Question #82339

A rigid vessel of 0.80 m^3 contains 1 kg of steam at a pressure of 2 bar evaluate the specific volume temperature dryness fraction internal energy enthalpy and entropy.

Answer:

The specific volume of the steam is:

$$v = \frac{V}{M} = \frac{0.8}{1} = 0.8\ \mathrm{m^3/kg}.$$

The specific volume of the saturated water and steam at 2 bar are:

$$v' = 0.00106052\ \mathrm{m^3/kg}, \qquad v'' = 0.88568\ \mathrm{m^3/kg}.$$

(see table at https://www.nist.gov/sites/default/files/documents/srd/NISTIR5078-Tab3.pdf)

Thus, the steam is saturated and moist.

The saturation temperature:

$$t = 120.21℃ = 393.36\ \mathrm{K}.$$

The dryness:

$$x = \frac{v - v'}{v'' - v'} = \frac{0.8 - 0.00106052}{0.88568 - 0.00106052} = 0.903.$$

Enthalpy:

$$h' = 504.7\ \mathrm{kJ/kg}, \qquad h'' = 2706.2\ \mathrm{kJ/kg},$$

$$h = h' + x(h'' - h') = 504.7 + 0.903(2706.2 - 504.7) = 2492.97\ \mathrm{kJ/kg},$$

$$H = Mh = 2492.97\ \mathrm{kJ}.$$

Entropy:

$$s' = 1.5302\ \mathrm{kJ/kg.K}, \qquad s'' = 7.1269\ \mathrm{kJ/kg.K},$$

$$s = s' + x(s'' - s') = 1.5302 + 0.903(7.1269 - 1.5302) = 6.5848\ \mathrm{kJ/kg.K},$$

$$S = Ms = 6.5848\ \mathrm{kJ/K}.$$

Internal energy:

$$U = TS = 393.36 \cdot 6.5848 = 2590.2\ \mathrm{kJ}.$$