열역학 과제 #11 안용상

2019101174

Date. No.

열역학 과제 HW# 11 (20191010[illegible] 이[illegible])

38, 50, 56, 61, 66, 73, 86, 89, 100

38번. 수증기, 순환공정

550kPa, 200°C $\xrightarrow{dV=0}$ 800kPa $\xrightarrow{dQ=0}$ 200°C $\xrightarrow{dT=0}$ 550kPa, 200°C

	1		2		3		4
V	385.19		385.19		1236.4		385.19
U	2640.6	→	2960.3		2655.3		2640.6
H	2852.5		3268.5		2871.7		2852.5
S	7.0108		7.5729	→	7.5729		7.0108
	Q, W=0				Q=0, W		

$dS = \frac{dQ}{T}$

$\Delta S = \frac{Q}{T}$

$dH = dQ + VdP$

$dU = dQ - pdV$

$Q_{12} = U_2 - U_1$

$= 320\ kJ/kg$

$dU = dW$

$W = U_3 - U_2$

$= -305\ kJ/kg$

$Q = T \times (S_4 - S_3)$

$= (200+273) \times (7.0108 - 7.5729)\ \frac{kJ}{kg \cdot K}$

$= -265.87\ kJ$

$dU = dQ + dW$

$W = \Delta U - Q$

$= U_4 - U_3 - Q$

$= 250.3$

$\therefore W = -305 - 306.94 = -611.94\ kJ/kg$

$Q = 320 + 292.2467 = 612.2467\ kJ/kg$

$W_{cycle} = -Q_{cycle} = -Q_{12} - Q_{31}$

$\therefore \eta = -\frac{-Q_{12} - Q_{31}}{Q_{12}} = 0.1675$

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6.50

$T_c = 425.2\,K$ P_c 42.77 bar Z_c 0.269, ω 0.193 T 380 K P 1919.4 kPa

P_0 101.33 kPa T_0 293.15 T_r 0.894 P_r 0.4499 T_n 268.7

$Z_0 = 0.7364$ $Z_1 = -0.1578$

$Z = Z_0 + \omega Z_1 = 0.7078$

$$V = \frac{ZRT}{P} = \frac{0.7078 \times 83.14 \times 10^5 \times 380}{1919.4 \times 10^3} = 1164.7 \frac{cm^3}{mol}$$

$H_R = H_0 + \omega H_1 = -3156.2 \frac{J}{mol}$ $S_R = S_0 + \omega S_1 = -6.393 \frac{J}{mol\,K}$

$H_{vap} = C_p \Delta T + H_R = 6194 J/mol$ $S_{vap} = C_p \Delta T / R + S_R = -1.103 J/mol$

$$\Delta H_1 = R \times T_n \left(\frac{1.092 \ln P_c - 1.013}{0.93 - \frac{T_n}{T_c}} \right) = 22447 \frac{J}{mol}$$

$$\Delta H = \Delta H_1 \left(\frac{1 - T_{vap}}{1 - \frac{T_n}{T_c}} \right)^{0.38} = 14003 \frac{J}{mol}$$

$H_{liq} = H_{vap} - \Delta H = -11809 \frac{J}{mol}$ $V_{liq} = V_c Z_c^{(1-T_r)^{0.2857}} = 109.8 \frac{cm^3}{mol}$

$S_{liq} = S_{vap} - \frac{\Delta H}{T} = -35.141 \frac{J}{mol\,K}$

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H_2S $T_c = 373.5K$ $P_c = 89.63 bar$ $\omega = 0.094$

$T_1 = 400K$, $P_1 = 5 bar$ $P_2 = 25 bar$, $T_2 = 600K$

$P_{r_1} = 0.055$ $T_{r_2} = 1.606$ $P_{r_2} = 0.279$

$\Delta H = C_p dT + RT_c(H_{R_2} - H_{R_1}) = 7821.4 \frac{J}{mol}$

$\Delta S = C_p dT/R + R(S_{R_2} - S_{R_1}) = 1.551 \frac{J}{mol \cdot K}$

6.61 $H_1 = 3344.6$ $S_1 = 7.0954$ $T_0 = 300K$

$H_2 = 112.5$ $S_2 = 0.3928$

$W_{ideal} = H_2 - H_1 - T_0(S_2 - S_1) = -1224.3 \frac{kJ}{kg}$

6.66 $H_1 = 1226.6 \frac{BTU}{lbm}$ $S_1 = 1.5131 \frac{BTU}{lbm \cdot R}$

$H^{liq} = 355.51 \frac{BTU}{lbm}$ $H^V = 1198.3$

$S^V = 0.5438$ $S^V = 1.5454$

$x^V = 0.96$

$H_2 = H' + x(H^V - H') = 1.165 \times 10^3 \frac{BTU}{lbm}$

$S = S' + x(S^V - S') = 1.54 \frac{BTU}{lbm \cdot R}$

$S_G = S - 0.55_1 - 0.55_2 = 2.895 \times 10^{-4} \frac{BTU}{lbm \cdot R}$

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6.13 3200kPa

$V' = 1.210 \frac{cm^3}{g}$ $V'' = 66.626$ $V_{tank} = 2m^3$

$H' = 1008.4$ $H'' = 2802.3$ $x_1 = 0.1$

$V_1 = V' + x_1 (V'' - V') = 7.0177 \times 10^{-3} \frac{m^3}{kg}$

$m_1 = \frac{V_{tank}}{V_1} = 2517.832 kg$

$Q = \Delta m_e \times H_e + H \times \Delta m_{tank}$

$\Delta m_e \times H_e = y(H_2 - H_1) - 0.6 m_1 H_1$

$0 = y(V'' - V') - 0.6 m_1 V' \rightarrow y = \frac{0.6 m_1 V_1}{(V'' - V')}$

$Q = \frac{0.6 m_1 V'}{(V'' - V')} \times (-1) \times (H'' - H') - 0.6 m_1 H' + H \times \Delta m_{tank}$

$H' = H$, $\Delta m_{tank} = 0.6 m_1$

$Q = \frac{0.6 m_1 V_1}{V'' - V'} (H'' - H_1) = 5154 kJ$

5.86

(a) work $-p = \frac{1}{k}\ln\frac{V}{V_1} - P_1$

$dW = -p\,dV = \frac{1}{k}\ln V\,dV - \left(P_1 + \frac{1}{k}\ln V\right)dV$

$W = \frac{1}{k}\left((V_2\ln V_2 - V_2) - (V_1\ln V_1 - V_1)\right) - P_1(V_2 - V_1) - \frac{1}{k}(V_2\ln V_2 - V_1\ln V_1)$

$= \frac{1}{k}\left(V_2\ln\frac{V_2}{V_1} + V_1 - V_2\right) - P_1(V_2 - V_1)$

$d\ln\frac{V_2}{V_1} = -k(P_2 - P_1)$ $\quad W = P_1V_1 - \beta V_2 - \frac{V_2 - V_1}{k}$

b) Entropy $ds = -\beta V\,dP$

$-p = \frac{\ln V}{k} - \frac{\ln V_1}{k} - P_1$ / $-dp = \frac{1}{k}d\ln V$

$ds = \frac{\beta V}{k}d\ln V = \frac{\beta}{k}$, $\Delta S = \frac{\beta}{k}(V_2 - V_1)$

c) Enthalpy

$dH = 1 - \beta T V\,dP$

$dH = -1 - \beta T V \times \frac{1}{k}d\ln V = -\frac{1-\beta T}{k}dV$

$\Delta H = \frac{1-\beta T}{k}(V_1 - V_2)$

$W = 4.855\ kJ/kg$ $\quad \Delta S = -0.036348\ kJ/kg\cdot K$

$\Delta H = 134.55\ kJ/kg$

6.89

$$ds = \left(\frac{\partial s}{\partial P}\right)_v dP + \left(\frac{\partial s}{\partial v}\right)_P dv$$

$$\hookrightarrow ds = \left(\frac{\partial s}{\partial T}\right)_v \left(\frac{\partial T}{\partial P}\right)_v dP + \left(\frac{\partial s}{\partial T}\right)_P \left(\frac{\partial T}{\partial v}\right)_P dv$$

$$\hookrightarrow ds = \frac{c_v}{T}\left(\frac{\partial T}{\partial P}\right)_v dP + \frac{c_p}{T}\left(\frac{\partial T}{\partial v}\right)_P dP$$

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6.100

CO_2 ω : 0.224 T_t : 216.55

T_c 304.2 P_t = 5.17bar

P_c 73.83bar

(a) T_r = 0.7 T = 0.7T_c T = 212.94

$T_{tr} = \frac{T_t}{T_c}$ = 0.712 $P_{tr} = \frac{P_t}{P_c} \rightarrow P_{tr}$ = 0.07

$\ln P_r^{0}(T_r) = 5.92714 - \frac{6.09648}{T_r} - 1.28862 \times \ln T_r + 0.1693 \times T_r^{6}$

$\ln P_r^{1}(T_r) = 15.2518 - \frac{15.6875}{T_r} - 13.4721 \times \ln T_r + 0.43577 \times T_r^{6}$

∴ ω = 0.224

b) $P_s \rightarrow \frac{1atm}{P_c}$ P_t^{sat} = 0.014 T_{rt} = 0.7

$\ln(P^{sat}_t) = \ln P_r^{0}(T_{rn}) + \omega \times \ln P_r^{1}(T_m) T_m$

T_n을 찾으면

T_{rn} = 0.609 $T_n = T_{rn} \times T_c \Rightarrow T_n$ = 185.3K

T_{rn} 은 0.6이다 (일반적 상응 조건에서)

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