Thermal Conductivity of a Particulate Composite

Effective thermal conductivity of a matrix with dispersed particles by the Maxwell–Eucken equation, with the parallel and series bounds.

Method: Maxwell (1873) / Eucken (1940) equation for dispersed spheres; Wiener parallel and series bounds

Input parameters

Unit system: SI

Parameter	Value	Unit
Matrix (continuous phase) conductivity	0.20000	W/(m·K)
Dispersed particle conductivity	30.000	W/(m·K)
Particle volume fraction	30.000	%

Calculated results

Parameter	Value	Unit
Maxwell–Eucken conductivity	0.44995	W/(m·K)
Parallel (upper) bound	9.1400	W/(m·K)
Series (lower) bound	0.28490	W/(m·K)

Notes for this case

• Maxwell–Eucken for spheres not touching each other (dilute to moderate loading). Above roughly 30–40 % the particles form conducting paths and conductivity rises faster (percolation).

Formula and method

$$k = k_m \frac{k_d + 2k_m + 2\phi(k_d - k_m)}{k_d + 2k_m - \phi(k_d - k_m)}$$

Variables

k_m	Matrix (continuous phase) conductivity	W/(m·K)
k_d	Dispersed particle conductivity	W/(m·K)
ϕ	Particle volume fraction	-
k_{ME}	Maxwell–Eucken conductivity	W/(m·K)
$k_{\parallel}$	Parallel (upper) bound	W/(m·K)
$k_{\perp}$	Series (lower) bound	W/(m·K)

Method and standards

Maxwell–Eucken.

Assumptions and limits

- Spherical, non-touching particles.

References

• Maxwell (1873) / Eucken (1940) equation for dispersed spheres; Wiener parallel and series bounds

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/materials/properties/particulate-composite-conductivity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.