1.) a) $\dot{Q}_{ans} = ?$

$$0 = \dot{m}[h_e - h_a] + \sum_i \dot{Q}_i$$

$$\Rightarrow \dot{m}[h_a - h_e] - \dot{Q}_R = \dot{Q}_{ans} = 0.36\frac{kg}{s}[h_2 - h_1] - 100\,kW$$

$h_{1fg} \overset{A-2}{=} 2626.8\frac{kJ}{kg}$, $h_{2g} \overset{A-2}{=} 2676.1\frac{kJ}{kg}$, $h_{1,f} = 292.98\frac{kJ}{kg}$, $h_{2,f} = 419.04\frac{kJ}{kg}$

$h = h_f + x(h_{fg})$

$h_1 = 304.65\frac{kJ}{kg}$ $\quad h_2 = 436.33\frac{kJ}{kg}$

$\dot{Q}_{ans} = -62.3\,kW$

b) $\overline{T}_{ICF} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{\overline{T}_{ICF}^{ans}(s_e - s_a)}{s_a - s_e} = \overline{T}_{ICF}^{ans} \cdot \frac{c_{if} \cdot \ln\left(\frac{T_{ein}}{T_{ans}}\right)}{c_{if} \cdot \ln\left(\frac{T_{ans}}{T_{ein}}\right)}$

$= T_{ICF,ans} \cdot \frac{\ln\left(\frac{288.15}{298.15}\right)}{\ln\left(\frac{298.15}{288.15}\right)} =$

c) $\dot{S}_{erz} = ?$

$\sum_i \frac{\dot{Q}_i}{T_i} + \dot{S}_{erz} = 0 \Rightarrow \dot{S}_{erz} = -\left(\frac{\dot{Q}_{ans}}{T_{ICF}}\right) = -\left(\frac{62.36\,kW}{295\,K}\right)$

$\dot{S}_{erz} = 0.211\frac{kW}{K}$

d) $m_2 u_2 - m_1 u_1 = \Delta m_{12}[h_{12}] + \sum_i Q_i$

$\Rightarrow m \cdot (u_2 - u_1) - Q_R = \Delta m_{12} h_{12}$

$\Delta m_{12} = \frac{m(h_2 - h_1) - Q_R}{h_{12}}$

$h_{12} \overset{A-2}{=} 2538.1\frac{kJ}{kg}$, $h_2 \overset{A-2}{=} 2626.8\frac{kJ}{kg}$, $h_1 \overset{A-2}{=} h_{1,f} + x_D \cdot h_{fg,1}$

$= 419.04\frac{kJ}{kg} + 0.005 \cdot 2257\frac{kJ}{kg}$

$= 430.325\frac{kJ}{kg}$

[redacted]

$$\Rightarrow \Delta m_{12} = \frac{57556\,kg\,(2626.8\,\frac{kJ}{kg} - 430.325\,\frac{kJ}{kg}) - 35'000\,kJ}{2538.1\,\frac{kJ}{kg}} = 4966.59\,kg$$

e) $\Delta S_{12} = ?$

$\Delta S_{12} = m(s_2 - s_1) \Rightarrow s_2 \overset{A-2}{=} 7.7553\,\frac{kJ}{kg\,K}$

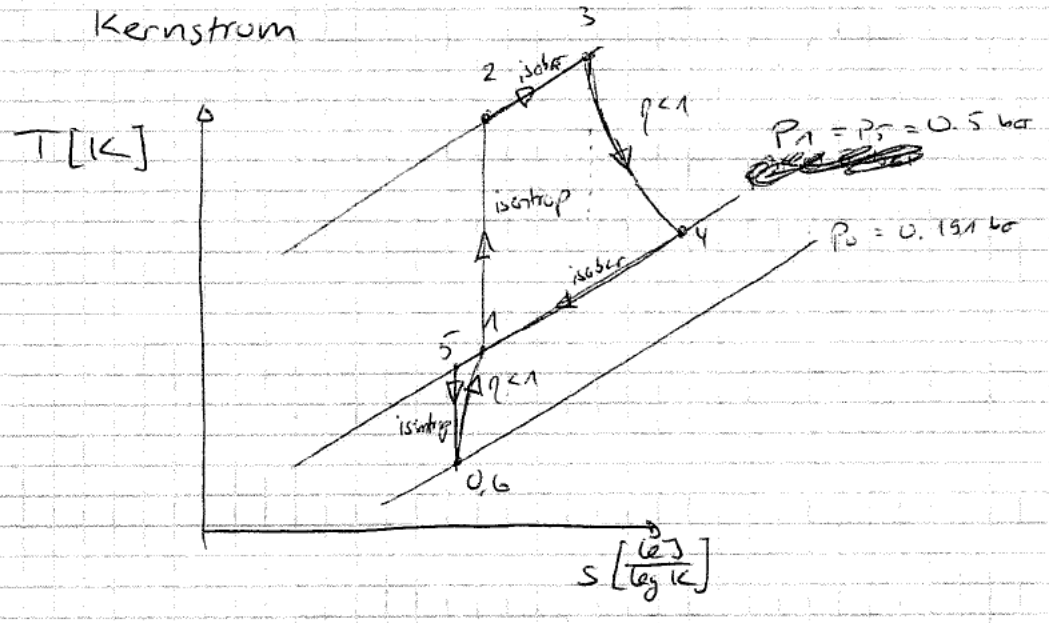
$s_1 \overset{A-2}{=} s_f + x_D \cdot (s_g - s_f) = 1.3069\,\frac{kJ}{kg\,K} + 0.005\,(7.3549 - 1.3069)\,\frac{kJ}{kg\,K} = 1.33714\,\frac{kJ}{kg\,K}$

$\Rightarrow \Delta S_{12} = (57556\,kg + 36006\,kg) \cdot 7.7553\,\frac{kJ}{kg\,K} - 57556\,kg \cdot 1.33714\,\frac{kJ}{kg\,K} = 64658.42\,\frac{kJ}{K}$

2) a) $0 \to 1$ adiabat $\eta < 1$; $1 \to 2$ isentrop ; $2 \to 3$ isobar ; $3 \to 4$ adiabat $\eta < 1$

$4 \to 5$ isobar

$5 \to 6$ isentrop



b) $w_6 = ?$ $T_6 = ?$

$T_5 = 431.9\,K$, $p_5 = 0.5$ bar, $w_5 = 220 \frac{m}{s}$, $p_6 = p_0 = 0.191$ bar

$n = \kappa = 1.4$

$$\left(\frac{T_2}{T_1}\right) = \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} \to \left(\frac{T_6}{T_5}\right) = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}$$

$$\to T_6 = T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} = 328.07\,K$$

$$0 = \dot{m}\left[h_e - h_a + \frac{w_e^2 - w_a^2}{2}\right] \to 0 = h_5 - h_6 + \frac{w_e^2 - w_a^2}{2}$$

$$\to h_6 - h_5 - \frac{w_5^2}{2} = -\frac{w_6^2}{2} \to w_6 = \sqrt{w_5^2 + 2(h_5 - h_6)}$$

$$h_5 \overset{A-22}{=} \frac{(431.9\,K - 430\,K)}{(440\,K - 430\,K)}\left(441.61 - 431.43\right)\frac{kJ}{kg} + 431.43\,\frac{kJ}{kg} = 433.364\,\frac{kJ}{kg}$$

$$h_6 \overset{A-22}{=} \frac{(328.07 - 325)K}{(330 - 325)K}\left(330.34 - 325.31\right)\frac{kJ}{kg} + 325.31\,\frac{kJ}{kg} = 328.4\,\frac{kJ}{kg}$$

$\to w_6 =$

c) $\Delta e_{x,str} = e_{xstr,6} - e_{xstr,0}$

$e_{xstr,6} - e_{xstr,0} = [h_6 - h_0 - T_0(s_6 - s_0) + \frac{w_6^2}{2} - \frac{w_0^2}{2}]$

$h_6 \overset{A-22}{=} 328.4 \frac{kJ}{kg}$, $w_6 = 510 \frac{m}{s}$, $T_6 = 340\,K$

$h_0 \overset{A-22}{=} \frac{(243.15 - 240)K}{(250 - 240)K}(250.05 - 240.02) + 240.02$

$\Delta e_{x,str} = [c_p(T_6 - T_0) - T_0 \cdot (c_p \cdot \ln(\frac{T_6}{T_0}) - R \cdot \ln(\frac{p_6}{p_0})) + \frac{w_6^2}{2} - \frac{w_0^2}{2}]$

$= [1.006 \frac{kJ}{kgK}(340K - 243.15K) - 243.15K \cdot (1.006 \frac{kJ}{kgK} \cdot \ln(\frac{340K}{243.15K}) - R \cdot \ln(1))$

$+ \frac{(510\frac{m}{s})^2}{2} - \frac{(200\frac{m}{s})^2}{2} = 121271.8\,J = 121.27\,kJ$

d) $e_{x,verl} = T_0 \cdot s_{erz}$ $\quad \dot{m}_{ges} = \dot{m}_{PM} + 5.293\,\dot{m}_K$

$s_{erz} \Rightarrow s_2 - s_1 = \sum_i \frac{Q_i}{T_i} + s_{erz}$ $\quad \rightarrow n_K = 0.8411$

$\Rightarrow s_{erz} = s_6 - s_0 - \frac{q_B}{T_B} = c_p \ln(\frac{T_6}{T_0}) - R \ln(\frac{p_6}{p_0}) - \frac{q_B}{T_B}$

$= 1.006 \frac{kJ}{kgK} \cdot \ln(\frac{340K}{243.15K}) - \frac{1155 \frac{kJ}{kg}}{T_B} \cdot 0.8411 = -0.4$

3) a) $p_{G,1}$, m_g

$$p_{G1} = p_0 + F_{mK} \cdot \frac{1}{A} + F_{mEW} \cdot \frac{1}{A} = p_0 + \left(\frac{32\,kg \cdot 9.81\,m/s^2 + 0.1\,kg \cdot 9.81\,\frac{m}{s^2}}{\pi \cdot \left(\frac{d}{2}\right)^2} \right)$$

$$p_{G1} = 140094.4\,Pa = 1.4\,bar$$

$$pV = mRT \rightarrow m_g = \frac{p_{G,1} \cdot V_{G,1}}{R\,T_{G,1}} = \frac{1.4\,bar \cdot 3.14 \cdot 10^{-3}\,m^3 \cdot 50 \cdot 10^{-3}\,\frac{kg}{mol}}{8.314\,\frac{1}{mol\,K} \cdot 773.15\,K}$$

$$m_g = 0.00342\,kg = 3.42\,g$$

b) $x_2 > 0$ $T_{G,2} = ?$ $p_{G,2} = ?$

$$\Delta E_G = \Delta E_{EW} \rightarrow \Delta E_G - \Delta E_{EW} = 0$$

$$\Delta E_G = \Delta U = m_G \cdot c_V \cdot (T_2 - T_1)$$

$$\Delta E_{EW} = \Delta U = m_{EW} \cdot (u_2 - u_1)$$

c) $\Delta E = E_2 - E_1 = Q_{12}$

$$\rightarrow Q_{12} = \Delta U = -m_G \cdot c_V (T_{2,G} - T_{1,G}) = -(0.00342\,kg \cdot 0.633\,\frac{kJ}{kg\,K} (773.15\,K - 273.153\,K)$$

$$= -1.082\,kJ$$

[redacted]

d) $T_{eis,2} = T_{G,2} = 0.003°C$

$\Rightarrow \Delta E = E_2 - E_1 = |Q_{12}| = 1500\,J$

$\Delta U_{12} = 1500\,J = m \cdot (u_2 - u_1) = m \cdot \left(\left(x_2 \cdot u_{2,fest} + (1-x_2) \cdot u_{2,flüssig} \right) - \left(x_1 \cdot u_{1,fest} + (1-x_1) u_{1,flüssig} \right) \right)$

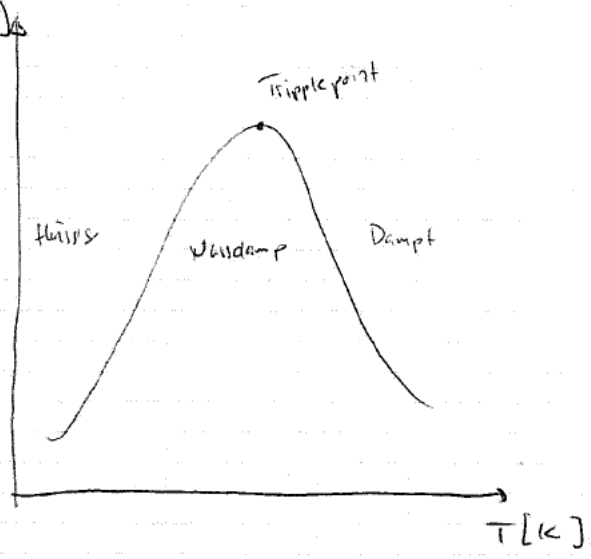
$\Rightarrow \frac{\Delta U_{12}}{m} + \left(x_1 \cdot u_{1fest} + (1-x_1) u_{1,flüssig} \right) = x_2 u_{2fest} + (1-x_2) u_{2,flüssig}$

$\Rightarrow x_2 = \left(\frac{\Delta U_{12}}{m} + \left(x_1 \cdot u_{1fest} + (1-x_1) u_{1flüss} \right) - u_{2flüssig} \right) \cdot \frac{1}{u_{2,fest} - u_{2,flüss}}$

$x_2 = 0.555$

4.) i)

a) p [bar]



b) $\dot{W}_K = 28\,W$ $\quad p_3 = 8\,bar$ $\quad h_3 =$ A-10

2 $\xrightarrow{\text{isentrop}}$ 3 $\quad s_2 = s_3 \rightarrow s_3 =$

$0 = \dot{m}[h_e - h_a] - \dot{W}_K \rightarrow \dot{W}_K = \dot{m}[h_2 - h_3]$

$\rightarrow \dot{m} = \frac{\dot{W}_K}{h_2 - h_3}$

$h_2 =$

c) $x_n = ?$

$x_n = \frac{h_n - h_{n,f}}{h_{n,g} - h_{n,f}}$

[redacted]

d) $\epsilon_K = \frac{|\dot{Q}_{ZH}|}{|\dot{W}_t|} = \frac{|\dot{Q}_K|}{|\dot{W}_K|} =$

e)