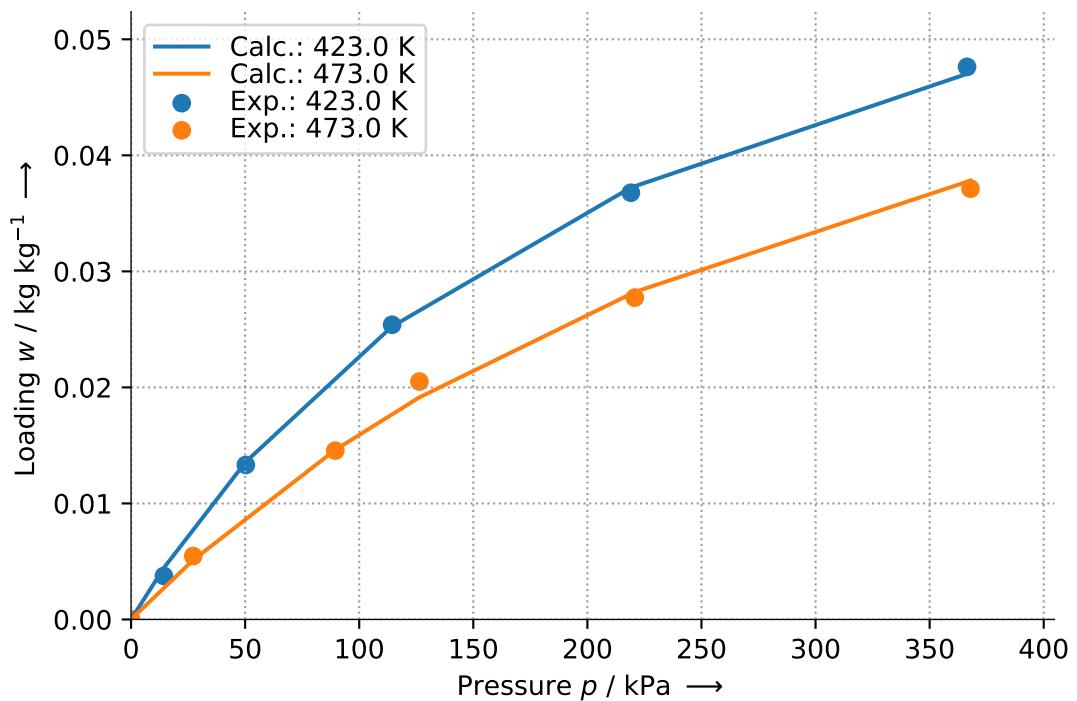
Equation is approximately valid for  $0.0\text{Pa} \leq p \leq 367890.0\text{Pa}$ ,  $423.0\text{K} \leq T \leq 473.0\text{K}$ , and  $0.0\text{kg kg}^{-1} \leq w \leq 0.04762476\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:



- Data source → Data was taken from table
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.41%.

### 5.10.6.2 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	4A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Da Silva, Francisco A.; Rodrigues, Alírio E. (1999): Adsorption Equilibria and Kinetics for Propylene and Propane over 13X and 4A Zeolite Pellets. In: Ind. Eng. Chem. Res. 38 (5), S. 2051–2057. DOI: 10.1021/ie980640z.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.0034
Diameter of pellet	mm	1.6
Diameter of extrudate	mm	3.2
Length of extrudate	mm	8-12
Porosity of pellet	-	0.34
Bulk density	kg m <sup>-3</sup>	>700
Pellet density	kg m <sup>-3</sup>	1700
Solid density	kg m <sup>-3</sup>	2590

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	6.000000000e-07	$Q^*$	K	0.000000000e+00
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	8.951691000e-02
$n_0$	-	1.000000000e+00			

**Validity:**

Equation is approximately valid for  $291.1\text{Pa} \leq p \leq 107707.2\text{Pa}$ ,  $303.0\text{K} \leq T \leq 473.0\text{K}$ , and  $0.0073\text{kg kg}^{-1} \leq w \leq 0.012964\text{kg kg}^{-1}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.10.7 Zeolite pellet 5A

#### 5.10.7.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.0011
Diameter of pore	mm	0.00005
Diameter of pellet	mm	2.5
Porosity of pellet	-	0.35
Pellet density	kg m <sup>-3</sup>	1130
Solid density	kg m <sup>-3</sup>	1740

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n) \quad , \text{ and}$$

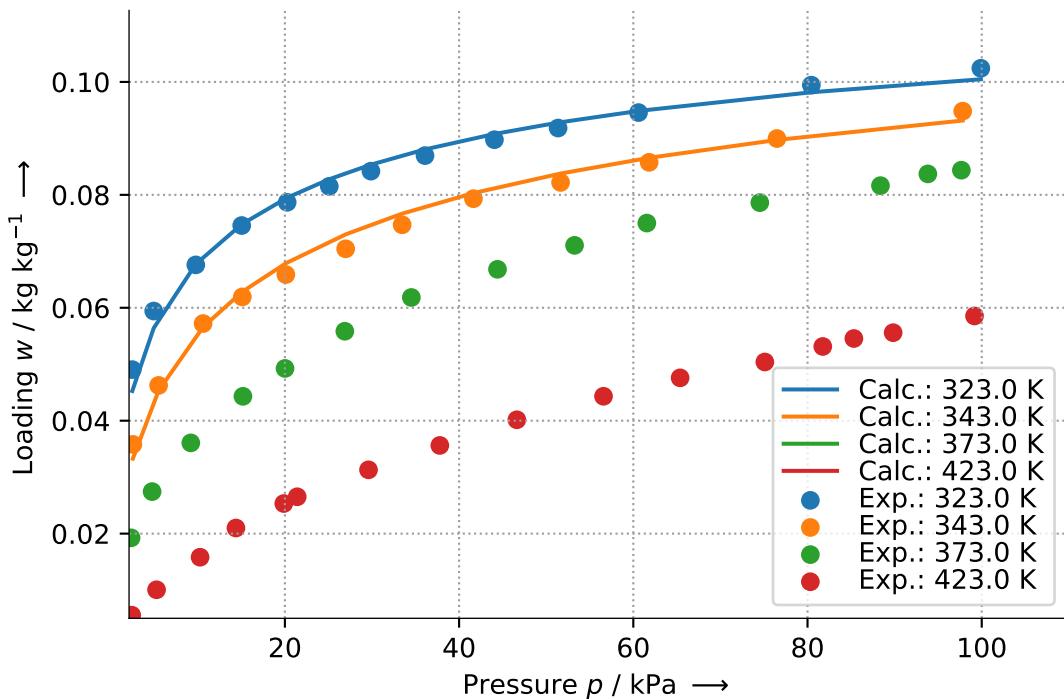
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.470000000e+00
E	J mol <sup>-1</sup>	1.820000000e+04	W <sub>0</sub>	kg kg <sup>-1</sup>	1.128960000e-01

**Validity:**

Equation is approximately valid for  $2375.0\text{Pa} \leq p \leq 99898.0\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.005826051\text{kg kg}^{-1} \leq w \leq 0.102996432\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.05%.

## 5.10.7.2 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propane
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.0011
Diameter of pore	mm	0.00005
Diameter of pellet	mm	1.65-2.5
Porosity of pellet	-	0.35
Pellet density	$\text{kg m}^{-3}$	1130
Solid density	$\text{kg m}^{-3}$	1740

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

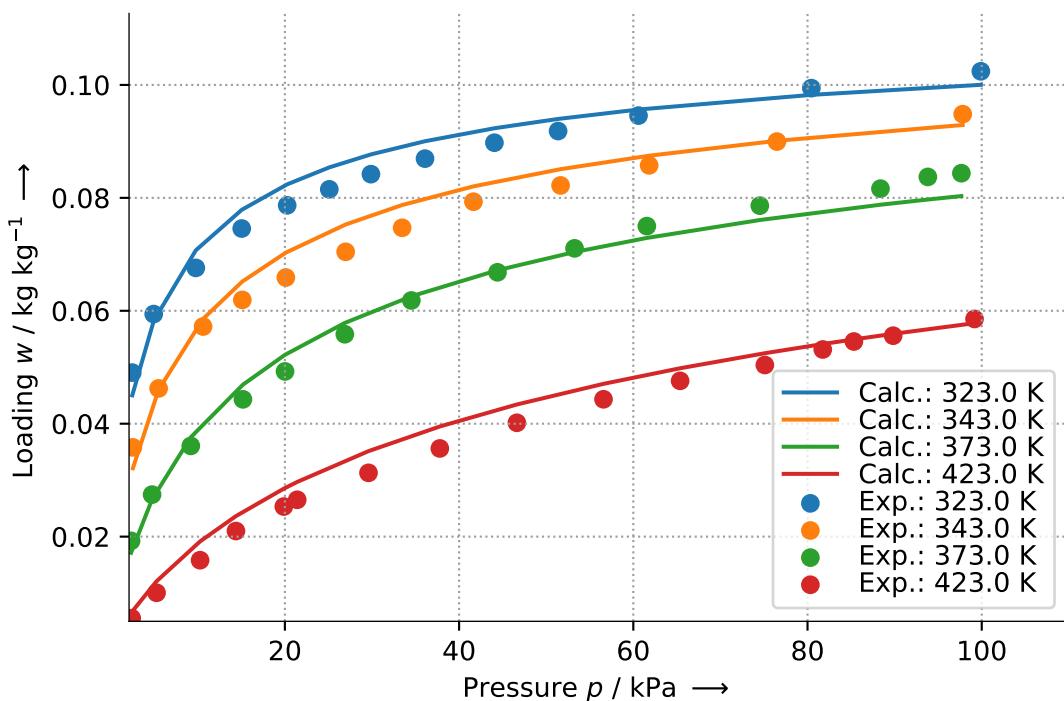
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	8.989322242e-06	$Q^*$	K	2.393419865e+03
$c$	K	0.000000000e+00	$r^*$	-	1.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$m$	-	1.724137931e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.150931700e-01
$n_0$	-	5.800000000e-01			

**Validity:**

Equation is approximately valid for  $2344.7\text{Pa} \leq p \leq 99897.9\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.005555781\text{kg kg}^{-1} \leq w \leq 0.102417046\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.43%.

## 5.11 Propylene

### 5.11.1 Carbon molecular sieve 4A

#### 5.11.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	carbon molecular sieve
<b>Subtype:</b>	4A
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Silva, Viviana M.T.M.; Gigola, Carlos; Rodrigues, Alirio E. (2003): Adsorption of propane and propylene onto carbon molecular sieve. In: Carbon 41 (13), S. 2533–2545. DOI: 10.1016/S0008-6223(03)00304-X.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.0003
Diameter of pellet	mm	1.1
Length of extrudate	mm	2.3-5
Porosity of pellet	-	0.315
Pellet density	kg m <sup>-3</sup>	900

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W p_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

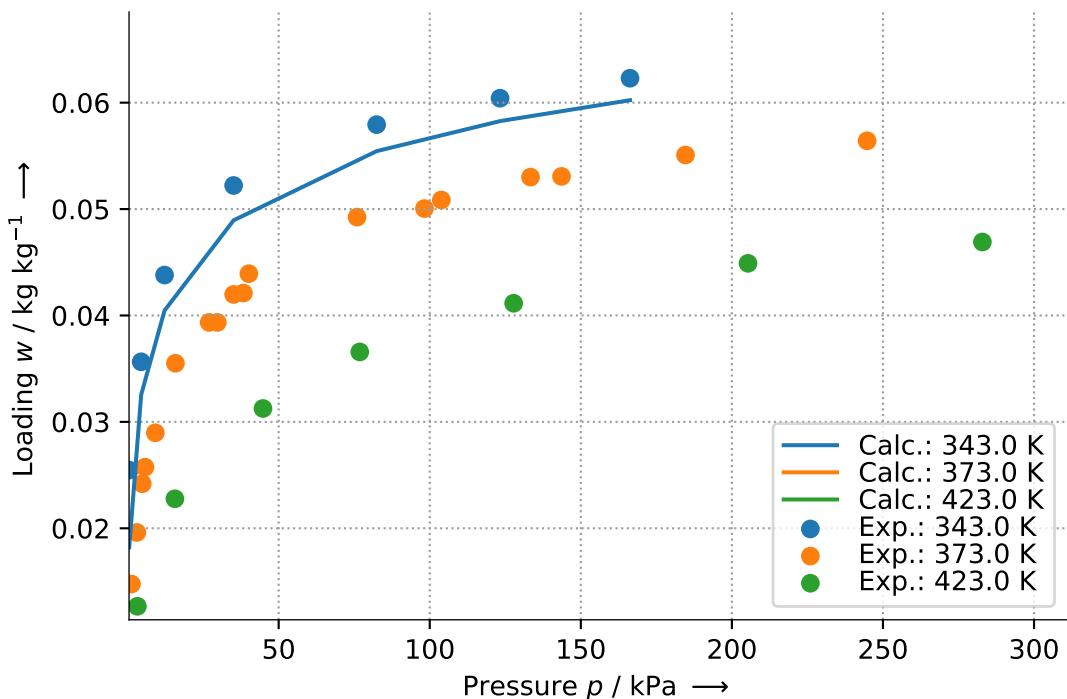
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.000000000e+00
E	J mol <sup>-1</sup>	2.123000000e+04	W <sub>0</sub>	kg kg <sup>-1</sup>	7.023152000e-02

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $109.0\text{Pa} \leq p \leq 283009.0\text{Pa}$ ,  $343.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.01275571\text{kg kg}^{-1} \leq w \leq 0.062451349\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 500
- Temperature, absolute, in K → 0.5

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.89%.

## 5.11.1.2 Toth - ID 1

<b>Sorbent:</b>	carbon molecular sieve
<b>Subtype:</b>	4A
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Silva, Viviana M.T.M.; Gigola, Carlos; Rodrigues, Alirio E. (2003): Adsorption of propane and propylene onto carbon molecular sieve. In: Carbon 41 (13), S. 2533–2545. DOI: 10.1016/S0008-6223(03)00304-X.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.0003
Diameter of pellet	mm	1.1
Length of extrudate	mm	2.3-5
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	0.31
Porosity of pellet	-	0.315
Pellet density	kg m <sup>-3</sup>	900

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

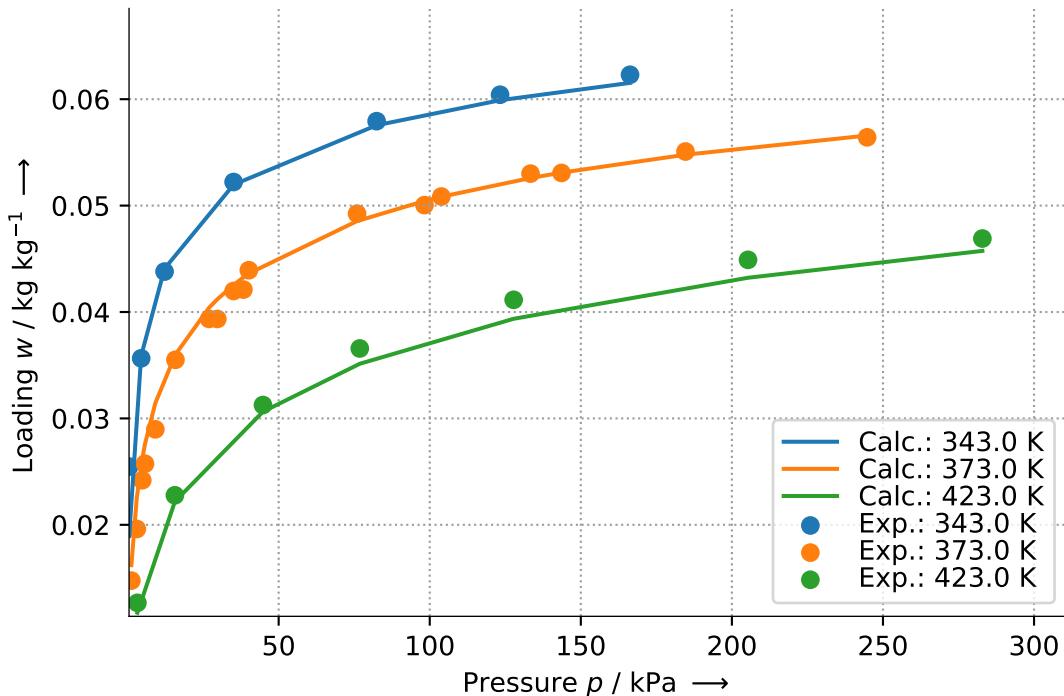
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	Pa <sup>-1</sup>	1.398214917e-03	$Q^*$	K	1.725908295e+03
$c$	K	0.000000000e+00	$r^*$	-	1.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$m$	-	3.076923077e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	8.108765898e-02
$n_0$	-	3.250000000e-01			

**Validity:**

Equation is approximately valid for  $540.0 \text{ Pa} \leq p \leq 282903.0 \text{ Pa}$ ,  $343.0 \text{ K} \leq T \leq 423.0 \text{ K}$ , and  $0.012668106 \text{ kg kg}^{-1} \leq w \leq 0.062296109 \text{ kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 500
- Temperature, absolute, in K → 0.5

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.85%.

### 5.11.2 Mof powder cubtc

#### 5.11.2.1 DualSiteSips - ID 1

<b>Sorbent:</b>	mof powder
<b>Subtype:</b>	cubtc
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	DualSiteSips
<b>ID:</b>	1
<b>Reference:</b>	Lamia, Nabil; Jorge, Miguel; Granato, Miguel A.; Almeida Paz, Filipe A.; Chevreau, Hubert; Rodrigues, Alírio E. (2009): Adsorption of propane, propylene and isobutane on a metal-organic framework. Molecular simulation and experiment. In: Chemical Engineering Science 64 (14), S. 3246–3259. DOI: 10.1016/j.ces.2009.04.010.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.0016
Surface area	$\text{m}^2 \text{g}^{-1}$	1500-2100
Bulk density	$\text{kg m}^{-3}$	350

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \sum_{i=A}^B w_i \frac{(b_i p)^{1/\eta_i}}{1 + (b_i p)^{1/\eta_i}} \quad , \text{ and}$$

$$b_i = b_{i,0} \exp\left(\frac{Q_i}{RT}\left(1 - \frac{T}{T_0}\right)\right) \quad .$$

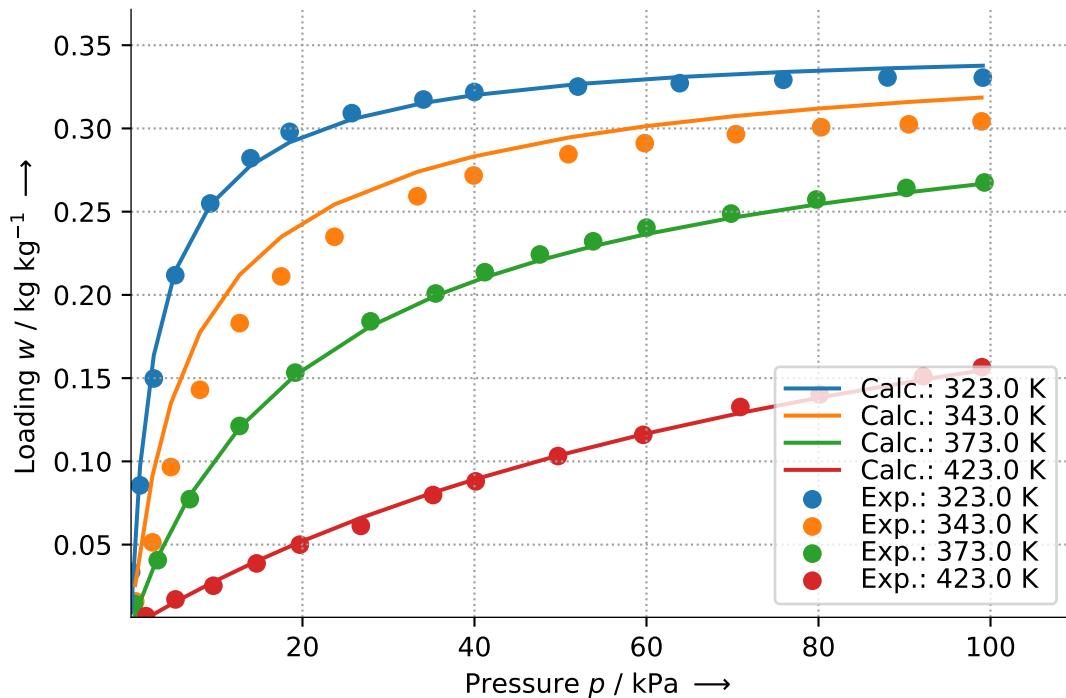
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_{A,0}$	$\text{Pa}^{-1}$	4.200000000e-04	$b_{B,0}$	$\text{Pa}^{-1}$	6.000000000e-05
$Q_A$	$\text{J mol}^{-1}$	4.190000000e+04	$Q_B$	$\text{J mol}^{-1}$	4.700000000e+04
$\eta_A$	-	1.000000000e+00	$\eta_B$	-	8.000000000e-01
$w_A$	$\text{kg kg}^{-1}$	2.983453566e-01	$w_B$	$\text{kg kg}^{-1}$	5.133728280e-02

Par.	Unit	Value	Par.	Unit	Value
$T_0$	K	3.230000000e+02			

**Validity:**

Equation is approximately valid for  $75.7\text{Pa} \leq p \leq 99297.6\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.007015955\text{kg kg}^{-1} \leq w \leq 0.33063272\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 50
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.87%.

### 5.11.3 Zeolite crystal 5A

#### 5.11.3.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeolite crystal
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.001

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

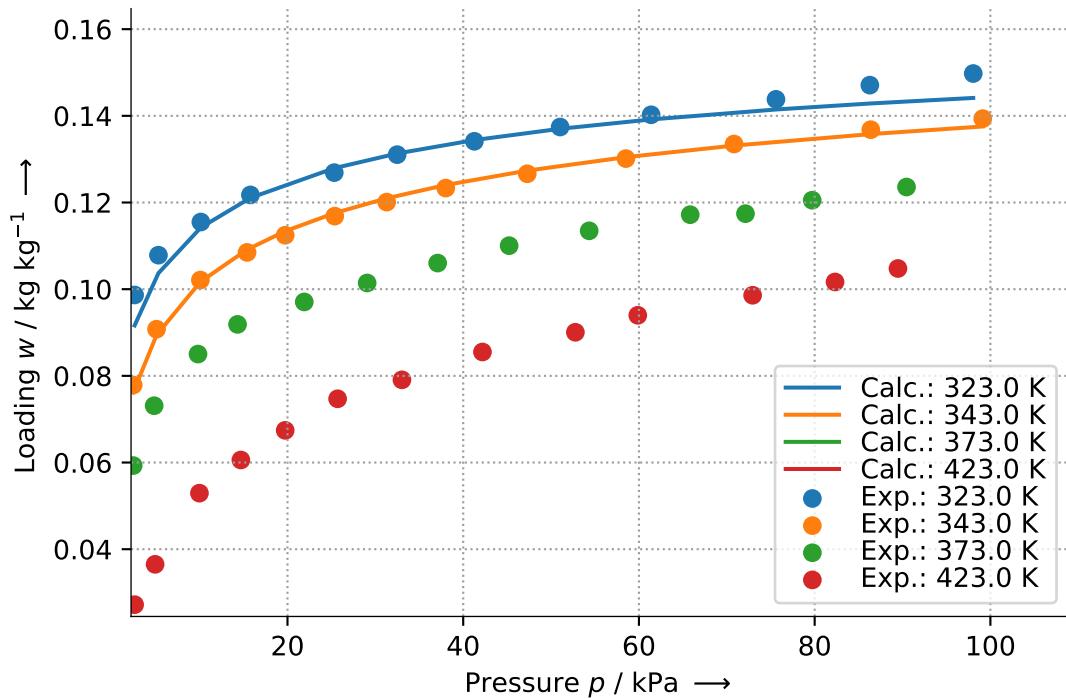
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.280000000e+00
E	$\text{J mol}^{-1}$	2.340000000e+04	$W_0$	$\text{kg kg}^{-1}$	1.578000000e-01

#### Validity:

Equation is approximately valid for  $2383.0\text{Pa} \leq p \leq 98972.0\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.027331802\text{kg kg}^{-1} \leq w \leq 0.150613578\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.35%.

## 5.11.3.2 Toth - ID 1

<b>Sorbent:</b>	zeolite crystal
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.001
Diameter of pore	mm	0.00005
Diameter of pellet	mm	1.65-2.5
Porosity of pellet	-	0.35
Pellet density	$\text{kg m}^{-3}$	1130
Solid density	$\text{kg m}^{-3}$	1740

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

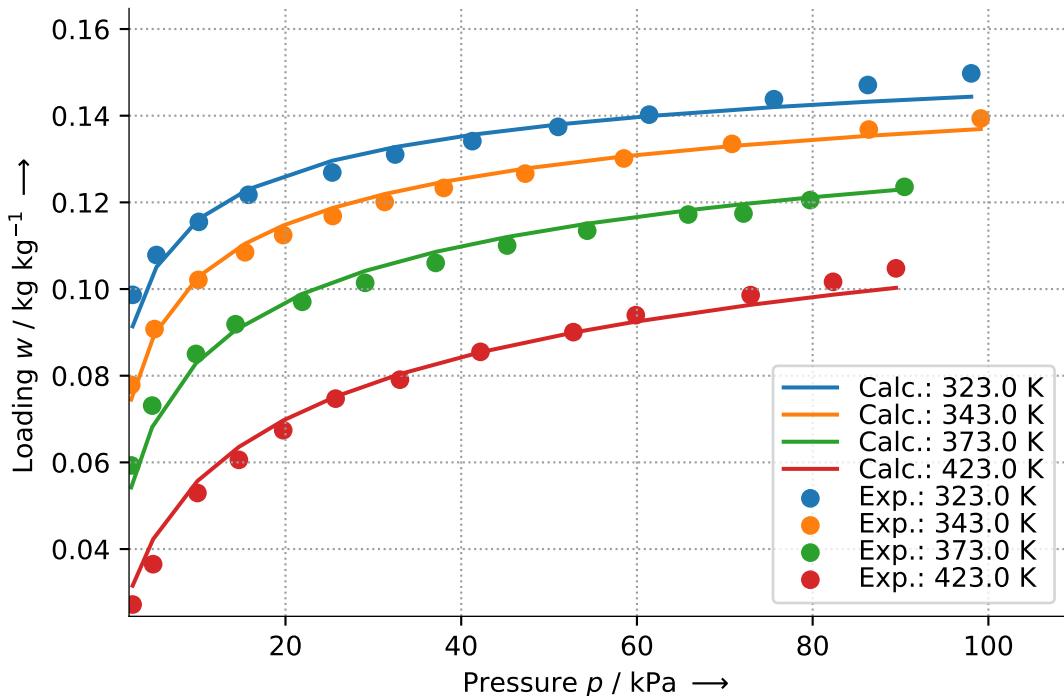
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	8.391732682e-04	$Q^*$	K	1.683812971e+03
$c$	K	0.000000000e+00	$r^*$	-	1.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$m$	-	2.500000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.691605548e-01
$n_0$	-	4.000000000e-01			

**Validity:**

Equation is approximately valid for  $2440.3\text{Pa} \leq p \leq 99132.3\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.027199923\text{kg kg}^{-1} \leq w \leq 0.149766003\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.65%.

### 5.11.4 Zeolite pellet 13X

#### 5.11.4.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Da Silva, Francisco A.; Rodrigues, Alírio E. (1999): Adsorption Equilibria and Kinetics for Propylene and Propane over 13X and 4A Zeolite Pellets. In: Ind. Eng. Chem. Res. 38 (5), S. 2051–2057. DOI: 10.1021/ie980640z.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.002
Diameter of pellet	mm	0.79
Diameter of extrudate	mm	1.5-1.9
Length of extrudate	mm	4-7
Porosity of pellet	-	0.39
Bulk density	kg m <sup>-3</sup>	630-680
Pellet density	kg m <sup>-3</sup>	1358
Solid density	kg m <sup>-3</sup>	2234

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

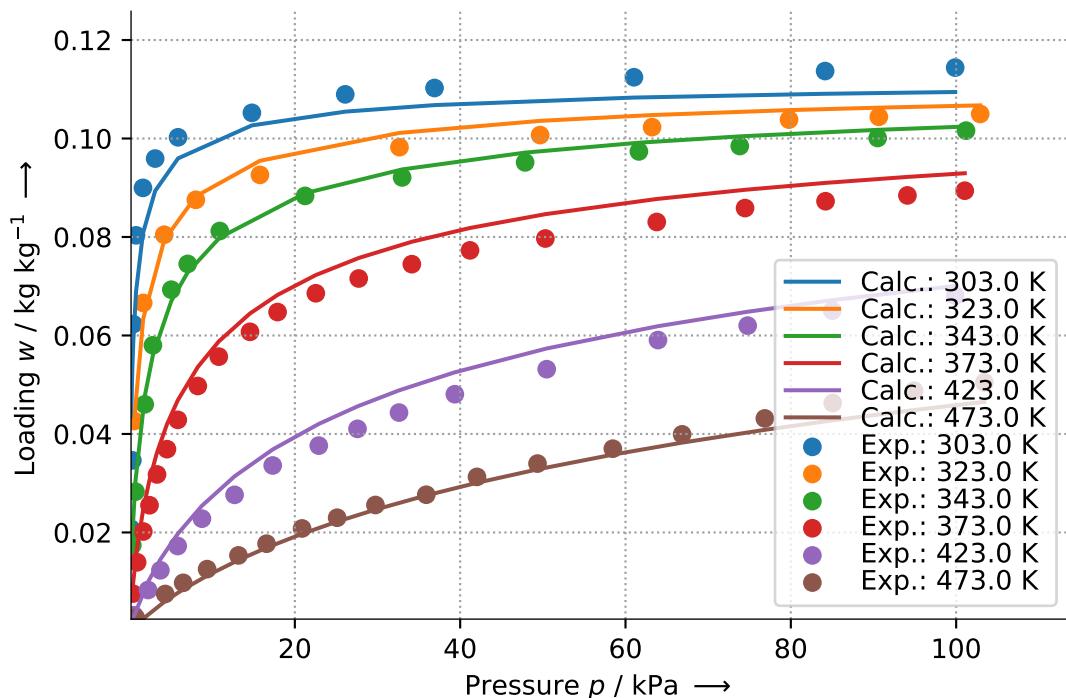
$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	3.500000000e-10	$Q^*$	K	5.100000000e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.127737032e-01
$n_0$	-	6.080000000e-01			

**Validity:**

Equation is approximately valid for  $207.5 \text{ Pa} \leq p \leq 103413.5 \text{ Pa}$ ,  $303.0 \text{ K} \leq T \leq 473.0 \text{ K}$ , and  $0.002668276 \text{ kg kg}^{-1} \leq w \leq 0.114398823 \text{ kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 26.73%.

## 5.11.4.2 Toth - ID 2

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	Toth
<b>ID:</b>	2
<b>Reference:</b>	Lamia, Nabil; Wolff, Luc; Leflaive, Philibert; Sá Gomes, Pedro; Grande, Carlos A.; Rodrigues, Alírio E. (2007): Propane/Propylene Separation by Simulated Moving Bed I. Adsorption of Propane, Propylene and Isobutane in Pellets of 13X Zeolite. In: Separation Science and Technology 42 (12), S. 2539–2566. DOI: 10.1080/01496390701515219.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.001
Diameter of pore	mm	0.0000005
Diameter of extrudate	mm	0.8
Porosity of pellet	-	0.395
Pellet density	kg m <sup>-3</sup>	1357

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

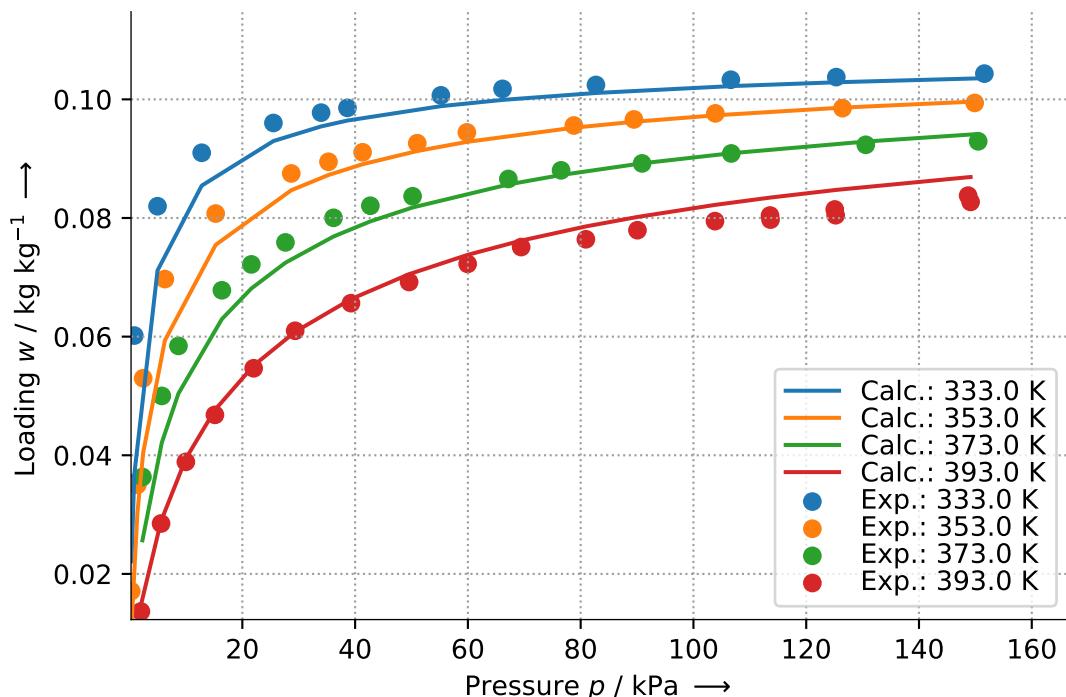
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$b_0$	Pa <sup>-1</sup>	2.500000000e-10		$Q^*$	K	5.099547854e+03

Par.	Unit	Value	Par.	Unit	Value
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.089865266e-01
$n_0$	-	6.580000000e-01			

**Validity:**

Equation is approximately valid for  $269.2\text{Pa} \leq p \leq 151780.1\text{Pa}$ ,  $333.0\text{K} \leq T \leq 393.0\text{K}$ , and  $0.004055645\text{kg kg}^{-1} \leq w \leq 0.10404889\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 50
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.91%.

### 5.11.5 Zeolite pellet 4A

#### 5.11.5.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	4A
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Da Silva, Francisco A.; Rodrigues, Alírio E. (1999): Adsorption Equilibria and Kinetics for Propylene and Propane over 13X and 4A Zeolite Pellets. In: Ind. Eng. Chem. Res. 38 (5), S. 2051–2057. DOI: 10.1021/ie980640z.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.0034
Diameter of pellet	mm	1.6
Diameter of extrudate	mm	3.2
Length of extrudate	mm	8-12
Porosity of pellet	-	0.34
Bulk density	kg m <sup>-3</sup>	>700
Pellet density	kg m <sup>-3</sup>	1700
Solid density	kg m <sup>-3</sup>	2590

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

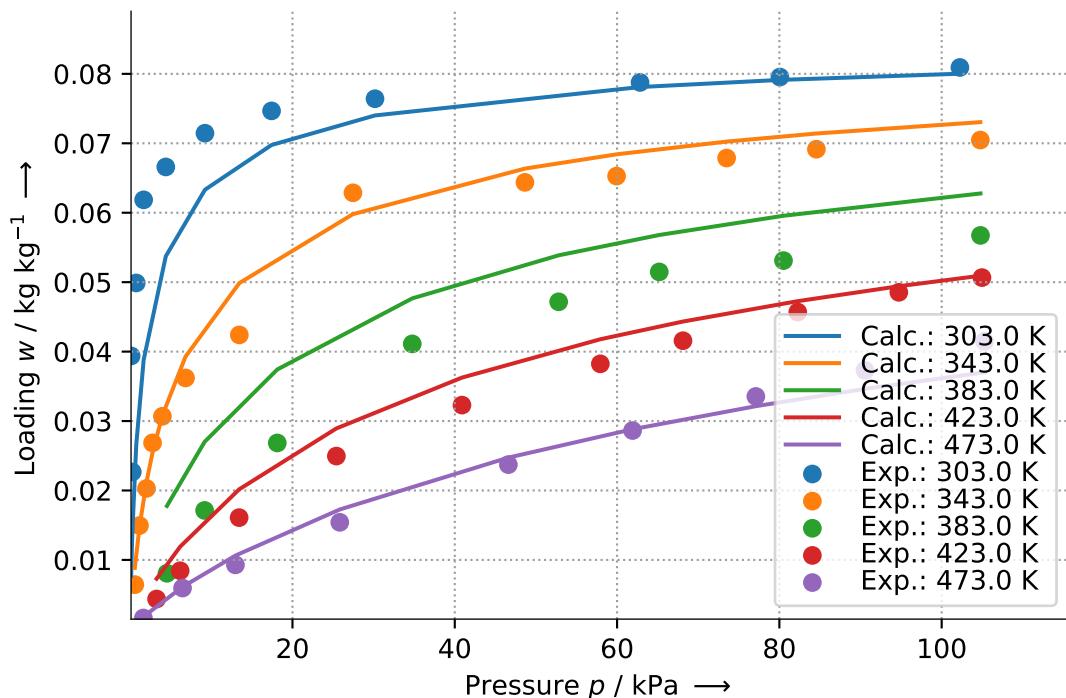
$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	7.400000000e-09	$Q^*$	K	3.594000000e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	8.542187220e-02
$n_0$	-	6.660000000e-01			

**Validity:**

Equation is approximately valid for  $207.5\text{Pa} \leq p \leq 102906.9\text{Pa}$ ,  $303.0\text{K} \leq T \leq 473.0\text{K}$ , and  $0.00287068\text{kg kg}^{-1} \leq w \leq 0.114398823\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 17.17%.

### 5.11.6 Zeolite pellet 5A

#### 5.11.6.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of crystal	mm	0.0011
Diameter of pore	mm	0.00005
Diameter of pellet	mm	2.5
Porosity of pellet	-	0.35
Pellet density	kg m <sup>-3</sup>	1130
Solid density	kg m <sup>-3</sup>	1740

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n) \quad , \text{ and}$$

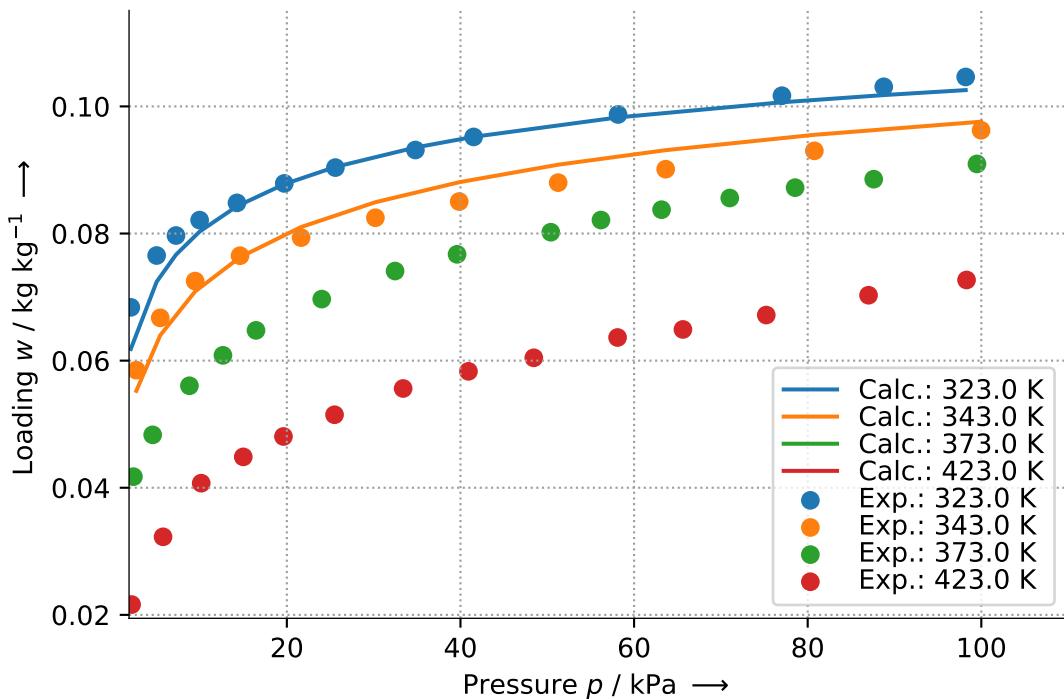
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.130000000e+00
E	J mol <sup>-1</sup>	2.340000000e+04	W <sub>0</sub>	kg kg <sup>-1</sup>	1.140368000e-01

**Validity:**

Equation is approximately valid for  $2096.0\text{Pa} \leq p \leq 99689.0\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.021808381\text{kg kg}^{-1} \leq w \leq 0.104713555\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.44%.

## 5.11.6.2 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Propylene
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Grande, Carlos A.; Gigola, Carlos; Rodrigues, Alírio E. (2002): Adsorption of Propane and Propylene in Pellets and Crystals of 5A Zeolite. In: Ind. Eng. Chem. Res. 41 (1), S. 85–92. DOI: 10.1021/ie010494o.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of crystal	mm	0.0011
Diameter of pore	mm	0.00005
Diameter of pellet	mm	1.65-2.5
Porosity of pellet	-	0.35
Pellet density	$\text{kg m}^{-3}$	1130
Solid density	$\text{kg m}^{-3}$	1740

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

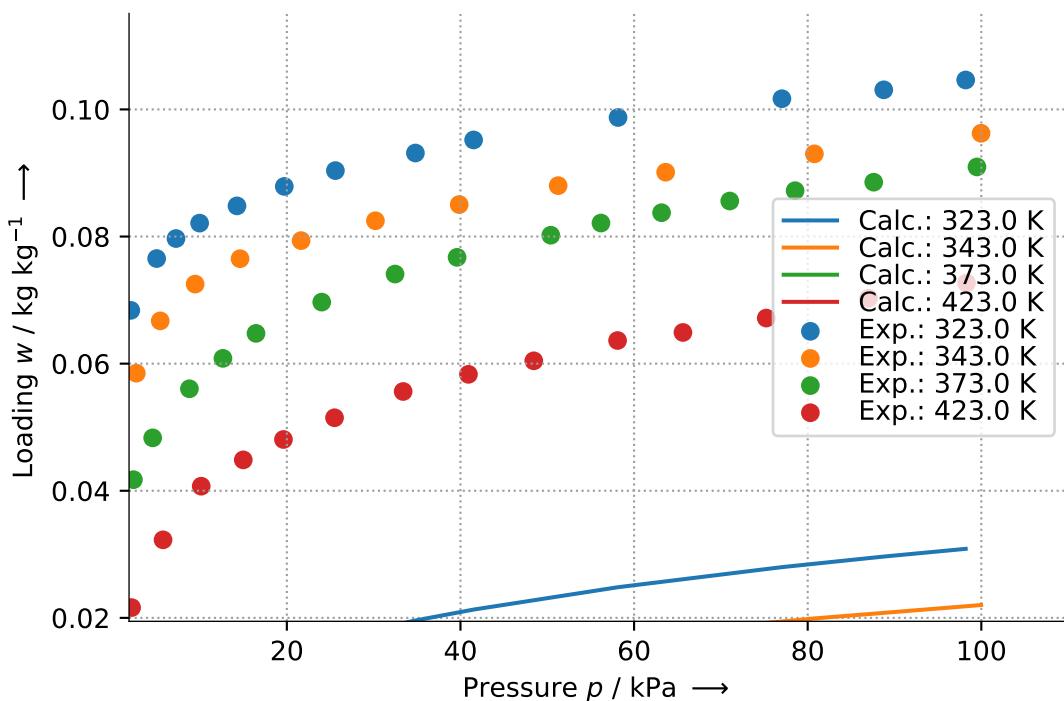
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	1.680162818e-04	$Q^*$	K	1.611649558e+03
$c$	K	0.000000000e+00	$r^*$	-	1.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$m$	-	2.777777778e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.232936382e-01
$n_0$	-	3.600000000e-01			

**Validity:**

Equation is approximately valid for  $2025.1\text{Pa} \leq p \leq 99973.3\text{Pa}$ ,  $323.0\text{K} \leq T \leq 423.0\text{K}$ , and  $0.021620991\text{kg kg}^{-1} \leq w \leq 0.104631694\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 40

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 88.85%.

## 5.12 R-1234ze(E)

### 5.12.1 Activated carbon powder Maxsorb III

#### 5.12.1.1 Toth - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-1234ze(E)
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Jribi, Skander; Saha, Bidyut Baran; Koyama, Shigeru; Chakraborty, Anutosh; Ng, Kim Choon (2013): Study on activated carbon/HFO-1234ze(E) based adsorption cooling cycle. In: Applied Thermal Engineering 50 (2), S. 1570–1575. DOI: 10.1016/j.applthermaleng.2011.11.066.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	1.300000000e-05	$Q^*$	K	3.863148044e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	3.740000000e+00
$n_0$	-	2.950000000e-01			

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 5.13 R-134a

### 5.13.1 Activated carbon Maxsorb III

#### 5.13.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut B.; Habib, Khairul; El-Sharkawy, Ibrahim I.; Koyama, Shigeru (2009): Adsorption characteristics and heat of adsorption measurements of R-134a on activated carbon. In: International Journal of Refrigeration 32 (7), S. 1563–1569. DOI: 10.1016/j.ijrefrig.2009.03.010.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.26e-4 * \exp(\ln(9.39e-4 / 7.26e-4) * (T - 246.78) / (374.21 - 246.78))$ in kg/m <sup>3</sup> ); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.072
Surface area	m <sup>2</sup> g <sup>-1</sup>	3150
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	1.7

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.300000000e+00
$E$	J mol <sup>-1</sup>	8.460000000e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	1.649000000e-03

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.13.1.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Saha, Bidyut B.; Habib, Khairul; El-Sharkawy, Ibrahim I.; Koyama, Shigeru (2009): Adsorption characteristics and heat of adsorption measurements of R-134a on activated carbon. In: International Journal of Refrigeration 32 (7), S. 1563–1569. DOI: 10.1016/j.ijrefrig.2009.03.010.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.26e-4 * \exp(\ln(9.39e-4 / 7.26e-4) * (T - 246.78) / (374.21 - 246.78))$ in kg/m <sup>3</sup> ); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.072
Surface area	m <sup>2</sup> g <sup>-1</sup>	3150
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	1.7

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-A/E)^n, \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.170000000e+00
E	J mol <sup>-1</sup>	8.700000000e+03	W <sub>0</sub>	kg kg <sup>-1</sup>	1.945000000e+00

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.13.2 Activated carbon SRD 1352/3

#### 5.13.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	SRD 1352/3
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; El-Sharkawy, Ibrahim I.; Thorpe, Roger; Critoph, Robert E. (2012): Accurate adsorption isotherms of R134a onto activated carbons for cooling and freezing applications. In: International Journal of Refrigeration 35 (3), S. 499–505. DOI: 10.1016/j.ijrefrig.2011.05.002.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.2643e-4 * \exp(\ln(9.39e-4 / 7.2643e-4) * (T - 246.78) / (374.21 - 246.78))$ in kg/m <sup>3</sup> ); inverse functions may not work anymore.

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-A/E)^n, \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

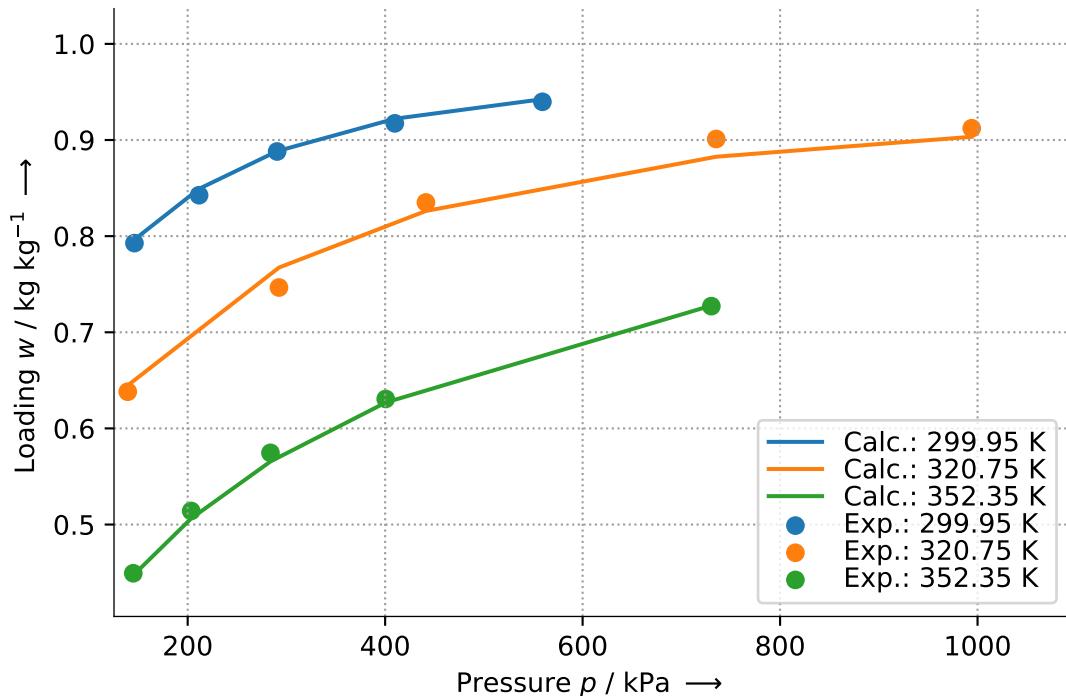
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.700000000e+00
$E$	J mol <sup>-1</sup>	1.091659312e+04	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	7.670000000e-04

#### Validity:

Equation is approximately valid for  $131850.0 \text{Pa} \leq p \leq 965390.0 \text{Pa}$ ,  $303.35 \text{K} \leq T \leq 351.65 \text{K}$ , and  $0.42159 \text{kg kg}^{-1} \leq w \leq 1.20432 \text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.95%.

### 5.13.2.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	SRD 1352/3
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Saha, Bidyut Baran; El-Sharkawy, Ibrahim I.; Thorpe, Roger; Critoph, Robert E. (2012): Accurate adsorption isotherms of R134a onto activated carbons for cooling and freezing applications. In: International Journal of Refrigeration 35 (3), S. 499–505. DOI: 10.1016/j.ijrefrig.2011.05.002.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.2643e-4 * \exp(\ln(9.39e-4 / 7.2643e-4) * (T - 246.78) / (374.21 - 246.78))$ in kg/m <sup>3</sup> ); inverse functions may not work anymore.

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.800000000e+00
E	J mol <sup>-1</sup>	9.729715794e+03	W <sub>0</sub>	kg kg <sup>-1</sup>	9.260000000e-01

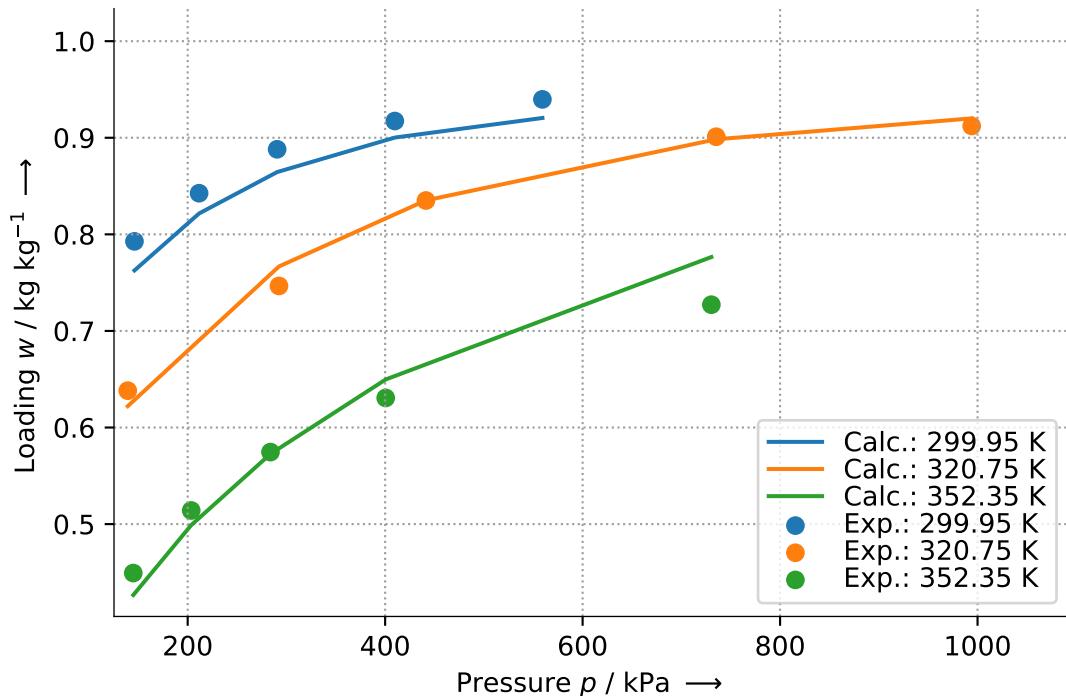
#### Validity:

Equation is approximately valid for  $131850.0 \text{ Pa} \leq p \leq 965390.0 \text{ Pa}$ ,  $303.35 \text{ K} \leq T \leq 351.65 \text{ K}$ , and  $0.42159 \text{ kg kg}^{-1} \leq w \leq 1.20432 \text{ kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.49%.

### 5.13.3 Activated carbon granular

#### 5.13.3.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	granular
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Askalany, Ahmed A.; Salem, M.; Ismail, I. M.; Ali, Ahmed Hamza H.; Morsy, M. G. (2012): Experimental study on adsorption-desorption characteristics of granular activated carbon/R134a pair. In: International Journal of Refrigeration 35 (3), S. 494–498. DOI: 10.1016/j.ijrefrig.2011.04.002.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	900
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.88
Bulk density	$\text{kg m}^{-3}$	510

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.830000000e+00
E	$\text{J mol}^{-1}$	9.575000000e+03	$W_0$	$\text{kg kg}^{-1}$	1.680000000e+00

#### Validity:

Equation is approximately valid for  $293.15\text{K} \leq T \leq 363.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.13.4 Activated carbon fiber A-20

#### 5.13.4.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut Baran; El-Sharkawy, Ibrahim I.; Thorpe, Roger; Critoph, Robert E. (2012): Accurate adsorption isotherms of R134a onto activated carbons for cooling and freezing applications. In: International Journal of Refrigeration 35 (3), S. 499–505. DOI: 10.1016/j.ijrefrig.2011.05.002.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.2643e-4 * \exp(\ln(9.39e-4 / 7.2643e-4) * (T - 246.78) / (374.21 - 246.78))$ in kg/m <sup>3</sup> ); inverse functions may not work anymore.

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

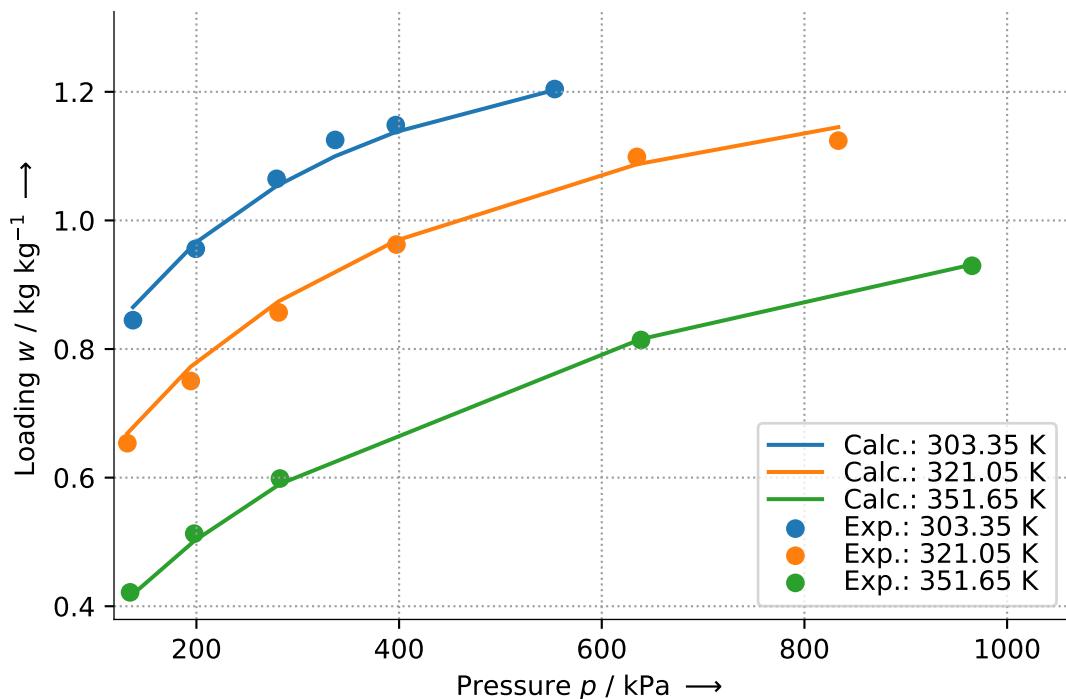
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.500000000e+00
$E$	J mol <sup>-1</sup>	8.611656172e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	1.010000000e-03

#### Validity:

Equation is approximately valid for  $139320.0 \text{Pa} \leq p \leq 994090.0 \text{Pa}$ ,  $299.95 \text{K} \leq T \leq 352.35 \text{K}$ , and  $0.44932 \text{kg kg}^{-1} \leq w \leq 0.93974 \text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.43%.

### 5.13.4.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Saha, Bidyut Baran; El-Sharkawy, Ibrahim I.; Thorpe, Roger; Critoph, Robert E. (2012): Accurate adsorption isotherms of R134a onto activated carbons for cooling and freezing applications. In: International Journal of Refrigeration 35 (3), S. 499–505. DOI: 10.1016/j.ijrefrig.2011.05.002.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.2643e-4 * \exp(\ln(9.39e-4 / 7.2643e-4) * (T - 246.78) / (374.21 - 246.78))$ in kg/m <sup>3</sup> ); inverse functions may not work anymore.

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-A/E)^n, \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.400000000e+00
E	J mol <sup>-1</sup>	7.720071086e+03	W <sub>0</sub>	kg kg <sup>-1</sup>	1.256000000e+00

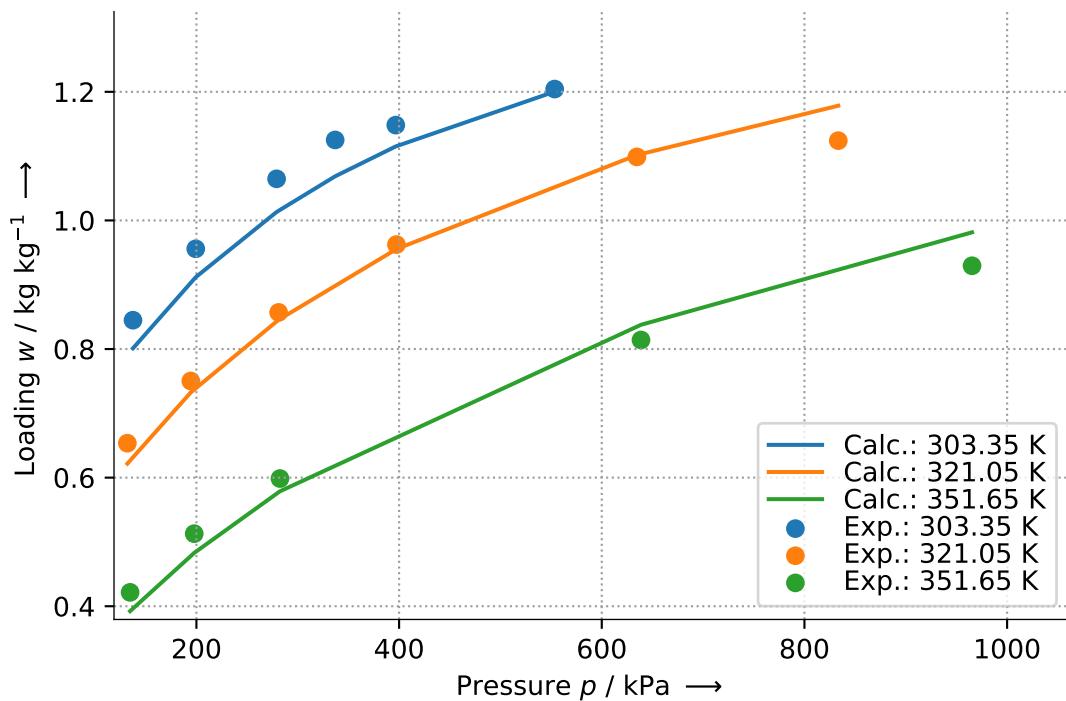
#### Validity:

Equation is approximately valid for  $139320.0 \text{Pa} \leq p \leq 994090.0 \text{Pa}$ ,  $299.95 \text{K} \leq T \leq 352.35 \text{K}$ , and  $0.44932 \text{kg kg}^{-1} \leq w \leq 0.93974 \text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.64%.

## 5.13.4.3 DubininAstakhov - ID 3

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	3
<b>Reference:</b>	Loh, Wai Soong; Ismail, Azhar Bin; Xi, Baojuan; Ng, Kim Choon; Chun, Won Gee (2012): Adsorption Isotherms and Isosteric Enthalpy of Adsorption for Assorted Refrigerants on Activated Carbons. In: J. Chem. Eng. Data 57 (10), S. 2766–2773. DOI: 10.1021/je3008099.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	0.00000216
Surface area	$\text{m}^2 \text{g}^{-1}$	1930
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.05
Solid density	$\text{kg m}^{-3}$	2200

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

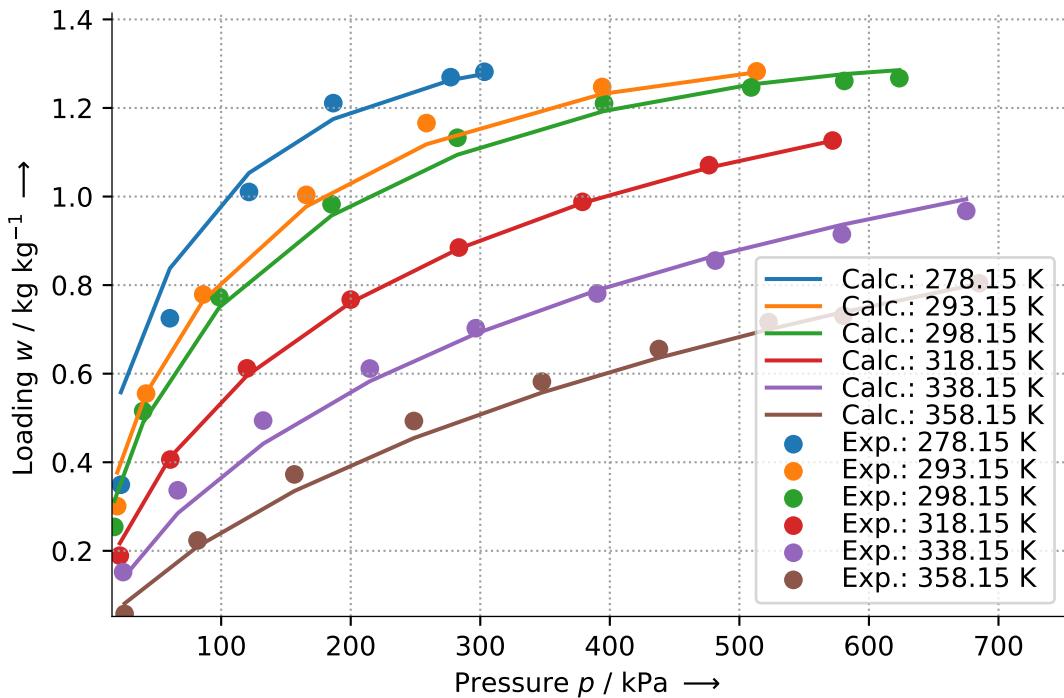
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.490000000e+00
E	$\text{J mol}^{-1}$	7.136010000e+03	$W_0$	$\text{kg kg}^{-1}$	1.290000000e+00

**Validity:**

Equation is approximately valid for  $17485.0 \text{Pa} \leq p \leq 685047.0 \text{Pa}$ ,  $278.15 \text{K} \leq T \leq$



328.15K, and  $0.05756\text{kg kg}^{-1} \leq w \leq 1.28264\text{kg kg}^{-1}$ .

### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % → 0 Pa < p < 5 MPa: 0.1
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.37%.

### 5.13.5 Activated carbon powder Maxsorb III

#### 5.13.5.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Loh, Wai Soong; Ismail, Azhar Bin; Xi, Baojuan; Ng, Kim Choon; Chun, Won Gee (2012): Adsorption Isotherms and Isosteric Enthalpy of Adsorption for Assorted Refrigerants on Activated Carbons. In: J. Chem. Eng. Data 57 (10), S. 2766–2773. DOI: 10.1021/je3008099.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3150
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

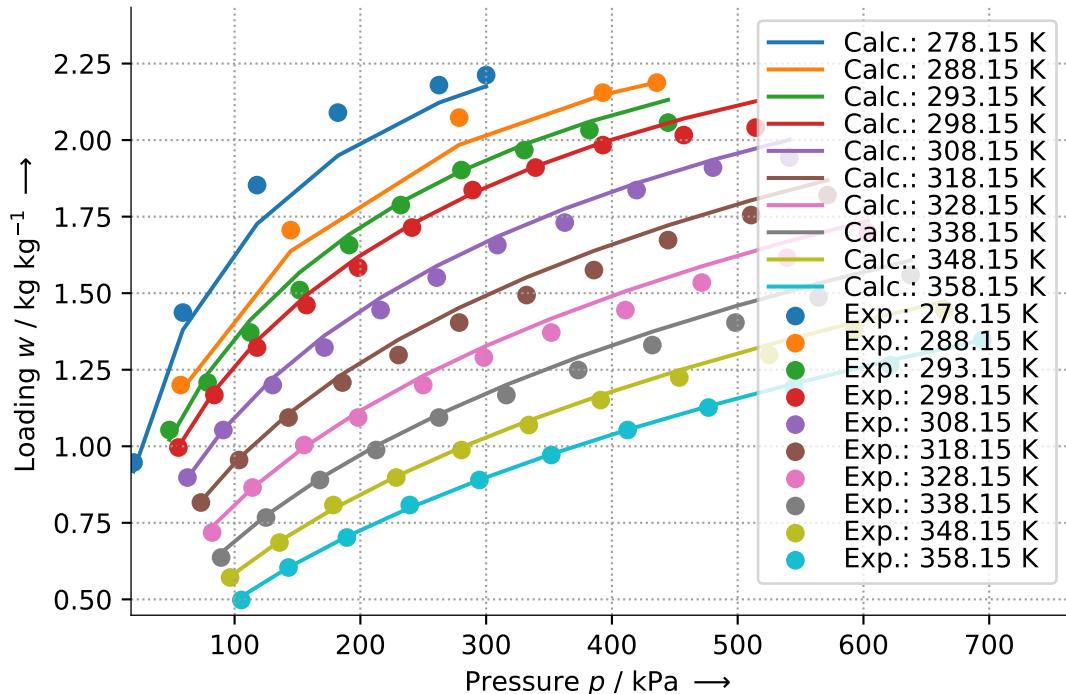
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.290000000e+00
E	$\text{J mol}^{-1}$	7.332690000e+03	$W_0$	$\text{kg kg}^{-1}$	2.220000000e+00

#### Validity:

Equation is approximately valid for  $19642.9 \text{Pa} \leq p \leq 694643.0 \text{Pa}$ ,  $278.15 \text{K} \leq T \leq$

358.15K, and  $0.497959\text{kg kg}^{-1} \leq w \leq 2.21224\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % →  $0 \text{ Pa} < p < 5 \text{ MPa}$ : 0.1
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.0%.

### 5.13.5.2 Toth - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Jribi, Skander; Saha, Bidyut Baran; Koyama, Shigeru; Chakraborty, Anutosh; Ng, Kim Choon (2013): Study on activated carbon/HFO-1234ze(E) based adsorption cooling cycle. In: Applied Thermal Engineering 50 (2), S. 1570–1575. DOI: 10.1016/j.applthermaleng.2011.11.066.
<b>Comment:</b>	None

**Properties of sorbent:**

Property data of sorbent and subtype does not exist.

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	3.510000000e-05	$Q^*$	K	3.027255176e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	4.320000000e+00
$n_0$	-	3.210000000e-01			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.13.6 Activated charcoal pellet Chemviron

#### 5.13.6.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal pellet
<b>Subtype:</b>	Chemviron
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Akkimaradi, Basavaraj S.; Prasad, Madhu; Dutta, Pradip; Srivivasan, Kandadai (2001): Adsorption of 1,1,1,2-Tetrafluoroethane on Activated Charcoal. In: J. Chem. Eng. Data 46 (2), S. 417–422. DOI: 10.1021/je000277e.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.2643 \times 10^{-4} \times \exp(\ln(9.39 \times 10^{-4}) / 7.2643 \times 10^{-4}) \times (T - 246.78) / (374.21 - 246.78)$ ) in kg/m <sup>3</sup> ; inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Solid density	kg m <sup>-3</sup>	2200

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

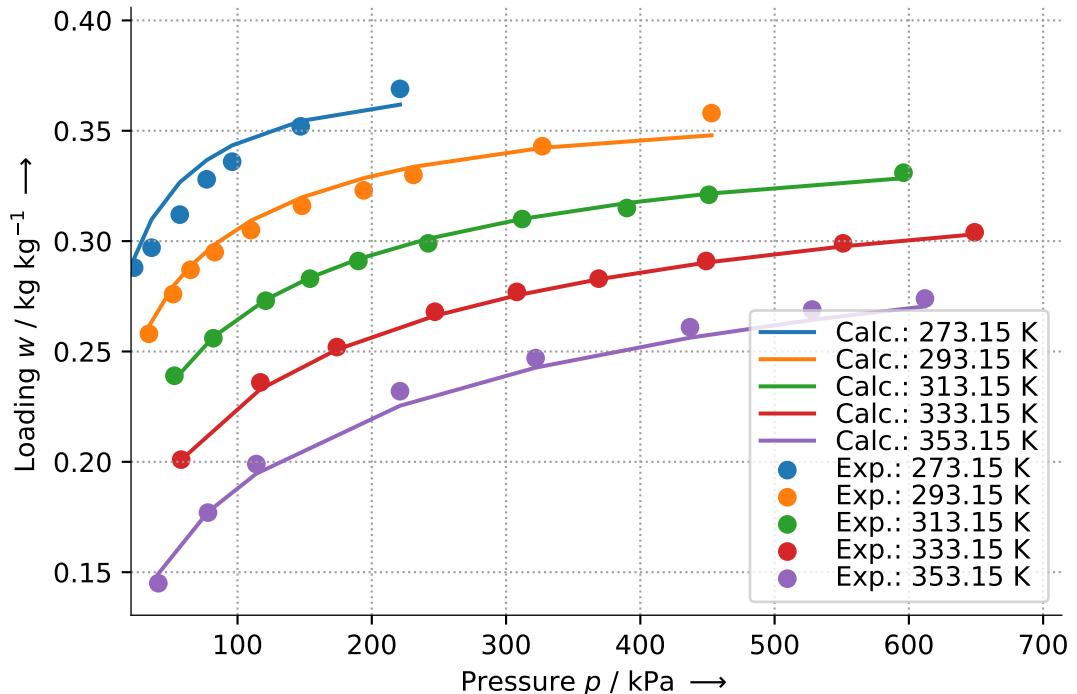
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.600000000e+00
E	J mol <sup>-1</sup>	1.487000000e+04	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	2.790000000e-04

#### Validity:

Equation is approximately valid for  $23000.0 \text{ Pa} \leq p \leq 649000.0 \text{ Pa}$ ,  $273.15 \text{ K} \leq T \leq$

353.15K, and  $0.145\text{kg kg}^{-1} \leq w \leq 0.369\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 2500

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.22%.

### 5.13.7 Activated charcoal powder Fluka

#### 5.13.7.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal powder
<b>Subtype:</b>	Fluka
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Akkimaradi, Basavaraj S.; Prasad, Madhu; Dutta, Pradip; Srinivasan, Kandadai (2001): Adsorption of 1,1,1,2-Tetrafluoroethane on Activated Charcoal. In: J. Chem. Eng. Data 46 (2), S. 417–422. DOI: 10.1021/je000277e.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.2643e-4 * \exp(\ln(9.39e-4 / 7.2643e-4) * (T - 246.78) / (374.21 - 246.78))$ in kg/m <sup>3</sup> ); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Surface area	m <sup>2</sup> g <sup>-1</sup>	1143
Solid density	kg m <sup>-3</sup>	2200

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

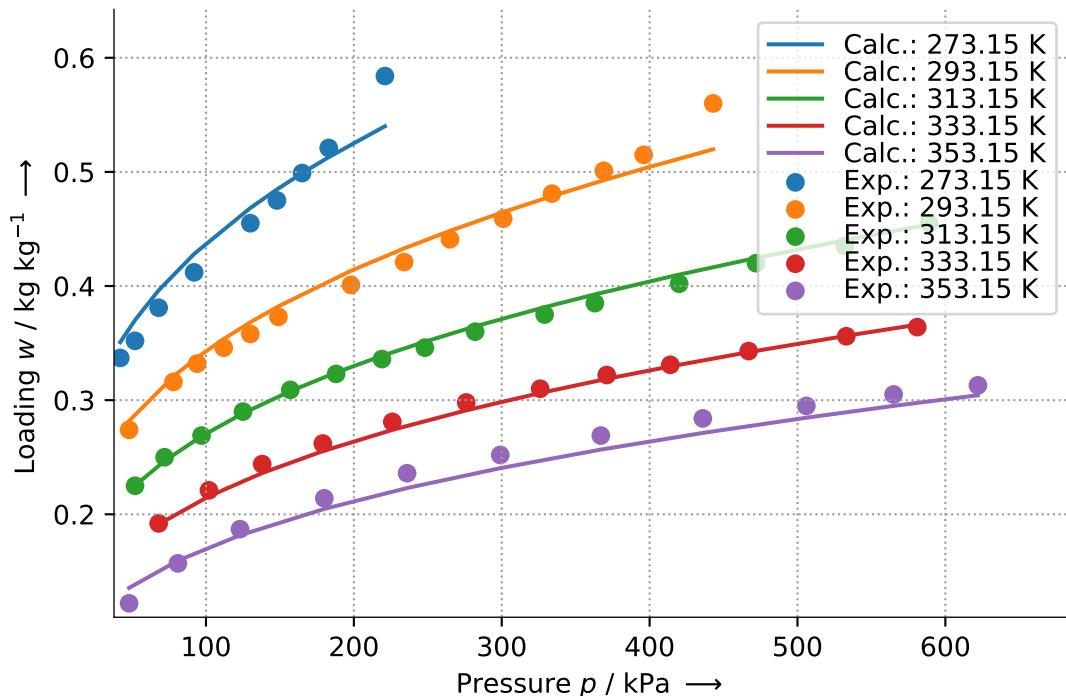
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	9.500000000e-01
E	J mol <sup>-1</sup>	8.897000000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	4.490000000e-04

#### Validity:

Equation is approximately valid for  $42000.0 \text{ Pa} \leq p \leq 622000.0 \text{ Pa}$ ,  $273.15 \text{ K} \leq T \leq$

353.15K, and  $0.122\text{kg kg}^{-1} \leq w \leq 0.584\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 2500

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.39%.

### 5.13.8 Activated charcoal powder Maxsorb

#### 5.13.8.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated charcoal powder
<b>Subtype:</b>	Maxsorb
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Akkimaradi, Basavaraj S.; Prasad, Madhu; Dutta, Pradip; Srivivasan, Kandadai (2001): Adsorption of 1,1,1,2-Tetrafluoroethane on Activated Charcoal. In: J. Chem. Eng. Data 46 (2), S. 417–422. DOI: 10.1021/je000277e.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., $1/\rho_{\text{adsorpt}} = 7.2643 \times 10^{-4} \times \exp(\ln(9.39 \times 10^{-4}) / 7.2643 \times 10^{-4}) \times (T - 246.78) / (374.21 - 246.78)$ ) in kg/m <sup>3</sup> ; inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Solid density	kg m <sup>-3</sup>	2200

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-A/E^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

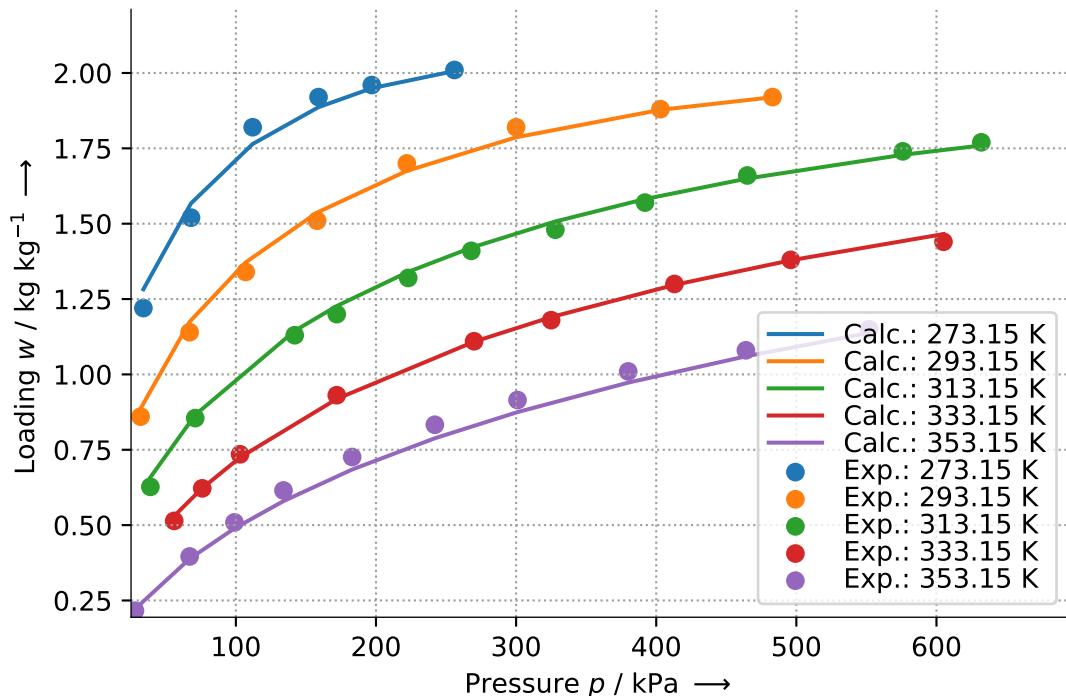
Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.500000000e+00
E	J mol <sup>-1</sup>	8.269000000e+03	W <sub>0</sub>	m <sup>3</sup> kg <sup>-1</sup>	1.548000000e-03

#### Validity:

Equation is approximately valid for  $28000.0 \text{ Pa} \leq p \leq 632000.0 \text{ Pa}$ ,  $273.15 \text{ K} \leq T \leq$

353.15K, and  $0.216\text{kg kg}^{-1} \leq w \leq 2.01\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 2500

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.03%.

## 5.14 R-32

### 5.14.1 Activated carbon fiber A-20

#### 5.14.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Askalany, Ahmed A.; Saha, Bidyut B.; Uddin, Kutub; Miyazaki, Takahiko; Koyama, Shigeru; Srinivasan, Kandadai; Ismail, Ibrahim M. (2013): Adsorption Isotherms and Heat of Adsorption of Difluoromethane on Activated Carbons. In: J. Chem. Eng. Data 58 (10), S. 2828–2834. DOI: 10.1021/je4005678.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., rho_adsorpt = 1.022 * T - rho_gas(p, T) in kg/m3); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	2200
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

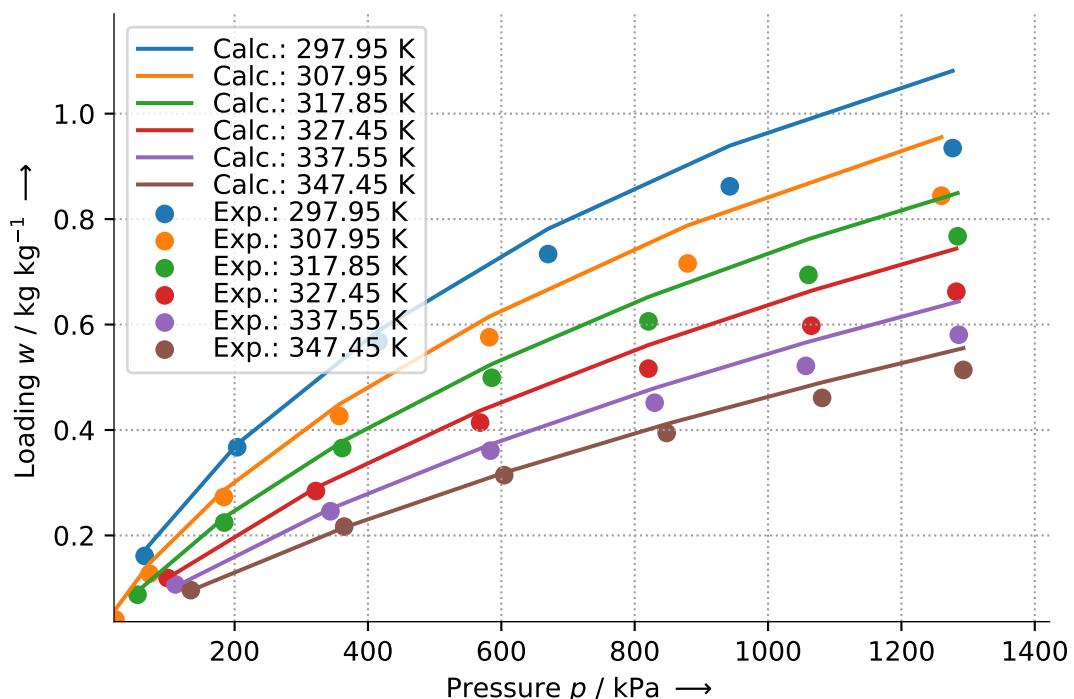
$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.090000000e+00
$E$	J mol <sup>-1</sup>	4.098000000e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	4.580000000e-03

**Validity:**

Equation is approximately valid for  $18790.0\text{Pa} \leq p \leq 1287470.0\text{Pa}$ ,  $298.08\text{K} \leq T \leq 347.37\text{K}$ , and  $0.05\text{kg kg}^{-1} \leq w \leq 0.94\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 4000
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.66%.

### 5.14.2 Activated carbon powder Maxsorb III

#### 5.14.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Askalany, Ahmed A.; Saha, Bidyut B.; Uddin, Kutub; Miyazaki, Takahiko; Koyama, Shigeru; Srinivasan, Kandadai; Ismail, Ibrahim M. (2013): Adsorption Isotherms and Heat of Adsorption of Difluoromethane on Activated Carbons. In: J. Chem. Eng. Data 58 (10), S. 2828–2834. DOI: 10.1021/je4005678.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., rho_adsorpt = 1.546 * T - rho_gas(p, T) in kg/m3); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3200
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\text{A}/\text{E})^n), \text{ and}$$

$$\text{A} = RT \ln(p_{\text{sat}}/p).$$

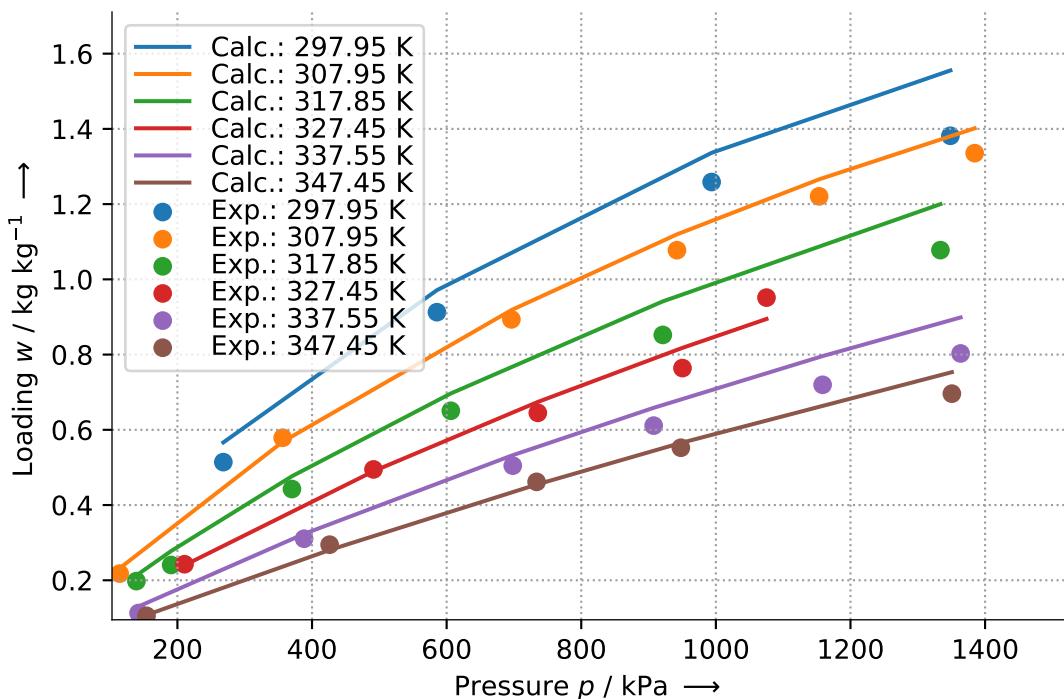
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.150000000e+00
E	$\text{J mol}^{-1}$	3.939000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.050000000e-03

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $112960.0\text{Pa} \leq p \leq 1381720.0\text{Pa}$ ,  $297.95\text{K} \leq T \leq 347.46\text{K}$ , and  $0.10552\text{kg kg}^{-1} \leq w \leq 1.44\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 4000
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.64%.

## 5.15 R-404a

### 5.15.1 Activated carbon AquaSorb 2000

#### 5.15.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	AquaSorb 2000
<b>Refrigerant:</b>	R-404a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Ghazy, Mohamed; Askalany, Ahmed A.; Harby, K.; Ahmed, Mahmoud S. (2016): Adsorption isotherms and kinetics of HFC-404A onto bituminous based granular activated carbon for storage and cooling applications. In: Applied Thermal Engineering 105, S. 639–645. DOI: 10.1016/j.applthermaleng.2016.03.057.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., rho_adsorpt = A - B * T - rho_gas(p, T) in kg/m3); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00028
Surface area	$\text{m}^2 \text{g}^{-1}$	1050
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.04
Bulk density	$\text{kg m}^{-3}$	480

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

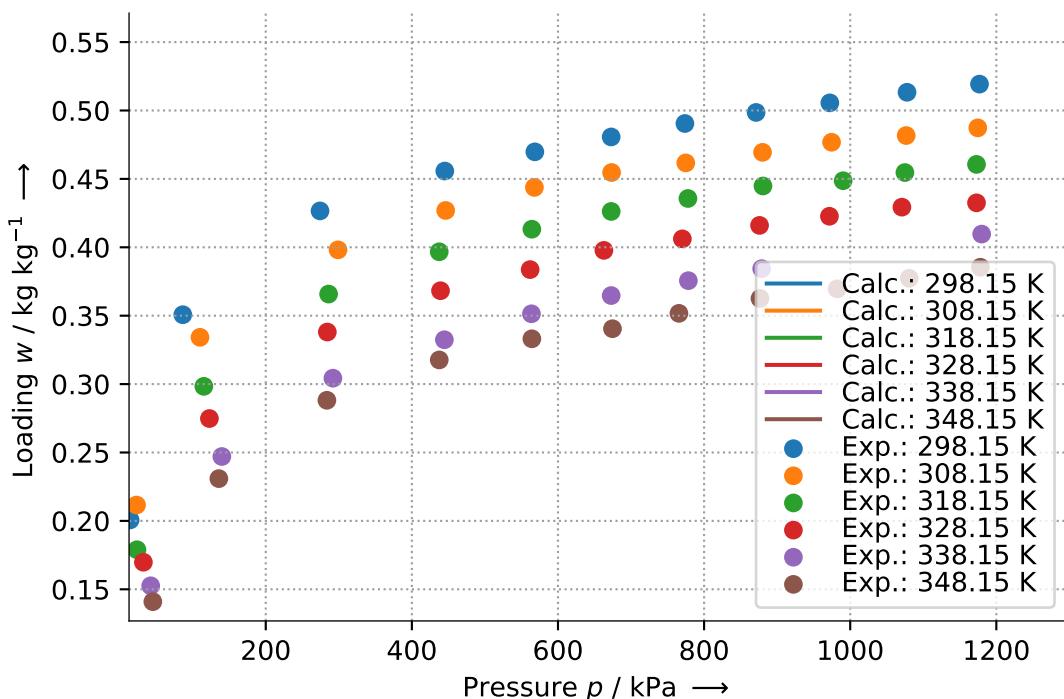
$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.030000000e+00
$E$	J mol <sup>-1</sup>	9.578464000e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	1.035000000e-03

**Validity:**

Equation is approximately valid for  $14330.0\text{Pa} \leq p \leq 1179920.0\text{Pa}$ ,  $298.15\text{K} \leq T \leq 348.15\text{K}$ , and  $0.140971\text{kg kg}^{-1} \leq w \leq 0.519275\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: NoVaporPressure - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 387.57%.

## 5.16 R-407c

### 5.16.1 Activated carbon AquaSorb 2000

#### 5.16.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon
<b>Subtype:</b>	AquaSorb 2000
<b>Refrigerant:</b>	R-407c
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	El-sharkawy, M. M.; Askalany, A. A.; Harby, K.; Ahmed, M. S. (2016): Adsorption isotherms and kinetics of a mixture of Pentafluoroethane, 1,1,1,2-Tetrafluoroethane and Difluoromethane (HFC-407C) onto granular activated carbon. In: Applied Thermal Engineering 93, S. 988–994. DOI: 10.1016/j.applthermaleng.2015.10.077.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., rho_adsorpt = A - B * T - rho_gas(p, T) in kg/m3); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00028
Surface area	$\text{m}^2 \text{g}^{-1}$	1050
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.04
Bulk density	$\text{kg m}^{-3}$	480

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

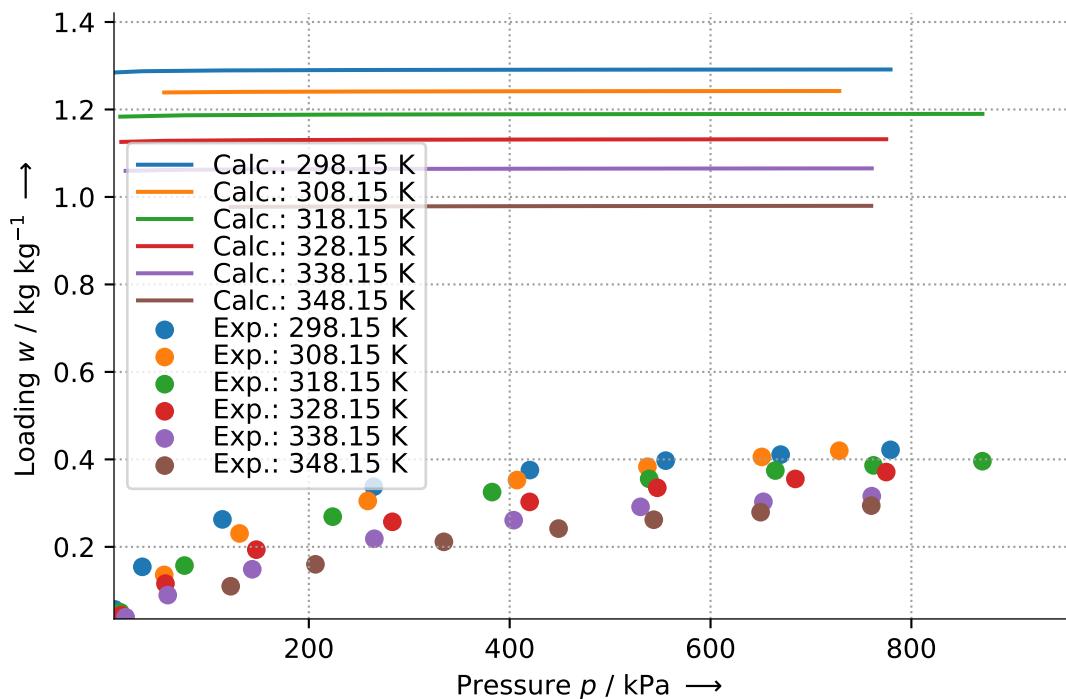
$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.360000000e+00
$E$	J mol <sup>-1</sup>	5.935559600e+05	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	1.139000000e-03

**Validity:**

Equation is approximately valid for  $6670.0\text{Pa} \leq p \leq 870740.0\text{Pa}$ ,  $298.15\text{K} \leq T \leq 348.15\text{K}$ , and  $0.039115\text{kg kg}^{-1} \leq w \leq 0.421769\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 539.8%.

## 5.17 R-410a

### 5.17.1 Activated carbon fiber A-20

#### 5.17.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	R-410a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Askalany, Ahmed A.; Saha, Bidyut B.; Ismail, Ibrahim M. (2014): Adsorption isotherms and kinetics of HFC410A onto activated carbons. In: Applied Thermal Engineering 72 (2), S. 237–243. DOI: 10.1016/j.applthermaleng.2014.04.075.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., rho_adsoprt = -1.0015 * T - rho_gas(p, T) in kg/m <sup>3</sup> ); inverse functions may not work anymore.

**Properties of sorbent:**

Property	Unit	Value
Diameter of pellet	mm	0.0216
Surface area	m <sup>2</sup> g <sup>-1</sup>	2000
Pore volume	mm <sup>3</sup> g <sup>-1</sup>	1.03
Solid density	kg m <sup>-3</sup>	800

**Equation and parameters:**

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

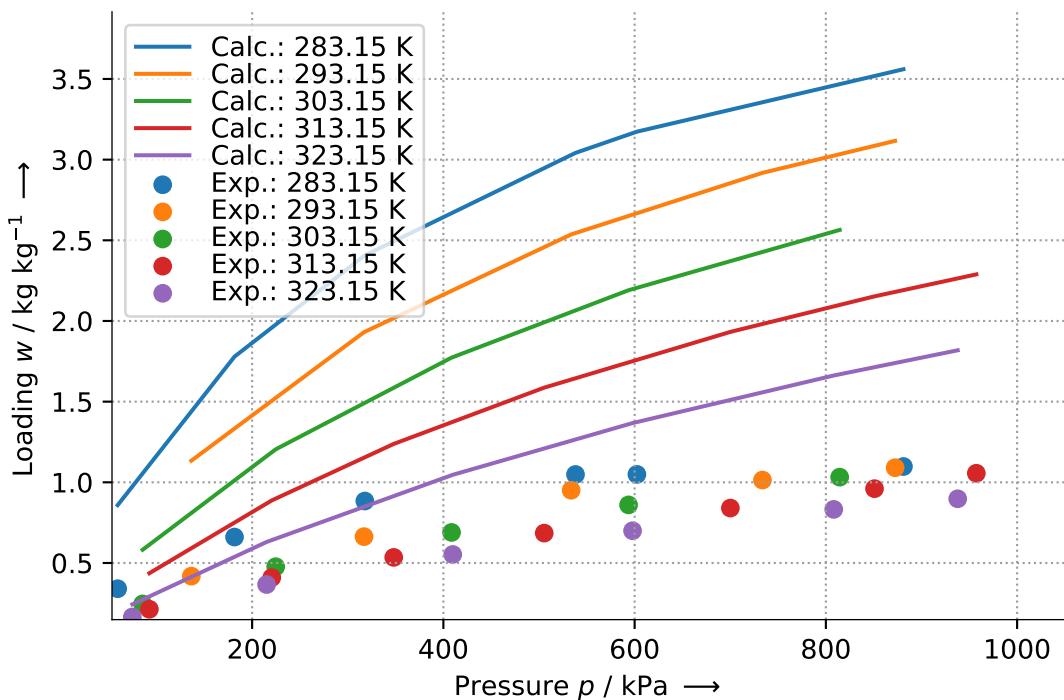
$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.430000000e+00
$E$	J mol <sup>-1</sup>	5.263500000e+03	$W_0$	m <sup>3</sup> kg <sup>-1</sup>	3.250000000e-03

**Validity:**

Equation is approximately valid for  $59390.0\text{Pa} \leq p \leq 957340.0\text{Pa}$ ,  $283.15\text{K} \leq T \leq 323.15\text{K}$ , and  $0.1655\text{kg kg}^{-1} \leq w \leq 1.09799\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 142.17%.

### 5.17.2 Activated carbon powder Maxsorb III

#### 5.17.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-410a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Askalany, Ahmed A.; Saha, Bidyut B.; Ismail, Ibrahim M. (2014): Adsorption isotherms and kinetics of HFC410A onto activated carbons. In: Applied Thermal Engineering 72 (2), S. 237–243. DOI: 10.1016/j.aplthermaleng.2014.04.075.
<b>Comment:</b>	See original literature: Use low-level interface for calculations as special form of density of adsorpt is required (i.e., rho_adsorpt = -1.0015 * T - rho_gas(p, T) in kg/m3); inverse functions may not work anymore.

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.072
Surface area	$\text{m}^2 \text{g}^{-1}$	3140
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\text{A}/\text{E})^n), \text{ and}$$

$$\text{A} = RT \ln(p_{\text{sat}}/p).$$

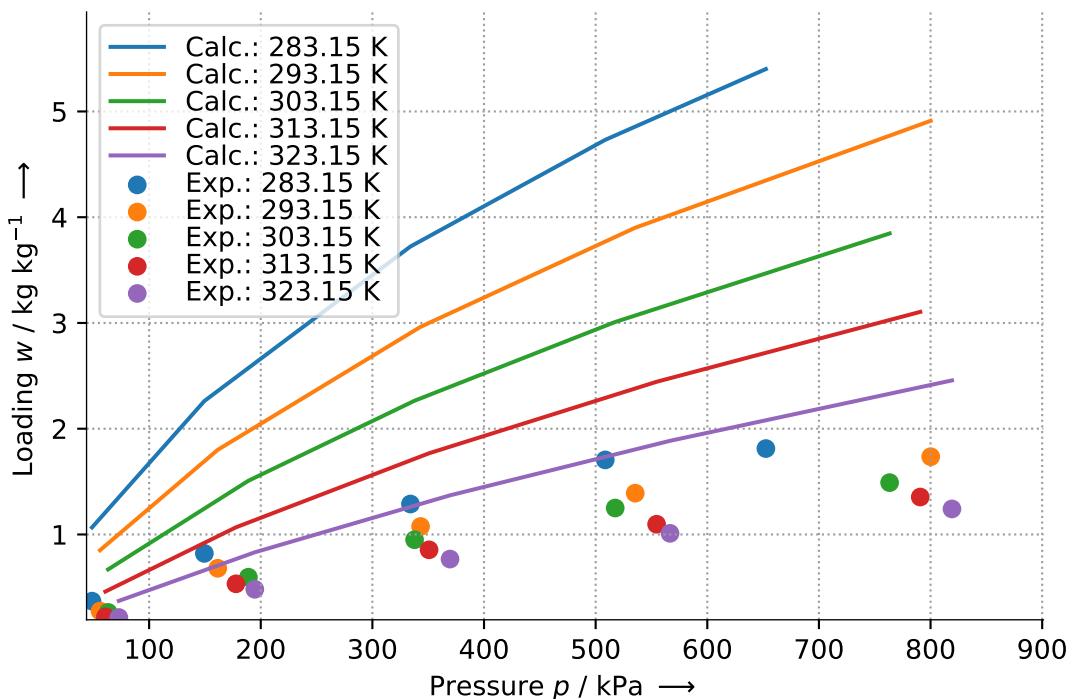
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.170000000e+00
E	$\text{J mol}^{-1}$	4.326960000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	5.960000000e-03

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $48831.0\text{Pa} \leq p \leq 819185.0\text{Pa}$ ,  $283.15\text{K} \leq T \leq 323.15\text{K}$ , and  $0.21476\text{kg kg}^{-1} \leq w \leq 1.81246\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 142.46%.

### 5.17.2.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-410a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Loh, Wai Soong; Ismail, Azhar Bin; Xi, Baojuan; Ng, Kim Choon; Chun, Won Gee (2012): Adsorption Isotherms and Isosteric Enthalpy of Adsorption for Assorted Refrigerants on Activated Carbons. In: J. Chem. Eng. Data 57 (10), S. 2766–2773. DOI: 10.1021/je3008099.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3150
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

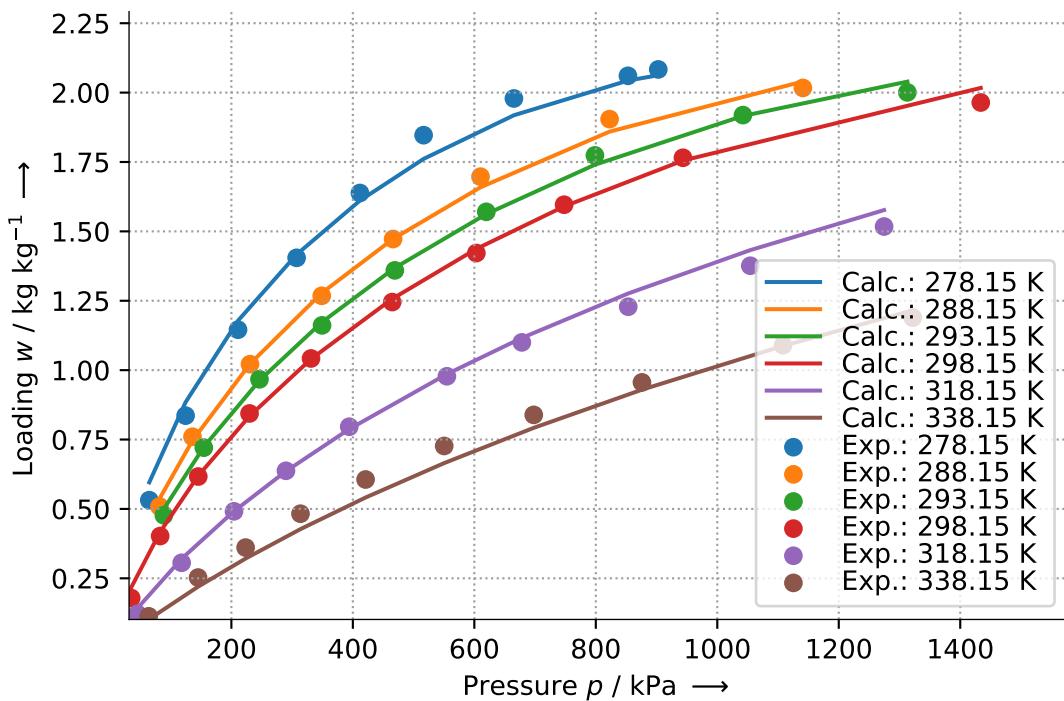
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.360000000e+00
E	$\text{J mol}^{-1}$	5.254380000e+03	$W_0$	$\text{kg kg}^{-1}$	2.070000000e+00

#### Validity:

Equation is approximately valid for  $35045.0 \text{Pa} \leq p \leq 1433809.0 \text{Pa}$ ,  $278.15 \text{K} \leq T \leq$



328.15K, and  $0.11303\text{kg kg}^{-1} \leq w \leq 2.08346\text{kg kg}^{-1}$ .

### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % → 0 Pa < p < 5 MPa: 0.1
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.62%.

## 5.18 R-507a

### 5.18.1 Activated carbon fiber A-20

#### 5.18.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon fiber
<b>Subtype:</b>	A-20
<b>Refrigerant:</b>	R-507a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Loh, Wai Soong; Ismail, Azhar Bin; Xi, Baojuan; Ng, Kim Choon; Chun, Won Gee (2012): Adsorption Isotherms and Isosteric Enthalpy of Adsorption for Assorted Refrigerants on Activated Carbons. In: J. Chem. Eng. Data 57 (10), S. 2766–2773. DOI: 10.1021/je3008099.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000216
Surface area	$\text{m}^2 \text{g}^{-1}$	1930
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.05
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

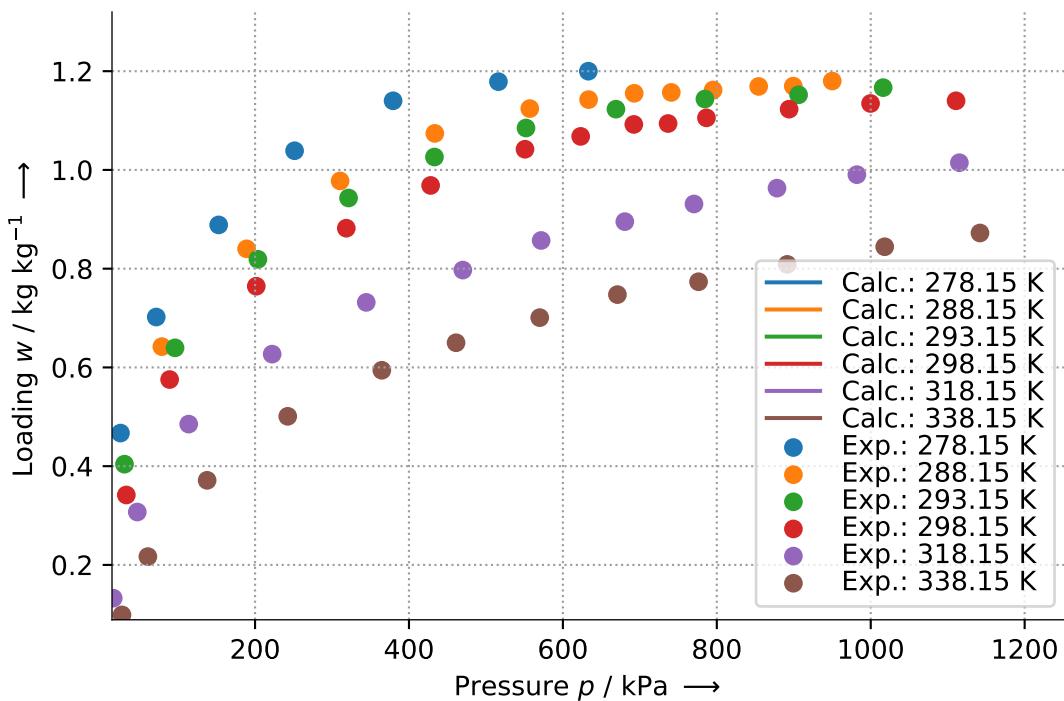
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.450000000e+00
E	$\text{J mol}^{-1}$	8.100780000e+03	$W_0$	$\text{kg kg}^{-1}$	1.190000000e+00

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $15701.0\text{Pa} \leq p \leq 1141964.0\text{Pa}$ ,  $278.15\text{K} \leq T \leq 318.15\text{K}$ , and  $0.098738\text{kg kg}^{-1} \leq w \leq 1.2\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: NoSaturatedLiquidDensity - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % →  $0 \text{ Pa} < p < 5 \text{ MPa}$ : 0.1
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 252.56%.

### 5.18.2 Activated carbon powder Maxsorb III

#### 5.18.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-507a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Saha, Bidyut B.; El-Sharkawy, Ibrahim I.; Habib, Khairul; Koyama, Shigeru; Srinivasan, Kandadai (2008): Adsorption of Equal Mass Fraction Near an Azeotropic Mixture of Pentafluoroethane and 1,1,1-Trifluoroethane on Activated Carbon. In: J. Chem. Eng. Data 53 (8), S. 1872–1876. DOI: 10.1021/je800204p.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.072
Surface area	$\text{m}^2 \text{g}^{-1}$	3142
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	n	-	1.470000000e+00
E	$\text{J mol}^{-1}$	5.740000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	1.175000000e-03

#### Validity:

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.18.2.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	activated carbon powder
<b>Subtype:</b>	Maxsorb III
<b>Refrigerant:</b>	R-507a
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Loh, Wai Soong; Ismail, Azhar Bin; Xi, Baojuan; Ng, Kim Choon; Chun, Won Gee (2012): Adsorption Isotherms and Isosteric Enthalpy of Adsorption for Assorted Refrigerants on Activated Carbons. In: J. Chem. Eng. Data 57 (10), S. 2766–2773. DOI: 10.1021/je3008099.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	3150
Pore volume	$\text{mm}^3 \text{g}^{-1}$	1.7
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

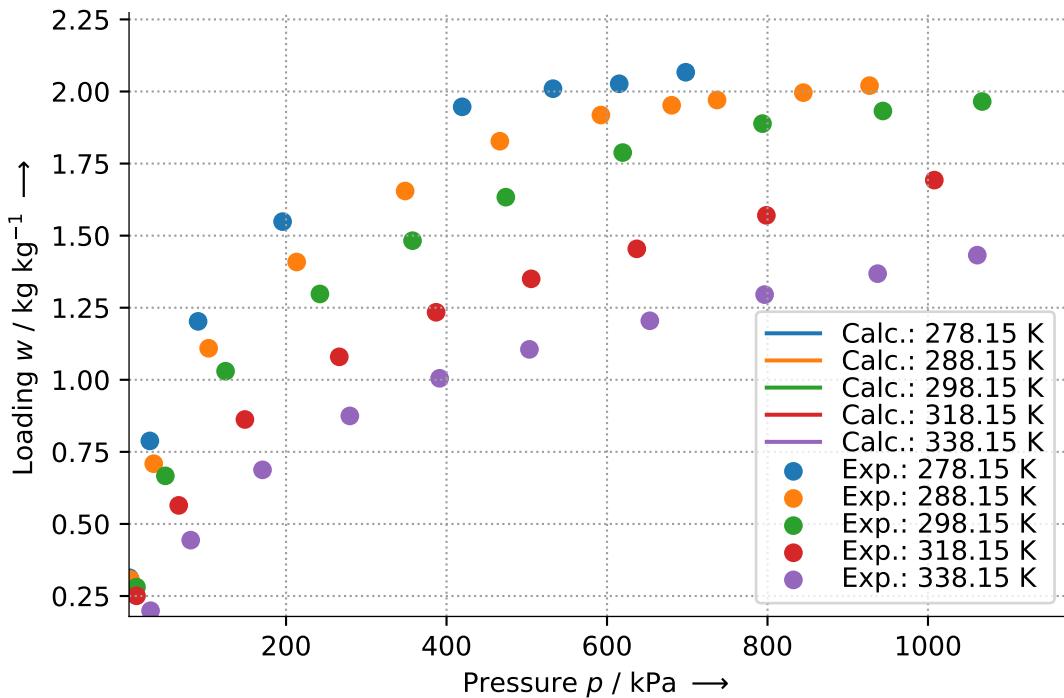
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.340000000e+00
E	$\text{J mol}^{-1}$	7.547250000e+03	$W_0$	$\text{kg kg}^{-1}$	2.050000000e+00

#### Validity:

Equation is approximately valid for  $4827.0 \text{Pa} \leq p \leq 1067573.0 \text{Pa}$ ,  $278.15 \text{K} \leq T \leq$



318.15K, and  $0.19899\text{kg kg}^{-1} \leq w \leq 2.06674\text{kg kg}^{-1}$ .

### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: NoSaturatedLiquidDensity - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, relative, in % →  $0 \text{ Pa} < p < 5 \text{ MPa}$ : 0.1
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 212.94%.

## 5.19 Water

### 5.19.1 Mof powder CPO-27(Ni)

#### 5.19.1.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	mof powder
<b>Subtype:</b>	CPO-27(Ni)
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Elsayed, Eman; AL-Dadah, Raya; Mahmoud, Saad; El-sayed, Ahmed; Anderson, Paul A. (2016): Aluminium fumarate and CPO-27(Ni) MOFs. Characterization and thermodynamic analysis for adsorption heat pump applications. In: Applied Thermal Engineering 99, S. 802–812. DOI: 10.1016/j.applthermaleng.2016.01.129.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.1075
Surface area	$\text{m}^2 \text{g}^{-1}$	469.777

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

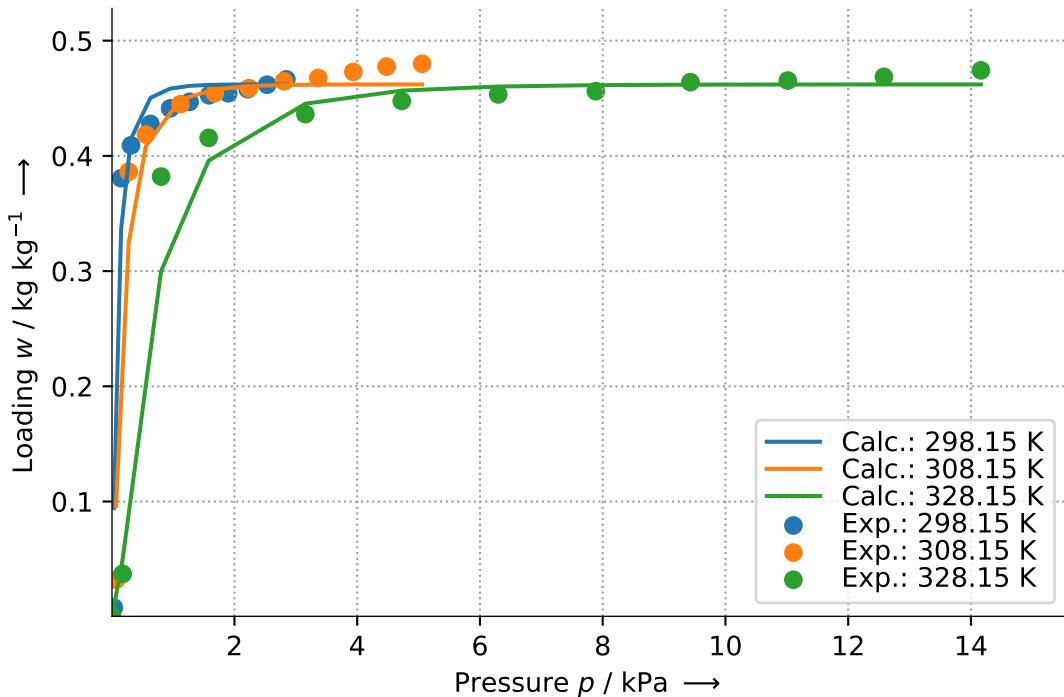
$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	4.000000000e+00
$E$	$\text{J mol}^{-1}$	1.001410000e+04	$W_0$	$\text{kg kg}^{-1}$	4.620000000e-01

**Validity:**

Equation is approximately valid for  $4.97\text{Pa} \leq p \leq 14163.11\text{Pa}$ ,  $298.15\text{K} \leq T \leq 328.15\text{K}$ , and  $0.000397\text{kg kg}^{-1} \leq w \leq 0.479969\text{kg kg}^{-1}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 44.91%.

### 5.19.2 Polymer PS-I

#### 5.19.2.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	polymer
<b>Subtype:</b>	PS-I
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Sultan, Muhammad; El-Sharkawy, Ibrahim I.; Miyazaki, Takahiko; Saha, Bidyut B.; Koyama, Shigeru; Maruyama, Tomohiro et al. (2015): Insights of water vapor sorption onto polymer based sorbents. In: Adsorption 21 (3), S. 205–215. DOI: 10.1007/s10450-015-9663-y.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.002581
Bulk density	kg m <sup>-3</sup>	520-560

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

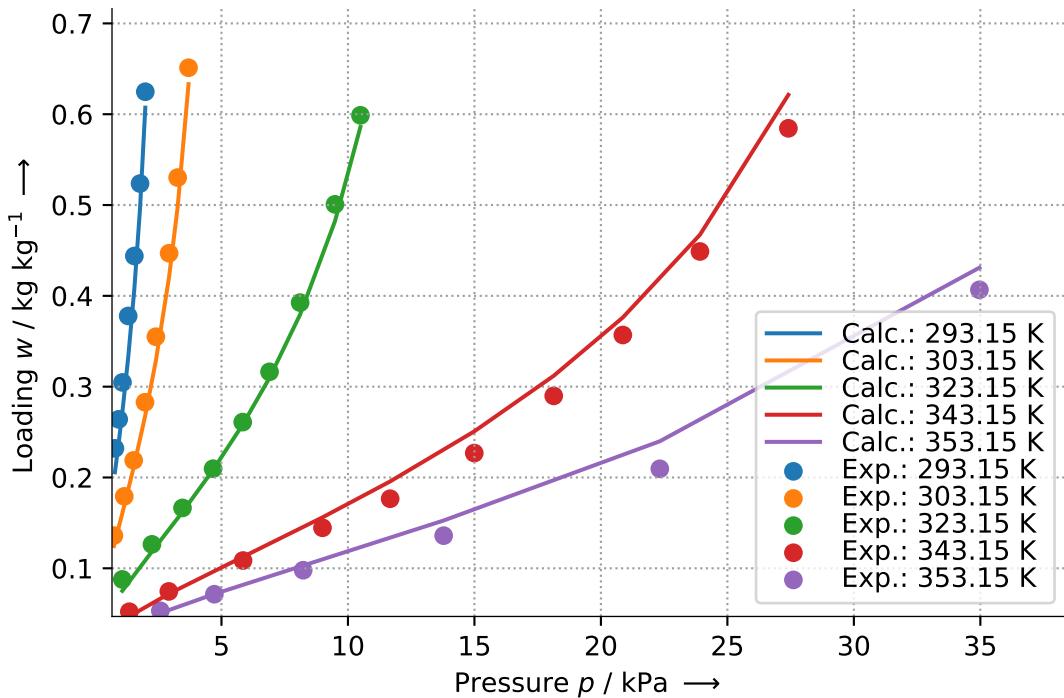
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	$n$	-	5.000000000e-01
$E$	J mol <sup>-1</sup>	8.531337000e+02	$W_0$	kg kg <sup>-1</sup>	1.200000000e+00

#### Validity:

Equation is approximately valid for  $747.2\text{Pa} \leq p \leq 34963.5\text{Pa}$ ,  $293.15\text{K} \leq T \leq$



363.15K, and  $0.05219\text{kg kg}^{-1} \leq w \leq 0.65117\text{kg kg}^{-1}$ .

### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, relative, in % → 0.002

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.35%.

### 5.19.3 Polymer PS-II

#### 5.19.3.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	polymer
<b>Subtype:</b>	PS-II
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Sultan, Muhammad; El-Sharkawy, Ibrahim I.; Miyazaki, Takahiko; Saha, Bidyut B.; Koyama, Shigeru; Maruyama, Tomohiro et al. (2015): Insights of water vapor sorption onto polymer based sorbents. In: Adsorption 21 (3), S. 205–215. DOI: 10.1007/s10450-015-9663-y.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.019316
Bulk density	kg m <sup>-3</sup>	800-840

#### Equation and parameters:

Loading  $w$  in kg kg<sup>-1</sup> is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n) \quad , \text{ and}$$

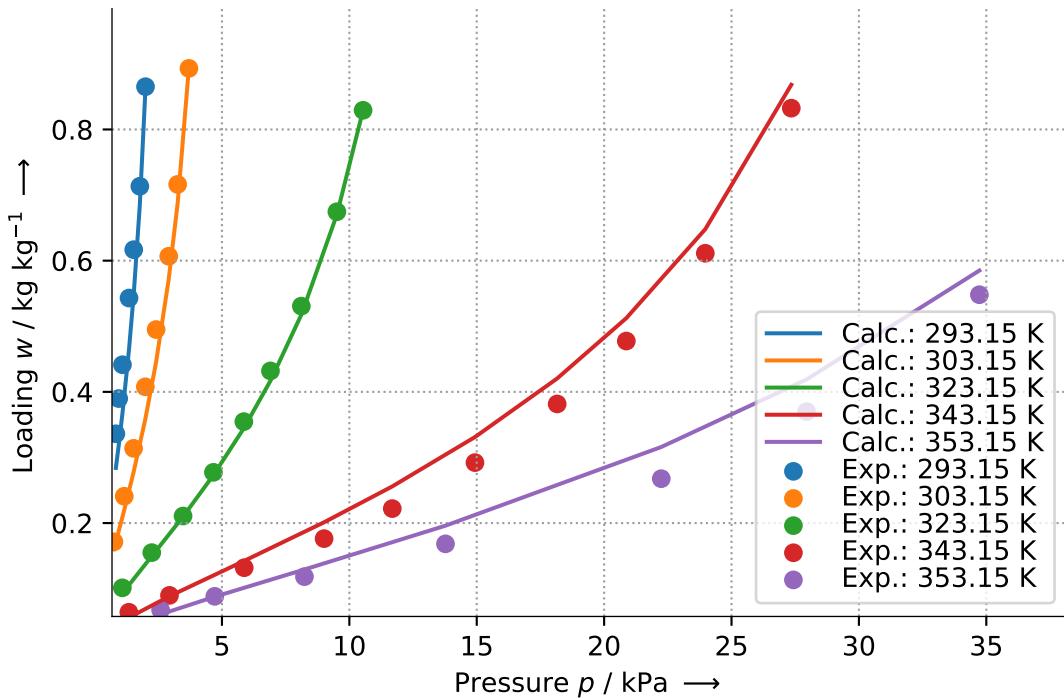
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	5.000000000e-01
E	J mol <sup>-1</sup>	7.535384000e+02	W <sub>0</sub>	kg kg <sup>-1</sup>	1.760000000e+00

#### Validity:

Equation is approximately valid for 760.8Pa ≤  $p$  ≤ 34728.1Pa, 293.15K ≤  $T$  ≤



363.15K, and  $0.06404\text{kg kg}^{-1} \leq w \leq 0.89308\text{kg kg}^{-1}$ .

### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, relative, in % → 0.002

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.04%.

### 5.19.4 Silica gel pellet

#### 5.19.4.1 Freundlich - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Freundlich
<b>ID:</b>	1
<b>Reference:</b>	Saha, B. B.; Koyama, S.; Lee, J. B.; Kuwahara, K.; Alam, K.C.A.; Hamamoto, Y. et al. (2003): Performance evaluation of a low-temperature waste heat driven multi-bed adsorption chiller. In: International Journal of Multiphase Flow 29 (8), S. 1249–1263. DOI: 10.1016/S0301-9322(03)00103-4.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$\begin{aligned} w &= A (p/p_{\text{sat}})^B \quad , \text{ and} \\ A &= A_0 + A_1 T + A_2 T^2 + A_3 T^3 \quad , \text{ and} \\ B &= B_0 + B_1 T + B_2 T^2 + B_3 T^3 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$A_0$	$\text{kg kg}^{-1}$	3.119800000e+01	$B_0$	-	4.158100000e+01
$A_1$	$\text{kg kg}^{-1} \text{K}^{-1}$	-2.665000000e-01	$B_1$	$\text{K}^{-1}$	-3.543500000e-01
$A_2$	$\text{kg kg}^{-1} \text{K}^{-2}$	7.690000000e-04	$B_2$	$\text{K}^{-2}$	1.019900000e-03
$A_3$	$\text{kg kg}^{-1} \text{K}^{-3}$	-7.389800000e-07	$B_3$	$\text{K}^{-3}$	-9.703400000e-07

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.19.4.2 Toth - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Wang, Yu; LeVan, M. Douglas (2009): Adsorption Equilibrium of Carbon Dioxide and Water Vapor on Zeolites 5A and 13X and Silica Gel. Pure Components. In: J. Chem. Eng. Data 54 (10), S. 2839–2844. DOI: 10.1021/je800900a.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$\begin{aligned} w &= \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}} \quad , \text{ and} \\ b &= b_0 \exp \left( \frac{Q^*}{T} \right) \quad , \text{ and} \\ n &= n_0 + c/T \quad , \text{ and} \\ r &= \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases} . \end{aligned}$$

The parameters of the equation are:

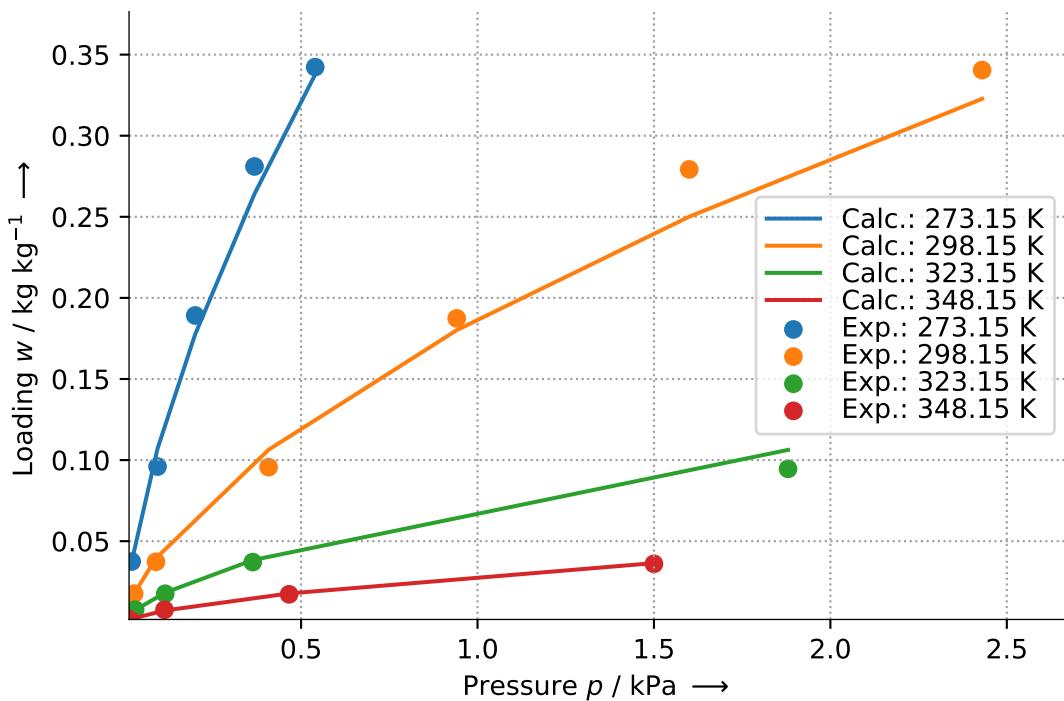
Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	2.787000000e-08	$Q^*$	K	1.093000000e+03
$c$	K	2.213000000e+01	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	1.142195901e+05
$n_0$	-	-1.190000000e-03			

#### Validity:

Equation is approximately valid for  $13.9\text{Pa} \leq p \leq 5250.0\text{Pa}$ ,  $273.15\text{K} \leq T \leq 348.15\text{K}$ , and  $0.001927635\text{kg kg}^{-1} \leq w \leq 0.34229032\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, relative, in % →  $0.067 \text{ Pa} < p < 13300 \text{ Pa}$ : 0.25
- Temperature, absolute, in K → 0.3

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.36%.

### 5.19.5 Silica gel pellet 123

#### 5.19.5.1 DubininArctan1 - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	123
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininArctan1
<b>ID:</b>	1
<b>Reference:</b>	Schawe, D. (2000): Theoretical and Experimental Investigations of an Adsorption Heat Pump with Heat Transfer between two Adsorbers. Dissertation. Universität Stuttgart, Stuttgart. Energietechnik.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	2.10E-06
Diameter of pellet	mm	0.5-1.25
Surface area	$\text{m}^2 \text{g}^{-1}$	750
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.4
Bulk density	$\text{kg m}^{-3}$	650
Pellet density	$\text{kg m}^{-3}$	1250
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = W \rho_{\text{sat}}^{\text{liq}} , \text{ and}$$

$$W = \frac{a}{\Pi} \left( \arctan \left( \frac{A - b}{c} \right) + \frac{\Pi}{2} \right) + d , \text{ and}$$

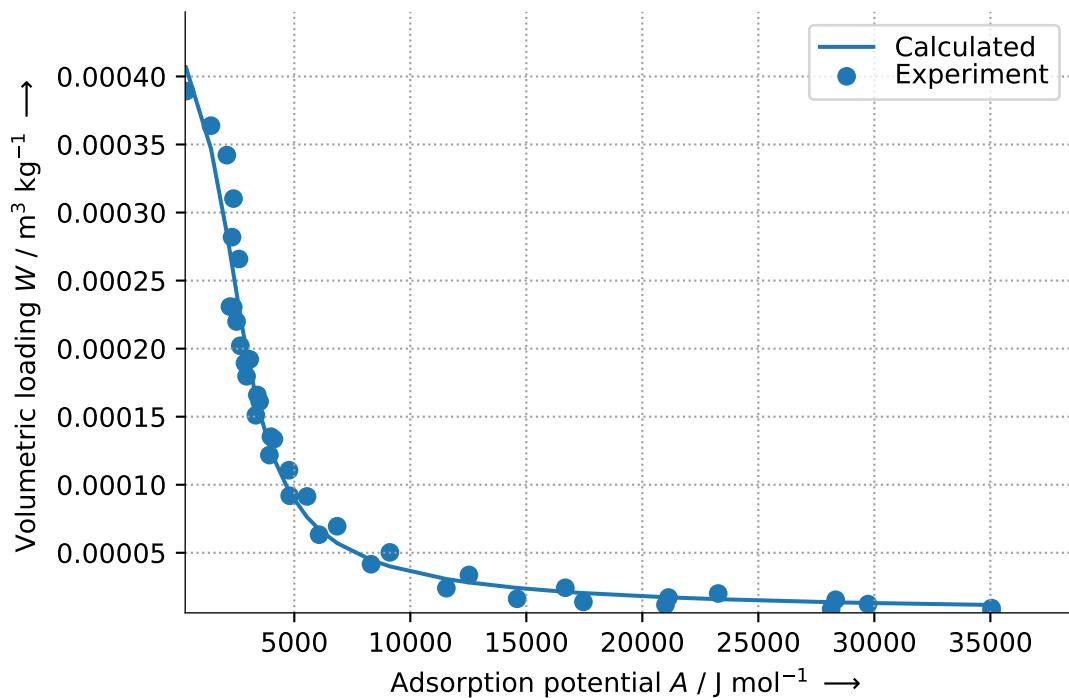
$$A = RT \ln \left( p_{\text{sat}} / p \right) .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	$\text{m}^3 \text{kg}^{-1}$	5.072313000e-04	$c$	$\text{J mol}^{-1}$	-1.529906401e+03
$b$	$\text{J mol}^{-1}$	2.351914097e+03	$d$	$\text{m}^3 \text{kg}^{-1}$	4.128962000e-06

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, absolute, in  $\text{kg kg}^{-1}$  → 0.000001

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 17.02%.

### 5.19.6 Silica gel pellet 125

#### 5.19.6.1 DubininArctan1 - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	125
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininArctan1
<b>ID:</b>	1
<b>Reference:</b>	Schawe, D. (2000): Theoretical and Experimental Investigations of an Adsorption Heat Pump with Heat Transfer between two Adsorbers. Dissertation. Universität Stuttgart, Stuttgart. Energietechnik.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	2.10E-06
Diameter of pellet	mm	1-3.5
Surface area	$\text{m}^2 \text{g}^{-1}$	750
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.4
Bulk density	$\text{kg m}^{-3}$	690-760
Pellet density	$\text{kg m}^{-3}$	1250
Solid density	$\text{kg m}^{-3}$	2200

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = W \rho_{\text{sat}}^{\text{liq}} , \text{ and}$$

$$W = \frac{a}{\Pi} \left( \arctan \left( \frac{A - b}{c} \right) + \frac{\Pi}{2} \right) + d , \text{ and}$$

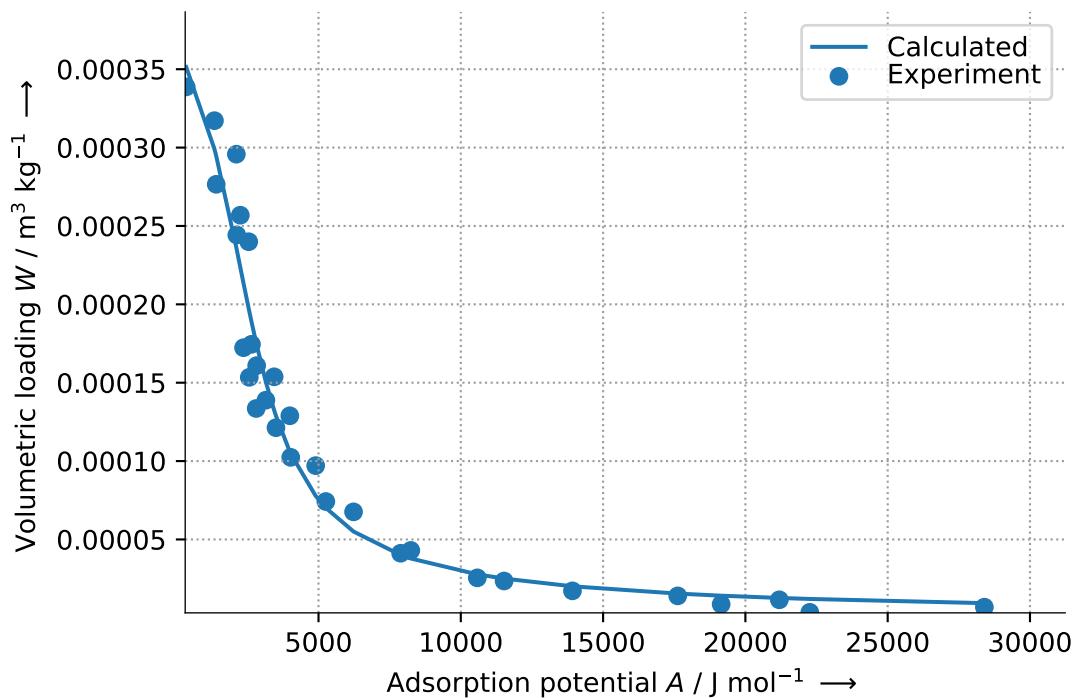
$$A = RT \ln \left( p_{\text{sat}} / p \right) .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	$\text{m}^3 \text{kg}^{-1}$	4.527805000e-04	$c$	$\text{J mol}^{-1}$	-1.593817135e+03
$b$	$\text{J mol}^{-1}$	2.214052508e+03	$d$	$\text{m}^3 \text{kg}^{-1}$	6.034706000e-07

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, absolute, in  $\text{kg kg}^{-1}$  → 0.000001

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 22.42%.

### 5.19.7 Silica gel pellet AF-25

#### 5.19.7.1 DubininArctan1 - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	AF-25
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininArctan1
<b>ID:</b>	1
<b>Reference:</b>	Schawe, D. (2000): Theoretical and Experimental Investigations of an Adsorption Heat Pump with Heat Transfer between two Adsorbers. Dissertation. Universität Stuttgart, Stuttgart. Energietechnik.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	2.50E-06
Surface area	$\text{m}^2 \text{g}^{-1}$	750
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.5
Bulk density	$\text{kg m}^{-3}$	600

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = W \rho_{\text{sat}}^{\text{liq}} , \text{ and}$$

$$W = \frac{a}{\Pi} \left( \arctan \left( \frac{A - b}{c} \right) + \frac{\Pi}{2} \right) + d , \text{ and}$$

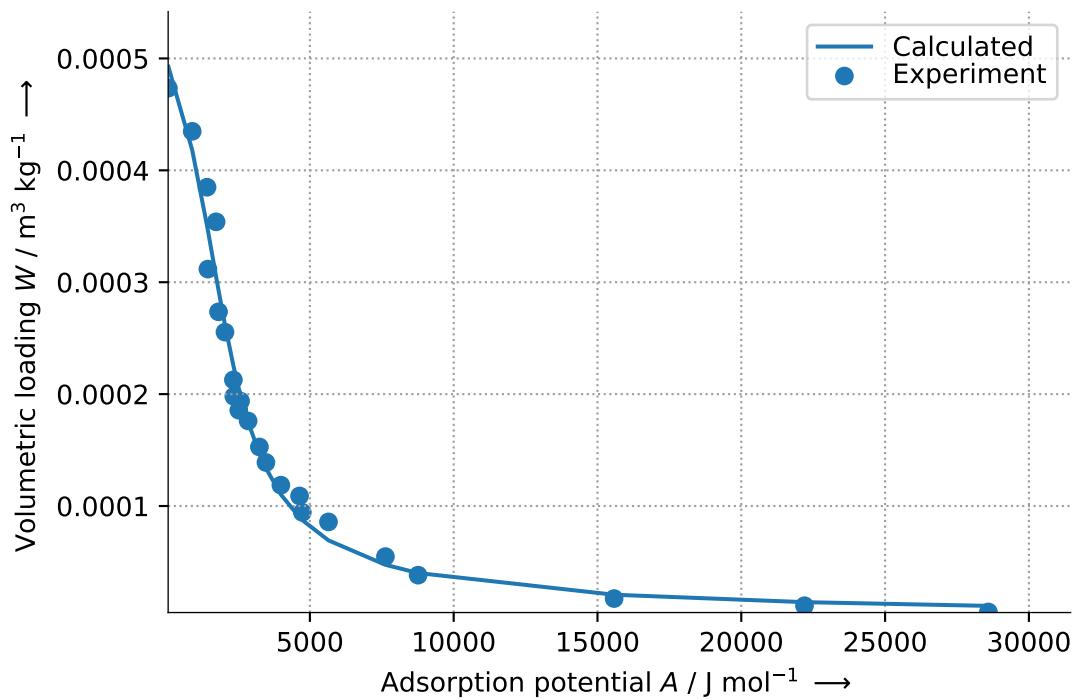
$$A = RT \ln \left( \frac{p_{\text{sat}}}{p} \right) .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	$\text{m}^3 \text{kg}^{-1}$	6.452701000e-04	$c$	$\text{J mol}^{-1}$	-1.413377094e+03
$b$	$\text{J mol}^{-1}$	1.617730967e+03	$d$	$\text{m}^3 \text{kg}^{-1}$	0.000000000e+00

**Validity:**

No data on validity available!



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, absolute, in  $\text{kg kg}^{-1}$  → 0.000001

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 13.57%.

### 5.19.8 Silica gel pellet Fuji

#### 5.19.8.1 DubininArctan1 - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Fuji
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininArctan1
<b>ID:</b>	1
<b>Reference:</b>	Schawe, D. (2000): Theoretical and Experimental Investigations of an Adsorption Heat Pump with Heat Transfer between two Adsorbers. Dissertation. Universität Stuttgart, Stuttgart. Energietechnik.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Surface area	$\text{m}^2 \text{g}^{-1}$	589
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.31

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = W \rho_{\text{sat}}^{\text{liq}} , \text{ and}$$

$$W = \frac{a}{\Pi} \left( \arctan \left( \frac{A - b}{c} \right) + \frac{\Pi}{2} \right) + d , \text{ and}$$

$$A = RT \ln \left( p_{\text{sat}} / p \right) .$$

The parameters of the equation are:

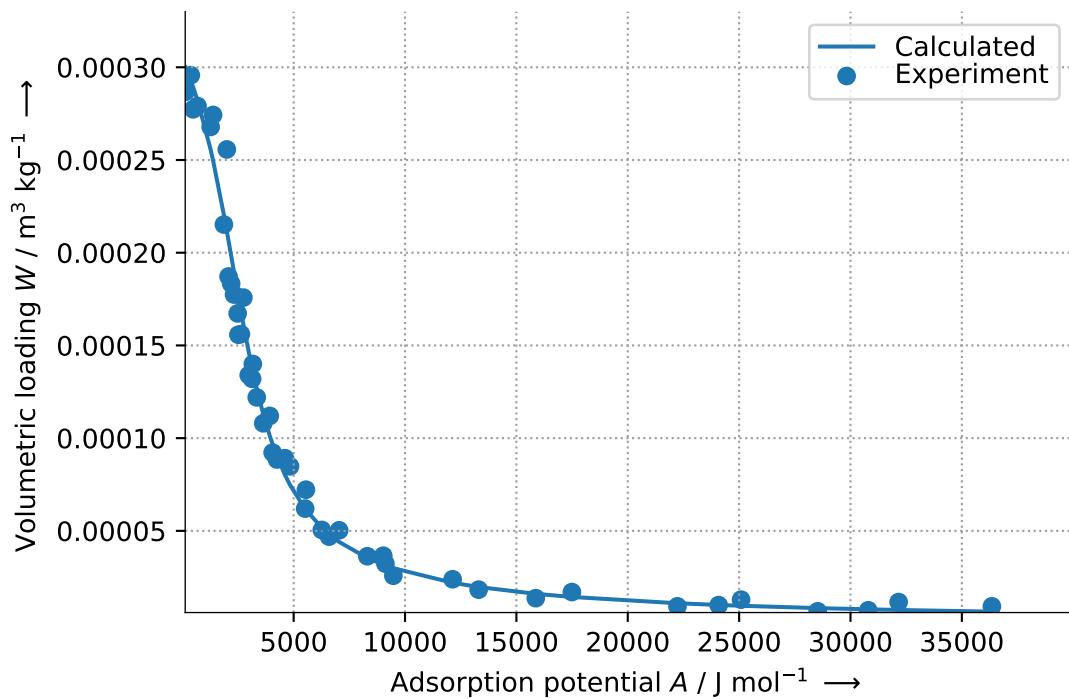
Par.	Unit	Value	Par.	Unit	Value
$a$	$\text{m}^3 \text{kg}^{-1}$	3.857567000e-04	$c$	$\text{J mol}^{-1}$	-1.786979370e+03
$b$	$\text{J mol}^{-1}$	2.274388346e+03	$d$	$\text{m}^3 \text{kg}^{-1}$	0.000000000e+00

#### Validity:

No data on validity available!

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, absolute, in  $\text{kg kg}^{-1}$  → 0.000001

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 9.55%.

### 5.19.9 Silica gel pellet Fuji A

#### 5.19.9.1 Freundlich - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Fuji A
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Freundlich
<b>ID:</b>	1
<b>Reference:</b>	SAKODA, AKIYOSHI; SUZUKI, MOTOYUKI (1984): Fundamental study on solar powered adsorption cooling system. In: J. Chem. Eng. Japan / JCEJ 17 (1), S. 52–57. DOI: 10.1252/jcej.17.52.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	0.71

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$\begin{aligned} w &= A (p/p_{\text{sat}})^B \quad , \text{ and} \\ A &= A_0 + A_1 T + A_2 T^2 + A_3 T^3 \quad , \text{ and} \\ B &= B_0 + B_1 T + B_2 T^2 + B_3 T^3 \quad . \end{aligned}$$

The parameters of the equation are:

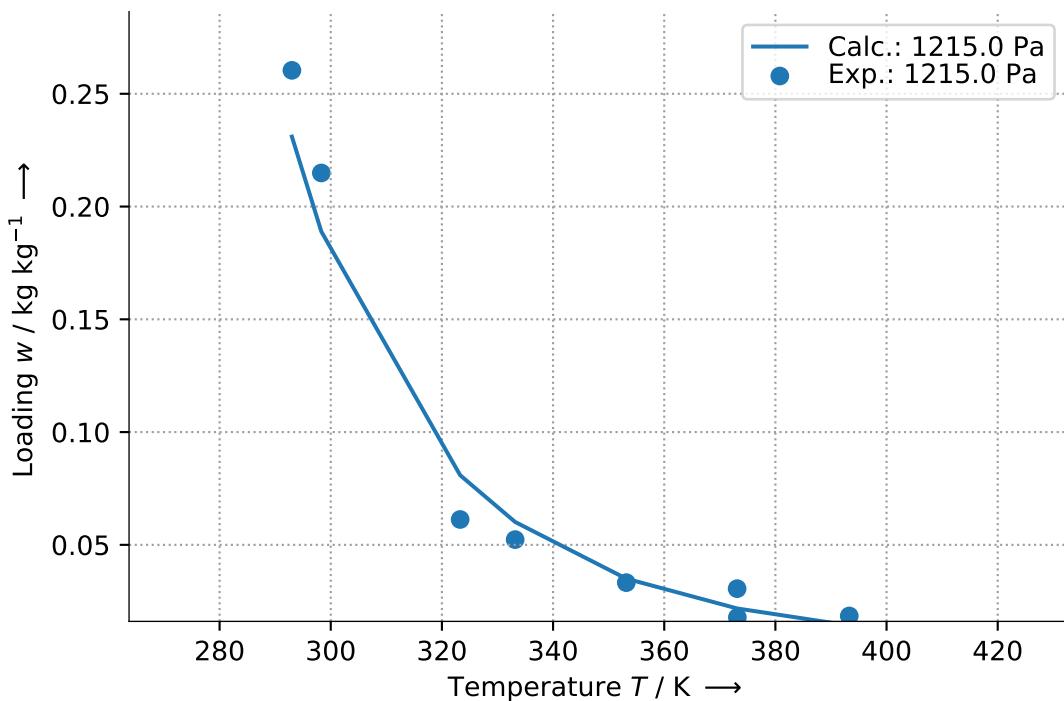
Par.	Unit	Value	Par.	Unit	Value
$A_0$	$\text{kg kg}^{-1}$	3.460000000e-01	$B_0$	-	6.250000000e-01
$A_1$	$\text{kg kg}^{-1} \text{K}^{-1}$	0.000000000e+00	$B_1$	$\text{K}^{-1}$	0.000000000e+00
$A_2$	$\text{kg kg}^{-1} \text{K}^{-2}$	0.000000000e+00	$B_2$	$\text{K}^{-2}$	0.000000000e+00
$A_3$	$\text{kg kg}^{-1} \text{K}^{-3}$	0.000000000e+00	$B_3$	$\text{K}^{-3}$	0.000000000e+00

#### Validity:

No data on validity available!

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 18.64%.

### 5.19.10 Silica gel pellet Fuji RD

#### 5.19.10.1 Freundlich - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Fuji RD
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Freundlich
<b>ID:</b>	1
<b>Reference:</b>	Miyazaki, T.; Akisawa, A.; Saha, B. B.; El-Sharkawy, I. I.; Chakraborty, A. (2009): A new cycle time allocation for enhancing the performance of two-bed adsorption chillers. In: International Journal of Refrigeration 32 (5), S. 846–853. DOI: 10.1016/j.ijrefrig.2008.12.002.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$\begin{aligned} w &= A (p/p_{\text{sat}})^B \quad , \text{ and} \\ A &= A_0 + A_1 T + A_2 T^2 + A_3 T^3 \quad , \text{ and} \\ B &= B_0 + B_1 T + B_2 T^2 + B_3 T^3 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$A_0$	$\text{kg kg}^{-1}$	-6.531400000e+00	$B_0$	-	-1.558700000e+01
$A_1$	$\text{kg kg}^{-1} \text{K}^{-1}$	7.245200000e-02	$B_1$	$\text{K}^{-1}$	1.591500000e-01
$A_2$	$\text{kg kg}^{-1} \text{K}^{-2}$	-2.395100000e-04	$B_2$	$\text{K}^{-2}$	-5.061200000e-04
$A_3$	$\text{kg kg}^{-1} \text{K}^{-3}$	2.549300000e-04	$B_3$	$\text{K}^{-3}$	5.329000000e-07

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.19.10.2 Freundlich - ID 2

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Fuji RD
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Freundlich
<b>ID:</b>	2
<b>Reference:</b>	Cho, Soon-Haeng; Kim, Jong-Nam (1992): Modeling of a silica gel/water adsorption-cooling system. In: Energy 17 (9), S. 829–839. DOI: 10.1016/0360-5442(92)90101-5.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$\begin{aligned} w &= A (p/p_{\text{sat}})^B \quad , \text{ and} \\ A &= A_0 + A_1 T + A_2 T^2 + A_3 T^3 \quad , \text{ and} \\ B &= B_0 + B_1 T + B_2 T^2 + B_3 T^3 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$A_0$	$\text{kg kg}^{-1}$	5.220000000e-01	$B_0$	-	6.250000000e-01
$A_1$	$\text{kg kg}^{-1} \text{K}^{-1}$	0.000000000e+00	$B_1$	$\text{K}^{-1}$	0.000000000e+00
$A_2$	$\text{kg kg}^{-1} \text{K}^{-2}$	0.000000000e+00	$B_2$	$\text{K}^{-2}$	0.000000000e+00
$A_3$	$\text{kg kg}^{-1} \text{K}^{-3}$	0.000000000e+00	$B_3$	$\text{K}^{-3}$	0.000000000e+00

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.19.10.3 Toth - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Fuji RD
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Chua, H. T.; Ng, K. C.; Wang, W.; Yap, C.; Wang, X. L. (2004): Transient modeling of a two-bed silica gel–water adsorption chiller. In: International Journal of Heat and Mass Transfer 47 (4), S. 659–669. DOI: 10.1016/j.ijheatmasstransfer.2003.08.010.
<b>Comment:</b>	None

**Properties of sorbent:**

Property data of sorbent and subtype does not exist.

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$\begin{aligned} w &= \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}} \quad , \text{ and} \\ b &= b_0 \exp \left( \frac{Q^*}{T} \right) \quad , \text{ and} \\ n &= n_0 + c/T \quad , \text{ and} \\ r &= \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases} . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	1.622222222e-12	$Q^*$	K	5.835031230e+03
$c$	K	0.000000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	4.500000000e-01
$n_0$	-	1.200000000e+01			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 5.19.11 Silica gel pellet Fuji RD 2560

#### 5.19.11.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Fuji RD 2560
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Thu, Kyaw; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2013): Thermo-physical properties of silica gel for adsorption desalination cycle. In: Applied Thermal Engineering 50 (2), S. 1596–1602. DOI: 10.1016/j.applthermaleng.2011.09.038.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.00000132
Surface area	$\text{m}^2 \text{g}^{-1}$	636.4

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

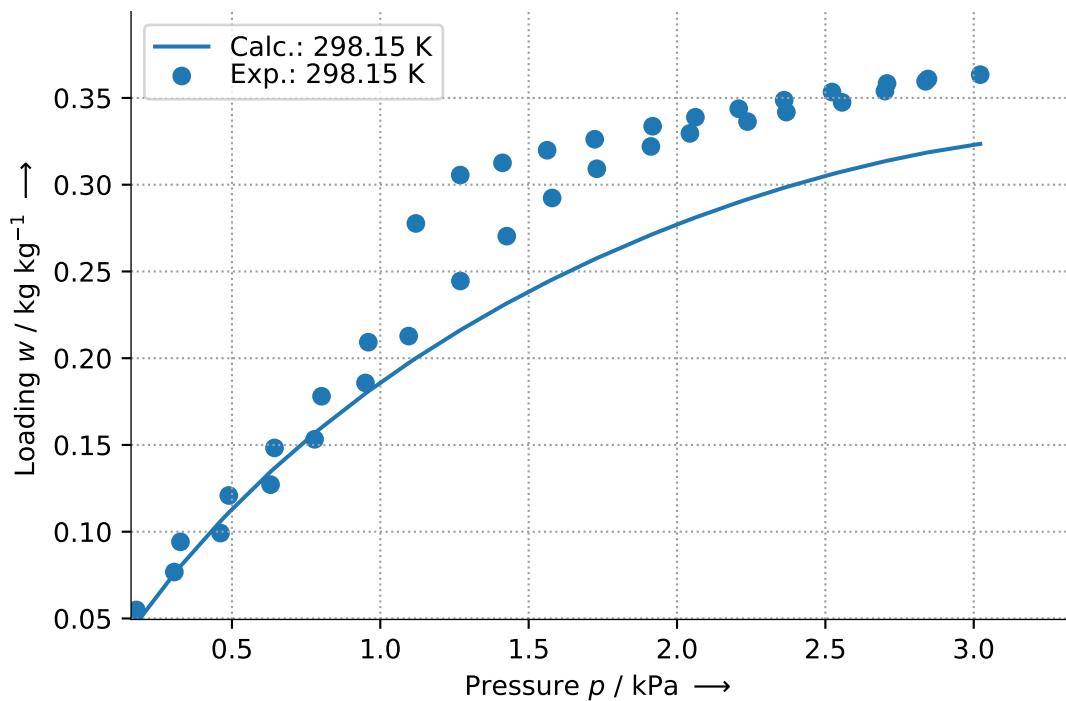
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.350000000e+00
$E$	$\text{J mol}^{-1}$	4.384000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	3.270000000e-04

#### Validity:

Equation is approximately valid for  $177.6967317\text{Pa} \leq p \leq 3021.839798\text{Pa}$ ,  $298.15\text{K} \leq T \leq 298.15\text{K}$ , and  $0.054920716\text{kg kg}^{-1} \leq w \leq 0.363416915\text{kg kg}^{-1}$ .



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 13.56%.

### 5.19.12 Silica gel pellet KD A5BW

#### 5.19.12.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	KD A5BW
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Thu, Kyaw; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2013): Thermo-physical properties of silica gel for adsorption desalination cycle. In: Applied Thermal Engineering 50 (2), S. 1596–1602. DOI: 10.1016/j.applthermaleng.2011.09.038.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000014
Surface area	$\text{m}^2 \text{g}^{-1}$	769.1

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

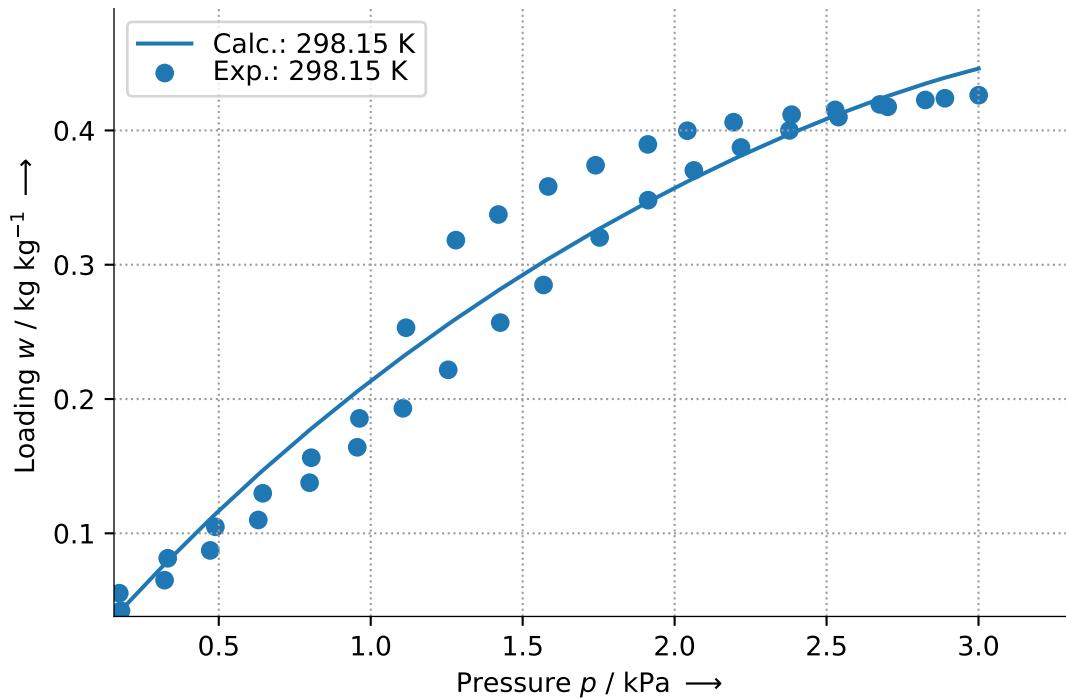
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.250000000e+00
$E$	$\text{J mol}^{-1}$	3.585000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	4.550000000e-04

#### Validity:

Equation is approximately valid for  $172.5202371\text{Pa} \leq p \leq 3000.537872\text{Pa}$ ,  $298.15\text{K} \leq T \leq 298.15\text{K}$ , and  $0.042329083\text{kg kg}^{-1} \leq w \leq 0.42624181\text{kg kg}^{-1}$ .



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.29%.

### 5.19.13 Silica gel pellet Mayekawa A++

#### 5.19.13.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Mayekawa A++
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Thu, Kyaw; Chakraborty, Anutosh; Saha, Bidyut Baran; Ng, Kim Choon (2013): Thermo-physical properties of silica gel for adsorption desalination cycle. In: Applied Thermal Engineering 50 (2), S. 1596–1602. DOI: 10.1016/j.applthermaleng.2011.09.038.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000138
Surface area	$\text{m}^2 \text{g}^{-1}$	836.6

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

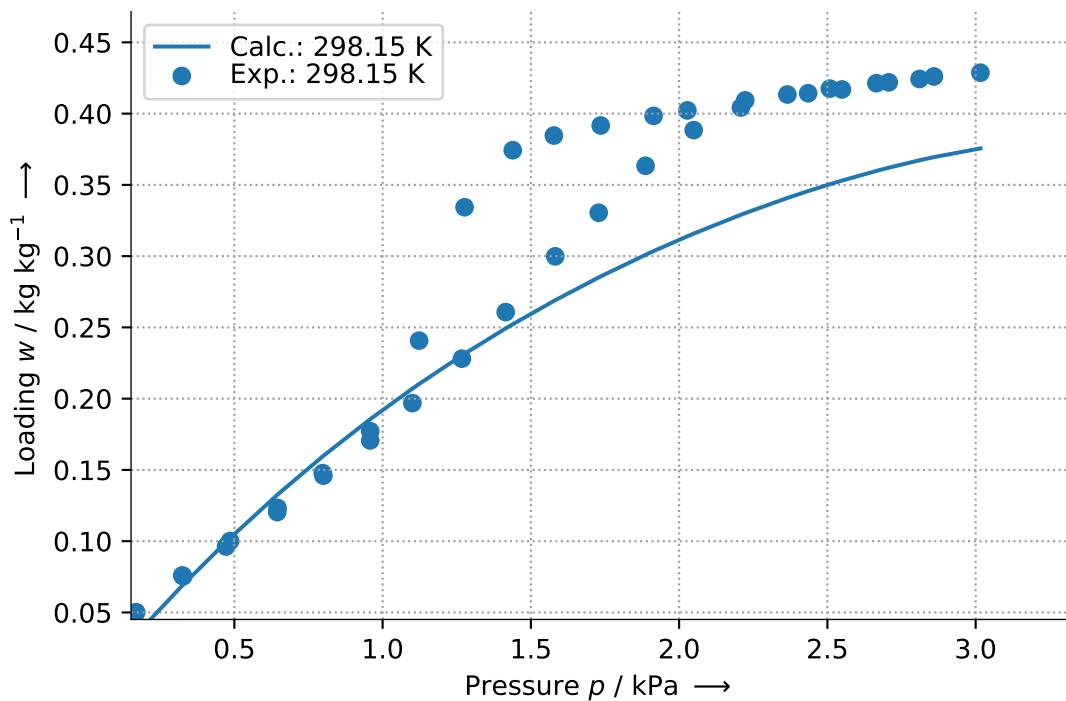
$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	1.350000000e+00
$E$	$\text{J mol}^{-1}$	3.804000000e+03	$W_0$	$\text{m}^3 \text{kg}^{-1}$	3.804000000e-04

#### Validity:

Equation is approximately valid for  $168.4151785\text{Pa} \leq p \leq 3016.175134\text{Pa}$ ,  $298.15\text{K} \leq T \leq 298.15\text{K}$ , and  $0.050099199\text{kg kg}^{-1} \leq w \leq 0.428702545\text{kg kg}^{-1}$ .



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 14.99%.

### 5.19.14 Silica gel pellet Siogel

#### 5.19.14.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	Siogel
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Sapienza, Alessio; Velte, Andreas; Girnik, Ilya; Fazzica, Andrea; Füldner, Gerrit; Schnabel, Lena; Aristov, Yuri (2017): "Water - Silica Siogel" working pair for adsorption chillers. Adsorption equilibrium and dynamics. In: Renewable Energy 110, S. 40–46. DOI: 10.1016/j.renene.2016.09.065.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.000002
Surface area	$\text{m}^2 \text{g}^{-1}$	800
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.4
Bulk density	$\text{kg m}^{-3}$	620-800

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(- (A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

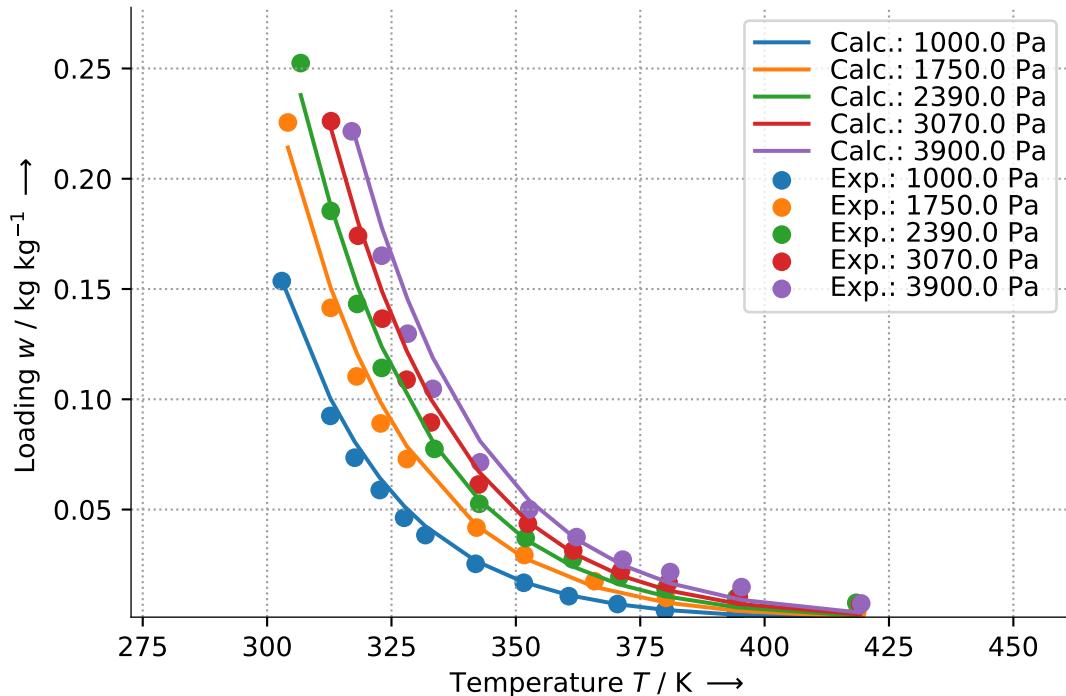
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.100000000e+00
E	$\text{J mol}^{-1}$	3.962200000e+03	$W_0$	$\text{kg kg}^{-1}$	3.800000000e-01

#### Validity:

Equation is approximately valid for  $1000.0 \text{Pa} \leq p \leq 3900.0 \text{Pa}$ ,  $303.057 \text{K} \leq T \leq$

419.518K, and  $0.001831\text{kg kg}^{-1} \leq w \leq 0.25151\text{kg kg}^{-1}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, relative, in % → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 14.88%.

### 5.19.15 Silica gel pellet WS

#### 5.19.15.1 DubininArctan1 - ID 1

<b>Sorbent:</b>	silica gel pellet
<b>Subtype:</b>	WS
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininArctan1
<b>ID:</b>	1
<b>Reference:</b>	Schawe, D. (2000): Theoretical and Experimental Investigations of an Adsorption Heat Pump with Heat Transfer between two Adsorbers. Dissertation. Universität Stuttgart, Stuttgart. Energietechnik.
<b>Comment:</b>	None

**Properties of sorbent:**

Property	Unit	Value
Diameter of pore	mm	2.50E-06
Surface area	$\text{m}^2 \text{g}^{-1}$	650
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.4
Bulk density	$\text{kg m}^{-3}$	700

**Equation and parameters:**

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = W \rho_{\text{sat}}^{\text{liq}} , \text{ and}$$

$$W = \frac{a}{\Pi} \left( \arctan \left( \frac{A - b}{c} \right) + \frac{\Pi}{2} \right) + d , \text{ and}$$

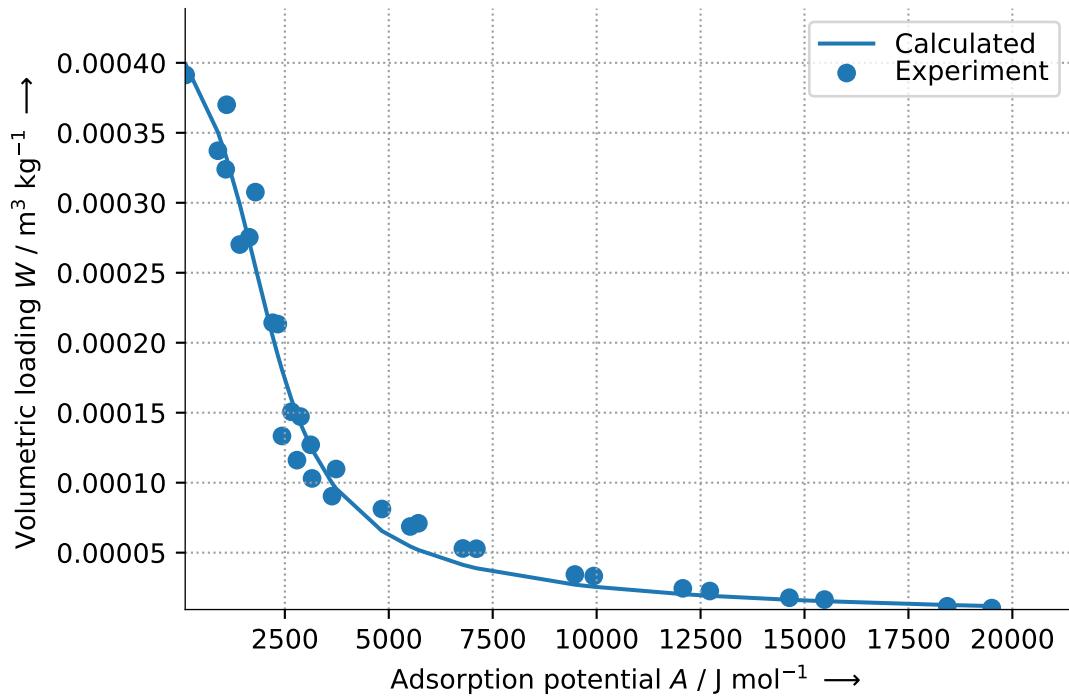
$$A = RT \ln \left( \frac{p_{\text{sat}}}{p} \right) .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a$	$\text{m}^3 \text{kg}^{-1}$	5.046468000e-04	$c$	$\text{J mol}^{-1}$	-1.308650854e+03
$b$	$\text{J mol}^{-1}$	1.805355210e+03	$d$	$\text{m}^3 \text{kg}^{-1}$	0.000000000e+00

**Validity:**

No data on validity available!



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Loading, absolute, in  $\text{kg kg}^{-1}$  → 0.000001

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 13.65%.

### 5.19.16 Zeolite pellet

#### 5.19.16.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Douss, N.; Meunier, F. (1988): Effect of operating temperatures on the coefficient of performance of active carbon-methanol systems. In: Heat Recovery Systems and CHP 8 (5), S. 383–392. DOI: 10.1016/0890-4332(88)90042-7.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pellet	mm	1.5

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n) \quad , \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p) \quad .$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	1.000000000e+00	$n$	-	2.000000000e+00
$E$	$\text{J mol}^{-1}$	1.959737633e+04	$W_0$	$\text{m}^3 \text{kg}^{-1}$	2.690000000e-04

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 5.19.17 Zeolite pellet 13X

#### 5.19.17.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	13X
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Wang, Yu; LeVan, M. Douglas (2009): Adsorption Equilibrium of Carbon Dioxide and Water Vapor on Zeolites 5A and 13X and Silica Gel. Pure Components. In: J. Chem. Eng. Data 54 (10), S. 2839–2844. DOI: 10.1021/je800900a.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$\begin{aligned} w &= \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}} \quad , \text{ and} \\ b &= b_0 \exp \left( \frac{Q^*}{T} \right) \quad , \text{ and} \\ n &= n_0 + c/T \quad , \text{ and} \\ r &= \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases} . \end{aligned}$$

The parameters of the equation are:

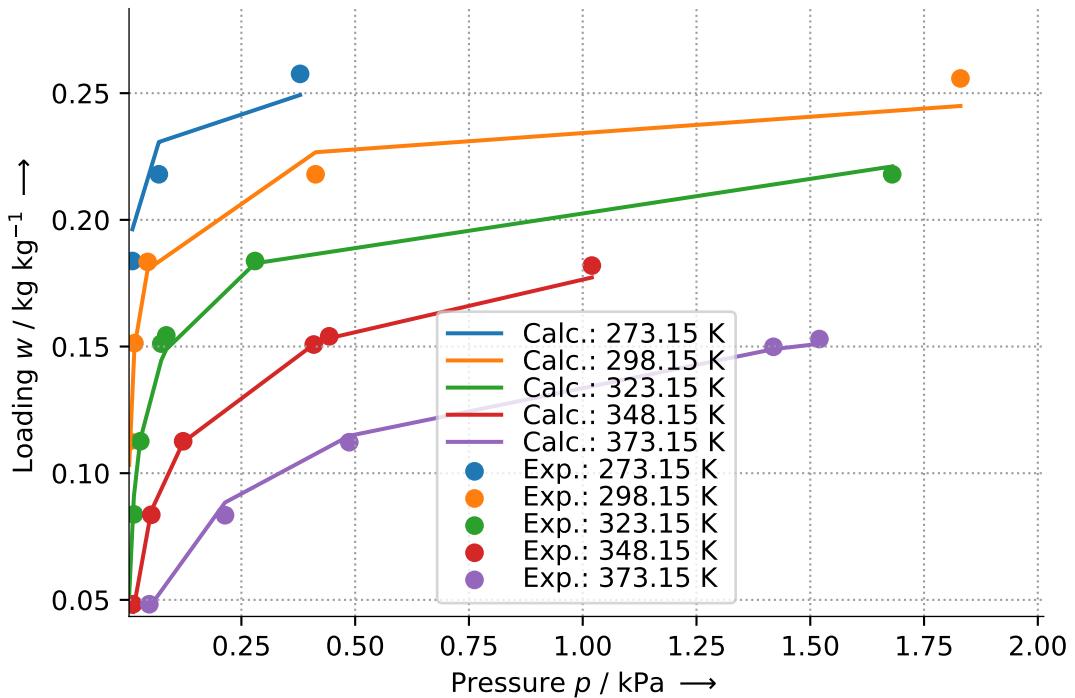
Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	2.408000000e-10	$Q^*$	K	6.852000000e+03
$c$	K	-4.199000000e+00	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	2.718751143e-01
$n_0$	-	3.974000000e-01			

#### Validity:

Equation is approximately valid for  $10.5\text{Pa} \leq p \leq 1830.0\text{Pa}$ ,  $273.15\text{K} \leq T \leq 373.15\text{K}$ , and  $0.04828095\text{kg kg}^{-1} \leq w \leq 0.257618504\text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, relative, in % →  $0.067 \text{ Pa} < p < 13300 \text{ Pa}$ : 0.25
- Temperature, absolute, in K → 0.3

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.31%.

### 5.19.18 Zeolite pellet 5A

#### 5.19.18.1 Toth - ID 1

<b>Sorbent:</b>	zeolite pellet
<b>Subtype:</b>	5A
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Toth
<b>ID:</b>	1
<b>Reference:</b>	Wang, Yu; LeVan, M. Douglas (2009): Adsorption Equilibrium of Carbon Dioxide and Water Vapor on Zeolites 5A and 13X and Silica Gel. Pure Components. In: J. Chem. Eng. Data 54 (10), S. 2839–2844. DOI: 10.1021/je800900a.
<b>Comment:</b>	None

#### Properties of sorbent:

Property data of sorbent and subtype does not exist.

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa and temperature  $T$  in K by:

$$w = \frac{w_{\text{sat}} b^m p}{(1 + b^r p^n)^{1/n}}, \text{ and}$$

$$b = b_0 \exp\left(\frac{Q^*}{T}\right), \text{ and}$$

$$n = n_0 + c/T, \text{ and}$$

$$r = \begin{cases} n & \text{if } r^* < 0 \\ r^* & \text{else} \end{cases}.$$

The parameters of the equation are:

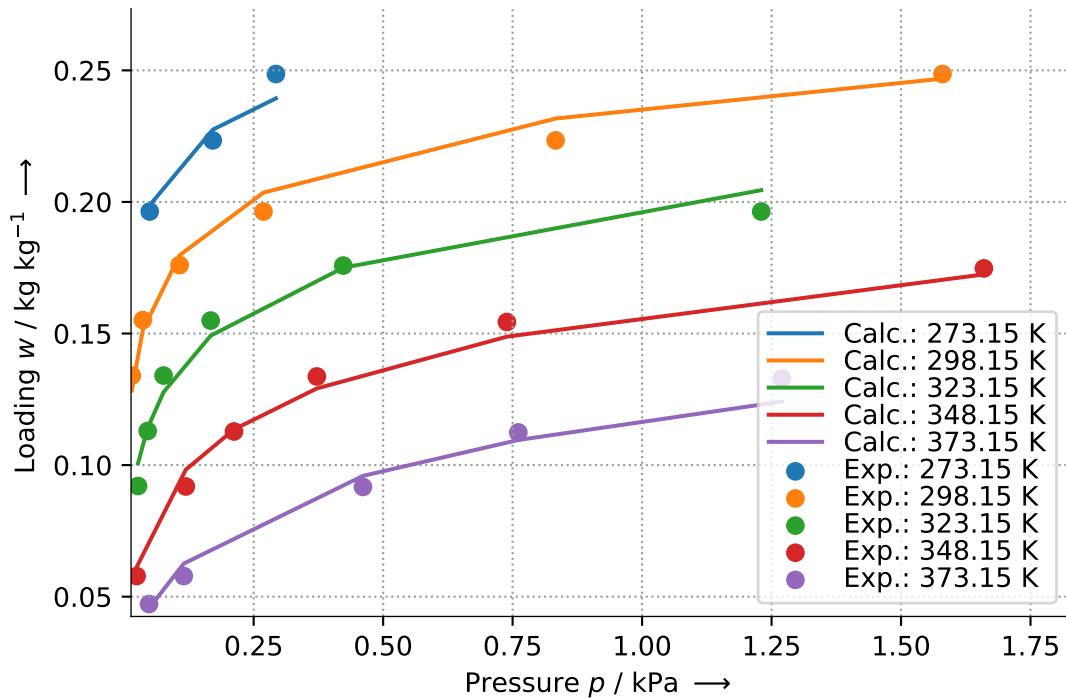
Par.	Unit	Value	Par.	Unit	Value
$b_0$	$\text{Pa}^{-1}$	4.714000000e-13	$Q^*$	K	9.955000000e+03
$c$	K	-5.114000000e+01	$r^*$	-	-1.000000000e+00
$m$	-	1.000000000e+00	$w_{\text{sat}}$	$\text{kg kg}^{-1}$	4.226750038e-01
$n_0$	-	3.548000000e-01			

#### Validity:

Equation is approximately valid for  $14.7 \text{ Pa} \leq p \leq 1660.0 \text{ Pa}$ ,  $273.15 \text{ K} \leq T \leq 373.15 \text{ K}$ , and  $0.047200034 \text{ kg kg}^{-1} \leq w \leq 0.248610864 \text{ kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, relative, in % →  $0.067 \text{ Pa} < p < 13300 \text{ Pa}$ : 0.25
- Temperature, absolute, in K → 0.3

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.63%.

### 5.19.19 Zeotype pellet AQSOA-Z01

#### 5.19.19.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeotype pellet
<b>Subtype:</b>	AQSOA-Z01
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Wei Benjamin Teo, How; Chakraborty, Anutosh; Fan, Wu (2017): Improved adsorption characteristics data for AQSOA types zeolites and water systems under static and dynamic conditions. In: Microporous and Mesoporous Materials 242, S. 109–117. DOI: 10.1016/j.micromeso.2017.01.015.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000074
Surface area	$\text{m}^2 \text{g}^{-1}$	130-250
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.071

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

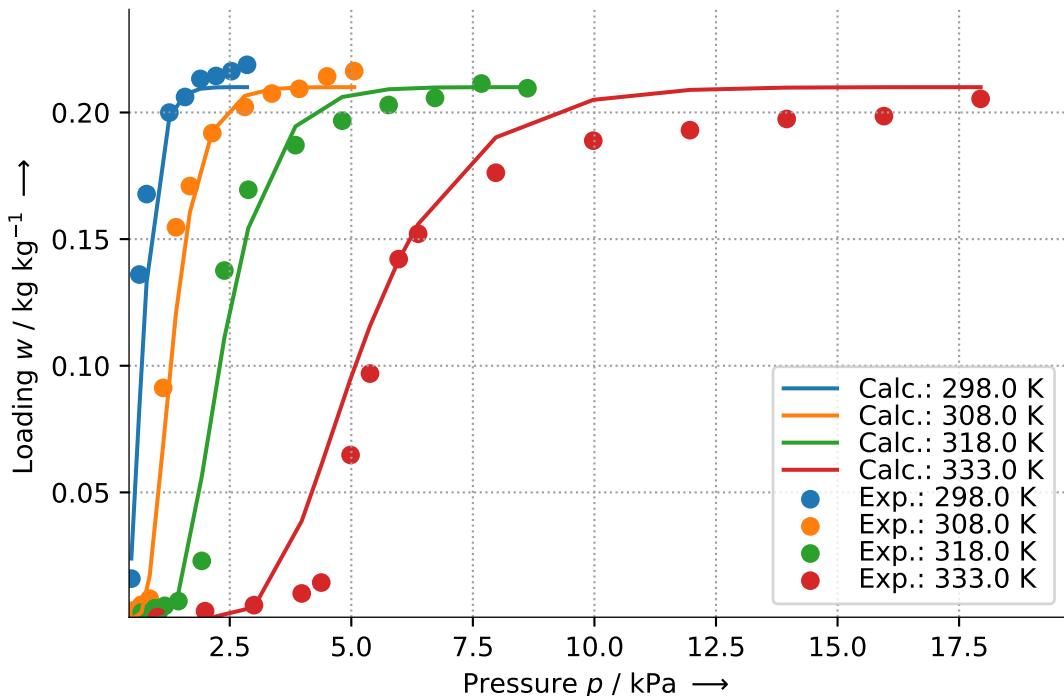
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	5.000000000e+00
E	$\text{J mol}^{-1}$	4.000000000e+03	$W_0$	$\text{kg kg}^{-1}$	2.100000000e-01

#### Validity:

Equation is approximately valid for  $476.7\text{Pa} \leq p \leq 17942.6\text{Pa}$ ,  $298.0\text{K} \leq T \leq 333.0\text{K}$ ,

and  $0.000788\text{kg kg}^{-1} \leq w \leq 0.218824\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 38.42%.

### 5.19.19.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	zeotype pellet
<b>Subtype:</b>	AQSOA-Z01
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Kayal, Sibnath; Baichuan, Sun; Saha, Bidyut Baran (2016): Adsorption characteristics of AQSOA zeolites and water for adsorption chillers. In: International Journal of Heat and Mass Transfer 92, S. 1120–1127. DOI: 10.1016/j.ijheatmasstransfer.2015.09.060.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000074
Surface area	$\text{m}^2 \text{g}^{-1}$	132
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.087

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(\mathcal{A}/E)^n), \text{ and}$$

$$\mathcal{A} = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

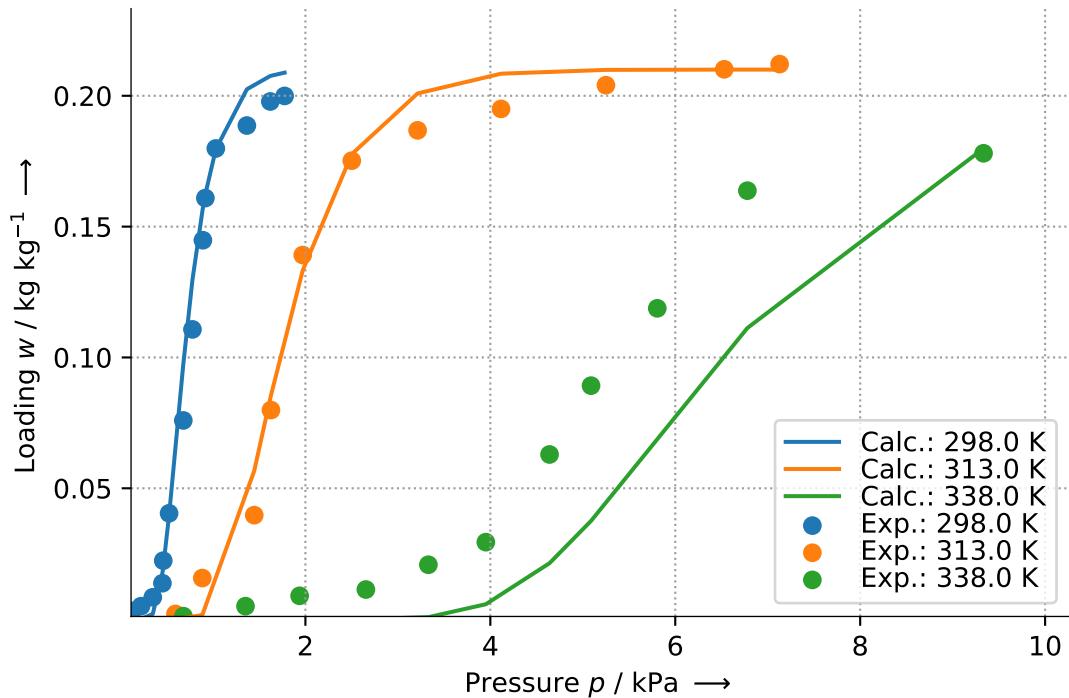
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	5.000000000e+00
E	$\text{J mol}^{-1}$	4.000000000e+03	$W_0$	$\text{kg kg}^{-1}$	2.100000000e-01

#### Validity:

Equation is approximately valid for  $127.0 \text{Pa} \leq p \leq 9334.3 \text{Pa}$ ,  $298.0 \text{K} \leq T \leq 338.0 \text{K}$ , and  $0.001131 \text{kg kg}^{-1} \leq w \leq 0.212104 \text{kg kg}^{-1}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.01

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 39.7%.

### 5.19.20 Zeotype pellet AQSOA-Z02

#### 5.19.20.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeotype pellet
<b>Subtype:</b>	AQSOA-Z02
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Wei Benjamin Teo, How; Chakraborty, Anutosh; Fan, Wu (2017): Improved adsorption characteristics data for AQSOA types zeolites and water systems under static and dynamic conditions. In: Microporous and Mesoporous Materials 242, S. 109–117. DOI: 10.1016/j.micromeso.2017.01.015.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000037
Surface area	$\text{m}^2 \text{g}^{-1}$	650-770
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.27

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

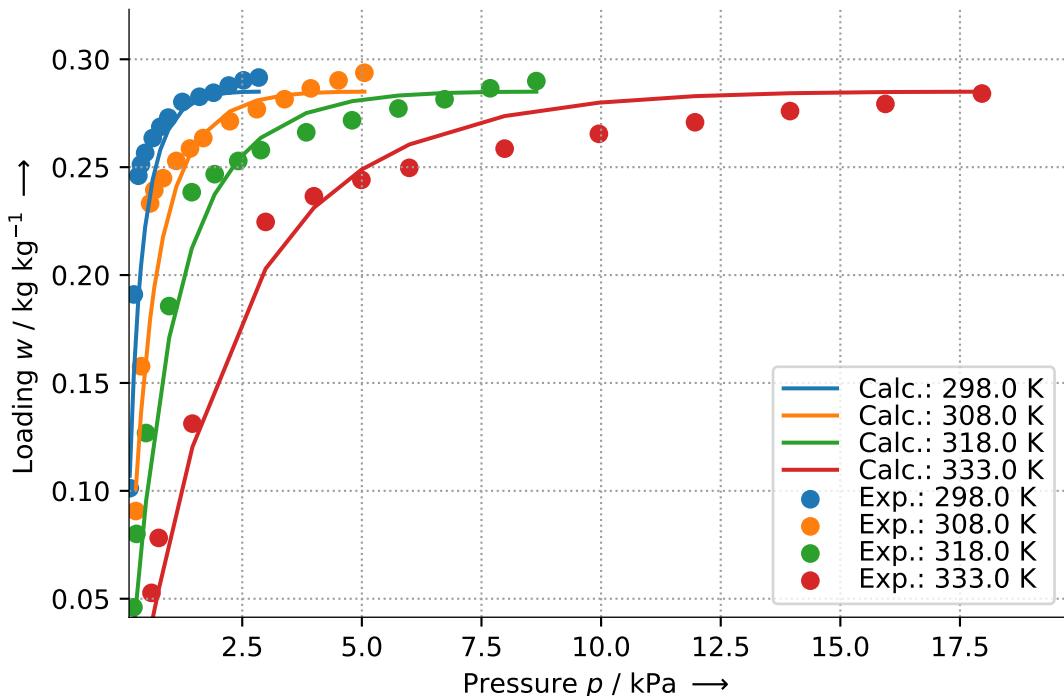
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	2.900000000e+00
E	$\text{J mol}^{-1}$	7.600000000e+03	$W_0$	$\text{kg kg}^{-1}$	2.850000000e-01

#### Validity:

Equation is approximately valid for  $149.4\text{Pa} \leq p \leq 17959.1\text{Pa}$ ,  $298.0\text{K} \leq T \leq 333.0\text{K}$ ,

and  $0.046033\text{kg kg}^{-1} \leq w \leq 0.293742\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.8%.

### 5.19.20.2 DubininAstakhov - ID 2

<b>Sorbent:</b>	zeotype pellet
<b>Subtype:</b>	AQSOA-Z02
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	2
<b>Reference:</b>	Kayal, Sibnath; Baichuan, Sun; Saha, Bidyut Baran (2016): Adsorption characteristics of AQSOA zeolites and water for adsorption chillers. In: International Journal of Heat and Mass Transfer 92, S. 1120–1127. DOI: 10.1016/j.ijheatmasstransfer.2015.09.060.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000037
Diameter of pellet	mm	0.17
Surface area	$\text{m}^2 \text{g}^{-1}$	590
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.2769

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(^A/E)^n), \text{ and}$$

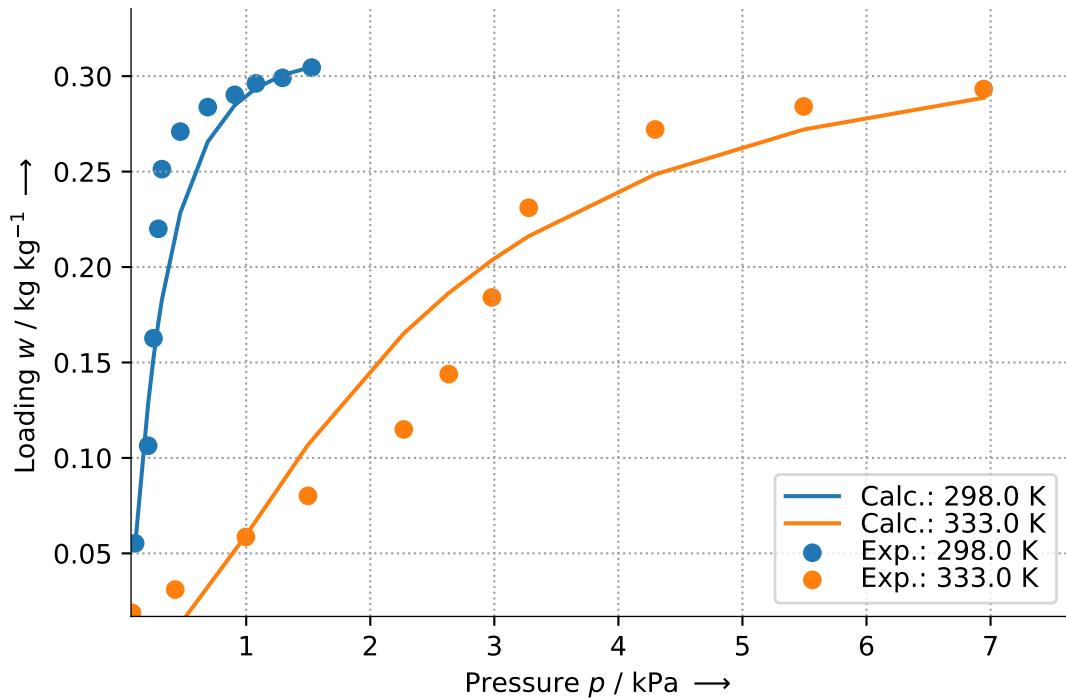
$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	3.000000000e+00
E	$\text{J mol}^{-1}$	7.000000000e+03	$W_0$	$\text{kg kg}^{-1}$	3.100000000e-01

#### Validity:

Equation is approximately valid for  $79.92\text{Pa} \leq p \leq 6944.81\text{Pa}$ ,  $298.0\text{K} \leq T \leq 333.0\text{K}$ , and  $0.018837\text{kg kg}^{-1} \leq w \leq 0.304504\text{kg kg}^{-1}$ .



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.01

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 18.78%.

### 5.19.21 Zeotype pellet AQSOA-Z05

#### 5.19.21.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeotype pellet
<b>Subtype:</b>	AQSOA-Z05
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Wei Benjamin Teo, How; Chakraborty, Anutosh; Fan, Wu (2017): Improved adsorption characteristics data for AQSOA types zeolites and water systems under static and dynamic conditions. In: Microporous and Mesoporous Materials 242, S. 109–117. DOI: 10.1016/j.micromeso.2017.01.015.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Diameter of pore	mm	0.0000074
Surface area	$\text{m}^2 \text{g}^{-1}$	210-330
Pore volume	$\text{mm}^3 \text{g}^{-1}$	0.07

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

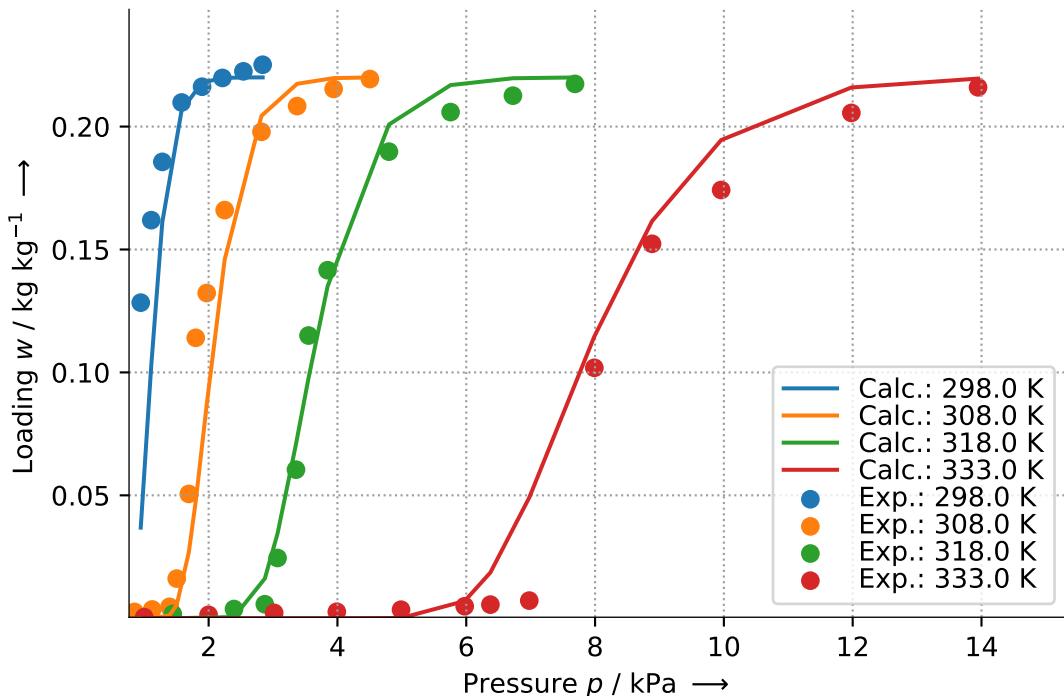
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	6.000000000e+00
E	$\text{J mol}^{-1}$	2.700000000e+03	$W_0$	$\text{kg kg}^{-1}$	2.200000000e-01

#### Validity:

Equation is approximately valid for  $849.4\text{Pa} \leq p \leq 13946.4\text{Pa}$ ,  $298.0\text{K} \leq T \leq 333.0\text{K}$ ,

and  $0.000463\text{kg kg}^{-1} \leq w \leq 0.225151\text{kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.15

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 56.57%.

### 5.19.22 Zeotype powder ETS-10

#### 5.19.22.1 DubininAstakhov - ID 1

<b>Sorbent:</b>	zeotype powder
<b>Subtype:</b>	ETS-10
<b>Refrigerant:</b>	Water
<b>Equation:</b>	DubininAstakhov
<b>ID:</b>	1
<b>Reference:</b>	Pinheiro, Joana M.; Valente, Anabela A.; Salústio, Sérgio; Ferreira, Nelson; Rocha, João; Silva, Carlos M. (2015): Application of the novel ETS-10/water pair in cyclic adsorption heating processes. Measurement of equilibrium and kinetics properties and simulation studies. In: Applied Thermal Engineering 87, S. 412–423. DOI: 10.1016/j.applthermaleng.2015.05.011.
<b>Comment:</b>	None

#### Properties of sorbent:

Property	Unit	Value
Porosity of pellet	-	0.58
Solid density	$\text{kg m}^{-3}$	2553

#### Equation and parameters:

Loading  $w$  in  $\text{kg kg}^{-1}$  is calculated depending on pressure  $p$  in Pa, temperature  $T$  in K, and vapor pressure  $p_{\text{sat}}$  in Pa by:

$$w = \begin{cases} W \rho_{\text{sat}}^{\text{liq}} & \text{if flag} \geq 0 \\ W & \text{else} \end{cases}, \text{ and}$$

$$W = W_0 \exp(-(A/E)^n), \text{ and}$$

$$A = RT \ln(p_{\text{sat}}/p).$$

The parameters of the equation are:

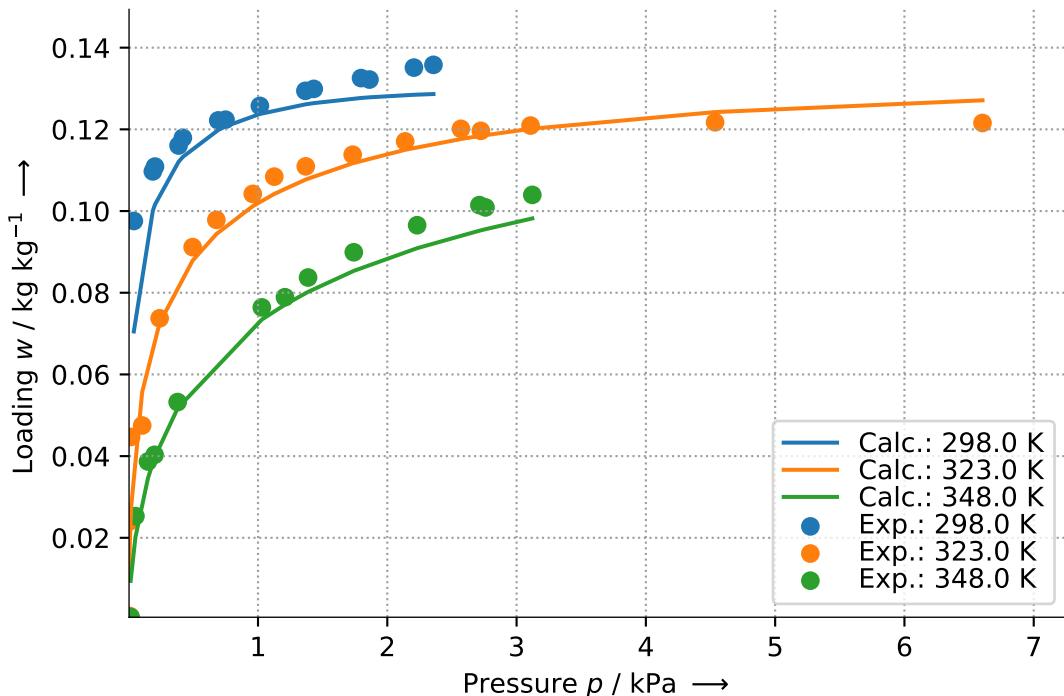
Par.	Unit	Value	Par.	Unit	Value
flag	-	-1.000000000e+00	n	-	1.980000000e+00
E	$\text{J mol}^{-1}$	1.398623832e+04	$W_0$	$\text{kg kg}^{-1}$	1.290000000e-01

#### Validity:

Equation is approximately valid for  $2.81\text{Pa} \leq p \leq 6603.69\text{Pa}$ ,  $298.0\text{K} \leq T \leq 348.0\text{K}$ ,

and  $0.000618 \text{ kg kg}^{-1} \leq w \leq 0.135792 \text{ kg kg}^{-1}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 87.32%.

# 6 Absorption

## 6.1 2-Propanol

### 6.1.1 Ionic liquid [BMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.1.1.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12} / RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21} / RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

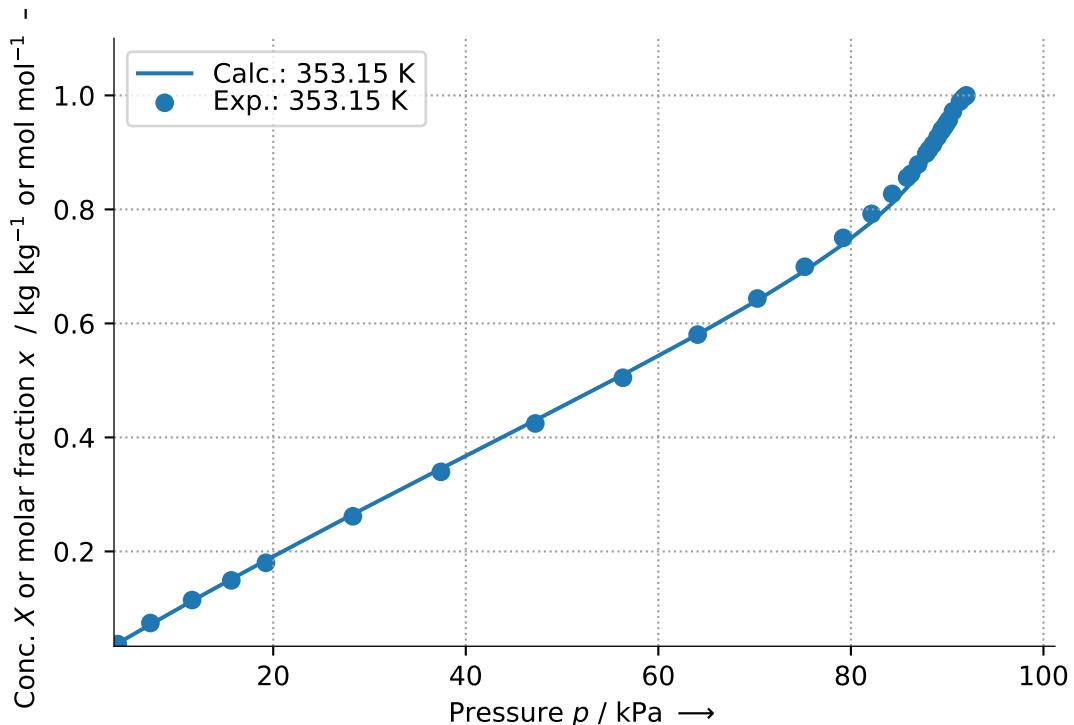
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	8.000000000e-01	$\alpha_{21}$	-	8.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	7.020333600e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-8.547912000e+02

Par.	Unit	Value	Par.	Unit	Value

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.21%.

### 6.1.1.2 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

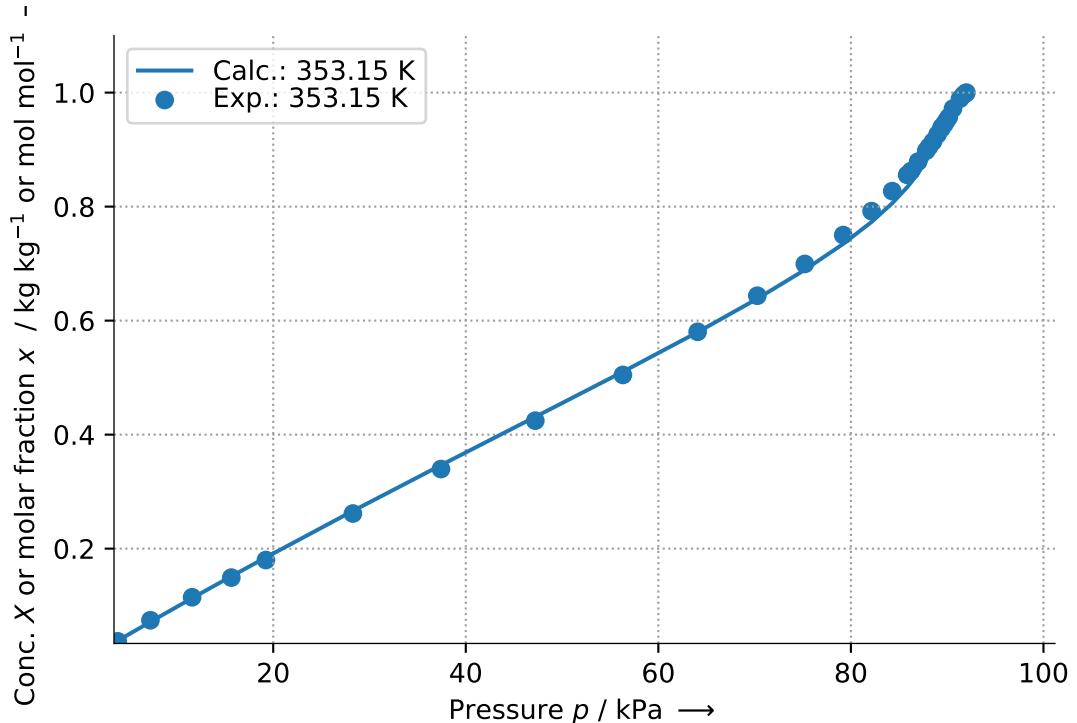
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.200766160e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-1.562096400e+02
$r_1$	-	2.779100000e+00	$r_2$	-	1.116000000e+01
$q_1$	-	2.508000000e+00	$q_2$	-	1.020000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.37%.

### 6.1.1.3 UniquacFixedDu - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	2
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF3SO2)2N], [BMIM][(CF3SO2)2N], [MMIM][(CH3)2PO4] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

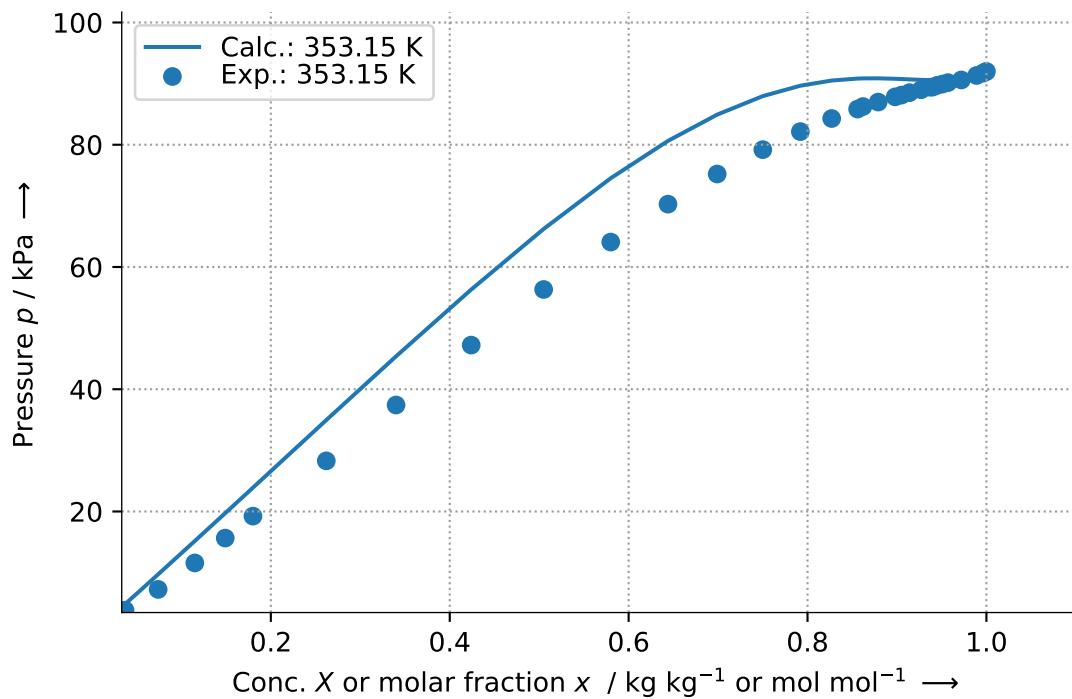
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.200800000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	1.562000000e+02
$r_1$	-	2.789000000e+00	$r_2$	-	1.116000000e+01
$q_1$	-	2.508000000e+00	$q_2$	-	1.020000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.22%.

### 6.1.1.4 WilsonFixedDI - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) & , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} & , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

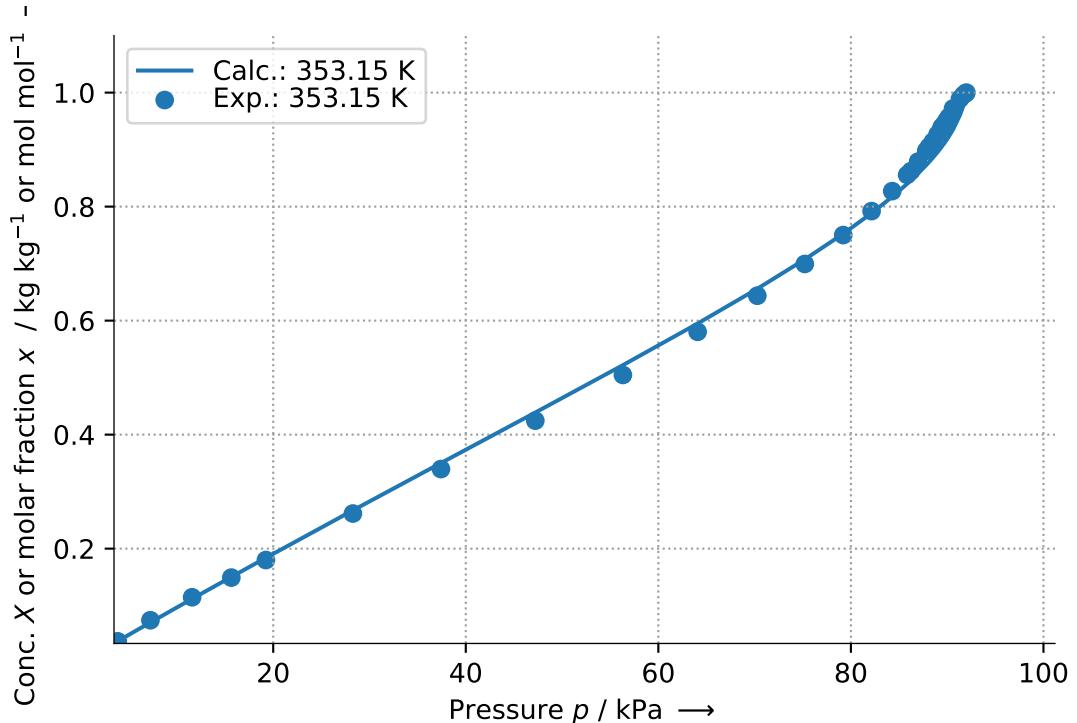
Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	1.276789440e+03	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	9.689725600e+03
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	7.692000000e+01	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	2.917100000e+02

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.42%.

### 6.1.2 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.1.2.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	6.000000000e-01	$\alpha_{21}$	-	6.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	7.795628800e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-1.003867120e+03

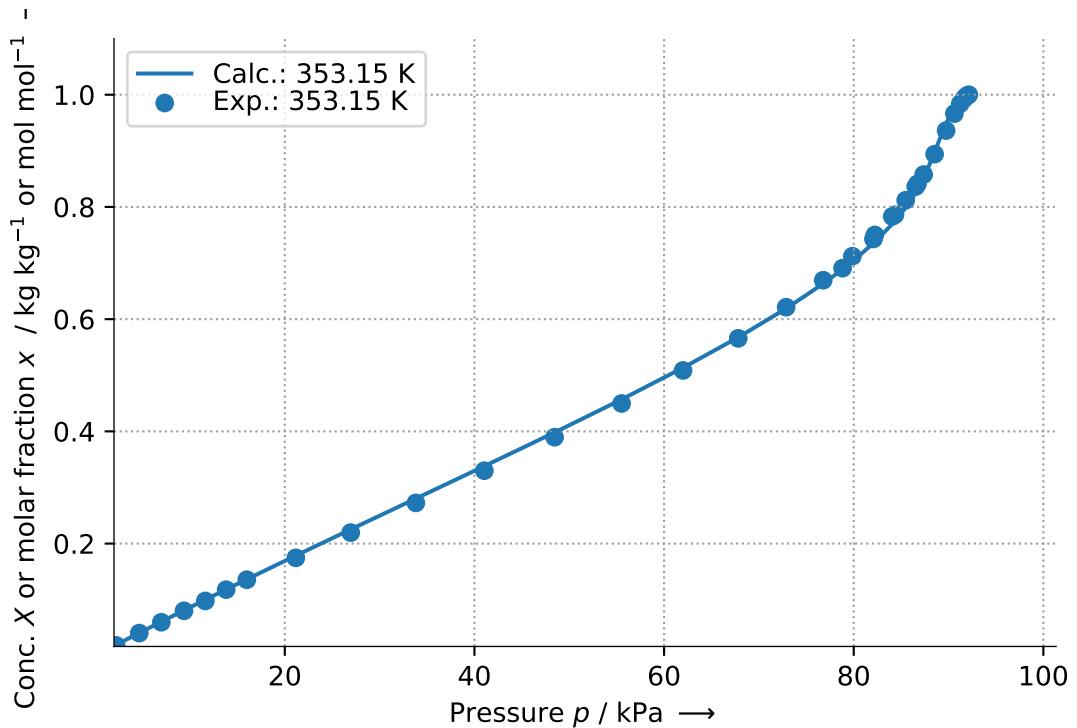
#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.27%.

### 6.1.2.2 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

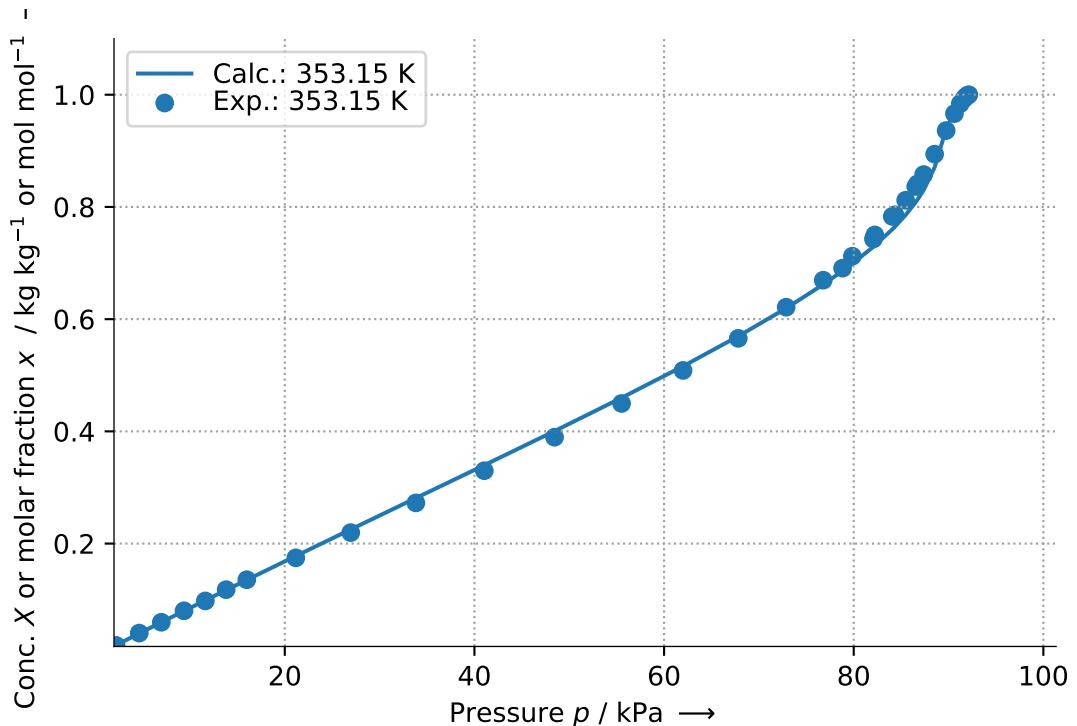
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.536364800e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-2.923904720e+02
$r_1$	-	2.779100000e+00	$r_2$	-	9.890000000e+00
$q_1$	-	2.508000000e+00	$q_2$	-	8.780000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.62%.

### 6.1.2.3 UniquacFixedDu - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	2
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF3SO2)2N], [BMIM][(CF3SO2)2N], [MMIM][(CH3)2PO4] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

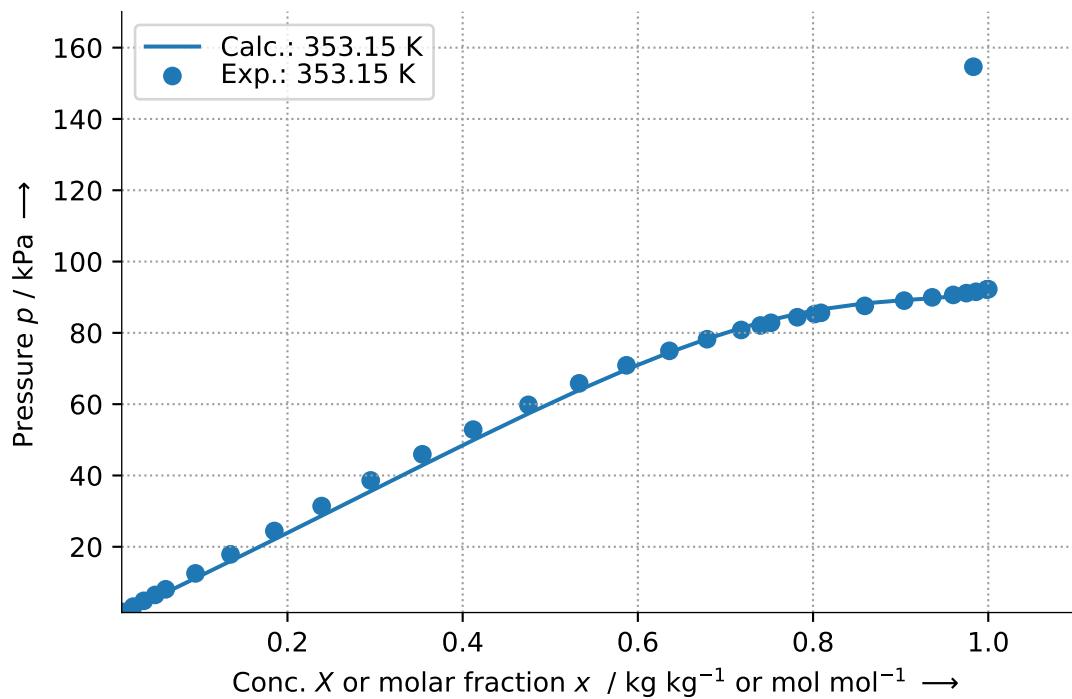
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.536400000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-2.924000000e+02
$r_1$	-	2.789000000e+00	$r_2$	-	9.890000000e+00
$q_1$	-	2.508000000e+00	$q_2$	-	8.780000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.7%.

### 6.1.2.4 WilsonFixedDI - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	2-Propanol
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

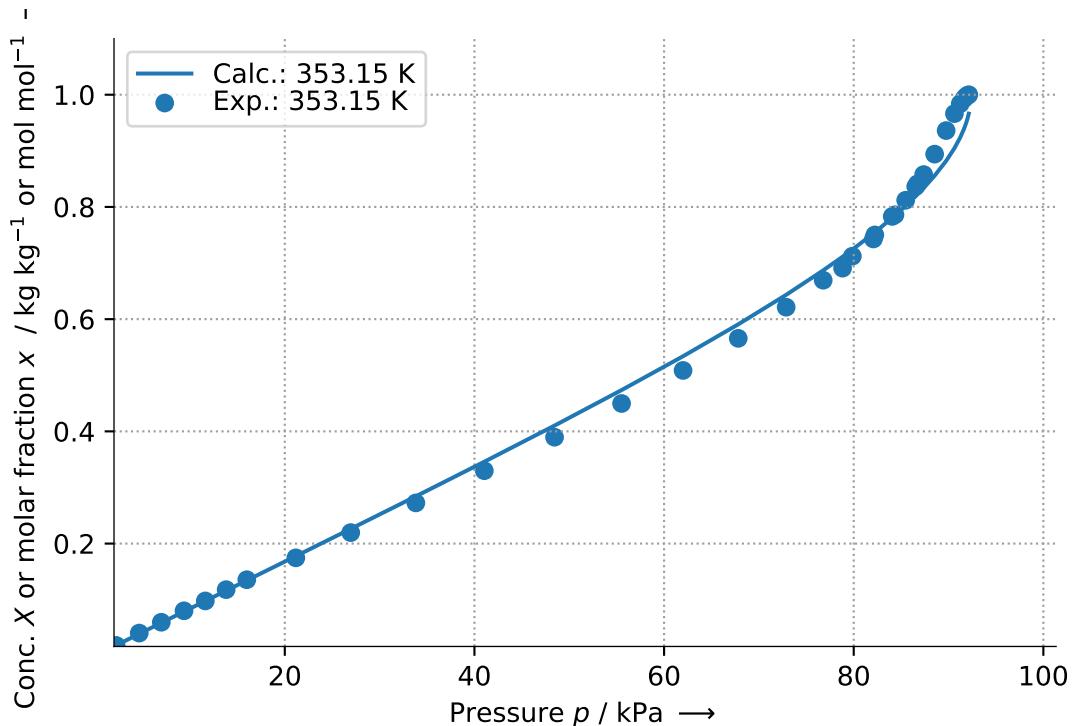
Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	1.189343840e+03	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	1.673600000e+04
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	7.692000000e+01	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	2.445800000e+02

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.02%.

## 6.2 Acetone

### 6.2.1 Ionic liquid [BMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.2.1.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

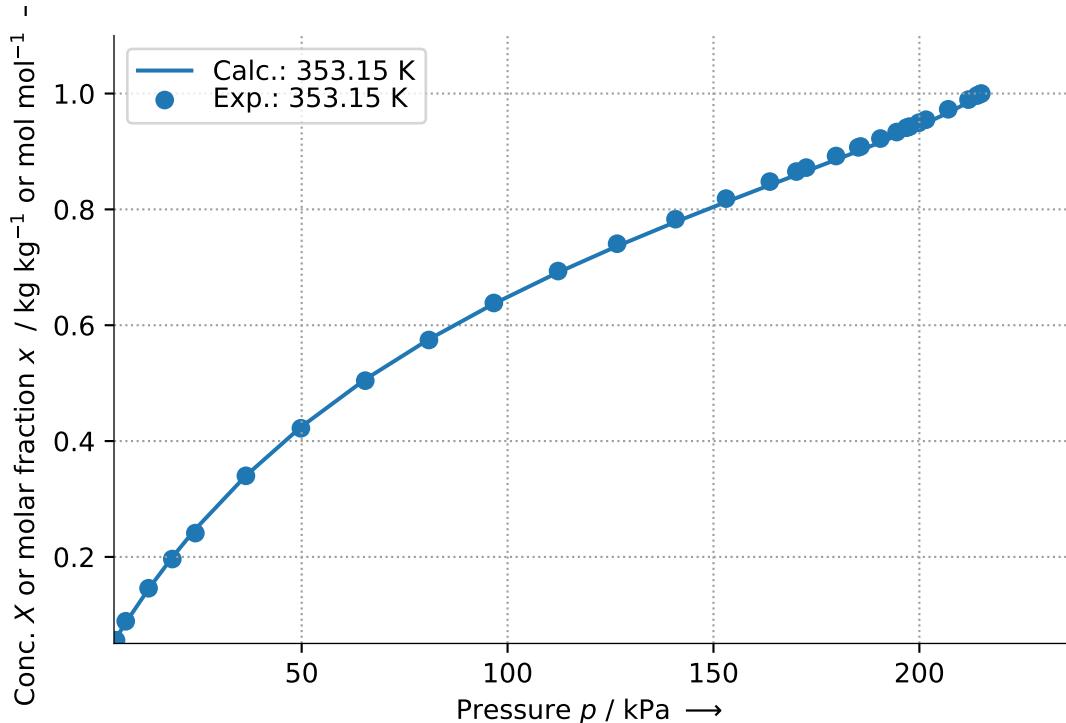
Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	4.700000000e-01	$\alpha_{21}$	-	4.700000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	4.093876640e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-5.089417600e+03

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.9%.

### 6.2.1.2 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

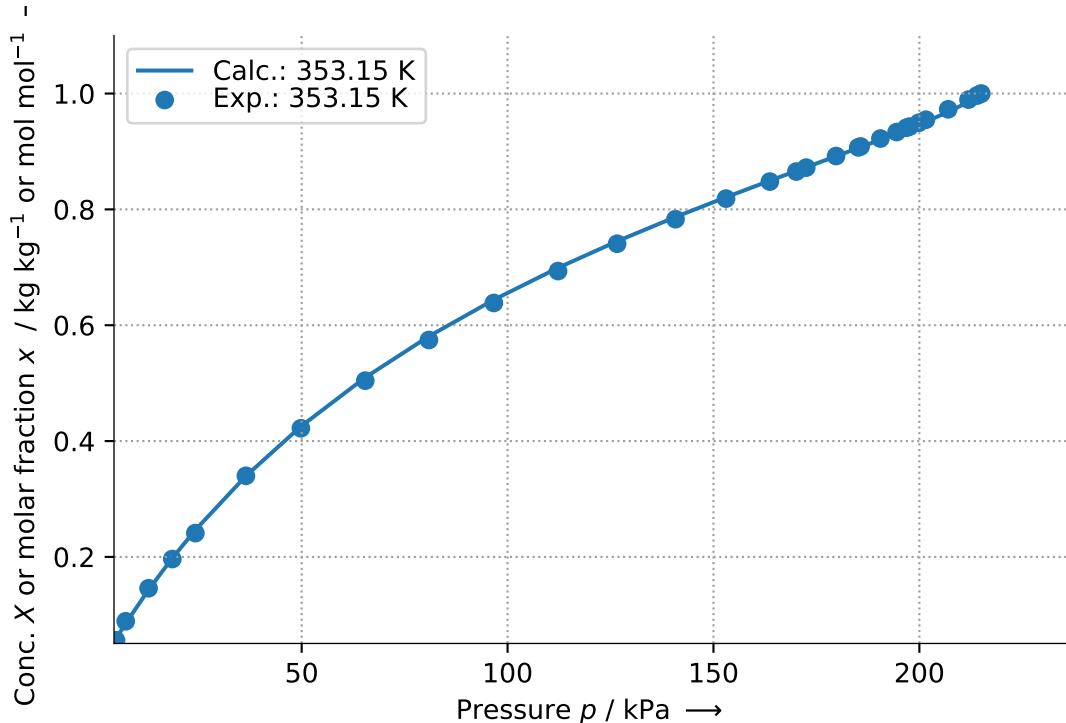
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-1.368795600e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	1.368795600e+03
$r_1$	-	2.573500000e+00	$r_2$	-	1.116000000e+01
$q_1$	-	2.336000000e+00	$q_2$	-	1.020000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.77%.

### 6.2.1.3 UniquacFixedDu - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	2
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF3SO2)2N], [BMIM][(CF3SO2)2N], [MMIM][(CH3)2PO4] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

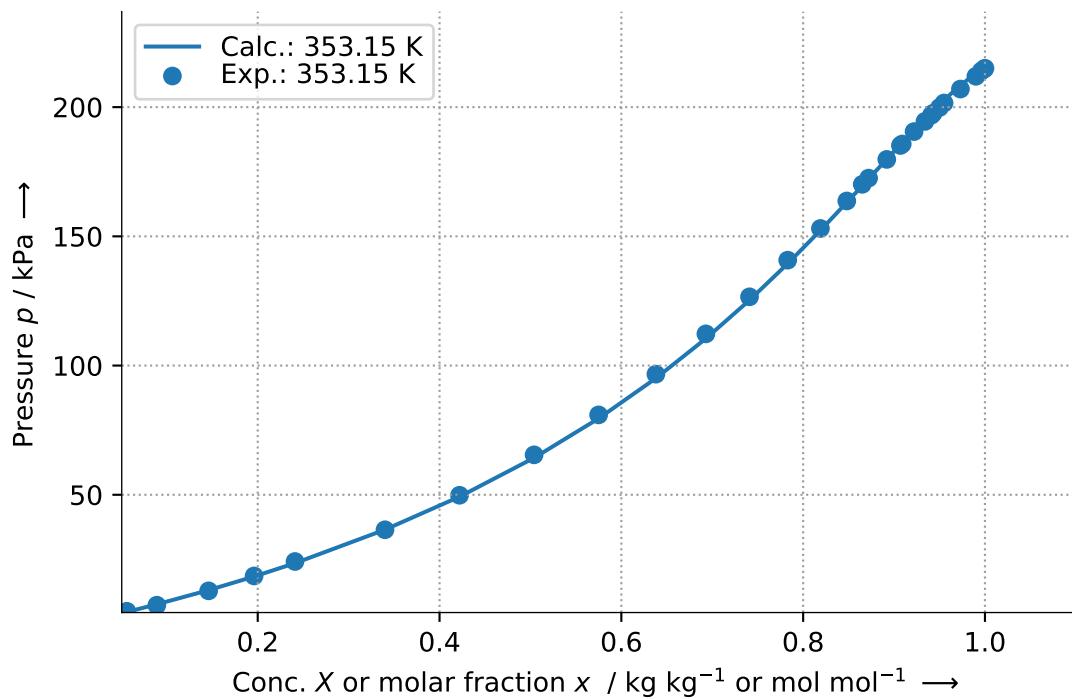
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-1.368800000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	1.368800000e+03
$r_1$	-	2.573500000e+00	$r_2$	-	1.116000000e+01
$q_1$	-	2.336000000e+00	$q_2$	-	1.020000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.06%.

### 6.2.1.4 WilsonFixedDI - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) & , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} & , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

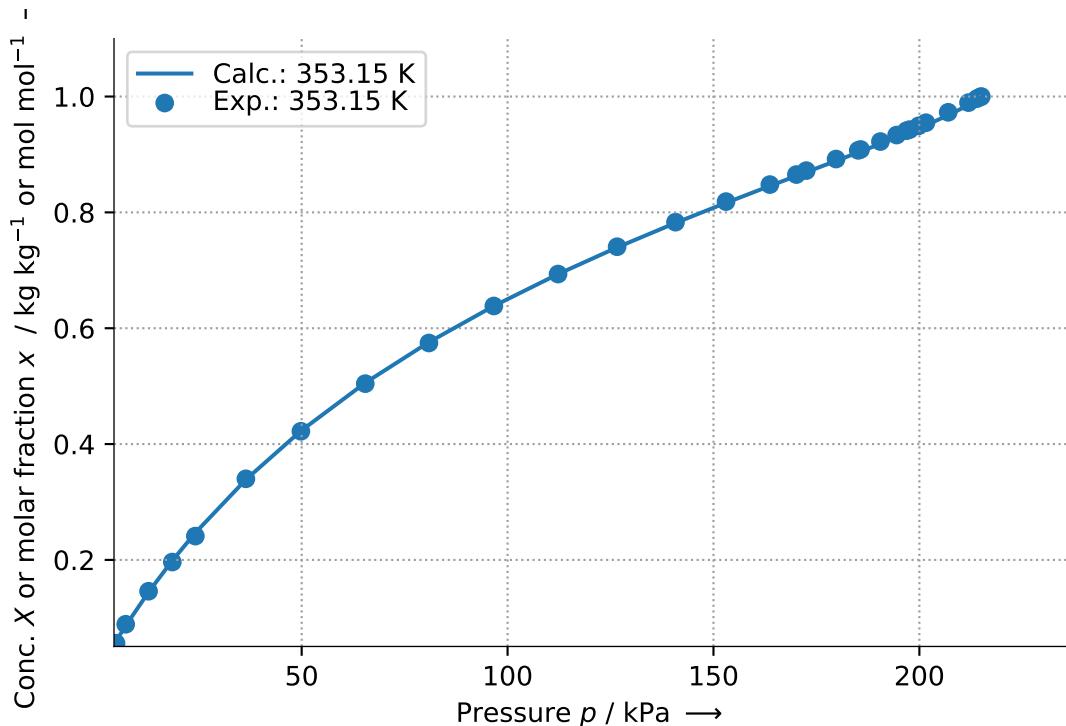
Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	-2.000412240e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-2.410360560e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	7.404000000e+01	$v_2$	$\text{m}^3 \text{mol}^{-1}$	2.917100000e+02

#### Validity:

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.71%.

### 6.2.2 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.2.2.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	4.700000000e-01	$\alpha_{21}$	-	4.700000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	4.612441600e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-4.922057600e+03

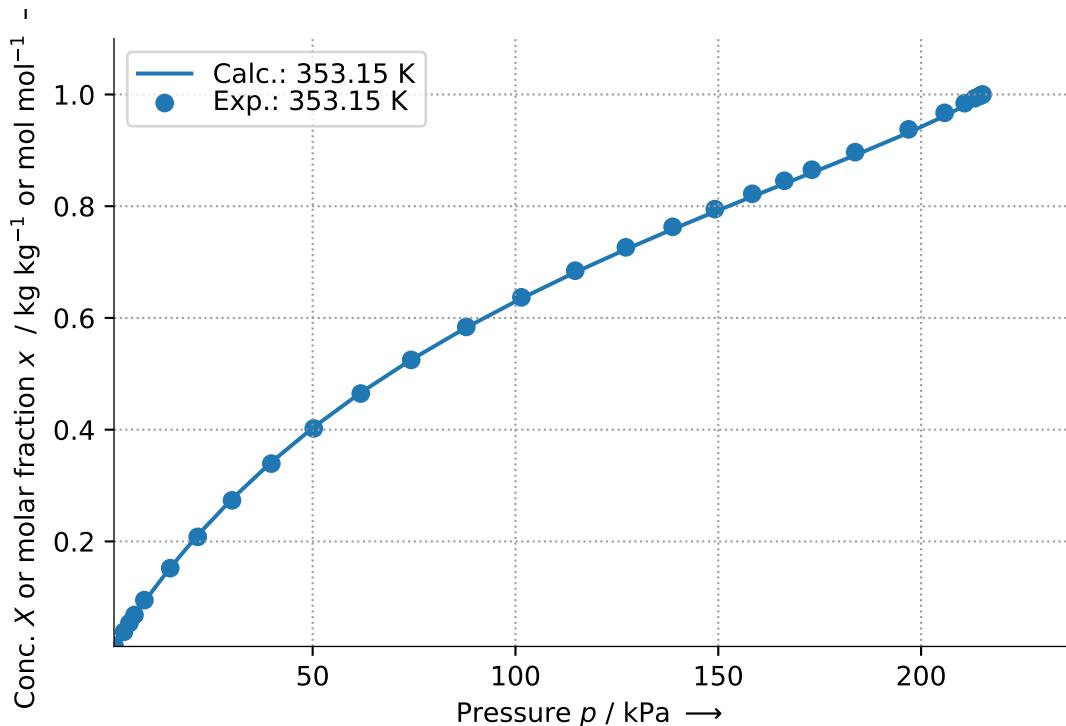
#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.71%.

### 6.2.2.2 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

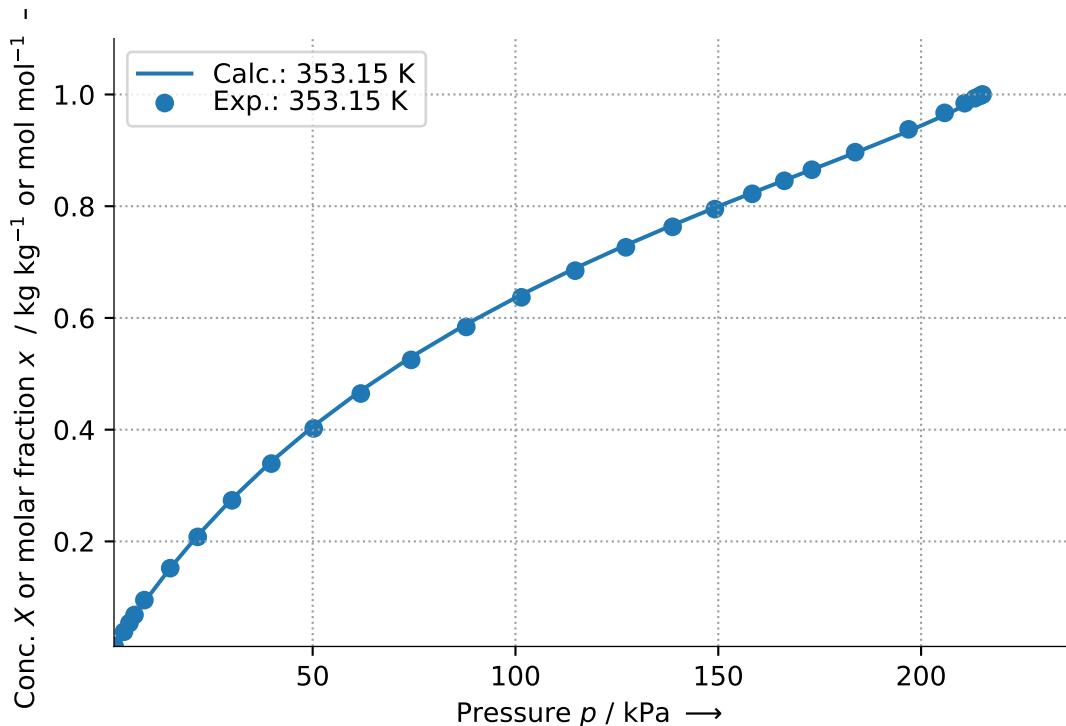
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-1.393857760e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	1.393857760e+03
$r_1$	-	2.573500000e+00	$r_2$	-	9.890000000e+00
$q_1$	-	2.336000000e+00	$q_2$	-	8.780000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.79%.

### 6.2.2.3 UniquacFixedDu - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	2
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF3SO2)2N], [BMIM][(CF3SO2)2N], [MMIM][(CH3)2PO4] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

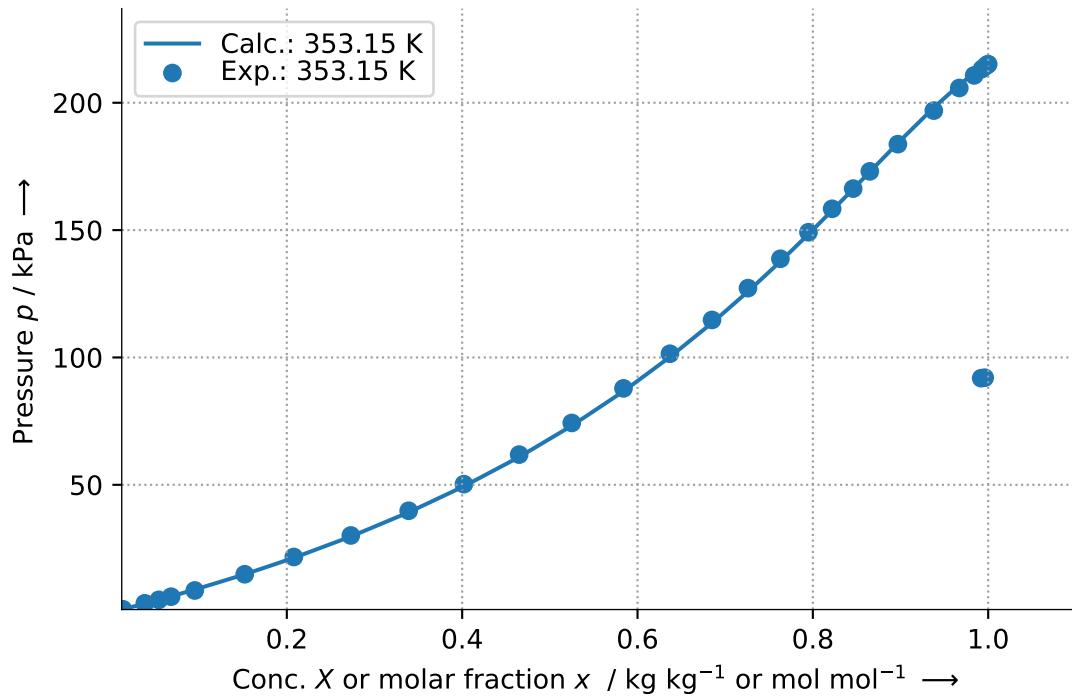
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-1.393900000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	1.393900000e+03
$r_1$	-	2.573500000e+00	$r_2$	-	9.890000000e+00
$q_1$	-	2.336000000e+00	$q_2$	-	8.780000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 9.49%.

### 6.2.2.4 WilsonFixedDI - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

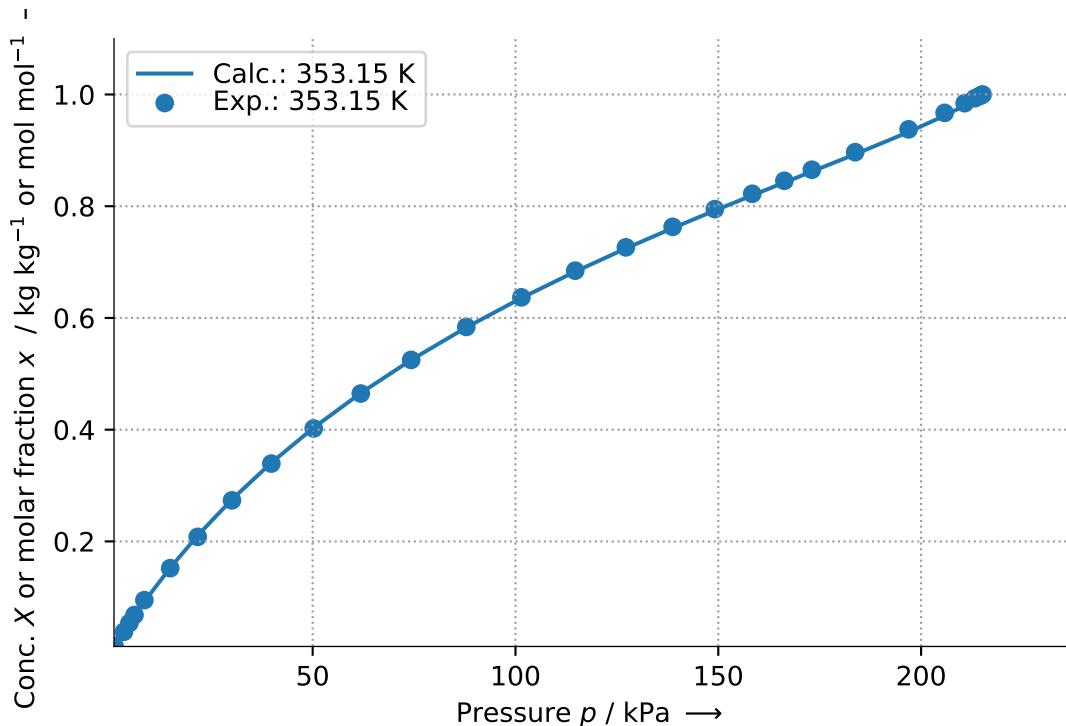
Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	-2.864115360e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-2.185052160e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	7.404000000e+01	$v_2$	$\text{m}^3 \text{mol}^{-1}$	2.445800000e+02

#### Validity:

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.58%.

### 6.2.3 Ionic liquid [MMIM]+[(CH<sub>3</sub>)<sub>2</sub>PO<sub>4</sub>]-

#### 6.2.3.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]-
<b>Refrigerant:</b>	Acetone
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [BMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [MMIM][(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

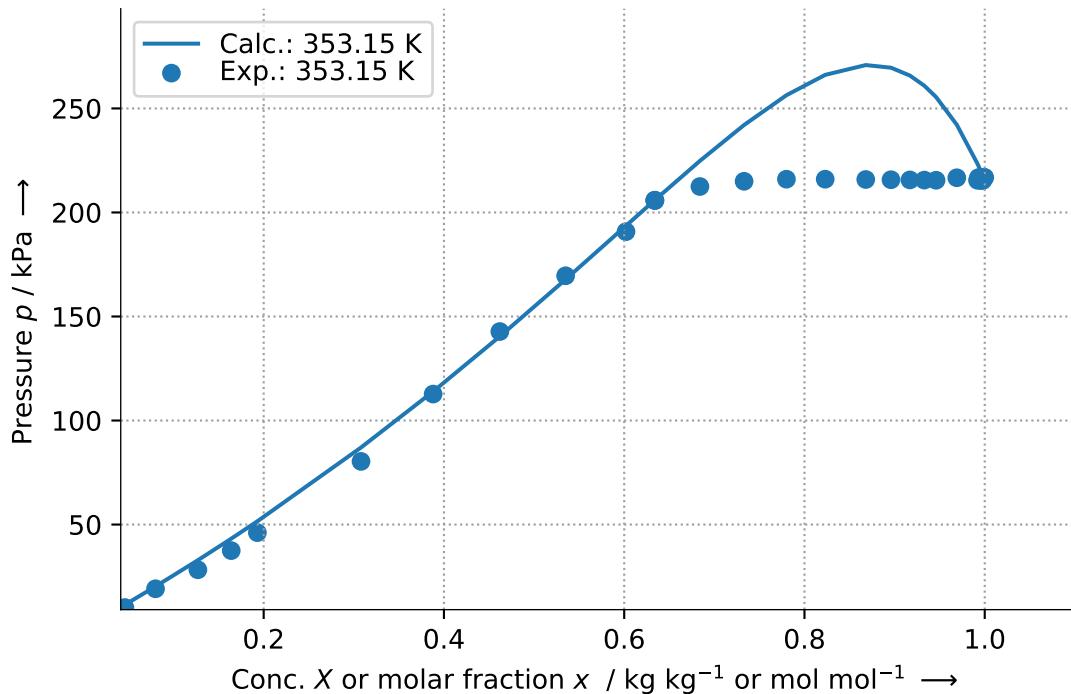
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	5.173100000e+04	$\Delta u_{21}$	J mol <sup>-1</sup>	-2.380600000e+03
$r_1$	-	2.573000000e+00	$r_2$	-	7.162000000e+00
$q_1$	-	2.336000000e+00	$q_2$	-	5.844000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.59%.

## 6.3 Benzene

### 6.3.1 Ionic liquid [BMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.3.1.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T \quad , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

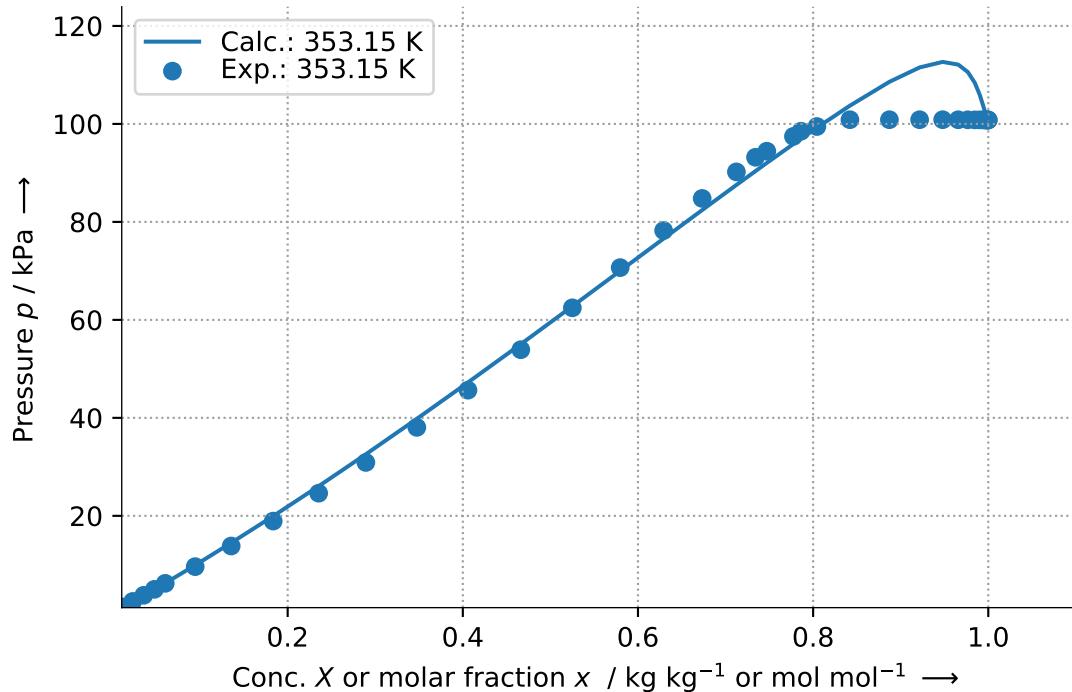
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	1.569126000e+05	$a_{21}$	J mol <sup>-1</sup>	7.416000000e+02
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-2.518600000e+02	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-3.960000000e+00

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.01%.

### 6.3.2 Ionic liquid [C<sub>2</sub>H<sub>5</sub>NH]+[C<sub>2</sub>H<sub>5</sub>OC<sub>2</sub>H<sub>4</sub>OSO<sub>3</sub>]-

#### 6.3.2.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C <sub>2</sub> H <sub>5</sub> NH]+[C <sub>2</sub> H <sub>5</sub> OC <sub>2</sub> H <sub>4</sub> OSO <sub>3</sub> ]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

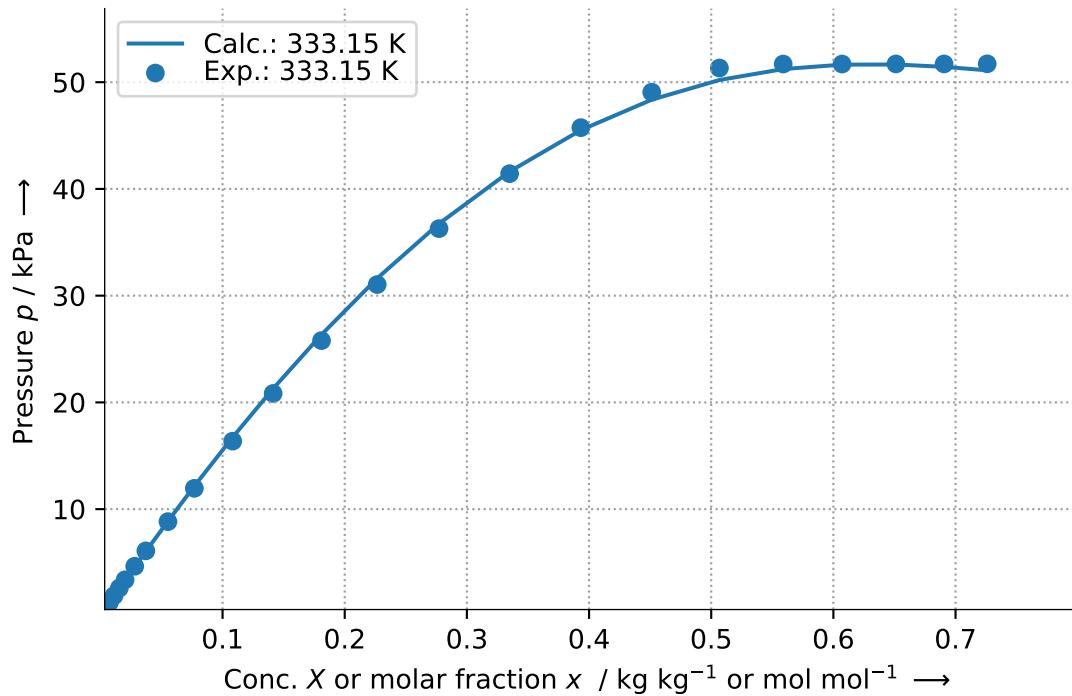
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) && , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) && , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) && , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT && , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT && , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12}T && , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21}T && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	1.053950000e+04	$a_{21}$	J mol <sup>-1</sup>	-1.719500000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.47%.

### 6.3.3 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.3.3.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

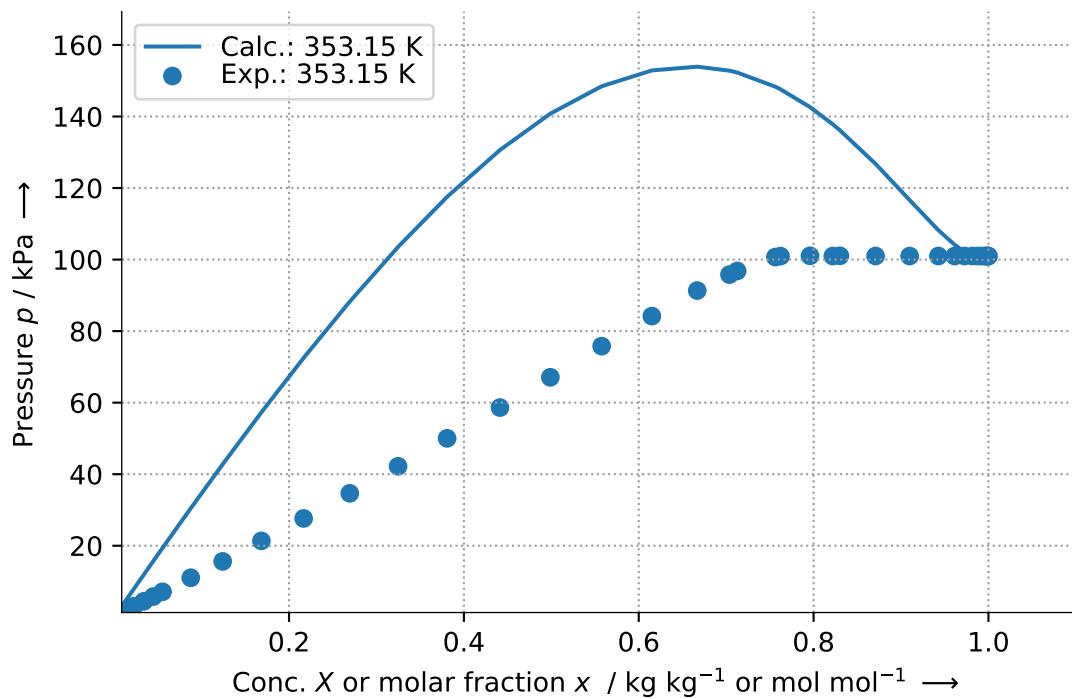
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) && , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) && , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) && , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT && , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT && , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T && , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	4.512030000e+04	$a_{21}$	J mol <sup>-1</sup>	8.422000000e+02
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-4.537000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-3.320000000e+00

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 72.92%.

### 6.3.4 Ionic liquid [EMIM]+[C2H5OSO3]-

#### 6.3.4.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[C2H5OSO3]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

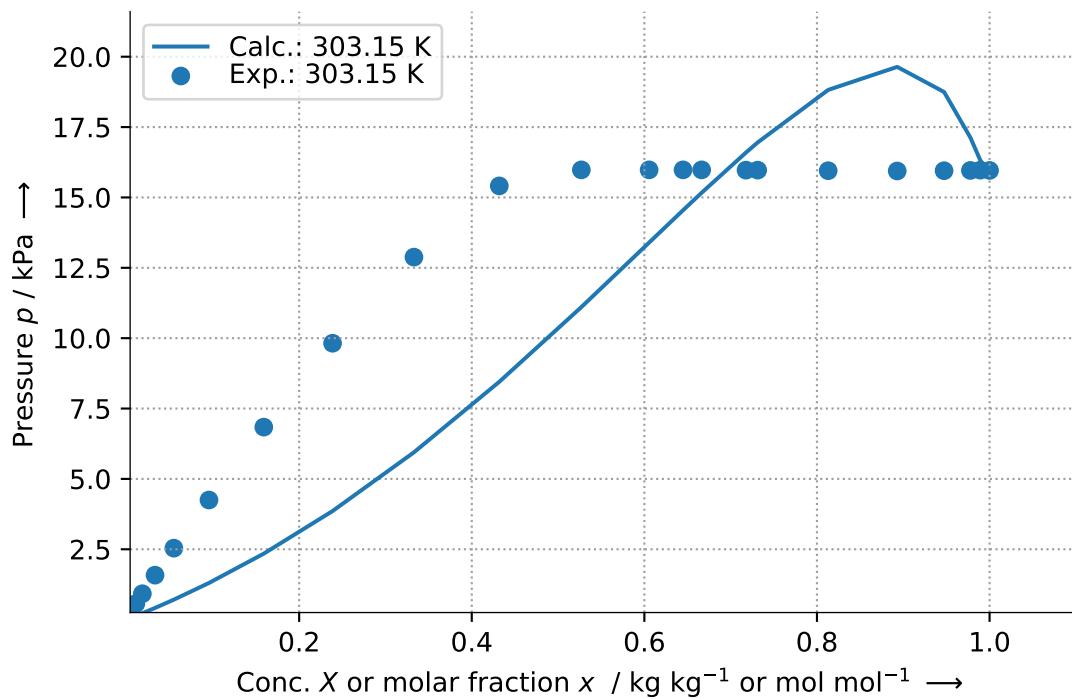
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T \quad , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	2.811520000e+04	$a_{21}$	J mol <sup>-1</sup>	-1.595100000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	5.292000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-1.420000000e+00

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 36.92%.

### 6.3.5 Ionic liquid [MMIM]+[(CFH<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.3.5.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CFH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

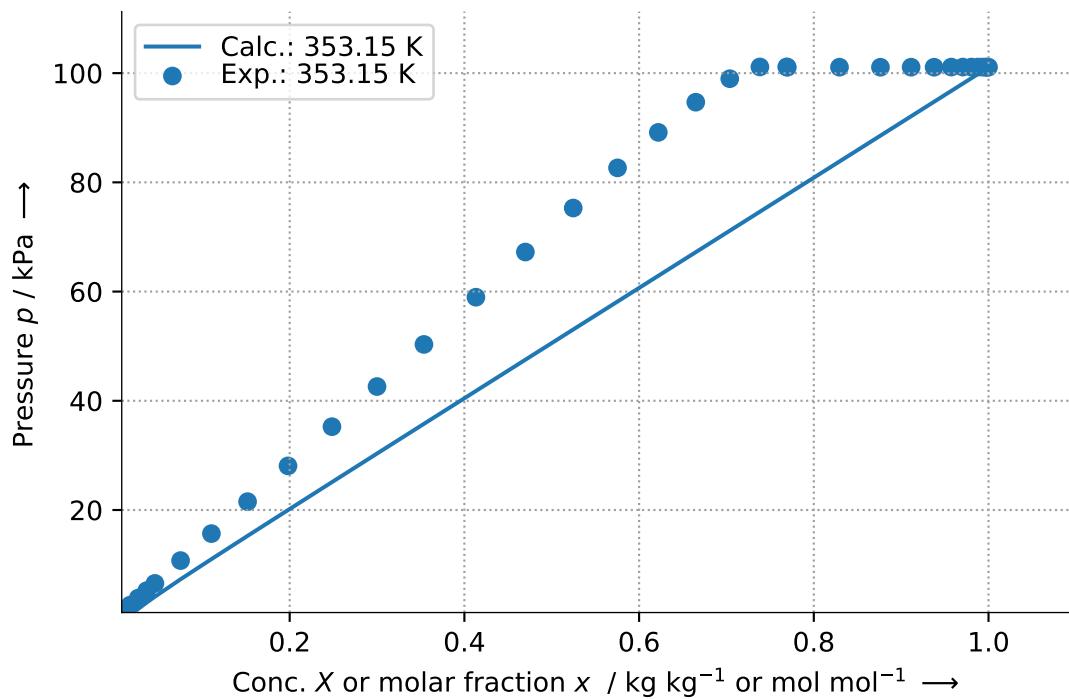
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) && , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) && , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) && , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT && , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT && , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T && , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	-6.099440000e+04	$a_{21}$	J mol <sup>-1</sup>	-5.319100000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-3.409200000e+02	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	1.510000000e+01

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 23.96%.

### 6.3.6 Ionic liquid [BMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.3.6.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	0.000000000e+00	$a_{21}$	J mol <sup>-1</sup>	-7.490000000e+02
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	1.294000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-3.500000000e+00
$r_1$	-	1.116000000e+01	$r_2$	-	2.400000000e+00
$q_1$	-	1.020000000e+01	$q_2$	-	3.188000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.3.7 Ionic liquid [C2H5NH]+[C2H5OC2H4OSO3]-

#### 6.3.7.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C2H5NH]+[C2H5OC2H4OSO3]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	6.965000000e+02	$a_{21}$	J mol <sup>-1</sup>	1.149300000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00
$r_1$	-	8.780000000e+00	$r_2$	-	2.400000000e+00
$q_1$	-	6.960000000e+00	$q_2$	-	3.188000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.3.8 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.3.8.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	7.518000000e+02	$a_{21}$	J mol <sup>-1</sup>	-8.167000000e+02
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	7.030000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-1.490000000e+00
$r_1$	-	9.890000000e+00	$r_2$	-	2.400000000e+00
$q_1$	-	8.780000000e+00	$q_2$	-	3.188000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.3.9 Ionic liquid [EMIM]+[C2H5OSO3]-

#### 6.3.9.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[C2H5OSO3]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	8.890200000e+03	$a_{21}$	J mol <sup>-1</sup>	-3.943000000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-2.145000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	1.183000000e+01
$r_1$	-	7.940000000e+00	$r_2$	-	2.400000000e+00
$q_1$	-	7.210000000e+00	$q_2$	-	3.188000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.3.10 Ionic liquid [MMIM]+[(CH<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.3.10.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Benzene
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	5.347200000e+03	$a_{21}$	J mol <sup>-1</sup>	1.942300000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-6.750000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	2.300000000e+00
$r_1$	-	9.260000000e+00	$r_2$	-	2.400000000e+00
$q_1$	-	8.080000000e+00	$q_2$	-	3.188000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.4 CarbonDioxide

### 6.4.1 Ionic liquid [C10mim][NTf2]

#### 6.4.1.1 MixingRule - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C10mim][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

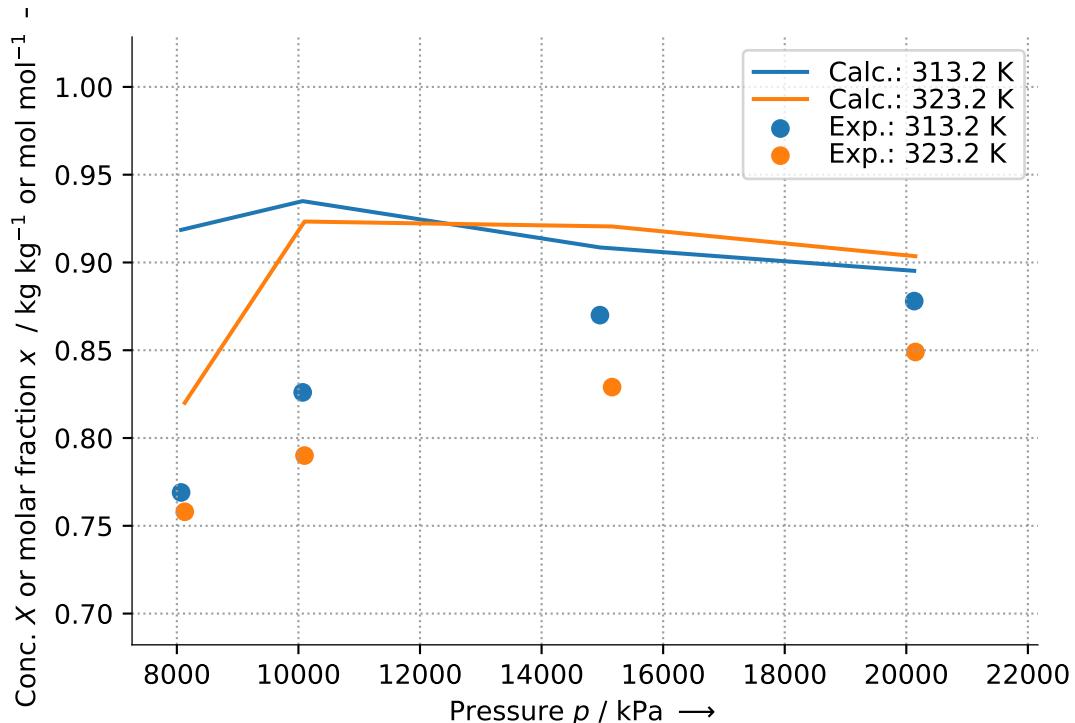
$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\left(T/T_{\text{crit},j}\right)}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	8.000000000e+02
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	1.867000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	5.741000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	5.600000000e-03	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.19%.

### 6.4.1.2 MixingRule - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C10mim][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

The parameters of the equation are:

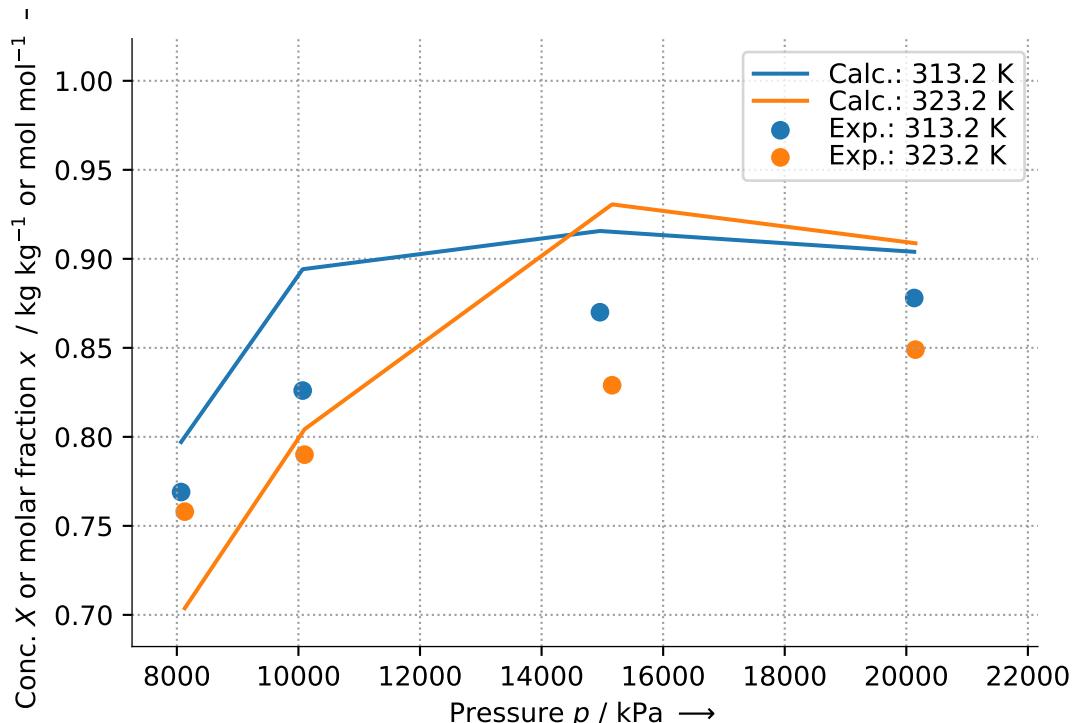
Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	8.000000000e+02
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	1.867000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	5.741000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	6.250000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.05%.

### 6.4.2 Ionic liquid [C4mim][NTf2]

#### 6.4.2.1 MixingRule - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C4mim][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\left(T/T_{\text{crit},j}\right)}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

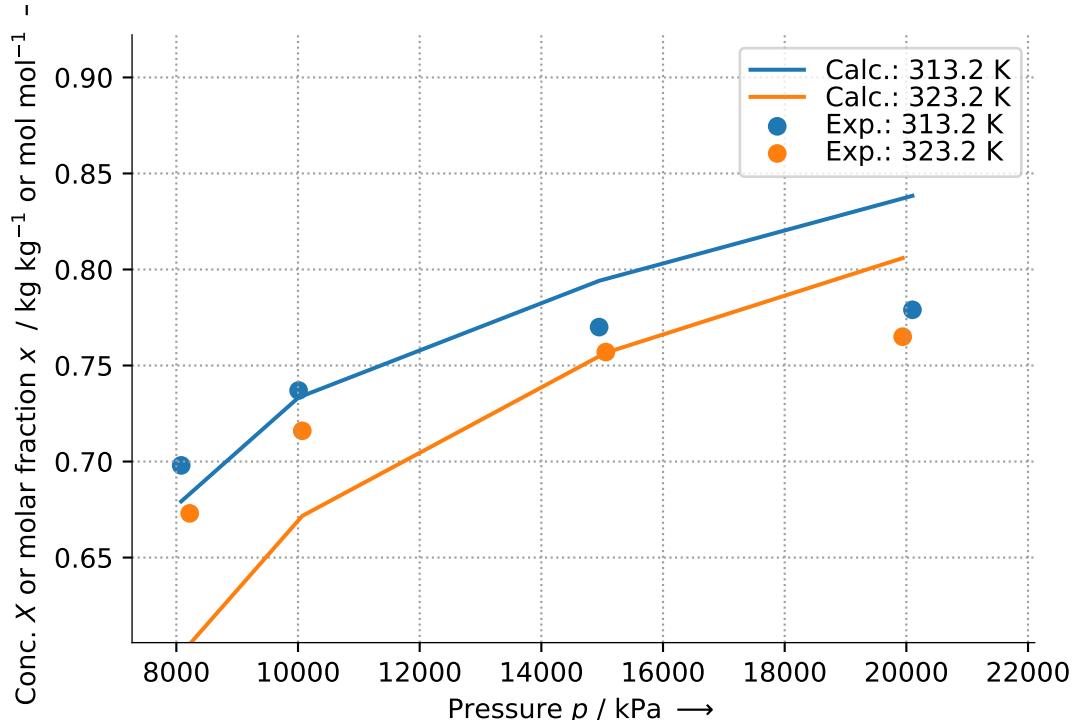
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	1.077000000e+03

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	2.765000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	3.004000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	4.930000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.45%.

### 6.4.2.2 MixingRule - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C4mim][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

The parameters of the equation are:

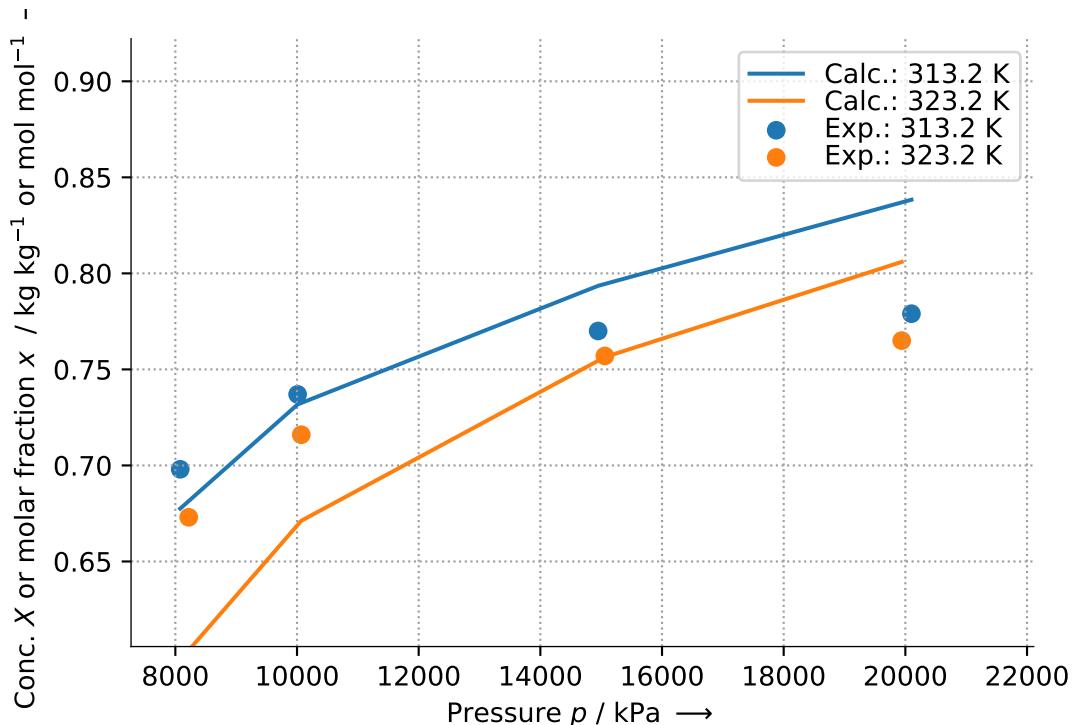
Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	1.077000000e+03
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	2.765000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	3.004000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	5.120000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.54%.

### 6.4.3 Ionic liquid [N1,8,8,8][NTf2]

#### 6.4.3.1 MixingRule - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[N1,8,8,8][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\left(T/T_{\text{crit},j}\right)}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

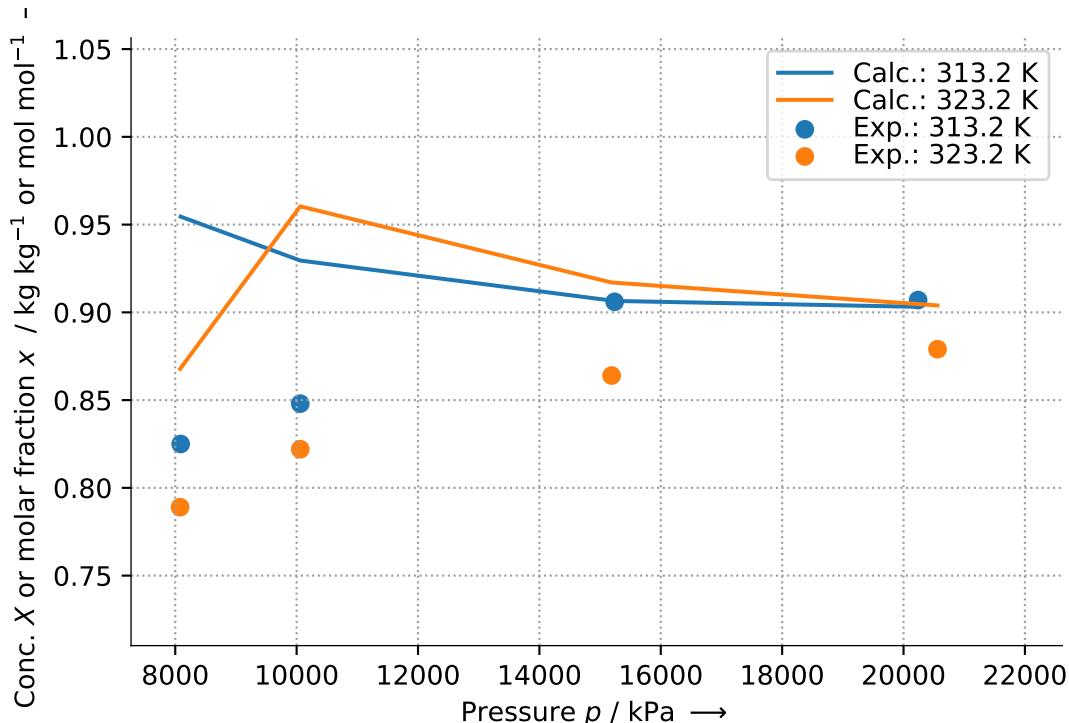
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	7.506000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	1.064000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	9.962000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	-8.000000000e-04	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.7%.

### 6.4.3.2 MixingRule - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[N1,8,8,8][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

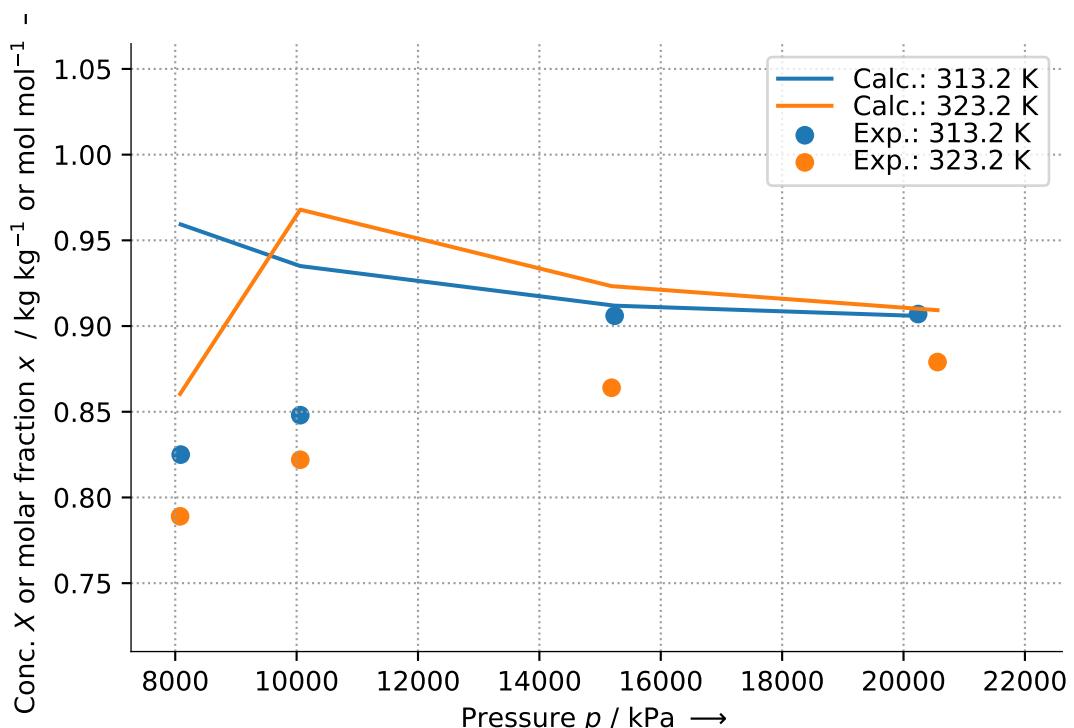
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	7.506000000e+02
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	1.064000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	9.962000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.470000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.05%.

#### 6.4.4 Ionic liquid [N4,1,1,1][NTf2]

##### 6.4.4.1 MixingRule - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[N4,1,1,1][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\left(T/T_{\text{crit},j}\right)}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

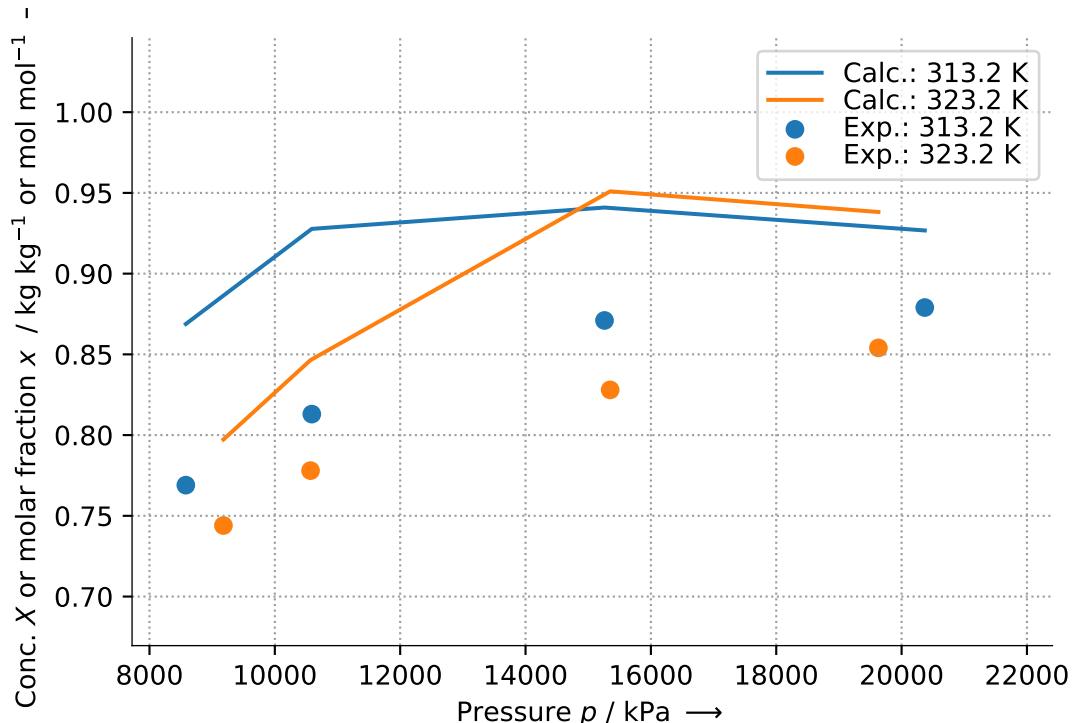
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	1.079600000e+03

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	2.588000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	3.334000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	-6.000000000e-04	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.15%.

#### 6.4.4.2 MixingRule - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[N4,1,1,1][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

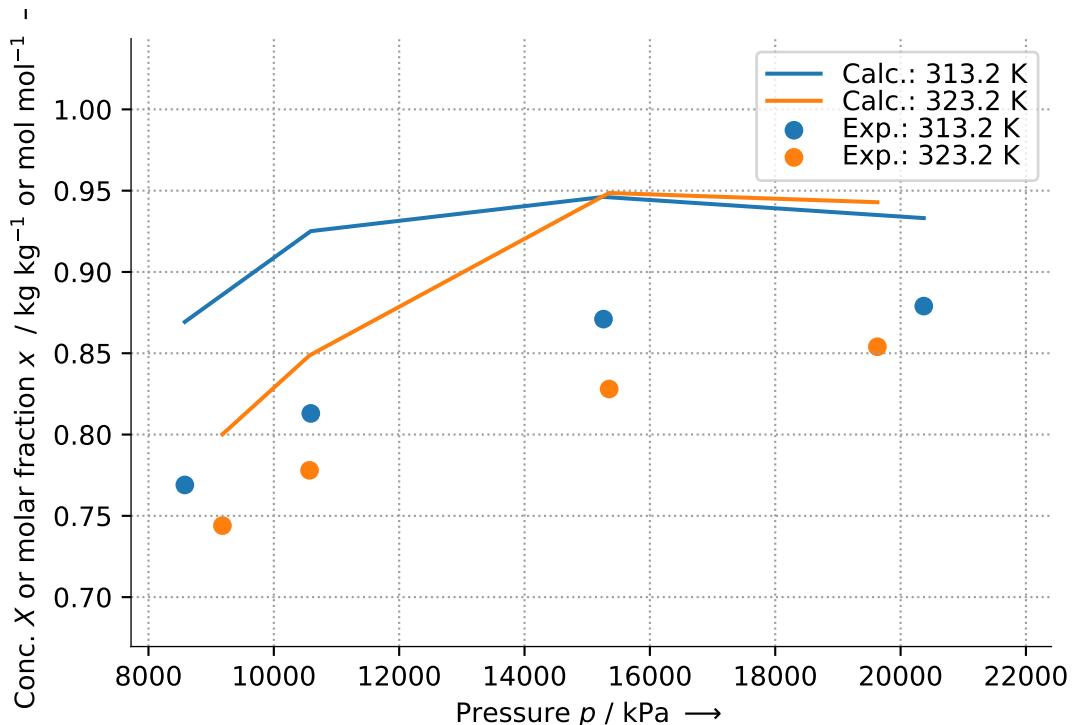
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	1.079600000e+03
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	2.588000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	3.334000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	-1.800000000e-03	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.4%.

### 6.4.5 Ionic liquid [P6,6,6,14][Cl]

#### 6.4.5.1 MixingRule - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[P6,6,6,14][Cl]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\left(T/T_{\text{crit},j}\right)}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

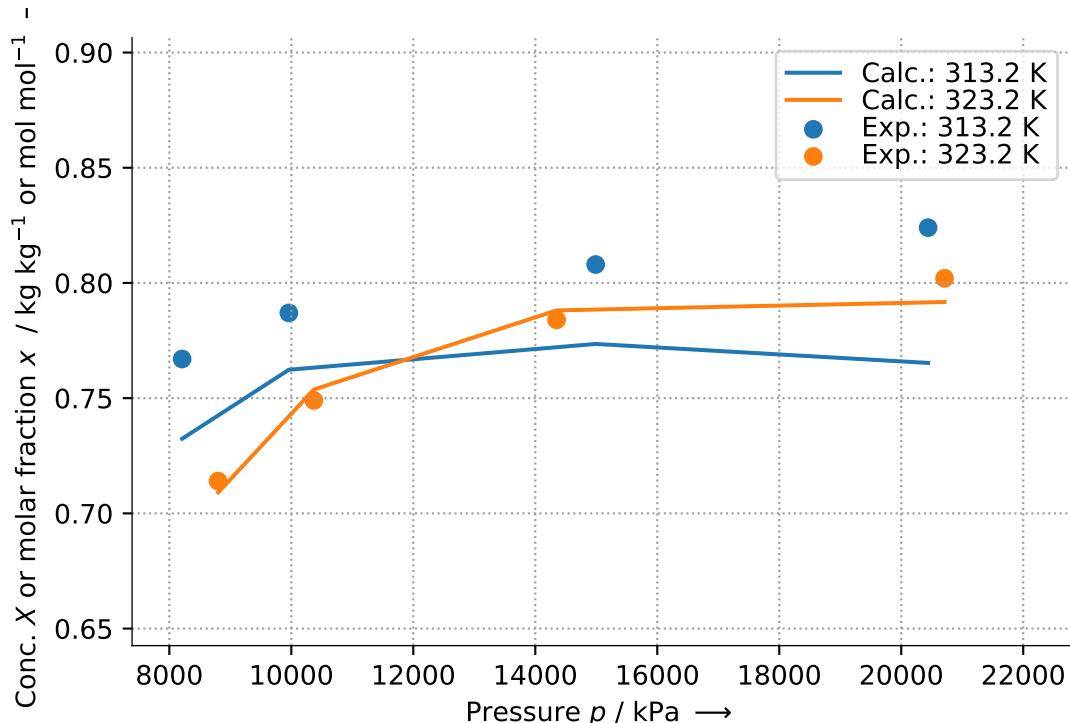
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	8.039000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	8.510000000e+05
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	8.915000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	9.120000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.77%.

#### 6.4.5.2 MixingRule - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[P6,6,6,14][Cl]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

The parameters of the equation are:

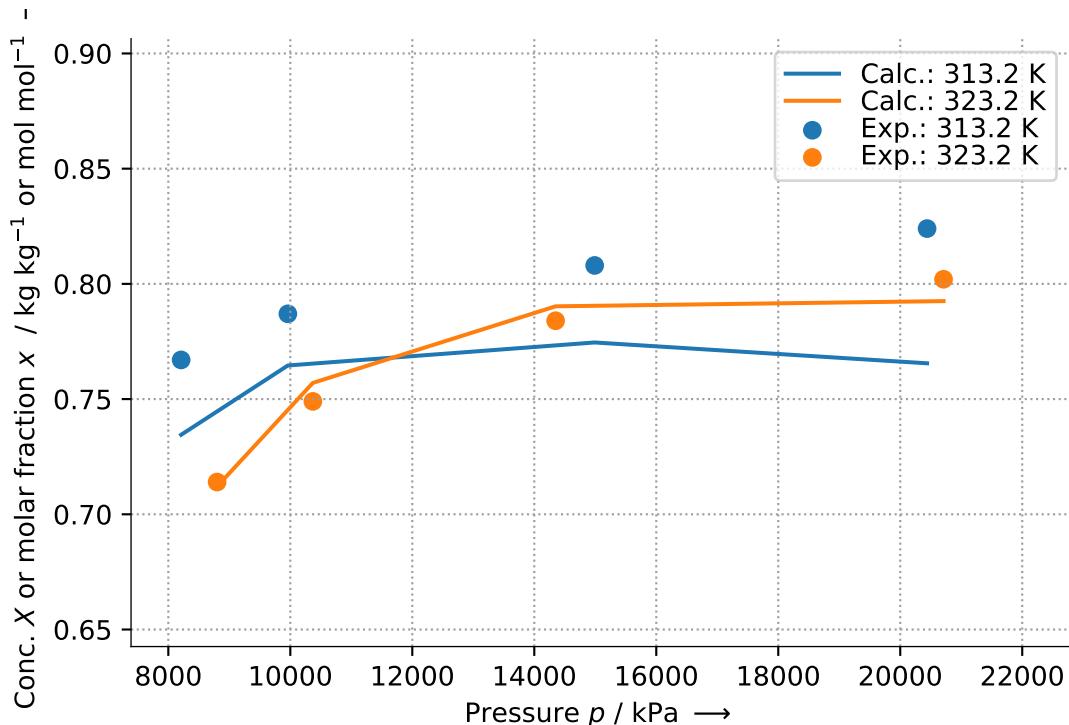
Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	8.039000000e+02
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	8.510000000e+05
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	8.915000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.111000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.7%.

#### 6.4.6 Ionic liquid [P6,6,6,14][NTf2]

##### 6.4.6.1 MixingRule - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[P6,6,6,14][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\left(T/T_{\text{crit},j}\right)}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

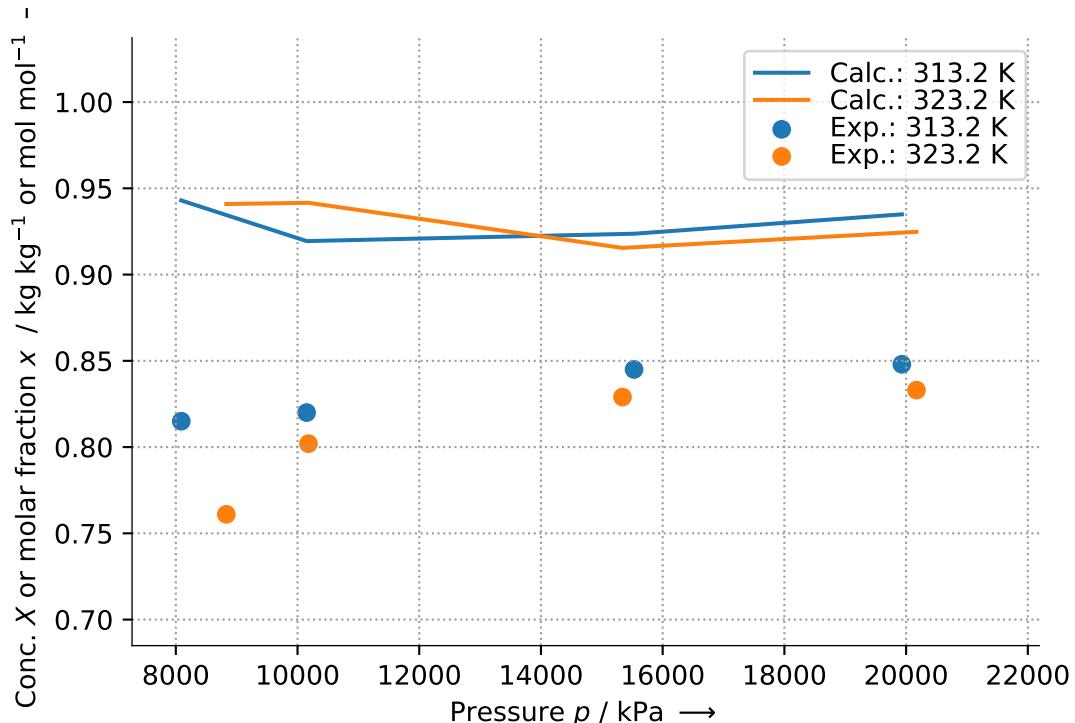
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	8.055000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	7.950000000e+05
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	7.947000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	-3.200000000e-03	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 13.74%.

#### 6.4.6.2 MixingRule - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[P6,6,6,14][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

The parameters of the equation are:

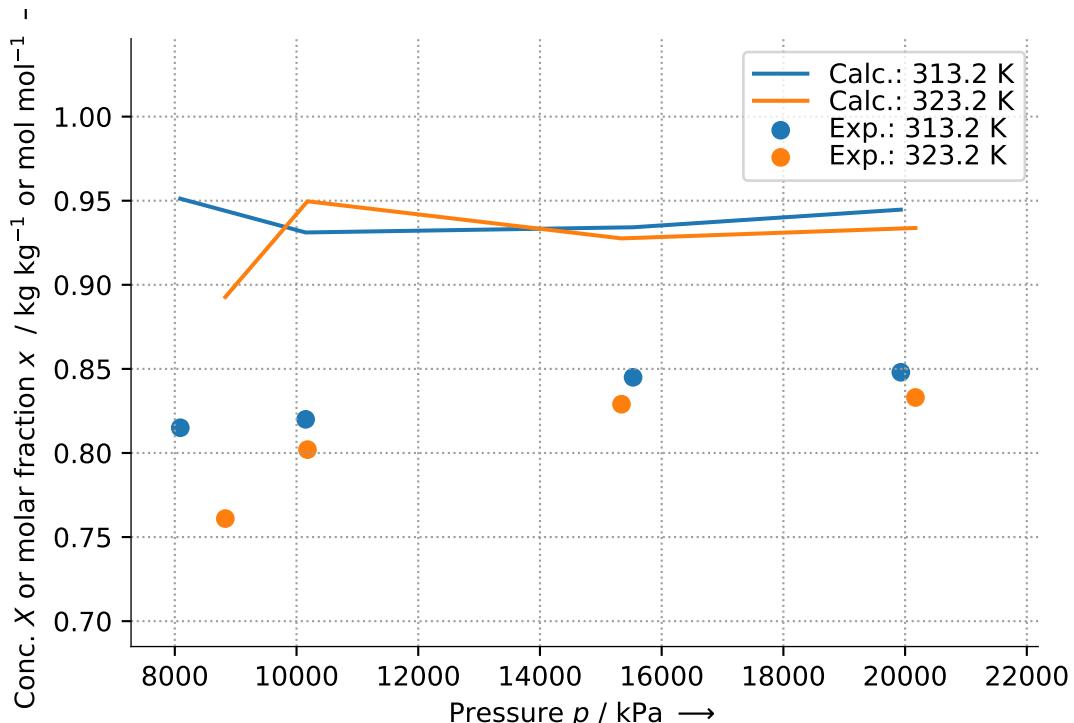
Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	8.055000000e+02
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	7.950000000e+05
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	7.947000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	4.880000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 13.99%.

### 6.4.7 Ionic liquid [Pyrr4,1][NTf2]

#### 6.4.7.1 MixingRule - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[Pyrr4,1][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	1.093100000e+03

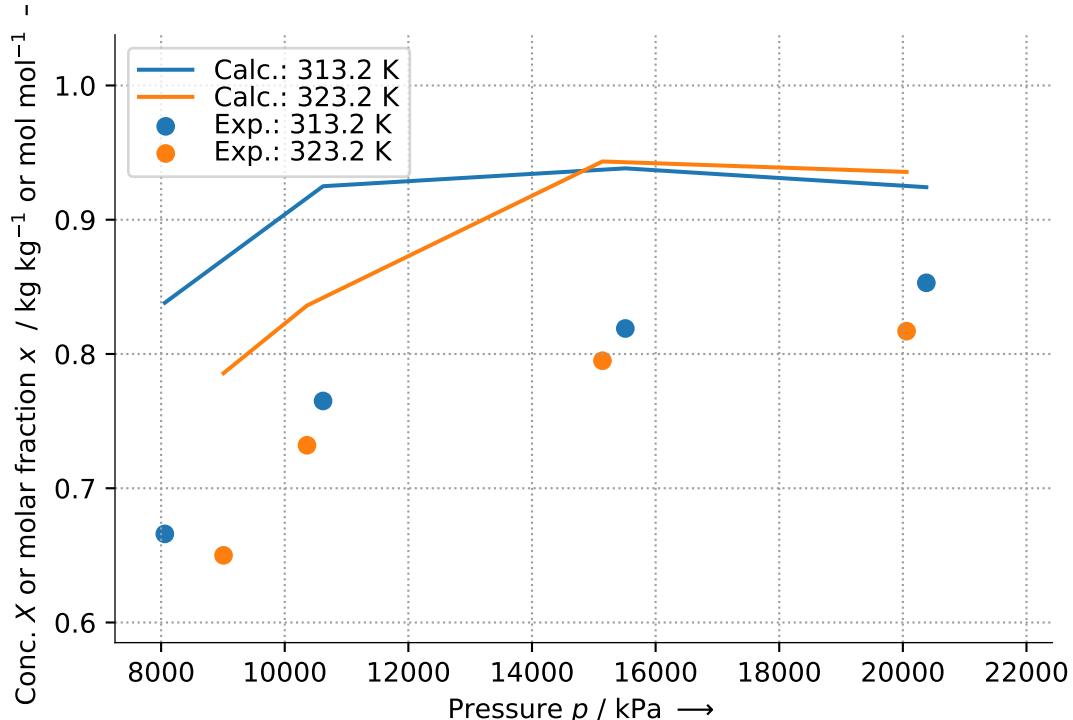
Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	2.425000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	3.467000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	5.260000000e-03	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

---

### Validity:

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 17.24%.

#### 6.4.7.2 MixingRule - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[Pyrr4,1][NTf2]
<b>Refrigerant:</b>	CarbonDioxide
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Manic, Marina S.; Queimada, António J.; Macedo, Eu-génia A.; Najdanovic-Visak, Vesna (2012): High-pressure solubilities of carbon dioxide in ionic liquids based on bis(trifluoromethylsulfonyl)imide and chloride. In: The Journal of Supercritical Fluids 65, S. 1–10. DOI: 10.1016/j.supflu.2012.02.016.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

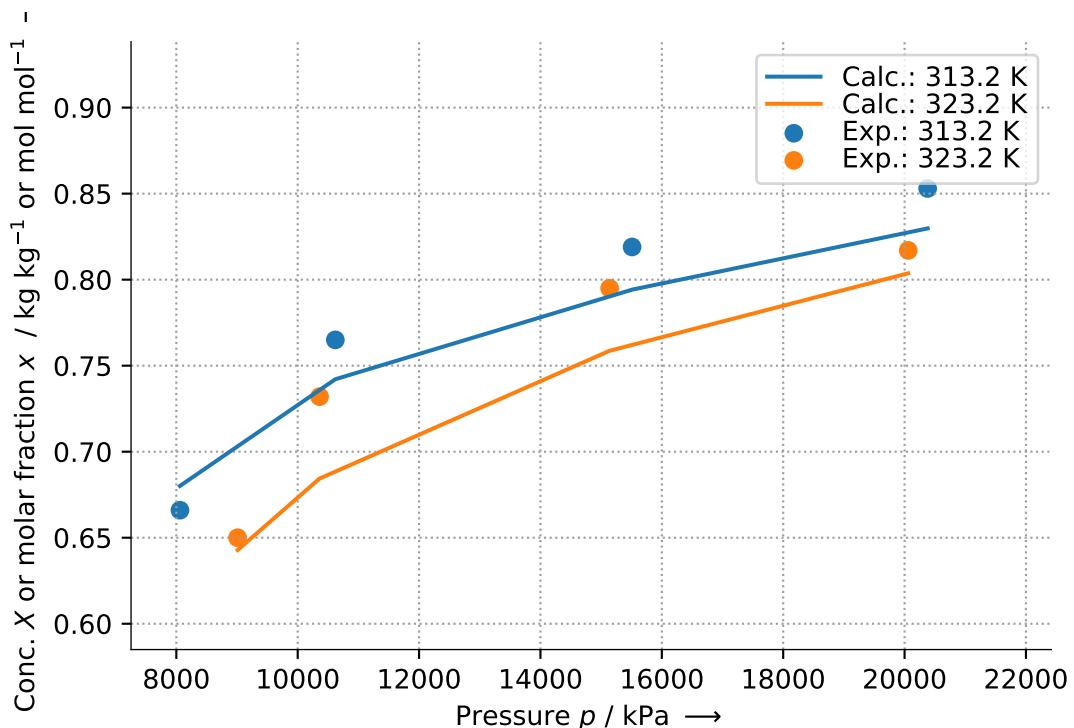
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.042000000e+02	$T_{\text{crit},2}$	K	1.093100000e+03
$p_{\text{crit},1}$	Pa	7.380000000e+06	$p_{\text{crit},2}$	Pa	2.425000000e+06
$\omega_1$	-	2.236000000e-01	$\omega_2$	-	3.467000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	5.680000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 7.00E+03
- Temperature, absolute, in K → 0.1

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.08%.

## 6.5 Cyclohexane

### 6.5.1 Ionic liquid [BMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.5.1.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

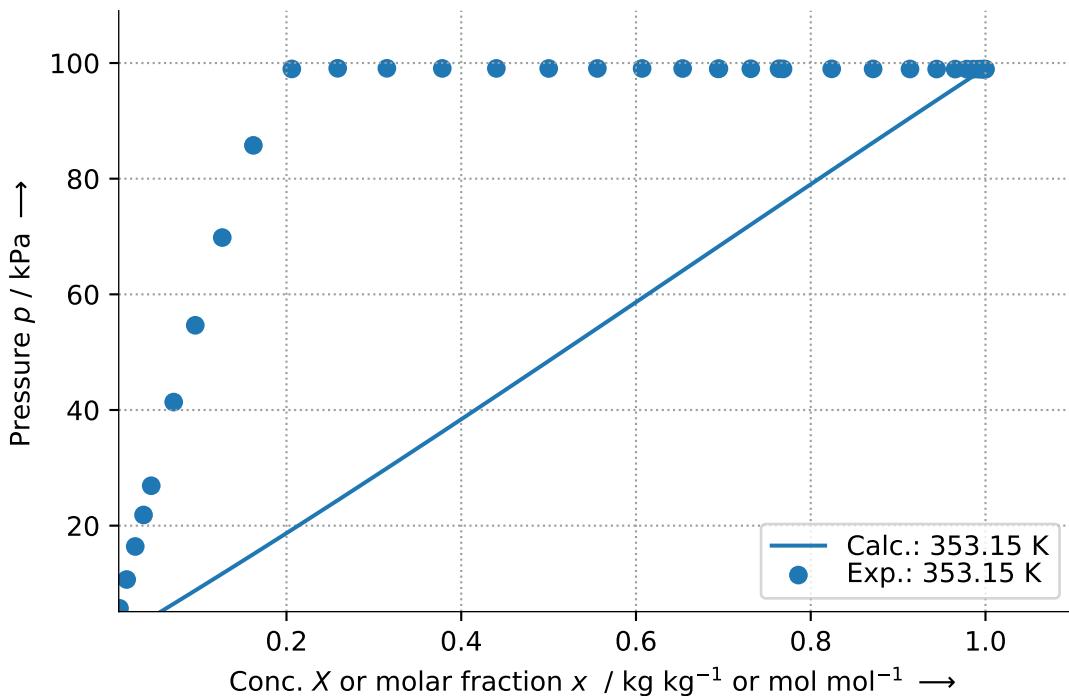
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T \quad , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	6.391100000e+03	$a_{21}$	J mol <sup>-1</sup>	4.691500000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-1.929000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-1.283000000e+01

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 40.75%.

### 6.5.2 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.5.2.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

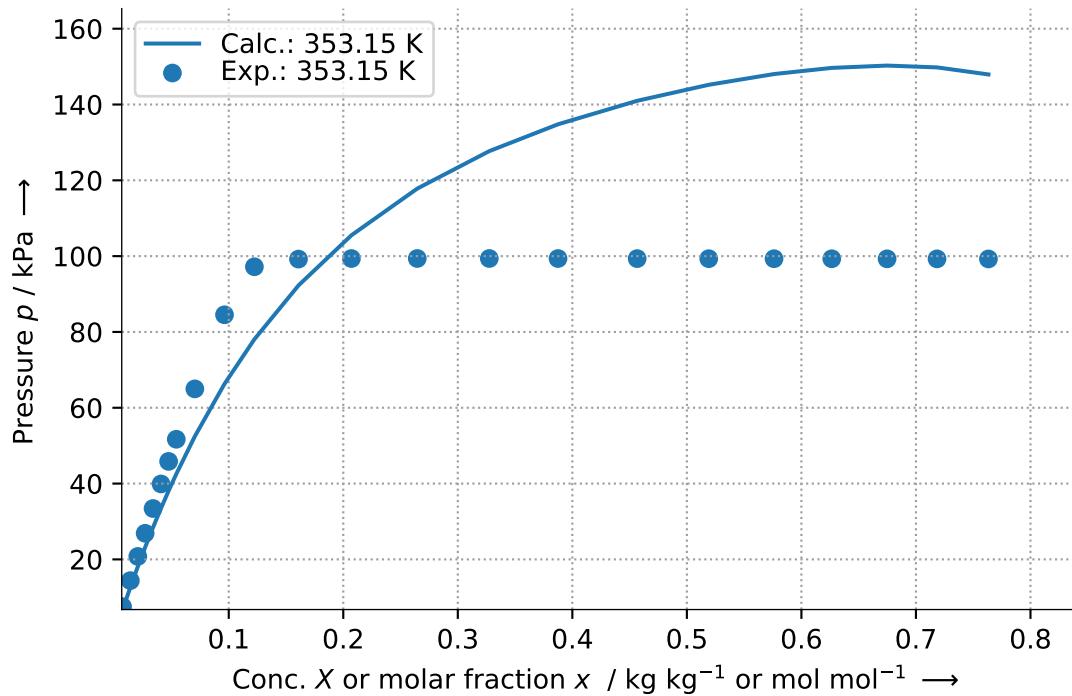
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T \quad , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	3.671460000e+04	$a_{21}$	J mol <sup>-1</sup>	9.986400000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	6.000000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-1.736000000e+01

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 26.56%.

### 6.5.3 Ionic liquid [EMIM]+[C2H5OSO3]-

#### 6.5.3.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[C2H5OSO3]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

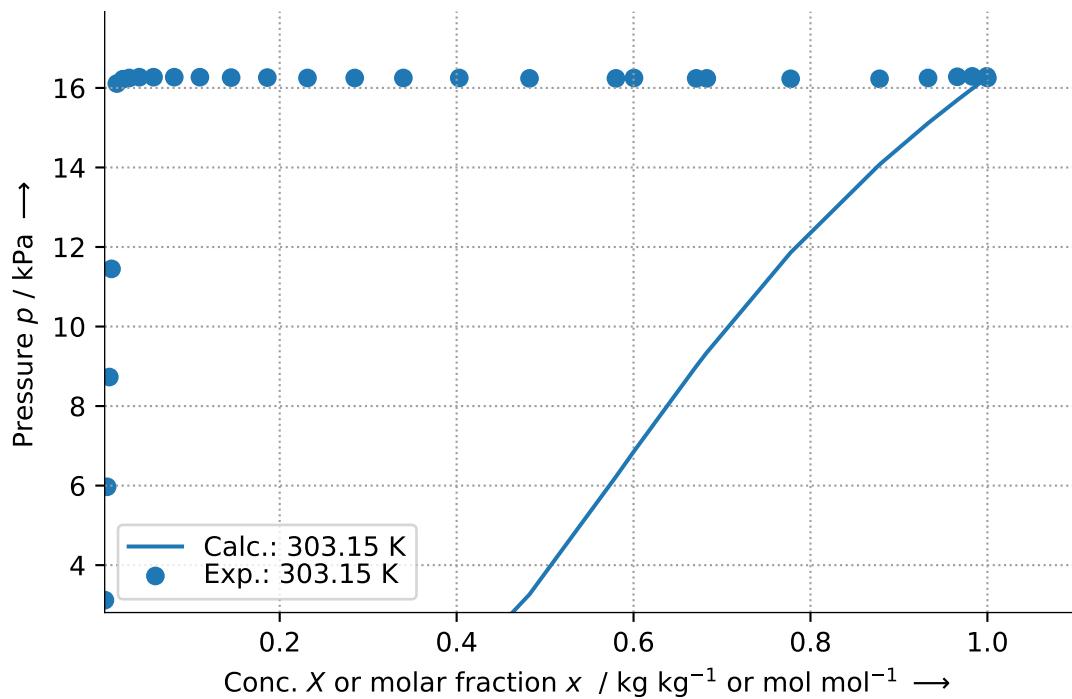
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) && , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) && , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) && , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT && , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT && , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T && , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	-2.612900000e+03	$a_{21}$	J mol <sup>-1</sup>	1.360890000e+04
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-5.774000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-2.519000000e+01

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 69.9%.

### 6.5.4 Ionic liquid [MMIM]+[(CFH<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.5.4.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CFH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

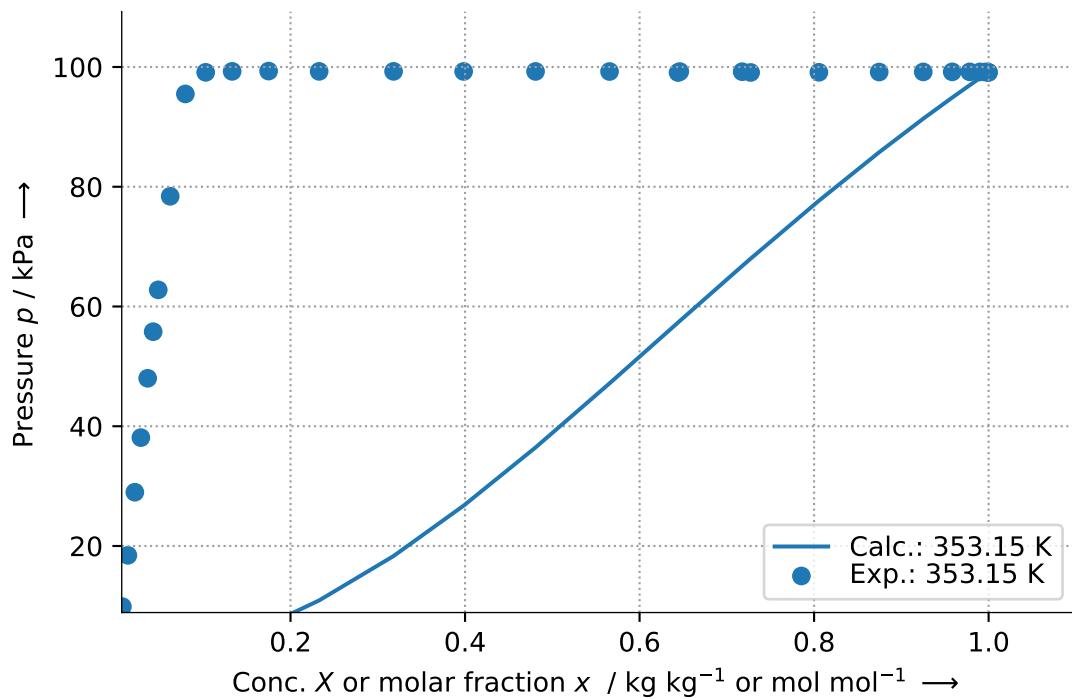
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T \quad , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	3.748100000e+03	$a_{21}$	J mol <sup>-1</sup>	7.324900000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-2.534000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-1.332000000e+01

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 55.75%.

### 6.5.5 Ionic liquid [BMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.5.5.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	-1.202800000e+03	$a_{21}$	J mol <sup>-1</sup>	2.743600000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	3.410000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-2.350000000e+00
$r_1$	-	1.116000000e+01	$r_2$	-	3.240000000e+00
$q_1$	-	1.020000000e+01	$q_2$	-	4.064000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.5.6 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.5.6.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	1.908866000e+05	$a_{21}$	J mol <sup>-1</sup>	1.268500000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-5.174400000e+02	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-4.970000000e+00
$r_1$	-	9.890000000e+00	$r_2$	-	3.240000000e+00
$q_1$	-	8.780000000e+00	$q_2$	-	4.064000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.5.7 Ionic liquid [EMIM]+[C2H5OSO3]-

#### 6.5.7.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[C2H5OSO3]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	-3.432810000e+04	$a_{21}$	J mol <sup>-1</sup>	4.016400000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	2.932600000e+02	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-1.075000000e+01
$r_1$	-	7.940000000e+00	$r_2$	-	3.240000000e+00
$q_1$	-	7.210000000e+00	$q_2$	-	4.064000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.5.8 Ionic liquid [MMIM]+[(CH<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.5.8.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CH <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Cyclohexane
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	1.126400000e+03	$a_{21}$	J mol <sup>-1</sup>	1.216900000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	-3.300000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	4.150000000e+00
$r_1$	-	9.260000000e+00	$r_2$	-	3.240000000e+00
$q_1$	-	8.080000000e+00	$q_2$	-	4.064000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.6 Cyclohexene

### 6.6.1 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.6.1.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Cyclohexene
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12} T \quad , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21} T \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	4.964320000e+04	$a_{21}$	J mol <sup>-1</sup>	1.132440000e+04
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	6.886000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-2.960000000e+01

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.7 Ethanol

### 6.7.1 Ionic liquid [MMIM]+[(CH<sub>3</sub>)<sub>2</sub>PO<sub>4</sub>]-

#### 6.7.1.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]-
<b>Refrigerant:</b>	Ethanol
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [BMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [MMIM][(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

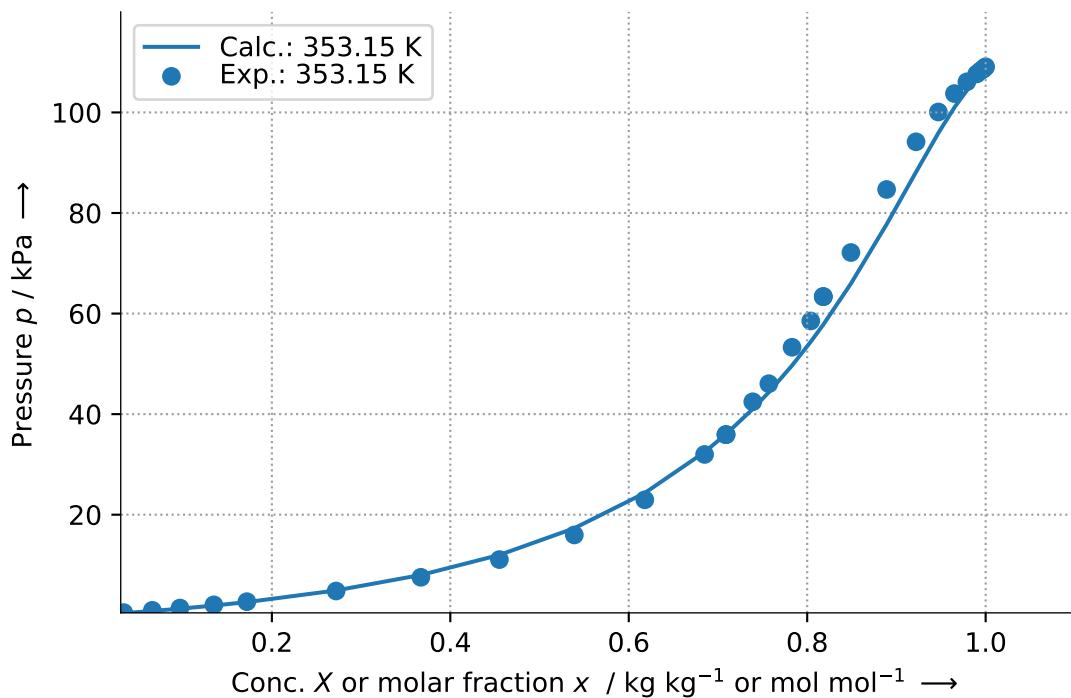
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-5.866000000e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	-2.027500000e+03
$r_1$	-	2.105000000e+00	$r_2$	-	7.162000000e+00
$q_1$	-	1.972000000e+00	$q_2$	-	5.844000000e+00
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.22%.

## 6.8 Hexane

### 6.8.1 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.8.1.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Hexane
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

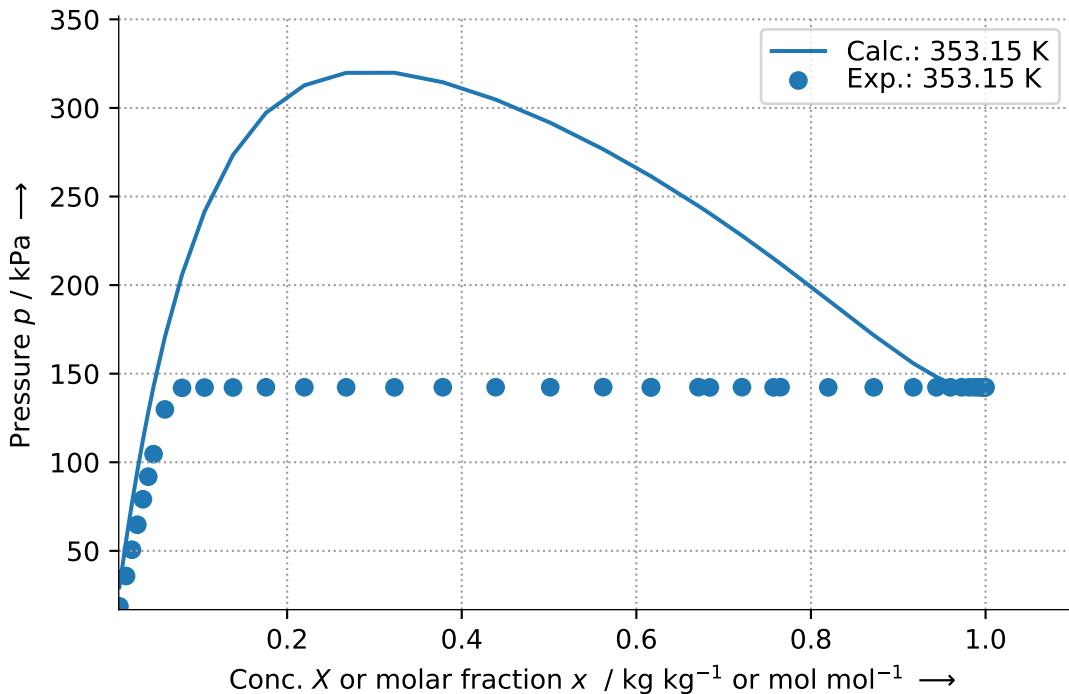
$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ \Delta g_{12} &= a_{12} + b_{12} T \quad , \text{ and} \\ \Delta g_{21} &= a_{21} + b_{21} T \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	1.500340000e+04	$a_{21}$	J mol <sup>-1</sup>	6.107000000e+02
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	2.803000000e+01	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	1.285000000e+01

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 50.53%.

## 6.8.2 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

### 6.8.2.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Hexane
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	-2.451700000e+03	$a_{21}$	J mol <sup>-1</sup>	5.699700000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	3.230000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	-4.780000000e+00
$r_1$	-	9.890000000e+00	$r_2$	-	3.856000000e+00
$q_1$	-	8.780000000e+00	$q_2$	-	4.500000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.9 Isobutane

### 6.9.1 Lubricant POE ISO7

#### 6.9.1.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE ISO7
<b>Refrigerant:</b>	Isobutane
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Marcelino Neto, Moisés A.; Barbosa, Jader R. (2008): Solubility, density and viscosity of a mixture of R-600a and polyol ester oil. In: International Journal of Refrigeration 31 (1), S. 34–44. DOI: 10.1016/j.ijrefrig.2007.08.004.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 .
 \end{aligned}$$

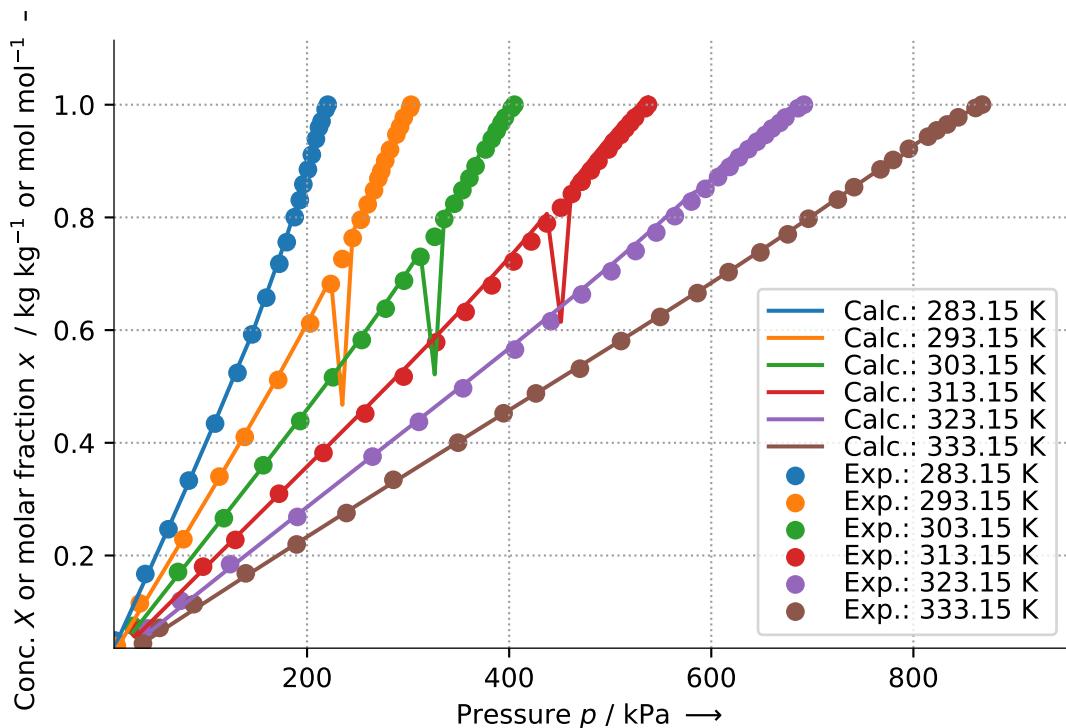
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
EoS	-	1.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	4.078100000e+02	$T_{\text{crit},2}$	K	7.430500000e+02
$p_{\text{crit},1}$	Pa	3.629000000e+06	$p_{\text{crit},2}$	Pa	1.127000000e+06
$\omega_1$	-	1.840000000e-01	$\omega_2$	-	7.915000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.749000000e-02	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.42%.

## 6.10 Methanol

### 6.10.1 Ionic liquid [MMIM]+[(CH<sub>3</sub>)<sub>2</sub>PO<sub>4</sub>]<sup>-</sup>

#### 6.10.1.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] <sup>-</sup>
<b>Refrigerant:</b>	Methanol
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [BMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [MMIM][(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

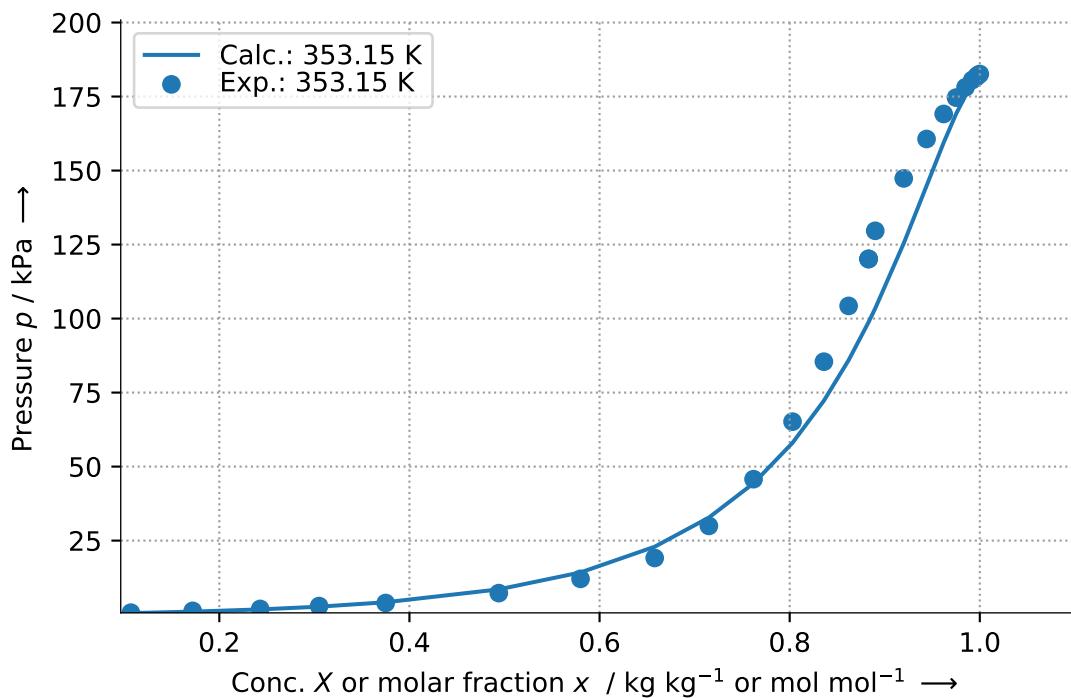
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-2.409900000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-2.864500000e+03
$r_1$	-	1.431000000e+00	$r_2$	-	7.162000000e+00
$q_1$	-	1.432000000e+00	$q_2$	-	5.844000000e+00
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.32%.

## 6.11 R-12

### 6.11.1 Lubricant AB32

#### 6.11.1.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	AB32
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.851500000e+02	$T_{\text{crit},2}$	K	8.570000000e+02
$p_{\text{crit},1}$	Pa	4.116000000e+06	$p_{\text{crit},2}$	Pa	1.015000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000200000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	3.965100000e-01	$\beta_{1,2}$	-	8.920000000e-01
$\beta_{2,1}$	-	-6.152000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	1.160000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	0.000000000e+00
$l_{12}$	-	3.390000000e-02	$l_{21}$	-	3.850000000e-02
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.11.2 Naphthenic

#### 6.11.2.1 Heil - ID 1

<b>Sorbent:</b>	naphthenic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((56.211 - 0.020808 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.325$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

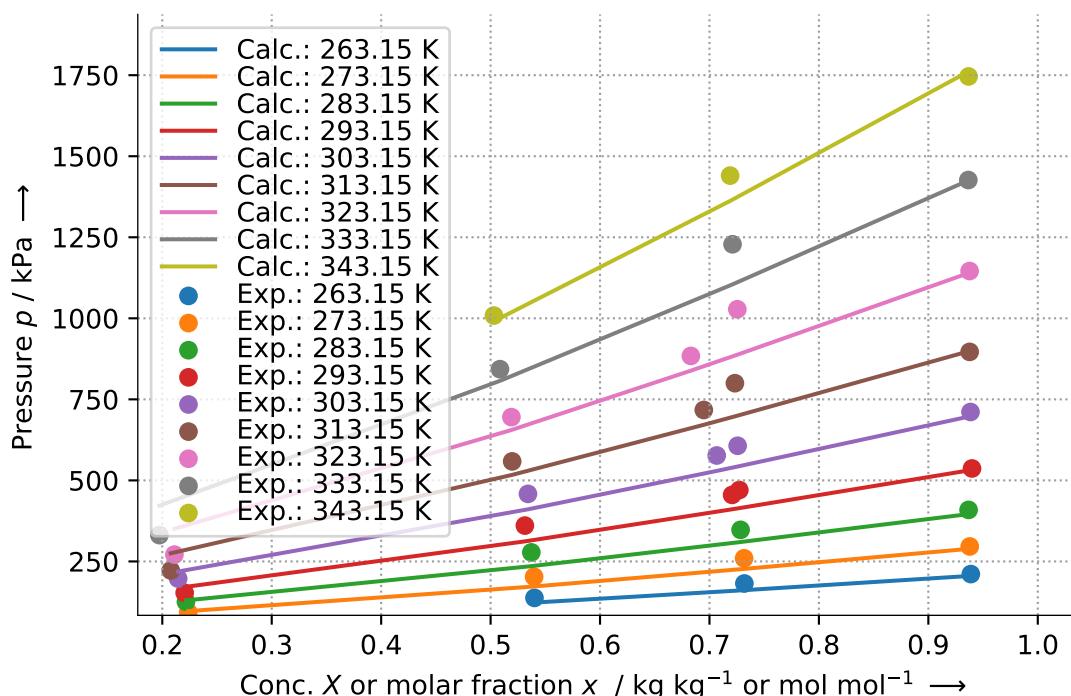
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.024000000e+03		$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	8.040000000e+02

Par.	Unit	Value	Par.	Unit	Value
$v_1$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $228.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.82%.

### 6.11.2.2 NRTLFixedDg - ID 1

<b>Sorbent:</b>	naphthenic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-1.105000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	4.571000000e+03

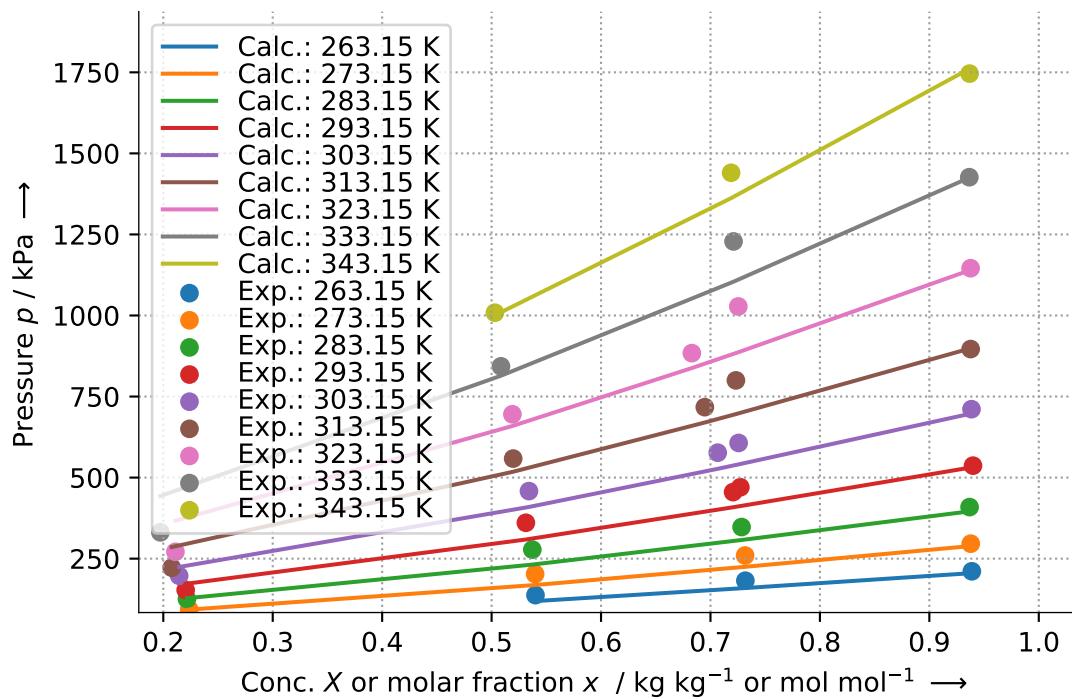
#### Validity:

Equation is approximately valid for  $228.15\text{K} \leq T \leq 394.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 9.5%.

### 6.11.2.3 TsubokaKatayama - ID 1

<b>Sorbent:</b>	naphthenic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((56.211-0.020808*((T-273.15)*1.8+32))*16.0185)*0.325$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

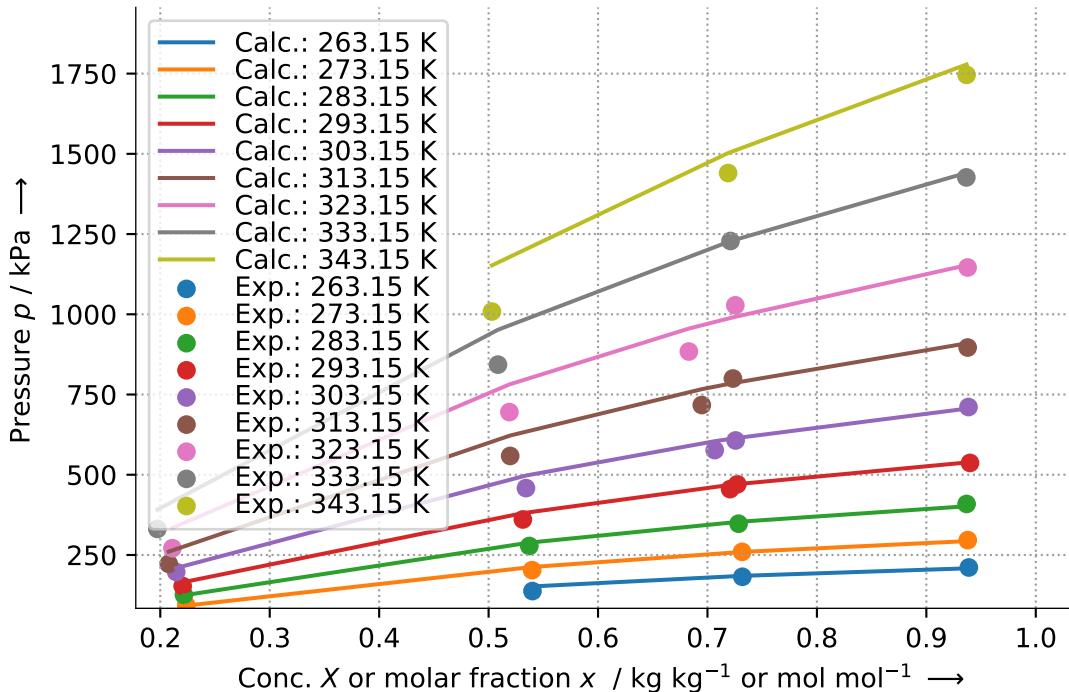
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	5.170000000e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	2.029000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

Equation is approximately valid for  $228.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.41%.

## 6.11.2.4 WangChao - ID 1

<b>Sorbent:</b>	naphthenic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((56.211 - 0.020808 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.325$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

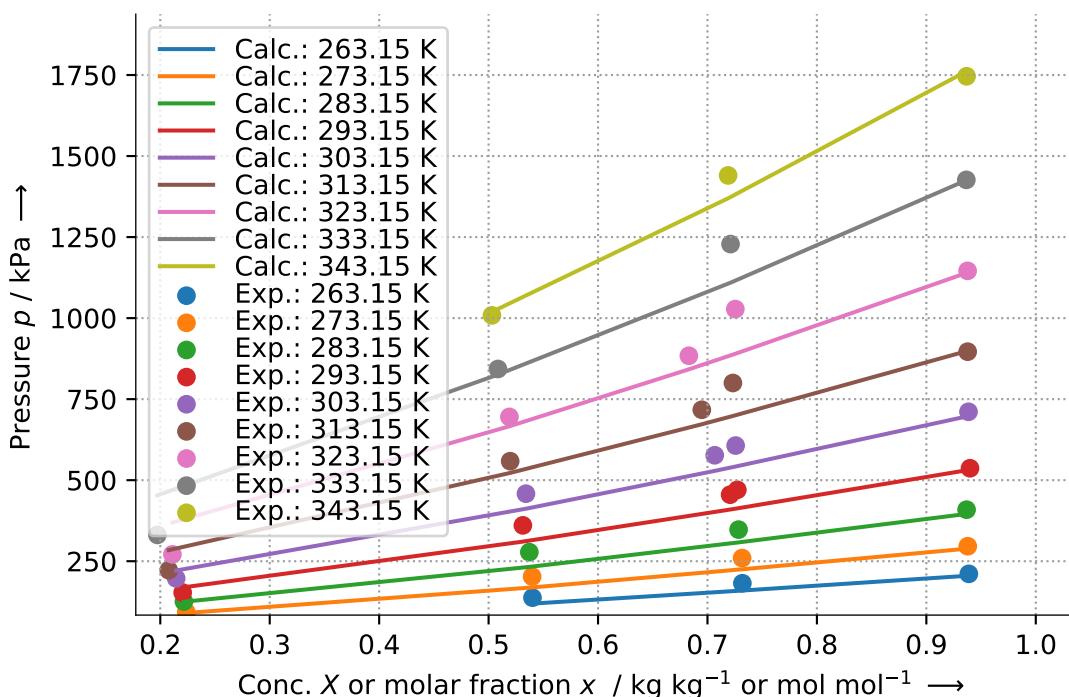
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + x_2/x_1 \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + x_1/x_2 \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	-1.890000000e+02	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	2.199000000e+03
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $228.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 9.32%.

## 6.11.2.5 WilsonFixedDI - ID 1

<b>Sorbent:</b>	naphthenic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((56.211 - 0.020808 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.325$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

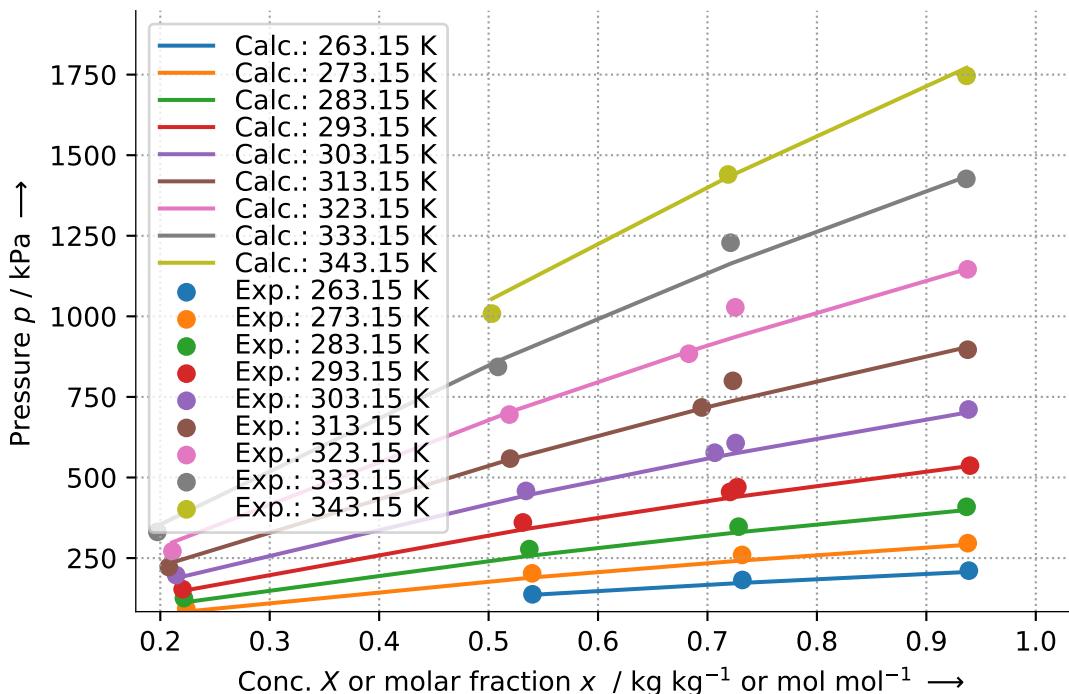
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) \quad , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} \quad , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.986000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	2.639000000e+02
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $228.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.95%.

### 6.11.3 Paraffinic

#### 6.11.3.1 Heil - ID 1

<b>Sorbent:</b>	paraffinic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((55.37-0.020428*((T-273.15)*1.8+32))*16.0185)*0.5$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

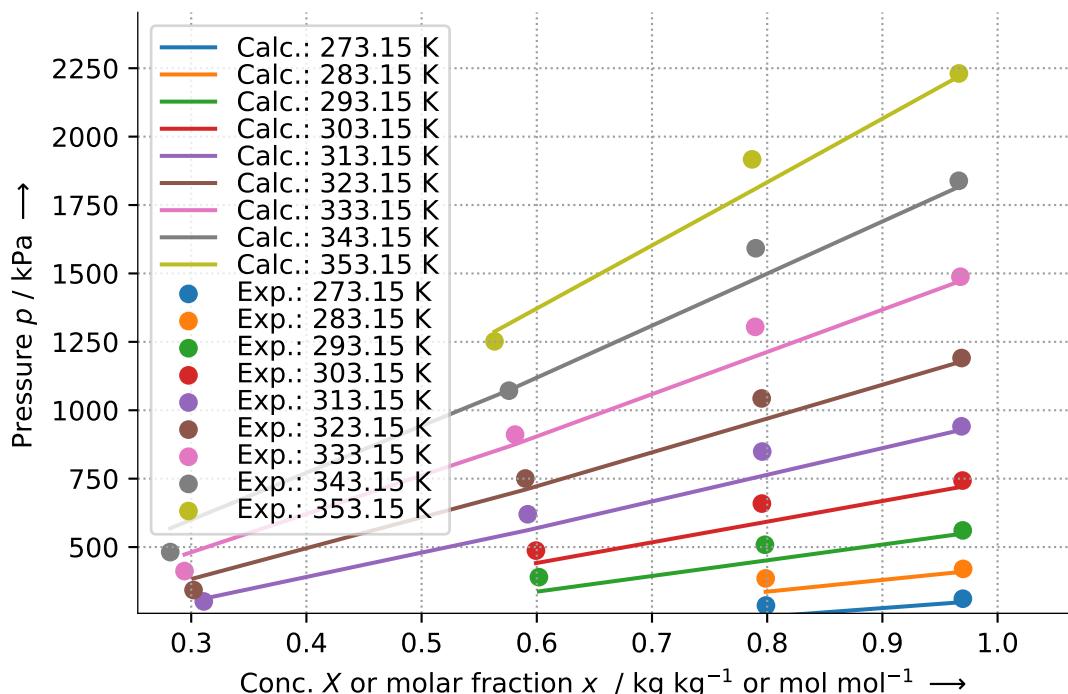
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.307000000e+03		$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	1.615000000e+03

Par.	Unit	Value	Par.	Unit	Value
$v_1$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.83%.

### 6.11.3.2 NRTLFixedDg - ID 1

<b>Sorbent:</b>	paraffinic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-2.059000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	6.981000000e+03

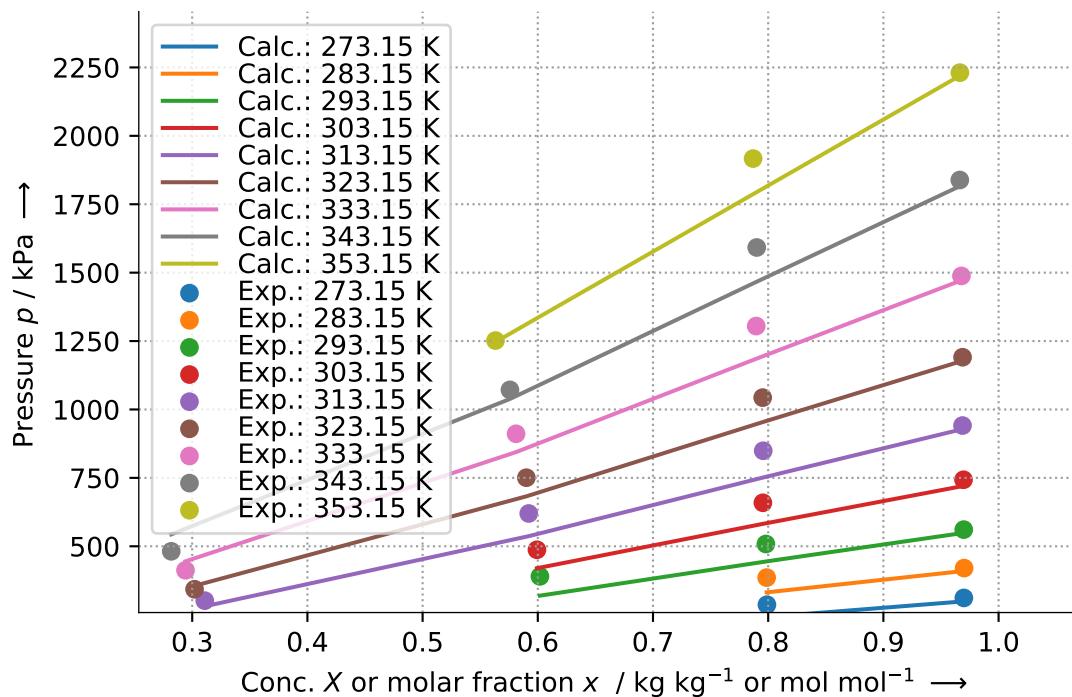
#### Validity:

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.29%.

### 6.11.3.3 TsubokaKatayama - ID 1

<b>Sorbent:</b>	paraffinic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((55.37-0.020428*((T-273.15)*1.8+32))*16.0185)*0.5$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

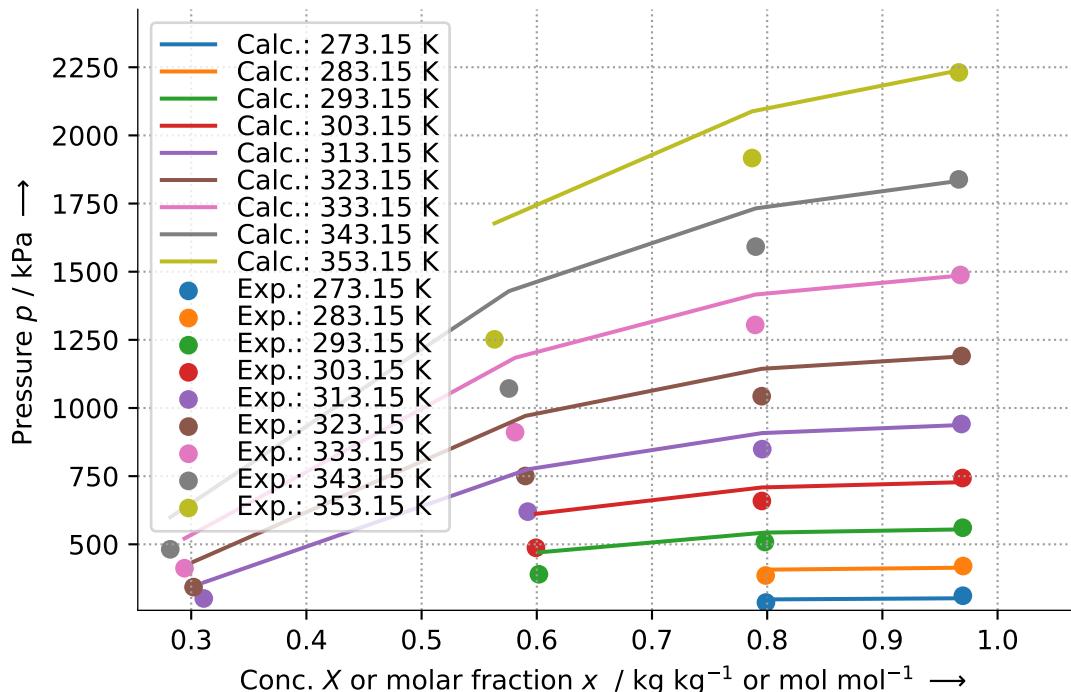
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.847000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-4.437000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 12.79%.

## 6.11.3.4 UniquacFixedDu - ID 1

<b>Sorbent:</b>	paraffinic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

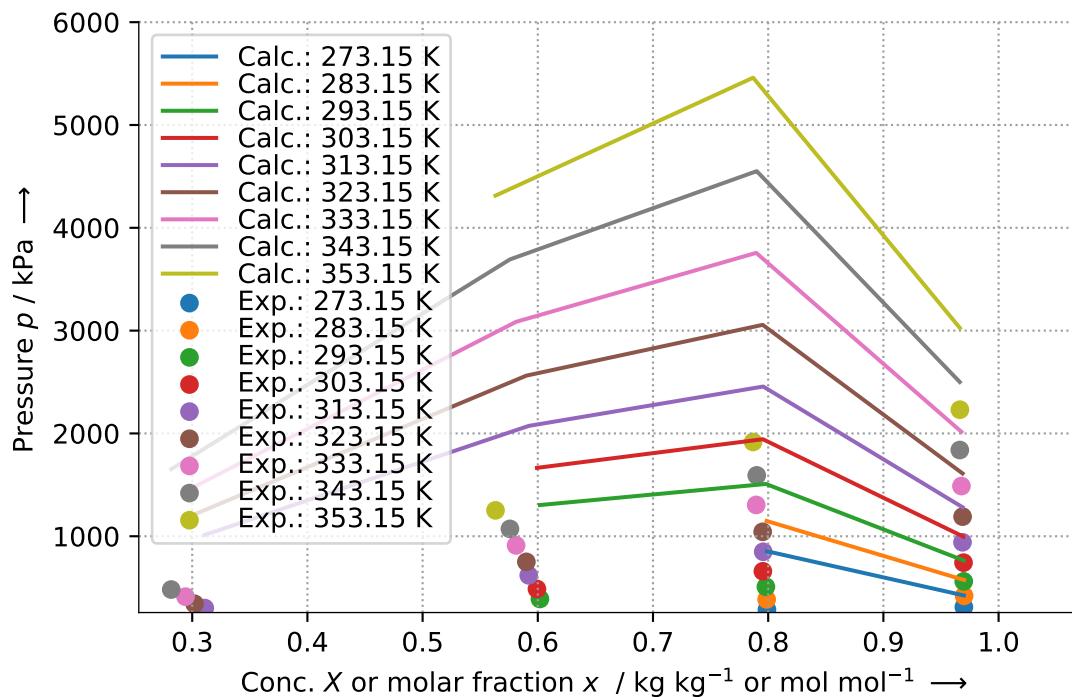
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	5.897000000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	2.770000000e+02
$r_1$	-	2.624300000e+00	$r_2$	-	2.450000000e+01
$q_1$	-	2.376000000e+00	$q_2$	-	2.028000000e+01
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for 255.15K  $\leq T \leq$  394.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 162.47%.

## 6.11.3.5 WangChao - ID 1

<b>Sorbent:</b>	paraffinic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{POE} = 1/((55.37-0.020428*((T-273.15)*1.8+32))*16.0185)*0.5$ in m <sup>3</sup> /mol), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{sat,1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

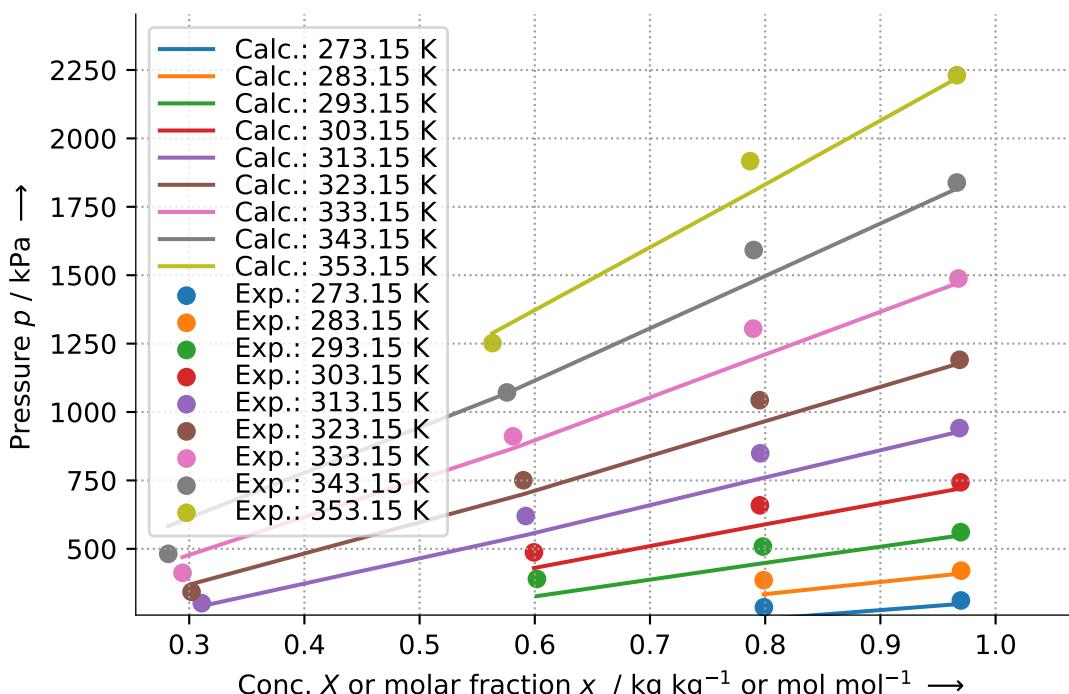
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{sat,1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + x_2/x_1 \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + x_1/x_2 \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	-4.300000000e+01	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	4.115000000e+03
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.23%.

## 6.11.3.6 WilsonFixedDI - ID 1

<b>Sorbent:</b>	paraffinic
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-12
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((55.37-0.020428*((T-273.15)*1.8+32))*16.0185)*0.5$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

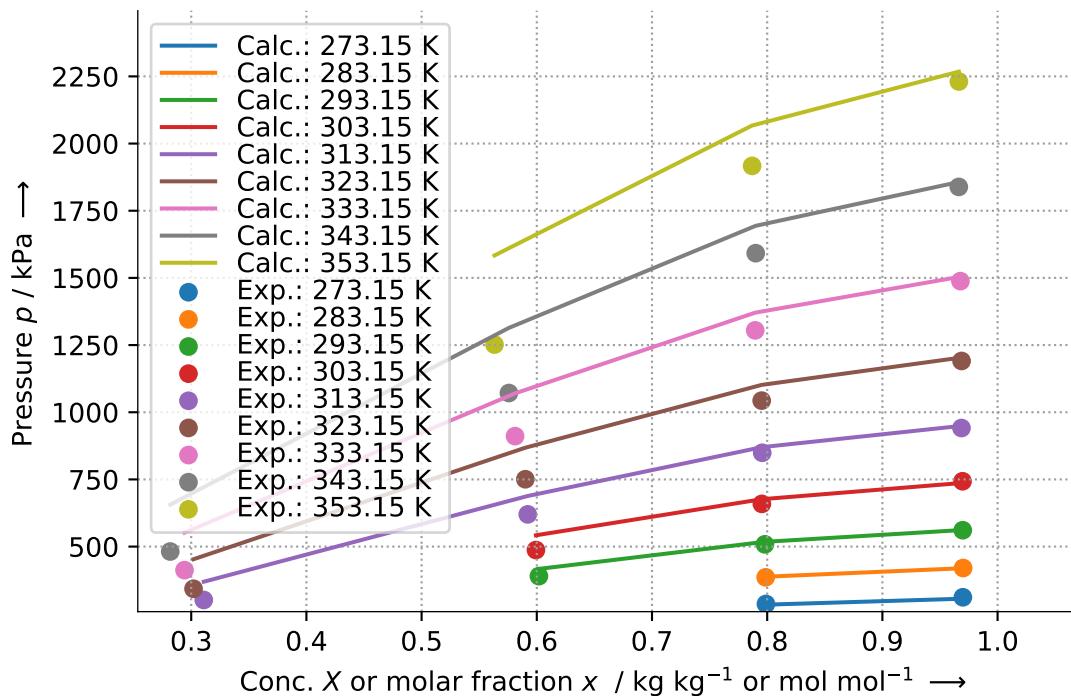
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) \quad , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} \quad , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	2.634000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	7.415000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 9.58%.

## 6.12 R-123

### 6.12.1 Lubricant MO56

#### 6.12.1.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	MO56
<b>Refrigerant:</b>	R-123
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	4.568300000e+02	$T_{\text{crit},2}$	K	8.320000000e+02
$p_{\text{crit},1}$	Pa	3.668000000e+06	$p_{\text{crit},2}$	Pa	1.104000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001600000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.792500000e-01	$\beta_{1,2}$	-	1.020000000e+00
$\beta_{2,1}$	-	-7.111000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	1.580000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-4.800000000e-02
$l_{12}$	-	3.840000000e-02	$l_{21}$	-	3.840000000e-02
$t$	-	7.580000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.13 R-1234ze(E)

### 6.13.1 Lubricant POE

#### 6.13.1.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-1234ze(E)
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Bock, Jessica (2015): VAPOR-LIQUID EQUILIBRIA OF A LOW GWP REFRIGERANT, R-1234ZE(E), MIXED WITH A POE LUBRICANT. PhD Thesis. University of Illinois at Urbana-Champaign, Illinois.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-3.082700000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	7.567500000e+03

#### Validity:

Equation is approximately valid for  $273.15\text{K} \leq T \leq 353.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 6.13.1.2 UniquacFixedDu - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-1234ze(E)
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Bock, Jessica (2015): VAPOR-LIQUID EQUILIBRIA OF A LOW GWP REFRIGERANT, R-1234ZE(E), MIXED WITH A POE LUBRICANT. PhD Thesis. University of Illinois at Urbana-Champaign, Illinois.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.662800000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	1.981200000e+03
$r_1$	-	2.740000000e+00	$r_2$	-	2.940000000e+01
$q_1$	-	2.490000000e+00	$q_2$	-	2.436000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for  $273.15\text{K} \leq T \leq 353.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 6.13.1.3 WilsonFixedDI - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-1234ze(E)
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Bock, Jessica (2015): VAPOR-LIQUID EQUILIBRIA OF A LOW GWP REFRIGERANT, R-1234ZE(E), MIXED WITH A POE LUBRICANT. PhD Thesis. University of Illinois at Urbana-Champaign, Illinois.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/(993.89 - 0.75658*(T-273.15))^0.7$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	2.000000000e+04	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	1.908000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

Equation is approximately valid for  $273.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.14 R-125

### 6.14.1 Hexadecane

#### 6.14.1.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	hexadecane
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (1997): The solubility of HFC 125, HFC 134a, HFC 143a and HFC 152a in n -eicosane, n -hexadecane, n -tridecane and 2, 6, 10, 14-tetramethylpentadecane. In: Can. J. Chem. Eng. 75 (3), S. 544–550. DOI: 10.1002/cjce.5450750308.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-1.679000000e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	2.618900000e+03
$r_1$	-	2.610000000e+00	$r_2$	-	2.314000000e+01
$q_1$	-	2.490000000e+00	$q_2$	-	1.706000000e+01
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for  $293.15K \leq T \leq 363.15K$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.2 Lubricant BAB15

#### 6.14.2.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB15
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeiki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\frac{T}{T_{\text{crit},j}}}\right) (0.7 - \frac{T}{T_{\text{crit},j}}) , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 .
 \end{aligned}$$

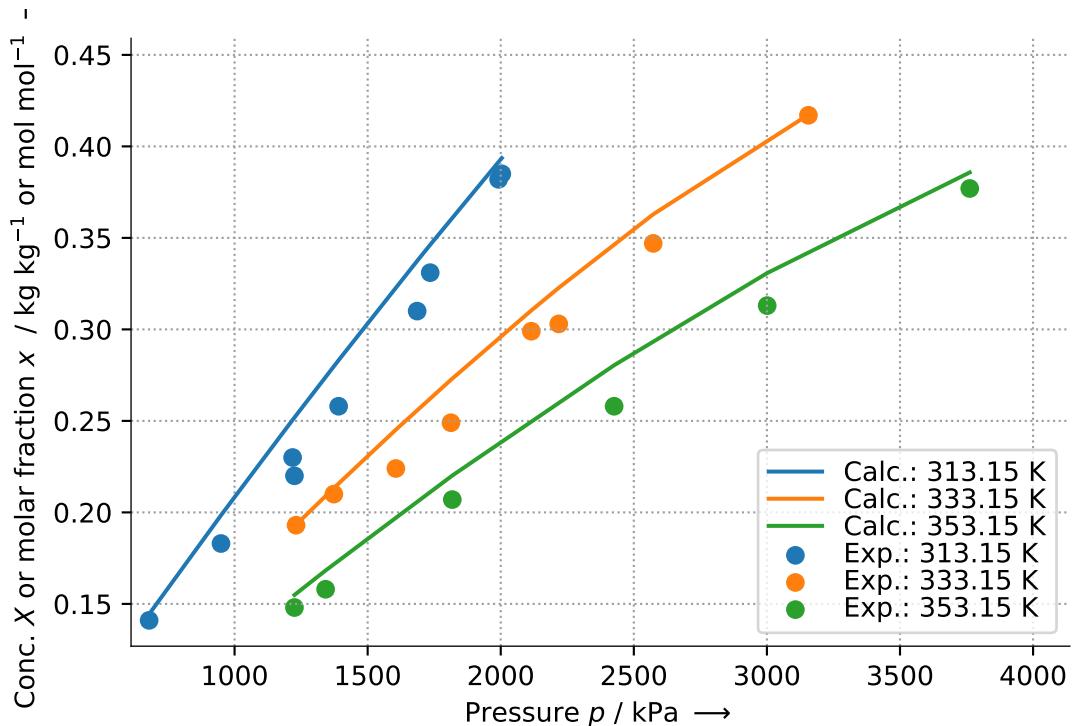
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
EoS	-	2.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	3.393300000e+02	$T_{\text{crit},2}$	K	7.633500000e+02
$p_{\text{crit},1}$	Pa	3.629000000e+06	$p_{\text{crit},2}$	Pa	1.199000000e+06
$\omega_1$	-	3.034900000e-01	$\omega_2$	-	7.160750000e-01
$\kappa_{1,1}$	-	-5.020000000e-02	$\kappa_{1,2}$	-	-1.331000000e-01
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.645000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.74%.

### 6.14.3 Lubricant BAB32

#### 6.14.3.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB32
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\frac{T}{T_{\text{crit},j}}}\right) (0.7 - \frac{T}{T_{\text{crit},j}}) , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 .
 \end{aligned}$$

The parameters of the equation are:

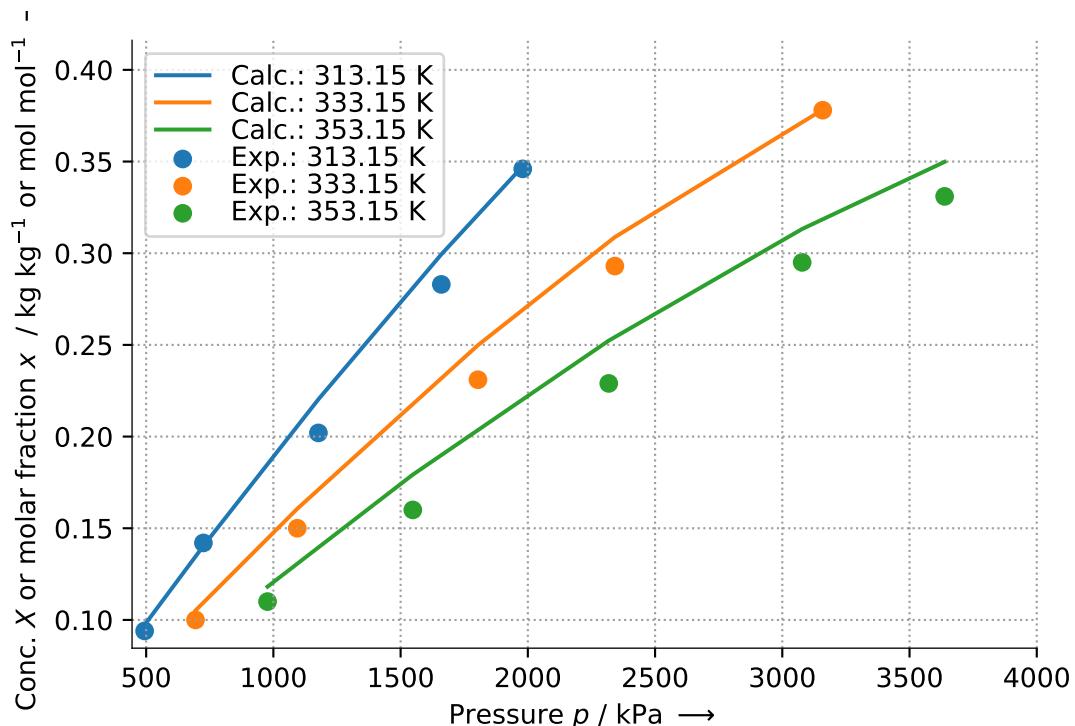
Par.	Unit	Value		Par.	Unit	Value
EoS	-	2.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	3.393300000e+02	$T_{\text{crit},2}$	K	7.728900000e+02
$p_{\text{crit},1}$	Pa	3.629000000e+06	$p_{\text{crit},2}$	Pa	1.138000000e+06
$\omega_1$	-	3.034900000e-01	$\omega_2$	-	6.947280000e-01
$\kappa_{1,1}$	-	-5.020000000e-02	$\kappa_{1,2}$	-	-9.860000000e-02
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.837000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.82%.

#### 6.14.4 Lubricant HAB15

##### 6.14.4.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HAB15
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

##### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.391900000e+02	$T_{\text{crit},2}$	K	7.550000000e+02
$p_{\text{crit},1}$	Pa	3.637000000e+06	$p_{\text{crit},2}$	Pa	1.145000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000100000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.773600000e-01	$\beta_{1,2}$	-	9.500000000e-01
$\beta_{2,1}$	-	-1.977000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.770000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.570000000e-01
$l_{12}$	-	9.150000000e-02	$l_{21}$	-	1.297000000e-01
$t$	-	1.220000000e+01			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.5 Lubricant HAB32

#### 6.14.5.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HAB32
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.391900000e+02	$T_{\text{crit},2}$	K	7.580000000e+02
$p_{\text{crit},1}$	Pa	3.637000000e+06	$p_{\text{crit},2}$	Pa	1.073000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000100000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.773600000e-01	$\beta_{1,2}$	-	1.115000000e+00
$\beta_{2,1}$	-	-1.977000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.770000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.536000000e-01
$l_{12}$	-	1.276000000e-01	$l_{21}$	-	1.422000000e-01
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.6 Lubricant HC16

#### 6.14.6.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HC16
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.391900000e+02	$T_{\text{crit},2}$	K	7.170000000e+02
$p_{\text{crit},1}$	Pa	3.637000000e+06	$p_{\text{crit},2}$	Pa	1.419000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000100000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.773600000e-01	$\beta_{1,2}$	-	7.310000000e-01
$\beta_{2,1}$	-	-1.977000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.770000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-2.174000000e-01
$l_{12}$	-	1.556000000e-01	$l_{21}$	-	1.556000000e-01
$t$	-	5.420000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.7 Lubricant PEB6

#### 6.14.7.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB6
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	3.940000000e+00	$w_0^*$	K	9.930000000e+02
$w_1$	K	-2.710000000e+02			

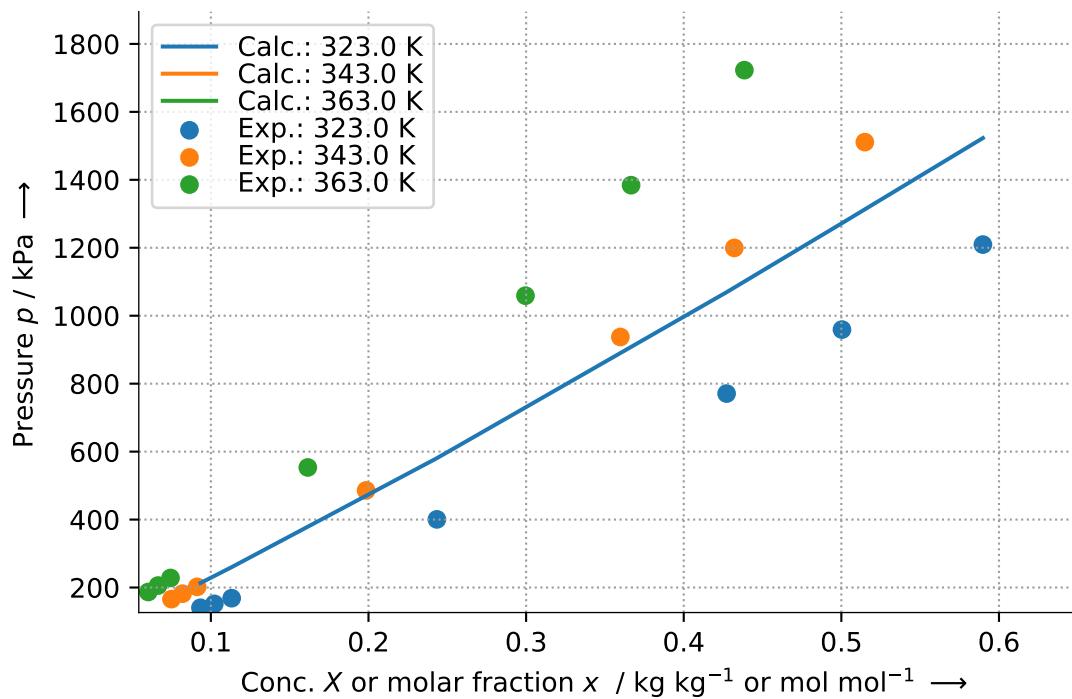
#### Validity:

Equation is approximately valid for 323.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 43.2%.

### 6.14.8 Lubricant PEB8

#### 6.14.8.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	5.810000000e+00	$w_0^*$	K	9.980000000e+02
$w_1$	K	-2.380000000e+02			

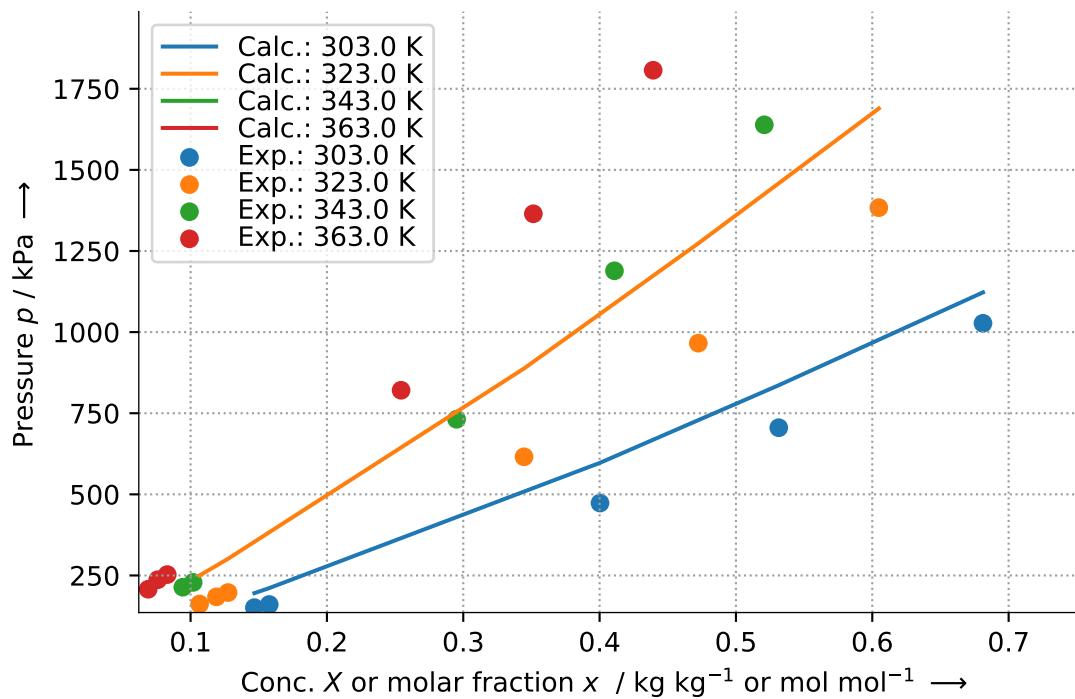
#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 33.89%.

### 6.14.8.2 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.391900000e+02	$T_{\text{crit},2}$	K	7.930000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	3.637000000e+06	$p_{\text{crit},2}$	Pa	7.720000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000100000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.773600000e-01	$\beta_{1,2}$	-	9.410000000e-01
$\beta_{2,1}$	-	-1.977000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.770000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	1.190000000e-02
$l_{12}$	-	5.000000000e-04	$l_{21}$	-	5.000000000e-04
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.9 Lubricant PEC9

#### 6.14.9.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEC9
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	6.910000000e+00	$w_0^*$	K	9.970000000e+02
$w_1$	K	-2.080000000e+02			

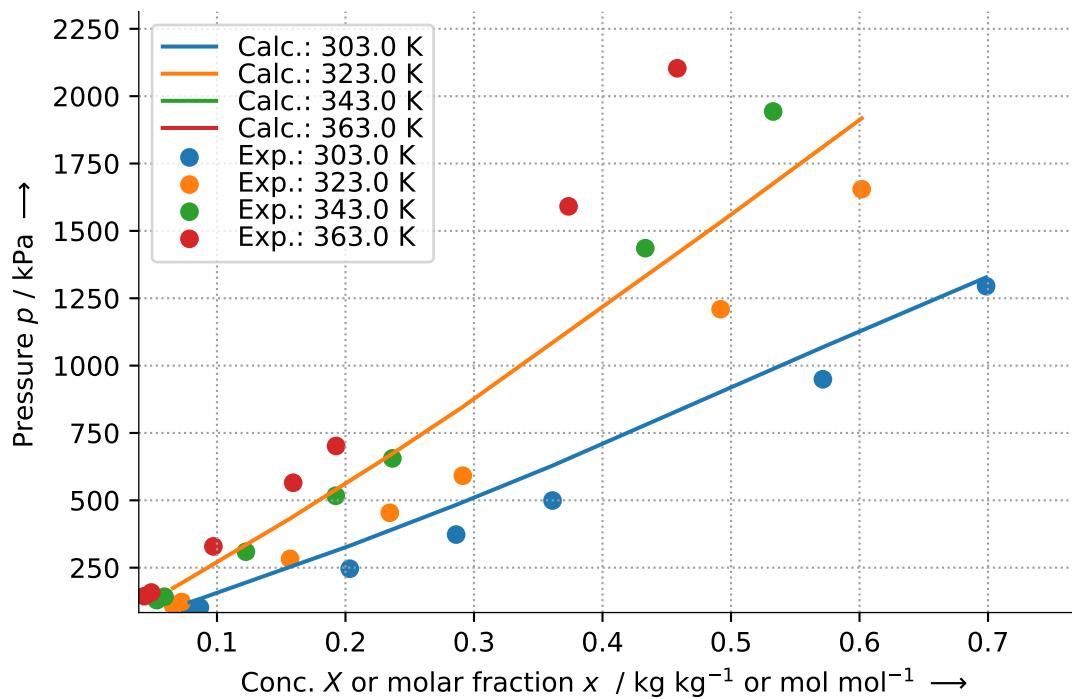
#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 33.34%.

### 6.14.10 Lubricant POE

#### 6.14.10.1 Heil - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/(993.89 - 0.75658*(T-273.15))^0.7$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

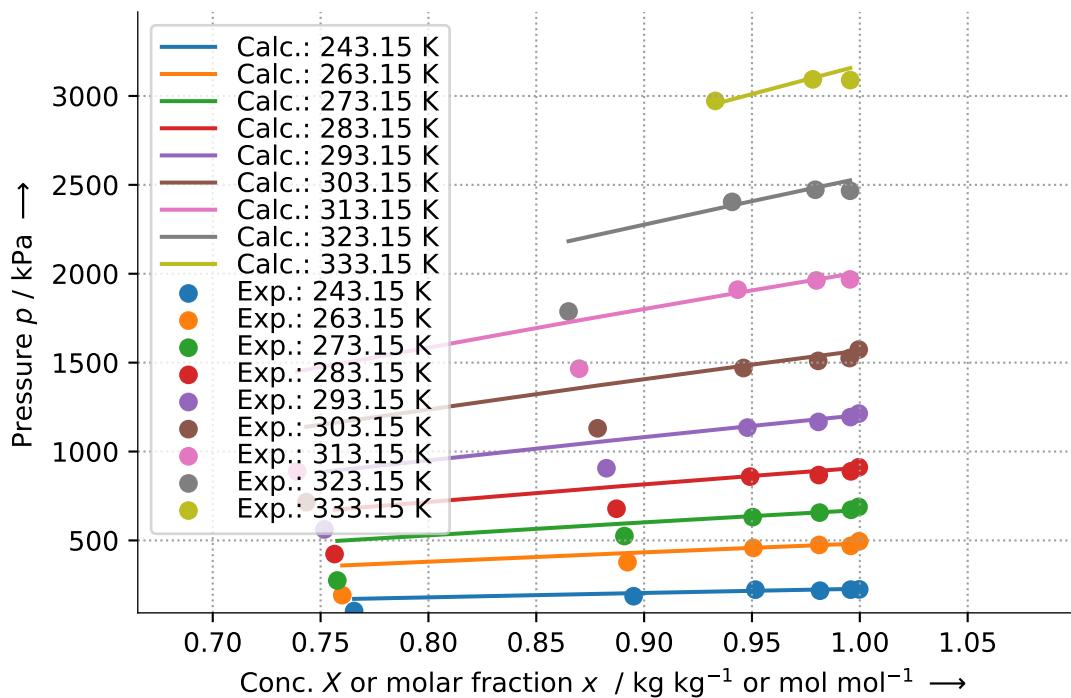
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\Lambda_{12}$	$\text{J mol}^{-1}$	6.420000000e+02	$\Delta\Lambda_{21}$	$\text{J mol}^{-1}$	5.493000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $243.15\text{K} \leq T \leq 333.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 13.55%.

## 6.14.10.2 NRTLFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-3.363000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	8.481000000e+03

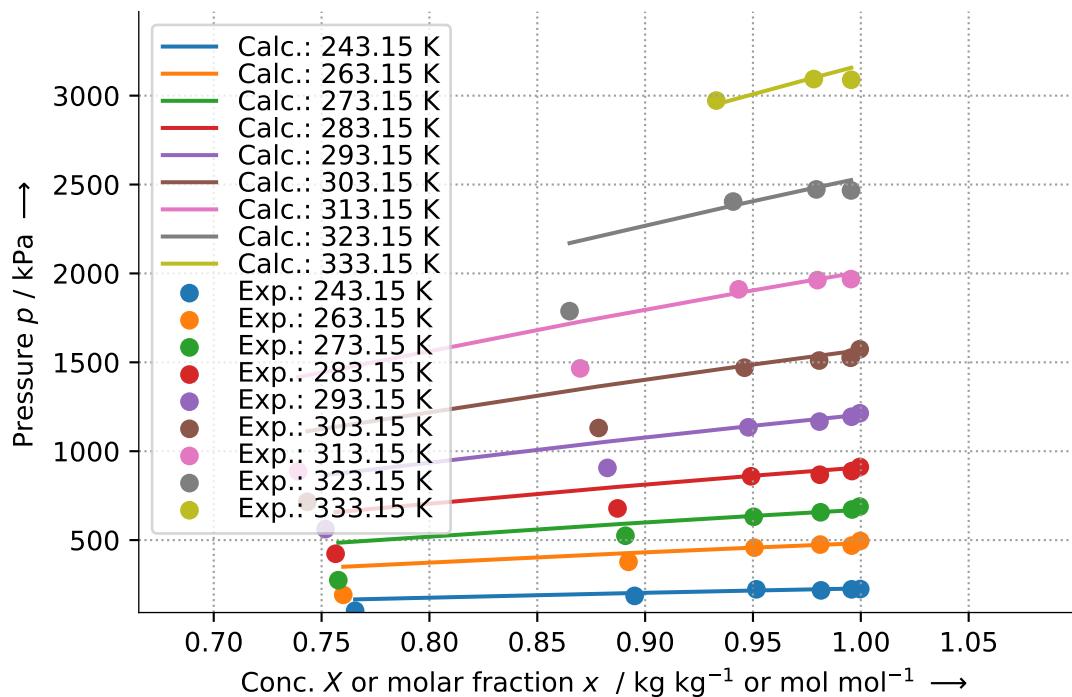
**Validity:**

Equation is approximately valid for 243.15K  $\leq T \leq$  333.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 12.85%.

## 6.14.10.3 TsubokaKatayama - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2; Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	9.180000000e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-4.941000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $243.15\text{K} \leq T \leq 333.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

#### 6.14.10.4 UniquacFixedDu - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

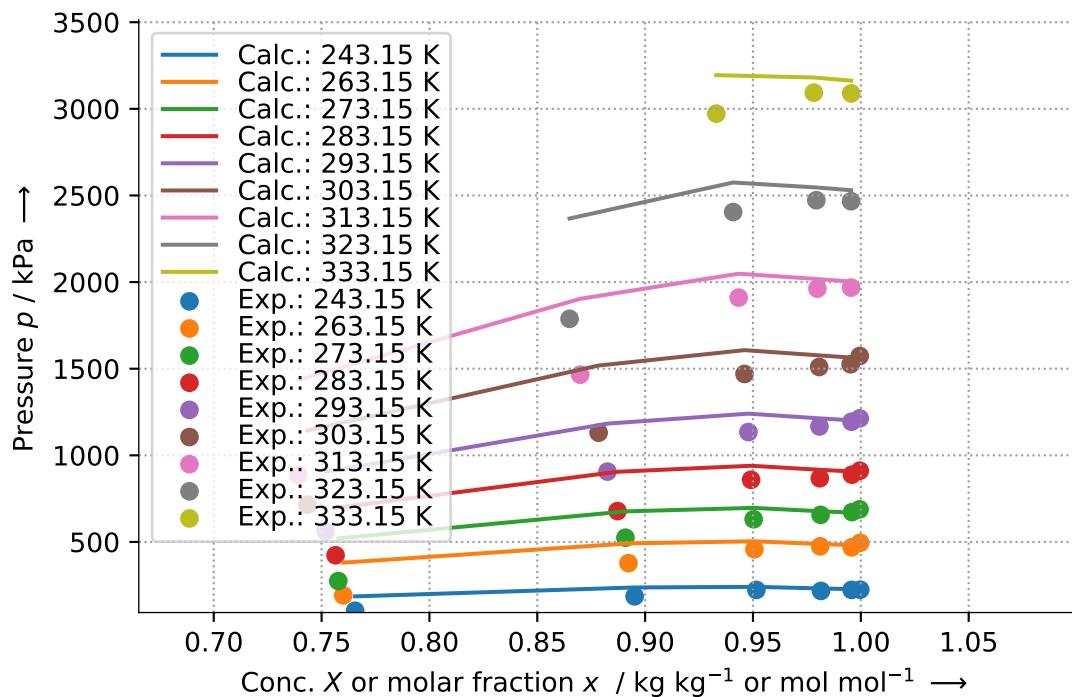
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.715000000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-5.700000000e+02
$r_1$	-	2.610000000e+00	$r_2$	-	2.940000000e+01
$q_1$	-	2.490000000e+00	$q_2$	-	2.436000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for  $243.15\text{K} \leq T \leq 333.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 18.8%.

## 6.14.10.5 WangChao - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.; Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + x_2/x_1 \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + x_1/x_2 \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= \frac{v_1/v_2}{x_1} && , \text{ and} \\
 \rho_{21} &= \frac{v_2/v_1}{x_2} && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	-3.810000000e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	4.579000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for  $-243.15\text{K} \leq T \leq 333.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.10.6 WilsonFixedDI - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/(993.89 - 0.75658*(T-273.15))*0.7$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

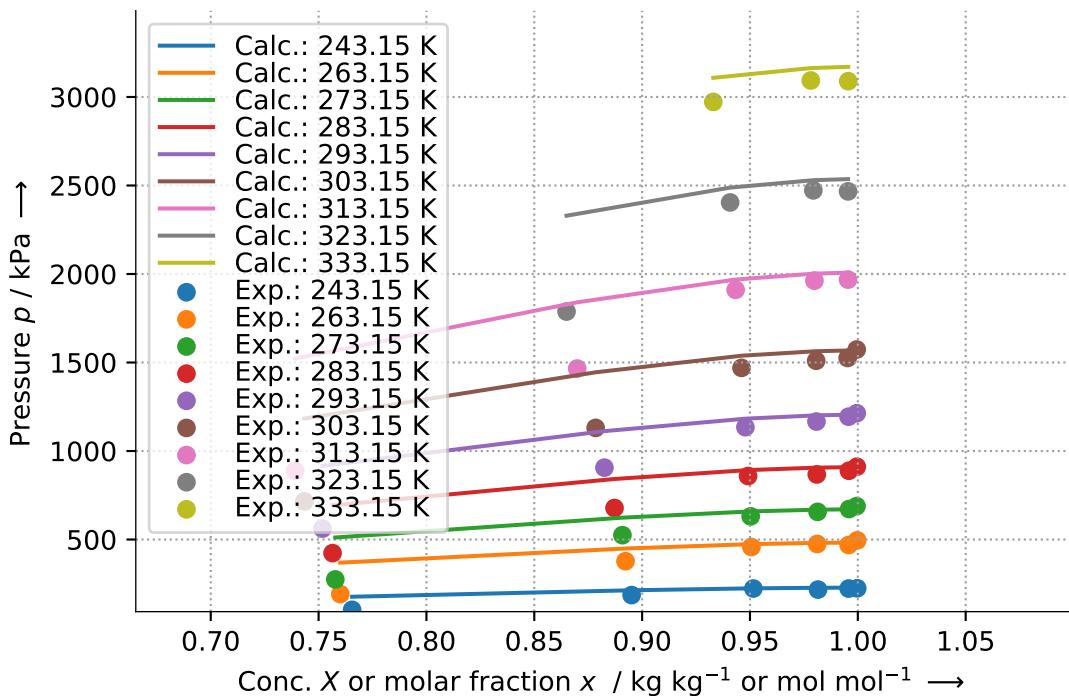
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.441000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	2.000000000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 16.29%.

### 6.14.11 Lubricant POE32

#### 6.14.11.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE32
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.391900000e+02	$T_{\text{crit},2}$	K	8.640000000e+02
$p_{\text{crit},1}$	Pa	3.637000000e+06	$p_{\text{crit},2}$	Pa	8.740000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000100000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.773600000e-01	$\beta_{1,2}$	-	9.130000000e-01
$\beta_{2,1}$	-	-1.977000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.770000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	2.960000000e-02
$l_{12}$	-	1.790000000e-02	$l_{21}$	-	2.900000000e-03
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.12 Lubricant POE68

#### 6.14.12.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE68
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.391900000e+02	$T_{\text{crit},2}$	K	7.460000000e+02
$p_{\text{crit},1}$	Pa	3.637000000e+06	$p_{\text{crit},2}$	Pa	6.820000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000100000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.773600000e-01	$\beta_{1,2}$	-	1.249000000e+00
$\beta_{2,1}$	-	-1.977000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.770000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	2.460000000e-02
$l_{12}$	-	2.450000000e-02	$l_{21}$	-	4.700000000e-03
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.14.13 Pentaerythritol tetrapentanoate ester

#### 6.14.13.1 FloryHuggins - ID 1

<b>Sorbent:</b>	pentaerythritol tetrapentanoate ester
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-125
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (1999): Solubility of HFC32, HFC125, HFC134a, HFC143a, and HFC152a in a Pentaerythritol Tetrapentanoate Ester. In: J. Chem. Eng. Data 44 (4), S. 823–828. DOI: 10.1021/je980235e.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	3.470000000e+00	$w_0^*$	K	9.670000000e+02
$w_1$	K	-2.620000000e+02			

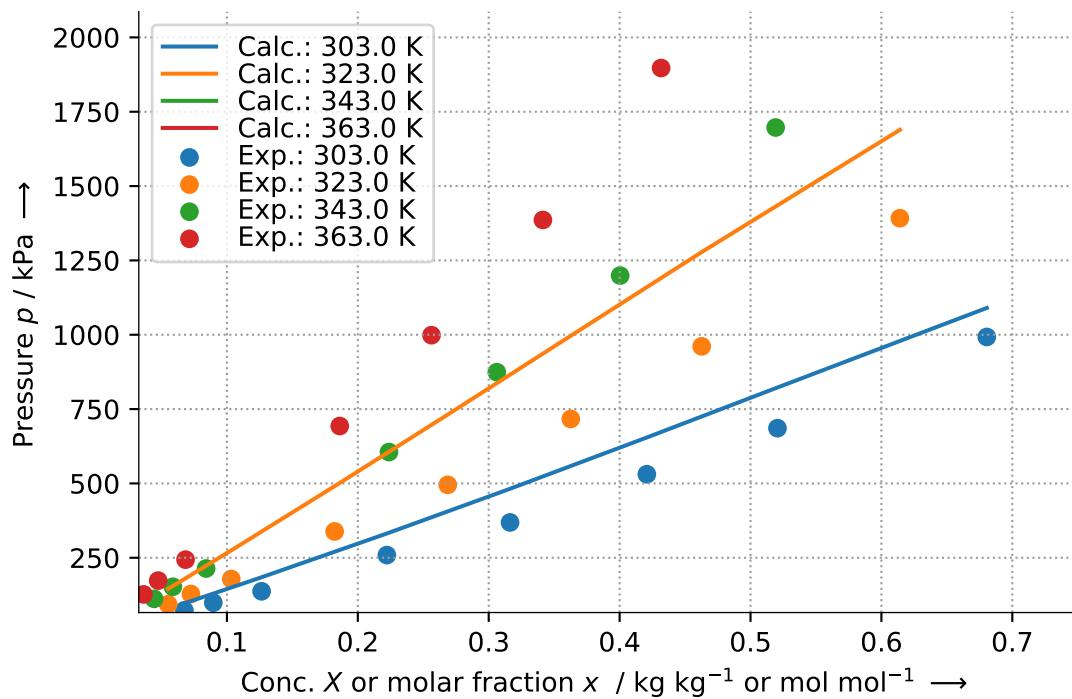
#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 363.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 34.66%.

## 6.15 R-13 B1

### 6.15.1 Lubricant AB32

#### 6.15.1.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	AB32
<b>Refrigerant:</b>	R-13 B1
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.402000000e+02	$T_{\text{crit},2}$	K	8.570000000e+02
$p_{\text{crit},1}$	Pa	3.960000000e+06	$p_{\text{crit},2}$	Pa	1.015000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.004200000e-01	$\beta_{1,2}$	-	8.920000000e-01
$\beta_{2,1}$	-	-8.728000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	2.920000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-2.990000000e-02
$l_{12}$	-	5.980000000e-02	$l_{21}$	-	1.994000000e-01
$t$	-	6.090000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.16 R-134a

### 6.16.1 Triegdme

#### 6.16.1.1 WilsonTemperatureDI - ID 1

<b>Sorbent:</b>	TriEGDME
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	WilsonTemperatureDI
<b>ID:</b>	1
<b>Reference:</b>	Marchi, Paolo; Scalabrin, Giancarlo; Ihmels, E. Christian; Fischer, Kai; Gmehling, Jürgen (2006): Bubble pressure measurements for the (1,1,1,2-tetrafluoroethane+triethylene glycol dimethyl ether) system. In: The Journal of Chemical Thermodynamics 38 (11), S. 1247–1253. DOI: 10.1016/j.jct.2006.03.004.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \frac{v_2/v_1 \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right)}{x_1} && , \text{ and} \\
 \Lambda_{21} &= \frac{v_1/v_2 \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right)}{x_2} && , \text{ and} \\
 \Delta\lambda_{12} &= R(\Delta\lambda_{12,c} + \Delta\lambda_{12,t}(T - c)) && , \text{ and} \\
 \Delta\lambda_{21} &= R(\Delta\lambda_{21,c} + \Delta\lambda_{21,t}(T - c)) && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

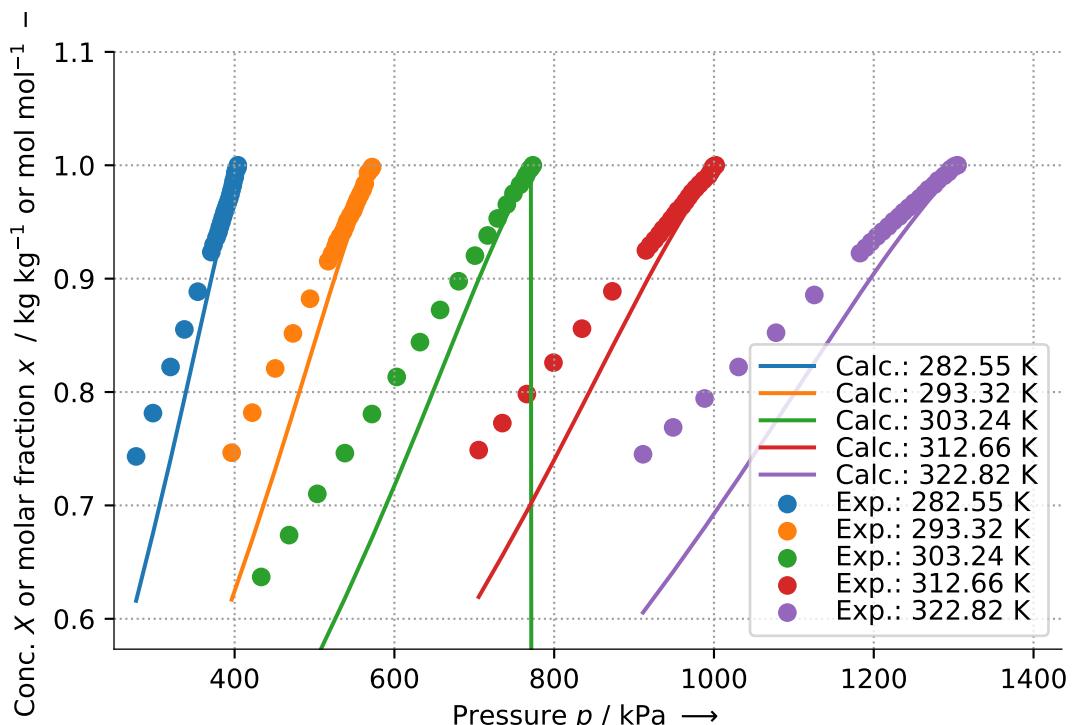
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12,c}$	K	-1.491280000e+02	$\Delta\lambda_{21,c}$	K	3.681890000e+02
$\Delta\lambda_{12,t}$	-	9.592910000e-01	$\Delta\lambda_{12,t}$	-	9.291260000e-01
$v_1$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00
$c$	K	2.731500000e+02			

**Validity:**

Equation is approximately valid for  $283.15\text{K} \leq T \leq 323.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 1.00E+02
- Temperature, absolute, in K → 0.03

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.69%.

### 6.16.2 Hexadecane

#### 6.16.2.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	hexadecane
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (1997): The solubility of HFC 125, HFC 134a, HFC 143a and HFC 152a in n -eicosane, n -hexadecane, n -tridecane and 2, 6, 10, 14-tetramethylpentadecane. In: Can. J. Chem. Eng. 75 (3), S. 544–550. DOI: 10.1002/cjce.5450750308.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-2.128000000e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	2.810100000e+03
$r_1$	-	2.460000000e+00	$r_2$	-	2.314000000e+01
$q_1$	-	2.360000000e+00	$q_2$	-	1.706000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 293.15K  $\leq T \leq$  363.15K.

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.16.3 Lubricant BAB15

#### 6.16.3.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB15
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\frac{T}{T_{\text{crit},j}}}\right) (0.7 - \frac{T}{T_{\text{crit},j}}) , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 .
 \end{aligned}$$

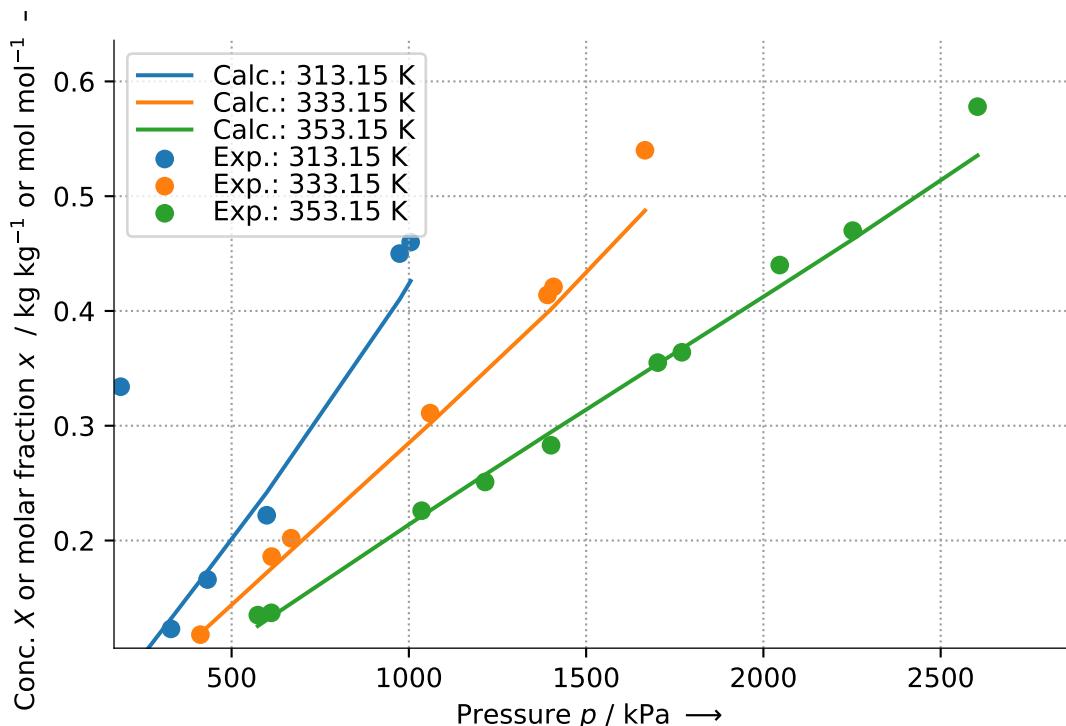
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
EoS	-	2.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	7.633500000e+02
$p_{\text{crit},1}$	Pa	4.059300000e+06	$p_{\text{crit},2}$	Pa	1.199000000e+06
$\omega_1$	-	3.268400000e-01	$\omega_2$	-	7.160750000e-01
$\kappa_{1,1}$	-	-7.700000000e-03	$\kappa_{1,2}$	-	-1.331000000e-01
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.496000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.78%.

### 6.16.4 Lubricant BAB32

#### 6.16.4.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB32
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\frac{T}{T_{\text{crit},j}}}\right) (0.7 - \frac{T}{T_{\text{crit},j}}) , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 .
 \end{aligned}$$

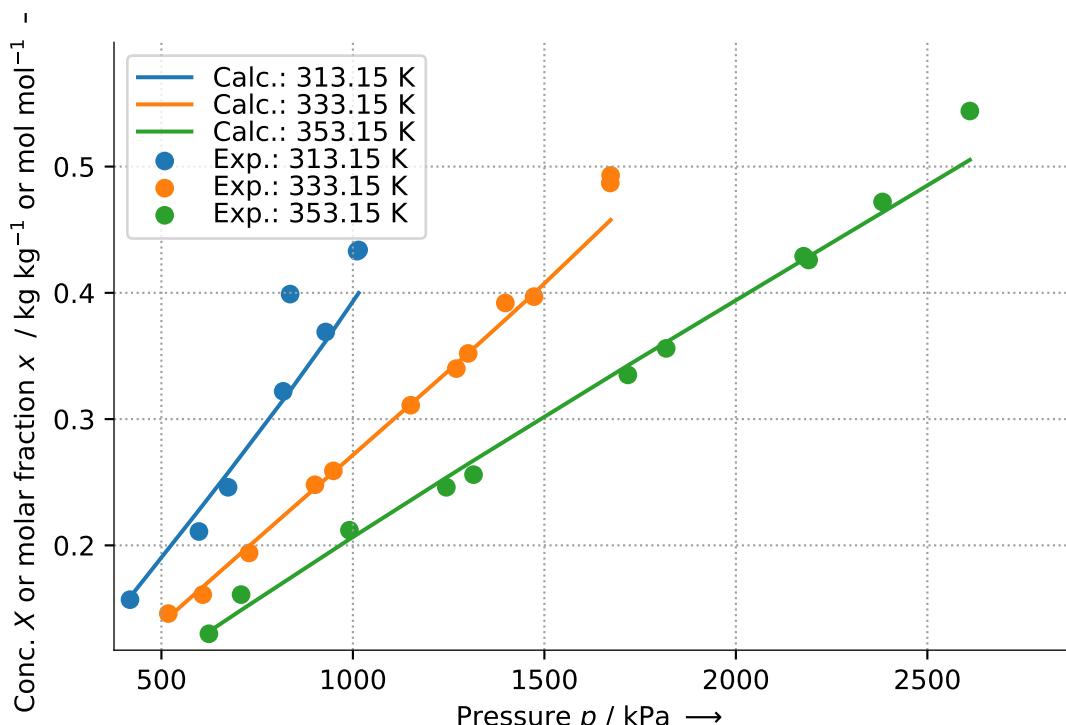
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
EoS	-	2.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	7.728900000e+02
$p_{\text{crit},1}$	Pa	4.059300000e+06	$p_{\text{crit},2}$	Pa	1.138000000e+06
$\omega_1$	-	3.268400000e-01	$\omega_2$	-	6.947280000e-01
$\kappa_{1,1}$	-	-7.700000000e-03	$\kappa_{1,2}$	-	-9.860000000e-02
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.598000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.73%.

### 6.16.5 Lubricant HAB32

#### 6.16.5.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HAB32
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	7.580000000e+02
$p_{\text{crit},1}$	Pa	4.059000000e+06	$p_{\text{crit},2}$	Pa	1.073000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.002500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	5.053200000e-01	$\beta_{1,2}$	-	1.115000000e+00
$\beta_{2,1}$	-	-4.983000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.661000000e-01
$l_{12}$	-	1.146000000e-01	$l_{21}$	-	1.332000000e-01
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.16.6 Lubricant HC13

#### 6.16.6.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HC13
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	6.760000000e+02
$p_{\text{crit},1}$	Pa	4.059000000e+06	$p_{\text{crit},2}$	Pa	1.720000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.002500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	5.053200000e-01	$\beta_{1,2}$	-	7.900000000e-01
$\beta_{2,1}$	-	-4.983000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.734000000e-01
$l_{12}$	-	8.590000000e-02	$l_{21}$	-	1.068000000e-01
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.16.7 Lubricant HC16

#### 6.16.7.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HC16
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

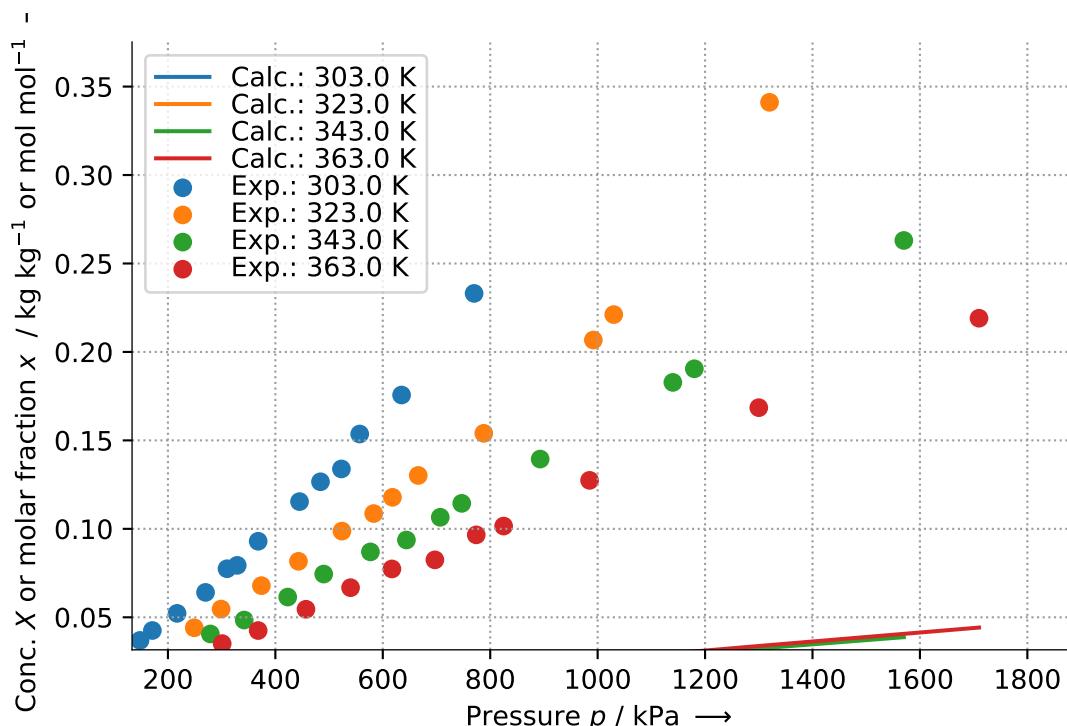
$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	7.170000000e+02
$p_{\text{crit},1}$	Pa	4.059000000e+06	$p_{\text{crit},2}$	Pa	1.419000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.002500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	5.053200000e-01	$\beta_{1,2}$	-	7.310000000e-01
$\beta_{2,1}$	-	-4.983000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.630000000e-01
$l_{12}$	-	9.280000000e-02	$l_{21}$	-	1.074000000e-01
$t$	-	4.190000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 85.4%.

### 6.16.8 Lubricant HC20

#### 6.16.8.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HC20
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	7.670000000e+02
$p_{\text{crit},1}$	Pa	4.059000000e+06	$p_{\text{crit},2}$	Pa	1.115000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.002500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	5.053200000e-01	$\beta_{1,2}$	-	1.076000000e+00
$\beta_{2,1}$	-	-4.983000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.536000000e-01
$l_{12}$	-	7.820000000e-02	$l_{21}$	-	1.029000000e-01
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.16.9 Lubricant PAG

#### 6.16.9.1 Heil - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PAG
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((62.365-0.024864*((T-273.15)*1.8+32))*16.0185)^2$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.667000000e+03		$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-4.626000000e+03

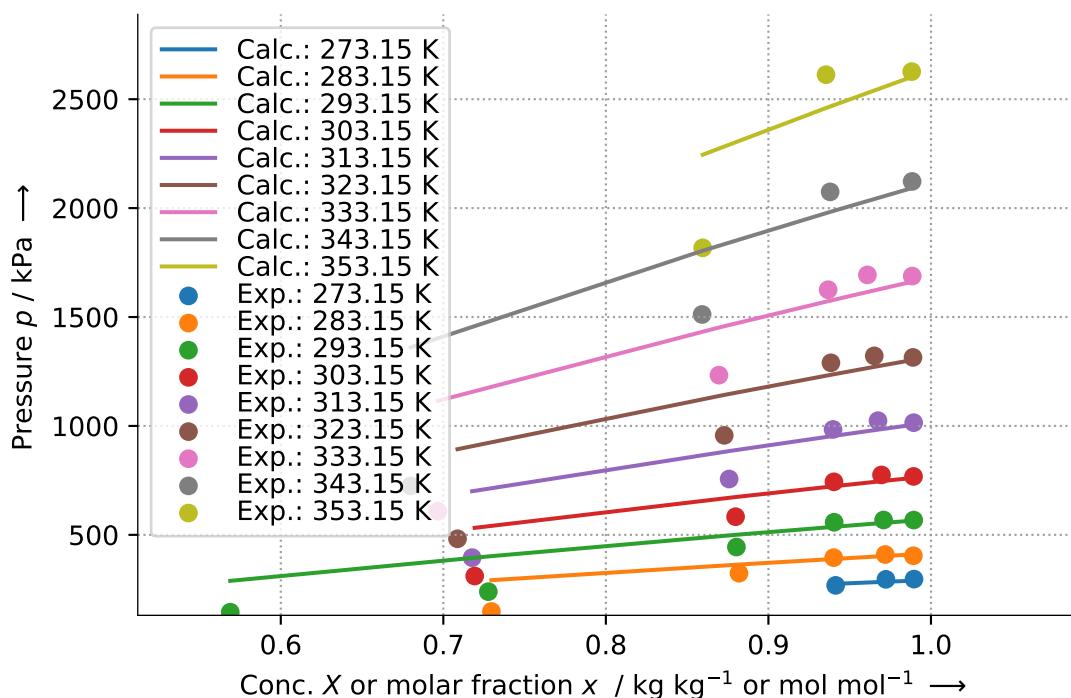
Par.	Unit	Value	Par.	Unit	Value
$v_1$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00

---

**Validity:**

Equation is approximately valid for  $263.15\text{K} \leq T \leq 343.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 21.26%.

### 6.16.9.2 NRTLFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PAG
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-4.788000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-3.590000000e+02

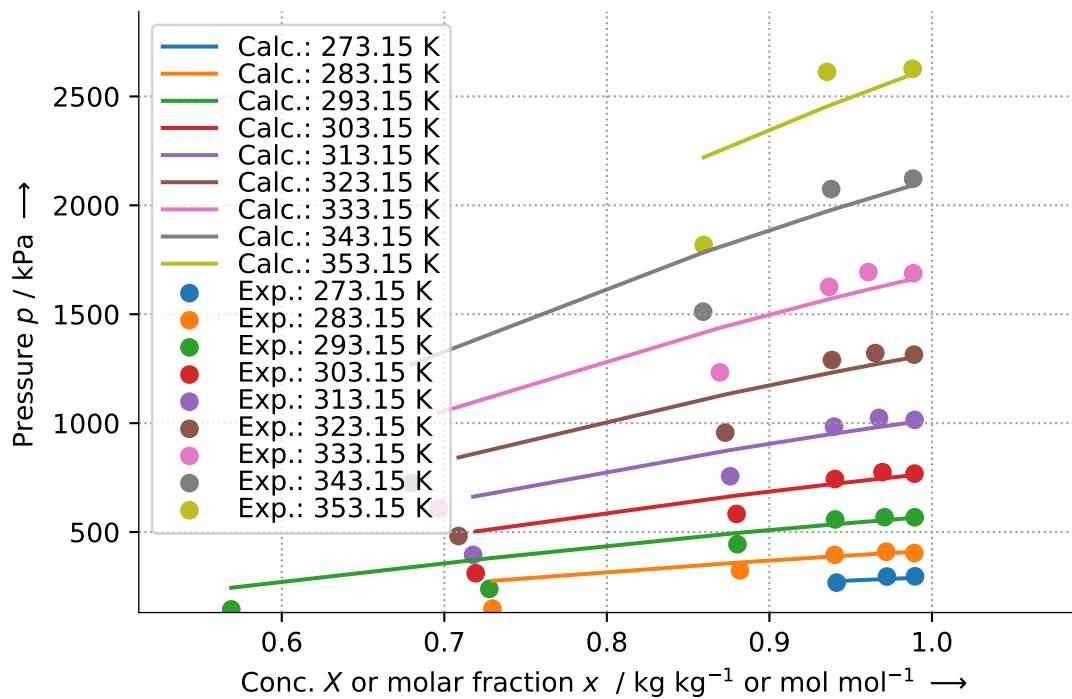
#### Validity:

Equation is approximately valid for 263.15K  $\leq T \leq$  343.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 18.57%.

### 6.16.9.3 TsubokaKatayama - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PAG
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((62.365-0.024864*((T-273.15)*1.8+32))*16.0185)^2$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

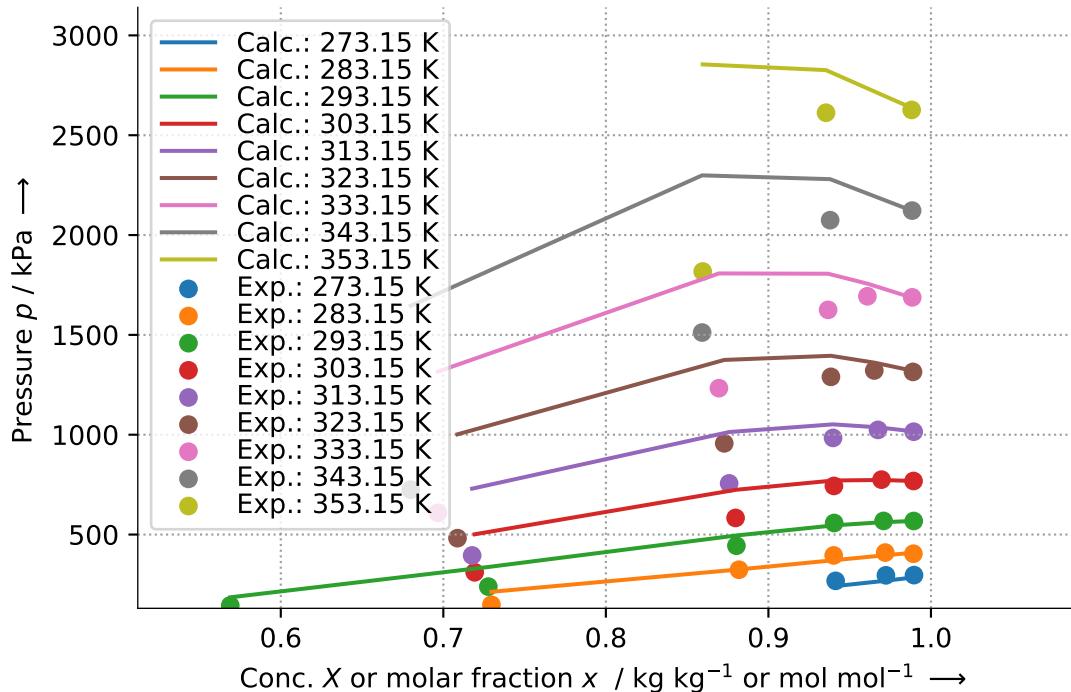
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	-2.470000000e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-1.525900000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

Equation is approximately valid for  $263.15\text{K} \leq T \leq 343.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 23.73%.

## 6.16.9.4 WangChao - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PAG
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((62.365-0.024864*((T-273.15)*1.8+32))*16.0185)*2$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

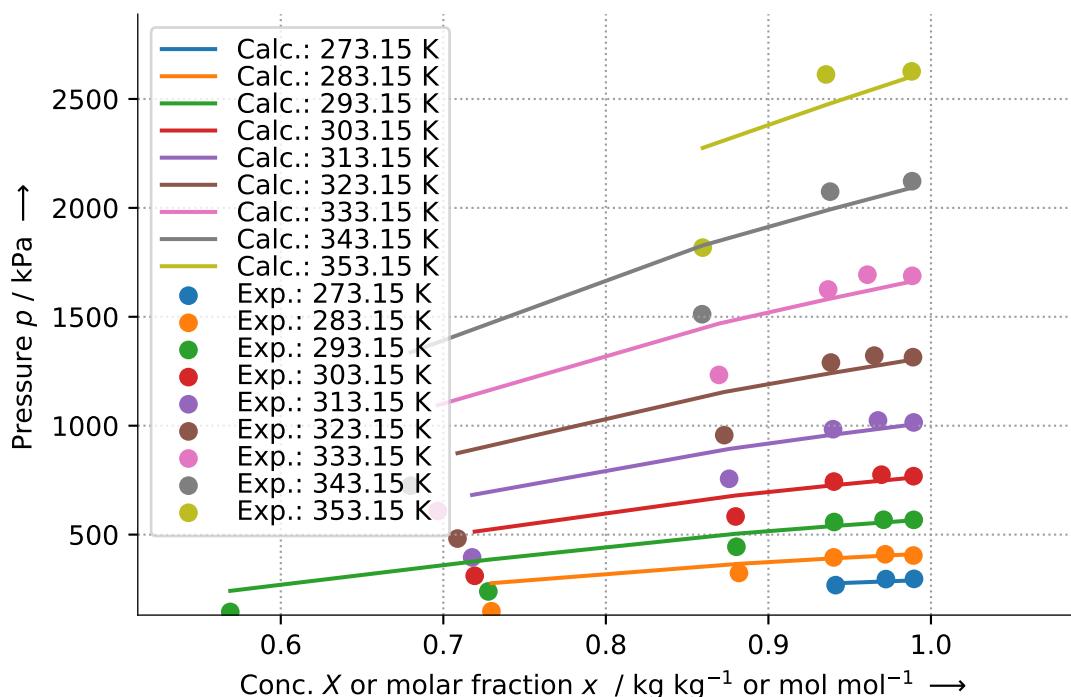
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + \frac{x_2}{x_1} \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + \frac{x_1}{x_2} \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= \frac{v_1/v_2}{x_{11}(1-x_{22})} && , \text{ and} \\
 \rho_{21} &= \frac{v_2/v_1}{x_{22}(1-x_{11})} && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	2.715000000e+03	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	-1.609000000e+03
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $263.15\text{K} \leq T \leq 343.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 19.66%.

## 6.16.9.5 WilsonFixedDI - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PAG
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((62.365-0.024864*((T-273.15)*1.8+32))*16.0185)^2$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

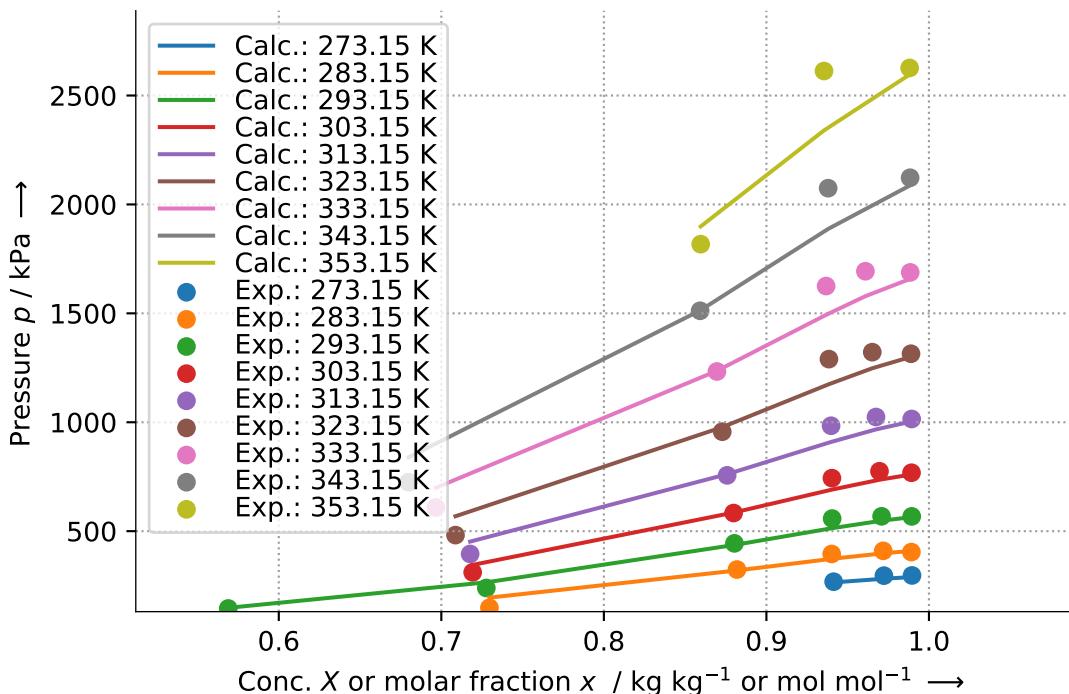
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	3.441000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-8.128000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $263.15\text{K} \leq T \leq 343.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.89%.

### 6.16.10 Lubricant PEB6

#### 6.16.10.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB6
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	7.030000000e+00	$w_0^*$	K	9.730000000e+02
$w_1$	K	-2.330000000e+02			

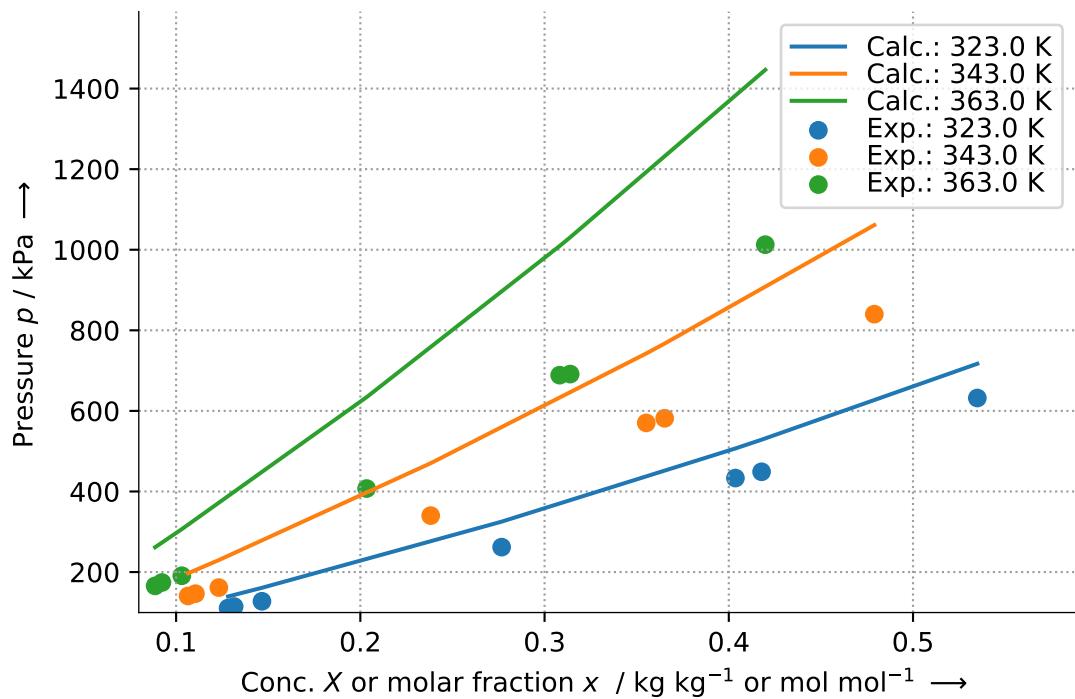
#### Validity:

Equation is approximately valid for 323.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 36.58%.

### 6.16.11 Lubricant PEB8

#### 6.16.11.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + \frac{w_1}{T} \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	6.940000000e+00	$w_0^*$	K	8.080000000e+02
$w_1$	K	-2.030000000e+02			

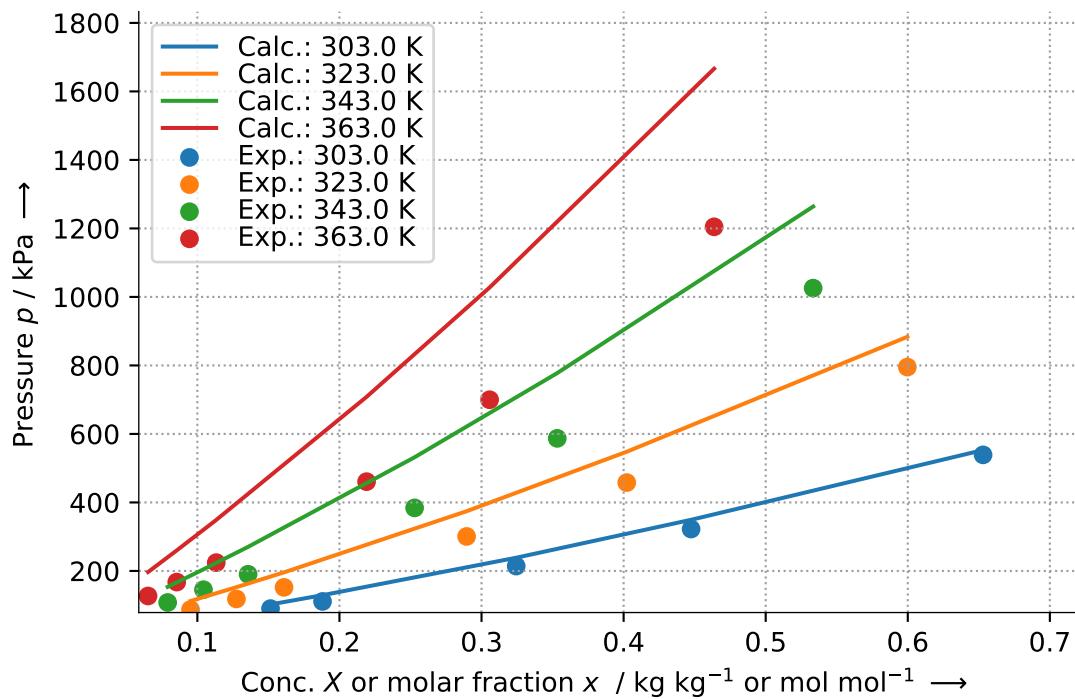
#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 31.22%.

### 6.16.11.2 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	7.930000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	4.059000000e+06	$p_{\text{crit},2}$	Pa	7.720000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.002500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	5.053200000e-01	$\beta_{1,2}$	-	9.410000000e-01
$\beta_{2,1}$	-	-4.983000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.930000000e-02
$l_{12}$	-	5.040000000e-02	$l_{21}$	-	3.590000000e-02
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.16.12 Lubricant PEC9

#### 6.16.12.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEC9
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	1.041000000e+01	$w_0^*$	K	9.380000000e+02
$w_1$	K	-1.760000000e+02			

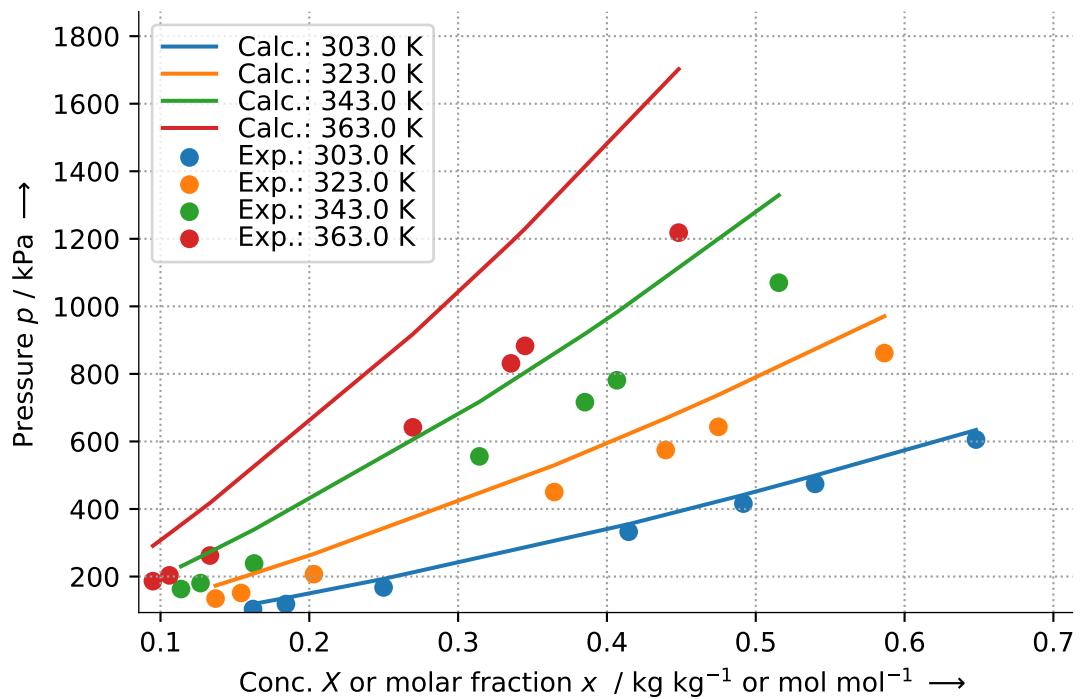
#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 363.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 28.28%.

### 6.16.13 Lubricant POE

#### 6.16.13.1 Heil - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

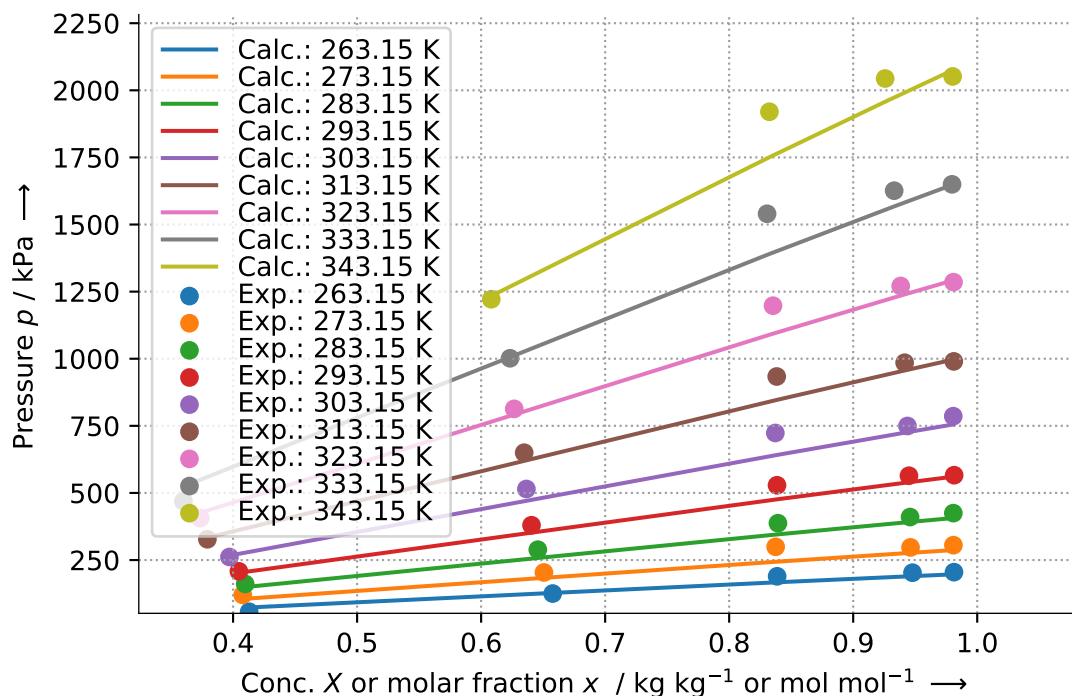
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	9.480000000e+02		$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	3.993000000e+03

Par.	Unit	Value	Par.	Unit	Value
$v_1$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.31%.

## 6.16.13.2 Heil - ID 2

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	Heil
<b>ID:</b>	2
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

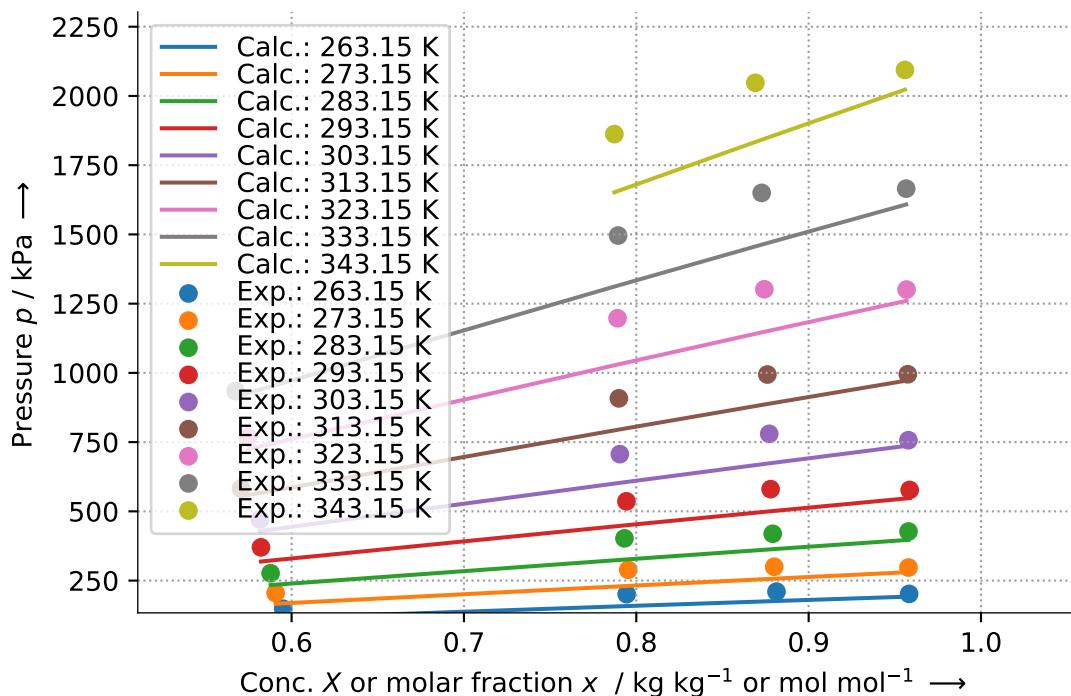
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.122000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	4.417000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $263.15\text{K} \leq T \leq 343.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 11.03%.

### 6.16.13.3 NrtlFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	NrtlFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-2.528000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	7.421000000e+03

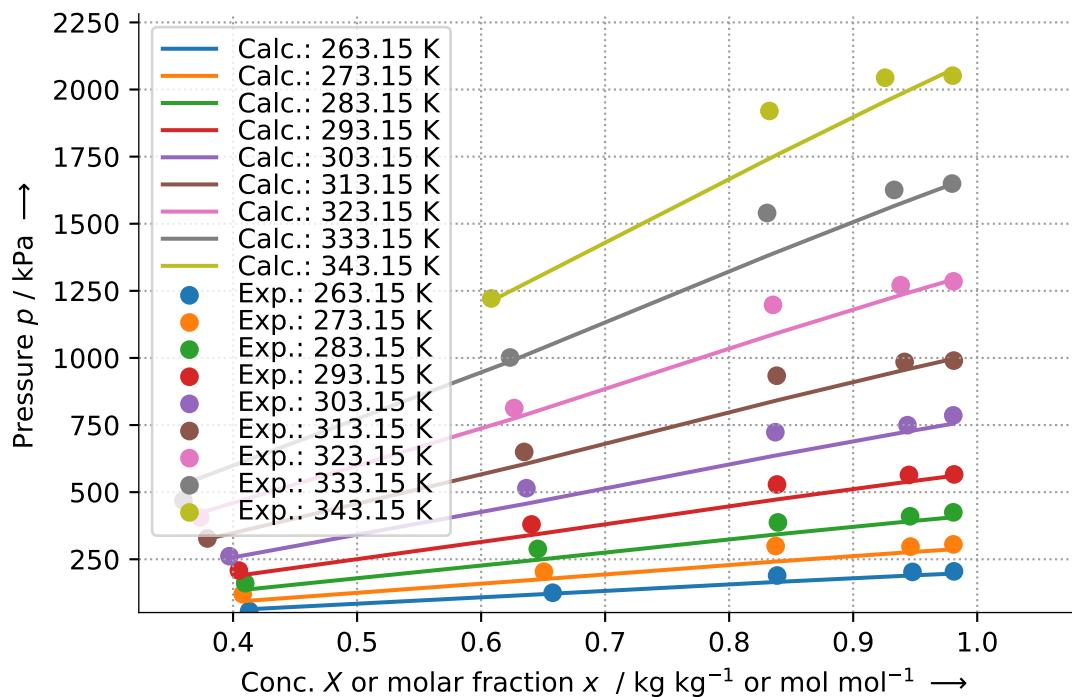
#### Validity:

Equation is approximately valid for 255.15K  $\leq T \leq$  394.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.03%.

### 6.16.13.4 NrtlFixedDg - ID 2

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	NrtlFixedDg
<b>ID:</b>	2
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-2.784000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	9.498000000e+03

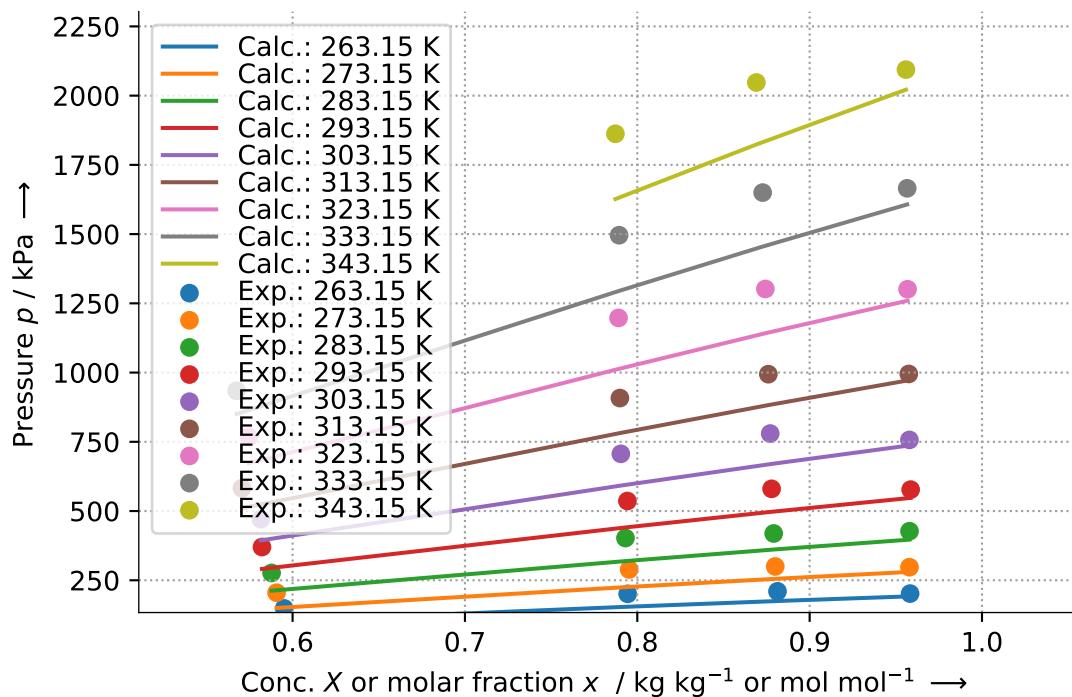
#### Validity:

Equation is approximately valid for 263.15K  $\leq T \leq$  343.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 13.28%.

### 6.16.13.5 TsubokaKatayama - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

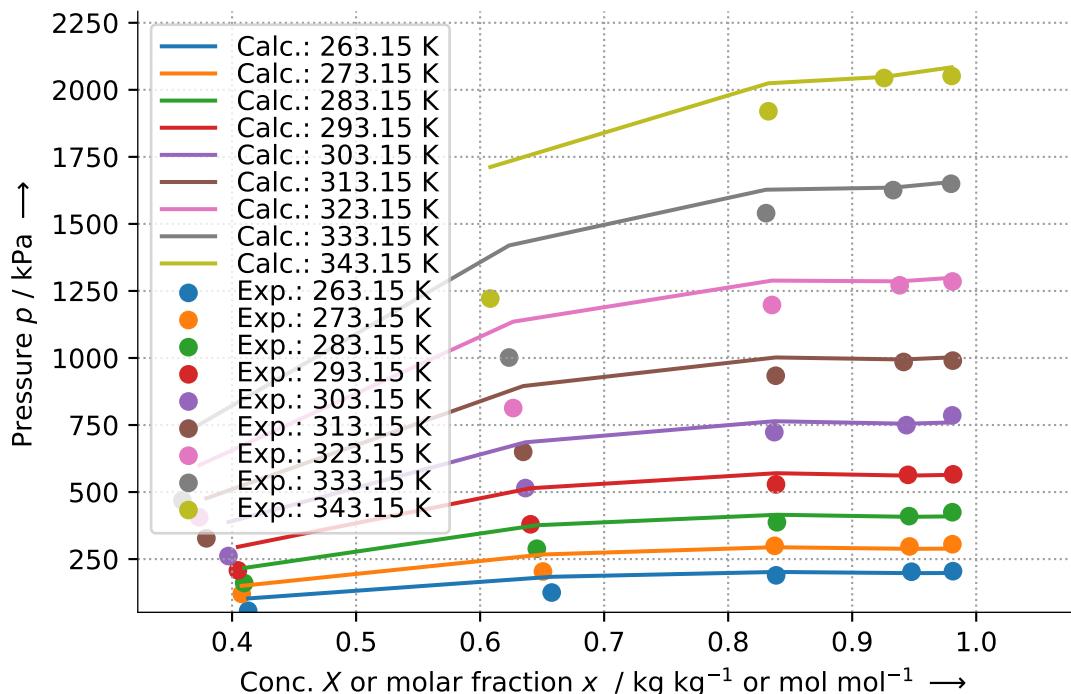
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.721000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-5.389000000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 18.15%.

### 6.16.13.6 TsubokaKatayama - ID 2

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	2
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

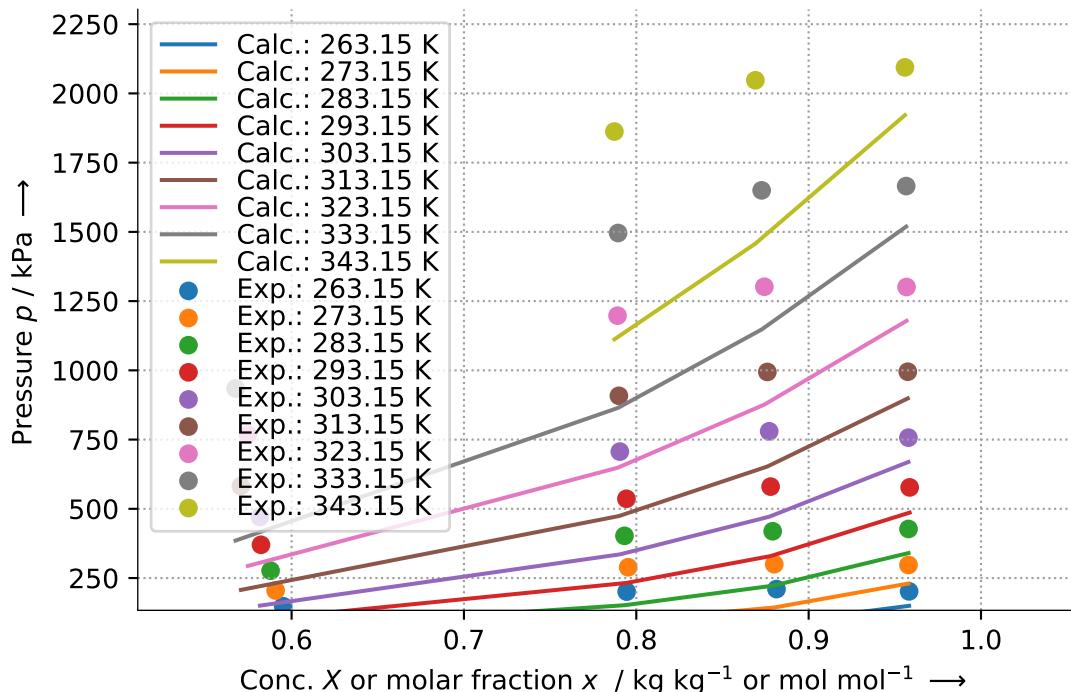
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	2.366000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-1.201300000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

Equation is approximately valid for  $263.15\text{K} \leq T \leq 343.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 44.24%.

### 6.16.13.7 UniquacFixedDu - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

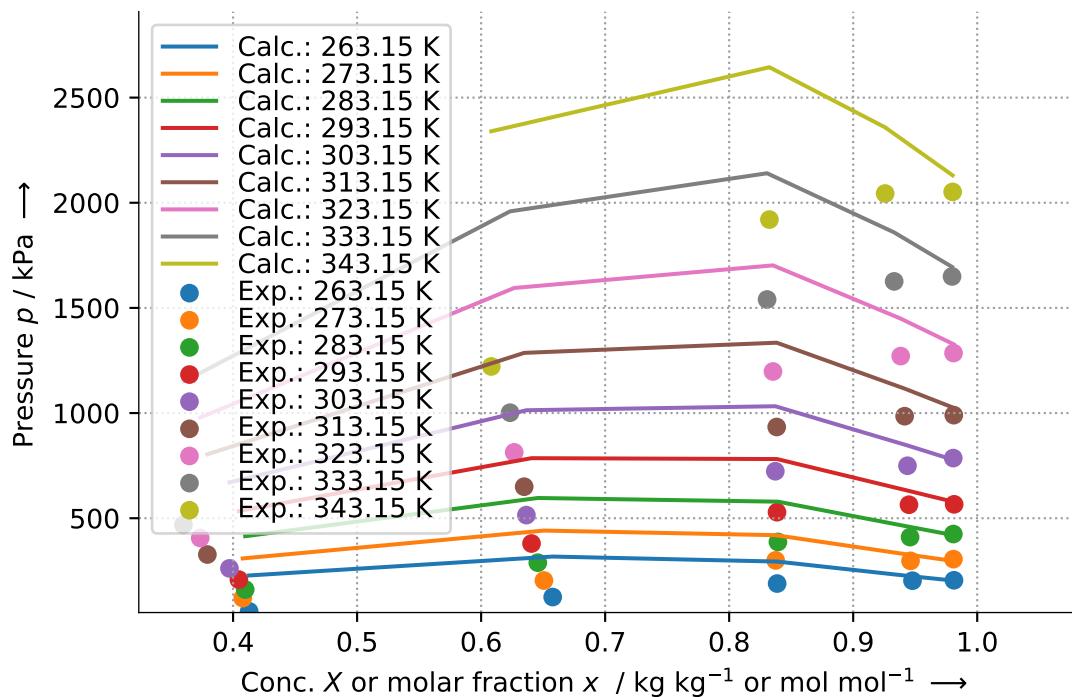
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	9.71000000e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	1.334000000e+03
$r_1$	-	2.46000000e+00	$r_2$	-	2.401000000e+01
$q_1$	-	2.36000000e+00	$q_2$	-	2.018000000e+01
$z$	-	1.00000000e+01			

#### Validity:

Equation is approximately valid for 255.15K  $\leq T \leq$  394.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 64.78%.

## 6.16.13.8 UniquacFixedDu - ID 2

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	2
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

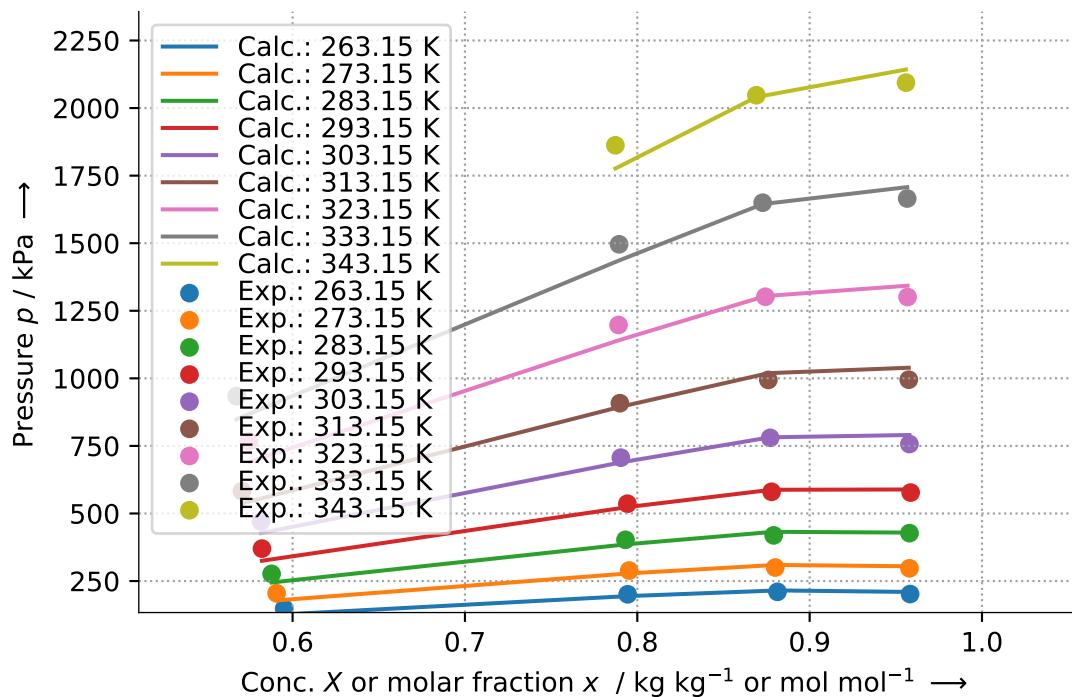
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.144000000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	7.980000000e+01
$r_1$	-	2.460000000e+00	$r_2$	-	2.940000000e+01
$q_1$	-	2.360000000e+00	$q_2$	-	2.436000000e+01
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for 263.15K  $\leq T \leq$  343.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.51%.

## 6.16.13.9 WangChao - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

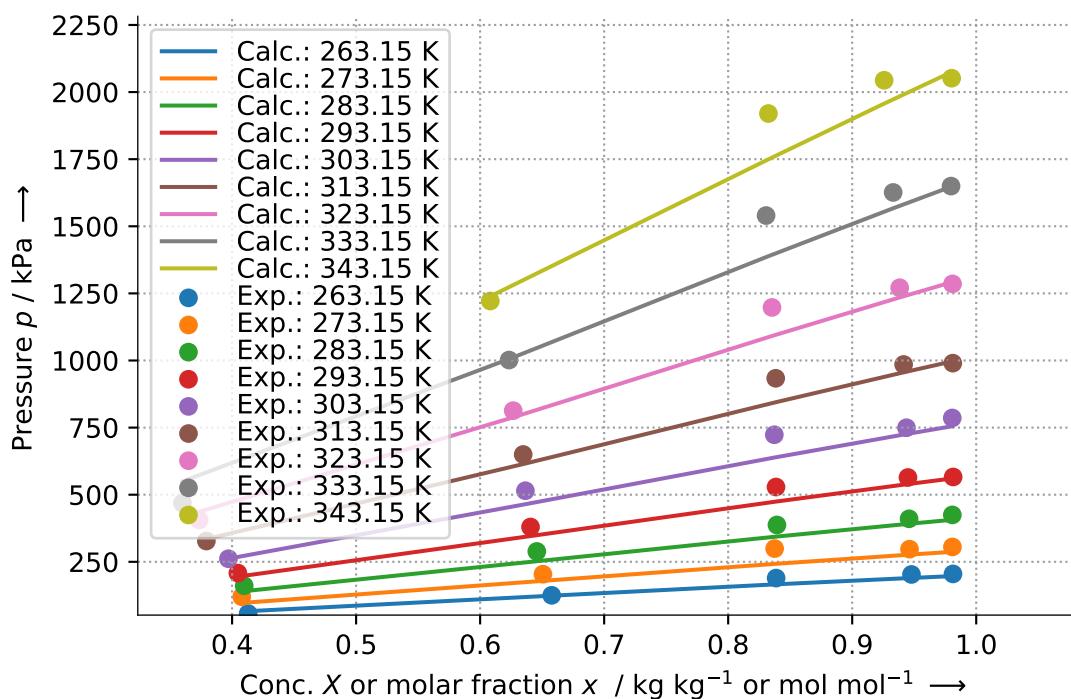
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + \frac{x_2}{x_1} \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + \frac{x_1}{x_2} \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= \frac{v_1}{v_2} && , \text{ and} \\
 \rho_{21} &= \frac{v_2}{v_1} && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	-1.360000000e+02	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	4.212000000e+03
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.78%.

## 6.16.13.10 WangChao - ID 2

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	WangChao
<b>ID:</b>	2
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

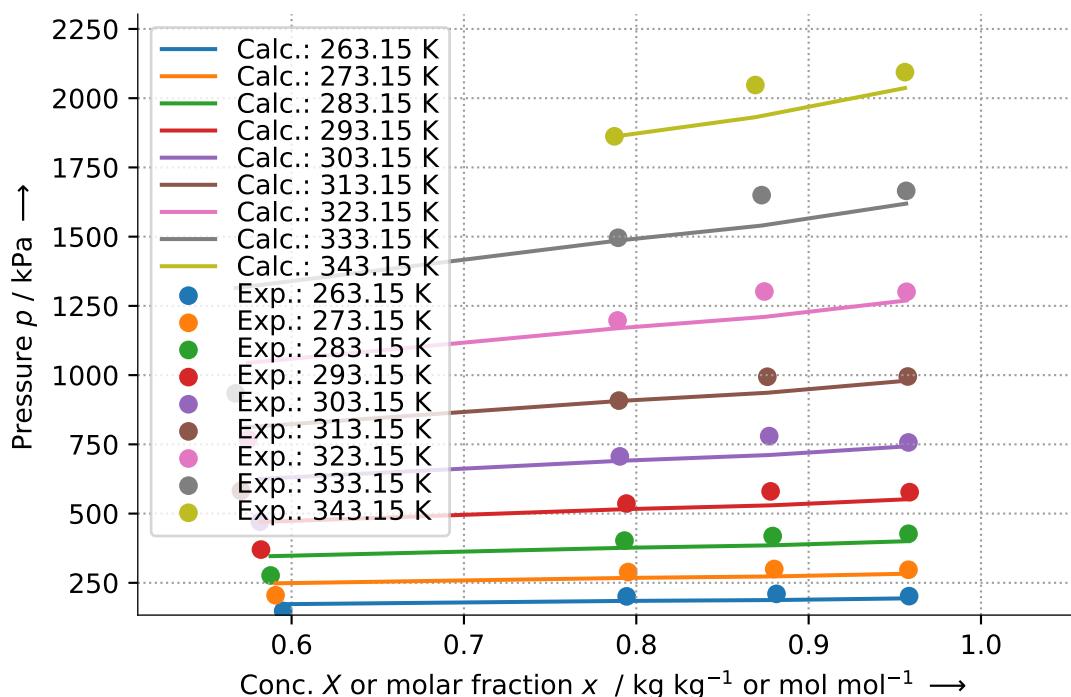
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + x_2/x_1 \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + x_1/x_2 \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	1.886000000e+03	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	2.000000000e+04
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $-263.15\text{K} \leq T \leq 343.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 10.58%.

## 6.16.13.11 WilsonFixedDI - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Grebner, J. J. (1992): The Effects of Oil on the Thermodynamic Properties of Dichlorodifluoromethane (R-12) and Tetrafluoroethane (R-134a). Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-13. Online verfügbar unter <a href="http://hdl.handle.net/2142/9702">http://hdl.handle.net/2142/9702</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

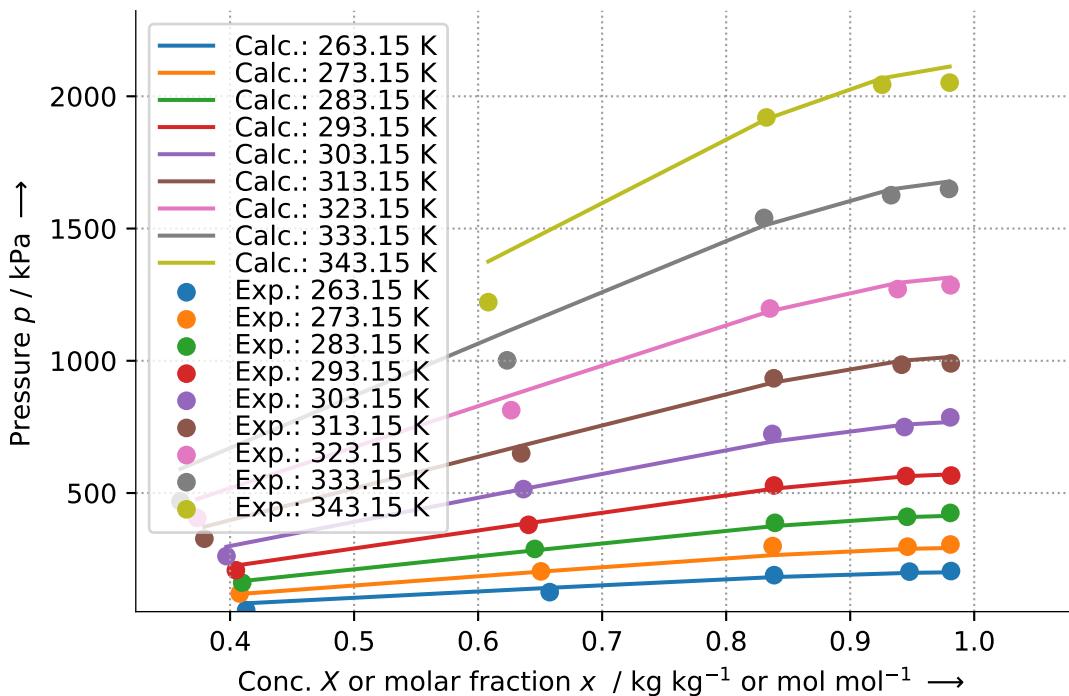
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	2.003000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	1.756900000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $255.15\text{K} \leq T \leq 394.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.58%.

## 6.16.13.12 WilsonFixedDI - ID 2

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	2
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((61.387-0.024138*((T-273.15)*1.8+32))*16.0185)*0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

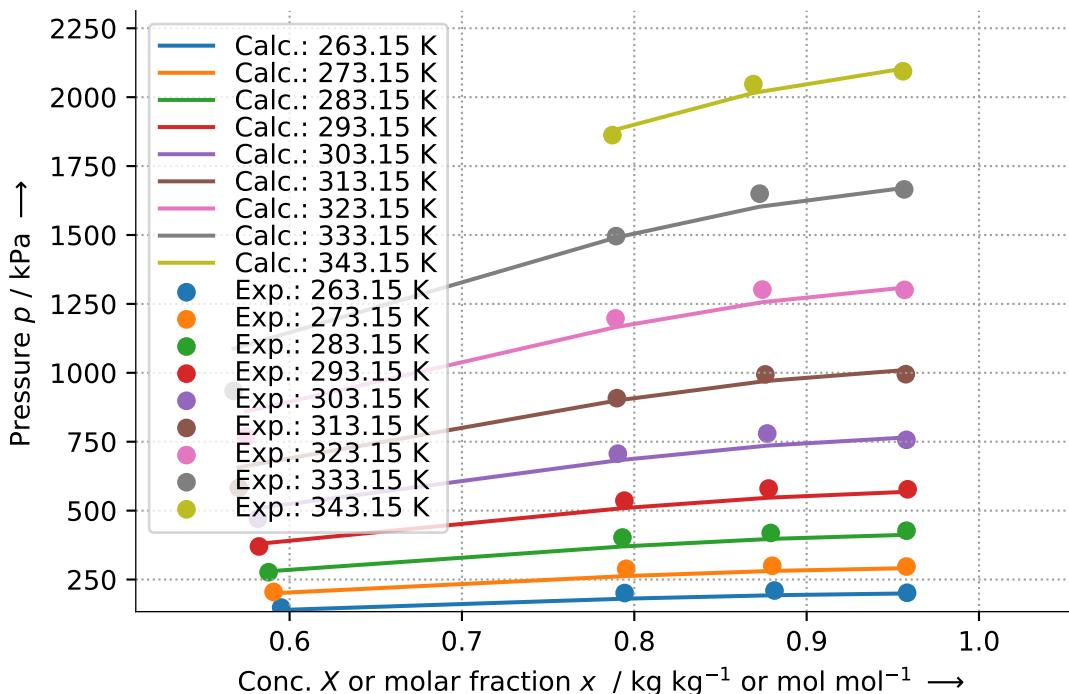
$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) \quad , \text{ and} \\ \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} \quad , \text{ and} \\ \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	2.510000000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	1.844900000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $263.15\text{K} \leq T \leq 343.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.44%.

### 6.16.14 Lubricant POE Castrol SW 46

#### 6.16.14.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE Castrol SW 46
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Fleming, J. S.; Yan, Y. (2003): The prediction of vapour–liquid equilibrium behaviour of HFC blend–oil mixtures from commonly available data. In: International Journal of Refrigeration 26 (3), S. 266–274. DOI: 10.1016/S0140-7007(02)00130-5.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	3.936000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-1.240000000e+03

#### Validity:

Equation is approximately valid for  $253.15\text{K} \leq T \leq 343.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 6.16.15 Lubricant POE32

#### 6.16.15.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE32
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

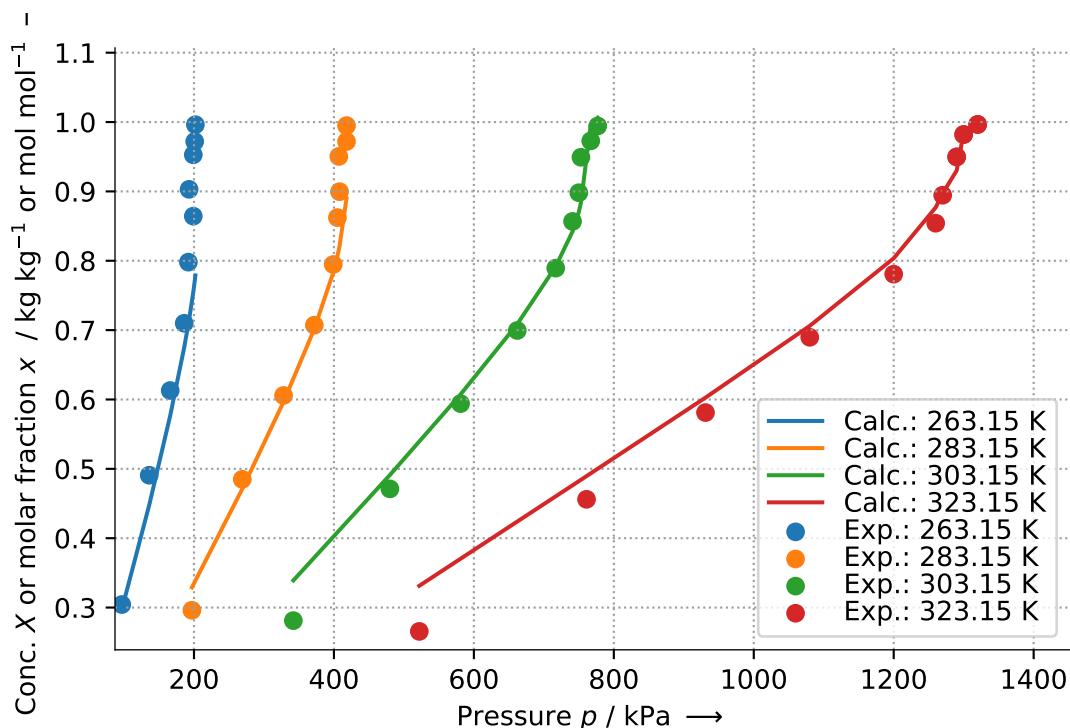
$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	8.640000000e+02
$p_{\text{crit},1}$	Pa	4.059000000e+06	$p_{\text{crit},2}$	Pa	8.740000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.002500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	5.053200000e-01	$\beta_{1,2}$	-	9.130000000e-01
$\beta_{2,1}$	-	-4.983000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.060000000e-02
$l_{12}$	-	5.610000000e-02	$l_{21}$	-	2.540000000e-02
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.73%.

### 6.16.16 Lubricant POE68

#### 6.16.16.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE68
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.742100000e+02	$T_{\text{crit},2}$	K	7.460000000e+02
$p_{\text{crit},1}$	Pa	4.059000000e+06	$p_{\text{crit},2}$	Pa	6.820000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.002500000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	5.053200000e-01	$\beta_{1,2}$	-	1.249000000e+00
$\beta_{2,1}$	-	-4.983000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.090000000e-02
$l_{12}$	-	6.780000000e-02	$l_{21}$	-	3.510000000e-02
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.16.17 Pentaerythritol tetrapentanoate ester

#### 6.16.17.1 FloryHuggins - ID 1

<b>Sorbent:</b>	pentaerythritol tetrapentanoate ester
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-134a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (1999): Solubility of HFC32, HFC125, HFC134a, HFC143a, and HFC152a in a Pentaerythritol Tetrapentanoate Ester. In: J. Chem. Eng. Data 44 (4), S. 823–828. DOI: 10.1021/je980235e.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	6.170000000e+00	$w_0^*$	K	8.780000000e+02
$w_1$	K	-2.210000000e+02			

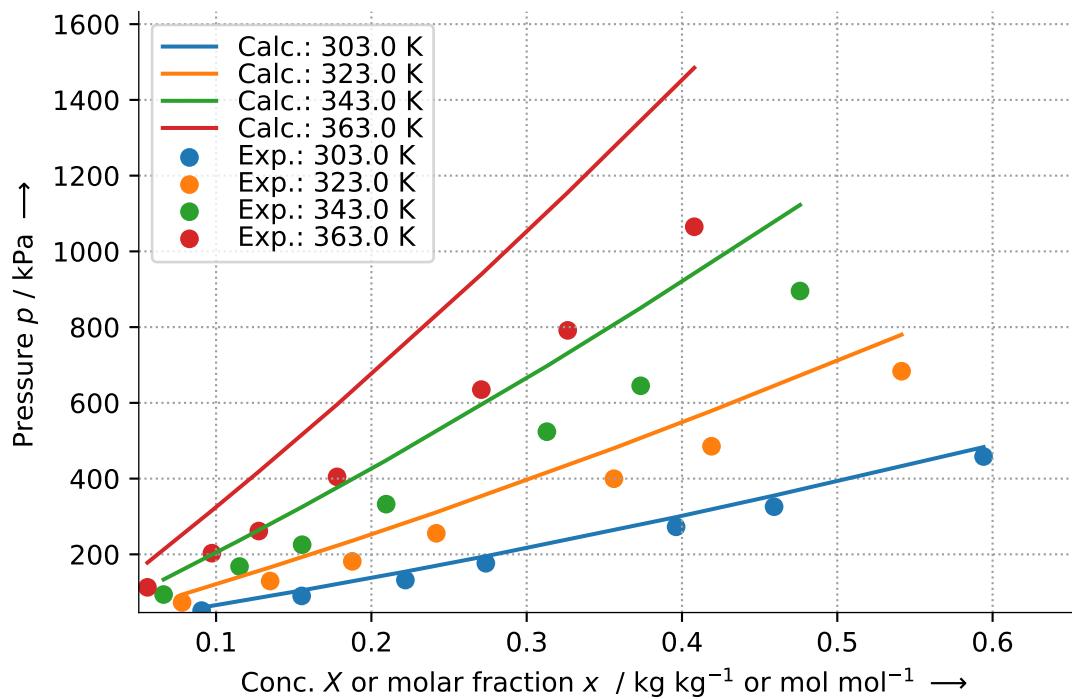
#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 363.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 30.38%.

## 6.17 R-143a

### 6.17.1 Lubricant BAB15

#### 6.17.1.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB15
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeiki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

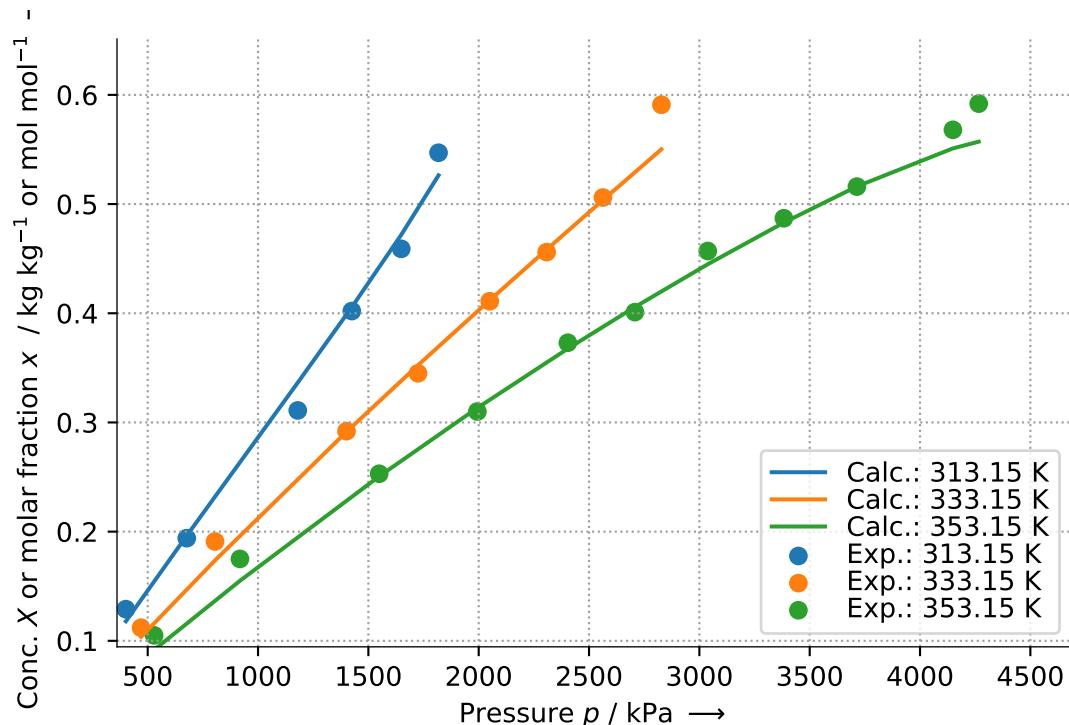
$$\begin{aligned}
 p &= R \frac{T}{v-b} - \frac{a}{v(v+b)+b(v-b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\left(T/T_{\text{crit},j}\right)}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\left(T/T_{\text{crit},j}\right)}\right) (0.7 - T/T_{\text{crit},j}) \quad , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	2.000000000e+01	Mix	-	-5.000000000e+00
$T_{\text{crit},1}$	K	3.458600000e+02	$T_{\text{crit},2}$	K	7.633500000e+02
$p_{\text{crit},1}$	Pa	3.764100000e+06	$p_{\text{crit},2}$	Pa	1.199000000e+06
$\omega_1$	-	2.604900000e-01	$\omega_2$	-	7.160750000e-01
$\kappa_{1,1}$	-	-3.990000000e-02	$\kappa_{1,2}$	-	-1.331000000e-01
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.293000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.74%.

### 6.17.2 Lubricant BAB32

#### 6.17.2.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB32
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\frac{T}{T_{\text{crit},j}}}\right) (0.7 - \frac{T}{T_{\text{crit},j}}) , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 .
 \end{aligned}$$

The parameters of the equation are:

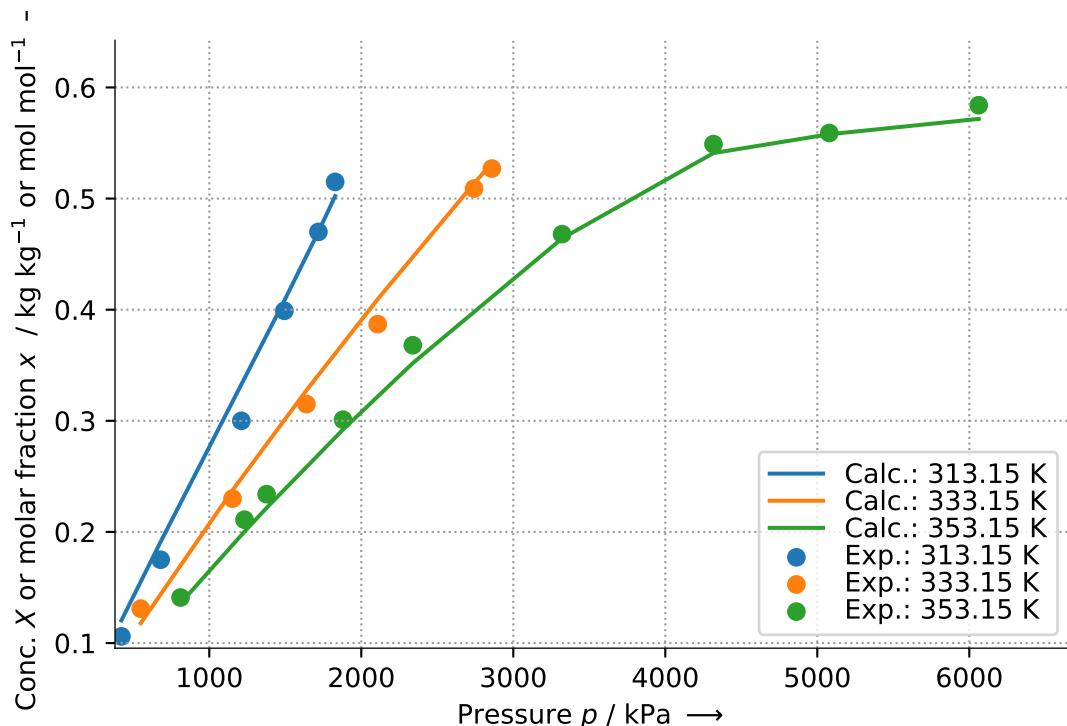
Par.	Unit	Value		Par.	Unit	Value
EoS	-	2.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	3.458600000e+02	$T_{\text{crit},2}$	K	7.728900000e+02
$p_{\text{crit},1}$	Pa	3.764100000e+06	$p_{\text{crit},2}$	Pa	1.138000000e+06
$\omega_1$	-	2.604900000e-01	$\omega_2$	-	6.947280000e-01
$\kappa_{1,1}$	-	-3.990000000e-02	$\kappa_{1,2}$	-	-9.860000000e-02
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.380000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.25%.

### 6.17.3 Lubricant HAB15

#### 6.17.3.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HAB15
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.462000000e+02	$T_{\text{crit},2}$	K	7.550000000e+02
$p_{\text{crit},1}$	Pa	3.759000000e+06	$p_{\text{crit},2}$	Pa	1.145000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000600000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.587400000e-01	$\beta_{1,2}$	-	9.500000000e-01
$\beta_{2,1}$	-	-4.846000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.430000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-9.000000000e-02
$l_{12}$	-	5.800000000e-02	$l_{21}$	-	9.040000000e-02
$t$	-	-3.680000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.17.4 Lubricant HC16

#### 6.17.4.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HC16
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.462000000e+02	$T_{\text{crit},2}$	K	7.170000000e+02
$p_{\text{crit},1}$	Pa	3.759000000e+06	$p_{\text{crit},2}$	Pa	1.419000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000600000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.587400000e-01	$\beta_{1,2}$	-	7.310000000e-01
$\beta_{2,1}$	-	-4.846000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.430000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.544000000e-01
$l_{12}$	-	1.167000000e-01	$l_{21}$	-	1.167000000e-01
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.17.5 Lubricant PEB6

#### 6.17.5.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB6
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	4.310000000e+00	$w_0^*$	K	7.720000000e+02
$w_1$	K	-1.990000000e+02			

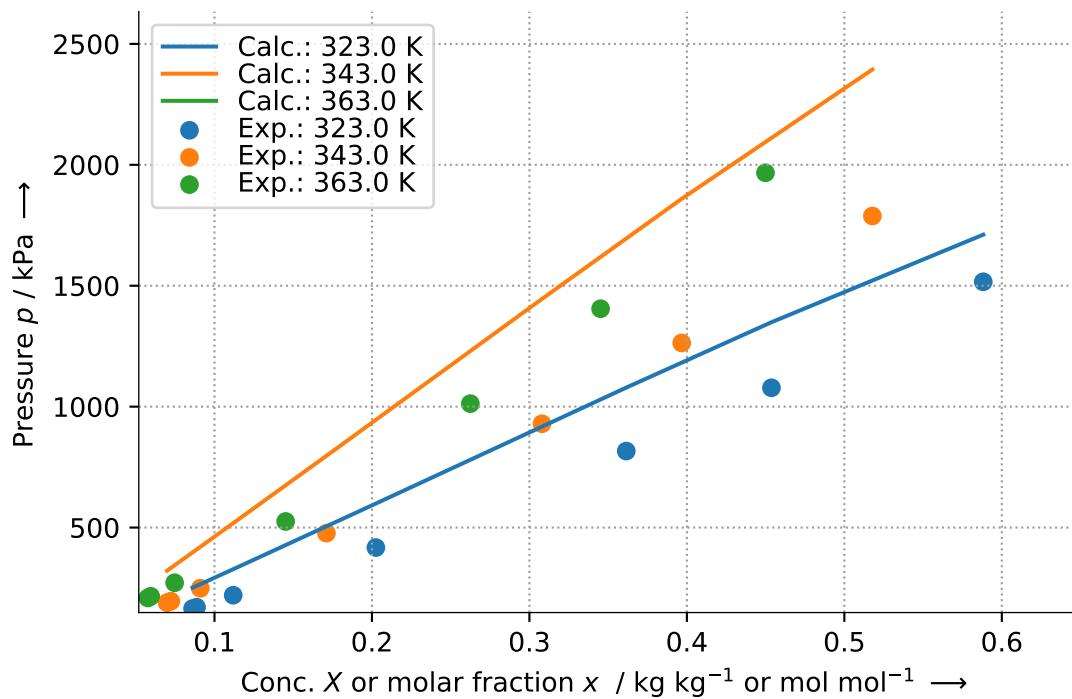
#### Validity:

Equation is approximately valid for 323.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 48.49%.

### 6.17.6 Lubricant PEB8

#### 6.17.6.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	5.760000000e+00	$w_0^*$	K	7.030000000e+02
$w_1$	K	-1.620000000e+02			

#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 6.17.6.2 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.462000000e+02	$T_{\text{crit},2}$	K	7.930000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	3.759000000e+06	$p_{\text{crit},2}$	Pa	7.720000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.000600000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.587400000e-01	$\beta_{1,2}$	-	9.410000000e-01
$\beta_{2,1}$	-	-4.846000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	-1.430000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	9.590000000e-02
$l_{12}$	-	-8.450000000e-02	$l_{21}$	-	-9.340000000e-02
$t$	-	-4.190000000e+01			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.17.7 Lubricant PEC9

#### 6.17.7.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEC9
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	7.790000000e+00	$w_0^*$	K	8.170000000e+02
$w_1$	K	-1.520000000e+02			

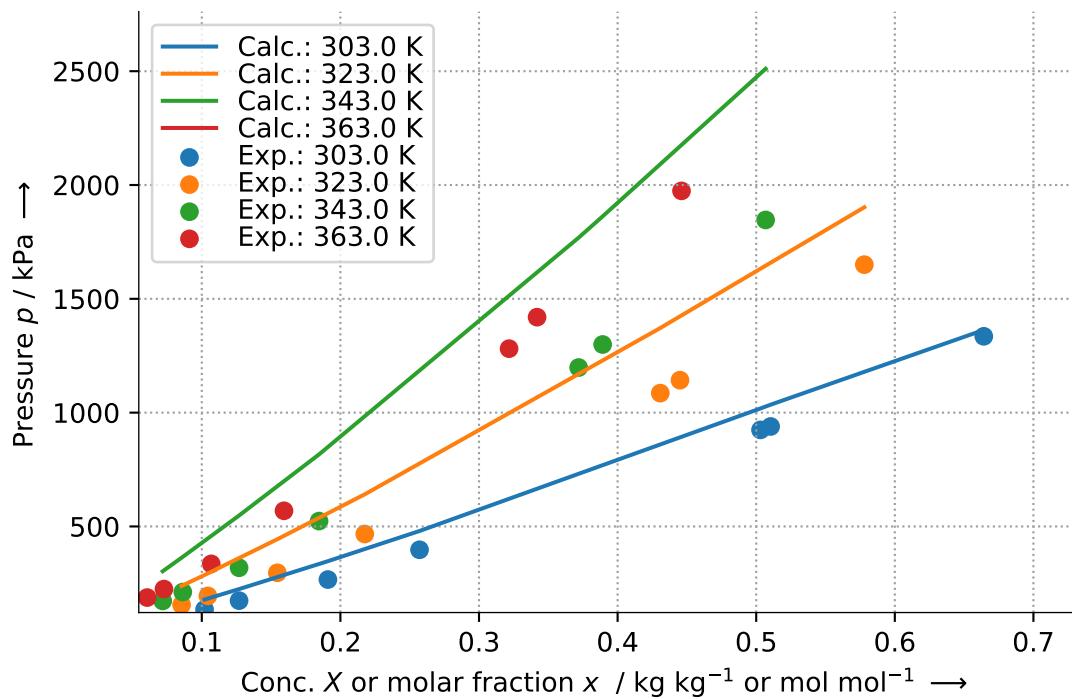
#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 37.87%.

### 6.17.8 Pentaerythritol tetrapentanoate ester

#### 6.17.8.1 FloryHuggins - ID 1

<b>Sorbent:</b>	pentaerythritol tetrapentanoate ester
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-143a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (1999): Solubility of HFC32, HFC125, HFC134a, HFC143a, and HFC152a in a Pentaerythritol Tetrapentanoate Ester. In: J. Chem. Eng. Data 44 (4), S. 823–828. DOI: 10.1021/je980235e.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= \frac{x_2}{r \frac{x_2}{x_1 + rx_2}} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	5.280000000e+00	$w_0^*$	K	8.490000000e+02
$w_1$	K	-1.830000000e+02			

#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 363.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 6.18 R-152a

### 6.18.1 Lubricant HC16

#### 6.18.1.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HC16
<b>Refrigerant:</b>	R-152a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.864400000e+02	$T_{\text{crit},2}$	K	7.170000000e+02
$p_{\text{crit},1}$	Pa	4.520000000e+06	$p_{\text{crit},2}$	Pa	1.419000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001200000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.849500000e-01	$\beta_{1,2}$	-	7.310000000e-01
$\beta_{2,1}$	-	-8.508000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	1.460000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.254000000e-01
$l_{12}$	-	7.880000000e-02	$l_{21}$	-	9.000000000e-02
$t$	-	3.490000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.18.2 Lubricant PEB6

#### 6.18.2.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB6
<b>Refrigerant:</b>	R-152a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	5.190000000e+00	$w_0^*$	K	4.910000000e+02
$w_1$	K	-2.050000000e+02			

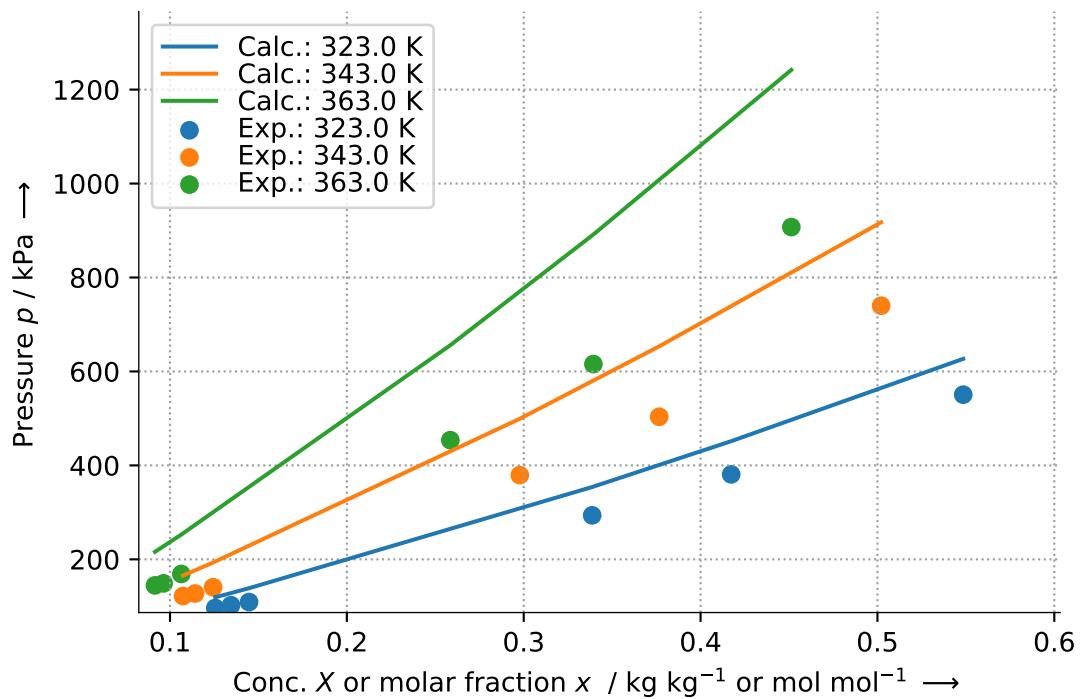
#### Validity:

Equation is approximately valid for 323.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS\_Cubic - ID 1
- Saturated liquid density: NoSaturatedLiquidDensity - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 33.59%.

### 6.18.3 Lubricant PEB8

#### 6.18.3.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-152a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	9.760000000e+00	$w_0^*$	K	7.070000000e+02
$w_1$	K	-1.690000000e+02			

#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

### 6.18.3.2 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-152a
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.864400000e+02	$T_{\text{crit},2}$	K	7.930000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	4.520000000e+06	$p_{\text{crit},2}$	Pa	7.720000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001200000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.849500000e-01	$\beta_{1,2}$	-	9.410000000e-01
$\beta_{2,1}$	-	-8.508000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	1.460000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	9.400000000e-02
$l_{12}$	-	-6.560000000e-02	$l_{21}$	-	-8.200000000e-02
$t$	-	-1.450000000e+01			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.18.4 Lubricant PEC9

#### 6.18.4.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEC9
<b>Refrigerant:</b>	R-152a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	1.003000000e+01	$w_0^*$	K	6.540000000e+02
$w_1$	K	-1.520000000e+02			

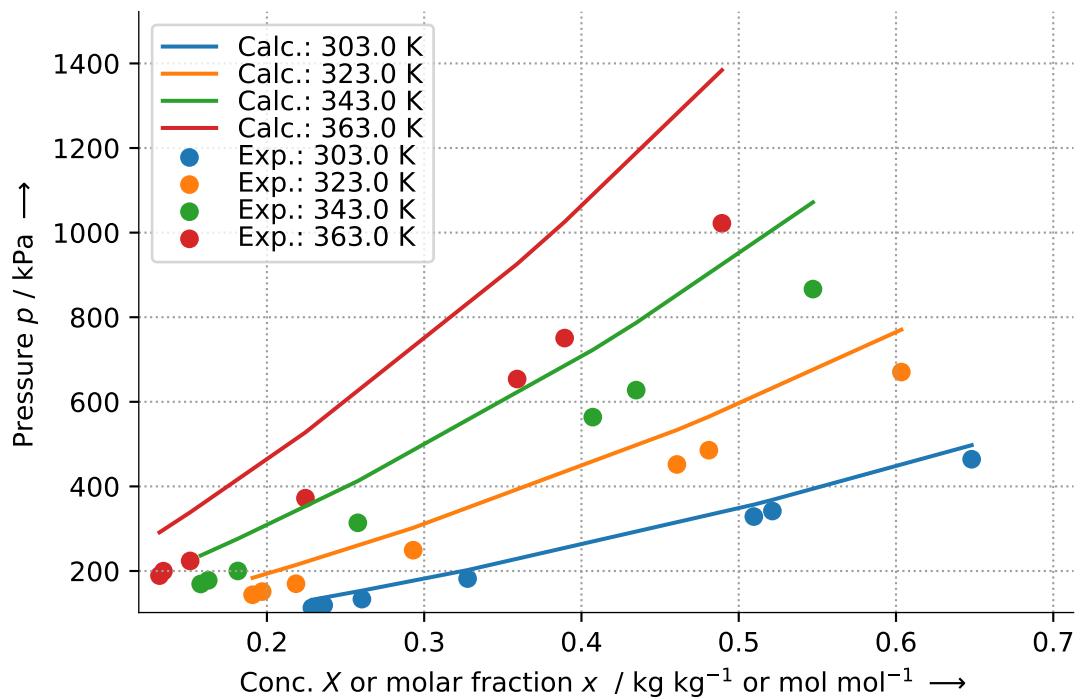
#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS\_Cubic - ID 1
- Saturated liquid density: NoSaturatedLiquidDensity - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 27.35%.

### 6.18.5 Pentaerythritol tetrapentanoate ester

#### 6.18.5.1 FloryHuggins - ID 1

<b>Sorbent:</b>	pentaerythritol tetrapentanoate ester
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-152a
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (1999): Solubility of HFC32, HFC125, HFC134a, HFC143a, and HFC152a in a Pentaerythritol Tetrapentanoate Ester. In: J. Chem. Eng. Data 44 (4), S. 823–828. DOI: 10.1021/je980235e.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= \frac{x_2}{r \frac{x_2}{x_1 + rx_2}} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	4.620000000e+00	$w_0^*$	K	4.820000000e+02
$w_1$	K	-2.040000000e+02			

#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 363.15\text{K}$ .

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 6.19 R-22

### 6.19.1 Lubricant AB32

#### 6.19.1.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	AB32
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.691700000e+02	$T_{\text{crit},2}$	K	8.570000000e+02
$p_{\text{crit},1}$	Pa	4.978000000e+06	$p_{\text{crit},2}$	Pa	1.015000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001100000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.329500000e-01	$\beta_{1,2}$	-	8.920000000e-01
$\beta_{2,1}$	-	-6.214000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	1.500000000e-02	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-3.950000000e-02
$l_{12}$	-	5.690000000e-02	$l_{21}$	-	6.940000000e-02
$t$	-	3.290000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.19.2 Lubricant POE

#### 6.19.2.1 Heil - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

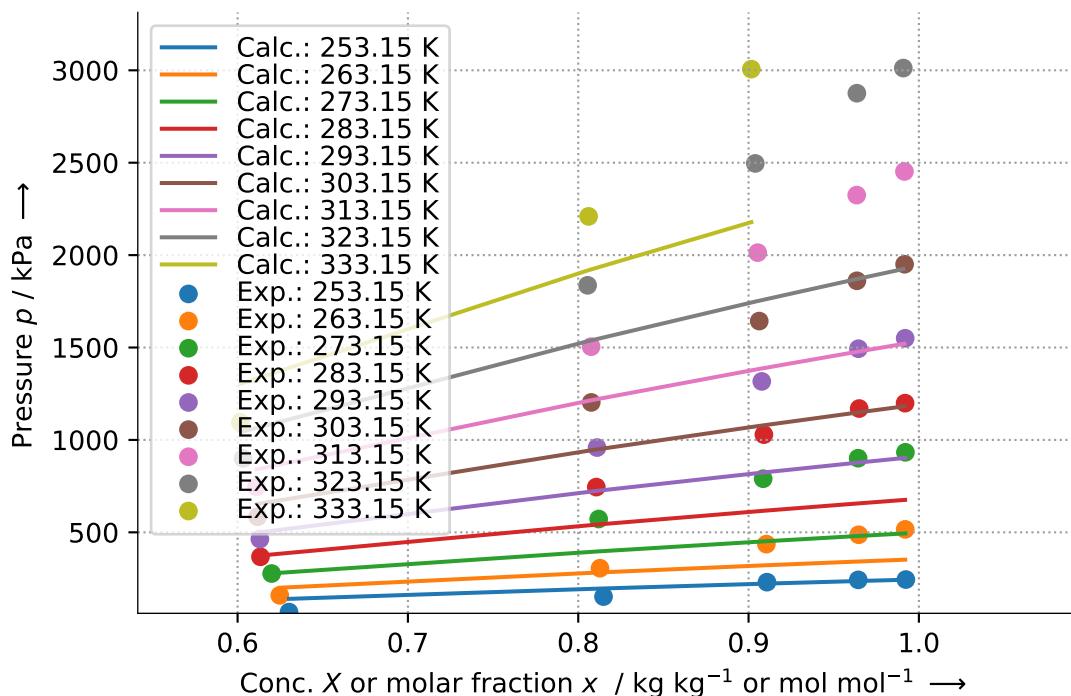
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	-2.240000000e+02		$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	6.371000000e+03

Par.	Unit	Value	Par.	Unit	Value
$v_1$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $253.15\text{K} \leq T \leq 333.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 28.25%.

### 6.19.2.2 NRTLFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-4.709000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-9.670000000e+02

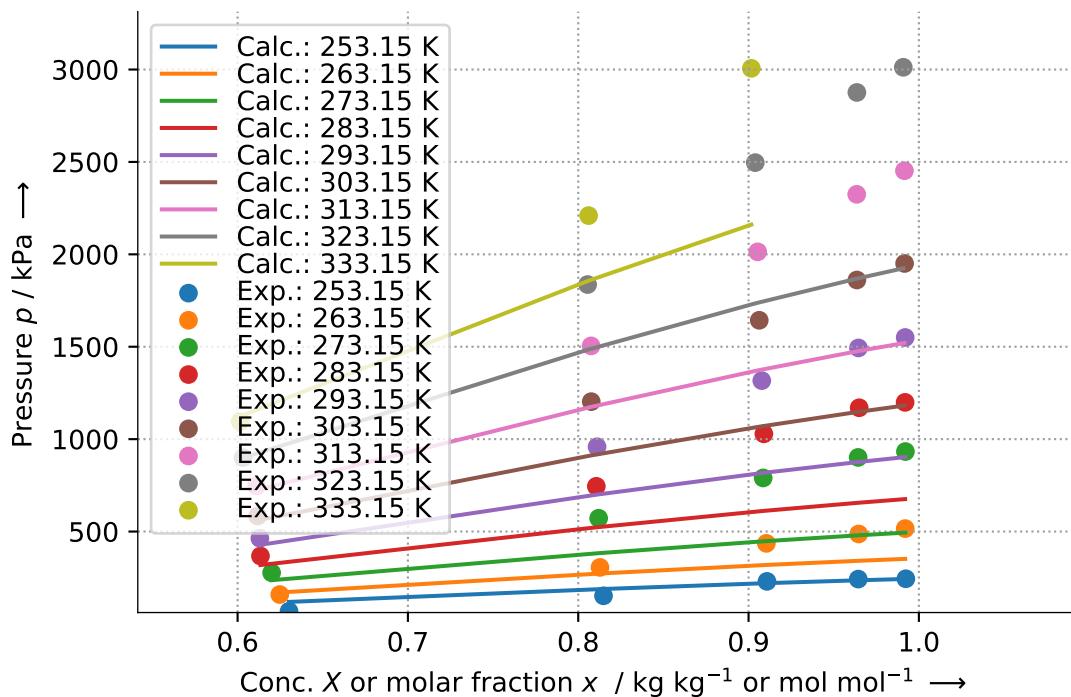
#### Validity:

Equation is approximately valid for 253.15K  $\leq T \leq$  333.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 27.05%.

### 6.19.2.3 TsubokaKatayama - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

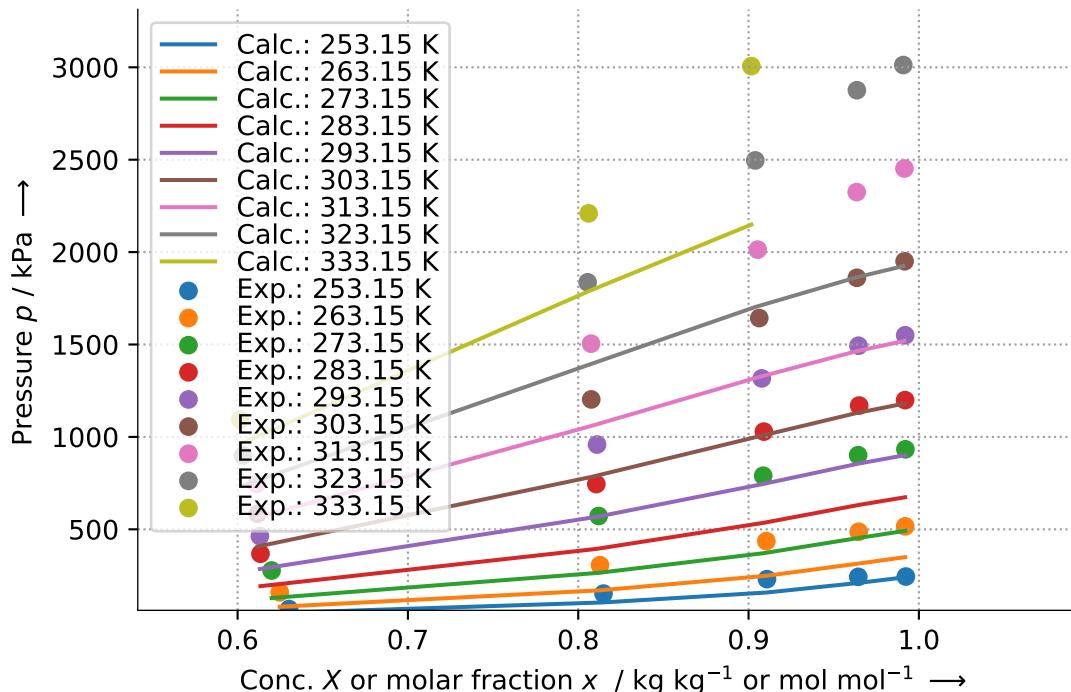
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	-8.890000000e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-1.147200000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

#### Validity:

Equation is approximately valid for  $253.15\text{K} \leq T \leq 333.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 36.26%.

### 6.19.2.4 UniquacFixedDu - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

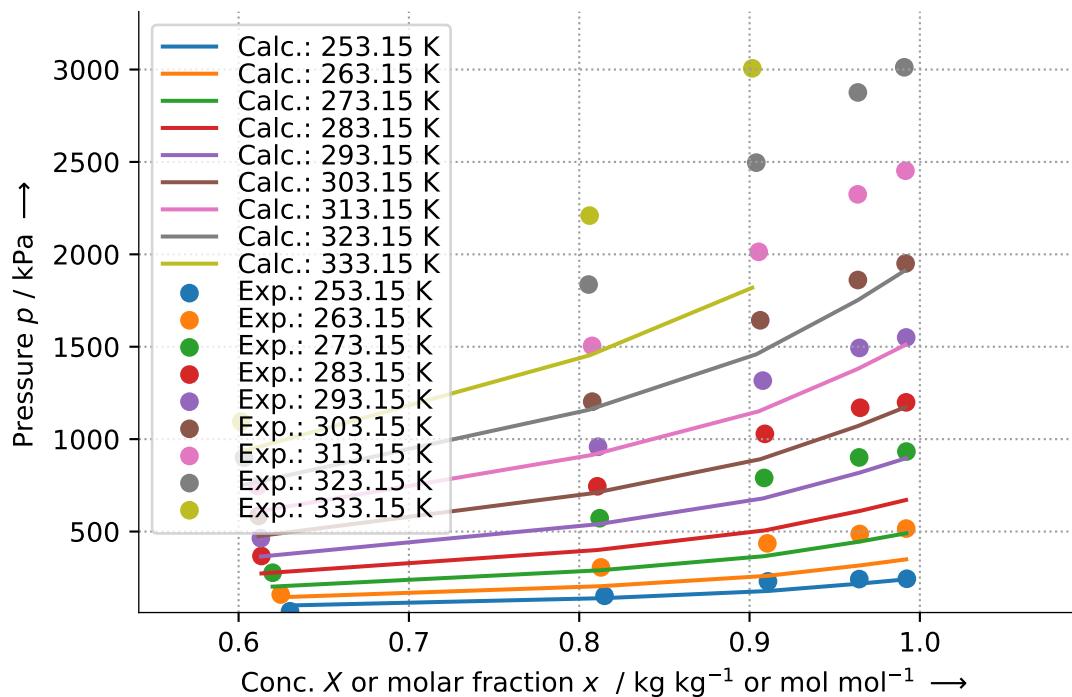
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-1.366000000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	4.115000000e+03
$r_1$	-	1.590000000e+00	$r_2$	-	2.940000000e+01
$q_1$	-	1.390000000e+00	$q_2$	-	2.436000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 253.15K  $\leq T \leq$  333.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 35.06%.

## 6.19.2.5 WangChao - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1 / ((61.387 - 0.024138 * ((T - 273.15) * 1.8 + 32)) * 16.0185) * 0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

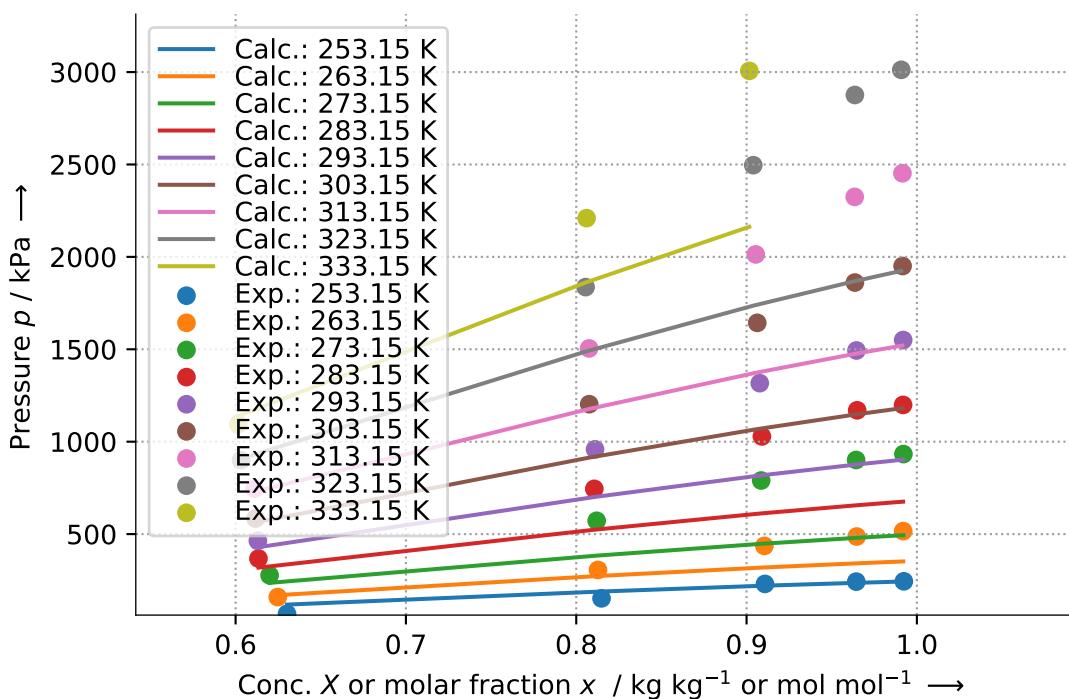
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + x_2/x_1 \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + x_1/x_2 \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	-1.070000000e+03	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	5.716000000e+03
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for 253.15K  $\leq T \leq$  333.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 27.01%.

## 6.19.2.6 WilsonFixedDI - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Martz, W. L.; Jacobi, A. M. (1994): Refrigerant-Oil Mixtures and Local Composition Modeling. Hg. v. Air Conditioning and Refrigeration Center. College of Engineering. University of Illinois at Urbana-Champaign. Air Conditioning and Refrigeration Center TR-68. Online verfügbar unter <a href="http://hdl.handle.net/2142/10986">http://hdl.handle.net/2142/10986</a> .
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/((61.387-0.024138*((T-273.15)*1.8+32))*16.0185)*0.59$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

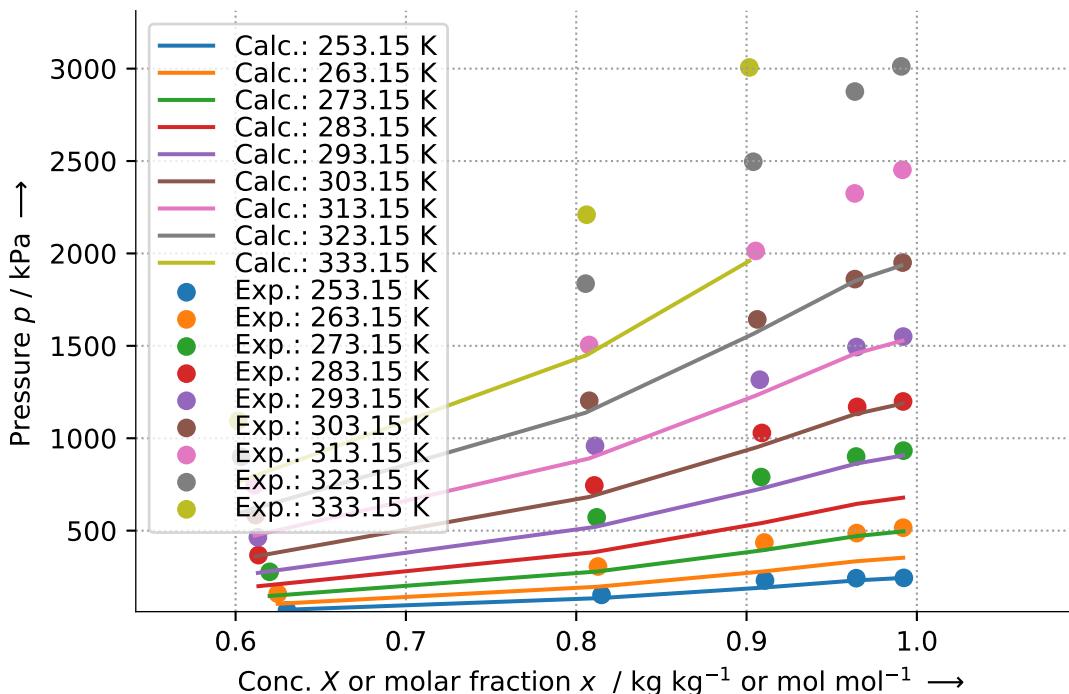
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) \quad , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} \quad , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	-4.030000000e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	2.000000000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

Equation is approximately valid for  $253.15\text{K} \leq T \leq 333.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from figure
- Pressure, absolute, in Pa → 3.45E+02
- Temperature, absolute, in K → 0.12

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 36.48%.

### 6.19.3 Lubricant POE Castrol SW 46

#### 6.19.3.1 NrtlFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE Castrol SW 46
<b>Refrigerant:</b>	R-22
<b>Equation:</b>	NrtlFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Fleming, J. S.; Yan, Y. (2003): The prediction of vapour–liquid equilibrium behaviour of HFC blend–oil mixtures from commonly available data. In: International Journal of Refrigeration 26 (3), S. 266–274. DOI: 10.1016/S0140-7007(02)00130-5.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	2.818000000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-4.620000000e+03

#### Validity:

Equation is approximately valid for 253.15K  $\leq T \leq$  343.15K.

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 6.20 R-23

### 6.20.1 1-phenyloctane

#### 6.20.1.1 MixingRule - ID 1

<b>Sorbent:</b>	1-Phenyloctane
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-23
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Bogatu, Cristina; Geană, Dan; Vîlcu, Rodica; Duță, Anca; Poot, Wim; Loos, Theo W. de (2010): Fluid phase equilibria in the binary system trifluoromethane+1-phenyloctane. In: Fluid Phase Equilibria 295 (2), S. 186–193. DOI: 10.1016/j.fluid.2010.04.013.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

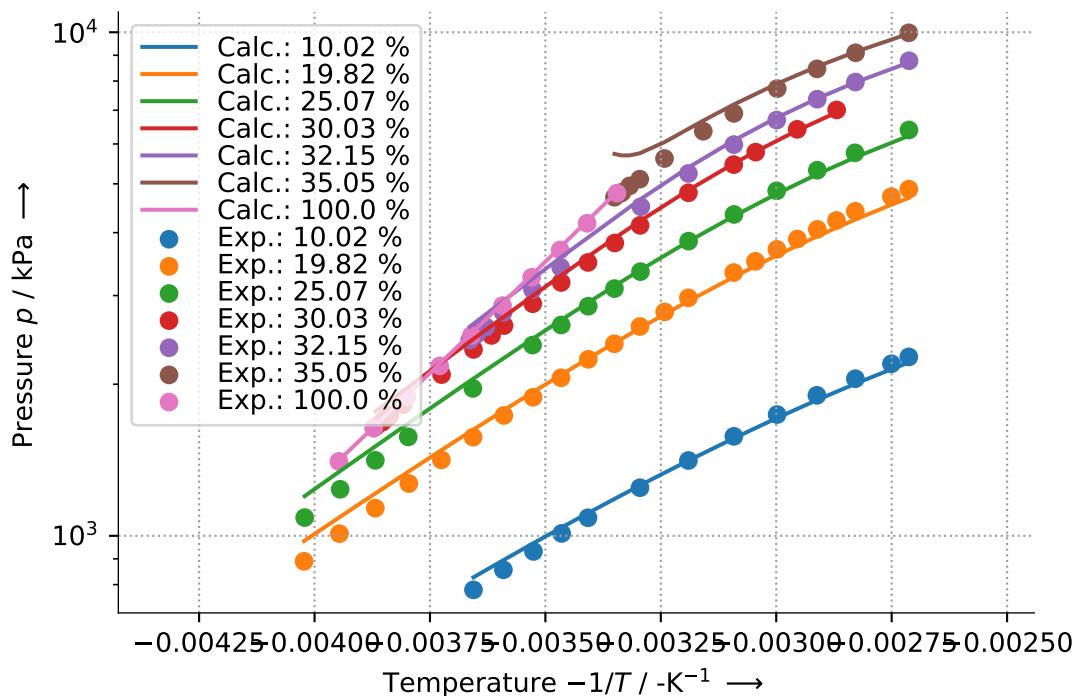
$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.37464 + 1.54226 \omega_j - 0.26992 \omega_j^2 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	1.000000000e+01	Mix	-	5.000000000e+00
$T_{\text{crit},1}$	K	2.993000000e+02	$T_{\text{crit},2}$	K	7.250000000e+02
$p_{\text{crit},1}$	Pa	4.858000000e+06	$p_{\text{crit},2}$	Pa	1.980000000e+06
$\omega_1$	-	2.670000000e-01	$\omega_2$	-	5.720000000e-01
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.480000000e-01	$m$	-	-1.400000000e-02
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $253.15\text{K} \leq T \leq 368.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 3.00E+03
- Temperature, absolute, in K → 0.01
- Concentration / Molar fraction, absolute, in kg kg<sup>-1</sup> / mol mol<sup>-1</sup> → 1.00E-03

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.79%.

### 6.20.1.2 MixingRule - ID 2

<b>Sorbent:</b>	1-Phenyl octane
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-23
<b>Equation:</b>	MixingRule
<b>ID:</b>	2
<b>Reference:</b>	Bogatu, Cristina; Geană, Dan; Vîlcu, Rodica; Duță, Anca; Poot, Wim; Loos, Theo W. de (2010): Fluid phase equilibria in the binary system trifluoromethane+1-phenyl octane. In: Fluid Phase Equilibria 295 (2), S. 186–193. DOI: 10.1016/j.fluid.2010.04.013.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 \quad , \text{ and} \\
 \kappa_j &= 0.48508 + 1.55171 \omega_j - 0.15613 \omega_j^2 \quad .
 \end{aligned}$$

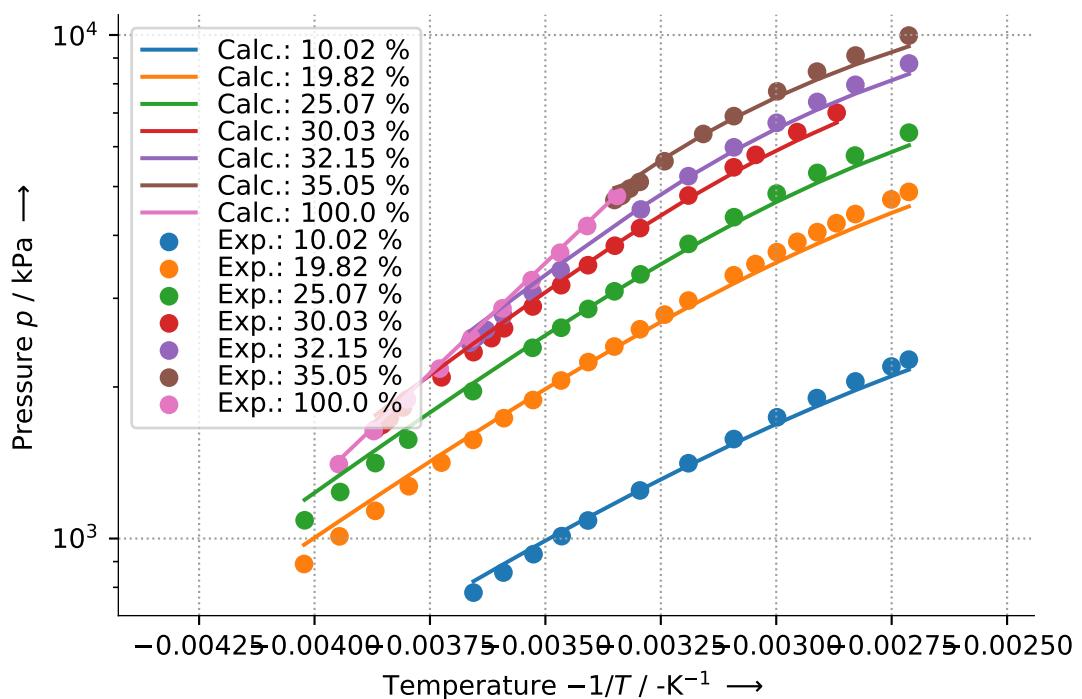
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-5.000000000e+00	Mix	-	5.000000000e+00
$T_{\text{crit},1}$	K	2.993000000e+02	$T_{\text{crit},2}$	K	7.250000000e+02
$p_{\text{crit},1}$	Pa	4.858000000e+06	$p_{\text{crit},2}$	Pa	1.980000000e+06
$\omega_1$	-	2.670000000e-01	$\omega_2$	-	5.720000000e-01

Par.	Unit	Value	Par.	Unit	Value
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.500000000e-01	$m$	-	-1.300000000e-02
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $253.15\text{K} \leq T \leq 368.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

- Pressure, absolute, in Pa → 3.00E+03
- Temperature, absolute, in K → 0.01
- Concentration / Molar fraction, absolute, in kg kg<sup>-1</sup> / mol mol<sup>-1</sup> → 1.00E-03

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.47%.

## 6.21 R-32

### 6.21.1 R-125

#### 6.21.1.1 Heil - ID 1

<b>Sorbent:</b>	R-125
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	8.780000000e+01		$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	1.100000000e+01

Par.	Unit	Value		Par.	Unit	Value
$v_1$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00		$v_2$	$\text{m}^3 \text{ mol}^{-1}$	1.000000000e+00

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.21.1.2 NRTLFixedDg - ID 1

<b>Sorbent:</b>	R-125
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	2.375000000e+02	$\Delta g_{21}$	J mol <sup>-1</sup>	-3.981000000e+02

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.21.1.3 TsubokaKatayama - ID 1

<b>Sorbent:</b>	R-125
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) & , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) & , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) & , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) & , \text{ and} \\
 \rho_{12} &= v_1/v_2 & , \text{ and} \\
 \rho_{21} &= v_2/v_1 & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	-6.940000000e+01	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	-1.010000000e+01
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.21.1.4 UniquacFixedDu - ID 1

<b>Sorbent:</b>	R-125
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) \quad , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) \quad , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) \quad , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) \quad , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} \quad , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	1.256000000e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	9.000000000e-01
$r_1$	-	1.430000000e+00	$r_2$	-	2.610000000e+00
$q_1$	-	1.420000000e+00	$q_2$	-	2.490000000e+00
$z$	-	1.000000000e+01			

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 6.21.1.5 WangChao - ID 1

<b>Sorbent:</b>	R-125
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta\lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta\lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + x_2/x_1 \exp(-\Delta\lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + x_1/x_2 \exp(-\Delta\lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta\lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta\lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	7.870000000e+01	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	0.000000000e+00
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	1.000000000e+01			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.21.1.6 WilsonFixedDI - ID 1

<b>Sorbent:</b>	R-125
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.907000000e+02	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	4.000000000e-01
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.21.2 Lubricant BAB15

#### 6.21.2.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB15
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeiki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\frac{T}{T_{\text{crit},j}}}\right) (0.7 - \frac{T}{T_{\text{crit},j}}) , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 .
 \end{aligned}$$

The parameters of the equation are:

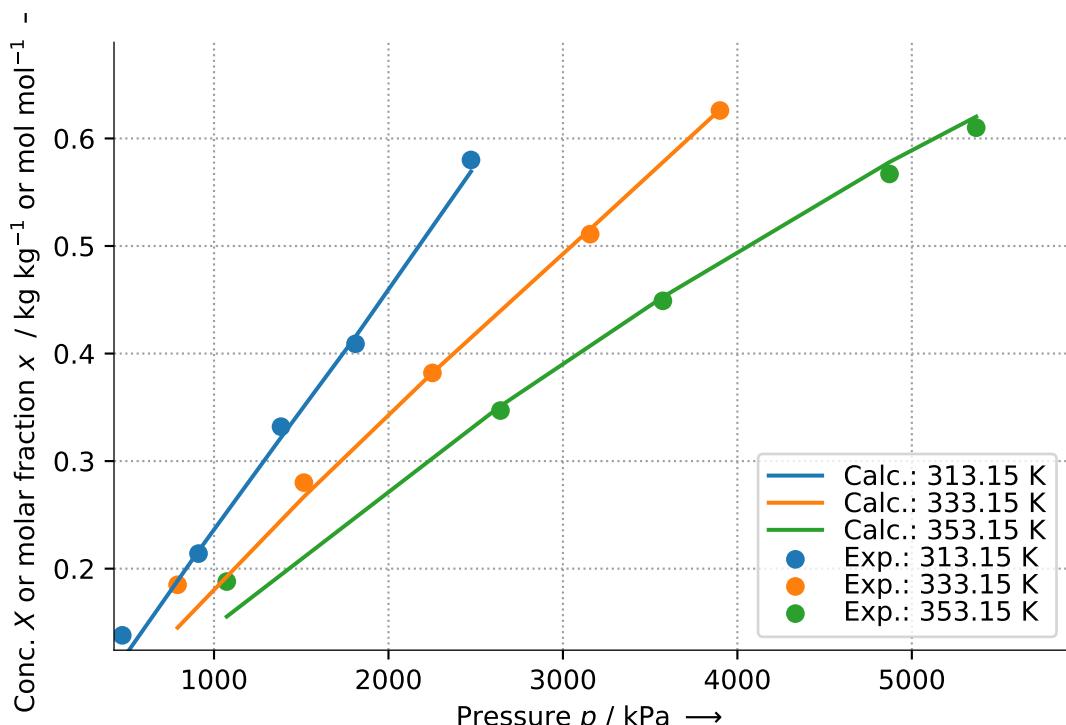
Par.	Unit	Value		Par.	Unit	Value
EoS	-	2.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	3.512550000e+02	$T_{\text{crit},2}$	K	7.633500000e+02
$p_{\text{crit},1}$	Pa	5.782000000e+06	$p_{\text{crit},2}$	Pa	1.199000000e+06
$\omega_1$	-	2.768000000e-01	$\omega_2$	-	7.160750000e-01
$\kappa_{1,1}$	-	-4.990000000e-02	$\kappa_{1,2}$	-	-1.331000000e-01
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.339000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

### Validity:

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.96%.

### 6.21.3 Lubricant BAB32

#### 6.21.3.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	BAB32
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Takigawa, Katsuya; Sandler, Stanley I.; Yokozeiki, Akimichi (2002): Solubility and viscosity of refrigerant/lubricant mixtures. Hydrofluorocarbon/alkylbenzene systems. In: International Journal of Refrigeration 25 (8), S. 1014–1024. DOI: 10.1016/S0140-7007(02)00025-7.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b) + b(v - b)} , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 , \text{ and} \\
 b &= z_1 b_1 + z_2 b_2 , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 - k_{12}) , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} , \text{ and} \\
 a_j &= 0.45724 \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j , \text{ and} \\
 b_j &= 0.07780 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} , \text{ and} \\
 \alpha_j &= \left(1 + \kappa_j \left(1 - \sqrt{\frac{T}{T_{\text{crit},j}}}\right)\right)^2 , \text{ and} \\
 \kappa_j &= \kappa_{0,j} + \kappa_{1,j} \left(1 + \sqrt{\frac{T}{T_{\text{crit},j}}}\right) (0.7 - \frac{T}{T_{\text{crit},j}}) , \text{ and} \\
 \kappa_{0,j} &= 0.378893 + 1.4897153 \omega_j - 0.17131848 \omega_j^2 + 0.0196554 \omega_j^3 .
 \end{aligned}$$

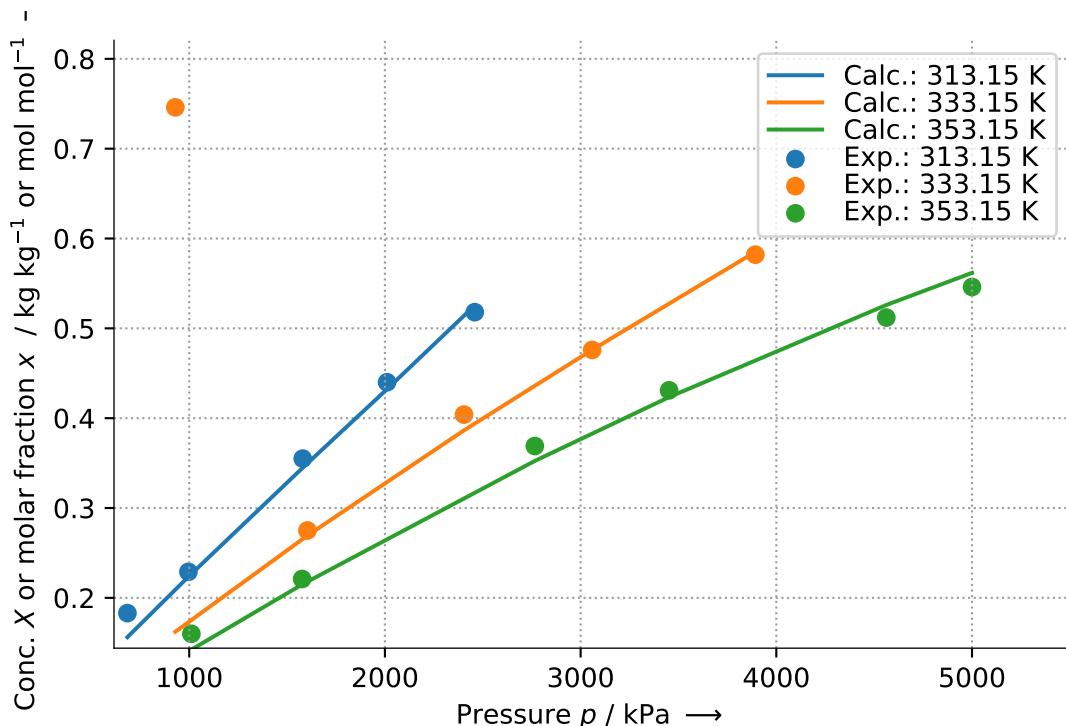
The parameters of the equation are:

Par.	Unit	Value		Par.	Unit	Value
EoS	-	2.000000000e+01		Mix	-	-5.000000000e+00

Par.	Unit	Value	Par.	Unit	Value
$T_{\text{crit},1}$	K	3.512550000e+02	$T_{\text{crit},2}$	K	7.728900000e+02
$p_{\text{crit},1}$	Pa	5.782000000e+06	$p_{\text{crit},2}$	Pa	1.138000000e+06
$\omega_1$	-	2.768000000e-01	$\omega_2$	-	6.947280000e-01
$\kappa_{1,1}$	-	-4.990000000e-02	$\kappa_{1,2}$	-	-9.860000000e-02
$\beta_{0,1}$	-	0.000000000e+00	$\beta_{0,2}$	-	0.000000000e+00
$\beta_{1,1}$	-	0.000000000e+00	$\beta_{1,2}$	-	0.000000000e+00
$\beta_{2,1}$	-	0.000000000e+00	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	0.000000000e+00	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	1.457000000e-01	$m$	-	0.000000000e+00
$l_{12}$	-	0.000000000e+00	$l_{21}$	-	0.000000000e+00
$t$	-	0.000000000e+00			

**Validity:**

Equation is approximately valid for  $313.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 8.37%.

### 6.21.4 Lubricant HAB32

#### 6.21.4.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	HAB32
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.512600000e+02	$T_{\text{crit},2}$	K	7.580000000e+02
$p_{\text{crit},1}$	Pa	5.782000000e+06	$p_{\text{crit},2}$	Pa	1.073000000e+06
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001900000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.833300000e-01	$\beta_{1,2}$	-	1.115000000e+00
$\beta_{2,1}$	-	-7.538000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	6.730000000e-03	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	-1.536000000e-01
$l_{12}$	-	1.276000000e-01	$l_{21}$	-	1.422000000e-01
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.21.5 Lubricant PEB6

#### 6.21.5.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB6
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	7.770000000e+00	$w_0^*$	K	6.800000000e+02
$w_1$	K	-2.090000000e+02			

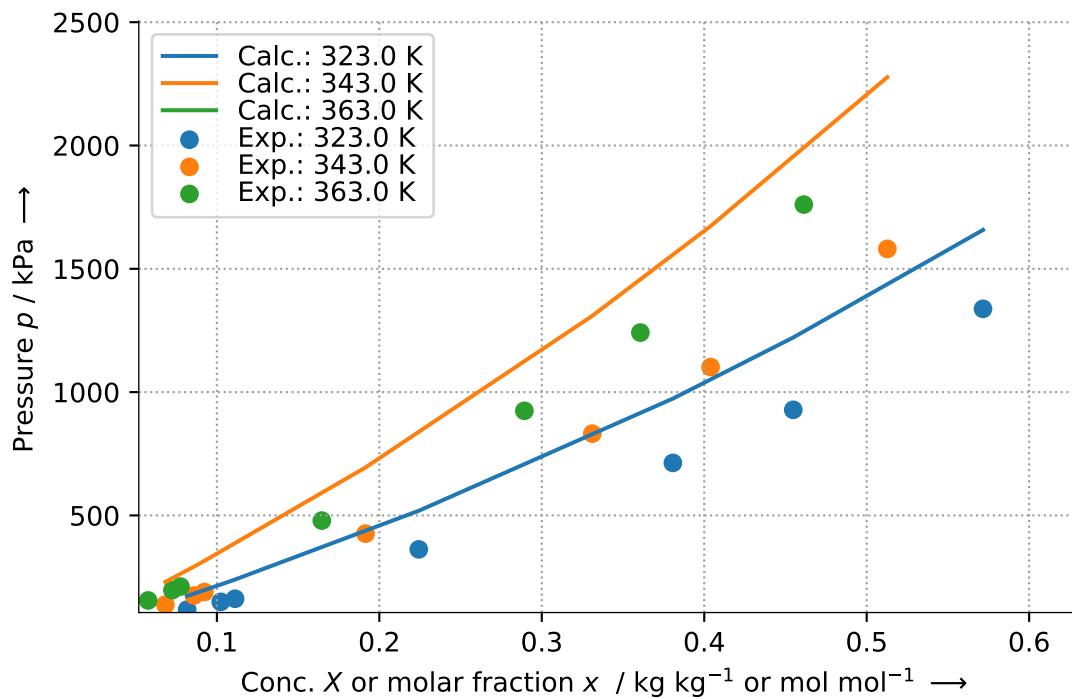
#### Validity:

Equation is approximately valid for 323.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 49.56%.

### 6.21.6 Lubricant PEB8

#### 6.21.6.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	1.158000000e+01	$w_0^*$	K	7.750000000e+02
$w_1$	K	-1.770000000e+02			

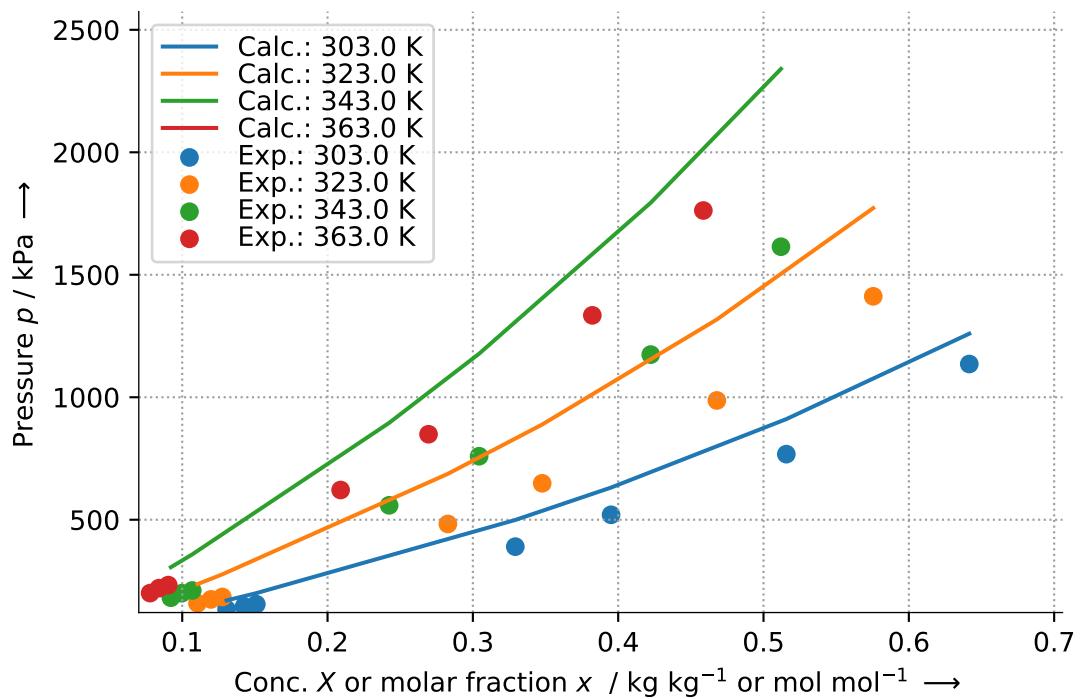
#### Validity:

Equation is approximately valid for 303.15K  $\leq T \leq$  363.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 41.26%.

### 6.21.6.2 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEB8
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.512600000e+02	$T_{\text{crit},2}$	K	7.930000000e+02

Par.	Unit	Value	Par.	Unit	Value
$p_{\text{crit},1}$	Pa	5.782000000e+06	$p_{\text{crit},2}$	Pa	7.720000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001900000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.833300000e-01	$\beta_{1,2}$	-	9.410000000e-01
$\beta_{2,1}$	-	-7.538000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	6.730000000e-03	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	1.210000000e-02
$l_{12}$	-	2.005800000e+01	$l_{21}$	-	6.980000000e-02
$t$	-	-7.820000000e+01			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.21.7 Lubricant PEC9

#### 6.21.7.1 FloryHuggins - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	PEC9
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (2000): Solubility of HFCs in Pentaerythritol Tetraalkyl Esters. In: J. Chem. Eng. Data 45 (1), S. 97–103. DOI: 10.1021/je990171n.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	1.493000000e+01	$w_0^*$	K	8.390000000e+02
$w_1$	K	-1.580000000e+02			

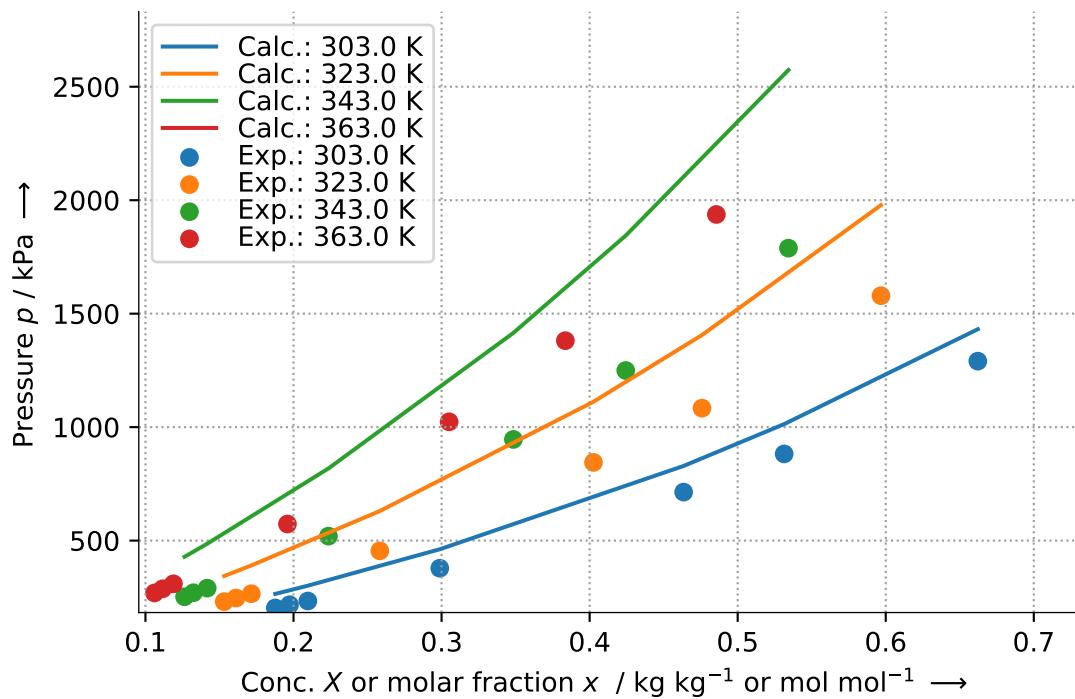
#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 363.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 39.22%.

### 6.21.8 Lubricant POE

#### 6.21.8.1 Heil - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	Heil
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/(993.89 - 0.75658*(T-273.15))^*0.7$ in $\text{m}^3/\text{mol}$ ), for calculations.

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Delta\Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= x_2^2 \left( \tau_{12} \left( \frac{\Lambda_{21}}{x_1 + \Delta\Lambda_{21}x_2} \right)^2 + \tau_{12} \frac{\Lambda_{12}}{(x_1\Lambda_{12} + x_2)^2} \right) && , \text{ and} \\
 \Delta\Lambda_{12} &= v_2/v_1 \exp(-\tau_{12}) && , \text{ and} \\
 \Delta\Lambda_{21} &= v_1/v_2 \exp(-\tau_{21}) && , \text{ and} \\
 \tau_{12} &= \lambda_{12}/RT && , \text{ and} \\
 \tau_{21} &= \lambda_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

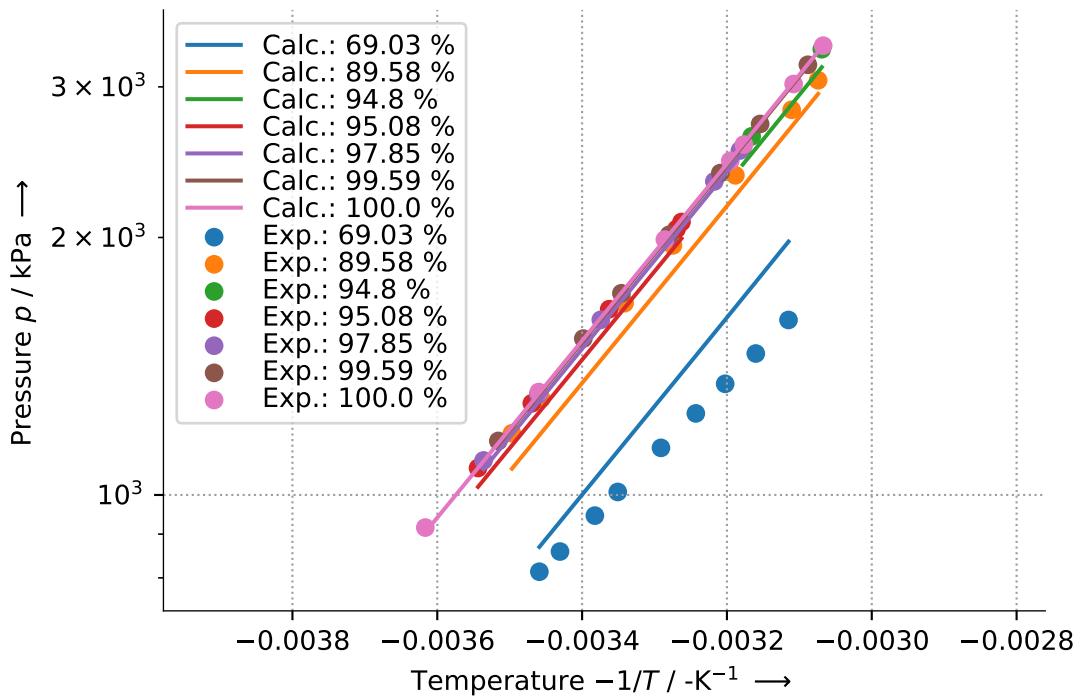
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\Lambda_{12}$	$\text{J mol}^{-1}$	1.204500000e+03	$\Delta\Lambda_{21}$	$\text{J mol}^{-1}$	6.706600000e+03
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

No data on validity available!

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 1730 Pa for  $p < 3.45$  bar | 17300 Pa for  $p < 34.5$  bar
- Temperature, absolute, in K → 0.21
- Concentration / Molar fraction, relative, in % → 4

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.23%.

### 6.21.8.2 NRTLFixedDg - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	5.000000000e-01	$\alpha_{21}$	-	5.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-2.852100000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	2.000000000e+04

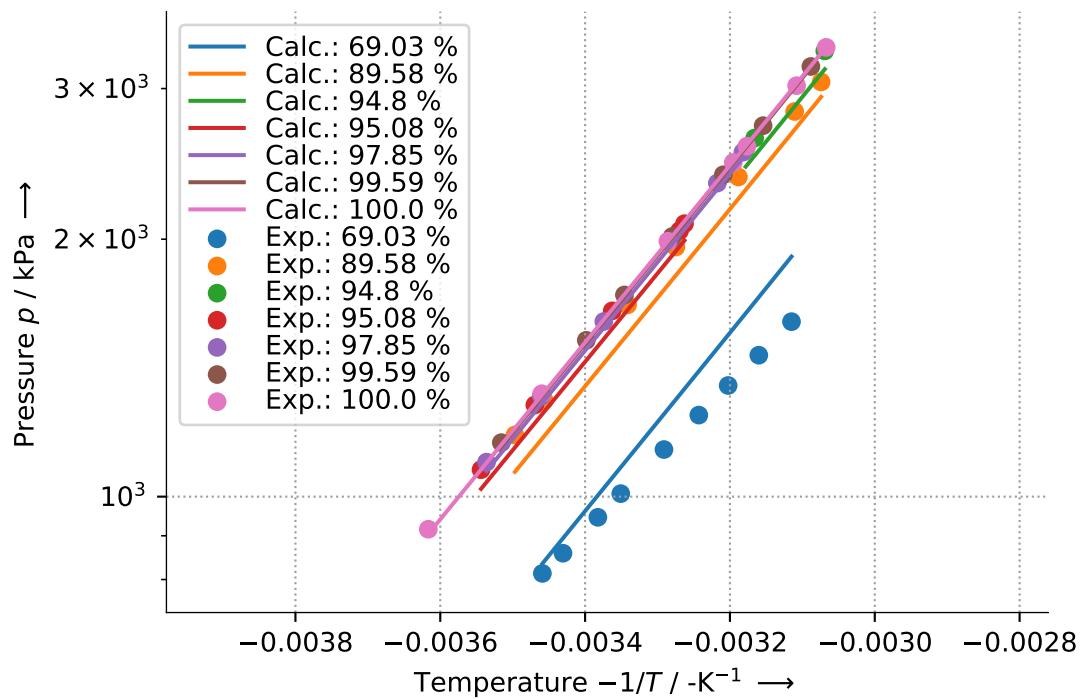
#### Validity:

No data on validity available!

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1



The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 1730 Pa for  $p < 3.45$  bar | 17300 Pa for  $p < 34.5$  bar
- Temperature, absolute, in K → 0.21
- Concentration / Molar fraction, relative, in % → 4

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.43%.

## 6.21.8.3 TsubokaKatayama - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	TsubokaKatayama
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

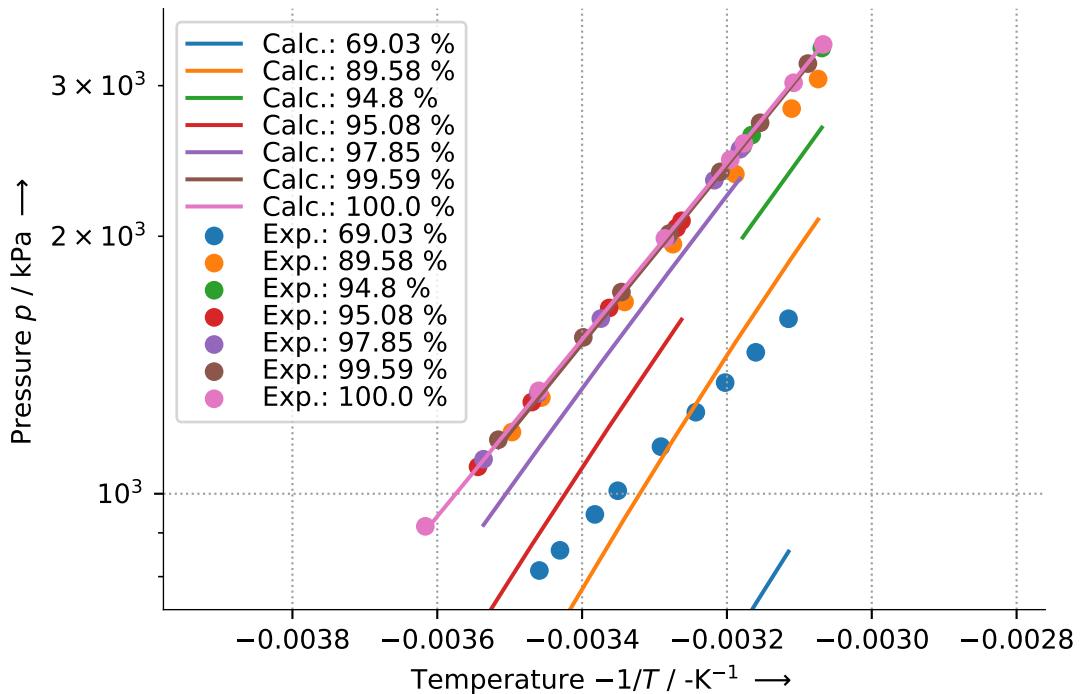
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1\Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \ln(x_1 + x_2\rho_{21}) - x_2 \left( \frac{\rho_{21}}{x_1 + x_2\rho_{21}} - \frac{\rho_{12}}{x_1\rho_{12} + x_2} \right) && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp(-\Delta\lambda_{12}/RT) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp(-\Delta\lambda_{21}/RT) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	1.143900000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	-1.505720000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 1730 Pa for  $p < 3.45$  bar | 17300 Pa for  $p < 34.5$  bar
- Temperature, absolute, in K → 0.21
- Concentration / Molar fraction, relative, in % → 4

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 24.64%.

#### 6.21.8.4 UniquacFixedDu - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

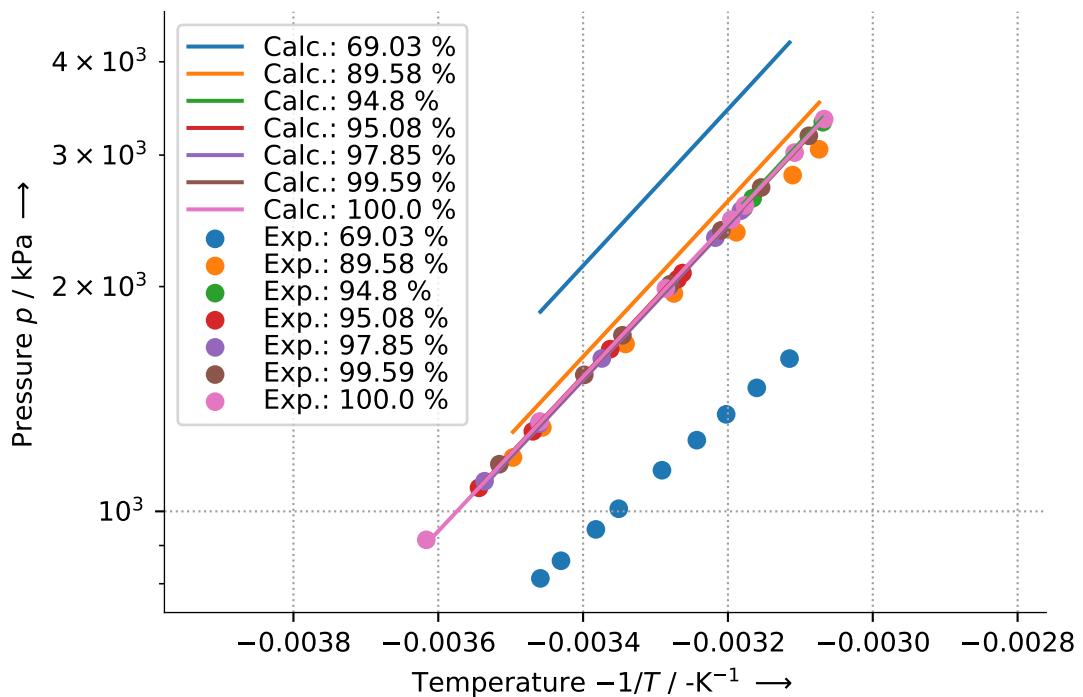
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-2.000000000e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	2.000000000e+04
$r_1$	-	1.430000000e+00	$r_2$	-	2.940000000e+01
$q_1$	-	1.420000000e+00	$q_2$	-	2.436000000e+01
$z$	-	1.000000000e+01			

#### Validity:

No data on validity available!

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 1730 Pa for  $p < 3.45$  bar | 17300 Pa for  $p < 34.5$  bar
- Temperature, absolute, in K → 0.21
- Concentration / Molar fraction, relative, in % → 4

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 31.92%.

## 6.21.8.5 WangChao - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	WangChao
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state, for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

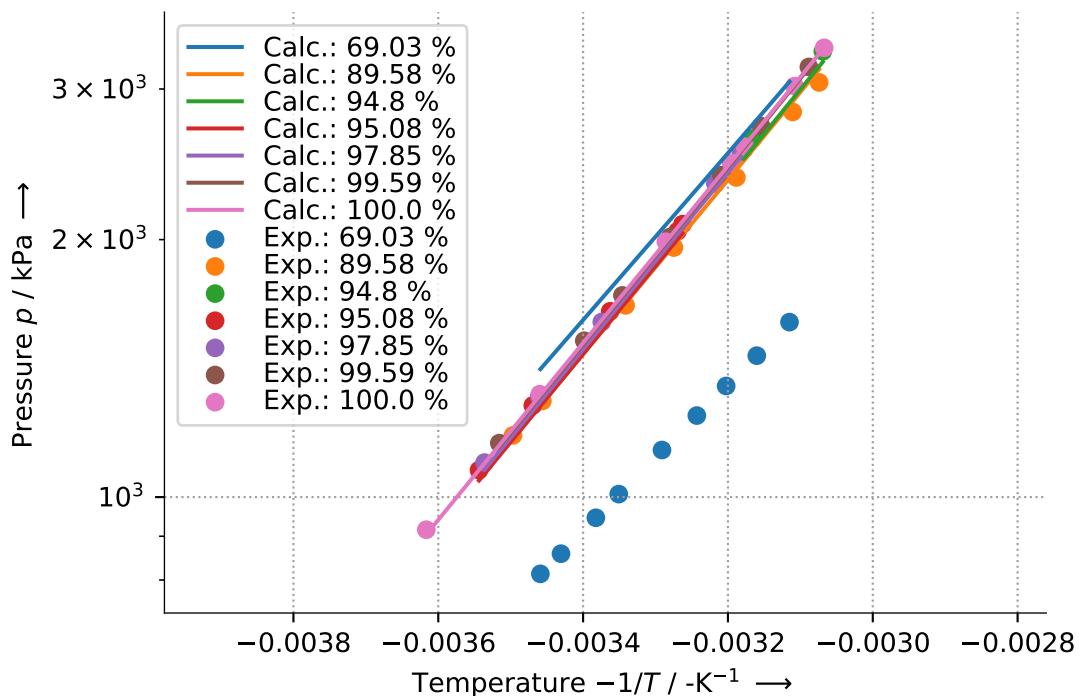
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{21}x_2) + x_2 \left( \frac{\Lambda_{21}}{x_1 + \Lambda_{21}x_2} - \frac{\Lambda_{12}}{x_1 \Lambda_{12} + x_2} \right) + \Phi \right) && , \text{ and} \\
 \Phi &= \frac{1}{RT} \frac{z}{2} \left( x_{21}^2 \Delta \lambda_{21} + x_2 x_{22} \frac{x_{12}}{x_1} \Delta \lambda_{12} \right) && , \text{ and} \\
 x_{11} &= (1 + x_2/x_1 \exp(-\Delta \lambda_{21}/RT))^{-1} && , \text{ and} \\
 x_{22} &= (1 + x_1/x_2 \exp(-\Delta \lambda_{12}/RT))^{-1} && , \text{ and} \\
 \Lambda_{12} &= \rho_{21} \exp \left( -\frac{\Delta \lambda_{12}}{RT} \right) && , \text{ and} \\
 \Lambda_{21} &= \rho_{12} \exp \left( -\frac{\Delta \lambda_{21}}{RT} \right) && , \text{ and} \\
 \rho_{12} &= v_1/v_2 && , \text{ and} \\
 \rho_{21} &= v_2/v_1 && , \text{ and} \\
 x_{12} &= 1 - x_{22} && , \text{ and} \\
 x_{21} &= 1 - x_{11} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	2.084500000e+03	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	1.577441000e+05
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	1.000000000e+00
$z$	-	1.000000000e+01			

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 1730 Pa for p < 3.45 bar | 17300 Pa for p < 34.5 bar
- Temperature, absolute, in K → 0.21

- Concentration / Molar fraction, relative, in % → 4

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 17.75%.

## 6.21.8.6 WilsonFixedDI - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Burton, C.; Jacobi, A. M.; Mehendale, S. S. (1999): Vapor-liquid equilibrium for R-32 and R-410A mixed with a polyol ester. Non-ideality and local composition modeling. In: International Journal of Refrigeration 22 (6), S. 458–471. DOI: 10.1016/S0140-7007(99)00012-2.
<b>Comment:</b>	See original literature: Use low-level interface to input molar volumes of both components, which are calculated by proper equations of state (i.e., $v_{\text{POE}} = 1/(993.89 - 0.75658*(T-273.15))*0.7$ in $\text{m}^3/\text{mol}$ ), for calculations.

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

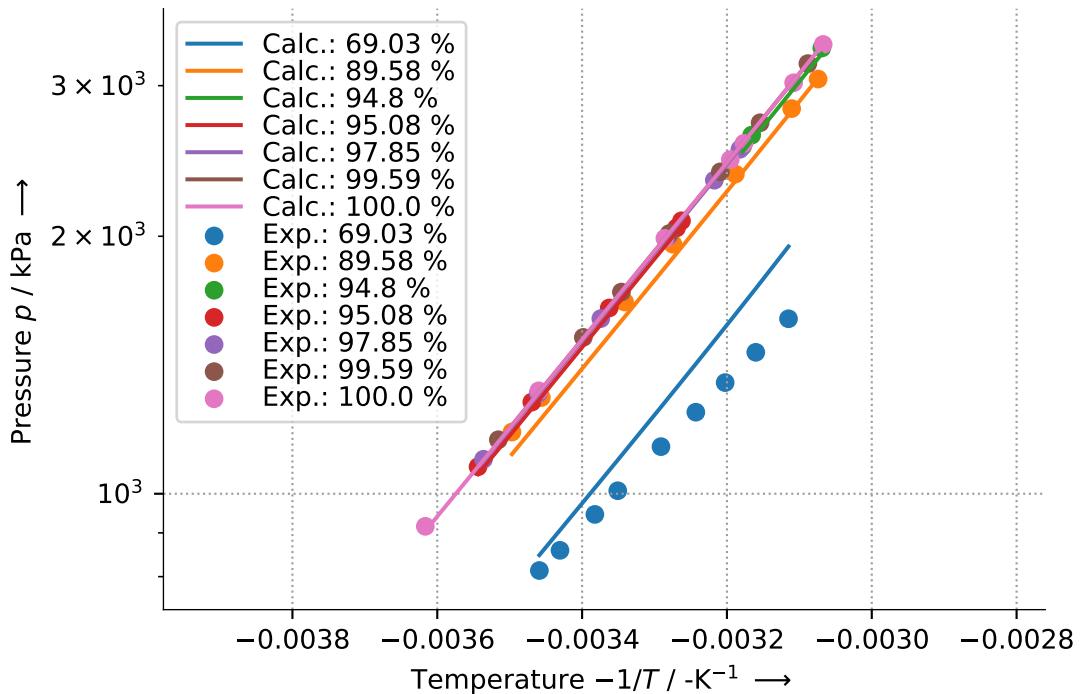
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) && , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} && , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	$\text{J mol}^{-1}$	2.650400000e+03	$\Delta\lambda_{21}$	$\text{J mol}^{-1}$	2.000000000e+04
$v_1$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00	$v_2$	$\text{m}^3 \text{mol}^{-1}$	1.000000000e+00

**Validity:**

No data on validity available!

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1
- Special refrigerant functions as described by comment and CoolProp

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Pressure, absolute, in Pa → 1730 Pa for  $p < 3.45$  bar | 17300 Pa for  $p < 34.5$  bar
- Temperature, absolute, in K → 0.21
- Concentration / Molar fraction, relative, in % → 4

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.35%.

### 6.21.9 Lubricant POE32

#### 6.21.9.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE32
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.512600000e+02	$T_{\text{crit},2}$	K	8.640000000e+02
$p_{\text{crit},1}$	Pa	5.782000000e+06	$p_{\text{crit},2}$	Pa	8.740000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001900000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.833300000e-01	$\beta_{1,2}$	-	9.130000000e-01
$\beta_{2,1}$	-	-7.538000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	6.730000000e-03	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	0.000000000e+00
$l_{12}$	-	6.460000000e-02	$l_{21}$	-	2.660000000e-02
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.21.10 Lubricant POE68

#### 6.21.10.1 MixingRule - ID 1

<b>Sorbent:</b>	lubricant
<b>Subtype:</b>	POE68
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	MixingRule
<b>ID:</b>	1
<b>Reference:</b>	Yokozeki, A. (2001): Solubility of Refrigerant in Various Lubricants. In: International Journal of Thermophysics 22 (4), S. 1057–1071. DOI: 10.1023/A:1010695705260.
<b>Comment:</b>	None

#### Equation and parameters:

Vapor pressure  $p_{\text{sat}}$  in Pa is calculated depending on temperature  $T$  in K and molar volume  $v$  in  $\text{mol m}^{-3}$  by using cubic equation of state. For this purpose, molar volumes of liquid and vapor phase are changed iteratively until fugacity coefficients of vapor and liquid phase are equal. Cubic equation of state and mixing rules are given by:

$$\begin{aligned}
 p &= R \frac{T}{v - b} - \frac{a}{v(v + b)} \quad , \text{ and} \\
 a &= z_1^2 a_1 + 2z_1 z_2 a_{12} + 2z_2^2 a_2 \quad , \text{ and} \\
 b &= z_1^2 b_1 + 2z_1 z_2 b_{12} + 2z_2^2 b_2 \quad , \text{ and} \\
 a_{12} &= (a_1 a_2)^{0.5} (1 + t/T) (1 - k_{12}) \quad , \text{ and} \\
 b_{12} &= \frac{b_1 + b_2}{2} (1 - m) \quad , \text{ and} \\
 k_{12} &= \frac{l_{12} l_{21} (z_1 + z_2)}{l_{21} z_1 + l_{12} z_2} \quad , \text{ and} \\
 z_j &= x_j \text{ or } y_j \text{ depending on phase} \quad , \text{ and} \\
 a_j &= \frac{1}{9(2^{1/3} - 1)} \frac{(RT_{\text{crit},j})^2}{p_{\text{crit},j}} \alpha_j \quad , \text{ and} \\
 b_j &= 0.08664 R \frac{T_{\text{crit},j}}{p_{\text{crit},j}} \quad , \text{ and} \\
 \alpha_j &= \beta_{0,j} + \sum_{i=1}^3 \beta_{i,j} \theta_j^i \quad , \text{ and} \\
 \theta_j &= T_{\text{crit},j}/T - T/T_{\text{crit},j} \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
EoS	-	-1.000000000e+01	Mix	-	1.000000000e+01
$T_{\text{crit},1}$	K	3.512600000e+02	$T_{\text{crit},2}$	K	7.460000000e+02
$p_{\text{crit},1}$	Pa	5.782000000e+06	$p_{\text{crit},2}$	Pa	6.820000000e+05
$\omega_1$	-	0.000000000e+00	$\omega_2$	-	0.000000000e+00
$\kappa_{1,1}$	-	0.000000000e+00	$\kappa_{1,2}$	-	0.000000000e+00
$\beta_{0,1}$	-	1.001900000e+00	$\beta_{0,2}$	-	1.000000000e+00
$\beta_{1,1}$	-	4.833300000e-01	$\beta_{1,2}$	-	1.249000000e+00
$\beta_{2,1}$	-	-7.538000000e-02	$\beta_{2,2}$	-	0.000000000e+00
$\beta_{3,1}$	-	6.730000000e-03	$\beta_{3,2}$	-	0.000000000e+00
$k_{12}$	-	0.000000000e+00	$m$	-	1.280000000e-02
$l_{12}$	-	8.710000000e-02	$l_{21}$	-	1.380000000e-02
$t$	-	0.000000000e+00			

**Validity:**

No data on validity available!

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.21.11 Pentaerythritol tetrapentanoate ester

#### 6.21.11.1 FloryHuggins - ID 1

<b>Sorbent:</b>	pentaerythritol tetrapentanoate ester
<b>Subtype:</b>	
<b>Refrigerant:</b>	R-32
<b>Equation:</b>	FloryHuggins
<b>ID:</b>	1
<b>Reference:</b>	Wahlström, Åsa; Vamling, Lennart (1999): Solubility of HFC32, HFC125, HFC134a, HFC143a, and HFC152a in a Pentaerythritol Tetrapentanoate Ester. In: J. Chem. Eng. Data 44 (4), S. 823–828. DOI: 10.1021/je980235e.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in  $\text{mol mol}^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in  $\text{m}^3 \text{mol}^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\ \gamma_1 &= \exp \left( \ln \left( 1 - \left( 1 - \frac{1}{r} \right) \Phi_2 \right) + \left( 1 - \frac{1}{r} \right) \Phi_2 + \Gamma \Phi_2^2 \right) && , \text{ and} \\ \Phi_2 &= r \frac{x_2}{x_1 + rx_2} && , \text{ and} \\ \Gamma &= w_0^*/T \left( 1 + w_1/T \right) && , \text{ and} \\ x_2 &= 1 - x_1 && . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$r$	-	9.780000000e+00	$w_0^*$	K	8.060000000e+02
$w_1$	K	-1.970000000e+02			

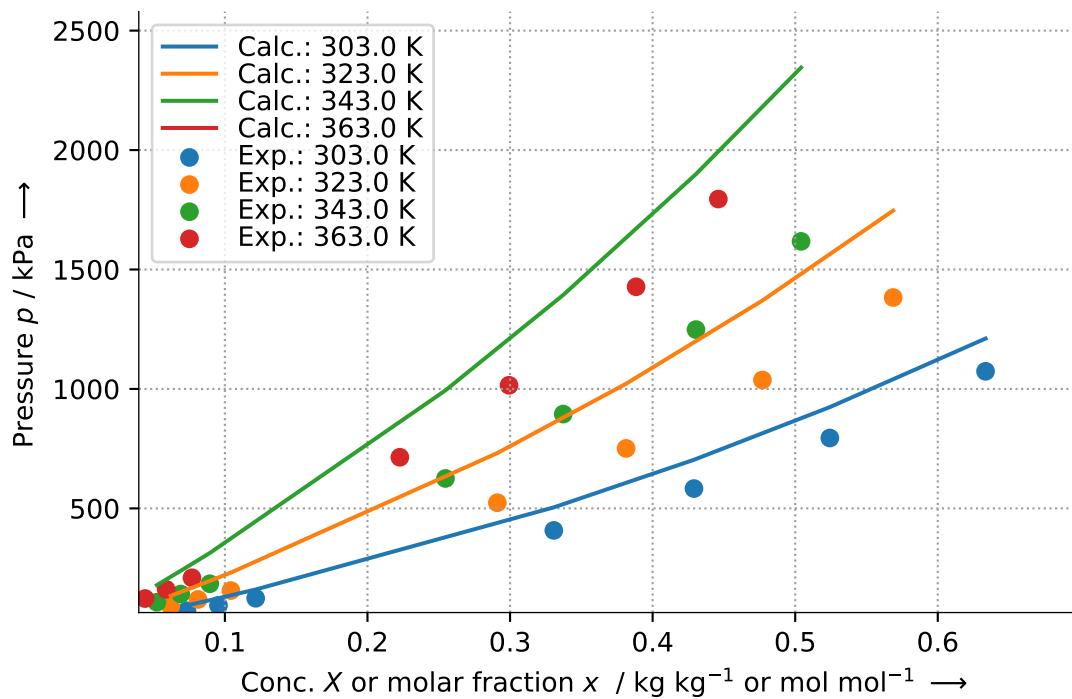
#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 363.15\text{K}$ .

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 41.17%.

## 6.22 TFE

### 6.22.1 Nmp

#### 6.22.1.1 Antoine - ID 1

<b>Sorbent:</b>	NMP
<b>Subtype:</b>	
<b>Refrigerant:</b>	TFE
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Shiming, Xu; Yanli, Liu; Lisong, Zhang (2001): Performance research of self regenerated absorption heat transformer cycle using TFE-NMP as working fluids. In: International Journal of Refrigeration 24 (6), S. 510–518. DOI: 10.1016/S0140-7007(00)00071-2.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in  $\text{kg kg}^{-1}$  and temperature  $T$  in K by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+03
$A_0$	-	6.819900000e+00	$B_0$	K	-2.076890000e+00
$A_1$	-	5.752530000e-03	$B_1$	K	1.537680000e-03
$A_2$	-	1.100930000e-04	$B_2$	K	2.581010000e-05
$A_3$	-	-1.848890000e-06	$B_3$	K	7.325510000e-07
$A_4$	-	7.875230000e-09	$B_4$	K	-7.196460000e-06

#### Validity:

No data on validity available!

#### Visualization:

No experimental data exists. Thus, isotherm is not visualized!

## 6.23 THF

### 6.23.1 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

#### 6.23.1.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	THF
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [BMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [MMIM][(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

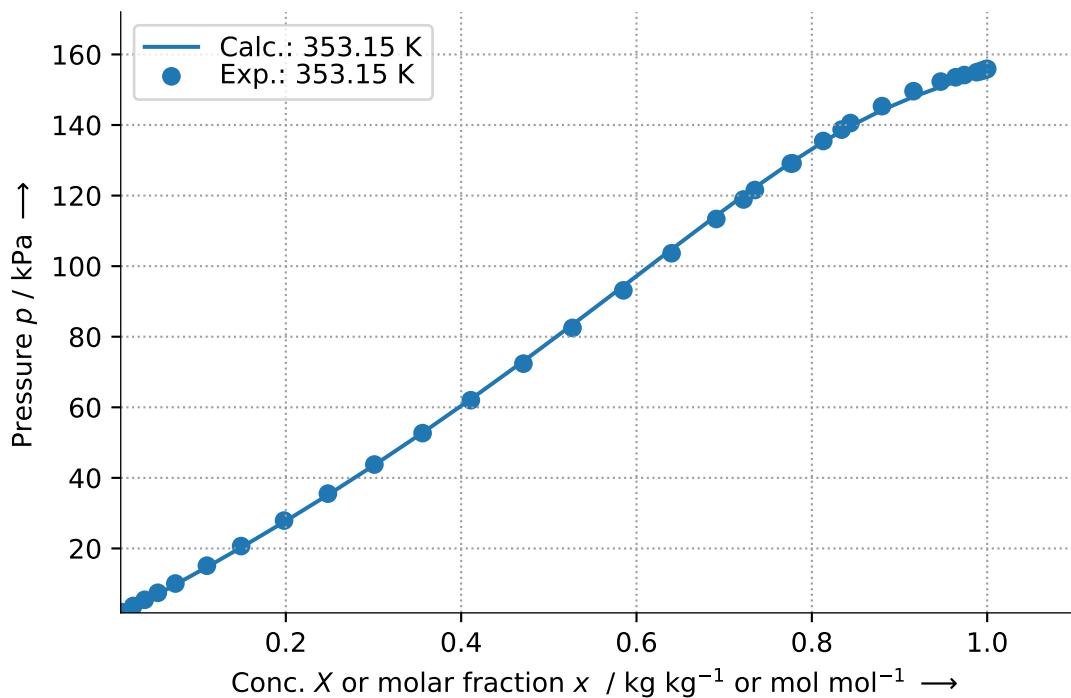
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	2.353400000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-1.298800000e+03
$r_1$	-	2.941000000e+00	$r_2$	-	9.890000000e+00
$q_1$	-	2.720000000e+00	$q_2$	-	8.780000000e+00
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_Antoine - ID 1
- Saturated liquid density: NoSaturatedLiquidDensity - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 1.67%.

### 6.23.2 Ionic liquid [MMIM]+[(CH<sub>3</sub>)<sub>2</sub>PO<sub>4</sub>]<sup>-</sup>

#### 6.23.2.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] <sup>-</sup>
<b>Refrigerant:</b>	THF
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [BMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [MMIM][(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

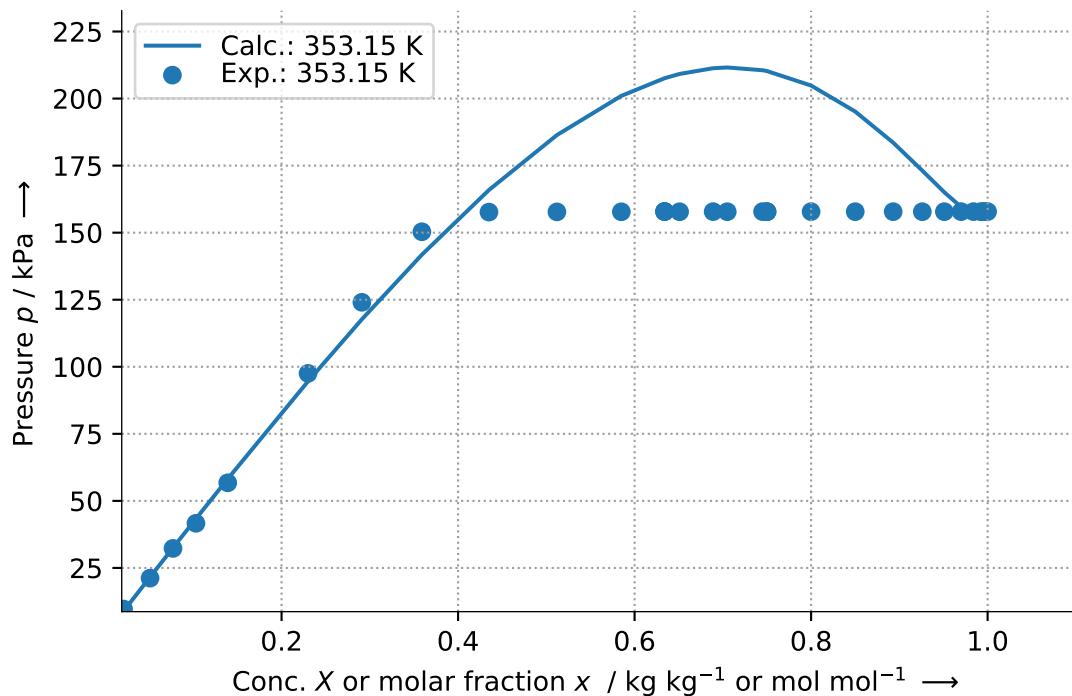
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	6.594000000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-1.331800000e+03
$r_1$	-	2.941000000e+00	$r_2$	-	7.162000000e+00
$q_1$	-	2.720000000e+00	$q_2$	-	5.844000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_Antoine - ID 1
- Saturated liquid density: NoSaturatedLiquidDensity - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 15.18%.

## 6.24 Toluene

### 6.24.1 Ionic liquid [C2H5NH]+[C2H5OC2H4OSO3]-

#### 6.24.1.1 NRTLTemperatureDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C2H5NH]+[C2H5OC2H4OSO3]-
<b>Refrigerant:</b>	Toluene
<b>Equation:</b>	NRTLTemperatureDg
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

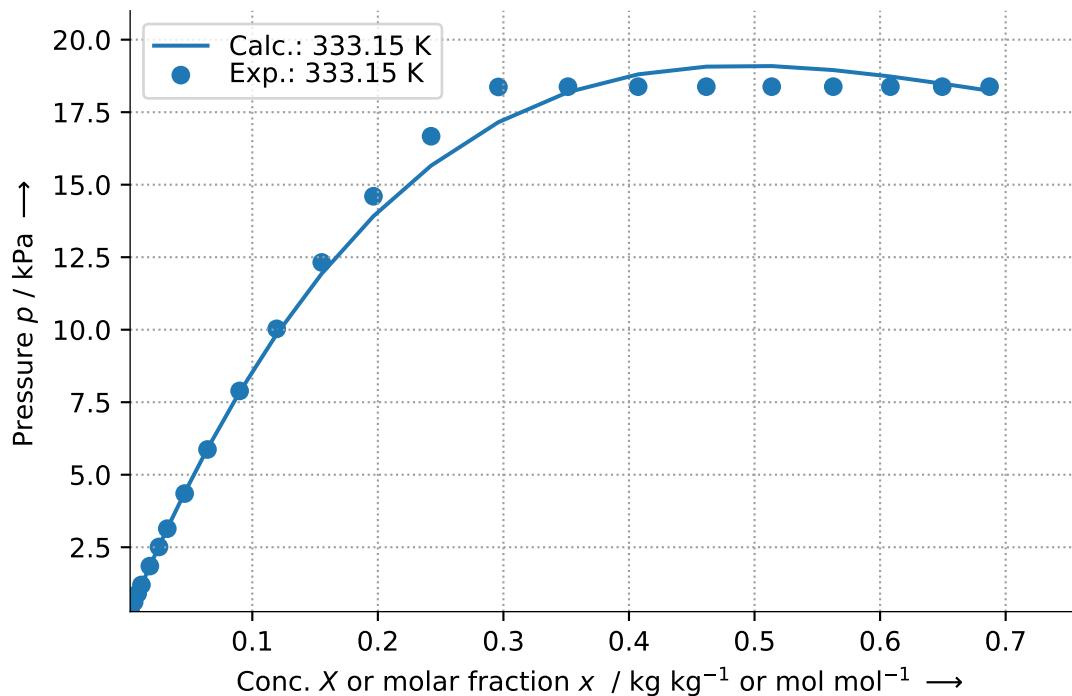
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\
 \Delta g_{12} &= a_{12} + b_{12}T \quad , \text{ and} \\
 \Delta g_{21} &= a_{21} + b_{21}T \quad , \text{ and} \\
 x_2 &= 1 - x_1 \quad .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.000000000e-01	$\alpha_{21}$	-	2.000000000e-01
$a_{12}$	J mol <sup>-1</sup>	8.690600000e+03	$a_{21}$	J mol <sup>-1</sup>	1.291000000e+02
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.03%.

## 6.24.2 Ionic liquid [C2H5NH]+[C2H5OC2H4OSO3]-

### 6.24.2.1 UniquacTemperatureDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[C2H5NH]+[C2H5OC2H4OSO3]-
<b>Refrigerant:</b>	Toluene
<b>Equation:</b>	UniquacTemperatureDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Krummen, Michael; Gmehling, Jürgen (2004): Measurement and correlation of vapor–liquid equilibria and excess enthalpies of binary systems containing ionic liquids and hydrocarbons. In: Fluid Phase Equilibria 224 (1), S. 47–54. DOI: 10.1016/j.fluid.2004.05.009.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 \Delta u_{ij} &= a_{ij} + b_{ij}T & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_{12}$	J mol <sup>-1</sup>	2.095000000e+02	$a_{21}$	J mol <sup>-1</sup>	1.627700000e+03
$b_{12}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00	$b_{21}$	J mol <sup>-1</sup> K <sup>-1</sup>	0.000000000e+00
$r_1$	-	8.780000000e+00	$r_2$	-	2.968000000e+00
$q_1$	-	6.960000000e+00	$q_2$	-	3.923000000e+00
$z$	-	6.000000000e+00			

**Validity:**

Equation is approximately valid for  $353.15\text{K} \leq T \leq 353.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

## 6.25 Water

### 6.25.1 Libr

#### 6.25.1.1 Duehring - ID 1

<b>Sorbent:</b>	LiBr
<b>Subtype:</b>	
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Duehring
<b>ID:</b>	1
<b>Reference:</b>	Handbook AF. American society of heating, refrigerating and air-conditioning engineers. Inc: Atlanta, GA, USA. 2009
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in  $\text{kg kg}^{-1}$  and temperature  $T$  in K by:

$$p = \frac{1}{r} 10^{C + \frac{D}{T_{\text{ref}}} + \frac{E}{T_{\text{ref}}^2}}, \text{ and}$$

$$T_{\text{ref}} = q + \frac{(nT + m - B)}{A}, \text{ and}$$

$$A = \sum_{i=0}^3 a_0 X_{\text{cor}}^i, \text{ and}$$

$$B = \sum_{i=0}^3 b_0 X_{\text{cor}}^i, \text{ and}$$

$$X_{\text{cor}} = 100X.$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_0$	-	-2.007550000e+00	$b_0$	-	3.211280000e+02
$a_1$	-	1.697600000e-01	$b_1$	-	-1.932200000e+01
$a_2$	-	-3.133362000e-03	$b_2$	-	3.743800000e-01
$a_3$	-	1.976680000e-05	$b_3$	-	-2.063700000e-03
$C$	-	6.211470000e+00	$D$	K	-2.886373000e+03
$m$	-	3.200000000e+01	$E$	$\text{K}^2$	-3.372694600e+05
$n$	-	1.800000000e+00	$q$	-	4.597200000e+02
$r$	$\text{Pa}^{-1}$	1.450000000e-04			

#### Validity:

Equation is approximately valid for  $277.15\text{K} \leq T \leq 450.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

### 6.25.2 Libr/ch3cook ratio 2/1

#### 6.25.2.1 Antoine - ID 1

<b>Sorbent:</b>	LiBr/CH <sub>3</sub> COOK
<b>Subtype:</b>	ratio 2/1
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Lucas, Antonio de; Donate, Marina; Rodríguez, Juan F. (2006): Vapour pressures, densities, and viscosities of the (water+lithium bromide+potassium acetate) system and (water+lithium bromide+sodium lactate) system. In: The Journal of Chemical Thermodynamics 38 (2), S. 123–129. DOI: 10.1016/j.jct.2005.04.007.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in kg kg<sup>-1</sup> and temperature  $T$  in K by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+03
$A_0$	-	6.950000000e+00	$B_0$	K	-1.640000000e+00
$A_1$	-	-1.330000000e-02	$B_1$	K	1.830000000e-03
$A_2$	-	-9.020000000e-06	$B_2$	K	-2.520000000e-06
$A_3$	-	0.000000000e+00	$B_3$	K	0.000000000e+00
$A_4$	-	0.000000000e+00	$B_4$	K	0.000000000e+00

#### Validity:

Equation is approximately valid for 293.15K  $\leq T \leq$  333.15K.

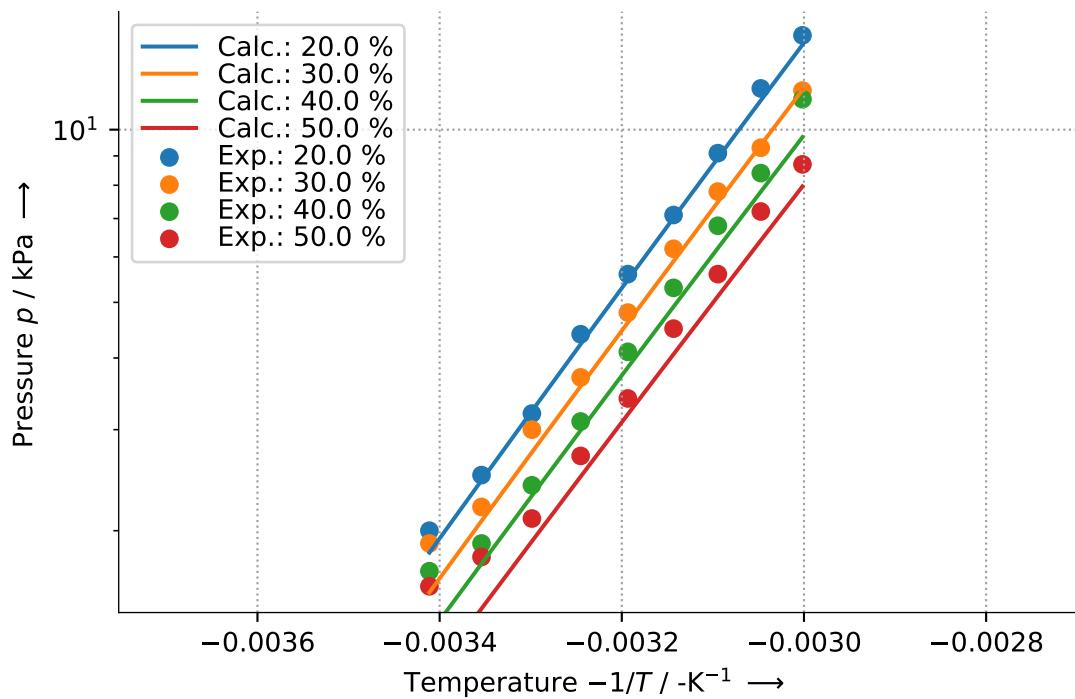
#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table



- Pressure, absolute, in Pa → 100
- Temperature, absolute, in K → 0.01
- Concentration / Molar fraction, absolute, in  $\text{kg kg}^{-1}$  /  $\text{mol mol}^{-1}$  → 1.00E-07

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.51%.

### 6.25.3 Libr/h2n(ch2)2oh ratio 3/5/1

#### 6.25.3.1 Antoine - ID 1

<b>Sorbent:</b>	LiBr/H2N(CH2)2OH
<b>Subtype:</b>	ratio 3/5/1
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Kim, Jin-Soo; Park, Young; Lee, Huen (1996): Densities and Viscosities of the Water + Lithium Bromide + Ethanolamine System. In: J. Chem. Eng. Data 41 (4), S. 678–680. DOI: 10.1021/je9503259.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in  $\text{kg kg}^{-1}$  and temperature  $T$  in K by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+03
$A_0$	-	1.227900000e+02	$B_0$	K	-3.833350000e+01
$A_1$	-	-7.188120000e+00	$B_1$	K	2.259820000e+00
$A_2$	-	1.658530000e-01	$B_2$	K	-5.165830000e-02
$A_3$	-	-1.688300000e-03	$B_3$	K	5.197140000e-04
$A_4$	-	6.412610000e-06	$B_4$	K	-1.956930000e-06

#### Validity:

Equation is approximately valid for  $318.15\text{K} \leq T \leq 418.15\text{K}$ .

#### Visualization:

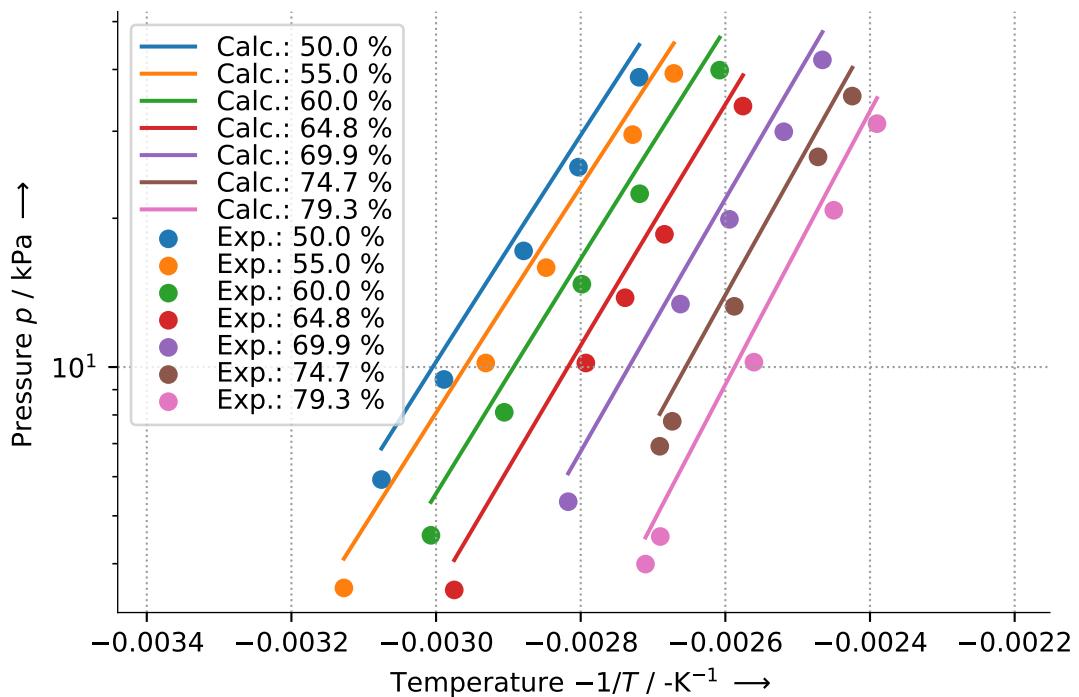
To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, relative, in % → 0.4

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 14.58%.



#### 6.25.4 Libr/ho(ch2)3oh ratio 3/5/1

##### 6.25.4.1 Antoine - ID 1

<b>Sorbent:</b>	LiBr/HO(CH <sub>2</sub> ) <sub>3</sub> OH
<b>Subtype:</b>	ratio 3/5/1
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Park, Young; Kim, Jin-Soo; Lee, Huen (1997): Physical properties of the lithium bromide + 1,3-propanediol + water system. In: International Journal of Refrigeration 20 (5), S. 319–325. DOI: 10.1016/S0140-7007(97)00021-2.
<b>Comment:</b>	None

##### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in  $\text{kg kg}^{-1}$  and temperature  $T$  in K by:

$$p/a = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

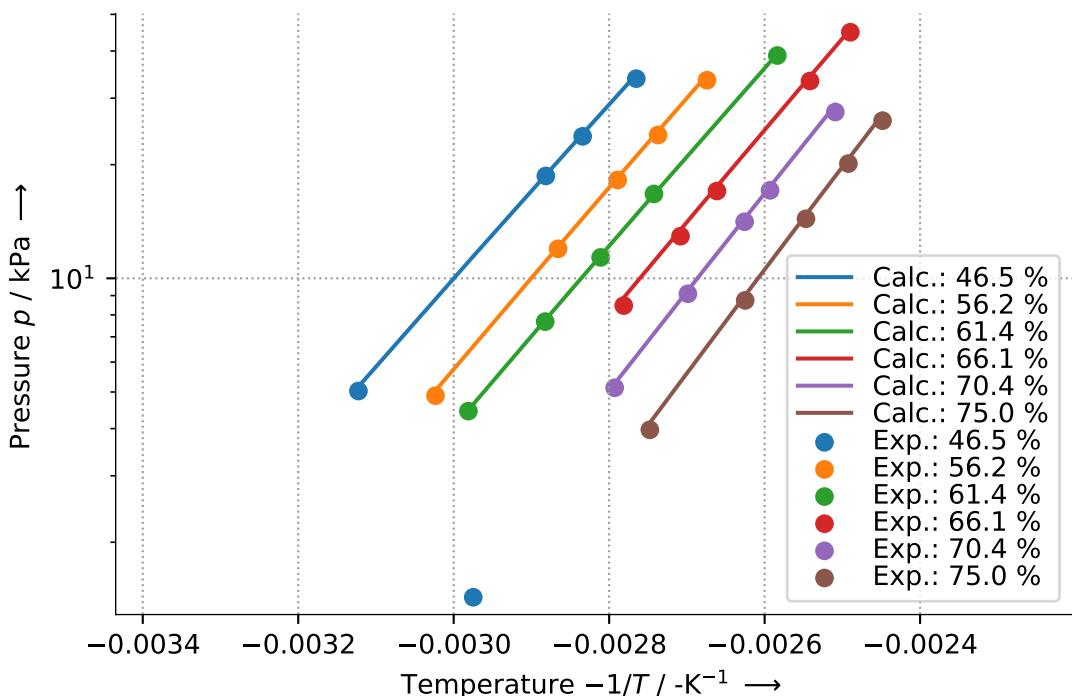
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+03
$A_0$	-	-2.429190000e+02	$B_0$	K	8.218560000e+01
$A_1$	-	1.662950000e+01	$B_1$	K	-5.585050000e+00
$A_2$	-	-4.093380000e-01	$B_2$	K	1.376500000e-01
$A_3$	-	4.420600000e-03	$B_3$	K	-1.489240000e-03
$A_4$	-	-1.767920000e-05	$B_4$	K	5.958560000e-06

**Validity:**

Equation is approximately valid for  $325.15\text{K} \leq T \leq 395.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.2

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 25.64%.

### 6.25.5 Libr/lii-oh(ch2)3oh massRatio 174/57/15

#### 6.25.5.1 Antoine - ID 1

<b>Sorbent:</b>	LiBr/LiI-OH(CH2)3OH
<b>Subtype:</b>	massRatio 174/57/15
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Kim, Jin-Soo; Lee, Huen (2001): Solubilities, Vapor Pressures, Densities, and Viscosities of the LiBr + LiI + HO(CH 2 ) 3 OH + H 2 O System. In: J. Chem. Eng. Data 46 (1), S. 79–83. DOI: 10.1021/je000154u.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in  $\text{kg kg}^{-1}$  and temperature  $T$  in K by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+03
$A_0$	-	9.537943000e+00	$B_0$	K	-2.181261000e+00
$A_1$	-	-1.303482000e-01	$B_1$	K	2.793675000e-02
$A_2$	-	1.919265000e-03	$B_2$	K	-3.596105000e-04
$A_3$	-	-7.926247000e-06	$B_3$	K	2.400981000e-08
$A_4$	-	0.000000000e+00	$B_4$	K	0.000000000e+00

#### Validity:

Equation is approximately valid for  $339.15\text{K} \leq T \leq 444.15\text{K}$ .

#### Visualization:

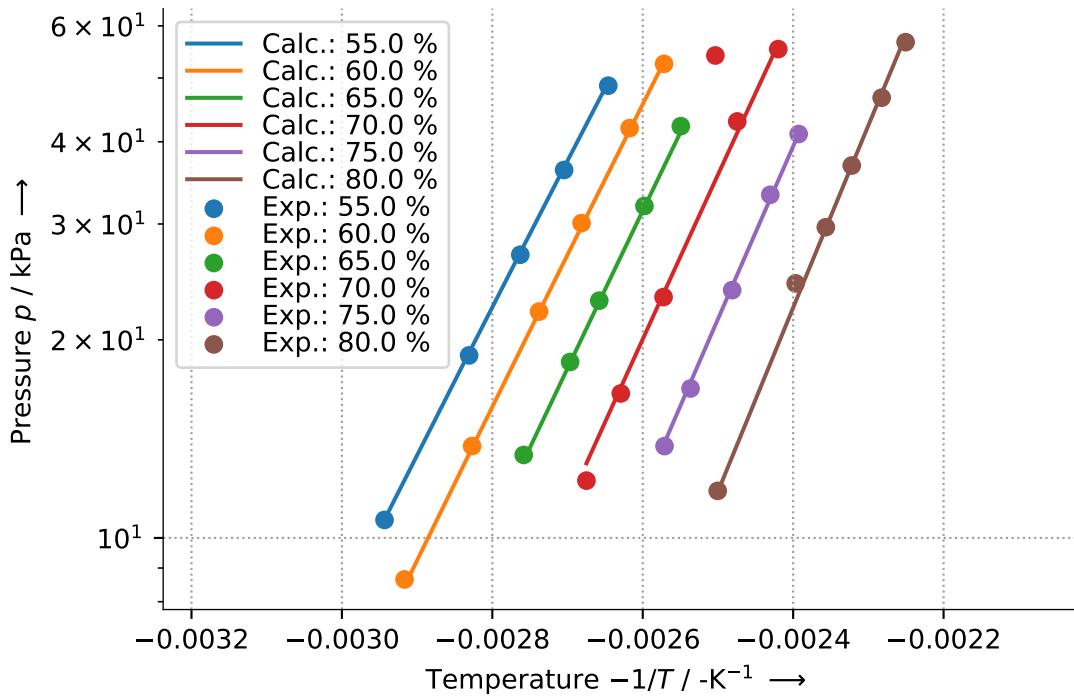
To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.5%.



### 6.25.6 Libr/lino3 massRatio 348/69

#### 6.25.6.1 Antoine - ID 1

<b>Sorbent:</b>	LiBr/LiNO <sub>3</sub>
<b>Subtype:</b>	massRatio 348/69
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Iyoki, Shigeki; Yamanaka, Ryousuke; Uemura, Tadashi (1993): Physical and thermal properties of the water-lithium bromide-lithium nitrate system. In: International Journal of Refrigeration 16 (3), S. 191–200. DOI: 10.1016/0140-7007(93)90048-D.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in kg kg<sup>-1</sup> and temperature  $T$  in K by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

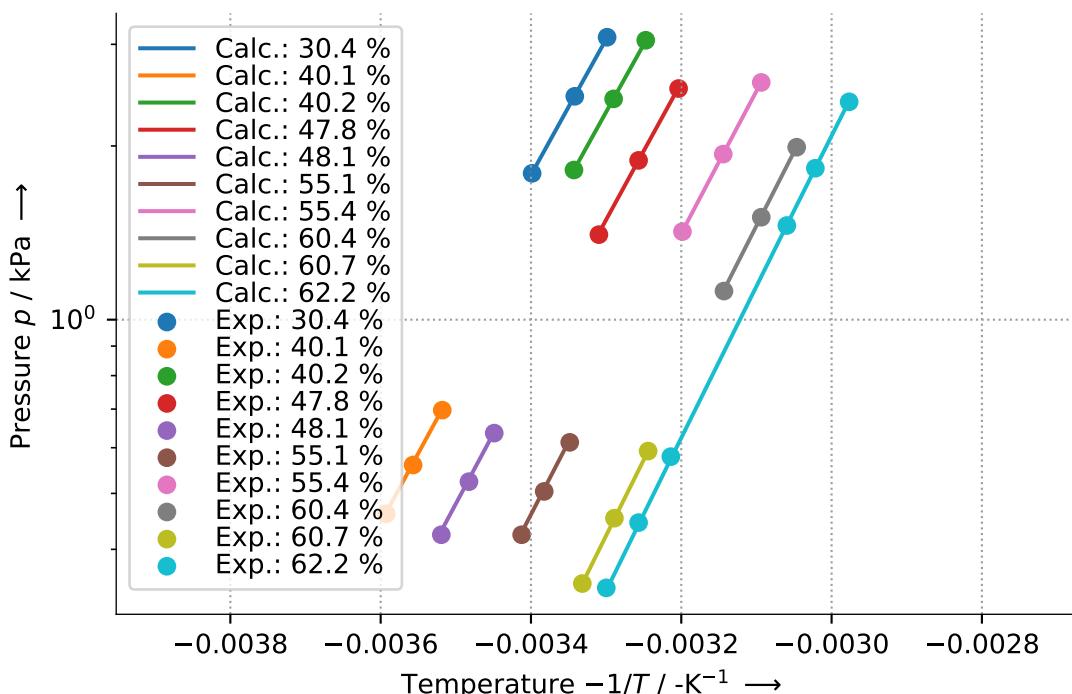
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+00
$A_0$	-	3.559780000e+00	$B_0$	K	-6.695280000e-01
$A_1$	-	6.304910000e-01	$B_1$	K	-1.020250000e-01
$A_2$	-	-2.171200000e-02	$B_2$	K	3.552500000e-03
$A_3$	-	3.144770000e-04	$B_3$	K	-5.127410000e-05
$A_4$	-	-1.628200000e-06	$B_4$	K	2.436950000e-07

**Validity:**

Equation is approximately valid for  $320.15\text{K} \leq T \leq 442.15\text{K}$ .

**Visualization:**



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 0.45%.

### 6.25.7 Libr/lino3/lii/licl ratio 5/1/1/2

#### 6.25.7.1 Antoine - ID 1

<b>Sorbent:</b>	LiBr/LiNO <sub>3</sub> /LiI/LiCl
<b>Subtype:</b>	ratio 5/1/1/2
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Koo, Kee-Kahb; Lee, Hyung-Rae; Jeong, Siyoung; Oh, Young-Sam; Park, Dal-Ryung; Baek, Young-Soon (1998): Solubilities, Vapor Pressures, Densities, and Viscosities of the (Water + Lithium Bromide + Lithium Iodide + Lithium Chloride) System. In: J. Chem. Eng. Data 43 (5), S. 722–725. DOI: 10.1021/je980063l.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in kg kg<sup>-1</sup> and temperature  $T$  in K by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+03
$A_0$	-	-1.276429000e+03	$B_0$	K	4.374120000e+02
$A_1$	-	8.764646000e+01	$B_1$	K	-3.008232000e+01
$A_2$	-	-2.233375000e+00	$B_2$	K	7.690697000e-01
$A_3$	-	2.517102000e-02	$B_3$	K	-8.697553000e-03
$A_4$	-	-1.058556000e-04	$B_4$	K	3.669313000e-05

#### Validity:

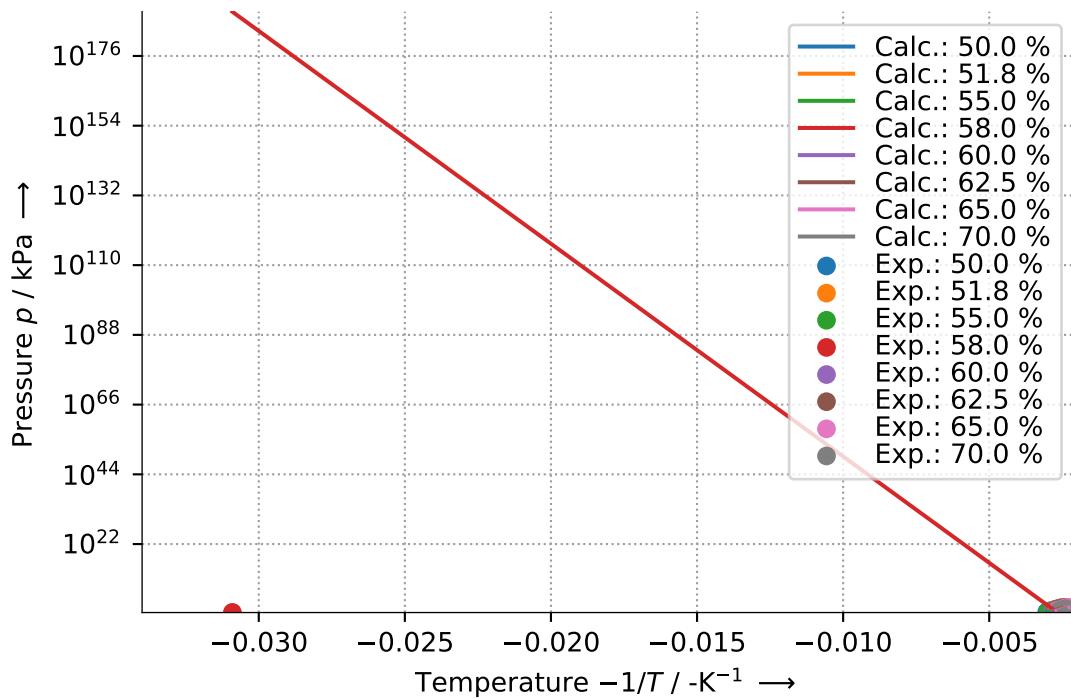
Equation is approximately valid for 330.15K  $\leq T \leq$  410.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:



- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in  $4.923607258526586e+189\%$ .

### 6.25.8 Libr/ch3ch(oh)coona ratio 2/1

#### 6.25.8.1 Antoine - ID 1

<b>Sorbent:</b>	Libr/CH <sub>3</sub> CH(OH)COONa
<b>Subtype:</b>	ratio 2/1
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Antoine
<b>ID:</b>	1
<b>Reference:</b>	Lucas, Antonio de; Donate, Marina; Rodríguez, Juan F. (2006): Vapour pressures, densities, and viscosities of the (water+lithium bromide+potassium acetate) system and (water+lithium bromide+sodium lactate) system. In: The Journal of Chemical Thermodynamics 38 (2), S. 123–129. DOI: 10.1016/j.jct.2005.04.007.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in kg kg<sup>-1</sup> and temperature  $T$  in K by:

$$p/d = 10^{\sum_{i=0}^4 (A_i + \frac{1000B_i}{T-c}) (100X)^i}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$c$	K	4.315000000e+01	$d$	Pa	1.000000000e+03
$A_0$	-	6.770000000e+00	$B_0$	K	-1.640000000e+00
$A_1$	-	5.110000000e-03	$B_1$	K	5.260000000e-04
$A_2$	-	-2.200000000e-04	$B_2$	K	-5.790000000e-07
$A_3$	-	0.000000000e+00	$B_3$	K	0.000000000e+00
$A_4$	-	0.000000000e+00	$B_4$	K	0.000000000e+00

#### Validity:

Equation is approximately valid for 298.15K  $\leq T \leq$  333.15K.

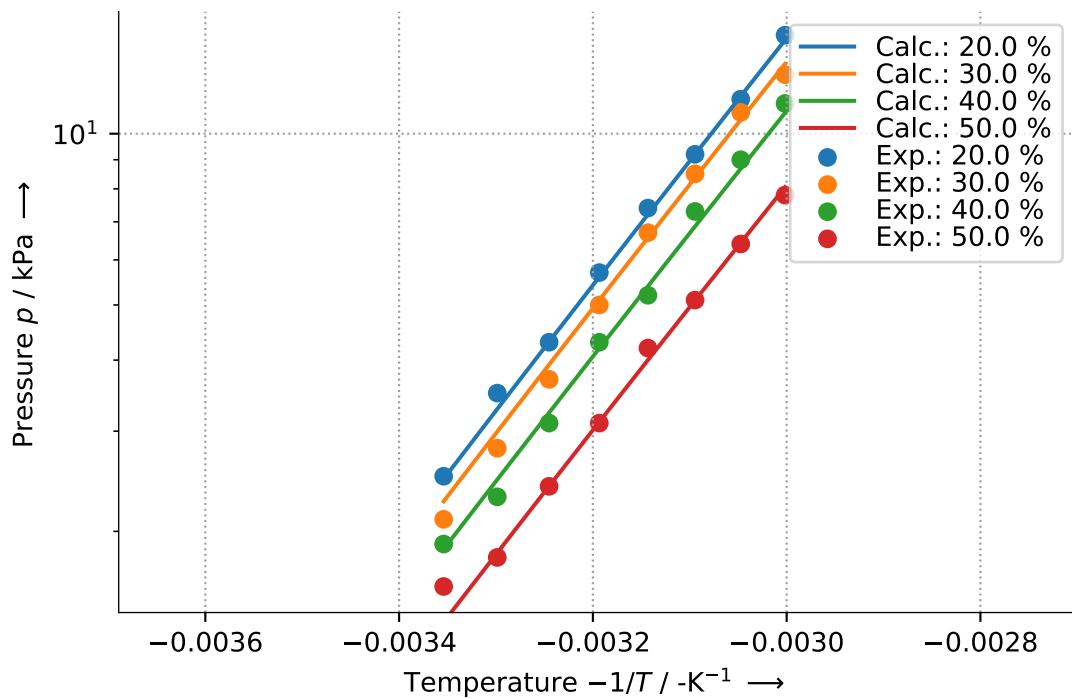
#### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table



- Pressure, absolute, in Pa → 100
- Temperature, absolute, in K → 0.01
- Concentration / Molar fraction, absolute, in  $\text{kg kg}^{-1}$  /  $\text{mol mol}^{-1}$  → 1.00E-07

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 3.31%.

### 6.25.9 Naoh-koh-csoh

#### 6.25.9.1 Duehring - ID 1

<b>Sorbent:</b>	NaOH-KOH-CsOH
<b>Subtype:</b>	
<b>Refrigerant:</b>	Water
<b>Equation:</b>	Duehring
<b>ID:</b>	1
<b>Reference:</b>	Herold, Keith E.; Radermacher, Reinhard; Howe, Lawrence; Erickson, Donald C. (1991): Development of an absorption heat pump water heater using an aqueous ternary hydroxide working fluid. In: International Journal of Refrigeration 14 (3), S. 156–167. DOI: 10.1016/0140-7007(91)90070-W.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on concentration  $X$  in  $\text{kg kg}^{-1}$  and temperature  $T$  in K by:

$$\begin{aligned} p &= 1/r 10^{C + \frac{D}{T_{\text{ref}}} + \frac{E}{T_{\text{ref}}^2}} \quad , \text{ and} \\ T_{\text{ref}} &= q + \frac{(nT + m - B)}{A} \quad , \text{ and} \\ A &= \sum_{i=0}^3 a_0 X_{\text{cor}}^i \quad , \text{ and} \\ B &= \sum_{i=0}^3 b_0 X_{\text{cor}}^i \quad , \text{ and} \\ X_{\text{cor}} &= 100X \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$a_0$	-	6.164233723e+00	$b_0$	-	-5.380343163e+01
$a_1$	-	-2.746665026e-01	$b_1$	-	5.004848451e+00
$a_2$	-	4.916023734e-03	$b_2$	-	-1.228273028e-01
$a_3$	-	-2.859098259e-05	$b_3$	-	1.096142341e-03
$C$	-	6.427154896e+00	$D$	K	-1.208919437e+03
$m$	-	0.000000000e+00	$E$	$\text{K}^2$	-1.661599630e+05
$n$	-	1.000000000e+00	$q$	-	2.731500000e+02
$r$	$\text{Pa}^{-1}$	1.000000000e-03			

#### Validity:

Equation is approximately valid for  $282.15\text{K} \leq T \leq 443.15\text{K}$ .

**Visualization:**

No experimental data exists. Thus, isotherm is not visualized!

6.25.10 Ionic liquid [BMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

## 6.25.10.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	3.000000000e-01	$\alpha_{21}$	-	3.000000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	1.943551680e+04	$\Delta g_{21}$	J mol <sup>-1</sup>	-3.489832560e+02

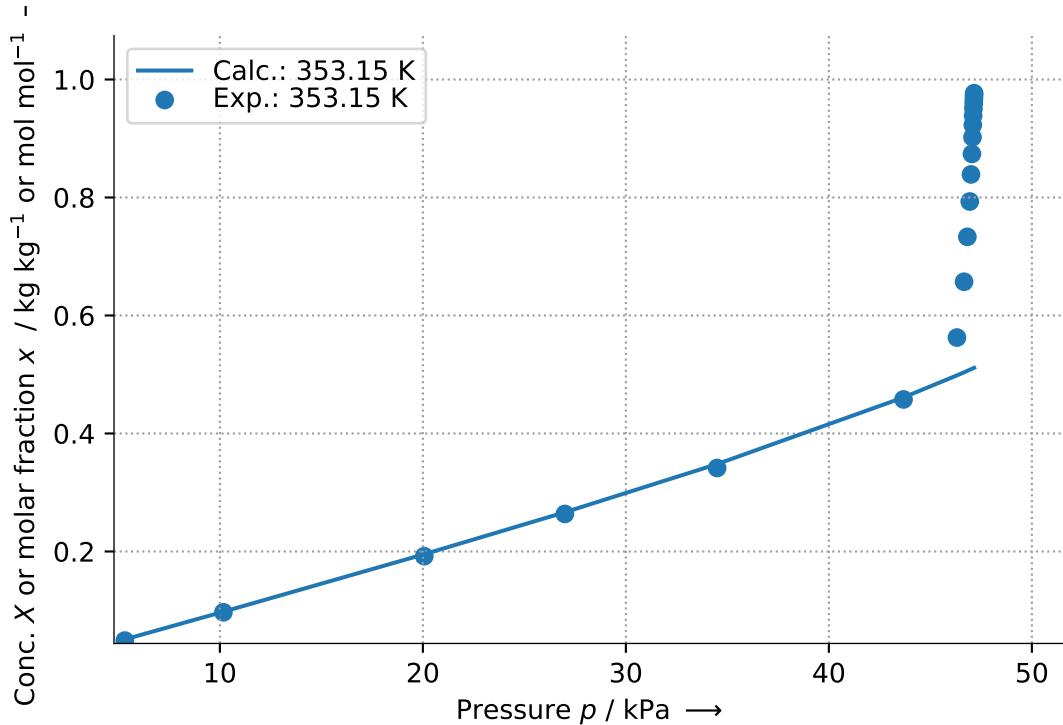
**Validity:**

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 28.12%.

### 6.25.10.2 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

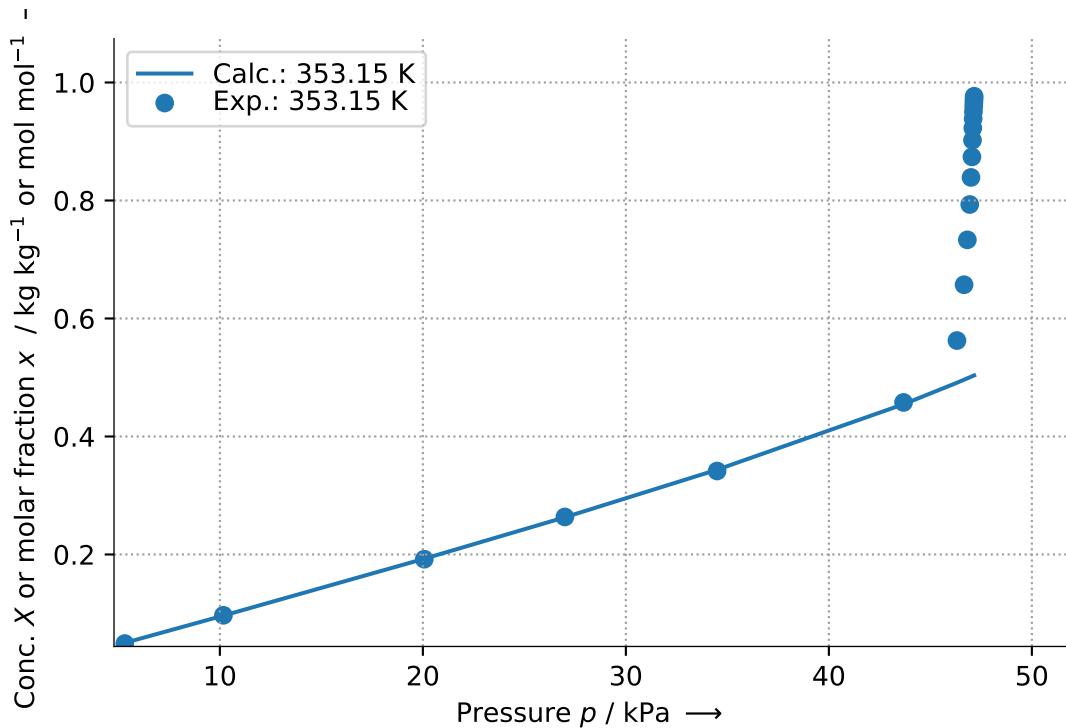
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	3.453055200e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	3.057123280e+03
$r_1$	-	9.200000000e-01	$r_2$	-	1.116000000e+01
$q_1$	-	1.400000000e+00	$q_2$	-	1.020000000e+01
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 28.46%.

## 6.25.10.3 UniquacFixedDu - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	2
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF3SO2)2N], [BMIM][(CF3SO2)2N], [MMIM][(CH3)2PO4] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

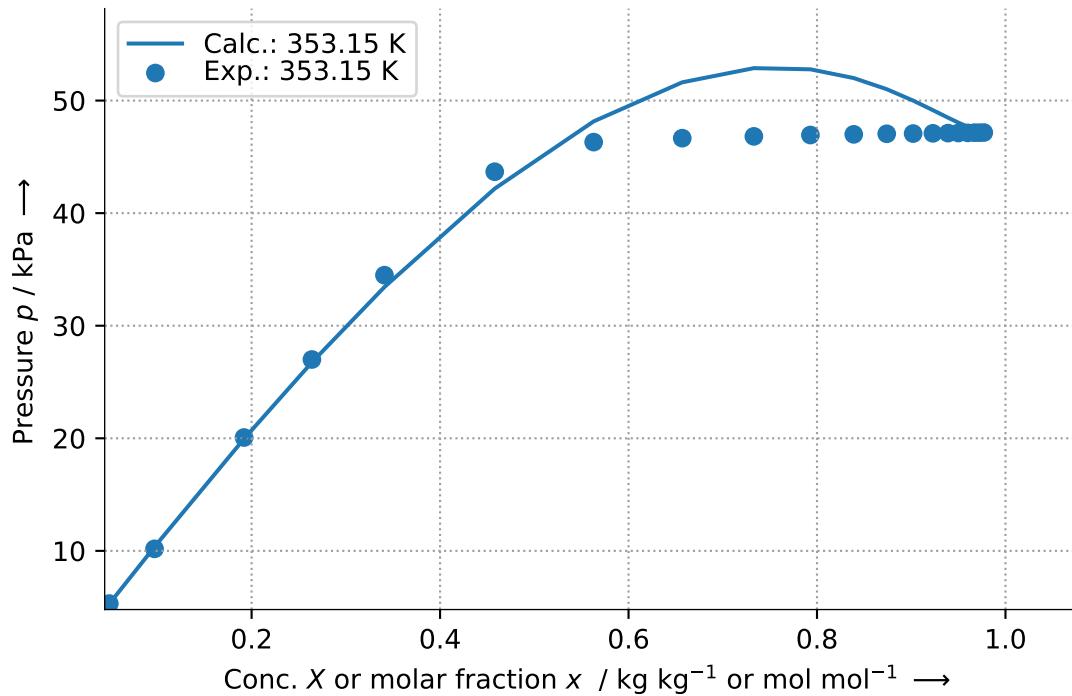
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-1.056836560e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	3.545856320e+03
$r_1$	-	9.200000000e-01	$r_2$	-	1.116000000e+01
$q_1$	-	1.400000000e+00	$q_2$	-	1.020000000e+01
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 4.35%.

## 6.25.10.4 WilsonFixedDI - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[BMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol $^{-1}$ , temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m $^3$  mol $^{-1}$ , and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) & , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} & , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

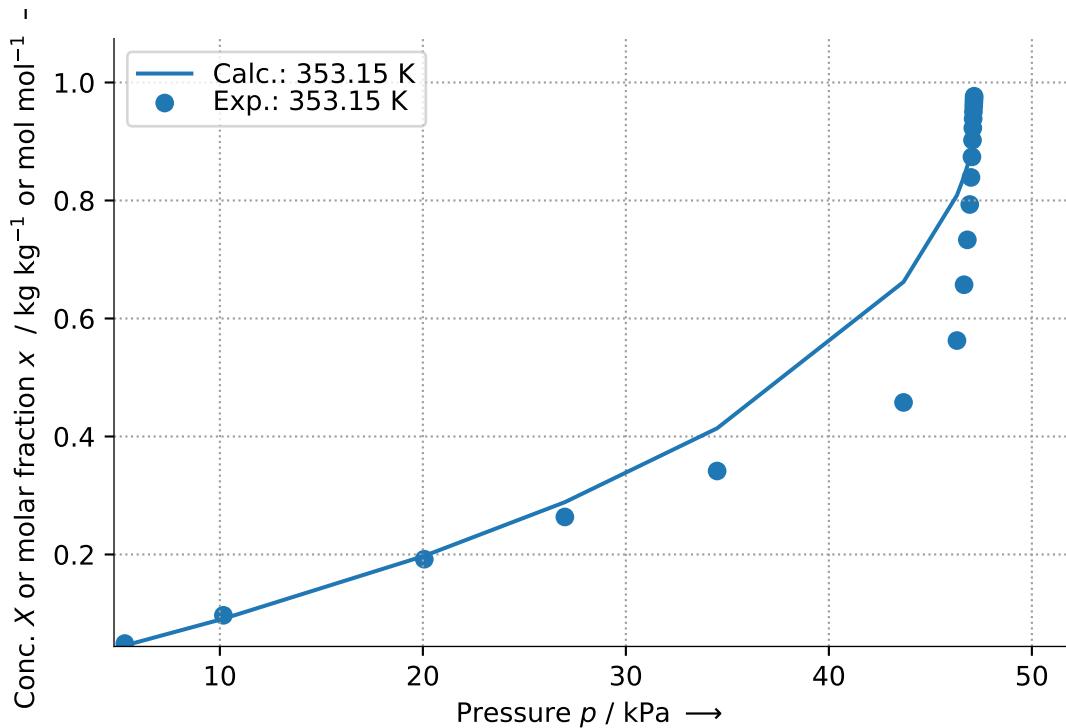
Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	J mol $^{-1}$	7.985164000e+03	$\Delta\lambda_{21}$	J mol $^{-1}$	1.673600000e+04
$v_1$	m $^3$ mol $^{-1}$	1.807000000e+01	$v_2$	m $^3$ mol $^{-1}$	2.917100000e+02

**Validity:**

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 11.84%.

### 6.25.11 Ionic liquid [DEMA][OMs]

#### 6.25.11.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[DEMA][OMs]
<b>Refrigerant:</b>	Water
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Römich, Christiane; Merkel, Nina C.; Valbonesi, Alessandro; Schaber, Karlheinz; Sauer, Sven; Schubert, Thomas J. S. (2012): Thermodynamic Properties of Binary Mixtures of Water and Room-Temperature Ionic Liquids. Vapor Pressures, Heat Capacities, Densities, and Viscosities of Water + 1-Ethyl-3-methylimidazolium Acetate and Water + Diethylmethylammonium Methane Sulfonate. In: J. Chem. Eng. Data 57 (8), S. 2258–2264. DOI: 10.1021/je300132e.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) && , \text{ and} \\
 G_{12} &= \exp(-\alpha_{12} \tau_{12}) && , \text{ and} \\
 G_{21} &= \exp(-\alpha_{21} \tau_{21}) && , \text{ and} \\
 \tau_{12} &= \Delta g_{12}/RT && , \text{ and} \\
 \tau_{21} &= \Delta g_{21}/RT && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

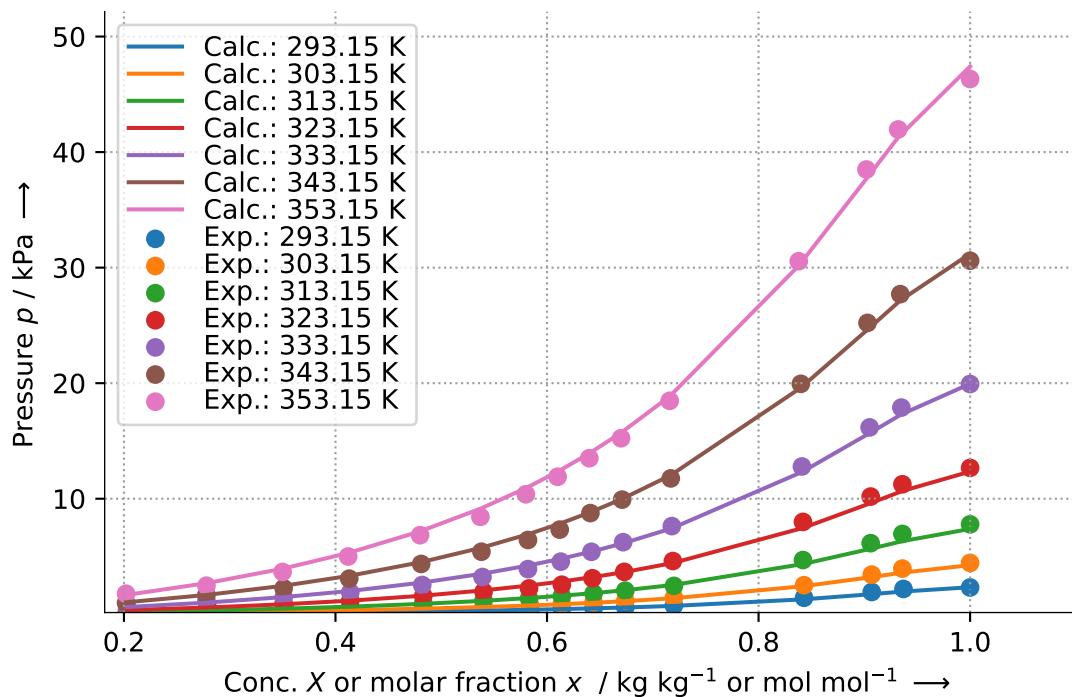
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	7.086200000e-01	$\alpha_{21}$	-	7.086200000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	-1.051400000e+03	$\Delta g_{21}$	J mol <sup>-1</sup>	-5.039900000e+03

#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 353.15\text{K}$ .

#### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.01

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 5.45%.

6.25.12 Ionic liquid [EMIM]+[(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>N]-

## 6.25.12.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	2.800000000e-01	$\alpha_{21}$	-	2.800000000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	1.291307920e+04	$\Delta g_{21}$	J mol <sup>-1</sup>	-1.458375040e+03

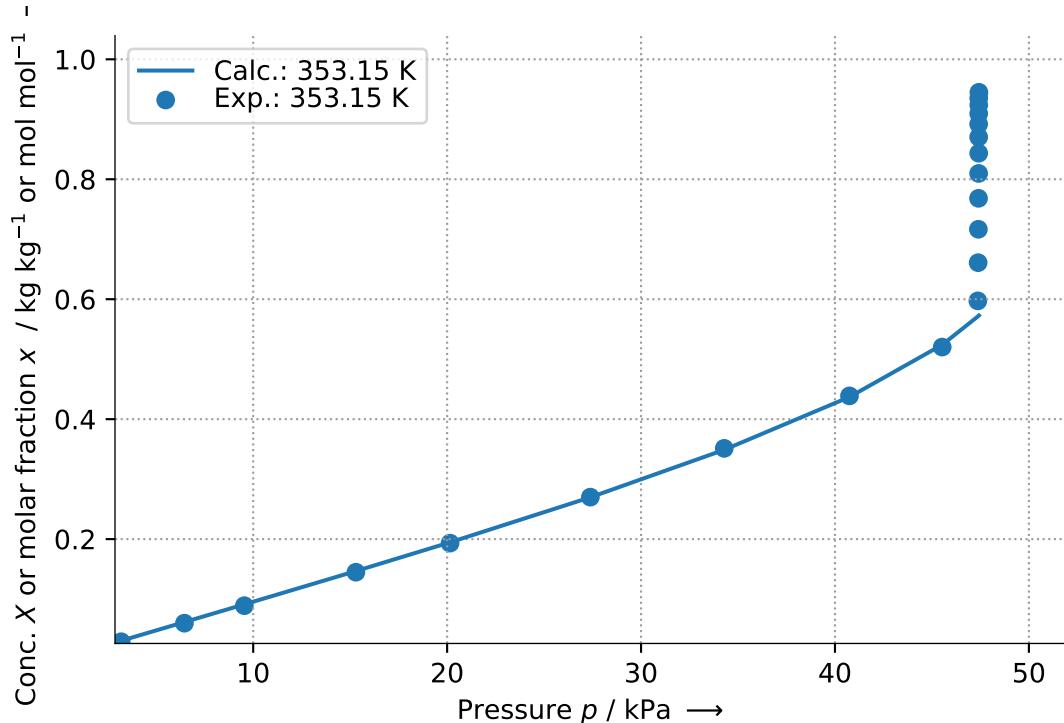
**Validity:**

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1



- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 17.31%.

### 6.25.12.2 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{ and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

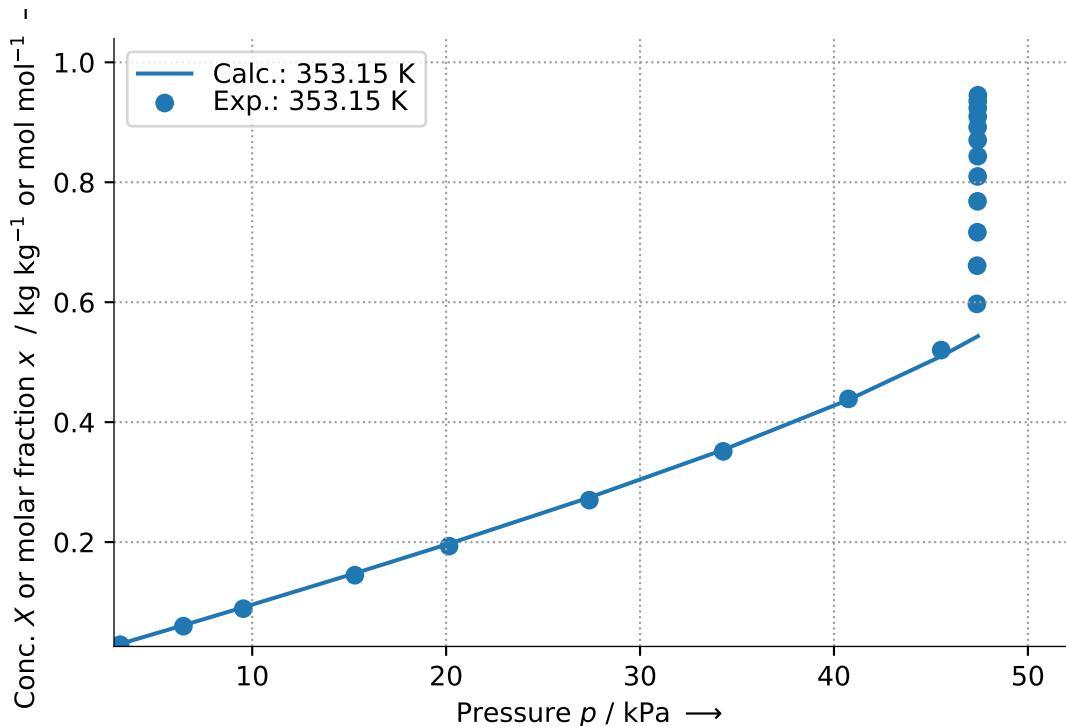
Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	6.721177600e+01	$\Delta u_{21}$	J mol <sup>-1</sup>	2.906499280e+03
$r_1$	-	9.200000000e-01	$r_2$	-	9.890000000e+00
$q_1$	-	1.400000000e+00	$q_2$	-	8.780000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

#### Visualization:

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 19.54%.

## 6.25.12.3 UniquacFixedDu - ID 2

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	2
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF3SO2)2N], [BMIM][(CF3SO2)2N], [MMIM][(CH3)2PO4] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

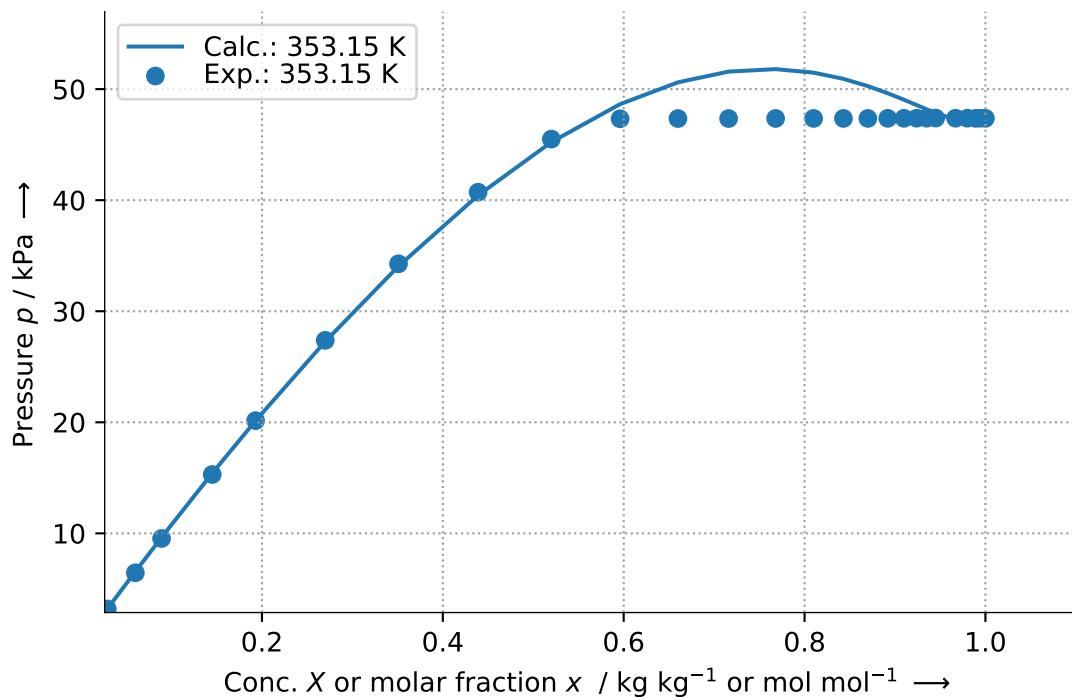
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} && , \text{and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) && , \text{and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) && , \text{and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) && , \text{and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) && , \text{and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} && , \text{and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} && , \text{and} \\
 x_2 &= 1 - x_1 && .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-2.304170640e+02	$\Delta u_{21}$	J mol <sup>-1</sup>	3.309585840e+03
$r_1$	-	9.200000000e-01	$r_2$	-	9.890000000e+00
$q_1$	-	1.400000000e+00	$q_2$	-	8.780000000e+00
$z$	-	1.000000000e+01			

**Validity:**

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.



### Visualization:

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 2.76%.

## 6.25.12.4 WilsonFixedDI - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM]+[(CF3SO2)2N]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	WilsonFixedDI
<b>ID:</b>	1
<b>Reference:</b>	Döker, Michael; Gmehling, Jürgen (2005): Measurement and prediction of vapor–liquid equilibria of ternary systems containing ionic liquids. In: Fluid Phase Equilibria 227 (2), S. 255–266. DOI: 10.1016/j.fluid.2004.11.010.
<b>Comment:</b>	None

**Equation and parameters:**

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, molar volumes of both components ( $v_1$  and  $v_2$ ) in m<sup>3</sup> mol<sup>-1</sup>, and vapor pressure  $p_{\text{sat},1}$  in Pa. If molar volumes less than zero are used as function arguments, constant molar volumes given by parameter record are used. Equilibrium equation is given by:

$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp \left( -\ln(x_1 + \Lambda_{12}x_2) + x_2 \left( \frac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \frac{\Lambda_{21}}{x_2 + \Lambda_{21}x_1} \right) \right) & , \text{ and} \\
 \Lambda_{12} &= \begin{cases} v_2/v_1 \exp(-\Delta\lambda_{12}/RT) & \text{if } \Lambda_{12}^* = 0 \\ \Lambda_{12}^* & \text{else} \end{cases} & , \text{ and} \\
 \Lambda_{21} &= \begin{cases} v_1/v_2 \exp(-\Delta\lambda_{21}/RT) & \text{if } \Lambda_{21}^* = 0 \\ \Lambda_{21}^* & \text{else} \end{cases} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

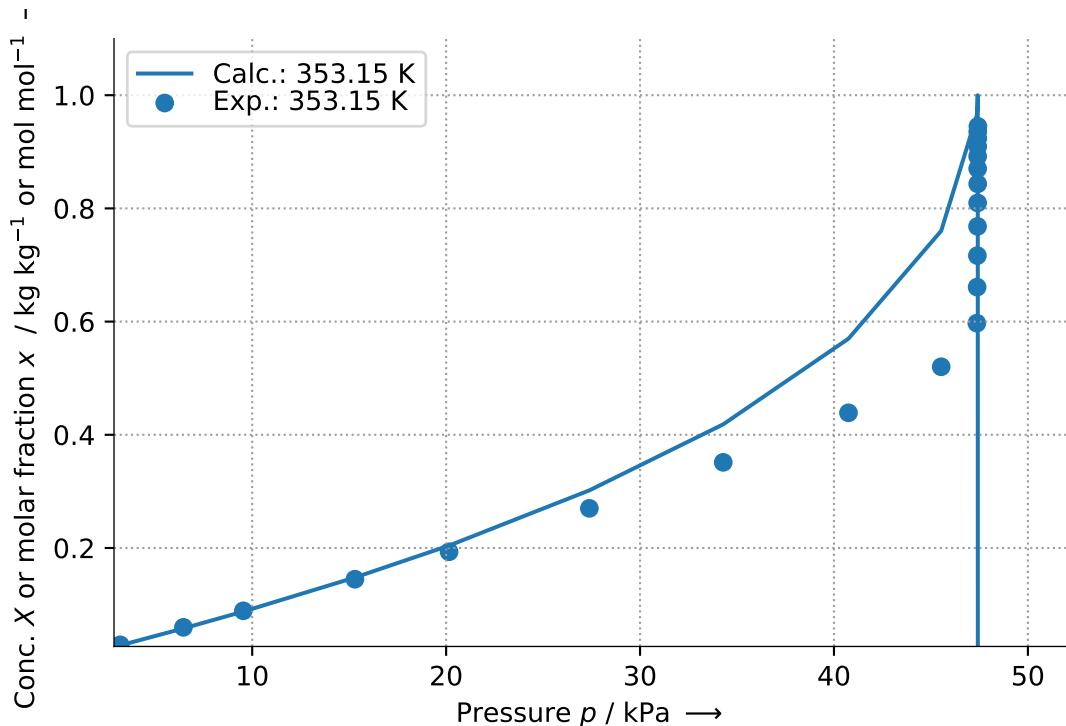
Par.	Unit	Value	Par.	Unit	Value
$\Lambda_{12}^*$	-	0.000000000e+00	$\Lambda_{21}^*$	-	0.000000000e+00
$\Delta\lambda_{12}$	J mol <sup>-1</sup>	7.363840000e+03	$\Delta\lambda_{21}$	J mol <sup>-1</sup>	1.673600000e+04
$v_1$	m <sup>3</sup> mol <sup>-1</sup>	1.807000000e+01	$v_2$	m <sup>3</sup> mol <sup>-1</sup>	2.445800000e+02

**Validity:**

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:



- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 28.45%.

### 6.25.13 Ionic liquid [EMIM][OAc]

#### 6.25.13.1 NRTLFixedDg - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[EMIM][OAc]
<b>Refrigerant:</b>	Water
<b>Equation:</b>	NRTLFixedDg
<b>ID:</b>	1
<b>Reference:</b>	Römich, Christiane; Merkel, Nina C.; Valbonesi, Alessandro; Schaber, Karlheinz; Sauer, Sven; Schubert, Thomas J. S. (2012): Thermodynamic Properties of Binary Mixtures of Water and Room-Temperature Ionic Liquids. Vapor Pressures, Heat Capacities, Densities, and Viscosities of Water + 1-Ethyl-3-methylimidazolium Acetate and Water + Diethylmethylammonium Methane Sulfonate. In: J. Chem. Eng. Data 57 (8), S. 2258–2264. DOI: 10.1021/je300132e.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

$$\begin{aligned} p &= \gamma_1 x_1 p_{\text{sat},1} \quad , \text{ and} \\ \gamma_1 &= \exp \left( x_2^2 \left( \tau_{21} \left( \frac{G_{21}}{x_1 + x_2 G_{21}} \right)^2 + \tau_{12} \frac{G_{12}}{(x_2 + x_1 G_{12})^2} \right) \right) \quad , \text{ and} \\ G_{12} &= \exp(-\alpha_{12} \tau_{12}) \quad , \text{ and} \\ G_{21} &= \exp(-\alpha_{21} \tau_{21}) \quad , \text{ and} \\ \tau_{12} &= \Delta g_{12}/RT \quad , \text{ and} \\ \tau_{21} &= \Delta g_{21}/RT \quad , \text{ and} \\ x_2 &= 1 - x_1 \quad . \end{aligned}$$

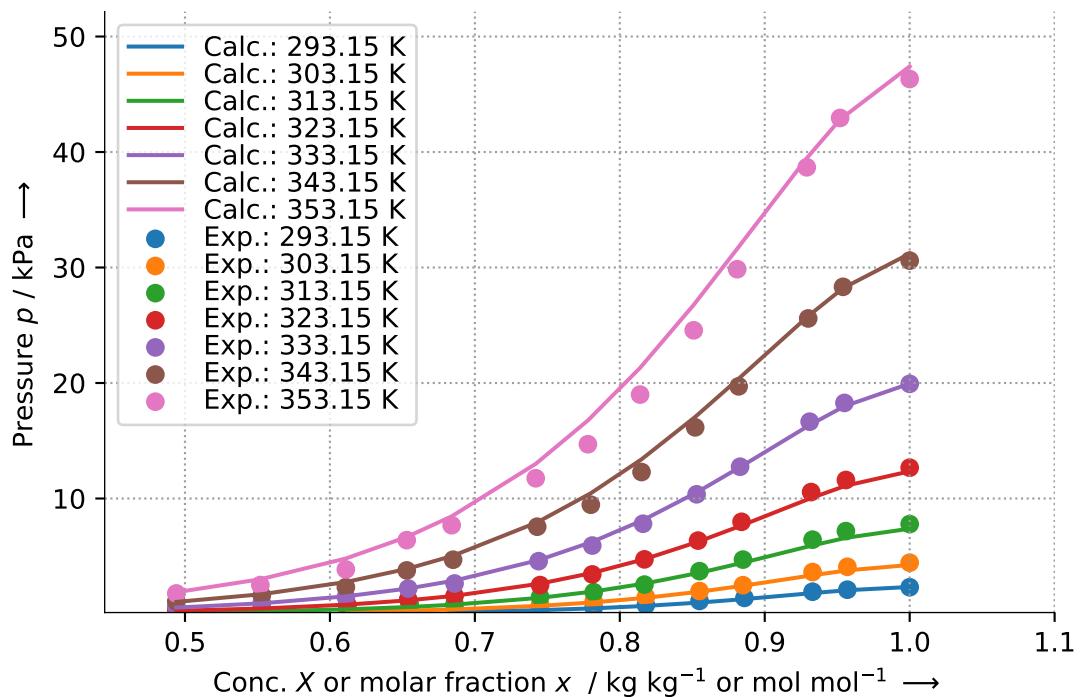
The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\alpha_{12}$	-	1.024300000e-01	$\alpha_{21}$	-	1.024300000e-01
$\Delta g_{12}$	J mol <sup>-1</sup>	2.893800000e+04	$\Delta g_{21}$	J mol <sup>-1</sup>	-2.569100000e+04

#### Validity:

Equation is approximately valid for  $303.15\text{K} \leq T \leq 353.15\text{K}$ .

#### Visualization:



To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table
- Temperature, absolute, in K → 0.01

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 6.74%.

### 6.25.14 Ionic liquid [MMIM]+[(CH<sub>3</sub>)<sub>2</sub>PO<sub>4</sub>]-

#### 6.25.14.1 UniquacFixedDu - ID 1

<b>Sorbent:</b>	ionic liquid
<b>Subtype:</b>	[MMIM]+[(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ]-
<b>Refrigerant:</b>	Water
<b>Equation:</b>	UniquacFixedDu
<b>ID:</b>	1
<b>Reference:</b>	Kato, Ryo; Gmehling, Jürgen (2005): Measurement and correlation of vapor–liquid equilibria of binary systems containing the ionic liquids [EMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [BMIM][(CF <sub>3</sub> SO <sub>2</sub> ) <sub>2</sub> N], [MMIM][(CH <sub>3</sub> ) <sub>2</sub> PO <sub>4</sub> ] and oxygenated organic compounds respectively water. In: Fluid Phase Equilibria 231 (1), S. 38–43. DOI: 10.1016/j.fluid.2005.01.002.
<b>Comment:</b>	None

#### Equation and parameters:

Pressure  $p$  in Pa is calculated depending on molar fraction of refrigerant in the liquid phase  $x_1$  in mol mol<sup>-1</sup>, temperature  $T$  in K, and vapor pressure  $p_{\text{sat},1}$  in Pa by:

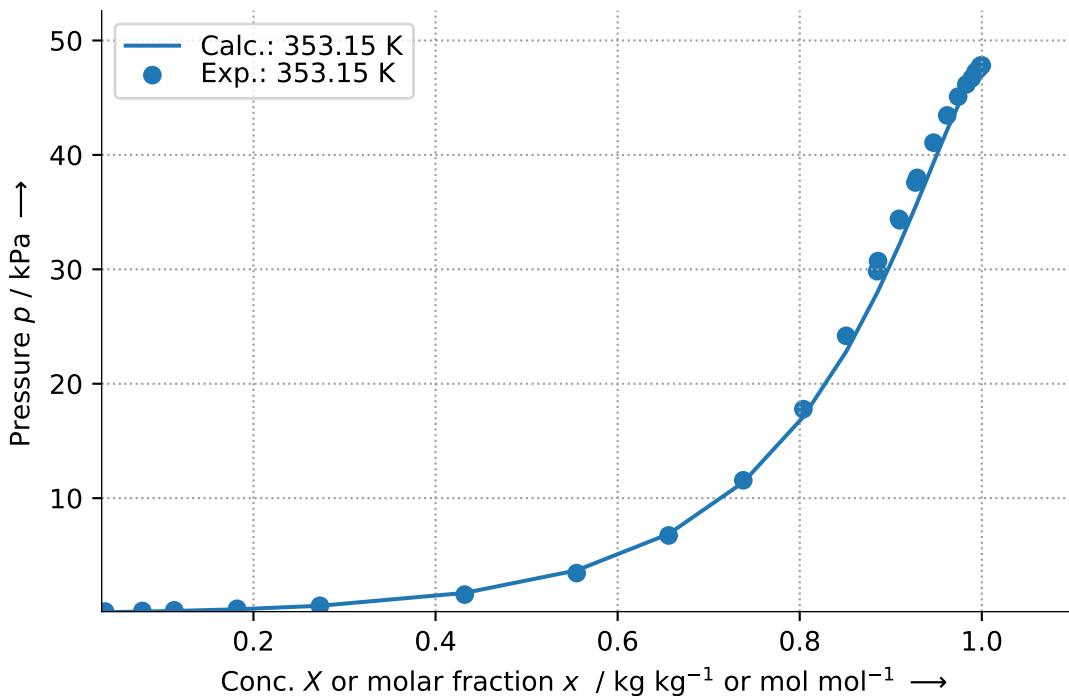
$$\begin{aligned}
 p &= \gamma_1 x_1 p_{\text{sat},1} & , \text{ and} \\
 \gamma_1 &= \exp(\ln(\Phi_1/x_1) + q_1 z/2 \ln(\Theta_1/\Phi_1) + l_1 - \Phi_1/x_2 (x_1 l_1 + x_2 l_2) + \Gamma) & , \text{ and} \\
 \Gamma &= -q_1 \ln(\Theta_1 + \Theta_2 \tau_{21}) + q_1 - q_1 \left( \frac{\Theta_1}{\Theta_1 + \Theta_2 \tau_{21}} + \frac{\Theta_2 \tau_{12}}{\Theta_1 \tau_{12} + \Theta_2} \right) & , \text{ and} \\
 \tau_{ij} &= \exp(\Delta u_{ij}/RT) & , \text{ and} \\
 l_i &= z/2 (r_i - q_i) (r_i - 1) & , \text{ and} \\
 \Theta_i &= \frac{q_i x_i}{\sum_{j=1}^2 q_j x_j} & , \text{ and} \\
 \Phi_i &= \frac{r_i x_i}{\sum_{j=1}^2 r_j x_j} & , \text{ and} \\
 x_2 &= 1 - x_1 & .
 \end{aligned}$$

The parameters of the equation are:

Par.	Unit	Value	Par.	Unit	Value
$\Delta u_{12}$	J mol <sup>-1</sup>	-2.949300000e+03	$\Delta u_{21}$	J mol <sup>-1</sup>	-3.130100000e+03
$r_1$	-	9.200000000e-01	$r_2$	-	7.162000000e+00
$q_1$	-	1.400000000e+00	$q_2$	-	5.844000000e+00
$z$	-	1.000000000e+01			

#### Validity:

Equation is approximately valid for 353.15K  $\leq T \leq$  353.15K.

**Visualization:**

To generate the figure, the following refrigerant functions were selected:

- Vapor pressure: VaporPressure\_EoS1 - ID 1
- Saturated liquid density: SaturatedLiquidDensity\_EoS1 - ID 1

The uncertainty of the experimental data is:

- Data source → Data was taken from table

The mean absolute percentage error (MAPE) between the experimental and calculated data results in 7.68%.