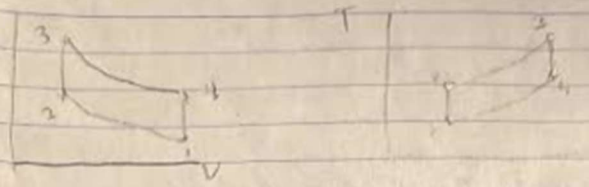
Ch 9 HW

35)



① $R = 0.287 \frac{kJ}{kg \cdot K}$, $P_1 = 95\ kPa$, $T_1 = 25°C \rightarrow 300°K$, $q_{in} = 750 \frac{kJ}{kg}$

② $T_2 = 673.1K$

③ $T_3 = 1539K$

④ $T_4 = 774.5K$

at 300K
$u_1 = 214.07$
$v_{r1} = 621.2$
$v_{r2} = \frac{v_2}{v_1} \cdot v_{r1} \rightarrow \frac{621.2}{8} = 77.65$

at 77.65
$T_2 = 673.1K$
$u_2 = 491.2 \frac{kJ}{kg}$
$P_2 = \frac{v_{r1}}{v_{r2}} \cdot \frac{T_2}{T_1} \cdot P_1 = 8 \cdot \frac{673.1}{300} \cdot 95 = 1705.19\ kPa$

$u_3 = q_{in} + u_2 = 750 + 491.2 = 1241.2 \frac{kJ}{kg}$

at $1241.2 \frac{kJ}{kg}$
$T_3 = 1539K$

$P_3 = \frac{T_3}{T_2} \cdot P_2 = \frac{1539}{673.1} \cdot 1705.19 = 3858.81\ kPa$

$v_{r_n} = \frac{v_1}{v_2} \cdot v_{r_2} = 8 \cdot$ [illegible] at 52.70

at 52.70

$T_4 = 724.5\,K$

$u_4 = 571.69\ \frac{kJ}{kg}$

$q_{out} = u_4 - u_1 = 571.69 - 214.07 = 357.62$

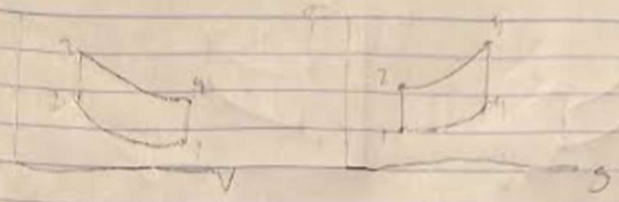
$w_{net} = q_{in} - q_{out} = 750 - 357.62 = 392.4\ \frac{kJ}{kg}$

$\text{thermal efficiency} = \frac{w_{net}}{q_{in}} = \frac{392.4}{750} = 0.523 = 52.3\%$

$v_1 = R\frac{T_1}{P_1} = 0.287 \cdot \frac{300}{95} = 0.906\ \frac{m^3}{kg}$

$v_2 = \frac{v_1}{r} =$ [illegible]

$MEP = \frac{w_{net}}{v_1 - v_2} = \frac{w_{net}}{v_1 \cdot (1 - \frac{1}{r})} = \frac{392.4}{0.906 \cdot 1 - \frac{1}{8}} = 495\,kPa$



① $T_1 = 104°F \rightarrow 40°C \rightarrow 313°K$ ② $T_2 = 792.47°K$ ③ $T_3 = 2400°F \rightarrow 1316°C \rightarrow 1589°K$ ④ $T_4 = 627.6°K$

$P_1 = 14 psig \rightarrow 96.53 kPa$

$$\gamma = \frac{V_1}{V_2} = \frac{\pi}{0.0981} = 10.20$$

$$\frac{T_2}{T_1} = \gamma^{\gamma-1} \rightarrow T_2 = 313 \cdot 10.20^{1.4-1} = 792.47°K$$

$$\frac{T_4}{T_3} = \left(\frac{V_3}{V_4}\right)^{\gamma-1} \rightarrow \left(\frac{1}{\gamma}\right)^{\gamma-1} \rightarrow T_4 = 1589 \cdot \left(\frac{1}{10.20}\right)^{1.4-1} = 627.6 K$$

$$q_{net} = C_v(T_3 - T_4) - C_v(T_2 - T_1) = 0.718(1589 - 627.6) - 0.718(792.47 - 31$$

$q_{net} = 345.811 kJ/kg$

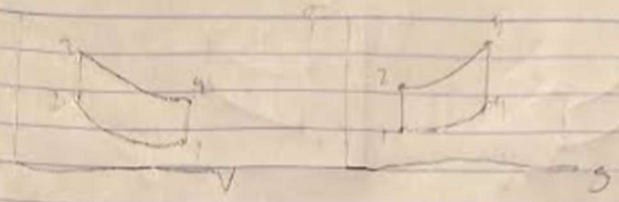
$14 psig = 96.53 kPa$

$$m = n p V \rightarrow n \cdot \frac{p}{R \cdot T_1} \cdot \frac{\pi}{4} d^2 \cdot L = 6 \cdot \frac{96.53}{0.287 \cdot 313} \cdot \frac{\pi}{4} \cdot (0.089)^2 \cdot 0.055$$

$m = 0.004 kg$

$q_{net/cycle} = 0.004 \cdot 345.81 = 1.383 kJ/cycle$

$$\dot{q}_{net} = \frac{q_{net/cycle} \cdot N}{N_{rev}} = \frac{1.383 \cdot \frac{250}{60}}{2} = 28.81 kW$$



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$q_{net} = 345.811 kJ/kg$

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$$m = n p V \rightarrow n \cdot \frac{p}{R \cdot T_1} \cdot \frac{\pi}{4} d^2 \cdot L = 6 \cdot \frac{96.53}{0.287 \cdot 313} \cdot \frac{\pi}{4} \cdot (0.089)^2 \cdot 0.055$$

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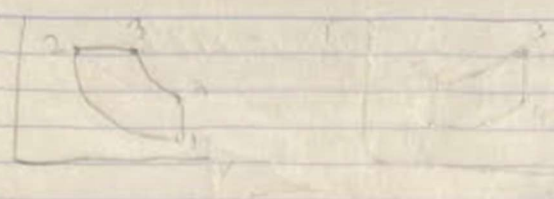
46

57



① $T_1 = 70°C \rightarrow 343°K$ $P_1 = 97 kPa$ ② $T_2 = 1181°K$ ③ $T_3 = 2126°K$ ④ $T_4 = 781°K$

$T_2 = T_1\left(\frac{V_1}{V_2}\right)^{k-1} = 343 \cdot (22)^{1.4-1} = 1181°K$

$T_3 = \left(\frac{V_3}{V_2}\right) \cdot T_2 = 1.8 \cdot 1181 = 2126°K$

$T_4 = T_3\left(\frac{1}{r_c}\right)^{k-1} = 2125.8\left(\frac{1}{22}\right)^{1.4-1} = 781°K$

$m_1 = \frac{P_1 V_1}{R T_1} = \frac{97 \cdot 0.0024}{.287 \cdot 343} = 0.002365 kg$

$q_{in} = m c_p (T_3 - T_2) = 0.002365 \cdot 1.005 (2126 - 1181)$

$q_{in} = 2.246 kJ$

$q_{out} = m c_v (T_4 - T_1) = 0.002365 \cdot 0.718 (781 - 343)$

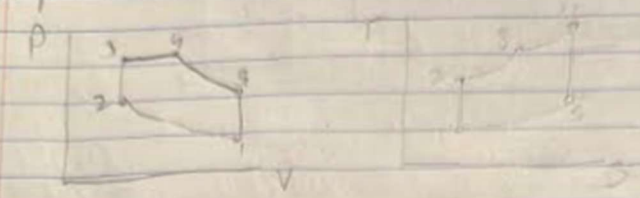
$q_{out} = 0.7438 kJ$

$w_{net} = q_{in} - q_{out} = 2.246 - 0.7438 = 1.5023$

$\dot{W}_{net} = \dot{n} w_{net} = \left(\frac{3500}{60}\right) \cdot 1.5023 = 87.6 kW$

5G 14.2 psia = 98 kPa 75°F = 24°C = 297K

$c_p = 1.005$ $c_v = 0.718$



① $P_1 = 98$ kPa, $T_1 = 297$K

② $P_2 = 4342.44$ kPa, $T_2 = 877.39$K

③ $T_3 = 965.12$K, $P_3 = 4776.904$ kPa

④ $P_4 = 4776.904$ kPa, $T_4 = 1351.16$K

⑤ $T_5 = 523.69$K

$v_1 = \frac{RT_1}{P_1} = \frac{0.287 \cdot 297}{98} = 0.8697 \text{ m}^3/\text{kg}$

$v_2 = \frac{v_1}{r} = \frac{0.8697}{15} = 0.05798 \text{ m}^3/\text{kg}$

$P_2 = P_1(r)^{\gamma} = 98(15)^{1.4} = 4342.64$ kPa

$T_2 = T_1(r)^{\gamma-1} = 297(15)^{1.4-1} = 877.39$K

$T_3 = T_2\left(\frac{P_3}{P_2}\right) = 877.39 \cdot 1.1 = 965.12$K

$\frac{P_3}{P_2} = 1.1$ $P_3 = P_4$ $P_4 = 1.1 \cdot 4342.64 = 4776.904$ kPa

$v_4 = \gamma \cdot v_3 = \gamma \cdot v_2 = 1.4 \cdot 0.05798 = 0.081172 \text{ m}^3/\text{kg}$

$T_4 = T_3\left(\frac{v_4}{v_3}\right) = 965.12\left(\frac{0.081172}{0.05798}\right) = 1351.16$K

$T_5 = T_4\left(\frac{v_5}{v_1}\right) = 1351.16\left(\frac{0.081172}{0.8697}\right) = 523.69$K

$q_{in} = c_v(T_3 - T_2) + c_p(T_4 - T_3) = 0.718(965.12 - 877.39) + 1.005(1351.16 -$

$q_{in} = 450.96$ kJ/kg

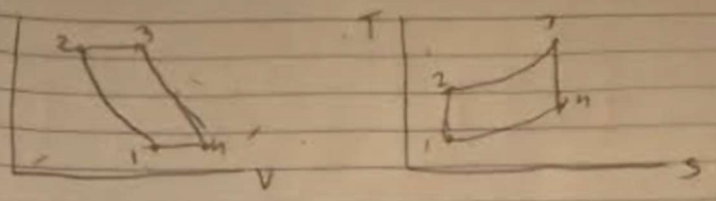
$q_{out} = c_v(T_5 - T_1) = 0.718(523.69 - 297) = 162.76$ kJ/kg

$W_{net} = q_{in} - q_{out} = 450.96 - 162.76 = 288.2$ kJ/kg

$\eta_{th} = \frac{W_{net}}{q_{in}} = \frac{288.2}{450.96} = 0.639 = 63.9\%$

went to class for help on this one

80



① $T_1 = 520R$ ② $T_2 = 996.48K$ ③ $T_3 = 2000R$ ④

$P_{r2} = 10 \cdot 1.247 = 12.147$

$T = 980, h = 236.02, P_r = 11.43$

$T = 1000, h = 240.98, P_r = 12.30$

$\frac{12.3 - 11.43}{12.3 - 12.147} = \frac{1000 - 980}{1000 - T_2}$ $T_2 = 996.48K$

$h_2 = 240.107 \frac{Btu}{lbm}$

$P_{r4} = \frac{P_4}{P_2} = \frac{127}{10} = 12.4$

$P_r = 16.28$ $h = 260.97$ $\frac{18.60 - 16.28}{18.60 - 17.4} = \frac{271.03 - 260.97}{271.03 - h_4}$

$P_r = 18.60$ $h = 721.03$

$h_4 = 265.826$

$W_t = 240.107 - 124.27 = 115.837$

$BWR = \frac{115.837}{235.884} = 0.4849$

$q_{in} = 504.71 - 240.107 = 264.603$

$n = \frac{238.554 - 115.837}{264.603} = 46.5\%$