일반물리Ⅰ. Chapter 19

11.

(a). 1기압에서 물의 어는 점 0 °C, 끓는 점 100 °C

$T_c = 273\,K$, $T_h = 373\,K$

가역 기관의 효율 : 카르노 기관의 효율

$$e = 1 - \frac{T_c}{T_h} = 1 - \frac{273\,K}{373\,K} = \text{약 } 0.268 \Rightarrow \boxed{26.8\,\%}$$

(b). $T_h = 298\,K$, $T_c = 277\,K$

$$e = 1 - \frac{T_c}{T_h} = 1 - \frac{277\,K}{298\,K} = \text{약 } 0.0705 \Rightarrow \boxed{7.05\,\%}$$

(c). 실온 20 °C 정도

$T_h = 1273\,K$, $T_c = 293\,K$

$$e = 1 - \frac{T_c}{T_h} = 1 - \frac{293\,K}{1273\,K} = \text{약 } 0.77 \Rightarrow \boxed{77\,\%}$$

14. $Q_h = 900J$, $W = 350J$

(a). $e = \frac{W}{Q_h} = \frac{350J}{900J} = 약\ 0.39 \Rightarrow$ 39%

(b). $e = 1 - \frac{Q_c}{Q_h}$, $1 - e = \frac{Q_c}{Q_h}$

$Q_c = Q_h(1-e) =$ 550J

(c). $e = 1 - \frac{T_c}{T_h}$, $T_c = 283K$

$1 - e = \frac{T_c}{T_h} \rightarrow T_h = \frac{T_c}{1-e} =$ 약 463K

(463K = 190°C)

22. $T = 440K$, $\Delta S = 25J/K$

$\Delta E_{\text{최소}} = T_{min}\Delta S = (440K)(25J/K)$

$=$ 11000J = 11KJ

35. $P = \frac{\Delta W}{\Delta t} = 750\,MW$, $Q = mc\Delta T$

(a). $T_c = 288K$, $\Delta T = 8.5K$

$2.8 \times 10^4 kg/s$: 시간에 따른 질량의 변화량(방출)

$$\frac{dQ_c}{dt} = c\Delta T \frac{dm}{dt}$$

$$= (4.184\,kJ/kg \cdot K)(8.5K)(2.8 \times 10^4 kg/s)$$

$$= 995792\,kJ/s = 995.792\,MW$$

연료에서 얻는 에너지 추출률 : $\frac{dQ_h}{dt}$ (시간에 따른 Q_h 변화량)

$W = Q_h - Q_c$ 이므로, $\frac{dW}{dt} = \frac{dQ_h}{dt} - \frac{dQ_c}{dt}$

$$\frac{dQ_h}{dt} = \frac{dW}{dt} + \frac{dQ_c}{dt} = P + \frac{dQ_c}{dt} = 750\,MW + 995.792\,MW$$

$= 1745.792\,MW =$ 약 $1.75\,GW$

(b). $e = \frac{W}{Q_h} = \frac{dW/dt}{dQ_h/dt} = \frac{750\,MW}{1745.792\,MW}$

$= 약\ 0.43 \Rightarrow 43\%$

(c).

$\frac{T_h}{T_c} = \frac{Q_h}{Q_c} \rightarrow T_h = \frac{Q_h}{Q_c} T_c = \frac{dQ_h/dt}{dQ_c/dt} T_c$

$= \left(\frac{1745.792\,MW}{995.792\,MW}\right) 288K = \boxed{약\ 505K}$

$(505K = 232°C)$

47. 46의 정의: $n = 0.350\,mol$, $T_0 = 586K$

A: 6.0 atm, 2.0 L

등압팽창

B: 6.0 atm, 6.0 L

등적과정

C: 3.0 atm, 6.0 L

등압수축

D: 3.0 atm, 2.0 L

W는 $W=\int P dV$ 이므로 $(6\times4-3\times4)\,L\cdot atm$

$= 12\,L\cdot atm$ 이다.

각각의 경우,

$W_{AB}=(6atm)(6-2)L=24L\cdot atm$

$W_{BC}=0$

$W_{CD}=(3atm)(2-6)L=-12L\cdot atm$

$W_{DA}=0$

$W=W_{AB}+W_{BC}+W_{CD}+W_{DA}=12L\cdot atm$

(a) $e=\frac{W}{Q_h}$

$Q_h=Q_{AB}+Q_{DA}$

$=nC_p(T_B-T_A)+nC_v(T_A-T_D)$

$=nC_p\left(\frac{P_BV_B}{nR}-\frac{P_AV_A}{nR}\right)+nC_v\left(\frac{P_AV_A}{nR}-\frac{P_DV_D}{nR}\right)$

$$= \frac{5}{2}(36-12)\,L\cdot atm + \frac{3}{2}(12-6)\,L\cdot atm$$

$$= 60\,L\cdot atm + 9\,L\cdot atm = 69\,L\cdot atm$$

$$\therefore e = \frac{12\,L\cdot atm}{69\,L\cdot atm} \fallingdotseq 0.174 \Rightarrow \boxed{17.4\%}$$

(b). $e_{Carnot} = 1 - \frac{T_c}{T_h} = 1 - \frac{T_{min}}{T_{max}} = 1 - \frac{T_D}{T_B}$

$T_B = \frac{P_B V_B}{nR}$, $T_D = \frac{P_D V_D}{nR}$

$$e = 1 - \frac{P_D V_D}{P_B V_B} = 1 - \frac{6\,L\cdot atm}{36\,L\cdot atm} \fallingdotseq 0.833$$

$\Rightarrow \boxed{83.3\%}$