[redacted]

1) a) $\frac{dE}{dt}^{\,0,\text{ da stationär}} = \sum_i \dot{m}_i (h_i + \cancel{ke_i} + \cancel{pe_i}) + \sum \dot{Q} - \cancel{\sum \dot{W}}^{\,0}$

$$0 = \dot{m}_{ein}(h_{ein} - h_{aus}) + \dot{Q}_R - \dot{Q}_{aus}$$

TAB A-2 $\begin{array}{|l} h_{ein} = h_f(T=70°C) = 292.98 \frac{kJ}{kg} \\ h_{aus} = h_f(100°C = T) = 419.04 \frac{kJ}{kg} \end{array}$

$$\underline{\underline{\dot{Q}_{aus} = 62.182\,kW}}$$

(*) $0 = \dot{m}(h_{KF,ein} - h_{KF,aus}) + \dot{Q}_{aus}$

$\Rightarrow q_{rev} = \frac{\dot{Q}_{aus}}{\dot{m}} = h_{KF,aus} - h_{KF,ein}$

b) $\overline{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{q_{rev}}{s_a - s_e} \overset{(*)}{=} \frac{(-h_{KF,ein} + h_{KF,aus})}{s_a - s_e}$

aus Stoffmodel $= \frac{c_w(T_2 - T_1) + v_w \overbrace{(p_2 - p_1)}^{0,\text{ da isobar}}}{c_w \ln\left(\frac{T_2}{T_1}\right)}$

$(T_2 = T_{KF,aus} \mid T_1 = T_{KF,ein})$: $\overline{T}_{KF} = \frac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)} = \underline{\underline{293.122\,K}}$

c) $\frac{dS}{dt}^{\,0,\text{ da stationär}} = \sum_i \dot{m}_i s_i^{\,0} + \sum_j \frac{\dot{Q}_j}{T} + \dot{S}_{erz}$

$$0 = -\frac{\dot{Q}_{aus}}{\overline{T}_{KF}} + \frac{\dot{Q}_{aus}}{\overline{T}_R} + \dot{S}_{erz}$$

$\overline{T}_R = T_{Reaktor}$

$$\dot{S}_{erz} = \dot{Q}_{aus}\left(\frac{1}{\overline{T}_{KF}} - \frac{1}{T_{Reaktor}}\right) = \underline{\underline{0.0455\,\frac{kW}{K}}}$$

d) $\frac{dE}{dt}^{=dU} = \sum \dot{m}_i h_i + \sum \dot{Q} - \cancel{\sum \dot{W}}^{=0} \quad \Big| \int$

$(m_1 = 5755\,kg)$

$\Delta U = \Delta m (h_{ein,12}) - \dot{Q}_{R,12}$

$m_{tot} u_2 - m_1 u_1 = \Delta m\, h_{ein,12} - \dot{Q}_{R,12}$, wobei $m_{tot} = \Delta m + m_1$

$(\Delta m + m_1) u_2 - m_1 u_1 = \Delta m\, h_{ein,12} - \dot{Q}_{R,12}$

$\Delta m\, u_2 - \Delta m\, h_{ein,12} = - \dot{Q}_{R,12} + m_1 u_1 - m_1 u_2$

$\Delta m (u_2 - h_{ein,12}) = \quad$ "

$\Rightarrow \underline{\underline{\Delta m = 3301.94\,kg}}$

Aus TAB-A2

$u_2 = u_f(70°C) = 292.95\,\frac{kJ}{kg}$

$u_1 = u_f(100°C) = 418.94\,\frac{kJ}{kg}$

$h_{ein,12} = h_f(20°C) = 83.96\,\frac{kJ}{kg}$

e) ~~$\frac{dS}{dt} = \sum_i \dot{m}_i s_i^{\text{geschlossen} = 0} + \sum_j \frac{\dot{Q}_j}{T_j} + \dot{S}_{erz} \quad \Big| \int$~~

~~$\Delta S = \frac{\dot{Q}_{aus}}{T} + \dot{S}_{erz}$~~

$\Delta S_{12} = m_{tot} s_2 - m_1 s_1$

$\underline{\underline{= 1127.26\,\frac{kJ}{K}}}$

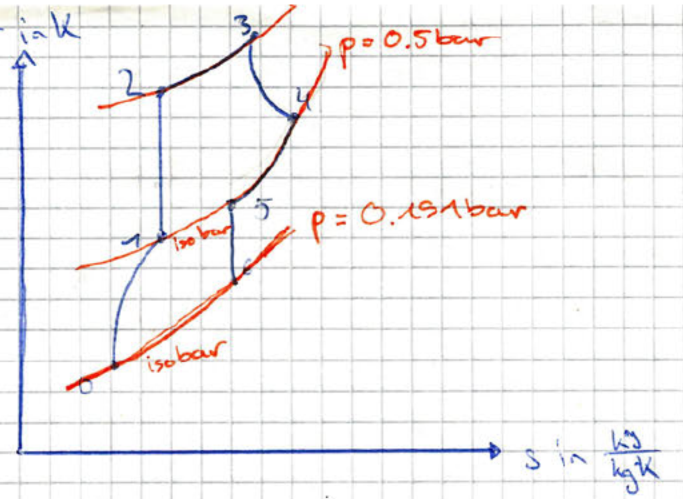
Aus TAB-A2

$s_2 = 0.9549 = s_f(70°C) \left[\frac{kJ}{kg K}\right]$

$s_1 = 1.3069 = s_f(100°C)$ "

[redacted]

2) a)



b) Polytropengleichung: $\frac{T_6}{T_5} = \left(\frac{\overset{= p_0}{p_6}}{p_5}\right)^{\frac{\kappa-1}{\kappa}} \Rightarrow \underline{\underline{T_6 = 328.075\,K}}$

$$\cancel{\frac{dE}{dt}}^{0} = \sum_i \dot m_i (h_i + ke_i + \cancel{pe_i}^{0}) + \cancel{\sum \dot Q}^{0,\text{ adiabat}} - \cancel{\sum \dot W}^{\text{düse}}$$

$$0 = \dot m_{ges}(h_5 - h_6 + ke_5 - ke_6)$$

$$0 = \dot m_{ges}\left(\underset{(const)}{c_p}(T_6 - T_5) + \frac{1}{2}\cdot 220\left(\frac{m}{s}\right)^2 - \frac{1}{2}w_6^2\right) \quad \Big|\text{ aus Stoffmodell für } h$$

$$\Rightarrow \underline{\underline{w_6 = 219.525\,\frac{m}{s}}}$$

c) $\Delta e_{x,str} = (h_6 - h_0 - T_0(s_6 - s_0) + ke_6 - ke_0)$

$$= \underbrace{c_p(T_6 - T_0)} - \underbrace{T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right) - \cancel{R \ln\left(\frac{p_6}{p_0}\right)}^{0}\right)} + \underbrace{\frac{1}{2}w_6^2 - \frac{1}{2}w_0^2}$$

$$= 85.434125\,kJ - 73.2757\,kJ + \frac{1}{kg}\ 4095.551745\,J$$

~~[illegible]~~

$$\underline{\underline{= 16.254\,kJ}}$$

d) $\cancelto{0,\text{ da stationär}}{\frac{dE_x}{dt}} = \sum_i \dot{E}_{x,\text{ström}} + \cancelto{0,\text{ da adiabat nach aussen}}{\sum_j \dot{E}_{x,a_j}} - \cancelto{0,\text{ da Arbeit nach aussen} = 0}{\sum\left(\dot{W}_n - p_0 \frac{dV}{dt}\right)} - \dot{E}_{x,\text{verl}}$

$$0 = \Delta \dot{E}_{x,\text{ström}\,16} - \dot{E}_{x,\text{verl}}$$

$$\dot{E}_{x,\text{verl}} = \Delta \dot{E}_{x,\text{ström}\,16} \quad \Big| : (\dot{m})$$

$$e_{x,\text{verl}} = \Delta e_{x,\text{ström}\,16}$$

$$\text{''} \quad \underline{\underline{= 16.254 \text{ kJ}}}$$

[redacted]

3) a) Kräfteglgw.:

$A = \left(\frac{0.1m}{2}\right)^2 \pi$

da EW inkompressibel: $p_{G,1} \cdot A = p_{amb} \cdot A + m_K \cdot g$

$\Rightarrow \underline{\underline{p_{G,1} = 1.3997 \text{ bar}}}$

m_g: ideales Gas Gesetz: $pV = mRT$

$\Rightarrow m = \frac{pV}{RT}$, wobei $R = \frac{\bar{R}}{M} = \cancel{166}\ 166.28 \frac{J}{kgK}$

$\Rightarrow m_g = \frac{p_{G,1} V_{g,1}}{R T_{G,1}} = \underline{\underline{3.419 g}}$

b) $\underline{p_{G,2} = p_{G,1}}$, da der Druck immernoch den Kolben nach oben drückt, bzw. im Glgw. ist

$T_{G,2} = 0.003 °C$

c) $\frac{dE}{dt}^{dU} = \cancel{\sum \dot{m}_i (h_i + ke_i + pe_i)}^{0} + \sum Q - \sum W$

$\Delta U_{12} = Q_{12} - W_{12}$

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

$m c_v (T_2 - T_1) = Q_{12} - p_{G,1} (\Delta V)$

$\Delta V = -V_{g,1} + \frac{V_{g,1}}{T_{G,1}} \cdot T_2$

$\underline{= -2.0306 L}$

~~$Q_{12} = 10?$~~

~~$Q_{12} = ?$~~

d) $\frac{dE}{dt}^{\to dU} = \cancel{\sum_i \dot{m}_i (h_i + ke_i + pe_i)}^{\to 0} + \sum \dot{Q} - \cancel{\sum \dot{W}}^{\to 0}$, Wasser macht keine W $\quad \int$

$m(u_2 - u_1) = \dot{Q}$ $\qquad p_{EW,2} = p_0 A + mg = p_{a,1}$

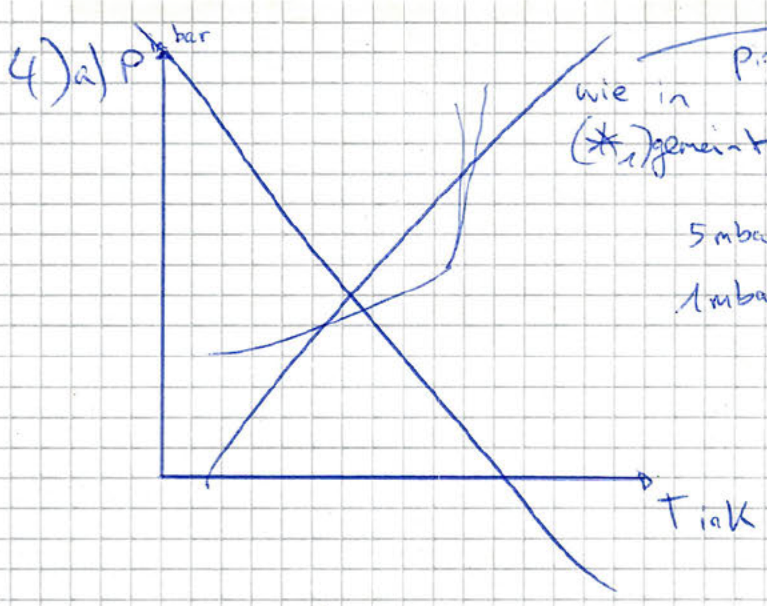
$= \underline{1.4\,\text{bar}}$

$\cancel{m\left(x_{Eis,2}\left(u_{2,Eis} - u_{1,Eis}\right) + 1 - x_{Eis}\right.}$

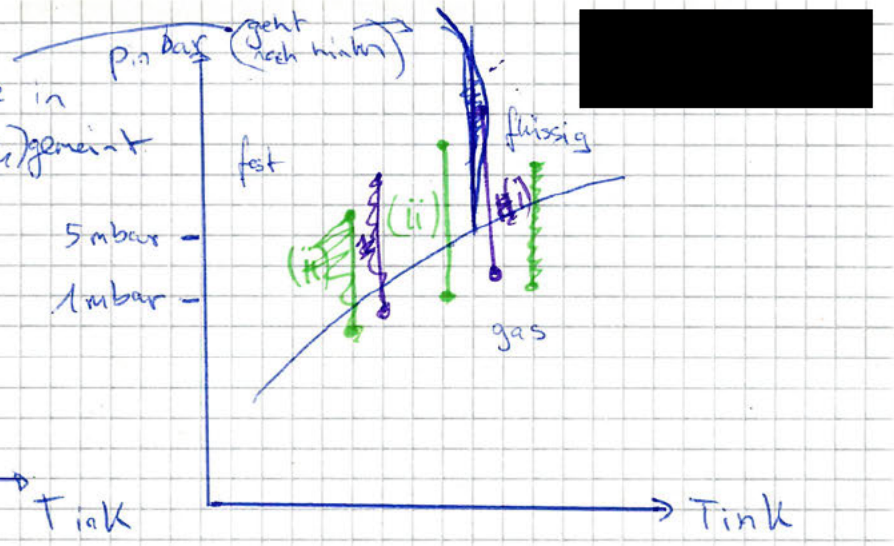
$m\left(x_{Eis,2}\left(u_{\cancel{flüssig}\,fest,2}\right) + (1 - x_{Eis,2})\,u_{flüssig,2} - \left(x_{Eis,1}\,u_{fest,1} + (1 - x_{Eis,1})\,u_{flüssig}\right)\right) = Q$

[redacted]

4) a)



wie in $(*_1)$ gemeint



b) $\frac{dE}{dt}^{0,\text{ da stationär}} = \sum_i \dot m_i (h_i + \cancel{ke_i}^{0} + \cancel{pe_i}) + \cancel{\sum \dot Q}^{0,\text{ da isentrop}} - \sum \dot W$ | von 2–3

$0 = \dot m_{R134a}(h_2 - h_3) + 28\,W$

$h_2 = h_g(T = T_i - 6K) =$

h_3: $s_2 = s_3 \Rightarrow$ rückwärts interpolieren für h_3

$h_3 = h_{unten} + \frac{s_3 - s_{unten}}{s_{oben} - s_{unten}}(h_{oben} - h_{unten})$

c) $p_1 = p_2$ $\quad p_3 = p_4 = 8\,bar$

$\frac{dE}{dt}^{0} = \sum \dot m_i (h_i) + \cancel{\sum \dot Q}^{0} - \sum \dot W$

$0 = \dot m(h_4 - h_1) - \dot W$

d) $\varepsilon_K = \frac{|\dot Q_{zu}|}{|\dot W_t|} = \frac{|\dot Q_K|}{|\dot W_K|} =$

$\dot Q_K = \dot m(h_2 - h_1)$