Thermal Conductivity of a Liquid Mixture (Filippov and Li)

Thermal conductivity of a binary liquid mixture from the pure-liquid values by the Filippov mass-fraction correlation and the Li volume-fraction method.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Conductivity of liquid 1	0.13830	W/(m·K)
Conductivity of liquid 2	0.20690	W/(m·K)
Mole fraction of liquid 1	30.200	%
Molar mass of 1	74.122	kg/kmol
Molar mass of 2	32.042	kg/kmol
Molar density of 1 (kmol/m³)	9.9335	
Molar density of 2 (kmol/m³)	25.371	

Calculated results

Parameter	Value	Unit
Mass fraction of 1	50.022	%
Volume fraction of 1	52.495	%
Mixture conductivity, Filippov	0.16024	W/(m·K)
Mixture conductivity, Li	0.16749	W/(m·K)
Mass-fraction average (for comparison)	0.17259	W/(m·K)

Notes for this case

• Perry's: 4–8 % for both; mixtures fall below the linear average. Aqueous mixtures with strong interactions may differ more. Estimate for design; use measured data where they exist.

Formula and method

$$k_{Filippov} = w_1 k_1 + w_2 k_2 - 0.72 w_1 w_2 |k_2 - k_1|$$

$$k_{Li} = \sum_i \sum_j \phi_i \phi_j \frac{2 k_i k_j}{k_i + k_j}, \quad \phi_i = \frac{x_i / \rho_i}{\sum x_j / \rho_j}$$

Variables

k_1	Conductivity of liquid 1	W/(m·K)
k_2	Conductivity of liquid 2	W/(m·K)
x_1	Mole fraction of liquid 1	-
M_1	Molar mass of 1	kg/kmol
M_2	Molar mass of 2	kg/kmol
ρ_1	Molar density of 1 (kmol/m³)	-
ρ_2	Molar density of 2 (kmol/m³)	-
w_1	Mass fraction of 1	-
ϕ_1	Volume fraction of 1	-
$k_{Filippov}$	Mixture conductivity, Filippov	W/(m·K)
k_{Li}	Mixture conductivity, Li	W/(m·K)

k_{linear}	Mass-fraction average (for comparison)	W/(m·K)

Method and standards

Filippov and Li correlations.

Assumptions and limits

- Binary; pure values at the mixture temperature.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 2
- Eqs. (2-113) (Filippov) and (2-114) (Li) with the diethyl ether–methanol example

Report details

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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-mixture-thermal-conductivity

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Reopens the calculator with the inputs of this report.