Temperature Drop along an Insulated Liquid Pipeline

Outlet temperature of a hot liquid flowing through an insulated pipeline in ambient air, the heat lost and the length at which it reaches a minimum temperature.

Method: Exponential temperature decay along an insulated pipe

Input parameters

Unit system: SI

Parameter	Value	Unit
Mass flow	18.000	t/h
Liquid specific heat	2.0000	kJ/(kg·K)
Pipe outside diameter	168.00	mm
Insulation thickness	50.000	mm
Insulation conductivity	0.045000	W/(m·K)
Outside heat transfer coefficient	10.000	W/(m²·K)
Inlet temperature	120.00	°C
Ambient temperature	15.000	°C
Pipeline length	2,000.0	m
Minimum allowed temperature	80.000	°C

Calculated results

Parameter	Value	Unit
Heat loss coefficient per metre	0.56480	W/(m·K)
Outlet temperature	108.78	°C
Heat lost	112.15	kW
Length to reach the minimum temperature	8.4910	km

Notes for this case

• T(x) = T_a + (T₀ − T_a)·exp(−U'x/(ṁc_p)), U' from insulation and outside film (fluid film and pipe wall neglected, conservative). Viscous products such as fuel oil and bitumen need tracing where the minimum length is shorter than the line.

Formula and method

$$T(x) = T_a + (T_0 - T_a)\exp\left(-\frac{U'x}{\dot{m}c_p}\right), \quad L_{min} = \frac{\dot{m}c_p}{U'}\ln\frac{T_0 - T_a}{T_{min} - T_a}$$

Variables

$\dot{m}$	Mass flow	kg/s
c_p	Liquid specific heat	J/(kg·K)
D_o	Pipe outside diameter	m
t_{ins}	Insulation thickness	m
λ	Insulation conductivity	W/(m·K)
h_o	Outside heat transfer coefficient	W/(m²·K)
T_0	Inlet temperature	K
T_a	Ambient temperature	K
L	Pipeline length	m
T_{min}	Minimum allowed temperature	K

U'	Heat loss coefficient per metre	W/(m·K)
T_L	Outlet temperature	K
$\dot{Q}$	Heat lost	W
L_{min}	Length to reach the minimum temperature	m

Method and standards

Line cooling.

Assumptions and limits

- Steady flow; constant properties; uniform insulation.

References

Exponential temperature decay along an insulated pipe

Report details

Report reference	FCC-V380-3QED (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/liquid-pipeline-temperature-drop

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Reopens the calculator with the inputs of this report.