

Answer on Question #73338, Physics / Molecular Physics | Thermodynamics

A mixture of saturated water and saturated steam at a temperature of 300 °C is contained in a closed vessel of 0.1 m³ capacity. If the mass of saturated water is 1 kg find the mass of steam in the vessel. Also, find the pressure, specific volume, dryness fraction and enthalpy of the mixture.

Solution:

From the Steam tables corresponding to 300°C,

$$v_f = v_1 = 0.001403 \text{ m}^3 / \text{kg}$$

$$v_g = v_s = 0.022 \text{ m}^3 / \text{kg}$$

$$p = 85.81 \text{ bar}$$

Total volume occupied by the liquid,

$$V_1 = m_1 \times v_1 = 1 \times 0.001403 = 0.001403 \text{ m}^3.$$

Total volume of the vessel,

$$V = \text{Volume of liquid} + \text{Volume of steam} = V_1 + V_s$$

$$0.1 = 0.001403 + V_s$$

$$V_s = 0.1 - 0.001403 = 0.098597 \text{ m}^3$$

Mass of steam,

$$m_s = V_s / v_s = 0.098597 / 0.022 = 4.48 \text{ kg}.$$

Mass of mixture of liquid and steam,

$$m = m_1 + m_s = 1 + 4.48 = 5.48 \text{ kg}.$$

Total specific volume of the mixture,

$$v = 0.1 / 5.48 = 0.01825 \text{ m}^3 / \text{kg}.$$

Dryness fraction can be expressed:

$$\zeta = m_s / (m_w + m_s)$$

$$\zeta = 4.48 / 5.48 = 0.8$$

$$v = v_f + x v_{fg}$$

$$0.01825 = 0.001403 + x (0.022 - 0.001403)$$

$$x = 0.81$$

From Steam table corresponding to 300 °C,

$$h_f = 1344 \text{ KJ / kg}$$

$$h_{fg} = 1405 \text{ KJ / kg}$$

Enthalpy of mixture,

$$h = h_f + x h_{fg} = 1344 + 0.81 \times 1405 = 2482.05 \text{ KJ / kg}$$

Answer: 85.81 bar; 4.48 kg; 0.01825 m³ / kg; 0.8; 2482.05 KJ / kg