(1) b) $\bar{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e} \overset{\text{isobar}}{=>} \frac{h_2 - h_1}{s_2 - s_1} = \frac{c_{pf}(T_2 - T_1)}{c_{pf}\ln\left(\frac{T_2}{T_1}\right)} =>$

$=> \bar{T}_{KF} = \frac{(298.15K - 288.15K)}{\ln\left(\frac{298.15K}{288.15K}\right)} = 293.12K$ //

c) $\dot{S}_{erz} = -\frac{\dot{Q}_{aus}}{T_{Reaktor}} + \frac{\dot{Q}_{aus}}{T_{KF}} = -\frac{65kW}{373.15K} + \frac{65kW}{293.12K} = 47.5\frac{W}{K}$ //

e) $\Delta S_{12} = m_2(s_2 - s_1) => s_1 = s_f(100°C) + x_D(s_g(100°C) - s_f(100°C)) =$

$s_1 \overset{TAB-A2}{=} 1.3069\frac{kJ}{kgK} + 0.005(7.3549 - 1.3069)\frac{kJ}{kgK} = 1.3371\frac{kJ}{kgK}$

$s_2 = s_f(70°C) \overset{TAB-A2}{=} 0.9549\frac{kJ}{kgK}$

$m_{2,ges} = m_{1,ges} + \Delta m_{12} = 5755kg + 3600kg = 9355kg$

$=> \Delta S_{12} = 9355kg\left(0.9549\frac{kJ}{kgK} - 1.3371\frac{kJ}{kgK}\right) = -3575kJ$ //

d) $m_2 u_2 - m_1 u_1 = \Delta m_{12} h_{ein}^{ein} + Q_{R,12}$

$=> m_2 = m_1 + \Delta m_{12} => Q_{R,12} = m_1(u_2 - u_1) + \Delta m_{12}(u_2 - h_{ein})$

$=> \Delta m_{12} = \frac{Q_{R,12} - m_1(u_2 - u_1)}{u_2 - h_{ein}} => u_2 = u_f(70°C) \overset{TAB-A2}{=} 292.95\frac{kJ}{kg}$

$u_1 = u_f(100°C) + x_D(u_g(100°C) - u_f(100°C)) \overset{TAB-A2}{=} 418.94\frac{kJ}{kg} + 0.005(2506.5 - 418.94)\frac{kJ}{kg} =$

$u_1 = 429.37\frac{kJ}{kg}$, $h_{ein} = h_f(20°C) \overset{TAB-A2}{=} 83.96\frac{kJ}{kg}$

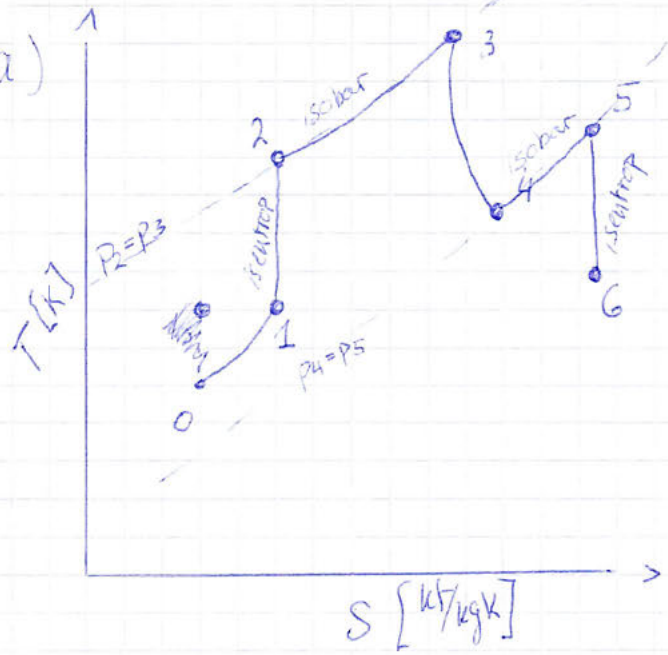
$\Delta m_{12} = \frac{35'000kJ - 5755kg(292.95 - 429.37)\frac{kJ}{kg}}{292.95\frac{kJ}{kg} - 83.96\frac{kJ}{kg}} = 3324kg$ //

a) Aus Energiebilanz $=> \dot{Q}_{aus} = \dot{m}(h_2 - h_1) - \dot{Q}_R$

$=> h_1 = h_f(70°C) \overset{TAB-A2}{=} 292.98\frac{kJ}{kg}$, $h_2 = h_f(100°C) \overset{TAB-A2}{=} 418.94\frac{kJ}{kg}$

$=> \dot{Q}_{aus} = 0.3\frac{kg}{s}(418.94\frac{kJ}{kg} - 292.98\frac{kJ}{kg}) - 100kW = -62.21kW$ //

(2) a)



b) adiabat reversibel => isentrop

$$\Rightarrow \frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{\kappa-1}{\kappa}} \Rightarrow T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{\kappa-1}{\kappa}} \Rightarrow p_6 = p_0 = 0.191\,\text{bar}$$

$$T_6 = 431.9\,K \left(\frac{0.191\,\text{bar}}{0.5\,\text{bar}}\right)^{\frac{1.4-1}{1.4}} = 328.1\,K \;//$$

$\Rightarrow w_6$

c) $e_{x,str,6} - e_{x,str,0} = h_6 - h_0 - T_0(s_6 - s_0) + \frac{w_6^2}{2} - \frac{w_0^2}{2}$

$\Rightarrow w_0 = 200\,m/s$, $w_6 = 510\,m/s$, $h_6 - h_0 = c_p^{ig}(T_6 - T_0) =$

$$h_6 - h_0 = 1.006\,\frac{kJ}{kgK}(340K - 243.15K) = 97.43\,\frac{kJ}{kg}$$

$$s_6 - s_0 = c_p^{ig}\ln\left(\frac{T_6}{T_0}\right) - \underbrace{R\ln\left(\frac{p_6}{p_0}\right)}_{0} = 1.006\,\frac{kJ}{kgK}\ln\left(\frac{340K}{243.15K}\right) = 0.337\,\frac{kJ}{kgK}$$

$$\Rightarrow e_{x,str,6} - e_{x,str,0} = 97.43 - 243.15K\left(0.337\,\frac{kJ}{kgK}\right) + \frac{(510\,m/s)^2}{2} - \frac{(200\,m/s)^2}{2} =$$

$$\Delta e_{x,str} = 125.47\,\frac{kJ}{kg}$$

d) $-\Delta e_{x,str} + e_{x,Q_B} - \sum_{H} \dot{\omega}_{T,H} = e_{x,verl}$

[redacted]

(3) a) $p_{1g} = p_{amb} + p_{Mk} + p_{Ew}$, $p_{amb} = 1\,bar$

$$p_{Mk} = \frac{32\,kg \cdot 9.81\,m/s^2}{(0.05\,m)^2 \pi} = \frac{N}{A} = 39969\,Pa$$

$$p_{Ew} = \frac{N}{A} = \frac{0.1\,kg \cdot 9.81\,m/s^2}{(0.05)^2 \pi} = 125\,Pa$$

$$\Rightarrow p_{1g} = 100'000\,Pa + 39'969\,Pa + 125\,Pa \approx 140'000\,Pa = 1.4\,bar$$

$$m_g = \frac{p_{1g} V_{1g}}{R T_{1g}} \Rightarrow R = \frac{\bar{R}}{M_g} = \frac{8.3145\,J/mol\,K}{50\,kg/kmol} = 166.3\,J/kg\,K$$

$$\Rightarrow m_g = \frac{140'000\,Pa \cdot 0.00314\,m^3}{166.3\,J/kg\,K \cdot 773.15\,K} = 3.4\,g$$

c) $m(u_2 - u_1) = Q_{12}$

$$u_2 - u_1 = c_v^{pg}(T_2 - T_1)$$

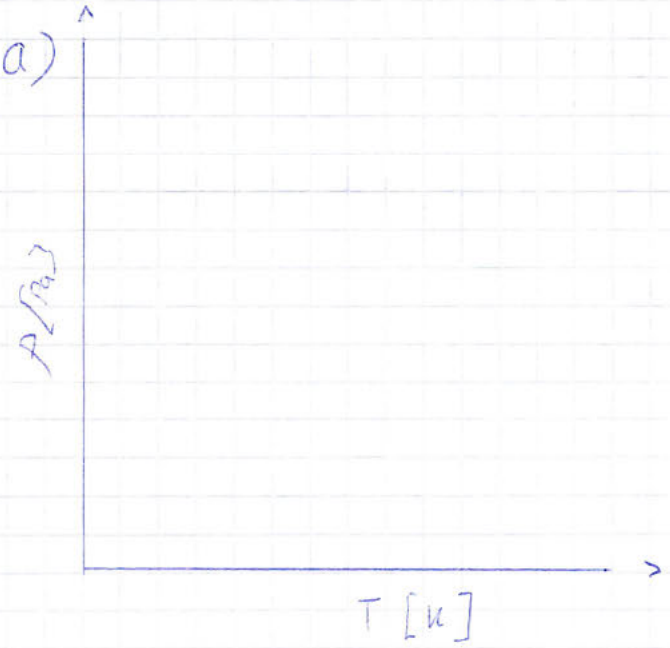
$$\Rightarrow Q_{12} = m c_v^{pg}(T_2 - T_1) = 0.0034\,g \cdot 0.633\,\frac{kJ}{kgK}(773.15\,K + 273.153\,K) =$$

$$= 1076\,J$$

d) $Q_{12} = m_{Ew}(u_2 - u_1)$ $\quad u_2 \Rightarrow x_{2,eis}$

[redacted]

(4) a)



b) $\dot{\omega}_K = \dot{m}_R (h_2 - h_3) \Rightarrow \dot{m}_R = \frac{\dot{\omega}_K}{h_2 - h_3}$

$s_2 = s_3 = s_g(T_2), h_2 = h_g(T_2) \Rightarrow h_3$ über Interpolation aus 8 bar, s_3

$\Rightarrow \dot{m}_R$

c) $h_4 = h_1 = h_f(8\,\text{bar}) \overset{\text{TAB-A11}}{=} 93.42 \frac{kJ}{kg} \Rightarrow p_2 = p_1 = p_{sat}(-22°C) = 1.2192\,\text{bar}$

$x_1 = \frac{h_1 - h_f(1.2192\,\text{bar})}{h_g(1.2192\,\text{bar}) - h_f(1.2192\,\text{bar})} \Rightarrow h_f(1.2192\,\text{bar}) \overset{\text{Interpolation}}{=} h_f(1.4\,\text{bar}) + \frac{h_f(1.4\,\text{bar}) - h_f(1.2\,\text{bar})}{1.4\,\text{bar} - 1.2\,\text{bar}} \cdot (1.2192\,\text{bar} - 1.2\,\text{bar}) =$

$h_f(1.2192\,\text{bar}) = 21.74 \frac{kJ}{kg}$, $h_g(1.2\,\text{bar}) \overset{\text{Interpolation, TAB A11}}{=} \frac{h_g(1.4\,\text{bar}) - h_g(1.2\,\text{bar})}{1.4\,\text{bar} - 1.2\,\text{bar}} (1.2192\,\text{bar} - 1.2\,\text{bar}) + h_g(1.2\,\text{bar}) =$

$h_g(1.2192\,\text{bar}) = 234.07 \frac{kJ}{kg}$

$\Rightarrow x_1 = \frac{93.42 \frac{kJ}{kg} - 21.74 \frac{kJ}{kg}}{234.07 \frac{kJ}{kg} - 21.74 \frac{kJ}{kg}} = 0.3376$ //

d) $\varepsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_+|} = \frac{|\dot{Q}_K|}{|\dot{W}_K|} = \frac{\dot{m}_a (h_2 - h_1)}{28\,\omega} \Rightarrow h_2 = h_g(-22°C) \overset{TAB-A10}{=} 234.08\ \frac{kJ}{kg}$

$\Rightarrow \dot{Q}_K = \frac{4\ \frac{kg}{h}}{3600\ s/h} \left(234.08 \frac{kJ}{kg} - 93.42 \frac{kJ}{kg}\right) = 156.2\,\omega$

$\Rightarrow \varepsilon_K = \frac{156.2\,\omega}{28\,\omega} = 5.578$ //