[redacted]

Aufgabe 1:

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

Stationärer Fliessprozess:

$$0 = \dot{m}_{KF}[h_{ein} - h_{aus}] + \sum_j \dot{Q}_j - \sum_n \dot{W}_{tn}$$

weil $p_{KF,aus} = p_{KF,ein} \Rightarrow \sum \dot{W}_{tn} = 0$

$$0 = \dot{m}_{KF}[h_{ein} - h_{aus}] + \dot{Q}_{aus}$$

$$\dot{Q}_{aus} = \dot{m}_{KF}[h_{aus} - h_{ein}]$$

~~weiter~~

$$h_{aus} - h_{ein} = \int_{T_{ein}}^{T_{aus}} c^{if}\, dT + \underbrace{v^{if}(p_2 - p_1)}_{=0 \text{ weil kein Druckverlust } p_{KF aus} = p_{KF ein}.}$$

$$h_{aus} - h_{ein} = c^{if}(T_{aus} - T_{ein}) = c^{if}(10K) =$$

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

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

$$0 = \dot{m}[s_e - s_a] + \sum \frac{\dot{Q}_y}{T} + \dot{S}_{erz}$$

$$\dot{S}_{erz} = \dot{m}[s_a - s_e] - \sum \frac{\dot{Q}_y}{T_y}$$

$$s_e = \cancel{s} = 0.9549 \frac{kJ}{kgK} \ (A-2)$$

$$s_a = 1.3069 \frac{kJ}{kgK} \ (A-2)$$

$$\dot{S}_{erz} = 0.3 \frac{kg}{s} \underbrace{[1.3069 - 0.9549]}_{\frac{kJ}{kgK}} + \frac{\dot{Q}_{ws}}{295K} 65e^3 W = \underline{0.326 \frac{kJ}{sK}}$$

d)

$$\left(\begin{array}{ll} 0 = \dot{m}[h_e - h_a] + \dot{Q}_y & W = 0 \\ \dot{m} = \dfrac{\dot{Q}_y}{[h_a - h_e]} = \underline{-65kW} & \end{array} \right)$$

Geschlossenes System:

$$\sum Q = \Delta E = U + \cancel{ke}^{=0} + \cancel{pe}^{=0}$$

$$Q_{ab} = E_2 - E_1 = Q_{R,12} \qquad \Delta E = mc^{il}\Delta T$$

m_{Wasser} +

20°C → Δm_{12}

70°C → 5755kg

e) $\Delta S = S_2 - S_1 = m(s_2 - s_1) = \sum \dfrac{Q_y}{T_y} + S_{erz}$

$m = 4355kg$

$s_1 = {}^{70°C} = 0.9549 \qquad s_2 = 0.2966 \ (A-2)$

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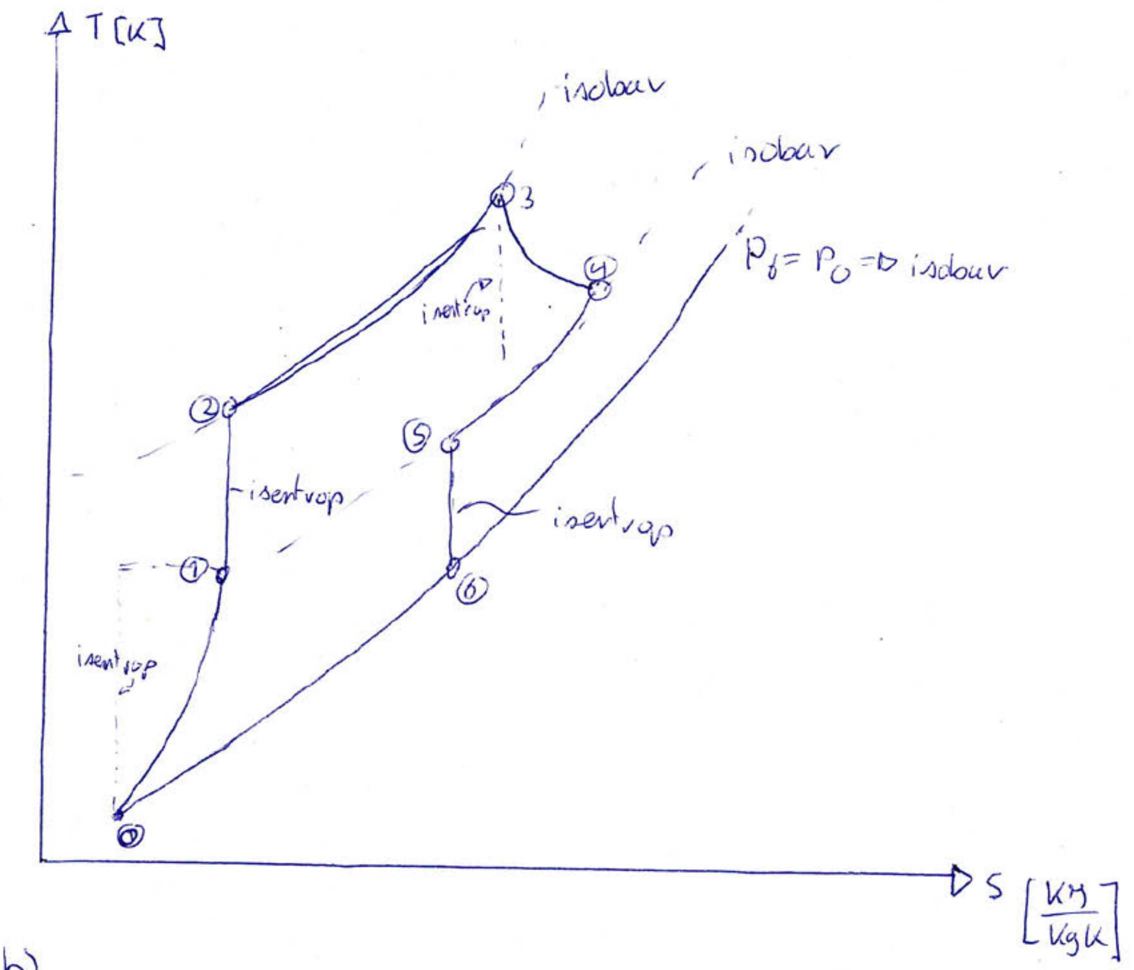
Aufgabe 2

a)



b) w_6

$$0 = \dot m_{ges}\left[h_5 - h_6 + \frac{w_5^2 - w_6^2}{2}\right] - \dot W_V$$

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

$$h_5 - h_6 = \int_{T_6}^{T_5} c_p(T)\,dT = \Delta T\, c_p = [431{,}9\,K - \quad]\; 1.006\,\frac{kJ}{kg K}$$

$$\sqrt{-\left(\frac{\dot W_V}{\dot m_{ges}} + h_6 - h_5\right) 2 + w_5^2} = w_6$$

$$\dot W_V = \int_1^2 p\,dV = \frac{1}{1-n}(p_2 V_2 - p_1 V_1) = \frac{R(T_6 - T_5)}{1 - 1.4} =$$

$pv = RT \qquad R = c_p - c_v \qquad R = 0.287\,\frac{kJ}{kg K}$

$\kappa = \frac{c_p}{c_v} = 1.4 \qquad c_v = \frac{c_p}{1.4} = \frac{1.006}{1.4} = 0.719\,\frac{kJ}{kg K}$

c) $\dot{m}_{ges}$

$$\Delta e_{xstr} = e_{xst\,6} - e_{xstr,0}$$

$$\Delta e_{xstr} = h_6 - h_0 - t_0 (s_6 - s_0) + \Delta ke + \cancel{\Delta pe} \to 0$$

$$\Delta ke = \frac{w_6^2 - w_0^2}{2}$$

$$\cancel{h_6} \quad h_6 - h_0 = \int_{T_0}^{t_6} c_p \, dt \Rightarrow c_p (T_6 - T_0) = c_p (340K - 243.15) = \cancel{\ldots} \frac{kJ}{kg} = 97.43 \frac{kJ}{kg}$$

$$s_6 - s_0 = \int_{T_0}^{t_6} \frac{c_p}{T} dt - R \ln\left(\frac{p_6}{p_0}\right)$$

$$= \ln\left(\frac{T_6}{t_0}\right) c_p - R \ln\left(\frac{p_6}{p_0}\right) = \ln\left(\frac{340K}{243.15K}\right) 1.006 - 0.287 \frac{kJ}{} (1) \to 0$$

$$= 0.337 \frac{kJ}{kgK}$$

$$\Delta e_{xst_r} = 97.43 - 243.15 (0.337) + \frac{510^2 - 200^2}{2} = 110 \, MW \; (110.065 \, MW)$$

d)

$$\cancel{Ex} \quad \varepsilon_{xverl} = T_0 \dot{s}_{erz} \qquad t_0 = 243.15K$$

$\dot{s}_{erz}$ aus entropiebilanz

$$0 = \dot{m}[s_e - s_a] + \sum \frac{\dot{Q}_j}{T_j} + \dot{S}_{erz}$$

$$\dot{s}_{erz} = [s_a - s_e] - \sum \frac{\dot{Q}_j}{T_{j,m}} = [s_6 - s_0] - \frac{q_B}{1289K}$$

$\cancel{s_6 \ldots}$

$$s_6 - s_0 = 0.337 \frac{kJ}{kgK} \qquad 0.337 - \frac{1195}{1289K} \qquad \dot{s}_{erz} = -0.59$$

Falsch muss > 0 sein.

$$\varepsilon_{xverl} = 243.15K \cdot \dot{s}_{erz}$$

Aufgabe 3

[redacted]

a) $P_{g,1}$ $\quad Pv = RT$

$$-m_K g - P_{umb} \cdot A_{Kolben} + P_{g,1} A_{Kolben} = 0$$

$$A_{Kolben} = \cancel{\ldots}\ \pi \left(\frac{0.1}{2}\right)^2 = \cancel{0.031}\ m^2 \quad \text{(value stored in calculator)}$$

$$7.85 \cdot 10^{-3} m^2$$

$$P_{g,1} = P_{umb} + \frac{m_K g}{A_{Kolben}} = \cancel{1 bar} + \frac{32 kg \cdot 9.81 ms^{-2}}{7.85 \cdot 10^{-3} m^2} = \cancel{1.399} = 1.4e^5 pa$$

$$1 \cdot 10^5 \frac{N}{m^2}$$

$$= 1.4 \text{ bar}$$

$m_{,g}$: $\quad PV = RTm \qquad m = \frac{PV}{RT} \qquad R = \frac{8.314 \frac{kJ}{kmol K}}{50 \frac{kg}{kmol}} = 0.166 \frac{kJ}{kg K}$

$$m = \frac{1.5 bar \cdot 3.14 L \cdot 10^2}{0.166 \frac{kJ}{kgK} \cdot 773.15 K} = 3.66 g$$

b) $T_{g,2}$ $\quad X_{E,\Delta,2} > 0$ $\quad P_{2,g}$

c) Q_{12}

$$Q = mc_v \Delta T = \cancel{0.1 \cdot 0.633 \cdot (0.003°C - 0°C)}$$

$$Q_{12} = mc_v \Delta T = \cancel{3.6}0.\ 3.6 \cdot 0.633 (0.003°C - 500°C) = \boxed{-1139.393 J}$$

$$Q_{12} = m_g c_v (T_{2,g} - T_{1,g})$$

negativ geht vom gas weg.

d) $x_{Eis,2}$ $\quad \phi = \phi_\ell + x(\phi_g - \phi_\ell)$

$T_2 = 0.003°C$

$$x = \frac{u_2 - u_\ell}{u_g - u_\ell} = \frac{-0.033}{-333.442 - 0.033}$$

$$X = \frac{m_F}{m_{Flüs} + m_{Fest}}$$

~~u_{2}~~ u von Zustand 2 einlesen

↳ interpolieren.

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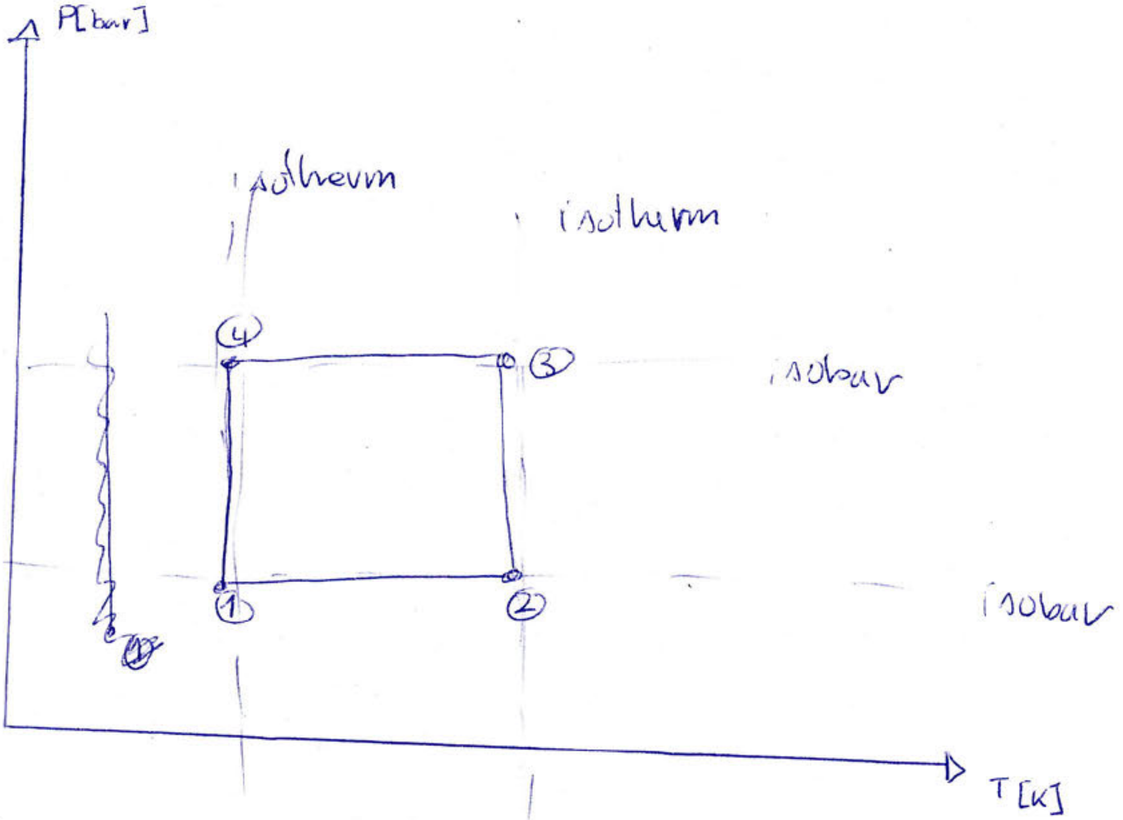
Aufgabe 4

a)



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

Energiebilanz für Verdichter:

$$0 = \dot{m}\left[h_e - h_a\right] + \sum \dot{Q}_j - \sum \dot{W}_{t,n}$$

Weil adiabat, $\dot{Q}_j = 0$

$\dot{W}_t = 28W = \dot{W}_K$

$h_e = h_2 =$

$P_2 = P_1 =$

$h_a = h_3 = 264.15 \frac{kJ}{kg}$ (A-11)

Adiabate Drossel = isenthalp.

$$\dot{m} = \dot{W}_{t,k}\left[h_a - h_e\right] = 28W\left[h_3 - h_2\right]$$

c) x_1

$$\phi = \phi_\ell + x(\phi_g - \phi_\ell) \Rightarrow x = \frac{\phi - \phi_\ell}{\phi_g - \phi_\ell}$$

$$x_1 = \frac{h_1 - h_\ell}{h_g - h_\ell}$$

$h_1 = h_4 = 93.42$ (A-11) $\quad h_\ell =$

$p_4 = 8\,\text{bar}$

d) $$\varepsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \frac{|\dot{Q}_{zu}|}{|\dot{Q}_{ab}| - |\dot{Q}_{zu}|} \Rightarrow \frac{\dot{W}_K}{\dot{Q}_{ab} - \dot{Q}_K} = \frac{28\,W}{}$$

Energiebilanz:

$$0 = \dot{m}[h_1 - h_2] + \dot{Q}_K \Rightarrow \dot{Q}_K = \dot{m}[h_2 - h_1] \qquad T_i = -10\,°C = 263.15\,K$$

$h_2 =$

$h_1 =$

e) ?