Nanofluid Properties: Conductivity, Density, Specific Heat, Viscosity

Thermal conductivity (Maxwell, Hamilton–Crosser), density, specific heat and viscosity (Einstein, Brinkman) of a nanofluid from particle and base-fluid data.

Input parameters

Unit system: SI

Parameter	Value	Unit
Particle volume fraction	1.0000	%
Particle conductivity	3,000.0	W/(m·K)
Base fluid conductivity	0.25000	W/(m·K)
Particle sphericity (1 = sphere)	50.000	%
Particle density	2,100.0	kg/m³
Base fluid density	1,110.0	kg/m³
Particle specific heat	0.70000	kJ/(kg·K)
Base fluid specific heat	2.4000	kJ/(kg·K)
Base fluid viscosity	16.000	mPa·s

Calculated results

Parameter	Value	Unit
Conductivity, Maxwell	0.25757	W/(m·K)
Conductivity, Hamilton–Crosser	0.26514	W/(m·K)
Density	1,119.9	kg/m³
Specific heat, volume-weighted	2,383.0	J/(kg·K)
Specific heat, heat-capacity balance (recommended)	2,368.1	J/(kg·K)
Viscosity, Einstein	16.400	mPa·s
Viscosity, Brinkman	16.407	mPa·s

Notes for this case

- Classical effective-medium models; measured nanofluid conductivity and viscosity are often higher (particle size, clustering, Brownian motion), so use measured data for design.

Formula and method

$$k_{nf} = k_f \frac{k_p + 2k_f + 2\phi(k_p - k_f)}{k_p + 2k_f - \phi(k_p - k_f)}, \quad k_{HC} = k_f \frac{k_p + (n-1)k_f - (n-1)\phi(k_f - k_p)}{k_p + (n-1)k_f + \phi(k_f - k_p)}, \quad n = \frac{3}{\psi}$$

$$\rho_{nf} = \phi\rho_p + (1-\phi)\rho_f, \quad (\rho c_p)_{nf} = \phi(\rho c_p)_p + (1-\phi)(\rho c_p)_f, \quad \mu_{nf} = \frac{\mu_f}{(1-\phi)^{2.5}}$$

Variables

ϕ	Particle volume fraction	-
k_p	Particle conductivity	W/(m·K)
k_f	Base fluid conductivity	W/(m·K)
ψ	Particle sphericity (1 = sphere)	-
ρ_p	Particle density	kg/m³

ρ_f	Base fluid density	kg/m³
$c_{p,p}$	Particle specific heat	J/(kg·K)
$c_{p,f}$	Base fluid specific heat	J/(kg·K)
μ_f	Base fluid viscosity	Pa·s
$k_{nf,Maxwell}$	Conductivity, Maxwell	W/(m·K)
$k_{nf,HC}$	Conductivity, Hamilton–Crosser	W/(m·K)
ρ_{nf}	Density	kg/m³
$c_{p,nf}$	Specific heat, volume-weighted	J/(kg·K)
$\mu_{nf,Einstein}$	Viscosity, Einstein	Pa·s
$\mu_{nf,Brinkman}$	Viscosity, Brinkman	Pa·s

Method and standards

Effective-medium property models for suspensions.

Assumptions and limits

- Dilute, well-dispersed suspensions.

Report details

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Release checks	3 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/mechanical/heat-transfer/nanofluid-thermophysical-properties

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Reopens the calculator with the inputs of this report.