Steam Temperature Drop Along a Superheated Main

Temperature drop and remaining superheat of steam along a long main from the heat loss per metre, length and steam flow, and whether it starts to condense (IAPWS-IF97).

Method: Energy balance of the steam; IAPWS R7-97 IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Steam flow	5,000.0	kg/h
Heat loss per metre of pipe From the pipe insulation heat-loss calculator.	150.00	W/m
Length of the main	400.00	m
Steam pressure (absolute)	10.000	bar
Steam temperature at the start	220.00	°C

Calculated results

Parameter	Value	Unit
Steam temperature at the end	201.69	°C
Temperature drop	18.315	K
Superheat left at the end	21.800	K
Dryness at the end (1 = still superheated)	100.00	%
Total heat lost	60.000	kW

Formula and method

$$h_2 = h_1 - \frac{q' L}{\dot{m}} \qquad T_2 = T(p, h_2) \qquad \Delta T_{sh} = T_2 - T_{sat}(p)$$

Variables

$\dot{m}$	steam flow	kg/s
q'	heat loss per metre	W/m
L	length	m
p	steam pressure	Pa
T_1	temperature at the start	K
T_2	temperature at the end	K
ΔT	temperature drop	K
ΔT_{sh}	superheat left	K
x_2	dryness at the end	–
$\dot{Q}$	total heat lost	W
h_1, h_2	enthalpies (IF97)	J/kg

Method and standards

Energy balance of the steam with constant pressure; state at the end from FireCAD's IAPWS-IF97.

Assumptions and limits

- Constant pressure along the main; uniform heat loss.
- A warning is given when the steam turns wet, and another when it condenses completely (the end state is then liquid, and the superheat and dryness are not shown).
- The heat loss per metre is held constant although the steam cools along the main.

References

- Energy balance of the steam
- IAPWS R7-97 IF97

Report details

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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/superheat-loss-in-main

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.