Insulation Thickness to Prevent Condensation on a Cold Pipe

Least insulation thickness that keeps a cold pipe's outer surface above the ambient dew point (plus a margin), by the ISO 12241 heat transfer method.

Method: ISO 12241 insulated pipe method (engine InsulatedPipe); thickness by bisection on the surface temperature; dew point from IAPWS

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outer diameter	114.30	mm
Insulation conductivity	0.035000	W/(m·K)
Pipe (fluid) temperature	5.0000	°C
Ambient air temperature	32.000	°C
Ambient relative humidity	80.000	%
Surface emissivity Low for bright metal cladding, which needs more thickness.	90.000	%
Safety margin above the dew point	0.50000	K

Calculated results

Parameter	Value	Unit
Ambient dew point	28.111	°C
Insulation thickness needed	24.498	mm
Surface temperature at that thickness	28.611	°C
Heat gain per metre at that thickness	14.555	W/m

Notes for this case

- Round up to the next thickness made. ISO 12241 still air; draughts help, bright cladding and high humidity need more.

Formula and method

$$\text{find } s: \; T_s(s) = T_{dp} + \Delta T_m$$

Variables

D_o	Pipe outer diameter	m
λ	Insulation conductivity	W/(m·K)
T_w	Pipe (fluid) temperature	K
T_a	Ambient air temperature	K
φ	Ambient relative humidity	-
$\mathcal{E}$	Surface emissivity	-
ΔT_m	Safety margin above the dew point	K
T_{dp}	Ambient dew point	K
S	Insulation thickness needed	m
T_s	Surface temperature at that thickness	K
q'	Heat gain per metre at that thickness	W/m

Method and standards

Bisection on the ISO 12241 surface temperature.

Assumptions and limits

- Still air, steady state.

References

- ISO 12241 insulated pipe method (engine InsulatedPipe)
- thickness by bisection on the surface temperature; dew point from IAPWS

Report details

Report reference	FCC-YNGB-EYR8 (the same inputs always give the same reference)
Generated	17 November 2026, 19:49 UTC
Calculator	Insulation Thickness to Prevent Condensation on a Cold Pipe
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/hvac/chillers/insulation-condensation-thickness

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.