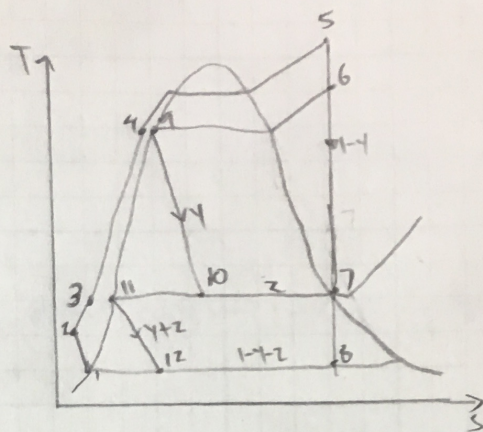
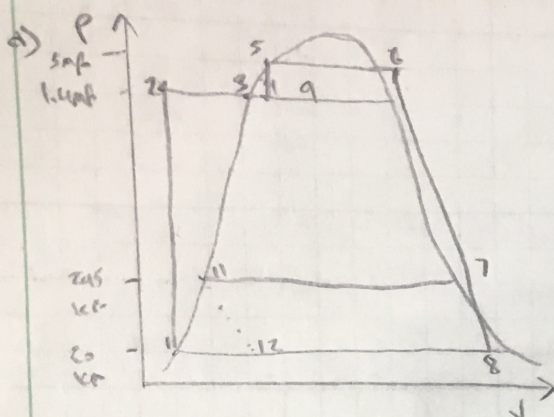


10.57)



b) $h_2 + z h_7 + y h_8 = h_3 + (y+z) h_{11}$, $z = ?$

$h_1 = h_8 = 251 \text{ kJ/kg}$
245
KPa

$V_1 = V_2 = 0.0102 \text{ m}^3/\text{kg}$
20 KPa

$h_2 = h_1 + w_{12}$
 $w_{12} = v_1(p_2 - p_1)$

$h_3 = h_{11} = h_8 = 533 \text{ kJ/kg}$, $h_4 = h_9 = h_6 = 830 \text{ kJ/kg}$
245
KPa
1400
KPa

$w_{12} = v_1(p_2 - p_1)$
 $= (.00102 \text{ m}^3/\text{kg})(5000 - 20 \text{ KPa})$

$w_{12} = 5.1 \text{ kJ/kg}$

$h_2 = 251 + 5.1$
 $h_2 = 256.1 \text{ kJ/kg}$

$z = \frac{(h_3 - h_2) + y(h_{11} - h_8)}{h_7 - h_{11}}$

$z = \frac{(533 - 256.089) + .1446(533 - 830)}{2,918 - 533}$

$z = .0981$

c) $\dot{m}_8 h_8 + \dot{m}_w h_w + \dot{m}_{12} h_{12} = \dot{m}_1 h_1 + \dot{m}_w h_w$

$\dot{m}_w (h_w - h_{11}) = \dot{m}_8 h_8 + \dot{m}_{12} h_{12} - \dot{m}_1 h_1$

$\dot{m}_w = \frac{\dot{m}_8 [(1-y-z) h_8 + (y+z) h_{12} - h_1]}{c_p \Delta T_w} = \frac{(75) [(1-.1446-.0981)(2477) + (.1446 + .0981)(533) - 251]}{(4.18)(10)}$

$\dot{m}_w = 3147 \text{ kg/s}$

$$d) \eta_{th} = \frac{\dot{W}_{net}}{\dot{Q}_{in}} = \frac{h_5 - 2h_7 - (1-y-2)h_8}{h_5 - h_4}$$

$$\dot{W}_{net} = \dot{W}_T - \dot{W}_P = 1240.3 \text{ kW} - 12.2 \text{ kW} = 1228.1 \text{ kW}$$

$$\begin{aligned} \dot{W}_{T,out} &= h_5 - y h_6 - 2 h_7 - (1-y-2) h_8 \\ &= 3900 - (1446)(3406) - (.09810)(2916) - (1 - .1446 - .09810)(2471) \end{aligned}$$

$$\dot{W}_{T,out} = 1245.4 \text{ kJ/kg}$$

$$\dot{W}_{net} = 1245.4 \text{ kJ/kg} - 5.1 \text{ kJ/kg}$$

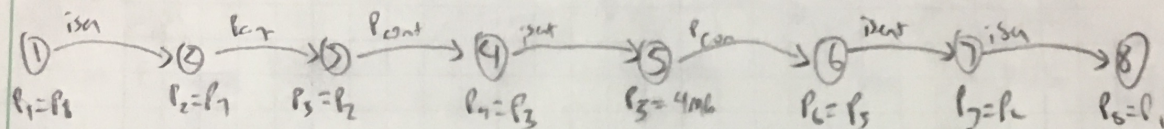
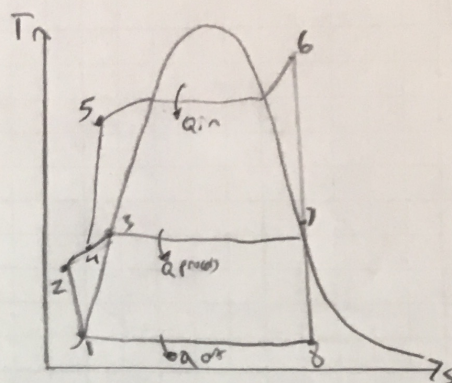
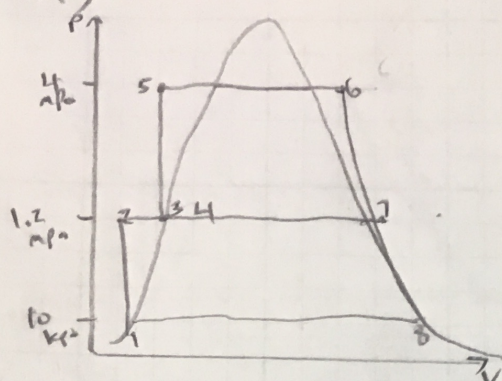
$$\dot{W}_{net} = 1240.3 \text{ kJ/kg}$$

$$\dot{W}_{net} = \dot{m} \dot{W}_{net} = (75 \text{ kg/s})(1240.3 \text{ kJ/kg}) = 93,024 \text{ kW}$$

$$\dot{Q}_{in} = \dot{m} (h_5 - h_4) = (75 \text{ kg/s})(3900 - 630) = 230,250 \text{ kW}$$

$$\eta_{th} = \frac{\dot{W}_{net}}{\dot{Q}_{in}} = \frac{93,024 \text{ kW}}{230,250 \text{ kW}} = 40.4\%$$

10.64)



$$P_1 = 10 \text{ MPa}$$

$$P_2 = 1.2 \text{ MPa}$$

$$h_3 = 798.33 \text{ kJ/kg}$$

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

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

$$h_4 = \frac{m_2 h_2 + m_3 h_3}{m_4}$$

$$h_4 = \frac{(22.5)(191.81) + (7.5)(798.33)}{30}$$

$$h_4 = 314.4 \text{ kJ/kg}$$

$$h_2 = h_1 + w_{12}$$

$$w_{12} = v_1 (P_2 - P_1)$$

$$= (0.00101)(1.2 - 10)$$

$$w_{12} = 1.20 \text{ kJ/kg}$$

$$h_2 = 191.81 \text{ kJ/kg} + 1.20 \text{ kJ/kg}$$

$$h_2 = 193.01 \text{ kJ/kg}$$

$$h_6 = 344.6 \text{ kJ/kg}$$

$$s_6 = 7.0922 \text{ kJ/kg}$$

$$h_7 = 3080.4 \text{ kJ/kg}$$

$$h_8 = h_7 + x_8 h_{fg}$$

$$x_8 = \frac{s_8 - s_g}{s_{fg}} = \frac{7.0922 - 6.4411}{7.4916}$$

$$x_8 = 0.8591$$

$$h_8 = 191.81(0.8591) + (2246.9)$$

$$h_8 = 2246.9 \text{ kJ/kg}$$

$$w_{\text{net}} = \dot{m}_6 (h_6 - h_7) + \dot{m}_8 (h_8 - h_6)$$

$$= (55 \text{ kg/s})(344.6 - 3080.4) + (7.5 \cdot 55)(2246.9 - 2246.9)$$

$$w_{\text{net}} = 54,494 \text{ kW}$$

$$w_{\text{ref}} = \dot{m}_1 w_{12} + \dot{m}_3 w_{34} = (7.5 \cdot 55 \text{ kg/s})(3080.4 - 2246.9)$$

$$w_{\text{ref}} = 208.3 \text{ kW}$$

$$w_{\text{net}} = w_{\text{ref}} - w_{\text{ref}} = 54,494 - 208.3$$

$$w_{\text{net}} = 54,285 \text{ kW}$$

$$Q_{\text{ref}} = \dot{m}_7 (h_7 - h_8)$$

$$= (7.5 \cdot 55 \text{ kg/s})(3080.4 - 2246.9)$$

$$Q_{\text{ref}} = 31,379 \text{ kW}$$

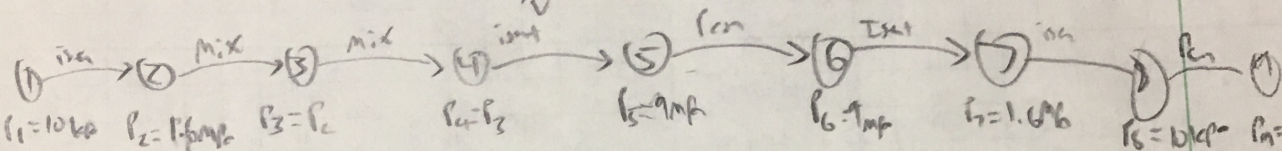
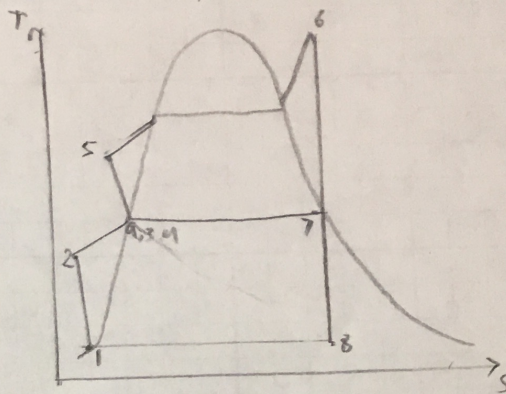
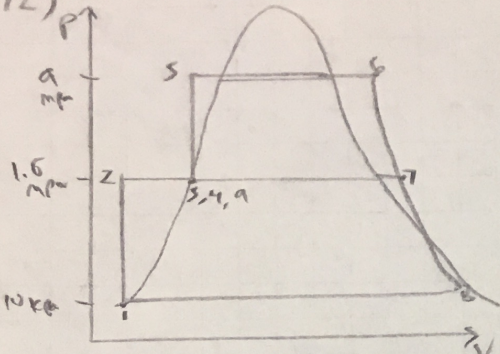
$$Q = \dot{m}_6 (h_6 - h_5) = (55 \text{ kg/s})(344.6 - 317.22)$$

$$Q_{\text{in}} = 170,435 \text{ kW}$$

$$\epsilon_c = \frac{w_{\text{net}} + Q_{\text{ref}}}{Q_{\text{in}}} = \frac{54,285 + 31,379}{170,435} = 50.3\%$$

$$\dot{m} = ?$$

10.72)



$$P_1 = 10 \text{ kPa} \quad P_2 = 1.6 \text{ MPa} \quad P_3 = P_4$$

$$h_1 = 45.82 \quad h_2 = h_1 + v(P_2 - P_1)$$

$$h_2 = 141.61 \frac{\text{kJ}}{\text{kg}} \quad h_3 = 145.916 \frac{\text{kJ}}{\text{kg}}$$

$$P_3 = 1.6 \text{ MPa} \quad P_4 = 1.6 \text{ MPa}$$

$$h_3 = 657.444 \frac{\text{kJ}}{\text{kg}} \quad h_4 = 857.444 \frac{\text{kJ}}{\text{kg}}$$

$$h_5 = 1011.50 \frac{\text{kJ}}{\text{kg}}$$

$$h_5 = h_4 + v_4(P_5 - P_4) \quad h_6 = 811.56 \frac{\text{kJ}}{\text{kg}}$$

$$h_5 = 866.6 \frac{\text{kJ}}{\text{kg}} \quad s_5 = 6.2576 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

$$s_7 = s_6 \quad s_7 = 6.2576 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

$$x_7 = \frac{s_7 - s_{f7}}{s_{g7} - s_{f7}}$$

$$x_7 = \frac{6.2576 - 2.34257}{4.0756}$$

$$x_7 = 0.1034$$

$$h_7 = h_{f7} + x_7 h_{fg7}$$

$$h_7 = 272.4371 \frac{\text{kJ}}{\text{kg}}$$

$$s_8 = s_7 \quad s_8 = 6.2576 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

$$x_8 = \frac{s_8 - s_{f8}}{s_{g8} - s_{f8}}$$

$$x_8 = 0.103$$

$$h_8 = 149.021 \frac{\text{kJ}}{\text{kg}}$$

$$\dot{W}_{net} = \dot{m}_1 (h_2 - h_7) + \dot{m}_2 (h_7 - h_8) - \dot{m}_1 (h_4 - h_5) - \dot{m}_2 (h_6 - h_9)$$

$$= \dot{m}_1 [(h_2 - h_7) + (1 - x_7)(h_7 - h_8) - (1 - x_7)(h_4 - h_5) - (h_6 - h_9)]$$

$$= \dot{m}_1 [389.36 + 0.65 \cdot 739.121 - 0.65 \cdot 1.606 - 8.575]$$

$$\dot{m}_1 = 29.063 \text{ kg/s}$$