Steam Properties (IAPWS-IF97)

Phase, saturation temperature, enthalpy, entropy, density, specific heat, viscosity and conductivity of water or steam at a pressure and temperature.

Method: IAPWS R7-97(2012) IF97; IAPWS R12-08 viscosity; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Absolute pressure Absolute. Choose a gauge unit (bar g, psig) to enter gauge readings.	10.000	bar
Temperature	250.00	°C

Calculated results

Parameter	Value	Unit
State	Superheated steam	
Saturation temperature at p	179.89	°C
Degree of superheat	70.114	K
Specific enthalpy	2,943.2	kJ/kg
Specific entropy	6.9266	kJ/(kg·K)
Specific volume	0.23274	m³/kg
Density	4.2967	kg/m³
Specific heat capacity	2.2116	kJ/(kg·K)
Dynamic viscosity	1.8058e-05	Pa·s
Kinematic viscosity	4.2029e-06	m²/s
Thermal conductivity	0.040456	W/(m·K)
Prandtl number	0.98720	
Speed of sound	550.11	m/s

Formula and method

$$\text{region } 1,\ 2,\ 5: \ g(p,T) \quad \Rightarrow \quad v = \left(\frac{\partial g}{\partial p}\right)_T,\ h = g - T\left(\frac{\partial g}{\partial T}\right)_p,\ s = -\left(\frac{\partial g}{\partial T}\right)_p,\ c_p = -T\left(\frac{\partial^2 g}{\partial T^2}\right)_p$$

$$\text{region } 3: \ f(\rho,T) \text{ with } p(\rho,T) = p \text{ solved for } \rho \qquad \Delta T_{sh} = T - T_{sat}(p) \qquad \nu = \mu/\rho \qquad Pr = c_p\mu/k$$

Variables

p	absolute pressure	Pa
T	temperature	K
phase	compressed liquid, superheated steam or supercritical fluid	–
T_{sat}	saturation temperature at p	K
ΔT_{sh}	degree of superheat (vapour only)	K
h	specific enthalpy	J/kg
s	specific entropy	J/(kg·K)
v	specific volume	m³/kg
ρ	density	kg/m³
c_p	isobaric specific heat capacity	J/(kg·K)
μ	dynamic viscosity	Pa·s

ν	kinematic viscosity	m²/s
k	thermal conductivity	W/(m·K)
Pr	Prandtl number	–
w	speed of sound	m/s

Method and standards

FireCAD's own implementation of the IAPWS Industrial Formulation 1997 (IAPWS R7-97(2012)): regions 1, 2 and 5 from their Gibbs equations, region 3 from the Helmholtz equation with the density found by iteration, the saturation line from the region 4 equation. Transport properties from the IAPWS 2008 (viscosity) and 2011 (thermal conductivity) formulations at the IF97 density. Verified against the check values printed in the releases.

Assumptions and limits

- 0 to 800 °C up to 1 000 bar, and 800 to 2 000 °C up to 500 bar (IF97 range). Above 800 °C the transport properties are extrapolations.
- The critical enhancement of viscosity and conductivity is omitted. It leaves the conductivity about 0.2 % low already for hot liquid near 200 °C and steam near 450 °C at 60–70 bar, and much more close to the critical point.
- Pressures are absolute. Enter gauge readings with a gauge unit (bar g, kg/cm² g, psig) and the page adds one standard atmosphere.

References

• IAPWS R7-97(2012) IF97
• IAPWS R12-08 viscosity
• IAPWS R15-11 thermal conductivity

Report details

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Release checks	4 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-properties

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.