Appendix C: Property Tables for R134a

Tables C-1 and C-2 present data for saturated liquid and saturated vapor. Table C-1 is presented information at regular intervals of temperature while Table C-2 is presented at regular intervals of pressure. Table C-3 presents data for superheated vapor over a matrix of temperatures and pressures. These tables were generated using EES with the substance R134a which implements the fundamental equation of state developed by R. Tillner-Roth and H.D. Baehr, 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, J. Phys. Chem, Ref. Data, Vol. 23, No. 5, 1994.

Table C-1: Properties of Saturated R134a, Presented at Regular Intervals of Temperature

Temp. T (°C)	Pressure P (kPa)	Specific volume (m^3/kg)		Specific internal energy (kJ/kg)		Specific enthalpy (kJ/kg)		Specific entropy (kJ/kg-K)		T (°C)
		$10^3\ v_f$	v_g	u_f	u_g	h_f	h_g	s_f	s_g	
-40	51.25	0.7053	0.36064	-0.04	207.38	0.00	225.86	0.0000	0.9687	**-40**
-35	66.19	0.7126	0.28373	6.25	210.25	6.29	229.03	0.0267	0.9619	**-35**
-30	84.43	0.7201	0.22577	12.58	213.12	12.64	232.19	0.0530	0.9559	**-30**
-25	106.5	0.7280	0.18152	18.95	215.99	19.03	235.32	0.0789	0.9505	**-25**
-20	132.8	0.7361	0.14735	25.37	218.86	25.47	238.43	0.1046	0.9457	**-20**
-15	164.0	0.7445	0.12066	31.85	221.72	31.97	241.51	0.1299	0.9415	**-15**
-10	200.7	0.7533	0.09960	38.38	224.56	38.53	244.55	0.1550	0.9378	**-10**
-5	243.5	0.7625	0.08282	44.96	227.38	45.15	247.55	0.1798	0.9345	**-5**
0	293.0	0.7722	0.06934	51.61	230.18	51.83	250.50	0.2043	0.9316	**0**
5	349.9	0.7823	0.05840	58.31	232.96	58.59	253.39	0.2287	0.9290	**5**
10	414.9	0.7929	0.04947	65.09	235.69	65.42	256.22	0.2528	0.9266	**10**
15	488.7	0.8041	0.04211	71.93	238.39	72.32	258.97	0.2768	0.9245	**15**
20	572.1	0.8160	0.03601	78.85	241.04	79.32	261.64	0.3006	0.9225	**20**
25	665.8	0.8286	0.03092	85.85	243.64	86.40	264.23	0.3243	0.9207	**25**
30	770.6	0.8421	0.02665	92.93	246.17	93.58	266.71	0.3479	0.9190	**30**
35	887.5	0.8565	0.02304	100.11	248.63	100.87	269.08	0.3714	0.9173	**35**
40	1017	0.8720	0.01997	107.39	251.00	108.28	271.31	0.3949	0.9155	**40**
45	1161	0.8889	0.01734	114.79	253.27	115.82	273.40	0.4184	0.9137	**45**
50	1319	0.9072	0.01509	122.30	255.42	123.50	275.32	0.4419	0.9117	**50**
55	1492	0.9274	0.01314	129.96	257.43	131.35	277.03	0.4655	0.9095	**55**
60	1688	0.9498	0.01144	137.79	259.25	139.38	278.51	0.4893	0.9069	**60**
65	1891	0.9751	0.00996	145.80	260.86	147.64	279.69	0.5133	0.9038	**65**
70	2118	1.0038	0.00865	154.04	262.20	156.16	280.52	0.5377	0.9000	**70**
75	2366	1.0372	0.00749	162.54	263.17	165.00	280.88	0.5625	0.8953	**75**
80	2635	1.0774	0.00644	171.43	263.66	174.27	280.63	0.5881	0.8893	**80**
85	2928	1.1273	0.00548	180.81	263.45	184.11	279.51	0.6149	0.8812	**85**
90	3247	1.1938	0.00459	190.94	262.13	194.82	277.04	0.6435	0.8699	**90**
95	3594	1.2945	0.00371	202.49	258.73	207.14	272.08	0.6760	0.8524	**95**
100	3975	1.5269	0.00266	218.73	248.46	224.80	259.02	0.7222	0.8139	**100**
101.03	4059	1.9685	0.0019685	232.95	233.90	241.88	241.88	0.7678	0.7678	**101.03**

Table C-2: Properties of Saturated R134a, Presented at Regular Intervals of Pressure

Pressure P (kPa)	Temp. T (°C)	Specific volume (m^3/kg)		Specific internal energy (kJ/kg)		Specific enthalpy (kJ/kg)		Specific entropy (kJ/kg-K)		P (kPa)
		$10^3\ v_f$	v_g	u_f	u_g	h_f	h_g	s_f	s_g	
40	-44.61	0.699	0.45483	-5.79	204.74	-5.76	222.94	-0.0249	0.9757	**40**
60	-36.95	0.710	0.31108	3.79	209.13	3.84	227.80	0.0163	0.9644	**60**
80	-31.13	0.718	0.23749	11.14	212.48	11.20	231.47	0.0471	0.9572	**80**
100	-26.37	0.726	0.19255	17.19	215.21	17.27	234.46	0.0718	0.9519	**100**
200	-10.09	0.753	0.09995	38.26	224.51	38.41	244.50	0.1545	0.9379	**200**
300	0.65	0.773	0.06778	52.48	230.55	52.71	250.88	0.2075	0.9312	**300**
400	8.91	0.791	0.05127	63.61	235.10	63.92	255.61	0.2476	0.9271	**400**
500	15.71	0.806	0.04117	72.92	238.77	73.32	259.36	0.2802	0.9242	**500**
600	21.55	0.820	0.03433	81.01	241.86	81.50	262.46	0.3080	0.9220	**600**
700	26.69	0.833	0.02939	88.24	244.51	88.82	265.08	0.3323	0.9201	**700**
800	31.31	0.846	0.02565	94.80	246.82	95.48	267.34	0.3541	0.9185	**800**
900	35.51	0.858	0.02270	100.84	248.88	101.62	269.31	0.3738	0.9171	**900**
1000	39.37	0.870	0.02033	106.47	250.71	107.34	271.04	0.3920	0.9157	**1000**
1200	46.29	0.893	0.01673	116.72	253.84	117.79	273.92	0.4245	0.9132	**1200**
1400	52.40	0.917	0.01412	125.96	256.40	127.25	276.17	0.4532	0.9107	**1400**
1600	57.88	0.940	0.01213	134.45	258.50	135.96	277.92	0.4792	0.9080	**1600**
1800	62.87	0.964	0.01057	142.36	260.21	144.09	279.23	0.5030	0.9052	**1800**
2000	67.45	0.989	0.00930	149.81	261.56	151.78	280.15	0.5252	0.9020	**2000**
2200	71.70	1.015	0.00824	156.90	262.57	159.13	280.70	0.5460	0.8985	**2200**
2400	75.66	1.042	0.00734	163.70	263.27	166.20	280.89	0.5658	0.8946	**2400**
2600	79.37	1.072	0.00657	170.29	263.63	173.08	280.70	0.5848	0.8901	**2600**
2800	82.86	1.104	0.00588	176.73	263.64	179.82	280.11	0.6033	0.8849	**2800**
3000	86.16	1.141	0.00527	183.09	263.26	186.51	279.08	0.6213	0.8789	**3000**
3200	89.29	1.182	0.00472	189.41	262.41	193.19	277.50	0.6392	0.8718	**3200**
3400	92.26	1.233	0.00420	195.91	260.96	200.10	275.23	0.6575	0.8631	**3400**
3600	95.08	1.297	0.00370	202.66	258.65	207.32	271.97	0.6765	0.8521	**3600**
3800	97.76	1.387	0.00319	210.26	254.87	215.54	266.99	0.6980	0.8367	**3800**
4000	100.31	1.562	0.00256	220.43	246.82	226.68	257.05	0.7272	0.8085	**4000**
4059	101.03	1.9685	0.0019685	232.95	233.90	241.88	241.88	0.7678	0.7678	**4059**

Table C-3: Properties of Superheated R134a: Pressures from 80 kPa to 400 kPa

P (kPa)		Temperature, *T* (°C)										
		-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**
80	*v* (m^3/kg)	0.2388	0.2501	0.2611	0.2720	0.2828	0.2935	0.3041	0.3147	0.3252	0.3357	0.3462
	u (kJ/kg)	213.2	220.2	227.2	234.3	241.6	249.1	256.7	264.5	272.4	280.6	288.8
	h (kJ/kg)	232.4	240.2	248.1	256.1	264.3	272.6	281.0	289.7	298.5	307.4	316.5
	s (kJ/kg-K)	0.9608	0.9922	1.023	1.053	1.082	1.111	1.139	1.167	1.195	1.222	1.249
100	*v* (m^3/kg)		0.1984	0.2074	0.2163	0.2251	0.2337	0.2423	0.2509	0.2594	0.2678	0.2763
	u (kJ/kg)		219.7	226.8	234.0	241.3	248.8	256.5	264.3	272.2	280.4	288.7
	h (kJ/kg)		239.5	247.5	255.6	263.8	272.2	280.7	289.4	298.2	307.1	316.3
	s (kJ/kg-K)		0.9721	1.003	1.033	1.063	1.092	1.12	1.149	1.176	1.204	1.231
120	*v* (m^3/kg)		0.1639	0.1716	0.1792	0.1866	0.1939	0.2011	0.2083	0.2155	0.2226	0.2296
	u (kJ/kg)		219.2	226.4	233.6	241.0	248.5	256.2	264.0	272.0	280.2	288.5
	h (kJ/kg)		238.9	246.9	255.1	263.4	271.8	280.3	289.0	297.9	306.9	316.0
	s (kJ/kg-K)		0.9553	0.9866	1.017	1.047	1.076	1.105	1.133	1.161	1.188	1.215
140	*v* (m^3/kg)			0.1461	0.1526	0.1591	0.1654	0.1717	0.1779	0.1841	0.1903	0.1964
	u (kJ/kg)			225.9	233.2	240.7	248.2	255.9	263.8	271.8	280	288.3
	h (kJ/kg)			246.4	254.6	262.9	271.4	280	288.7	297.6	306.6	315.8
	s (kJ/kg-K)			0.9724	1.003	1.033	1.062	1.091	1.12	1.147	1.175	1.202
160	*v* (m^3/kg)			0.1268	0.1327	0.1385	0.1441	0.1496	0.1551	0.1606	0.1660	0.1714
	u (kJ/kg)			225.5	232.9	240.4	248.0	255.7	263.6	271.6	279.8	288.1
	h (kJ/kg)			245.8	254.1	262.5	271.0	279.6	288.4	297.3	306.3	315.5
	s (kJ/kg-K)			0.9599	0.9909	1.021	1.051	1.08	1.108	1.136	1.164	1.191
180	*v* (m^3/kg)			0.1119	0.1172	0.1224	0.1275	0.1325	0.1374	0.1423	0.1471	0.152
	u (kJ/kg)			225.0	232.5	240.0	247.7	255.4	263.3	271.4	279.6	287.9
	h (kJ/kg)			245.2	253.6	262.1	270.6	279.3	288.1	297.0	306.1	315.3
	s (kJ/kg-K)			0.9485	0.9799	1.010	1.040	1.069	1.098	1.126	1.153	1.181
200	*v* (m^3/kg)			0.09991	0.1048	0.1096	0.1142	0.1187	0.1232	0.1277	0.1321	0.1364
	u (kJ/kg)			224.6	232.1	239.7	247.4	255.2	263.1	271.2	279.4	287.7
	h (kJ/kg)			244.6	253.1	261.6	270.2	278.9	287.7	296.7	305.8	315.0
	s (kJ/kg-K)			0.9381	0.9699	1.001	1.030	1.060	1.088	1.116	1.144	1.171
300	*v* (m^3/kg)					0.0709	0.0742	0.0775	0.0806	0.0837	0.0868	0.0898
	u (kJ/kg)					237.9	245.8	253.8	261.9	270.1	278.4	286.8
	h (kJ/kg)					259.2	268.1	277.0	286.1	295.2	304.4	313.8
	s (kJ/kg-K)					0.9611	0.9920	1.022	1.051	1.080	1.108	1.136
400	*v* (m^3/kg)					0.0515	0.0542	0.0568	0.0593	0.0617	0.0641	0.0664
	u (kJ/kg)					236.0	244.2	252.4	260.6	268.9	277.3	285.9
	h (kJ/kg)					256.6	265.9	275.1	284.3	293.6	303.0	312.5
	s (kJ/kg-K)					0.9306	0.9628	0.9937	1.024	1.053	1.081	1.109
P (kPa)		**-30**	**-20**	**-10**	**0**	**10**	**20**	**30**	**4 0**	**50**	**60**	**70**
		Temperature, *T* (°C)										

Table C-3 (continued): Properties of Superheated Vapor: Pressures from 500 kPa to 1.3 MPa

P (kPa)		Temperature, T (°C)										
		20	**30**	**40**	**50**	**60**	**70**	**80**	**900**	**100**	**110**	**120**
500	v (m^3/kg)	0.0421	0.0443	0.0465	0.0485	0.0505	0.0524	0.0543	0.0562	0.0580	0.0599	0.0617
	u (kJ/kg)	242.4	250.9	259.3	267.7	276.3	284.9	293.7	302.5	311.5	320.6	329.9
	h (kJ/kg)	263.5	273.0	282.5	292.0	301.5	311.1	320.8	330.6	340.5	350.6	360.8
	s (kJ/kg-K)	0.9384	0.9704	1.001	1.031	1.06	1.088	1.116	1.144	1.171	1.197	1.223
600	v (m^3/kg)		0.0360	0.0379	0.0397	0.0414	0.0431	0.0447	0.0463	0.0479	0.0494	0.051
	u (kJ/kg)		249.2	257.9	266.5	275.2	283.9	292.7	301.7	310.7	319.9	329.2
	h (kJ/kg)		270.8	280.6	290.3	300.0	309.8	319.6	329.5	339.5	349.6	359.8
	s (kJ/kg-K)		0.95	0.9817	1.012	1.042	1.071	1.099	1.126	1.154	1.18	1.207
700	v (m^3/kg)		0.0300	0.0317	0.0333	0.0349	0.0364	0.0378	0.0393	0.0406	0.0420	0.0434
	u (kJ/kg)		247.5	256.4	265.2	274.0	282.9	291.8	300.8	310	319.2	328.6
	h (kJ/kg)		268.5	278.6	288.5	298.4	308.3	318.3	328.3	338.4	348.6	358.9
	s (kJ/kg-K)		0.9314	0.9642	0.9955	1.026	1.055	1.084	1.112	1.139	1.166	1.192
800	v (m^3/kg)			0.0270	0.0286	0.0300	0.0313	0.0327	0.0339	0.0352	0.0364	0.0376
	u (kJ/kg)			254.8	263.9	272.8	281.8	290.9	300.0	309.2	318.5	327.9
	h (kJ/kg)			276.5	286.7	296.8	306.9	317	327.1	337.3	347.6	358.0
	s (kJ/kg-K)			0.9481	0.9803	1.011	1.041	1.07	1.098	1.126	1.153	1.18
900	v (m^3/kg)			0.0234	0.02481	0.0262	0.0274	0.0286	0.0298	0.0310	0.0321	0.0332
	u (kJ/kg)			253.2	262.5	271.6	280.7	289.9	299.1	308.4	317.7	327.2
	h (kJ/kg)			274.2	284.8	295.1	305.4	315.6	325.9	336.2	346.6	357.0
	s (kJ/kg-K)			0.9328	0.9661	0.9977	1.028	1.057	1.086	1.114	1.141	1.168
1000	v (m^3/kg)			0.0204	0.0218	0.0231	0.0243	0.0254	0.0265	0.0276	0.0286	0.0296
	u (kJ/kg)			251.3	261.0	270.3	279.6	288.9	298.2	307.5	317.0	326.5
	h (kJ/kg)			271.7	282.8	293.4	303.9	314.3	324.7	335.1	345.5	356.1
	s (kJ/kg-K)			0.918	0.9526	0.9851	1.016	1.046	1.075	1.103	1.131	1.158
1100	v (m^3/kg)				0.0193	0.0205	0.0217	0.0228	0.0238	0.0248	0.0257	0.0267
	u (kJ/kg)				259.4	269.0	278.4	287.8	297.2	306.7	316.2	325.8
	h (kJ/kg)				280.6	291.6	302.3	312.9	323.4	333.9	344.5	355.1
	s (kJ/kg-K)				0.9396	0.973	1.005	1.035	1.065	1.093	1.121	1.148
1200	v (m^3/kg)				0.0172	0.0184	0.0195	0.0205	0.0215	0.0224	0.0234	0.0242
	u (kJ/kg)				257.6	267.6	277.2	286.8	296.3	305.8	315.4	325.1
	h (kJ/kg)				278.3	289.7	300.6	311.4	322.1	332.7	343.4	354.1
	s (kJ/kg-K)				0.9268	0.9615	0.9939	1.025	1.055	1.084	1.112	1.139
1300	v (m^3/kg)				0.0154	0.0166	0.0177	0.0187	0.0196	0.0205	0.0213	0.0222
	u (kJ/kg)				255.8	266.1	276.0	285.7	295.3	304.9	314.6	324.3
	h (kJ/kg)				275.8	287.6	298.9	309.9	320.8	331.5	342.3	353.1
	s (kJ/kg-K)				0.914	0.9501	0.9835	1.015	1.045	1.075	1.103	1.131
P (kPa)		**20**	**30**	**40**	**50**	**60**	**70**	**80**	**900**	**100**	**110**	**120**
		Temperature, T (°C)										

Table C-3 (continued): Properties of Superheated Vapor: Pressures from 1.4 MPa to 3.0 MPa

P (kPa)		Temperature, T (°C)										
		60	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**
1400	v (m^3/kg)	0.0150	0.0161	0.0170	0.0179	0.0188	0.0196	0.0204	0.0212	0.0219	0.0226	0.0234
	u (kJ/kg)	264.5	274.6	284.5	294.3	304	313.8	323.6	333.4	343.4	353.4	363.5
	h (kJ/kg)	285.5	297.1	308.4	319.4	330.3	341.2	352.1	363	374	385.1	396.2
	s (kJ/kg-K)	0.939	0.9734	1.006	1.036	1.066	1.095	1.123	1.15	1.177	1.204	1.23
1600	v (m^3/kg)	0.0124	0.0134	0.0144	0.0152	0.0160	0.0168	0.0175	0.0182	0.0189	0.0196	0.0202
	u (kJ/kg)	260.9	271.8	282.1	292.2	302.2	312.1	322	332	342.1	352.2	362.4
	h (kJ/kg)	280.7	293.3	305.1	316.5	327.8	338.9	350	361.1	372.3	383.5	394.7
	s (kJ/kg-K)	0.9164	0.9536	0.9875	1.019	1.05	1.08	1.108	1.136	1.163	1.19	1.216
1800	v (m^3/kg)		0.0113	0.0123	0.0131	0.0139	0.0146	0.0153	0.0159	0.0165	0.0171	0.0177
	u (kJ/kg)		268.6	279.5	289.9	300.2	310.3	320.4	330.6	340.7	351	361.3
	h (kJ/kg)		288.9	301.5	313.5	325.1	336.6	347.9	359.2	370.5	381.8	393.2
	s (kJ/kg-K)		0.9338	0.97	1.003	1.035	1.065	1.094	1.123	1.15	1.178	1.204
2000	v (m^3/kg)		0.0096	0.0105	0.0114	0.0121	0.0128	0.0134	0.0141	0.0146	0.0152	0.0158
	u (kJ/kg)		264.8	276.6	287.5	298.1	308.5	318.8	329.1	339.4	349.7	360.1
	h (kJ/kg)		283.9	297.6	310.3	322.3	334.1	345.7	357.2	368.6	380.1	391.6
	s (kJ/kg-K)		0.9131	0.9525	0.9877	1.02	1.052	1.081	1.11	1.138	1.166	1.193
2200	v (m^3/kg)			0.0091	0.0099	0.0107	0.0113	0.0120	0.0125	0.0131	0.0136	0.0142
	u (kJ/kg)			273.3	284.9	295.9	306.6	317.1	327.5	338	348.4	358.9
	h (kJ/kg)			293.3	306.7	319.3	331.5	343.4	355.1	366.8	378.4	390
	s (kJ/kg-K)			0.9346	0.9722	1.006	1.039	1.069	1.099	1.127	1.155	1.182
2400	v (m^3/kg)			0.0078	0.0087	0.0094	0.0101	0.0107	0.0113	0.0118	0.0123	0.0128
	u (kJ/kg)			269.4	282	293.5	304.5	315.3	325.9	336.5	347.1	357.7
	h (kJ/kg)			288.2	302.9	316.2	328.8	341	353	364.8	376.6	388.4
	s (kJ/kg-K)			0.9154	0.9565	0.9926	1.026	1.057	1.087	1.117	1.145	1.172
2600	v (m^3/kg)			0.0066	0.0076	0.0084	0.0090	0.0096	0.0102	0.0107	0.0112	0.0117
	u (kJ/kg)			264.6	278.8	291	302.4	313.4	324.3	335	345.7	356.4
	h (kJ/kg)			281.9	298.6	312.8	325.9	338.5	350.8	362.9	374.8	386.8
	s (kJ/kg-K)			0.8935	0.9401	0.9787	1.013	1.046	1.077	1.106	1.135	1.163
2600	v (m^3/kg)				0.0067	0.0075	0.0081	0.0087	0.0093	0.0098	0.0102	0.0107
	u (kJ/kg)				275	288.2	300.1	311.5	322.6	333.5	344.3	355.2
	h (kJ/kg)				293.6	309.1	322.9	335.9	348.5	360.8	373	385.1
	s (kJ/kg-K)				0.9226	0.9645	1.001	1.035	1.066	1.096	1.126	1.154
3000	v (m^3/kg)				0.0058	0.0066	0.0073	0.0079	0.0084	0.0089	0.0094	0.0098
	u (kJ/kg)				270.4	285	297.7	309.4	320.8	331.9	342.9	353.9
	h (kJ/kg)				287.7	305	319.6	333.2	346.1	358.7	371.1	383.4
	s (kJ/kg-K)				0.9027	0.9497	0.9885	1.023	1.056	1.087	1.116	1.145
P (kPa)		**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**
		Temperature, T (°C)										