Liquid Thermal Conductivity (Pachaiyappan, Missenard)

Thermal conductivity of an organic liquid: modified Pachaiyappan for hydrocarbons, and Missenard from boiling point, density and heat capacity.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Temperature	60.000	°C
Critical temperature	387.35	°C
Molar mass	134.22	kg/kmol
Hydrocarbon class (Pachaiyappan)	Branched, cyclic or aromatic	
Molar volume at 20 °C	162.01	cm³/mol
Normal boiling point (Missenard)	183.25	°C
Liquid molar density at 0 °C (kmol/m³)	6.3600	
Liquid heat capacity at 0 °C (J/(mol·K))	225.00	
Atoms in the molecule	24.000	

Calculated results

Parameter	Value	Unit
Thermal conductivity, Pachaiyappan	0.11207	W/(m·K)
Missenard conductivity at 0 °C	0.12558	W/(m·K)
Thermal conductivity, Missenard	0.11457	W/(m·K)

Notes for this case

- Pachaiyappan applies to hydrocarbons only (about 10 %); Missenard to nonassociating organics (about 20 %). Estimate for design; use measured data where they exist.

Formula and method

$$k = \frac{CM^m}{V_{293}} \cdot \frac{3 + 20(1 - T_r)^{2/3}}{3 + 20(1 - T_{r,293})^{2/3}} \quad (C = 0.1811,\ m = 1.001 \text{ or } C = 0.4407,\ m = 0.7717)$$

$$k_{273} = \frac{8.4\, T_b^{1/2} \rho_{273}^{1/2} M^{-1/2} C_{p,273}}{n_A^{1/4}} \ \mathrm{mW/(m\,K)} \ (\rho \ \mathrm{mol/cm^3})$$

Variables

T	Temperature	K
T_c	Critical temperature	K
M	Molar mass	kg/kmol
class	Hydrocarbon class (Pachaiyappan)	-
V_{293}	Molar volume at 20 °C	m³/mol
T_b	Normal boiling point (Missenard)	K
ρ_{273}	Liquid molar density at 0 °C (kmol/m³)	-
$C_{p,273}$	Liquid heat capacity at 0 °C (J/(mol·K))	-
n_A	Atoms in the molecule	-

k_P	Thermal conductivity, Pachaiyappan	W/(m·K)
k_{273}	Missenard conductivity at 0 °C	W/(m·K)
k_M	Thermal conductivity, Missenard	W/(m·K)

Method and standards

Modified Pachaiyappan; Missenard with Perry's temperature correction.

Assumptions and limits

- Low to moderate pressure; the liquid state is not checked, but a note appears above the normal boiling point.
- The Missenard defaults (molar density 6.36 kmol/m³, C_p 225 J/(mol·K), 24 atoms) are illustrative n-butylbenzene-like values without a particular source; the second preset uses Perry's m-xylene data. The 273 K reference in the Missenard temperature correction follows the 0 °C basis of k_{273}; using 273.15 K would change the result by far less than its accuracy.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 2
- Eqs. (2-109)
- (2-111) and (2-112) (modified Pachaiyappan; Missenard) with the n-butylbenzene and m-xylene examples

Report details

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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/physical-properties/liquid-thermal-conductivity-estimate

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Reopens the calculator with the inputs of this report.