Electric Heat Tracing for Pipe Freeze Protection

Heat loss of an insulated pipe at the lowest ambient for a maintain temperature, the design heat with margin, number of tracer passes and circuit power.

Method: Cylindrical insulation heat loss for trace heating

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outside diameter	114.00	mm
Insulation thickness	50.000	mm
Insulation conductivity at mean temperature	0.040000	W/(m·K)
Outside heat transfer coefficient	15.000	W/(m²·K)
Maintain temperature	5.0000	°C
Lowest ambient temperature	-20.000	°C
Safety factor	1.2000	
Cable output at the maintain temperature	25.000	W/m
Circuit length	100.00	m
Supply voltage	230.00	V

Calculated results

Parameter	Value	Unit
Heat loss per metre	9.5970	W/m
Design heat per metre	11.516	W/m
Tracer passes	1.0000	
Circuit power	2.5000	kW
Circuit current	10.870	A

Notes for this case

- q' = (T_m − T_a)/R', R' = ln(r₂/r₁)/(2πλ) + 1/(2πr₂h); add valves, flanges and supports as extra length (often 10–30 %). Self-regulating cable output falls as pipe temperature rises; take output and maximum circuit length from the maker's data.

Formula and method

$$q' = \frac{T_m - T_a}{\frac{\ln(r_2/r_1)}{2\pi\lambda} + \frac{1}{2\pi r_2 h_o}}, \quad n = \left\lceil \frac{k_s q'}{q_c} \right\rceil$$

Variables

D_o	Pipe outside diameter	m
t_{ins}	Insulation thickness	m
λ	Insulation conductivity at mean temperature	W/(m·K)
h_o	Outside heat transfer coefficient	W/(m²·K)
T_m	Maintain temperature	K
T_a	Lowest ambient temperature	K
k_s	Safety factor	-
q_c	Cable output at the maintain temperature	W/m

L	Circuit length	m
V	Supply voltage	V
q'	Heat loss per metre	W/m
q'_d	Design heat per metre	W/m
n	Tracer passes	-
P	Circuit power	W
I	Circuit current	A

Method and standards

Trace heating.

Assumptions and limits

- Steady state; dry insulation.

References

Cylindrical insulation heat loss for trace heating

Report details

Report reference	FCC-XB30-XDB1 (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/mechanical/piping/electric-heat-tracing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.