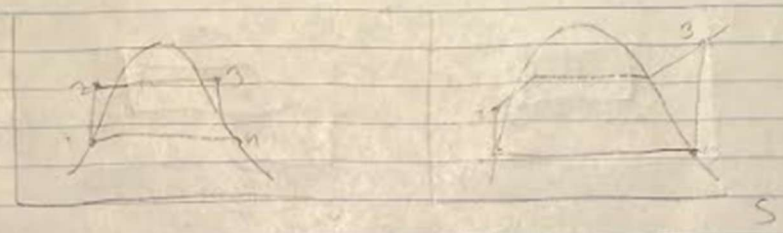
18



① $P_1 = 2$ psia ② $P_2 = 1500$ psia ③ $P_3 = 1500$ psia $T_3 = 800°F$ ④ $P_4 = 2$ psia

at 2 psia $h_1 = 94.02$ Btu/lbm

$h_2 = h_1 + v_1(P_2 - P_1) = 94.02 + 0.01623(1500 - 2) \cdot \frac{1 Btu}{3.4 psi} = 98.52$ Btu/lbm

$h_3 = 1363.1$ Btu/lbm at $T_3 = 800°F$ and $P_3 = 1500$ psia

$s_3 = 1.5089 \frac{Btu}{lbm \cdot R}$

at $P_2 = 2$ psia

$s_f = 0.1750 \frac{Btu}{lbm \cdot R}$

$s_{fg} = 1.7445 \frac{Btu}{lbm \cdot R}$

$x_{45} = \frac{s_3 - s_f}{s_{fg}} = \frac{1.5089 - 0.1750}{1.7445} = 0.7633$

$h_{45} = h_f + x_{45} h_{fg} = 94.02 + 0.7633 \cdot 1021.7 = 873.88$ Btu/lbm

$0.9 = \frac{1363.1 - h_4}{1363.1 - 873.88}$ → $h_4 = 922.8$ Btu/lbm

$\dot{m} = \frac{2500}{(1363.1 - 98.52) - (922.8 - 94.02)} \cdot 0.99782 = 5.437$ lbm/s

$P = 5.437(1363.1 - 922.8) = 2394$ Btu/s → 2525.8 kW

$Q_h = 5.437(1363.1 - 98.52) = 6875.6$ Btu/lbm

$\eta_{th} = \frac{2500}{6875.6} \cdot 0.99782 = 0.345 = 34.5\%$

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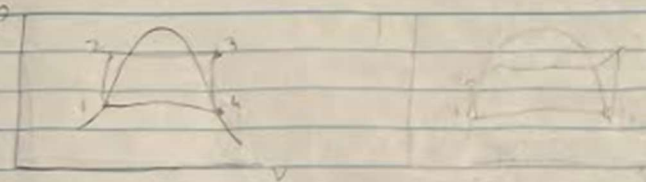

① $T_1 = 160°C$ $P_1 = 40\ kPa$ ② $T_2 = 70°C$ ③ ④ $T_4 = 77.59°C$

$h_1 = 273.01\ kJ/kg$ $v_1 = 0.001042\ m^3/kg$

$h_3 = 761.54\ kJ/kg$ $h_4 = 689.74\ kJ/kg$

$h_{2s} = 670.4\ kJ/kg$ $c_p = 4.258\ kJ/kg$

$(h_{2s} - h_1) = v_1 \cdot (P_3 - P_1) = 0.001847\,(3.25 \cdot 10^3 - 0.410 \cdot 10^3)$

$= 5.230\ kJ/kg$

$h_2 = \frac{(h_{2s} - h_1)}{\eta} + h_1 = \frac{5.230}{0.9} + 273.01 = 278.823\ kJ/kg$

$\dot{m}_3 = \frac{2535.9 \cdot 4.258(70)}{761.54 - 278.823} = 343.248\ kg/s$

$\eta_T = \frac{h_3 - h_{4s}}{h_3 - h_{4s}} = \frac{761.54 - 689.74}{761.54 - 670.4} = 0.788 = 78.8\%$

$P_{net} = 343.248((761.54 - 689.74) - (278.823 - 273.01)) = 22,650\ kW$

$\eta_{th} = \frac{P_{net}}{\dot{m}_3(h_3 - h_2)} = \frac{22,65}{343.248(761.54 - 278.823)} = 0.137 = 13.7\%$

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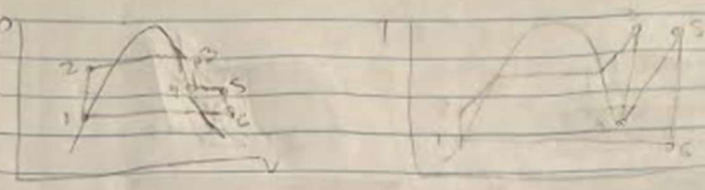

① $P_1 = 20 kPa$ ② $P_2 = 5000 kPa$ ③ $P_3 = 5000 kPa$ ④ ⑤ ⑥ $P_6 = 20 kPa$

at 1200 kPa $h_f = 798.33$ kJ/kg $h_{fg} = 1585.4$ kJ/kg

$h_4 = 798.33 + 0.96 \cdot 1585.4 = 2704.314$

$s_f = 2.2159$ kJ/kg·K $s_{fg} = 4.3058$

$s_4 = 2.2159 + 0.96 \cdot 4.3058 = 6.349$ kJ/kg·K

$s_3 = s_4$ IS

$s_3 = 6.345$ P = 5000 kPa from steam table $T_3 = 327°C$

$h_3 = 3008$ kJ/kg

at 20 kPa $h_f = 251.42$ $h_{fg} = 2357.5$

$h_6 = 251.42 + 0.96 \cdot 2357.5 = 2514.62$ kJ/kg

$s_f = 0.83202$ $s_{fg} = 7.0752$

$s_6 = 0.83202 + 0.96 \cdot 7.0752 = 7.6242$ kJ/kgK

$s_6 = s_5$

$s_5 = 7.6242$ P = 1200 → $T = 481°C$

$h_5 = 3433.5$ kJ/kg

$W_{net} = (3008 - 2704.314) + (3433.5 - 2514.62) - (256.48 - 251.42)$

$= 1217.50$ kJ/kg

$Q_{in} = (3008 - 256.48) + (3433.5 - 2704.314)$

$= 3480.706$

$\eta_{th} = \frac{1217.50}{3480.706} = 0.35 = 35\%$

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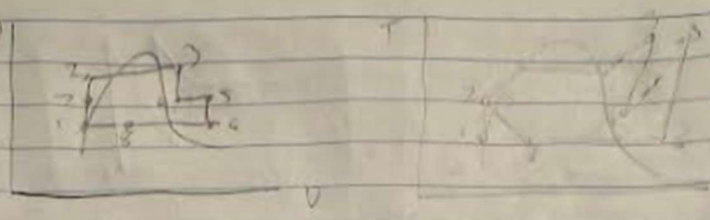


① ② ③ ④ ⑤ ⑥ ⑦ ⑧

$P_1 = 20\ kPa$ $P_2 = 3000\ kPa$ $P_3 = 3000\ kPa$ $P_4 = 1000\ kPa$ $P_5 = 1000\ kPa$ $P_6 = 20\ kPa$

at 3000 kPa and $T_3 = 350°C$

$h = 3116.1\ kJ/kg$ $s = 6.7449\ kJ/kg\,K$

at 1000 kPa

$h = 2851.8$ $s = 6.7449$ $T = 209.85°C$

at 20 kPa

$h_{f6} = 251.42$ $h_{fg} = 2357.49$ $s_f = 0.83202$ $s_{fg} = 7.07518$

$v_1 = 0.0010172\ m^3/kg$

$6.7449 = 0.83202 + x \cdot 7.07518$

$x = 0.8357$

$h = 251.42 + 0.8357 \cdot 2357.49 = 2221.62\ kJ/kg$

$W_p = 0.0010172(3000 - 2000) = 3.03\ kJ/kg$

$h = 251.42 + 3.03 = 254.44\ kJ/kg$

$x = \frac{262.52 - 256.44}{2651.8 - 262.52} = 0.24318$

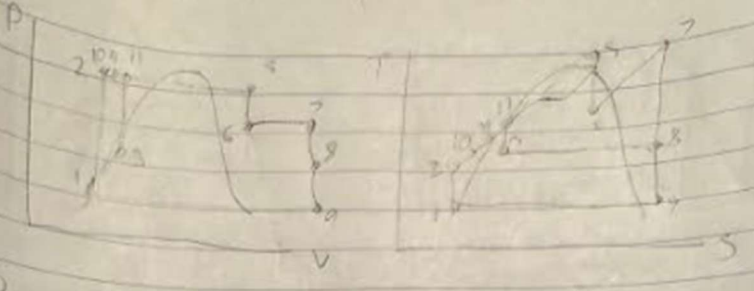
$W_T = (3116.1 - 2851.8) + (1 - 0.24318)(2851.8 - 2221.62)$

$= 741\ kJ/kg$

$Q = 3116.1 - 762.52 = 2353\ kJ/kg$

Needed help from chegg

S3



P_1 = 10 kPa P_2 = 600 kPa P_3 = 0.6 MPa P_4 = 10 MPa P_5 = 10 MPa P_6 = 0.6 MPa P_7 = 10 kPa

$h_1 = 191.81$ $v_1 = 0.00101 m^3/kg$

From ASPE ↓

$W_{P_1} = 0.00101(600-10) = 0.5959$ kJ/kg

$h_2 = 191.81 + 0.5959 = 192.4$ kJ/kg

$h_3 = 670.38$ kJ/kg $v_4 = 0.00110 m^3/kg$

$W_{P_2} = 0.0540 \cdot (10000-600) = 10.35$ kJ/kg

$h_4 = 670.38 + 10.35 = 680.73$ kJ/kg

$h_6 = 798.33 + (0.00113)(10000-1200) = 808.35$ kJ/kg

$h_8 = 3625.8$ $s_8 = 6.9045$

$h_{eg} = 1684.3$ $s_g = s_8$

$x_g = \frac{6.9045 - 2.215}{4.303} = 1.0896$

$h_9 = 798.6 + 1.0856 \cdot 1684.3 = 2960.5$ kJ/kg

$s_{11} = s_8$

$x_{11} = \frac{6.905 - 0.650}{7.496} = 8.341$

$h_{11} = 1518 + 0.8341 \cdot 342.1 = 2787$ kJ/kg

$m \cdot (2924.5 - 798.33) = 1(798.33 - 680.73)$

$m = 0.0544$

$z = \frac{(670.38 - 192.4) - (0.0509)(798.33 - 192.4)}{2830.9 - 192.4} = 0.1694$

$q_{in} = 3625.08 - 798.37 = 2827.47$

$q_{out} = (1 - 0.0540 - 0.1694)(2787 - 1910.84) = 1549.38$

$w_{net} = 1278.091$ kJ/kg

$\dot{m} = \frac{400 \cdot 10^3}{1278.09}$ kJ/s $= 313$ kg/s

$\eta = 1 - \frac{1549.38}{2827.47} = 0.452 = 45.2\%$