Thermo HW11

1.) $P_2 = 1.6\ MPa$ ✓ $COP_R = ?$ $T_4 = ?$ ✓ [illegible]?
$P_1 = 0.08\ MPa$ ✓ $w_s' = ?$ ✓ $T_2 = ?$ ✓ $q = ?$
✓ $T_3' = ?$

$s_2 = s_3' = 0.95710$

S	H	T
0.9535	293.25	70
0.95710		~~T_3' $31.13\ ^\circ C$~~
0.9875	305.07	80

$$H_3' = 293.25 + \frac{(305.07 - 293.25)}{(0.9875 - 0.9535)}(0.9571 - 0.9535) = 294.5\ \frac{kJ}{kg}$$

$$T_3' = 70 + \frac{(0.9571 - 0.9535)}{(0.9875 - 0.9535)}(80 - 70) = 71.1\ ^\circ C = T_3'$$

$H_4 = 135.93\ \frac{kJ}{kg}$ $\quad H_4 - H_1 = 0$ (throttle)

$q = \frac{H_1 - H^L}{H^V - H^L}$

$$q = \frac{135.93 - 11.21}{231.46 - 11.21} = 0.57 = q_1$$

$$s_1 = (1-q)s^L + q s^V = (1 - 0.57)(0.04711) + (0.57)(0.9571) = 0.5624$$

$$\Delta S_{gen} = s_1 - s_4 = 0.5624 - 0.47911 = 0.0833\ \frac{kJ}{kg\ K}$$

$$w_s' = H_3' - H_2 = 294.5\ \frac{kJ}{kg} - 231.46\ \frac{kJ}{kg} = 63.04\ \frac{kJ}{kg}$$

$T_1 = T_2 = -31.13\ ^\circ C$

$$COP_R = \frac{q_L}{w_s'} = \frac{H_2 - H_1}{w_s'} = \frac{231.46 - 135.93\ \frac{kJ}{kg}}{63.04} = 1.52$$

$T_4 = 57.88\ ^\circ C$

2.) $W_{s,net} = 600\ MW$ $\quad P_1 = 10\ MPa$ $\quad T_1 = 600°C$

$P_2 = 10\ kPa$ $\quad HHV = 26000\ \frac{kJ}{kg}$

$S_3 = S_{4'}$ $\quad T_{4'} = T_5$ $\quad P_4 = P_5$, $P_6 = P_3$

	T	P	q	H	S	V
3	600	10		3625.8	6.9045	
4'	45.81	0.01			6.9045	
5	45.81	0.01	0	191.81		0.00101
6		10				

$$q_{4'} = \frac{S_{4'} - S^L}{S^V - S^L} = \frac{6.9045 - 0.6492}{8.1488 - 0.6492} = 0.834$$

$$H_{4'} = (1-q)H^L + qH^V = (1-0.834)\cdot 191.81 + 0.834 \cdot 2583.9 = 2187.02\ \frac{kJ}{kg}$$

$$H_6 = H_5 + V(P_2 - P_1) = 191.81 + 0.00101(10000 - 10) = 201.90\ \frac{kJ}{kg}$$

$$\eta_o = 1 - \frac{H_{4'} - H_5}{H_3 - H_6} = 1 - \frac{2187.02 - 191.81}{3625.8 - 201.9} = 0.42$$

$\eta_{gen} = 0.98$

$\eta_{boil} = 0.91$

$$\therefore \eta_{overall} = 0.42 \cdot 0.98 \cdot 0.91 = 37\%$$

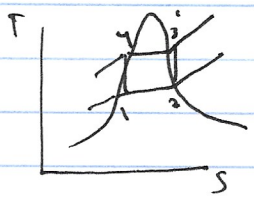
$$\dot{m}_{coal} = \frac{W_e}{\eta_{overall} HHV} = \frac{600\,000\ kW}{0.37 \cdot 26000\ \frac{kJ}{kg}} = 62.01\ \frac{kg}{sec}$$

(3)

3) $\dot{W}_{s,net} = 8.5\ kw$ $\quad P_1 = 100\ kPa$ $\quad \dot{m} = 3.5\ \frac{kg}{s}$

$P_2 = ?$

$V = 0.001\,00\ \frac{m^3}{kg}$



$P_1 = P_2 = 100 kPa$ $\quad S_2 = S_3 = 1.3028$

$P_3 = P_4$

$\frac{m^3\ kPa}{s} \cdot \frac{s}{m^3} = kPa$

~~$h_3 =$~~

$8.5\ kw = 8.5\ \frac{m^3\ kPa}{s}$

$\therefore 8.5\ \frac{m^3\ kPa}{s} \cdot \frac{1\ s}{0.001 \cdot 3.5\ m^3} =$ **2429 kPa**