Heat Loss from a Buried Pipe (Conduction Shape Factor)

Heat loss per metre from a buried horizontal pipe to the ground surface by the conduction shape factor, with an optional insulation layer in series.

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outside diameter (bare)	219.00	mm
Depth of the pipe centre below the surface	1.2000	m
Soil thermal conductivity	1.5000	W/(m·K)
Pipe outer wall temperature	80.000	°C
Ground surface temperature	5.0000	°C
Insulation thickness (0 = bare)	60.000	mm
Insulation conductivity	0.027000	W/(m·K)

Calculated results

Parameter	Value	Unit
Shape factor per metre	2.3752	
Soil resistance per metre	0.28068	
Insulation resistance per metre	2.5755	
Heat loss per metre of pipe	26.259	W/m

Notes for this case

• Shape factor S = 2πL/cosh⁻¹(2z/D) for a long isothermal cylinder in a semi-infinite medium with an isothermal surface. Resistances are in K·m/W. Moist soil conducts 1–2.5 W/(m·K), dry sand 0.3.

Formula and method

$$S = \frac{2\pi L}{\cosh^{-1}(2z/D)}, \quad q' = \frac{T_p - T_s}{\frac{1}{k_e S/L} + \frac{\ln(D_{ins}/D)}{2\pi k_{ins}}}$$

Variables

D	Pipe outside diameter (bare)	m
z	Depth of the pipe centre below the surface	m
k_e	Soil thermal conductivity	W/(m·K)
T_p	Pipe outer wall temperature	K
T_s	Ground surface temperature	K
t_{ins}	Insulation thickness (0 = bare)	m
k_{ins}	Insulation conductivity	W/(m·K)
S/L	Shape factor per metre	-
R_e	Soil resistance per metre	-
R_{ins}	Insulation resistance per metre	-
q'	Heat loss per metre of pipe	W/m

Method and standards

Conduction shape factor for a buried cylinder in series with insulation.

Assumptions and limits

- Steady state, uniform soil, long pipe.

Report details

Report reference	FCC-3EC1-8PK7 (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/heat-transfer/buried-pipe-heat-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.