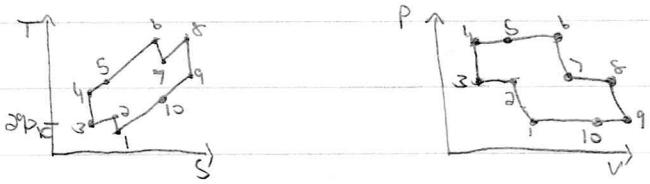
Jordan Whitaker

HW 1.5

(123)



$T_2 = T_4 = T_1 r_p^{(k-1)/k} = (290)(4)^{0.4/1.4} = 430.9\,K$

$T_5 = T_{11} + 20 = 430.9 + 20 = 450.9\,K$

$q_{in} = C_p(T_6 - T_5) \Rightarrow T_6 = T_5 + \frac{q_{in}}{C_p} = 450.9 + \frac{300}{1.005} = 749.4\,K$

$T_7 = T_6\left(\frac{1}{r_p}\right)^{\frac{k-1}{k}} = 749.4\left(\frac{1}{4}\right)^{0.4/1.4} = 504.3\,K$

$T_8 = T_7 + \frac{q_{in}}{C_p} = 504.3 + \frac{300}{1.005} = 802.8\,K$

$T_9 = T_8\left(\frac{1}{r_p}\right)^{\frac{k-1}{k}} = (802.8)\left(\frac{1}{4}\right)^{0.4/1.4} = 540.2\,K$

$T_{10} = T_9 - 20 = 540.2 - 20 = 520.2\,K$

$q_{in} = 300 + 300 = 600\ kJ/kg$

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

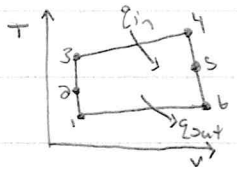
$= 1.005(520.2 - 290) + 1.005(430.9 - 290)$

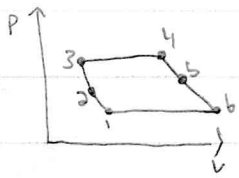
$= 373\ kJ/kg$

$\eta_{th} = 1 - \frac{q_{out}}{q_{in}} = 1 - \frac{373}{600} = 0.378 \times 100.$

$= 37.8\%$

12.9





$C_p = 0.24$ Btu/lbm·R $k = 1.4$

a) $T_2 = T_1 \frac{V_2^2 - V_1^2}{2C_p}$

$= 470 + \frac{(900)^2}{2(0.24)} \cdot \frac{1 \text{ Btu/lbm}}{25037 \text{ ft}^2/\text{s}^2}$

$T_2 = 537.4$ R

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

$= (7)\left(\frac{537.3}{470}\right)^{1.4/0.4}$

$P_2 = 11.19$ psia

$P_3 = P_4 = \gamma (F_p)(P_2)$

$P_3 = 13(11.19)$

$P_3 = 145.5$ psia

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

$= 537.4 (13)^{0.4/1.4}$

$T_3 = 1118.3$ R

$T_5 = T_4 - T_3 + T_2$

$= (2400 - 1118.3 + 537.4)$

$T_5 = 1819.1$ R

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

$= 145.5\left(\frac{1819.1}{2400}\right)^{1.4/0.4}$

$\boxed{P_5 = 52.2 \text{ psia}}$

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

$= (1819.1)\left(\frac{7}{55.2}\right)^{0.4/1.4}$

$T_6 = 1208.4$ R

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

$= \sqrt{2(0.24)(1819.1 - 1208.6)\left(\frac{25037 \text{ ft}^2/\text{s}^2}{1 \text{ Btu/lbm}}\right)}$

$\boxed{V_6 = 3121 \text{ ft/s}}$

c) $W_p = (V_{exit} - V_{inlet}) V_{aircraft}$

$= (3121 - 900)(900)\left(\frac{1 \text{ Btu/lbm}}{25037 \text{ ft}^2/\text{s}^2}\right)$

$W_p = 79.8$ Btu/lbm

$q_{in} = h_4 - h_3 = \gamma C_p (T_4 - T_3)$

$= (0.24)(2400 - 1118.3)$

$q_{in} = 307.6$ Btu/lbm

$\eta_p = \frac{79.8}{307.6} \times 100$

$= 0.259$

$\boxed{\eta_p = 25.9\%}$

ME350
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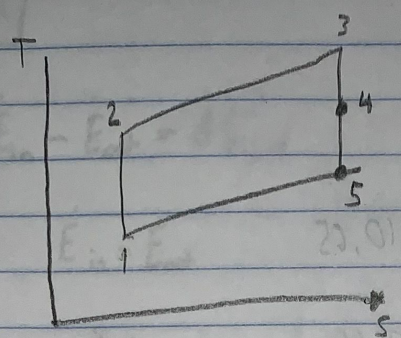
HW # 1.5
9-135)



$T_1 = 300\,K$
$h_1 = 300.19\ kJ/kg$
$P_{r_1} = 1.386$

$$P_{r_2} = \frac{P_2}{P_1} P_{r_1} = (12)(1.386)$$

$P_{r_2} = 16.63$
$h_2 \Rightarrow 610.65\ kJ/kg$

$$\dot{Q}_{in} = \dot{m}_f (HV)$$

$= (0.2\ kg/s)(42{,}700\ kJ/kg)$

$= 8540\ kJ/s$

$$q_{in} = \frac{\dot{Q}_{in}}{\dot{m}}$$

$$= \frac{8540\ kJ/s}{10\ kg/s} = 854\ kJ/kg$$

HW#15
9-135 cont.

$$q_{in} = h_3 - h_2$$

$$854 = h_3 - 610.65$$

$$h_3 = 1464.65\ kJ/kg$$

$$\Rightarrow P_{r3} = 396.27$$

$$W_{comp,in} = W_{t,out}$$

$$\Rightarrow h_2 - h_1 = h_3 - h_4$$

$$\Rightarrow h_4 = h_3 - h_2 + h_1$$

$$= 1464.65 - 610.65 + 300.19$$

$$h_4 = 741.17\ kJ/kg$$

$$P_{r5} = P_{r3}\left(\frac{P_5}{P_3}\right)$$

$$= (396.27)\left(\frac{1}{12}\right)$$

$$= 33.02$$

$$\Rightarrow h_5 = 741.79\ kJ/kg$$

HW 1.5
9-135 cont:

$$\dot{E}_{in} - \dot{E}_{out} = \Delta E_{syst}$$

$$\dot{E}_{in} = \dot{E}_{out}$$

$$\Rightarrow h_4 + V_4^2/2 = h_5 + V_5^2/2$$

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

$$= \sqrt{(2)(1154.19 - 741)\left(\frac{1000\ m^2/s^2}{1\ kJ/kg}\right)}$$

$$= 908.9\ m/s$$

$$\text{Thrust} = \dot{m}(V_{exit} - V_{inlet}) = (10\ kg/s)(908.9)\left(\frac{1\ N}{1\ kg\ m/s^2}\right)$$

$$= 9089\ N$$