工業熱力学 基礎編 中間試験範囲略解

第1章

6. $4\times10^{4}\times\frac{0.8}{10\times60}\approx 8.89$ [kW]

第2章

4. $\Delta U = C_v\,dT$

$= 2.6\times\frac{1}{1.4-1}\times 287\times(1600-340)$

≈ 485

$Q = \Delta U + W = 485-420 = 65.0$ [kJ]

5. $W = P\Delta V = \frac{7.3}{28.9}\times 8.31\times(500-300)$

$= 419$ J

$W = R(T_2-T_1)$

$q = \frac{K}{K-1}R(T_2-T_1) = 1.47$ kJ

7. $Q-W' = (U_2+p_2V_2+\frac{1}{2}m c_2^2+mgz_2)$

$-(U_1+p_1V_1+\frac{1}{2}m c_1^2+mgz_1)$

$\therefore Q = \frac{1}{2}5.7(150^2-30^2)\times\frac{1}{10^6}+(1000-550)\times 5.7\times\frac{1}{10^3}$

$= 0.06156+2.565$

≈ 2.63 MW

10. $Q = mC_p dT = mKC_v dT$

$\therefore K = \frac{Q}{mC_v dT} = \frac{336}{95\times1.72\times(600-300)}\approx 1.30$

$C_v = \frac{\frac{R}{M}}{K-1}$

$\therefore M = \frac{R}{C_v(K-1)} = \frac{8.31}{1.72(1.3-1)}\approx 16.0$

第3章

6.(1) $Q_{12} = m\times\frac{K}{K-1}\times\frac{R}{M_{air}}dT$

$= 20.0\times\frac{1.4}{1.4-1}\times\frac{8.314}{29.0\times10^{-3}}\times(473-300)$

$= 3.46$ MJ

$\Delta H_{12} = Q_{12} = 3.46$ MJ

$\Delta U_{12} = \frac{1}{K}\Delta H_{12} = 2.48$ MJ

1st law より

$W_{12} = Q_{12}-\Delta U_{12}$

$= 3.46-2.48$

$= 0.98$ MJ

(2) $\Delta H_{12}' = \Delta H_{12} = 3.46$ MJ

$\Delta U_{12}' = \Delta U_{12} = 2.48$ MJ

定容変化より $W_{12}' = 0$ MJ

$Q_{12}' = W_{12}' + \Delta U_{12}' = 2.48$ MJ

7.

$\begin{cases} pV^K = \text{const} \\ \frac{pV}{T} = \text{const} \end{cases} \rightarrow p^{1-K}T^K = \text{const.}$

$(1.00\times10^5)^{1-K}\,273^K = p_2^{1-K}\,873^K$

$\therefore p_2 = 1.00\times10^5\times\left(\frac{273}{873}\right)^{\frac{1.4}{1-1.4}}$

$\approx 5.85\times10^6$

1st law より

$0 = \Delta U - W$

$\therefore W = \Delta U = m\int_1^2 C_v\,dT$

$= \frac{1}{K-1}\times\frac{R}{M_{air}}\times m_{air}\times(873-273)$

$= \frac{5}{2}\times\frac{8.314}{29.0}\times 2.0\times 600$

$\approx 8.60\times10^5$

$\frac{T}{p^{\frac{n-1}{n}}} = \text{const}$ より

$\frac{273}{(1.00\times10^5)^{\frac{1.25-1}{1.25}}} = \frac{873}{p_2^{\frac{1.25-1}{1.25}}}$ $\therefore p_2\approx 33.4$ MPa

$Q = \frac{n-K}{n-1}C_v(T_1-T_2)$

$= \frac{1.25-1.4}{1.25-1}\cdot\frac{1}{1.4-1}\times\frac{8.31}{28.9}\times 2\times(273-873) = 5.16\times10^2$ kJ