Gas Thermal Conductivity at Low Pressure (Stiel–Thodos and Chung)

Thermal conductivity of a pure gas at low pressure from viscosity, heat capacity and molar mass by the Stiel–Thodos (Eucken-type) and Chung–Lee–Starling methods.

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Temperature	226.85	°C
Critical temperature	318.60	°C
Acentric factor	0.26400	
Molar mass	92.138	kg/kmol
Gas viscosity at T	0.011408	cP
Ideal-gas heat capacity at T (J/(mol·K)) Per mole, not per kg: multiply a value in J/(kg·K) by the molar mass in kg/mol.	170.78	
Molecule shape (Stiel–Thodos)	Nonlinear	

Calculated results

Parameter	Value	Unit
Heat capacity at constant volume (J/(mol·K))	162.47	
Thermal conductivity, Stiel–Thodos	0.025226	W/(m·K)
Chung Ψ	7.2931	
Thermal conductivity, Chung	0.028155	W/(m·K)

Notes for this case

- Perry's: about 15 % for either method; Stiel–Thodos is meant for nonpolar gases, Chung also suits polar ones. Estimate for design; use measured data where they exist.

Formula and method

$$\frac{kM}{\eta C_v} = 1.15 + 2.033\frac{R}{C_v}\ \text{(nonlinear)},\quad 1.30 + 1.7614\frac{R}{C_v} - \frac{0.3523}{T_r}\ \text{(linear)},\quad 2.5\ \text{(monatomic)}$$

$$\frac{kM}{\eta C_v} = \frac{3.75\Psi}{C_v/R},\quad \Psi = 1 + \alpha\frac{0.215 + 0.28288\alpha - 1.061\beta + 0.26665Z}{0.6366 + \beta Z + 1.061\alpha\beta}$$

$$\alpha = \frac{C_v}{R} - 1.5,\quad \beta = 0.7862 - 0.7109\omega + 1.3168\omega^2,\quad Z = 2.0 + 10.5T_r^2$$

Variables

T	Temperature	K
T_c	Critical temperature	K
ω	Acentric factor	-
M	Molar mass	kg/kmol
η	Gas viscosity at T	Pa·s
C_p°	Ideal-gas heat capacity at T (J/(mol·K))	-
shape	Molecule shape (Stiel–Thodos)	-

C_v	Heat capacity at constant volume (J/(mol·K))	-
k_{ST}	Thermal conductivity, Stiel–Thodos	W/(m·K)
Ψ	Chung Ψ	-
k_{Chung}	Thermal conductivity, Chung	W/(m·K)

Method and standards

Stiel–Thodos and Chung–Lee–Starling.

Assumptions and limits

- Low pressure; C_v = C_p° − R.
- C_p° is per mole, in J/(mol·K), and at least 2.5R; a per-kg value must be multiplied by the molar mass first.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 2
- Eqs. (2-103) to (2-108) (Stiel–Thodos; Chung, Lee and Starling) with the toluene example

Report details

Report reference	FCC-66FW-0WHA (the same inputs always give the same reference)
Generated	17 November 2026, 19:36 UTC
Calculator	Gas Thermal Conductivity at Low Pressure (Stiel–Thodos and Chung)
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 reference cases of this calculator, computed independently, are checked on every release

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Reopens the calculator with the inputs of this report.