Steam Tracing Heat Loss and Steam Consumption

Heat lost from an insulated steam-traced pipe held at a set temperature in cold weather (ISO 12241), and the tracer steam needed to replace it.

Method: ISO 12241; IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Traced pipe outer diameter	114.30	mm
Insulation thickness	50.000	mm
Insulation thermal conductivity	0.045000	W/(m·K)
Temperature to maintain	60.000	°C
Lowest design ambient temperature	-5.0000	°C
Emissivity of the cladding	0.10000	
Traced length	200.00	m
Tracer steam pressure (absolute, saturated)	4.5000	bar

Calculated results

Parameter	Value	Unit
Heat loss per metre	24.788	W/m
Heat loss of the traced length	4.9576	kW
Tracer steam needed	8.4178	kg/h
Tracer steam temperature	147.91	°C
Cladding surface temperature	4.8958	°C

Notes for this case

- Loss of the pipe alone under its insulation; tracer runs add a little, and runs longer than about 50 m need their own trap.

Formula and method

$$q' = \frac{T_i - T_{sf}}{\ln(D/D_o)/(2\pi\lambda)} = h_{se}\,\pi D\,(T_{sf} - T_a) \qquad \dot{Q} = q' L \qquad \dot{m}_s = \frac{\dot{Q}}{h_{fg}(p_s)}$$

$$h_{se} = h_{cv} + h_r, \quad h_{cv} = 1.25\left(\frac{\Delta T}{D}\right)^{1/4} \ (D^3\Delta T \le 10\ \mathrm{m^3K}), \quad h_{cv} = 1.21\,\Delta T^{1/3} \ (D^3\Delta T > 10), \quad h_r = \varepsilon\sigma\frac{T_{sf}^4 - T_a^4}{T_{sf} - T_a}$$

Variables

D_o	pipe outer diameter	m
t	insulation thickness	m
λ	insulation conductivity	W/(m·K)
T_i	temperature to maintain	K
T_a	design ambient	K
ε	cladding emissivity	–
L	traced length	m
p_s	tracer steam pressure	Pa
q'	loss per metre	W/m
$\dot{Q}$	total loss	W

$\dot{m}_s$	tracer steam	kg/s
T_s	tracer steam temperature	K
T_{sf}	cladding surface temperature	K
D	outer diameter of insulation	m
h_{se}	ISO 12241 surface coefficient	W/(m²·K)
h_{fg}	latent heat	J/kg
$h_{cv}\$, \$h_r$	convection and radiation parts of h_{se}	W/(m²·K)
ΔT	surface to ambient temperature difference	K
σ	Stefan–Boltzmann constant	W/(m²·K⁴)

Method and standards

ISO 12241 insulated pipe loss in still air at the lowest design ambient; tracer steam condenses fully, IAPWS-IF97 latent heat.

Assumptions and limits

- Still air (wind ignored); insulation dry; tracer contact and the extra area of the tracer are ignored.
- A tracer less than 10 K hotter than the pipe is flagged; the result is still shown for the heat loss.
- The temperature to maintain must be above the ambient temperature.

References

• ISO 12241
• IAPWS-IF97

Report details

Report reference	FCC-NCGA-JRPW (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/boilers-power-plant/steam/steam-tracing-heat-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.