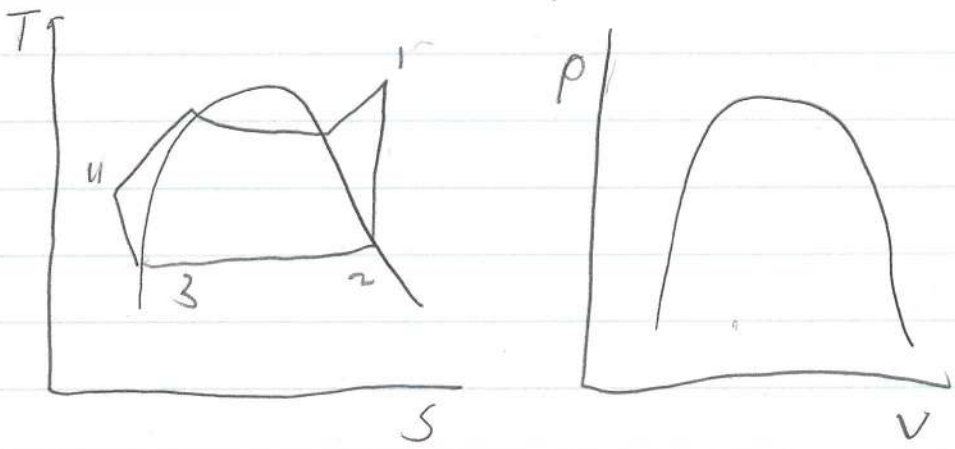
Thermal applications 2.1 hw Ben Smithson

ch 10: 18, 25, 34, 48, 53



1 2 3 4

$P_1 = 1500 psi$

$T_1 = 800°F$

$h_1 = 362.49$

$s_1 = 1.506$

$h_2 = 954.3$

$h_{25} = 908$

$P_3 = 4 psi$

$v_3 = 0.016$

$h_4 = 125.42$

$$x_{25} = \frac{s_2 - s_f}{s_{fg}} = \frac{1.506 - 0.219}{1.642} = 0.783$$

$$h_{25} = h_f + x_{25} h_{fg} = 120.89 + 0.783 \cdot 1006.4 = 908.86$$

$$h_2 = h_1 - \eta_t (h_1 - h_{25}) = 1362 - 0.9(1362.45 - 908)$$

$h_3 - h_f = 120.89$ $v_3 = v_f = 0.016$ ft³/lb

$$h_4 = 120.69 + [0.163 \cdot \frac{144}{778}] (1600 - 4) = 125.42$$

$w_{net} = (h_1 - h_2) - (h_4 - h_3) = (1362.4 - 954.3) - (125.4 - 120)$

$= 403.6$

$W_{net} = m w_{net}$

$2369.94 = m \cdot 403.61$

$m = 5.87$

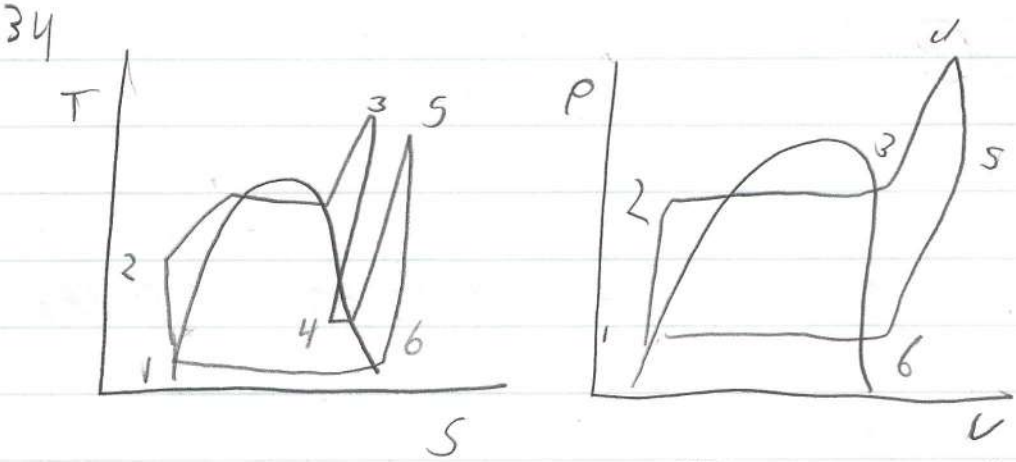
$W_T = m(h_1 - h_2) = 5.87 (1362 - 954.3) = 2396.1$ BTU/s

$Q_{in} = m(h_1 - h_4 = 5.87 (1362.4 - 125.4) = 7262.35$

$\eta = 0.32$

Thermal applications Ben Smithson hw 2.1

34



① ② ③ ④ ⑤ ⑥

$T_1 = 300$ $T_2 =$ $T_3 = 329°C$ $s_6 = 7.624$

$P_1 = 80 kPa$ $P_2 =$ $P_3 = 5000 kPa$ $P_4 = 1200 kPa$ $s_5 = s_6$

3091.9 $s_4 = 6.34$

$s_4 = s_f + x s_{fg}$

$s_4 = 2.21 + 0.96(6.5 - 2.2) = 6.34$

$$\frac{6.34 - 6.21}{6.45 - 6.34} = \frac{T - 300}{350 - T}$$

$T_3 = 329°C$

$P_3 = 5000 kPa$

$s_6 = 0.832 + 0.96(7.9072 - 0.832) = 7.624$

$s_5 = s_6$

$T_5 = 500^\circ C$ @ 5 5

$h_6 = h_f + x\, h_{fg}$

$h_6 = 251.4 + 0.96(2608 - 251.4) = 2514.6\ kJ/kg$

$h_2 - h_1 = 0.0012 \times (P_2 - P_1$

$0.0012 \times (5000 - 20) = 256.69$

$Q_A = h_2 - h_4 + h_5 - h_4$

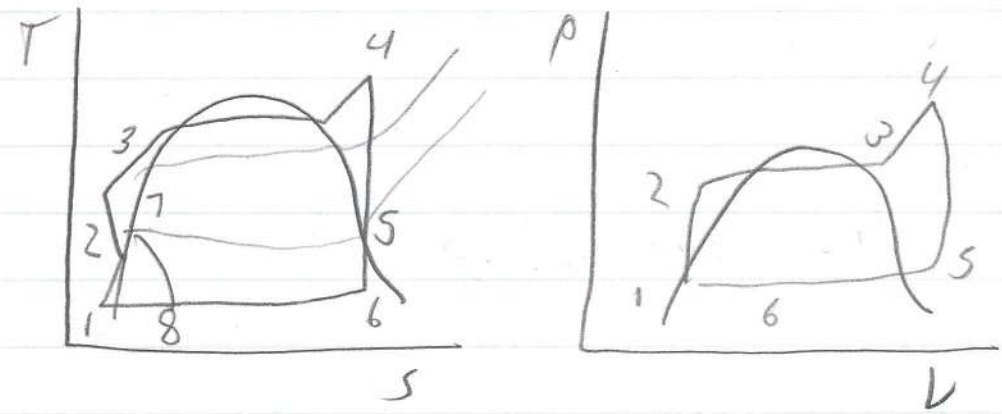
$= (3011.9 - 256.4 + 3476.9 - 2704.3)$

$= 3527.65$

$w_{net} = ?$

Thermal applications hw 2.1 Ben smithson

48



① ② ③ ④ ⑤ ⑥ ⑦ ⑧

$h_1 = 289.4$ $h_2 = 292.26$ $h_3 = 763$ $h_4 = 3116$ $h_5 = 2891.9$ $h_6 = 2274.6$ $h_7 = h_8 = 762.9$

$v_1 = 0.001012$ $P_3 = 3000$ $S_4 = 6.749$ $P_6 = 30$

$W_p = 0.001012 (3000 - 30$

$W_p = 3.035$ kJ/kg

$h_2 = h_1 + W_p = 292.264$

$h_4 = 3116$

$w = \frac{h_3 - h_2}{h_5 - h_7} = \frac{763.53 - 292.64}{2891.9 - 762.9} = 0.2297$

$W_t = h_4 - h_5 + 1 - w (h_5 - h_6) = 3161.1 - 2891.9 + (1 - 0.2297)$
$(2851.9 - 2274.63$

$W_t = 711.27$

$w_p = v(P_2 - P_1) = 0.00102\,(3000 - 30)$

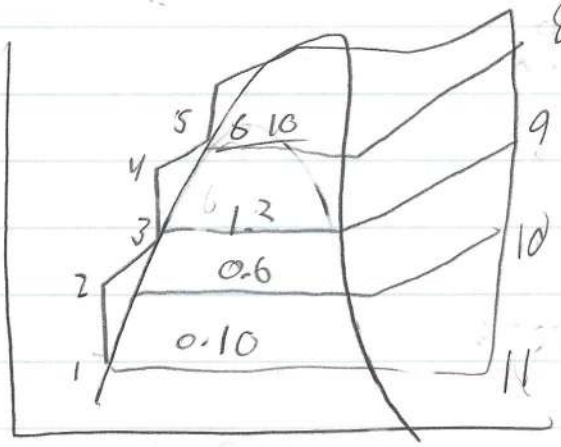
$w_p = 3.0353$ kJ/kg

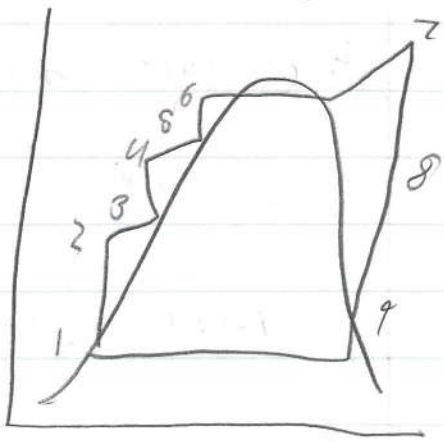
$q_{in} = h_4 - h_3$

$q_{in} = 3116 - 763 = 2352$ kJ/kg

Thermal applications hw 2.1 Bensmithsons

63 T





s

① ② ③ ④ ⑤ ⑥ ⑦

$h_1 = 191.81$ (10) $h_2 = 192.4$ $h_3 = 670.38$ $h_4 = 680.7$ $T_5 = T_6$ $h_6 = 798$

$V_1 = 0.00101\ m^3$ $V_3 = 0.00101$ $h_5 = h_6$ $T_6 = 188°$

⑧ ⑨ ⑩ ⑪

$S_8 = 3625$

$h_8 = 6.904$

$S_{11} = 58$

$W_{pump} = v_1 (P_2 - P_1$

$= 0.00101\ (600 - 10) = 0.5959$

$h_2 = h_1 + Pump = 191.81 + 0.5959 = 192.4$

$Pump\ 2 = -v_3 (P_4 - P_3) = 0.001\ [10000 - 600) = 10.35$

$h_4 = h_3 + pump\ 2 = 680.7$

$\eta_{th} = \dfrac{6.9 - 0.64}{7.49} = 0.83$

$h_{11} = 191.8 + 0.83 \cdot 2392.61$

$= 2187 \text{ kJ/kg}$

$m_9(h_9 - h_6) = m_5(h_5 - h_4)$

$y = 2794.5 - 78.3) = 1(78.3 - 680.7)$

$y = 0.054$

$z = \dfrac{h_3 - h_2 - y(h_7 - h_2)}{h_{10} - h_2}$

$\dfrac{6738 - 192.4) - 0.054(78.3 - 192)}{2820.9 - 192.4}$

$= 0.169$

$q_{out} = 1 - y - z(h_{11} - h_1) = 1 - 0.054 - 0.169)(2187 - 191.8)$

$= 1549.38$

$w_{net} = 2827 - 1549 = 1278 \text{ kJ/kg}$

$\eta = 1 - \dfrac{q_{out}}{q_{in}} = \dfrac{1549}{2827} = 45\%$