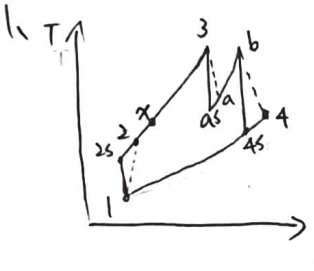
E14082181 蘇品瑄 熱力期末

1.



$\dot{m} = 6\ kg/s$, $\frac{P_{2s}}{P_1} = 10$, $\frac{P_3}{P_{as}} = \frac{P_b}{P_{4s}} = 10$

$P_1 = 100kPa$, $T_1 = 300K$

$T_3 = T_b = 1400k$

$\eta_c = \eta_t = \eta_{reg} = 80\%$

$k = 1.4$

(a) $\dot{Q}_{in} = \dot{m}(h_3 - h_x)$

$T_1 \rightarrow \boxed{h_1 = 300.19}$

$T_{2s} = T_1 (\frac{P_{2s}}{P_1})^{k-1/k} = 300 \times 10^{0.4/1.4} = 579.21 \rightarrow h_{2s} = 585.2$

$\eta_c = \frac{h_{2s} - h_1}{h_2 - h_1} \Rightarrow \boxed{h_2 = \frac{h_{2s} - h_1}{\eta_c} + h_1 = 656.453}$

$T_3 \rightarrow \boxed{h_3 = 1515.42 = h_b}$

$T_{as} = T_3 (\frac{P_{as}}{P_3})^{k-1/k} = 1400 \times (\frac{1}{10})^{0.4/1.4} = 1455.13 \rightarrow h_{as} = 140.22$

$T_{4s} = T_b (\frac{P_{4s}}{P_b})^{k-1/k} = 1400 \times (\frac{1}{10})^{0.4/1.4} \rightarrow h_{4s} = h_{as} = 140.22$

$\eta_t = \frac{h_3 - h_a}{h_3 - h_{as}} = \frac{h_b - h_4}{h_b - h_{4s}} \Rightarrow h_a = h_3 - \eta_t(h_3 - h_{as})$, $h_4 = h_b - \eta_t(h_b - h_{4s})$ $\rightarrow \boxed{h_a = h_4 = 895.26}$

$\eta_{reg} = \frac{h_x - h_2}{h_4 - h_2} \Rightarrow \boxed{h_x = \eta_{reg}(h_4 - h_2) + h_2 = 847.5}$

$\dot{Q}_{in} = \dot{m}(h_3 - h_x) = 6 \times (1515.42 - 847.5) = 4009.52\ kJ/s$ #

(b) $bwr = \frac{\dot{W}_c/\dot{m}}{\dot{W}_t/\dot{m}} = \frac{h_2 - h_1}{(h_3 - h_a) + (h_b - h_4)} = 0.289$ #

2.

$P_1 = P_4 = 2.4\ bar$

$P_3 = P_2 = 8\ bar$

$\dot{Q}_{out} = 15\ kW = \dot{m}(h_2 - h_3)$

①= Saturated vapor, $P_1 = 2.4\ bar$

③= Saturated liquid, $P_3 = 8\ bar$

$P_1 \rightarrow \boxed{h_1 = 244.09}$, $s_1 = 0.9222$

$P_3 \rightarrow \boxed{h_3 = 93.42 = h_4}$

$s_2 = s_1$, $P_2 = P_3$ $\rightarrow \boxed{h_2 = 268.99}$

$\dot{m} = \frac{\dot{Q}_{out}}{h_2 - h_3} = 0.085\ kg/s$

(a) $\dot{Q}_{in} = \dot{m}(h_1 - h_4) = 0.085 \times (244.09 - 93.42) = 12.8\ kW$ #

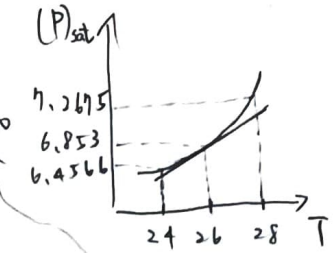
(b) $\gamma = \frac{\dot{Q}_{out}}{\dot{W}_c} = \frac{15}{\dot{m}(h_2 - h_1)} = 7.093$ #

(c) $\gamma_{max} = \frac{T_H}{T_H - T_C} = \frac{20 + 273}{20} = 14.65$ #

4、 $h_g - h_f = T(v_g - v_f)\left(\frac{dP}{dT}\right)_{sat}$ (kJ/kg, K, m³/kg, N/m²·K)

$= (26+273)(0.0298 - 0.8309\times10^{-3}) \times 20300 \times 10^{-3}$

$= 175.83$ kJ/kg #



$\left(\frac{dP}{dT}\right)_{sat} = \frac{7.2675 - 6.4566}{28-24}$

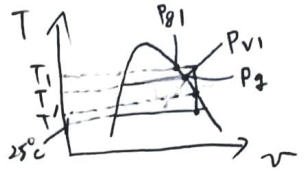
$= 0.203$ bar/K

$= 20300$ N/m²·K

5、 $V = 20\,m^3$, $P = 1.2$ bar, $T_1 = 130°C$, $\phi = 15\%$

↓

$T_2 = 25°C$.



(a) $T_1 \rightarrow P_{g1} = 2.701$

$P_{v1} = \phi P_{g1} = 0.15 \times 2.701 = 0.405$ bar $= P_g$

↘ $T = 76.143°C$ #

(b) $v_{v1} = v' = \frac{RT_1}{P_{v1}} = \frac{\frac{8314}{18} \times (130+273)}{0.405\times10^5} = 4.6\ m^3/kg = v_g \rightarrow T' = 72.426°C$ #

(c) $m_{v1} = \frac{V}{v_1} = \frac{20}{4.6} = 4.348$ kg

$x_2 = \frac{v_2 - v_{f2}}{v_{g2} - v_{f2}} = \frac{4.6 - 1.0029\times10^{-3}}{43.36 - 1.0029\times10^{-3}} = 0.106$

$m_{v2} = 0.106 \times 4.348 = 0.461$

$m_w = m_{v1} - m_{v2} = 4.348 - 0.461 = 3.887$ kg #

(d) $Q = U_2 - U_1$

$= (m_a u_{a2} + m_{v2}\underbrace{u_{v2}}_{u_{g2}} + m_{w2}\underbrace{u_{w2}}_{u_{f2}}) - (m_a u_{a1} + m_{v1}\underbrace{u_{v1}}_{u_{g1}})$

$= m_a(u_{a2} - u_{a1}) + m_{v2}u_{g2} + m_{w2}u_{f2} - m_{v1}u_{g1}$

$T_1 = 130+273 = 403$ K

$T_2 = 25+273 = 298$ K

$m_a = \frac{P_{a1}V}{RT_1} = \frac{(1.2 - 0.405)\times10^5 \times 20}{\frac{8314}{28.97} \times (130+273)} = 13.75$ kg

$Q = 13.75(212.64 - 288.34) + 0.461 \times 2409.8 + 3.887 \times 104.88 - 4.348 \times 2539.9$

$= -10565.8$ kJ #

3、 $m = 2$ kg Air, $V_1 = 0.02\,m^3$, $P_1 = 8$ MPa, $V_2 = 0.08\,m^3$, (a) $P_2 = ?$ (b) $W = ?$

$P = \frac{\bar{R}T}{\bar{v} - b} - \frac{a}{\bar{v}(\bar{v}+b)T^{1/2}}$, $a = 15.989$ bar$(\frac{m^3}{kmol})^2 K^{1/2}$, $b = 0.02541\ m^3/kmol$

$\bar{v}_1 = M v = M\frac{V_1}{m} = 28.97 \times \frac{0.02}{2} = 0.29\ m^3/kmol$

8×10^{-1} bar $= \frac{8314\,T}{0.29 - 0.02541} \times 10^{-5} - \frac{15.989}{0.29(0.29+0.02541) \times T^{1/2}} \Rightarrow T = 69.35$ K

(a) $P_2 = \frac{8314 \times 69.35}{1.16 - 0.02541} \times 10^{-5} - \frac{15.989}{1.16(1.16+0.02541) \times 69.35^{1/2}} = 3.686$ bar #.

$\bar{v}_2 = M\frac{V_2}{m} = 28.97 \times \frac{0.08}{2} = 1.16$