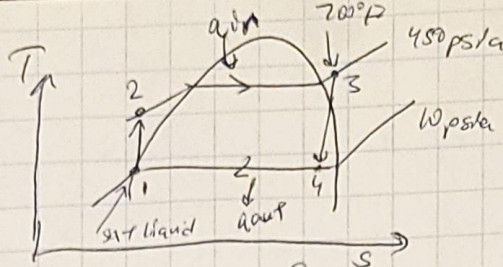


Q1.



(a) Rankine Cycle

$$\eta = \frac{w_{net}}{q_{in}} = 1 - \frac{q_{out}}{q_{in}} = 1 - \frac{h_4 - h_1}{h_3 - h_2} \quad \left(\begin{array}{l} w_{net} = q_{in} - q_{out} \\ q_{in} = h_3 - h_2 \\ q_{out} = h_4 - h_1 \end{array} \right)$$

$$h_1 = h_f @ 10 \text{ psia} = 161.25 \text{ Btu/lbm}$$

$$h_2 = h_1 + w_{in}, \quad w_{in} = \frac{\dot{w}}{\dot{m}} = \frac{42.9 \text{ Btu/s}}{33 \text{ lbm/s}} = 1.3 \text{ Btu/lbm}$$

$$h_2 = 161.25 + 1.3 = 162.55 \text{ Btu/lbm}$$

$$h_3 = h @ T=700^\circ\text{F}, P=450 \text{ psia} = 1360.0 \text{ Btu/lbm}$$

$$h_4 = h_f + x_4 h_{fg}, \quad s_4 = s_3 \text{ (isentropic)}$$

$$s_3 = 1.6253 \text{ Btu/lbm} \cdot R = s_4$$

$$x_4 = \frac{s_4 - s_f}{s_{fg}} = \frac{1.6253 - 0.28362}{1.50391} = 0.892$$

$$h_4 = h_f + x_4 h_{fg} = 161.25 + 0.892(981.82) = 1037.16 \text{ Btu/lbm}$$

$$\eta = 1 - \frac{h_4 - h_1}{h_3 - h_2} = 1 - \frac{1037.16 - 161.25}{1360.0 - 162.55} = 0.269 = \boxed{26.9\%}$$

(b) Max eff = $1 - \frac{q_{out}}{q_{in}} = 1 - \frac{T_L}{T_H}$ $q_{out} \approx T_L, \quad q_{in} \approx T_H$

$$T_L = T_{sat} @ 10 \text{ psia} = 193.16^\circ\text{F} = 652.83 \text{ R}$$

$$T_H = T_{sat} @ 450 \text{ psia} = 456.31^\circ\text{F} = 915.98 \text{ R}$$

$$\eta_{max} = 1 - \frac{652.83}{915.98} = 0.287 = \boxed{28.7\%}$$