Heat Loss Through a Composite Wall (Three Layers)

Heat flux and interface temperatures through a plane wall of up to three layers with inside and outside surface coefficients, by thermal resistances in series.

Method: Fourier conduction with resistances in series (Incropera, DeWitt, Bergman and Lavine, Fundamentals of Heat and Mass Transfer, ch. 3)

Input parameters

Unit system: SI

Parameter	Value	Unit
Inside fluid temperature	900.00	°C
Outside fluid temperature	30.000	°C
Inside surface coefficient	50.000	W/(m²·K)
Outside surface coefficient (convection + radiation)	10.000	W/(m²·K)
Layer 1 thickness	230.00	mm
Layer 1 conductivity	1.2000	W/(m·K)
Layer 2 thickness	115.00	mm
Layer 2 conductivity	0.25000	W/(m·K)
Layer 3 thickness	6.0000	mm
Layer 3 conductivity	45.000	W/(m·K)

Calculated results

Parameter	Value	Unit
Overall coefficient	1.2957	W/(m²·K)
Heat flux	1,127.2	W/m²
Inside surface temperature	877.46	°C
Interface 1–2 temperature	661.40	°C
Interface 2–3 temperature	142.87	°C
Outside surface temperature	142.72	°C

Notes for this case

- Conductivities at the mean temperature of each layer; check each interface against the layer's temperature limit.

Formula and method

$$q'' = \frac{T_{in} - T_{out}}{\frac{1}{h_i} + \sum \frac{L_j}{k_j} + \frac{1}{h_o}}$$

Variables

T_{in}	Inside fluid temperature	K
T_{out}	Outside fluid temperature	K
h_i	Inside surface coefficient	W/(m²·K)
h_o	Outside surface coefficient (convection + radiation)	W/(m²·K)
L_1	Layer 1 thickness	m
k_1	Layer 1 conductivity	W/(m·K)
L_2	Layer 2 thickness	m
k_2	Layer 2 conductivity	W/(m·K)

L_3	Layer 3 thickness	m
k_3	Layer 3 conductivity	W/(m·K)
U	Overall coefficient	W/(m²·K)
q''	Heat flux	W/m²
$T_{s,i}$	Inside surface temperature	K
T_{12}	Interface 1–2 temperature	K
T_{23}	Interface 2–3 temperature	K
$T_{s,o}$	Outside surface temperature	K

Method and standards

Steady one-dimensional conduction.

Assumptions and limits

- Plane wall, steady state.
- Constant conductivities: enter each at its layer's mean temperature and repeat if the interface temperatures move a lot (refractory conductivity varies strongly with temperature).
- A fixed outside coefficient h_o including radiation: at hot surfaces radiation makes h_o depend on the surface temperature, so check h_o against the T_s,o found and repeat.

References

• Fourier conduction with resistances in series (Incropera, DeWitt, Bergman and Lavine, Fundamentals of Heat and Mass Transfer, ch. 3)

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/composite-wall-conduction

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.