空气动力学 HW 6

7.1

解：$p = \rho R T$

$\rho = \frac{p}{RT}$ $\quad R = 287\ J/(kg\cdot k)$

$p = 7.8\ atm = 7.8 \times 1.01 \times 10^5\ Pa$

$T = 934^\circ R = 518.89\ K$

$\therefore \rho = \frac{7.8 \times 1.01 \times 10^5}{287 \times 518.89} = 5.29\ kg/m^3$

7.3

解：$h = e + pv = e + \frac{p}{\rho} = c_p T$

$e = C_v T = \frac{R}{\gamma - 1} T$

$e_2 - e_1 = \frac{R}{\gamma-1}(T_2 - T_1) = \frac{287}{1.4-1} \times (690 - 288)$

$= 288.435\ kJ/kg$

$h_2 - h_1 = \frac{\gamma R}{\gamma - 1}(T_2 - T_1) = \frac{1.4 \times 287}{1.4-1} \times (690-288)$

$= 403.809\ kJ/kg$

$S_2 - S_1 = C_p \ln\frac{T_2}{T_1} - R\ln\frac{P_2}{P_1}$

$= \frac{\gamma R}{\gamma - 1} \ln\frac{T_2}{T_1} - R\ln\frac{P_2}{P_1}$

$= \frac{1.4 \times 287}{1.4-1} \ln\frac{690}{288} - 287 \ln\frac{8.656}{1}$

$= 258.24\ J/(k\cdot kg)$

7.4

解：等熵

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

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

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

$= \left(\frac{3.6}{4.35}\right)^{\frac{0.4}{1.4}} \times 245$

$= 232.1\ k$

$P = \rho R T$

$\therefore \rho = \frac{P_2}{RT_2} = \frac{3.6 \times 10^4}{287 \times 232.1}$

$= 0.5404\ kg/m^3$

7.5

解：等熵

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

$\frac{1}{10} = \left(\frac{T_2}{500}\right)^{\frac{1.4}{0.4}} \Rightarrow T_2 = 258.97\ k$

$\rho = \frac{P_2}{RT_2} = \frac{1.01 \times 10^5}{287 \times 258.97} = 1.359\ kg/m^3$

7.6

解：$\tau_T = -\frac{1}{v}\left(\frac{dv}{dp}\right)_T = +\frac{1}{v} \cdot \frac{RT}{P^2} = \frac{1}{P}$

$= \frac{1}{0.2 \times 1.01 \times 10^5}\ Pa^{-1} = 4.95 \times 10^{-5}\ Pa^{-1}$

$\tau_S = -\frac{1}{v}\left(\frac{dv}{dp}\right)_S$

Since $\frac{P_1}{P_2} = \left(\frac{\rho_1}{\rho_2}\right)^\gamma = \left(\frac{v_2}{v_1}\right)^\gamma \Rightarrow P v^\gamma = Const$

$v = \left(\frac{C}{P}\right)^{\frac{1}{\gamma}}$, $\frac{dv}{dp} = \frac{1}{\gamma}\left(\frac{C}{P}\right)^{\frac{1}{\gamma}-1} \cdot C \cdot \frac{-1}{P^2}$

$\therefore \tau_S = \frac{1}{\gamma P} = \frac{1}{1.4 \times 0.2 \times 1.01 \times 10^5} = 3.536 \times 10^{-5}\ Pa^{-1}$