Alloy Electrical Resistivity (Matthiessen and Nordheim)

Electrical resistivity of a dilute or binary solid-solution alloy at temperature from the pure metal's thermal part and Nordheim's rule, with conductivity and %IACS.

Method: Matthiessen's and Nordheim's rules

Input parameters

Unit system: SI

Parameter	Value	Unit
Pure metal resistivity at 20 °C	1.7200	µΩ·cm
Temperature coefficient of the pure metal (1/K)	0.003930	
Temperature	20.000	°C
Nordheim coefficient	450.00	µΩ·cm
Solute atom fraction	1.0000	%

Calculated results

Parameter	Value	Unit
Thermal (lattice) resistivity	1.7200	µΩ·cm
Solute (impurity) resistivity	4.4550	µΩ·cm
Alloy resistivity	6.1750	µΩ·cm
Conductivity	1.6194e+07	S/m
Conductivity as % IACS	27.921	

Notes for this case

• Matthiessen's rule adds independent scattering contributions: lattice vibrations (rising roughly linearly with temperature) and solute atoms (nearly independent of temperature). Nordheim's rule gives the solute part of a disordered binary solid solution as ρ_i = Cx(1 − x), which explains why even small additions lower the conductivity of copper and aluminium conductors sharply. 100 % IACS is 1/58 Ω·mm²/m = 1.7241 µΩ·cm. Ordered alloys and compounds do not follow the rule.

Formula and method

$$\rho = \rho_{20}[1 + \alpha(T - 293.15)] + Cx(1 - x)$$

Variables

ρ_{20}	Pure metal resistivity at 20 °C	Ω·m
α	Temperature coefficient of the pure metal (1/K)	-
T	Temperature	K
C	Nordheim coefficient	Ω·m
x	Solute atom fraction	-
ρ_T	Thermal (lattice) resistivity	Ω·m
ρ_i	Solute (impurity) resistivity	Ω·m
ρ	Alloy resistivity	Ω·m
σ	Conductivity	S/m
$\%IACS$	Conductivity as % IACS	-

Method and standards

Alloy resistivity.

Assumptions and limits

- Disordered solid solution; linear temperature dependence.

References

Matthiessen's and Nordheim's rules

Report details

Report reference	FCC-56WR-4A8B (the same inputs always give the same reference)
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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/materials/properties/nordheim-alloy-resistivity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.