Aufgabe 1)

a) $\dot{Q}_{ans}$

$$\dot{m}\left[h_{ein} - h_{ans}\right] = -\dot{Q}$$

$$\dot{Q}_{ans} = \dot{Q}_{ein} + \dot{Q}_R$$

$$\dot{Q}_{ein} = \dot{m} h_{ein}$$

b) $\bar{T}_{ieF}$

$$\bar{T}_{ieF} = \frac{\int_{ein}^{ans} T\,ds}{s_a - s_e} \rightarrow \text{da keine Druckänderung: } \frac{h_a - h_e}{s_a - s_e} = \bar{T}_{ieF}$$

$$h_a - h_e = \int_{T_1}^{T_2} c\,dT + v(p_2 - p_1)$$

$$s_a - s_e = \int_{T_1}^{T_2} \frac{c}{T}\,dT$$

c) $\dot{S}_{erz} = \frac{\dot{Q}_{aus}}{\bar{T}_R} - \frac{\dot{Q}_{aus}}{\bar{T}_{UF}} = -\frac{65kW}{358K} + \frac{65kW}{295K} = -0.0387 \frac{kJ}{kgK}$

$\bar{T}_R = \frac{100°C + 70°C}{2} = 85°C = 358K$

$\bar{T}_{UF} = 295K$

$\dot{Q}_{aus} = 65kW$

d) $T_1 = 100°C = 373K$ $\quad h_1 =$

$T_2 = 70°C = 343K$ $\quad h_2 =$

$T_W = 20°C = 293K$

$Q_R = Q_{aus} = 35MJ$

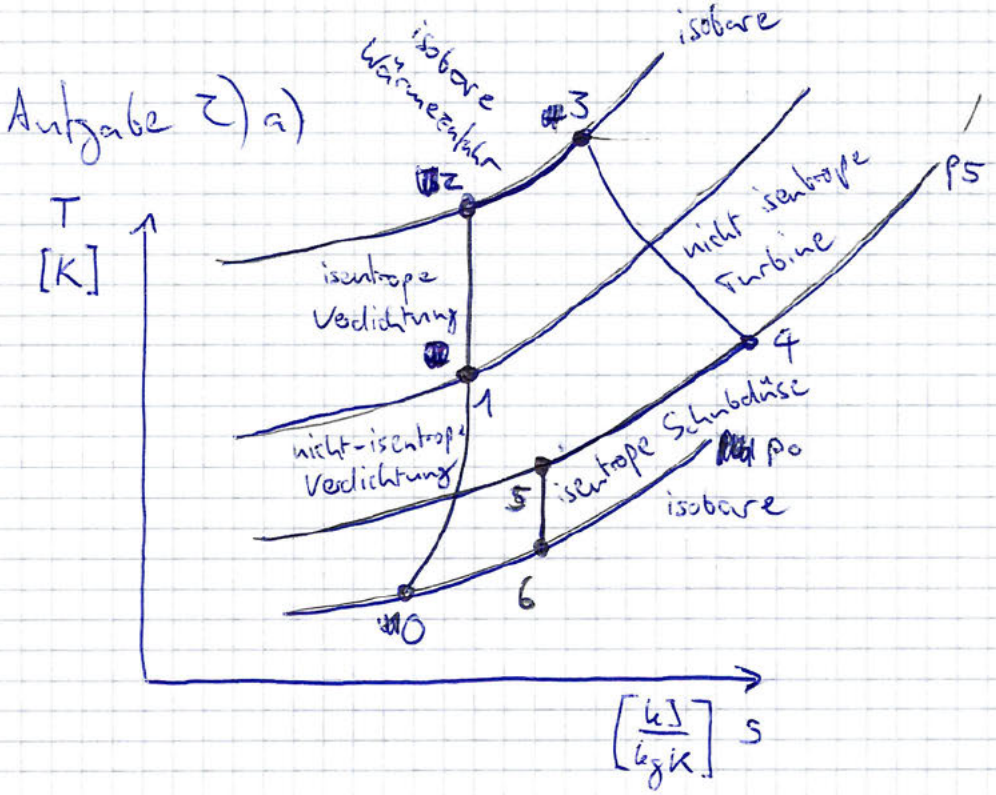
$m_{ges} = 5755kg$

$\Delta U = U_2 - U_1 = Q_2 - Q_1$

$\frac{dE}{dt} = \dot{m}_i h_i + \dot{Q}$

e) ΔS_{12}

Aufgabe 2) a)



b) w_6 , T_6

$T_5 = 431.3K$

$p_5 = 0.56bar$

$w_5 = 220 \frac{m}{s}$

isentrope Schubdüse: $\kappa = 3\kappa = \frac{c_p}{c_v}$

$p_6 = p_0 = 0.1516bar$

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{3\kappa-1}{3\kappa}} \Rightarrow T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{3\kappa-1}{3\kappa}} = 431.3K \cdot \left(\frac{0.1516bar}{0.56bar}\right)^{\frac{0.4}{1.4}} \approx 328.07K$$

$\Delta E = 0 = \Delta U + \Delta KE$

$\Rightarrow \Delta U = -\Delta KE$

$\Delta u = c_v (T_6 - T_5) = \frac{c_p}{3\kappa}(T_6 - T_5)$

$= -79.605 = -\Delta ke$

$\Delta ke = 79.605 = \frac{\Delta w^2}{2}$

$\Delta w = \sqrt{2 \cdot 79.605} = 12.215 \frac{m}{s}$

$w_6 = w_5 + \Delta w = 232.215 \frac{m}{s}$

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

$e_{x,str} = h - h_0 - T_0(s - s_0) + ke$

$k = h_6 - h_0 - T_0(s_6 - s_0) + ke$

$= c_p(T_6 - T_0) - T_0(s_6 - s_0) + \frac{\omega_6^2}{2}$

$T_0 = 293K$

$T_6 = 328.07K$

$s_6 - s_0 = \int_{T_1}^{T_2} \frac{c_p}{T} dT - R \ln\left(\frac{p_6}{p_0}\right)$ ($\frac{p_6}{p_0} = 1$, $\ln(1) = 0$)

$= c_p \cdot \ln\left(\frac{T_6}{T_0}\right) - R \ln\left(\frac{p_6}{p_0}\right)$

$R = c_p - c_v = c_p - \frac{c_p}{3.5} = 0.2874$

$c_v = \frac{c_p}{3.5}$

$\Rightarrow s_6 - s_0 = 0.302$

$\Delta e_{x,str}$

$= 1.006(328.07 - 293) - 293 \cdot 0.302 + \frac{233.215^2}{2} = 26974.037 \frac{J}{kgK}$ //

d) $e_{x,vesl} = T_0 \dot{S}_{0z} =$ [illegible]

[illegible] $(s_6 - s_0) + \frac{q_j}{T_j} = T_0(s_6 - s_0)$

$=$

Aufgabe 3)

a) $p_{g,1}$, m_g $\qquad M_g = 50 \frac{kg}{kmol}$

$T_{g,1} = 500°C = 773K$

$V_{g,1} = 3.14L = 0.00314 m^3$

$pV = mRT \qquad m = \frac{pV}{RT} \qquad pV = n\bar{R}T$

$R = \frac{\bar{R}}{M_g} = 0.166$ ~~[illegible]~~

~~[illegible]~~ aus $p = \frac{mRT}{V}$

~~[illegible]~~ $= 2.348$

aus

b) $x_{Eis,2} > 0$

$T_{g,2}$, $p_{g,2}$

~~Da ein Wärmestrom vom Gas zum Eis fliesst und so~~

$p_{g,1} = 1.56 bar$

$m_g = 3.6 g = 0.0036 kg$

$V_{g,2} = 0.00314 m^3$

$T = \frac{p_2 V_2}{R m_g} \qquad \frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\kappa - 1} \Rightarrow T_2 = T_1$

$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} \Rightarrow p_2 = p_1$

Massen und Volumen bleiben gleich → v bleiben gleich

c) Q_{12}

$$Q_{12} = dU + W$$

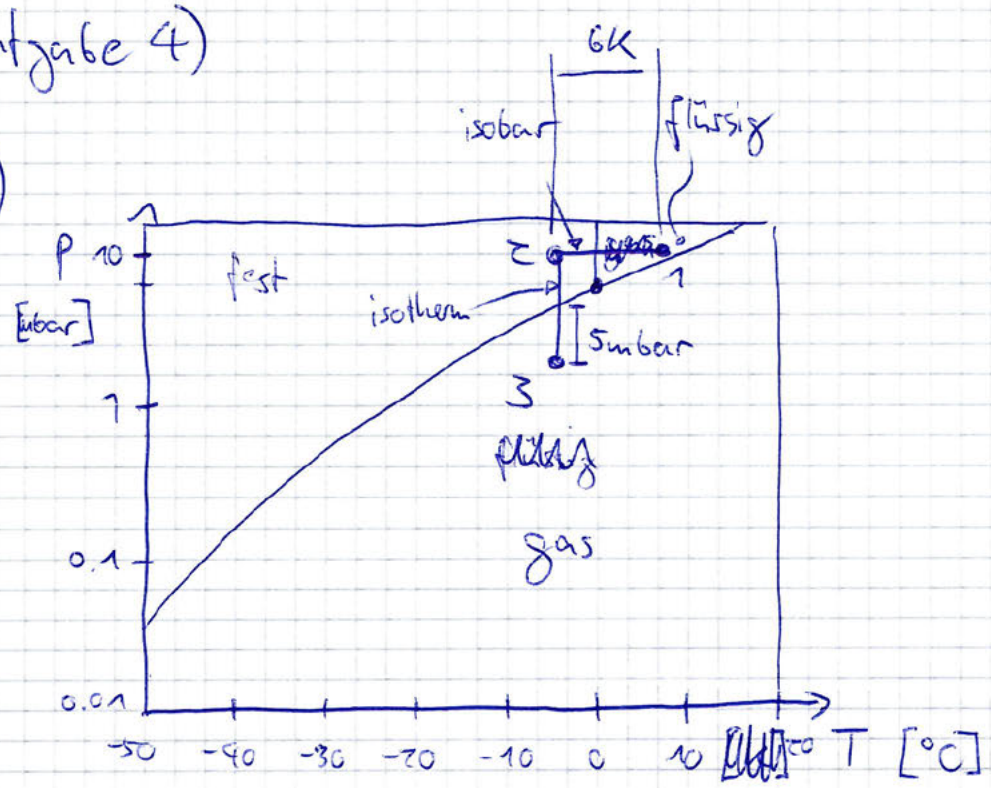
$$W = \int_1^2 p\,dV = p\,(V_2 - V_1)$$

$$dU =$$

d) $$x_2 = \frac{u_2 - u_{\text{fest}}}{u_{\text{flüssig}} - u_{\text{fest}}}$$

Aufgabe 4)

a)



b) $\dot{m}_{R134a}$

Zustand 2: gesättigter Kühlmi. Heldampf $\rightarrow h_2 =$

Zustand 3: $p_3 = 8\,bar$ $h_3 = 264.15 \frac{kJ}{kg}$ (Table A-11)

$\dot{m}[h_2 - h_3] = \dot{W}_K$

Zustand 4: gerade vollständig kondensiertes Kühlmittel, isobar: $p_3 = p_4$

$\rightarrow h_4 = 93.42 \frac{kJ}{kg}$

$\dot{m}[h_3 - h_4] = \dot{Q}_{ab}$

c) $x_1 = \frac{h_1 - h_f}{h_{gas} - h_f}$

$x_4 = 0$

p_4 , h_4

d) $\epsilon_{ik} = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \frac{|\dot{Q}_{zu}|}{|\dot{Q}_{ab}| - |\dot{Q}_{zu}|} = \frac{|\dot{Q}_{ik}|}{|\dot{Q}_{ab}| - |\dot{Q}_{ik}|}$

e) Sie würde solange sinken bis die Temperatur im Gefriertrockner bei 0°C ist