Psychrometric Calculator (Moist Air Properties)

Humidity ratio, relative humidity, wet bulb, dew point, enthalpy, specific volume and density of moist air from dry bulb with relative humidity or wet bulb.

Method: ASHRAE Handbook—Fundamentals ch. 1 Psychrometrics; IAPWS-IF97 saturation pressure

Input parameters

Unit system: SI

Parameter	Value	Unit
Dry-bulb temperature	35.000	°C
Second property	Relative humidity	
Relative humidity	50.000	%
Wet-bulb temperature (ice bulb below 0 °C)	26.000	°C
Barometric pressure (absolute)	101.33	kPa

Calculated results

Parameter	Value	Unit
Humidity ratio	17.768	g/kg
Relative humidity	50.000	%
Wet-bulb temperature (ice bulb below 0 °C)	26.141	°C
Dew-point temperature (frost point below 0 °C)	23.020	°C
Enthalpy per kg of dry air	80.804	kJ/kg
Specific volume per kg of dry air	0.89789	m³/kg
Density of the moist air	1.1335	kg/m³
Partial pressure of water vapour	2.8143	kPa

Formula and method

$$p_v = \varphi\, p_{sat}(T) \qquad W = \frac{M_w}{M_{da}}\frac{p_v}{p - p_v}$$

$$h = 1006\,t + W(2\,501\,000 + 1860\,t) \qquad v = \frac{RT}{M_{da}\,p}\left(1 + \frac{W M_{da}}{M_w}\right) \qquad \rho = \frac{1+W}{v}$$

$$W = \frac{(2\,501\,000 - 2326\,t_{wb})\,W_{s,wb} - 1006\,(t - t_{wb})}{2\,501\,000 + 1860\,t - 4186\,t_{wb}}$$

$$W = \frac{(2\,830\,000 - 240\,t_{ib})\,W_{s,ib} - 1006\,(t - t_{ib})}{2\,830\,000 + 1860\,t - 2100\,t_{ib}}$$

Variables

T	dry-bulb temperature (t in °C)	K
given	second property entered: RH or wet bulb	–
φ	relative humidity	–
T_{wb}	wet-bulb temperature (t_wb in °C)	K
p	barometric pressure	Pa
W	humidity ratio	kg/kg dry air

T_{dp}	dew-point temperature	K
h	enthalpy per kg dry air	J/kg
v	volume per kg dry air	m³/kg
ρ	density of the moist air	kg/m³
p_v	vapour pressure	Pa
p_{sat}	saturation pressure (IF97)	Pa
M_w, M_{da}	molar masses of water and dry air	kg/kmol
$W_{s,wb}$	saturation humidity ratio at the wet bulb	kg/kg

Method and standards

Ideal-gas mixture relations of ASHRAE Handbook—Fundamentals ch. 1: humidity ratio from vapour pressure, enthalpy with 1006, 2 501 000 and 1860 J/kg constants, wet bulb from eq. (33) solved by bisection. Saturation pressure and dew point from IAPWS-IF97.

Assumptions and limits

- Dry bulb 0–100 °C. Wet bulb and dew point over liquid water at or above 0 °C; below it the ice bulb and the frost point over ice, down to −60 °C.
- Ideal gas; no enhancement factor (under 0.5 % near 1 atm).

References

• ASHRAE Handbook—Fundamentals ch. 1 Psychrometrics
• IAPWS-IF97 saturation pressure

Report details

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Release checks	5 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/psychrometry/psychrometric-properties

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Reopens the calculator with the inputs of this report.