Boiler Tube Metal Temperature from Heat Flux

Inside, outside and mean wall temperature of a boiler tube from the fluid temperature, inside film coefficient, scale, wall conduction and outside heat flux.

Method: Conduction through a cylindrical wall with film and scale resistances in series

Input parameters

Unit system: SI

Parameter	Value	Unit
Fluid temperature inside the tube	300.00	°C
Inside film coefficient	20,000	W/(m²·K)
Heat flux on the outside surface	250.00	kW/m²
Tube outside diameter	63.500	mm
Wall thickness	6.0000	mm
Wall thermal conductivity	40.000	W/(m·K)
Inside scale (fouling) resistance	0	m²·K/W

Calculated results

Parameter	Value	Unit
Outside wall temperature (hottest)	356.98	°C
Mean wall temperature	336.19	°C
Inside wall temperature	315.41	°C
Rise across the inside film	15.413	K
Rise across the scale	0	K
Rise across the wall	41.564	K

Notes for this case

- Compare the outside and mean metal temperatures with the allowable temperature of the tube material.

Formula and method

$$d_i = d_o - 2w \qquad q_i'' = q'' \frac{d_o}{d_i} \qquad \Delta T_f = \frac{q_i''}{h_i} \qquad \Delta T_s = q_i'' R_s \qquad \Delta T_w = \frac{q''\,(d_o/2)\ln(d_o/d_i)}{k_w}$$

$$T_i = T_f + \Delta T_f + \Delta T_s \qquad T_o = T_i + \Delta T_w \qquad T_m = T_i + \frac{\Delta T_w}{2}$$

Variables

T_f	fluid temperature	K
h_i	inside film coefficient	W/(m²·K)
q''	heat flux on the outside surface	W/m²
d_o	outside diameter	m
w	wall thickness	m
k_w	wall conductivity	W/(m·K)
R_s	scale resistance	m²·K/W
T_o	outside wall temperature	K
T_m	mean wall temperature	K
T_i	inside wall temperature	K

ΔT_f	rise across the film	K
ΔT_s	rise across the scale	K
ΔT_w	rise across the wall	K
d_i	inside diameter	m
q_i''	flux at the inside surface	W/m²

Method and standards

One-dimensional radial conduction with the heat flux referred to the outside surface; film and scale resistances on the inside area.

Assumptions and limits

- Uniform flux around the tube, referred to the outside surface; steady state. Furnace wall tubes are heated on one side with a peak flux at the crown: enter the peak local flux for the hottest point.
- The mean wall temperature is the arithmetic mean of the inside and outside values.
- A note appears above about 450 °C on the outside wall.

References

- Conduction through a cylindrical wall with film and scale resistances in series

Report details

Report reference	FCC-AC34-2BYP (the same inputs always give the same reference)
Generated	17 November 2026, 19:38 UTC
Calculator	Boiler Tube Metal Temperature from Heat Flux
Method last reviewed	11 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/boilers-power-plant/boiler-pressure-parts/tube-metal-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.