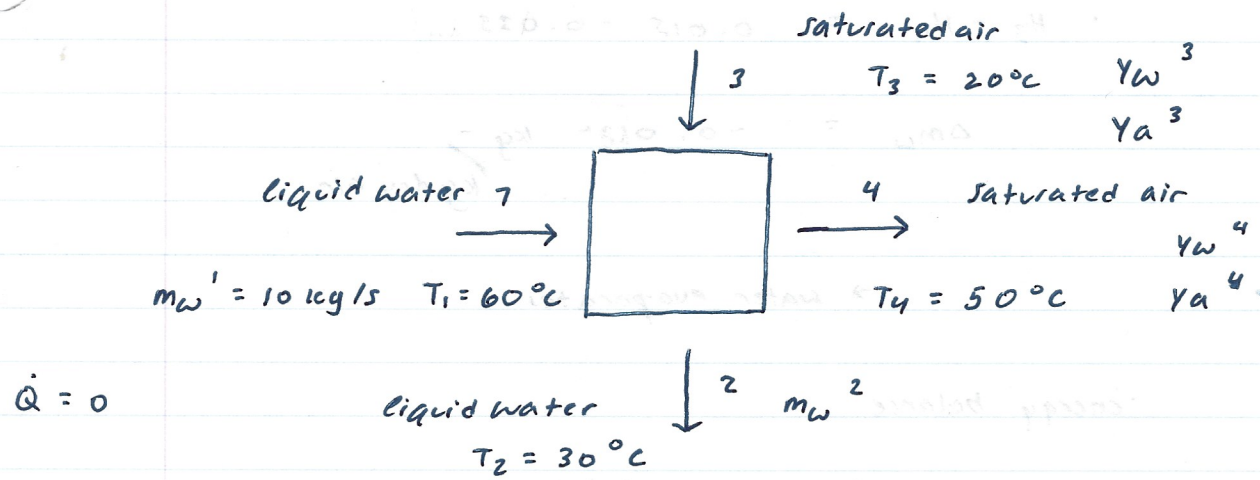
CHEE 204 - Problem Set 9



MB - DoF = 6 # SV
- 2 # MB
- 1 # SSV
- 2 # SR (H_3, H_4)
= 1

Comb - DoF = 6 # SV
- 2 # MB
- 1 # EB
- 1 # SSV
- 2 # SR
= 0

- psychrometric chart (Felder)

- stream 3

$\Delta H_3 = 57.5$ kJ / kg dry air

$H_3 = 0.015$ kg / kg dry air

- stream 4

$\Delta H_4 = 137$ kJ / kg dry air

$H_4 = 0.033$ kg / kg dry air

· $H_3 - H_4 = 0.015 - 0.033$

$\Delta m_w = -0.018$ kg / kg dry air

→ water evaporates

· energy balance

$$\Sigma \Delta H^{in} - \Sigma \Delta H^{out} = 0$$

$$F' \Delta H_w'(60°C) + F_A^3 \Delta H_3 - F^2 \Delta H_w^2(30°C) - F_A^4 \Delta H_4 = 0$$

$$m_w' \Delta H_w'(60°C) + F_A^3(\Delta H_3 - \Delta H_4) - m_w^2 \Delta H_w^2(30°C) = 0$$

· by mass balance

$$F_A^3 = F_A^4$$

$$m_w' = m_w^2 + \Delta m_w F_A^3$$

↳ -ve value

· reference state H_2O (liquid, 0°C, 1 atm)
dry air (0°C, 1 atm)

$$m_w' \int_0^{60°C} Cp_w^L \, dT + F_A^3(\Delta H_3 - \Delta H_4)$$

$$-(m_w' + \Delta m_w F_A^3) \int_0^{30°C} Cp_w^L \, dT = 0$$

· 1 eq", 1 unknown (F_A^3)

→ MATLAB

$$F_A^{\,3} = 16.2448 \text{ kg/s}$$

from psychrometric chart

- humid volume $= 0.85 \text{ m}^3/\text{kg dry air}$ at 20 °C

$$\therefore \dot{V} = 0.85 \frac{\text{m}^3}{\text{kg dry air}} \cdot 16.2448 \text{ kg/s}$$

$$= 13.80808 \text{ m}^3/\text{s}$$

$$\boxed{\dot{V} = 13.8 \text{ m}^3/\text{s}}$$

Check:

$$m_w^{\,3} = H^3 \cdot F^3$$

$$= 0.243672 \text{ kg}$$

$$n_w^{\,3} = 0.013537 \text{ kmol}$$

$W_A = 28.97 \frac{\text{kg}}{\text{kmol}}$

$$n_A^{\,3} = 0.560746 \text{ kmol}$$

$$\rightarrow y_w^{\,3} = 0.023572$$

$$P_{H_2O}^{\,*}(20°C) = 2.35 \text{ kPa}$$

$$\rightarrow P = \frac{P_{H_2O}^{\,*}}{y_w} = 99.694 \text{ kPa}$$

$$\rightarrow V = \frac{nRT}{P} = 14.04 \text{ m}^3$$ ✓