Thermo test 2

1.) $W_{s,net} = 1000\,kW$ $\quad \dot{m} = 1.5\,kg/s$ $\quad T_1 = 760°C$ $\quad P_1 = 4\,MPa$ $\quad P_2 = 0.2\,MPa$

Open system

$0 = -\Delta H + W_s' \quad \therefore \Delta H = W_s'$

$H_1 = 3906.3\ \frac{kJ}{kg}$ $\qquad S_1 = S_2$

$S_1 = 7.6214 = S_2$

$$H_2 = H_{low} + \frac{(S_1 - S_{low})}{(S_{high} - S_{low})}(H_{high} - H_{low})$$

$$\therefore H_2 = 2870.7 + \frac{(7.6214 - 7.5081)}{(7.7100 - 7.5081)}(2971.2 - 2870.7) = 2927.1$$

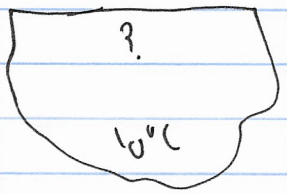
$$\therefore W_s' = (2927.1 - 3906.3)\frac{kJ}{kg} = -979.203\ \frac{kJ}{\cancel{kg}} \cdot 1.5\frac{\cancel{kg}}{s}$$

$= -1468.8\,kW$

$$\eta = \frac{\text{actual}}{\text{isentropic}} = \frac{1000}{1468.8} = 0.68 < 1 \quad \therefore \text{Possible}$$

I would buy from them

2) $Q_H = A \cdot Flux = 10^5 \, m^2 \cdot 250 \, \frac{W}{m^2} = 2.5 \times 10^4 \, kW$



$$\eta_{th} = \frac{W_{net}}{Q_H} = 1 - \frac{Q_C}{Q_H}$$

$$\eta_{th} = \frac{2000 \, kW}{2.5 \times 10^4 \, kW} = 0.08 = 1 - \frac{Q_C}{Q_H} \rightarrow 0.92 = \frac{Q_C}{Q_H}$$

$$Q_C = 2.3 \times 10^4 \, kW$$

$$\frac{Q_C}{Q_H} = \frac{T_C}{T_H} \quad \therefore \quad \frac{2.3 \times 10^4}{2.5 \times 10^4} = \frac{283.15}{T_H} \rightarrow T_H = \frac{283.15 \, (2.5 \times 10^4)}{2.3 \times 10^4}$$

$$T_H = 307.8 \, K = 34.6^\circ C$$

3.) $m = 2.5\ kg \quad T_1 = 225°C \quad q = 0.5 \quad Q = 1500\ kJ$

$P_1 = P_2$ reversible

$\Delta U = Q + W_{EC} + \cancel{W_S}^{0}$ $\quad Q = \Delta U + \int P dV$

$\therefore Q = \Delta H$

$\boxed{\Delta H = 1500\ kJ}$

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2) $T_2 = ? \quad H_1 = (1-q)H^L + qH^V = (1-0.5)(966.8) + (0.5)(2802.15)$

$H_1 = 1884.5\ \frac{kJ}{kg}$

$mH_1 = 4711.2\ kJ$

$Q = H_2 - H_1$

$\therefore H_2 = Q + H_1 = 1500\ kJ + 2.5\ \cancel{kg}\left(1884.5 \frac{kJ}{\cancel{kg}}\right)$

$H_2 = 6211.2\ kJ$

$H_2 = 2484.5\ \frac{kJ}{kg}$

$T_2 = T_{low} + \frac{(H_2 - H_{low})}{(H_{high} - h_{low})}(T_{high} - T_{low})$

$\therefore T_2 = 355°C + \frac{(2484.5 - 2526.65)}{(2481.49 - 2526.65)}(360 - 355) \quad \boxed{= 359.6°C}$

3.) $\Delta S = ? \quad S_1 = (1-q)S^L + qS^V = (1-0.5)(2.5640) + (0.5)(6.2483)$

$S_1 = 4.41\ \frac{kJ}{kg\,K}$

$S_2\ (\text{sat vap}) = S_{low} + \frac{(T_2 - T_{low})}{(T_{high} - T_{low})}(S_{high} - S_{low})$

$S_2 = 5.138 + \frac{(359.6 - 355)}{(360 - 355)}(5.0536 - 5.138) = 5.060\ \frac{kJ}{kg\,K}$

$\therefore \Delta S = S_2 - S_1 = (5.060 - 4.41)\ \frac{kJ}{kg\,K} = 0.65 \frac{kJ}{\cancel{kg}\,K}(2.5\ \cancel{kg}) \quad \boxed{= 1.64\ \frac{kJ}{K}}$

4.) $S_{gen} = 0$ — reversible process