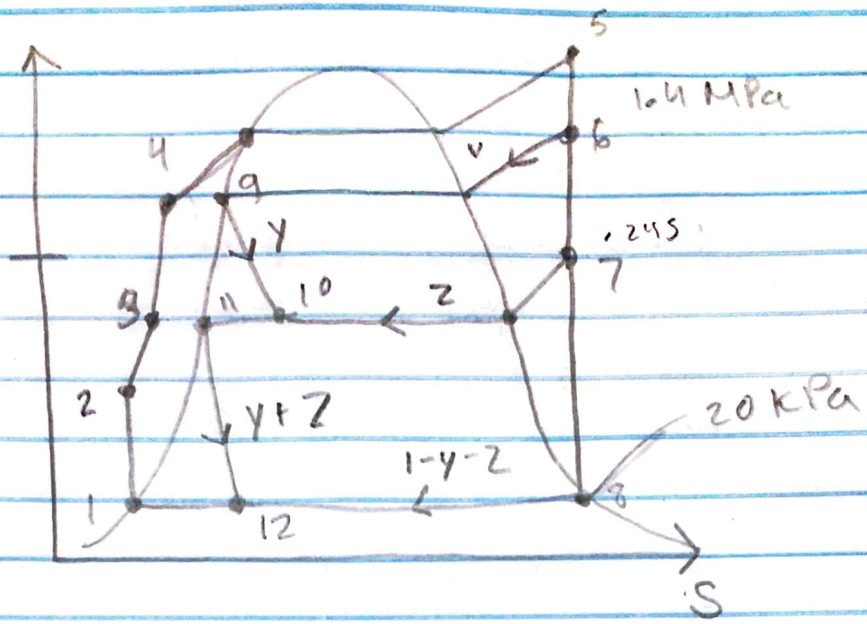
57 a)



b)

$h_1 = h_f$
$= 251 \text{ kJ/kg}$ } at 20 kPa

$v_1 = v_f$
$= 0.00102 \text{ m}^3/\text{kg}$

$W_{pump,in} = v_1 (P_2 - P_1)$
$= .00102 (5000 - 20)$
$= 5.1 \text{ kJ/kg}$

$h_2 = h_1 + W_{pump,in}$
$= 251 + 5.1$
$= 256.1 \text{ kJ/kg}$

$h_{11} = h_f$ at 245 kPa
$= 533 \text{ kJ/kg}$

$h_3 = h_{11}$

$h_{11} = h_{12}$

$h_9 = h_f$ at 1400 kPa
$= 830 \text{ kJ/kg}$

$h_4 = h_9$

$h_{10} = h_{11} = 533 \text{ kJ/kg}$

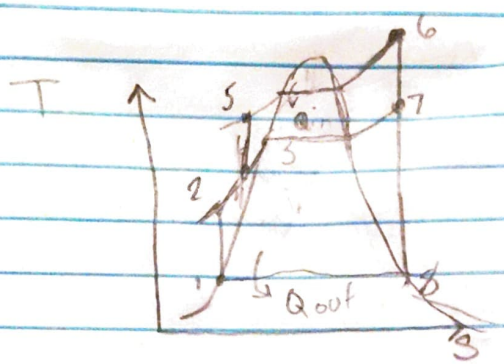
$$z = \frac{(h_3 - h_2) + y(h_{11} - h_{10})}{(h_7 - h_{11})}$$

$$z = \frac{(533 - 256.1) + (.1153)(533 - 80)}{(2918 - 533)}$$

$$= 276.9 - 34.24 \;/\; 2385$$

$$= \boxed{0.1017}$$

72.



$h_f = h_1 = 191.81 \text{ kJ/kg}$

$v_f = v_1 = 0.00101 \text{ m}^3/\text{kg}$

$W_{pi,in} = v_1(P_2 - P_1)$

$0.00101\,(12000 - 10) \times \left(1 \text{ kJ} / 1 \text{ kPa} \cdot \text{m}^3\right)$

$W_{pi,in} = 1.20 \text{ kJ/kg}$

$h_2 = h_1 + w_{in}$

$= 191.81 + 1.20$

$= 193.01 \text{ kJ/kg}$

at 12.00 MPa

$h_3 = h_f$

$= 798.33 \text{ kJ/kg}$

$m_3 = .25(55) = 13.75 \text{ kg/s}$

$m_2 = 55 - 13.75 = 41.75 \text{ kg/s}$

$h_4 = \dfrac{(41.25 \times 193.01) + (13.75 \times 798.33)}{55}$

$= 344.34 \text{ kJ/kg}$

$\dot{E}_{in} = \dot{E}_{out}$

$\dot{m}_4 h_4 = \dot{m}_2 h_2 + \dot{m}_3 h_3$

$h_4 = \dfrac{\dot{m}_2 h_2 + \dot{m}_3 h_3}{\dot{m}_4}$

$v_4 = v_f = 0.001031 \ m^3/kg$

$W_{pII,in} = v_4 (P_3 - P_4)$

$= .001031 (4,000 - 1200) \times (1 kJ / 1 kPa \cdot m^3)$

$W_{pII,in} = 2.89 \ kJ/kg$

$h_5 = h_{4i} + W_{pII,in}$

$= 344.34 + 2.89$

$= 347.23 \ kJ/kg$

4 MPa at 500°C

$h_6 = 3,446 \ kJ/kg$

$s_6 = 7.0922 \ kJ/kg$

$s_7 = s_6$

1.2 MPa at 7.0922 kJ/kg·K

$h_7 = 3080.3 \ kJ/kg$

$\frac{7.2139 - 7.0922}{7.2139 - 7.0335} = \frac{3154.2 - h_7}{3154.7 - 3096.3}$

$s_6 = s_7$

$s_8 = 7.0922 \ kJ/kg \cdot K$

$s_f = 0.6492 \ kJ/kg \cdot K$

$s_{fg} = 7.4996 \ kJ/kg \cdot K$

$h_f = 191.81 \ kJ/kg$

$h_{fg} = 2392.1 \ kJ/kg$

$$x_8 = \frac{s_8 - s_f}{s_{fg}}$$

$$x = \frac{7.0922 - 0.6492}{7.4996}$$

$$= 0.8591$$

$$h_8 = h_f + x_8 h_{fg}$$

$$= 191.81 + 0.8591 (2392.1)$$

$$= 2246.85 \text{ kJ/kg}$$

$$W_{T,out} = m_6 (h_6 - h_7) + m_8 (h_7 - h_8)$$

$$= 55 (3446 - 3081.4) + (.75(55)) (3081.4 - 2246.85)$$

$$W_T = 54,478.2 \text{ KW}$$

$$W_{p,in} = m_1 w_{pi} + m_4 p_{II}$$

$$W_p = [(.75)(55)(1.2)] + [(55)(2.89)]$$

$$= 208.45 \text{ KW}$$

$$W_{net} = 54,478.2 - 208.45$$

$$= 54269.75 \text{ KW}$$

$$Q_{pres} = m_7 (h_7 - h_3)$$

$$= (.25 \times 55) (3081.4 - 798.33)$$

$$= 31392.2 \text{ KW}$$

$$Q_{in} = m_5 (h_6 - h_5)$$

$$= 55 (3446 - 347.73)$$

$$= 170432.35 \text{ KW}$$

$$\eta_U = \frac{W_{net} + Q_{process}}{Q_{in}}$$

$$\eta_U = \frac{54269.75 + 31392.2}{170432.35}$$

$$= 0.5026$$

$$= 50.26\%$$