

# Q4 REOD

isothermal:  $T_1 = T_2 = 400^\circ\text{C}$ ,  $P_1 = 100,000 \text{ kPa}$ ,  $P_2 = 30 \text{ MPa}$   
 assume  $\Delta KE, \Delta PE \ll \Delta h$ ; so negligible  
 $\dot{m} = 3 \text{ kg/s}$

Find  $\Delta h$ : from table A-6:

$$\text{EB: } \dot{Q} + 5000 \text{ kW} = \dot{m}[h_2 - h_1]$$

need to find.

$$\begin{cases} h_1 = 3278.6 \text{ kJ/kg} \\ h_2 = 2152.8 \text{ kJ/kg} \end{cases}$$

$$\begin{aligned} \hookrightarrow \dot{Q} &= 3 \text{ kg/s} [2152.8 - 3278.6 \text{ kJ/kg}] - 5000 \text{ kW} \\ &= -8377.4 \text{ kW} \Rightarrow \frac{\dot{Q}}{T} = -12.45 \frac{\text{kJ}}{\text{K}\cdot\text{s}} \end{aligned}$$

Find  $\Delta S$ : from table A-6:

$$\begin{cases} s_1 = 8.4542 \text{ kJ/kg}\cdot\text{K} \\ s_2 = 4.4758 \text{ kJ/kg}\cdot\text{K} \end{cases}$$

$$\text{SB: } \frac{\dot{Q}}{T} + \dot{S}_{\text{gen}} = \dot{m}[s_2 - s_1]$$

$$\dot{S}_{\text{gen}} = 3 \text{ kg/s} [4.4758 - 8.4542 \text{ kJ/kg}\cdot\text{K}] + 12.45 \text{ kW/K} = 0.237 \text{ kW/K}$$

$\dot{S}_{\text{gen}} > 0 \Rightarrow$  process is realizable

isothermal

$$\text{b) EB: } \dot{Q} + \dot{W} = \dot{m}[h_2 - h_1] \quad \text{IDEAL GAS: } m c_p \Delta T = 0 \quad \text{b/c } \Delta T = 0$$

$$\Rightarrow \dot{Q} = -\dot{W} \Rightarrow \dot{Q} = -5000 \text{ kW} \Rightarrow \frac{\dot{Q}}{T} = -\frac{5000 \text{ kW}}{673.15 \text{ K}} = -7.43 \frac{\text{kJ}}{\text{K}\cdot\text{s}}$$

$$\text{SB: } \frac{\dot{Q}}{T} + \dot{S}_{\text{gen}} = \dot{m}[s_2 - s_1] = \dot{m}[-R \ln(\frac{P_2}{P_1})] = 3 \text{ kg/s} [-0.4615 \ln(\frac{300 \text{ bar}}{1 \text{ bar}})] = -7.90 \frac{\text{kJ}}{\text{K}\cdot\text{s}}$$

$$\hookrightarrow \dot{S}_{\text{gen}} = -7.90 \frac{\text{kJ}}{\text{K}\cdot\text{s}} + 7.43 \frac{\text{kJ}}{\text{K}\cdot\text{s}} = -0.469 \frac{\text{kJ}}{\text{K}\cdot\text{s}} < 0$$

$\dot{S}_{\text{gen}} < 0 \Rightarrow$  not realizable

in ideal case,  $\Delta H = m c_p \Delta T$ , which is only a fn of temp.  
 Thus,  $\Delta H$  equated zero, when it shouldn't have b/c in  
 reality,  $\Delta H$  is dependent on other factors like  $\Delta P + \Delta V$ .  
 and specific heat is variable.