

Q4 REDO

(a) Isothermal: $T_1 = T_2 = 400^\circ\text{C}$, $P_1 = 100,000 \text{ kPa}$, $P_2 = 30 \text{ MPa}$

assume $\Delta E, \Delta P \ll \Delta h$, so negligible

$$m = 3 \text{ kg/s}$$

Find Δh : from table A-6:

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

need to find \leftarrow

$$h_1 = 3278.6 \text{ kJ/kg}\cdot\text{K}$$

$$h_2 = 2152.8 \text{ kJ/kg}\cdot\text{K}$$

$$\hookrightarrow \dot{Q} = 3 \text{ kg/s} [2152.8 - 3278.6 \text{ kJ/kg}] - 5000 \text{ kW}$$

$$= -8377.4 \text{ kW} \Rightarrow \frac{\dot{Q}}{T} = -12.45 \frac{\text{kJ}}{\text{K}\cdot\text{s}}$$

Find DS: from table A-6:

$$s_1 = 8.4542 \text{ kJ/kg}\cdot\text{K}$$

$$s_2 = 4.4758 \text{ kJ/kg}\cdot\text{K}$$

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

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

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

isothermal

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

$$\Rightarrow \dot{Q} = \dot{W} \Rightarrow \dot{Q} = -5000 \text{ kW} \rightarrow \frac{\dot{Q}}{T} = -\frac{5000 \text{ kW}}{673.15 \text{ K}} = -7.43 \text{ kW/K}$$

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

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

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

in ideal case, $\Delta H = m c_p \Delta T$, which is only a fxn of temp.

Thus, ΔH equated zero, when it shouldn't have b/c in

reality, ΔH is dependent on other factors like ΔP or ΔV .

and specific heat is variable.