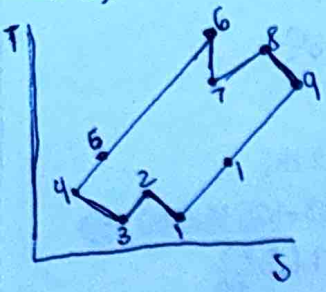
Ramzie Abbas
MET 350 HW 1.5

① $T_1 = 290K$ ② $T_2 = 430.9K$ ③ $T_3 = 290K$ ④ ⑤ $T_5 = 450.9K$ ⑥ $T_6 = 749.4K$ ⑦ $T_7 = 504.3K$ ⑧ $T_8 = 802.8K$ ⑨ $T_9 = 540.2K$ ⑩ $T_{10} = 520K$

123)



$T_{10} = T_8 r_p^{-(k-1)/k} - 20$

$T_{10} = (802.8 \cdot 4^{-(1.4-1)/1.4} - 20)K$

$T_{10} = 520.2K$

$T_6 = T_4 + 20 + \frac{q_{5-6}}{c_p}$

$= T_3 r_p^{(k-1)/k} + 20 + \frac{q_{5-6}}{c_p}$

$= (200.4^{(1.4-1)/1.4} + 20 + \frac{300}{1.005})K$

$T_6 = 749.1K$

$q_{out} = c_p(T_{10} - T_1 + T_2 - T_3)$

$= 1.005(520.2 - 290 + 290.4^{(1.4-1)/1.4} - 290)$

$q_{out} = 373 \frac{kJ}{kg}$

$T_8 = T_6 r_p^{-(k-1)/k} + \frac{q_{7-8}}{c_p}$

$T_8 = (749.4 \cdot 4^{-(1.4-1)/1.4} + \frac{300}{1.005})K$

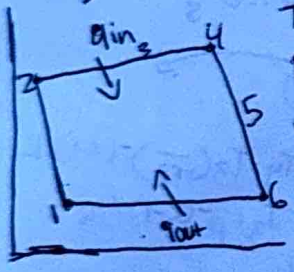
$T_8 = 802.8K$

$\eta_{th} = 1 - \frac{q_{out}}{q_{in}}$

$= 1 - \frac{373}{2 \cdot 300}$

$\eta_{th} = 0.378$

129)



① $T_1 = 420R$, $P_1 = 7psia$, $V_1 = 900ft/s$

② $T_2 = 537R$, $P_2 = 11.16psia$, $T_2 = T_1 + \frac{V_1^2}{2c_p}$

③ $T_3 = 1117R$, $P_3 = 145psia$

⑤ $P_5 = 55.07psia$

⑥ $T_6 = 1010R$, $V_6 = 3120ft/s$

$T_6 = T_5 \left(\frac{P_6}{P_5}\right)^{k-1/k}$

$= 1820\left(\frac{7}{55.07}\right)^{1.4/1.4}$

$T_6 = 1010R$

$T_2 = (420 + \frac{900^2}{25037 \cdot 2 \cdot 0.24})R$

$T_2 = 537R$

$P_2 = P_1 \left(\frac{T_2}{T_1}\right)^{k/k-1}$

$P_2 = 7\left(\frac{537}{420}\right)^{1.4/1.4-1}$

$P_2 = 11.16 psia$

$P_3 = r_p P_2$

$= 13 \cdot 11.16$

$P_3 = 145 psia$

$T_3 = T_2 \left(\frac{P_3}{P_2}\right)^{(k-1)/k}$

$= 537\left(\frac{145}{11.16}\right)^{(1.4-1)/1.4}$

$T_3 = 1117R$

$T_3 - T_2 = T_4 - T_5$

$T_5 = T_4 - T_3 + T_2$

$T_5 = 1820R$

$P_5 = P_4 \left(\frac{T_5}{T_4}\right)^{k/(k-1)}$

$= 145\left(\frac{1820}{2400}\right)^{1.4/(1.4-1)}$

$P_5 = 55.07 psia$

$V_6 = \sqrt{2 c_p (T_5 - T_6)}$

$= \sqrt{2 \cdot 0.24(1820 - 1010) \cdot 25037}$

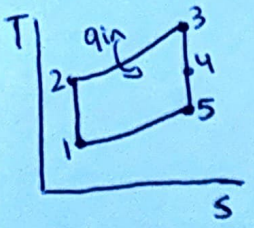
$V_6 = 3120 ft/s$

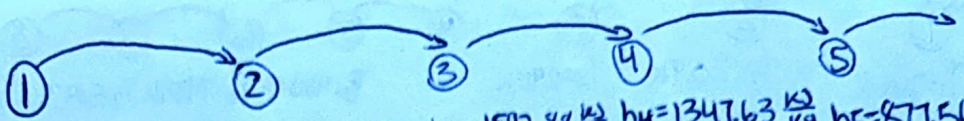
$\eta_p = \frac{(V_6 - V_1)V_1}{c_p(T_4 - T_3)}$

$= \frac{(3120 - 900)2900}{0.24(2400 - 1117) \cdot 25037}$

$\eta_p = 0.259$

135)





$h_1 = 280.13 \frac{kJ}{kg}$ $h_2 = 525.38 \frac{kJ}{kg}$ $h_3 = 1592.88 \frac{kJ}{kg}$ $h_4 = 1347.63 \frac{kJ}{kg}$ $h_5 = 877.56 \frac{kJ}{kg}$

$P_{r_1} = 1.0889$ $P_{r_2} = 9.8$ $P_{r_3} = 544$ $P_{r_5} = 60.44$

$T_1 = 280.15K$ $V_5 = 969.6 \frac{m}{s}$

$P_1 = 95 kpa$

$P_{r2} = r_p P_{r_1}$

$P_{r_2} = 9.1.0889$

$P_{r_2} = 9.8$

$h_3 = h_2 + \frac{mf}{m}(\text{heating value})$

$= (525.38 + \frac{0.5}{20} \cdot 42700)$

$h_3 = 1592.88 \frac{kJ}{kg}$

$h_4 = h_3 - h_2 + h_1$

$= (1592.88 - 525.38 + 280.13)$

$h_4 = 1347.63 \frac{kJ}{kg}$

$P_{r_5} = \frac{P_{r3}}{r_p}$

$= \frac{544}{9}$

$P_{r_5} = 60.44$

$V_5 = \sqrt{2(h_4 - h_5)}$

$= \sqrt{2(1347.63 - 877.56)}$

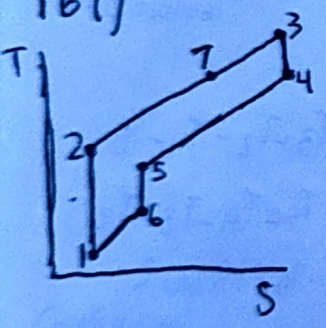
$V_5 = 969.6 \frac{m}{s}$

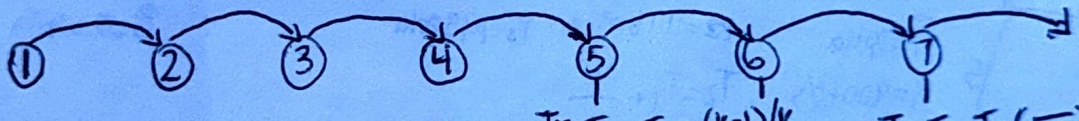
$F = mV_5$

$= 20 \cdot 969.6$

$\boxed{F = 19392 N}$

167)





$T_5 = T_2 = T_1 r_p^{(k-1)/k}$

$T_7 = T_4 = T_3 (\sqrt{r_p})^{-(k-1)/k}$

$= T_3 r_p^{-(k-1)/2k}$

$T_6 = T_5 (\sqrt{r_p})^{-(k-1)/k}$

$= T_1 r_p^{(k-1)/2k}$

$q_{in} = h_3 - h_7$

$= c_p (T_3 - T_7)$

$= c_p T_3 (1 - r_p^{-(k-1)/2k})$

$q_{out_{6-1}} = h_6 - h_1$

$= c_p (T_6 - T_1)$

$= c_p T_1 (r_p^{(k-1)/2k} - 1)$

$\eta_{th} = 1 - \frac{q_{out}}{q_{in}}$

$\boxed{\eta_{th} = 1 - \frac{T_1}{T_3} \frac{r_p^{(k-1)/2k} - 1}{1 - r_p^{-(k-1)/2k}}}$