pure substances

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The water in a container has the pressure of 2 bar and the specific volume of 0.95 m^3/kg. Determine:

a) the phase of water. ✓
b) the temperature of water.
c) enthalpy of water.

a) → two intensive properties are used to define the state of a pure substance.

↳ P = 2 bar (200 kPa)
↳ v = 0.95 m^3/kg ⇒ look at the table A-5

→ check the specific volume corresponding to the given pressure.

↳ $v_f = 0.001061\ m^3/kg$, $v_g = 0.88578$

$v > v_g$ ⇒ it is superheated vapor

→ from superheated water table:

P = 0.2MPa

(T)°C	(v) m^3/kg	(h) kJ/kg
120.21	0.88578	2706.3
T	0.95	h
150	0.95986	2769.1

linear interpolation:

b) $\frac{T-120.21}{150-120.21} = \frac{0.95-0.88578}{0.95986-0.88578}$

$T = 146.03°$

c) $\frac{h-2706.3}{2769.1-2706.3} = \frac{146.03-120.21}{150-120.21}$

$h = 2760.7\ kJ/kg$

The total volume of water in a boiler is 2000L. Water is at 200kPa. If the volume of the liquid phase is 20% of the total volume, then calculate the:

a) temperature
b) total mass
c) quality
d) specific volume

$\frac{V_f}{V_{tot}} = \frac{2}{10}$

the phase is saturated mixture

a) P = 200kPa , $T = T_{sat} = 120.21\ °C$

b) V = 2000L = $2\ m^3$, $\frac{V_f}{V_{total}} = 0.2 \Rightarrow V_f = 0.2 \cdot 2\ m^3 = 0.4\ m^3$

$V_g = (2-0.4)\ m^3 = 1.6\ m^3$

from table:
$v_f = 0.001061$
$v_g = 0.88578$

$\frac{V_f}{v_f} = m_f \rightarrow \frac{0.4}{0.001061} = 377\ kg$

$\frac{V_g}{v_g} = m_g \rightarrow \frac{1.6}{0.88578} = 1.806\ kg$

$m_{total} = 377 + 1.806\ kg = 378.806\ kg$

c) $x = \frac{m_g}{m_{total}} \rightarrow \frac{1.806}{378.806} = 0.0048$

d) $v = \frac{V}{m} \Rightarrow \frac{2}{378.806} = 0.0052\ m^3/kg$ 1st way

$v = x\,v_g + (1-x)\,v_f$ 2nd way