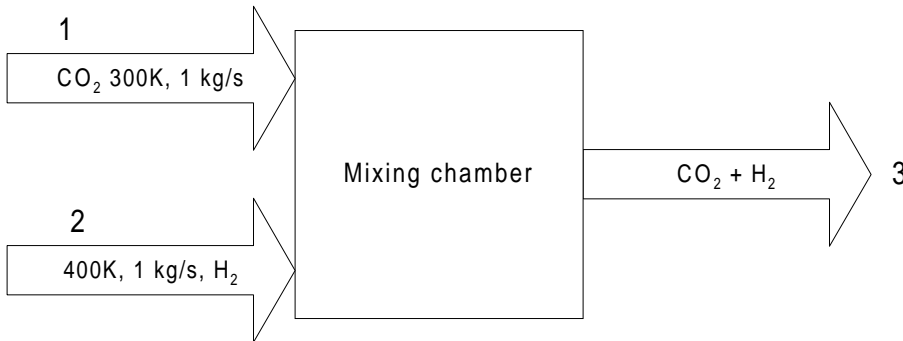


Problem 1: (40 points)



$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3$$

$$\dot{m}_1 c_{p,1} (T_1 - T_3) + \dot{m}_2 c_{p,2} (T_2 - T_3) = 0$$

$$T_3 = \frac{c_{p,1} T_1 + c_{p,2} T_2}{c_{p,1} + c_{p,2}} = 394.4 \text{ K}$$

$$\dot{N}_1 = \dot{m}_1 / M_1 = 0.0227 \text{ kmol / s}$$

$$\dot{N}_2 = \dot{m}_2 / M_2 = 0.5 \text{ kmol / s}$$

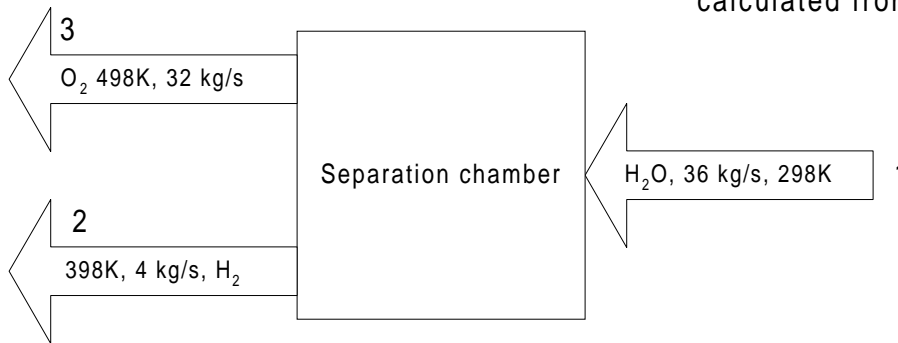
$$y_{CO_2} = 0.0434$$

$$y_{H_2} = 0.956$$

$$S_{gen} = \dot{S}_3 - \dot{S}_1 - \dot{S}_2 = \dot{m}_1 \left[ c_{p,1} \ln \left( \frac{T_3}{T_1} \right) - \frac{R_u}{M_c} \ln y_{CO_2} \right] + \dot{m}_2 \left[ c_{p,2} \ln \left( \frac{T_3}{T_2} \right) - \frac{R_u}{M_{H_2}} \ln y_{H_2} \right] = 0.807 \text{ kW / K}$$

Problem 2: (40 points)

Exiting mass flowrate of O<sub>2</sub> is calculated from a mass balance.



$$\dot{Q} = \dot{H}_3 + \dot{H}_2 - \dot{H}_1 = \dot{m}_3 \left[ \Delta h_f^0 + c_{p,3} (T_3 - \frac{29}{8} \text{ K}) \right] + \dot{m}_2 \left[ \Delta h_f^0 + c_{p,2} (T_2 - \frac{29}{8} \text{ K}) \right] - \dot{m}_1 \left[ \Delta h_f^0 + c_{p,1} (T_1 - \frac{29}{8} \text{ K}) \right]$$

$$\dot{Q} = \frac{32 \text{ kg}}{\text{s}} \frac{0.91 \text{ kJ}}{\text{kg} \cdot \text{K}} \left( \frac{49}{8} \text{ K} - \frac{29}{8} \text{ K} \right) + \frac{4 \text{ kg}}{\text{s}} \frac{1.30 \text{ kJ}}{\text{kg} \cdot \text{K}} \left( \frac{39}{8} \text{ K} - \frac{29}{8} \text{ K} \right) + \frac{6 \text{ kg}}{\text{s}} \frac{24182 \text{ kJ}}{\text{kmol}} \frac{1}{18 \text{ kg}} - \frac{36 \text{ kg}}{\text{s}} \frac{0 \text{ kJ}}{\text{kmol}} \frac{1}{18 \text{ kg}}$$

$$\dot{Q} = 49.24 \text{ e } 5.0 \text{ kW}$$

Problem 3: (20 points)

[Return to test](#)

Humid air is at 20°C, 50% RH. Calculate the humidity ratio and the dewpoint temperature.

$$\phi = \frac{p_v}{p_g}$$

$$p_g = p_{sat}(20^\circ\text{C}) = 2.339 \text{ kPa}$$

$$p_v = 2.339 \times 0.5 = 1.1695 \text{ kPa}$$

$$\omega = \frac{0.622 p_v}{p - p_v} = \frac{0.622 \times 1.1695 \text{ kPa}}{101 \text{ kPa} - 1.1695 \text{ kPa}} = 0.00729 \frac{\text{kgv}}{\text{kgda}}$$

$$T_{dp} = T_{sat}(p_v) = 9.18^\circ\text{C} \text{ (interpolate from table)}$$