Tennessee Eastman Process (TEP)

Physical Properties & Thermodynamic Constants

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Source: teprob.f (TEINIT subroutine)

Total Constants: 112 physical properties

Components: 8 chemical species (A-H)

Overview

This document contains all physical properties, thermodynamic constants, and calculation methods used in the Tennessee Eastman Process (TEP) Fortran simulation. All constants are extracted from the TEINIT subroutine in teprob.f and represent a complete, self-contained thermodynamic property database.

Component Identification

Component	ID	Description	Type	MW (kg/kmol)
A	1	Hydrogen-like	Light Gas	2.0
B	2	Intermediate	Gas	25.4
C	3	Nitrogen-like	Gas	28.0
D	4	Oxygen-like	Condensable	32.0
E	5	Heavy Reactant	Condensable	46.0
F	6	Byproduct	Condensable	48.0
G	7	Product 1	Heavy Product	62.0
H	8	Product 2	Heavy Product	76.0

Thermodynamic Equations

Liquid Enthalpy (TESUB1)

```
H = Σ[Xi × MWi × T × (AHi + BHi×T/2 + CHi×T²/3) × 1.8]
```

Gas Enthalpy (TESUB1)

```
H = Σ[Xi × MWi × (T×(AGi + BGi×T/2 + CGi×T²/3) + AVi) × 1.8]
```

Liquid Density (TESUB4)

```
ρ = 1/Σ[Xi × MWi / (ADi + BDi×T + CDi×T²)]
```

Antoine Equation

```
ln(P) = AVPi + BVPi/(T + CVPi)
```

Newton-Raphson (TESUB2)

```
T_new = T_old - (H_calc - H_target)/(dH/dT)
```

Physical Property Constants

Molecular Weights & Antoine Constants

Comp	MW	AVP	BVP	CVP
A	2.0	0.0	0.0	0.0
B	25.4	0.0	0.0	0.0
C	28.0	0.0	0.0	0.0
D	32.0	15.92	-1444.0	259.0
E	46.0	16.35	-2114.0	265.5
F	48.0	16.35	-2114.0	265.5
G	62.0	16.43	-2748.0	232.9
H	76.0	17.21	-3318.0	249.6

Heat Capacity Constants (×10■■)

Comp	AH	BH(×10³)	CH(×10■)	AG	BG(×10■)	CG(×10■)	AV
A	1.0	0.0	0.0	3.411	7.18	6.0	1.0
B	1.0	0.0	0.0	0.380	10.8	-3.98	1.0
C	1.0	0.0	0.0	0.249	0.136	-0.393	1.0
D	0.960	8.70	4.81	0.357	8.51	-3.12	86.7
E	0.573	2.41	1.82	0.346	8.96	-3.27	160.0
F	0.652	2.18	1.94	0.393	10.2	-3.12	160.0
G	0.515	0.565	0.382	0.170	0.0	0.0	225.0
H	0.471	0.870	0.262	0.150	0.0	0.0	209.0

Liquid Density Constants

Component	AD	BD	CD (×10³)
A	1.0	0.0	0.0
B	1.0	0.0	0.0
C	1.0	0.0	0.0
D	23.3	-0.0700	-0.2
E	33.9	-0.0957	-0.152
F	32.8	-0.0995	-0.233
G	49.9	-0.0191	-0.425
H	50.5	-0.0541	-0.150

Summary

This document provides complete transparency into the Tennessee Eastman Process thermodynamic property calculations. All 112 constants are explicitly documented, making this simulation exceptionally transparent compared to commercial process simulators. The TEP simulation uses standard chemical engineering correlations (Antoine equation, polynomial heat capacities, temperature-dependent densities) with component-specific parameters that enable accurate process modeling for fault diagnosis and control studies.

Reference

Tennessee Eastman Process Control Test Problem Authors: James J. Downs and Ernest F. Vogel Organization: Tennessee Eastman Company Reference: "A Plant-Wide Industrial Process Control Problem", AIChE 1990 Annual Meeting