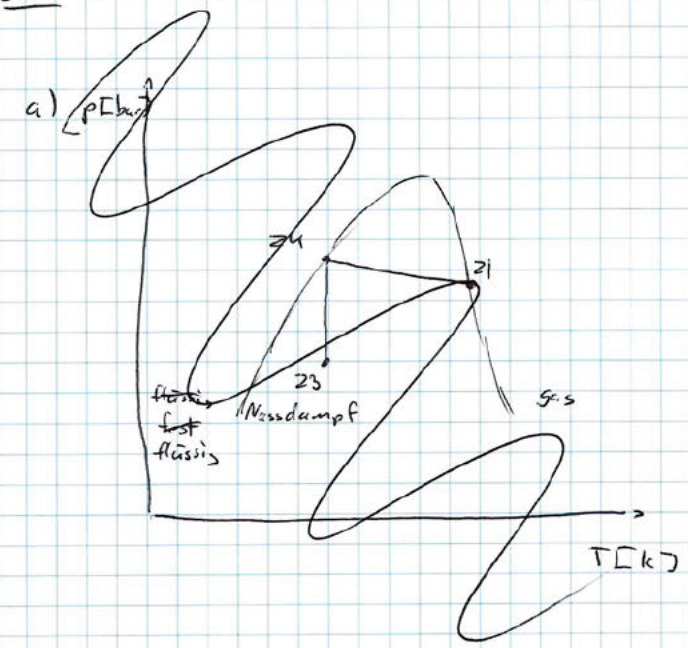
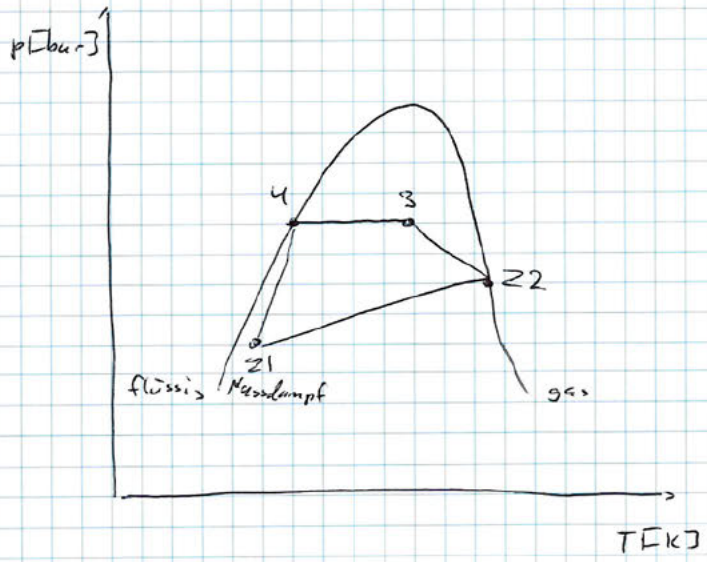
ex. 4

a)





b) 1. HS 2 -> 3

$0 = \dot{m}(h_2 - h_3) + \dot{W}_{tk}$

$\dot{m} = \frac{\dot{W}_{tk}}{h_3 - h_2}$

$s_2 = s_3 = s_{2,g}$

$T_1 = 20°C = 293.15\,K$

$s_{2,g}(20°C) = 6.9102\ \frac{kJ}{kg\,K}$

1. HS 2 -> 3

$0 = \dot{m}(h_2 - h_3) + \dot{W}_{tk}$

$\dot{m} = \frac{\dot{W}_{tk}}{h_3 - h_2}$

$h_{2,g}(20°C) =$

c) $\dot{m}_{R134a} = 4 \frac{kg}{h}$

$T_2 = -22°C$

$x_1 = ?$

$s_1 = s_4 = s_{4,f}$

$p_4 = 8\,bar$

$\rightarrow s_{4,f}(8\,bar) = 0.3459$ ✓

TAB 4-11

$x_1 = \frac{s_1 - s_{1,f}}{s_{1,g} - s_{1,f}}$

~~$0 = \dot{m}(h_4 - h_1)$~~

d) $\varepsilon_k = \frac{|\dot{Q}_k|}{|\dot{Q}_{zu}| - |\dot{Q}_k|}$

1. HS 3 → 4:

$0 = \dot{m}_3 (h_3 - h_4) + \dot{Q}_{zu}$

$\dot{Q}_{zu} = \dot{m}_3 (h_3 - h_4)$

$h_4 = h_{4,f}(8\,bar) = \boxed{33.42 \frac{kJ}{kg}}$ ✓

TAB 4-11

~~$h_5 = h_{3,f}(8\,bar$~~

$x_3 = \frac{s_2 - s_{3,f}}{s_{3,g} - s_{3,f}}$ (@ 8 bar)

$\rightarrow$ ~~$s_3 = s_5$~~

$h_3 = h_{3,f} + x_3 (h_{3,g} - h_{3,f})$ (@ 8 bar)

Ex. 3

a) $p_{G,1} = ?$ $\quad pV = mRT$

$m_{G,1} = ?$

$p_{G,1}$

$R = r = \frac{D}{2} = 0.05\,m$

$A = \pi r^2 \approx 0.00785\,m^2$

$p_{G,1} \cdot A = m_{Ew} \cdot g + m_k \cdot g + A \cdot p_{amb}$

$p_{G,1} = \boxed{1.401\,bar}$

$p_{G,1} V_{G,1} = m_{G,1} R_G T_{G,1}$

$m_{G,1} = \frac{p_{G,1} V_{G,1}}{R_G T_{G,1}} = \boxed{3.422\,g}$

$R_G = \frac{\bar{R}}{M} = 0.16628 \frac{kJ}{kg\,K}$

b) $p_{G,2} = p_{G,1} = 1.401\,bar$ → Die Masse des EW verändert sich nicht, was dazu führt, dass die oben benutzte Formel für $p_{G,1}$ nicht verändert $p_{G,1}$ das selbe Resultat gibt.

$\frac{V_2}{T_1} = \frac{V_1}{T_2}$

c) $T_{G,2} = 0.003\,°C = 273.153\,K$

$dE = -Q_{12}$ $\qquad u_1 - u_2 = c_v (T_1 - T_2) = \boxed{316.498}\,\frac{kJ}{kg\,K} \cdot K \frac{kJ}{kg}$

$m_2 u_2 - m_1 u_1 = -Q_{12}$

$m_G (u_2 - u_1) = -Q_{12}$

$Q_{12} = m_G (u_1 - u_2) = \boxed{1.083\,kJ}$

d)

$\Delta U = Q_{12} \rightarrow m_{EW}(u_2 - u_1) = Q_{12}$

$u_2 = \frac{Q_{12}}{m_{EW}} + u_1 = \boxed{-122.58 \frac{kJ}{kg}}$

$u_1(0°C) = u_{1,f_e} + x_1 (u_{1,f_l} - u_{1,f_e})$

$= u_{1,f_e} + x_1 (u_{1,f_l} - u_{1,f_e})$

$= -333.458 + 0.6(-0.045 + 0.333458)$

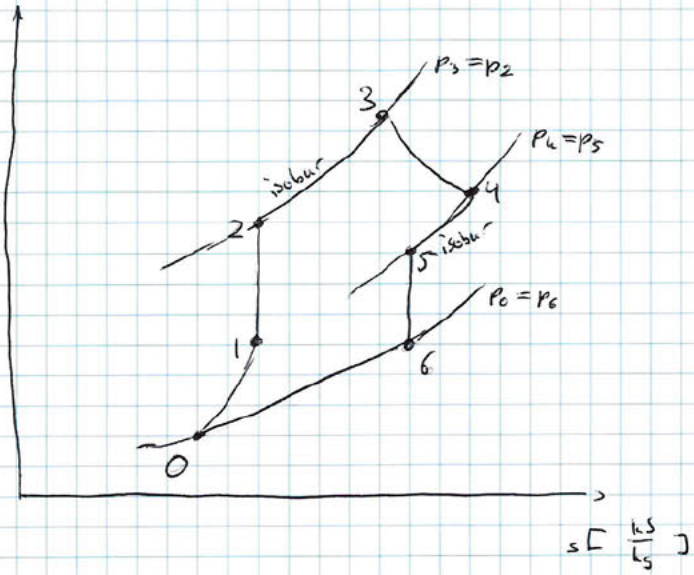
$\boxed{= -133.4162 \frac{kJ}{kg}}$

$\rightarrow T_{EW,2} = 0.003°C$

$x_2 = \frac{u_2 - u_{2,f_e}}{u_{2,f_l} - u_{2,f_e}} = \boxed{0.632}$

ex. 2

a)



b) $w_6 - ?$

$T_6 - ?$ ✓

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}$$

$$T_6 = T_5\left(\frac{p_0}{p_5}\right)^{\frac{n-1}{n}} = 431.69 \cdot \left(\frac{0.101}{0.5}\right)^{\frac{0.4}{1.4}} = \boxed{328.075\,K}$$

$\dot{Q} = \dot{m} \dots$

w_0: $0 = \dot{m}\left(h_5 - h_6 + \frac{w_5^2}{2} - \frac{w_6^2}{2}\right)$

c) $w_6 = 510 \frac{m}{s}$

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

$e_{x,str,6} = \dot{m}\left(h_6 - h_0 - T_0(s_6 - s_0) + \frac{w^2}{2}\right)$

$= \dot{m}\left(h_6 - h_0 + \frac{w_6^2}{2}\right)$

$e_{x,str,6} = \dot{m}\left(h_6 - h_0 - T_0(s_6 - s_0) + \frac{w_6^2}{2}\right)$

$e_{x,str,0} = \dot{m}\left(h_6 - h_0 - T_0(s_6 - s_0) + \frac{w_0^2}{2}\right)$

$\Delta e_{x,str} = \dot{m}\left(h_6 - h_0 - T_0(s_6 - s_0) + \frac{w_6^2}{2} - \frac{w_0^2}{2}\right)$

$h_6 - h_0 = c_{p,Luft}^{\text{ideal}}(T_6 - T_0) = \boxed{85.435 \frac{kJ}{kg}}$

$s_6 - s_0 = c_{p,Luft} \ln\left(\frac{T_6}{T_0}\right) - R \ln\left(\frac{p_6}{p_0}\right)$

$= c_{p,Luft} \ln\left(\frac{T_6}{T_0}\right) = \boxed{0.301 \frac{kJ}{kgK}}$

$\frac{w_6^2}{2} - \frac{w_0^2}{2} = 105'850$

-> falls $\dot{m}$ bekannt einfach Werte einsetzen

d) $0 = \Delta e_{x,str} - e_{x,verl}$

$e_{x,verl} = 100 \frac{kJ}{kg}$

ex.1

a) 1.HS: $0 = \dot{m}_{ein}(h_1 - h_2) + \dot{Q}_R - \dot{Q}_{aus}$

$$\dot{Q}_{aus} = \dot{m}_{ein}(h_1 - h_2) + \dot{Q}_R$$

$h_1 = h_{1,f}$ * (70°C) $\overset{\text{TAB3 A-2}}{=}$ 292.98 $\frac{kJ}{kg}$

$h_2 = h_{2,f}$ (100°C) $\overset{\text{TAB3 A-2}}{=}$ 419.04 $\frac{kJ}{kg}$

$$\dot{Q}_{aus} = 0.3 * (h_1 - h_2) + 100 = \boxed{62.182\ kW}$$

b) $\bar{T} = \dfrac{\int_e^a T\,ds}{s_a - s_e}$

$\bar{T}^{KF}_{aus} = 25°C$

$\bar{T}^{KF}_{ein} = 15°C$

$$s_a - s_e = \int_{\bar{T}_e}^{\bar{T}_a} \frac{c^{if}}{T}\,dT = c^{if} \ln\left(\frac{\bar{T}^{KF}_{aus}}{\bar{T}^{KF}_{ein}}\right)$$

c) $\bar{\bar{T}}_{KF} = 295K$

Entropiebilanz: $0 = \dot{m}_{ein}(s_1 - s_2) + \dfrac{\dot{Q}_R}{\bar{\bar{T}}_{KF}} - \dfrac{\dot{Q}_{aus}}{\bar{\bar{T}}_{KF}} + \dot{S}_{erz}$

$$\dot{S}_{erz} = \dot{m}_{ein}(s_2 - s_1) + \frac{\dot{Q}_R}{\bar{\bar{T}}_{KF}} - \frac{\dot{Q}_{aus}}{\bar{\bar{T}}_{KF}}$$

$s_2 = s_{2,f}$ (100°C) $\overset{\text{TAB3 A-2}}{=}$ 1.3069 $\frac{kJ}{kg\,K}$

$s_1 = s_{1,f}$ (70°C) $\overset{\text{TAB3 A-2}}{=}$ 0.9549 $\frac{kJ}{kg\,K}$

$$\rightarrow \boxed{\dot{S}_{erz} = 0.234\ \frac{kJ}{K\,s}}$$

d) $\frac{dE}{dt} = \sum \dot{m}_i (h_i + pe_i + ke_i) + \sum \dot{Q}_j - \sum \dot{W}_n$ (=0, =0, =0)

$dE = \Delta U = \Delta m_{12} (h_1 - h_2) + - \dot{Q}_{R,12}$

$h_1(100°C) = h_{1,f} + x_D (h_{1,g} - h_{1,f})$

$\overset{\text{TAB A-2}}{=} 419.04 + 0.005 (2257.0)$

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

$h_2(70°C) = h_{2,f} + x_D (h_{2,g} - h_{2,f})$

$= 292.98 + 0.005 (2333.8)$

$\overset{\text{TAB A-2}}{=} \boxed{304.649 \ \frac{kJ}{kg}}$

$\Delta U = (m_{Ges} + \Delta m_{12}) u_2 - (m_{Ges}) u_1$

$u_2(70°C) = u_{2,f} + x_D (u_{2,g} - u_{2,f})$

$= 292.95 + 0.005 (2469.6 - 292.95)$

$\overset{\text{TAB A-2}}{=} \boxed{303.833 \ \frac{kJ}{kg}}$

$u_1(100°C) = u_{1,f} + x_D (u_{1,g} - u_{1,f})$

$\overset{\text{TAB A-2}}{=} 418.94 + 0.005 (2506.5 - 418.94)$

$= \boxed{429.378 \ \frac{kJ}{kg}}$

$m_{Ges} u_2 + \Delta m_{12} u_2 - m_{Ges} u_1 = \Delta m_{12} (h_1 - h_2) - \dot{Q}_R$

$\Delta m_{12} (u_2 + h_2 - h_1) = m_{Ges} (u_1 - u_2) - \dot{Q}_R$

$\Delta m_{12} = m_{Ges} \frac{u_1 - u_2}{u_2 + h_2 - h_1}$ a $- \frac{\dot{Q}_R}{u_2 + h_2 - h_1}$ $\quad (\dot{Q}_R = 35 \cdot 1000 \, kJ)$

$= \boxed{3859.02 \, kg}$

ex. 1

e) $\frac{dS}{dt} = \sum_i \dot{m}_i s_i - \sum_j \frac{\dot{Q}_j}{T_j} + \dot{S}_{ciz}$

$$\Delta S_{12} = \sum \Delta m_{12}(s_1 - s_i) - \frac{\bar{Q}_n}{T} + \dot{S}_{cr2}$$