Air in Steam: Partial Pressure and Temperature Drop (Dalton)

Saturation temperature of steam containing air from the steam's partial pressure (Dalton's law, IF97) and the temperature lost against pure steam.

Method: Dalton's law of partial pressures; saturation temperature from IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Total pressure (absolute)	3.0000	bar
Air by volume (mole fraction) in the steam	10.000	%

Calculated results

Parameter	Value	Unit
Steam partial pressure	2.7000	bar
Saturation temperature of pure steam	133.53	°C
Temperature of the steam–air mixture	129.97	°C
Temperature drop	3.5575	K

Notes for this case

- Air also collects as a film on heating surfaces, cutting heat transfer far more than the temperature drop alone: vent it.

Formula and method

$$p_s = p(1 - y_a), \quad T = T_{sat}(p_s), \quad \Delta T = T_{sat}(p) - T$$

Variables

p	Total pressure (absolute)	Pa
y_a	Air by volume in the steam	-
p_s	Steam partial pressure	Pa
$T_{sat}(p)$	Saturation temperature of pure steam	K
T	Temperature of the steam–air mixture	K
ΔT	Temperature drop	K

Method and standards

Dalton's law.

Assumptions and limits

- Saturated, well-mixed steam–air mixture: the result is for the bulk composition. Near a condensing surface air accumulates, so the local air share and temperature drop can be much larger.
- The air share is by volume (mole fraction); a mass share entered by mistake understates the drop.

References

- Dalton's law of partial pressures; saturation temperature from IAPWS-IF97

Report details

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Release checks	2 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/air-in-steam-temperature-drop

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.