Insulation Thickness for Personnel Protection (Surface Temperature)

Insulation thickness that keeps the outer surface of a hot pipe at or below a safe touch temperature, with the heat loss at that thickness.

Method: Radial conduction with a surface coefficient; thickness by bisection

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outside diameter	114.30	mm
Pipe (process) temperature	250.00	°C
Ambient temperature	35.000	°C
Highest safe surface temperature	60.000	°C
Insulation thermal conductivity at mean temperature	0.045000	W/(m·K)
Outer surface coefficient (convection plus radiation)	9.0000	W/(m²·K)

Calculated results

Parameter	Value	Unit
Insulation thickness needed	30.860	mm
Surface temperature at that thickness	60.000	°C
Heat loss per metre	124.42	W/m
Outer diameter of insulation	176.02	mm

Notes for this case

• Heat flows out through the insulation (resistance $\ln(r_2/r_1)/(2\pi k)$ per metre) and from the surface to the air ($1/(2\pi r_2 h)$). The surface temperature is ambient plus the heat flow times the surface resistance; the thickness is found by bisection so that it equals the safe limit, commonly 60 °C for metal jacketing and slightly higher for non-metallic surfaces. Bright metal jacketing radiates little, so its surface coefficient is lower and it runs hotter: use a lower h for it.

Formula and method

$$q = \frac{T_i - T_a}{\frac{\ln(r_2/r_1)}{2\pi k} + \frac{1}{2\pi r_2 h_s}}, \quad T_s = T_a + \frac{q}{2\pi r_2 h_s} \le T_{max}$$

Variables

D	Pipe outside diameter	m
T_i	Pipe (process) temperature	K
T_a	Ambient temperature	K
T_{max}	Highest safe surface temperature	K
k	Insulation thermal conductivity at mean temperature	W/(m·K)
h_s	Outer surface coefficient (convection plus radiation)	W/(m²·K)
t	Insulation thickness needed	m
T_s	Surface temperature at that thickness	K
q	Heat loss per metre	W/m
D_o	Outer diameter of insulation	m

Method and standards

Personnel protection.

Assumptions and limits

- Steady state; uniform conductivity.

References

Radial conduction with a surface coefficient, thickness by bisection

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/piping/personnel-protection-insulation

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Reopens the calculator with the inputs of this report.