[redacted]

Aufgabe 1

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

$$\frac{dE}{dt} = \dot{m}[h_1 - h_2] + \dot{Q}_{aus}$$

($\frac{dE}{dt} = 0$)

$$\Rightarrow \dot{Q}_{aus} = \dot{m}[h_2 - h_1]$$

$$\dot{Q}_{aus} = m \cdot c \cdot [T_2 - T_1]$$

$$= [298{,}15 - 288{,}15]$$

1

b) ~~$\dot{m}(s_e - s_s)$~~

$$\bar{T} = \frac{\int_e^e T \, ds}{s_e - s_e}$$

c)

$$0 = \dot{m}[\cancel{s_e} - s_e] + \frac{\dot{Q}}{\bar{T}} + \dot{S}_{erz}(t)$$

$$\dot{S}_{erz} = -\frac{\dot{Q}}{\bar{T}}$$

$$= \frac{65 \cdot 10^3}{295}$$

$$= 220 \frac{J}{KS}$$

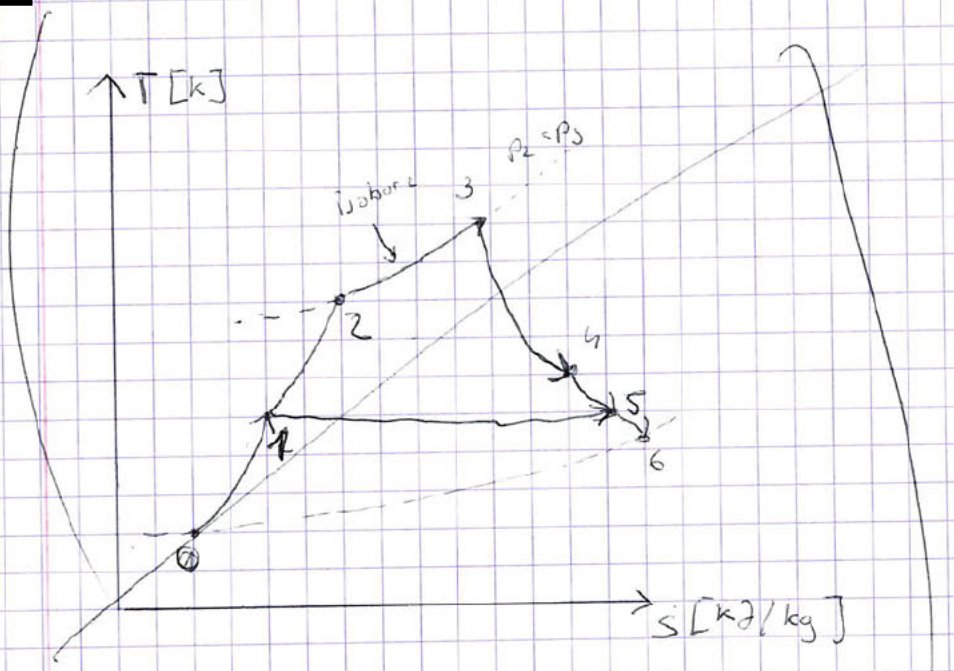
d) $$\frac{dU}{dt} = \dot{m}[h_2 - h_1] + \dot{Q} - \dot{W}$$

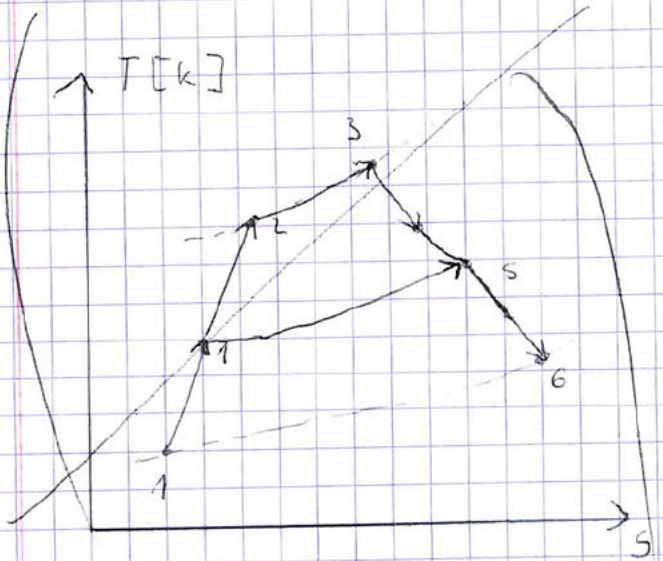
$$dU = m[h_2 - h_1] + Q$$

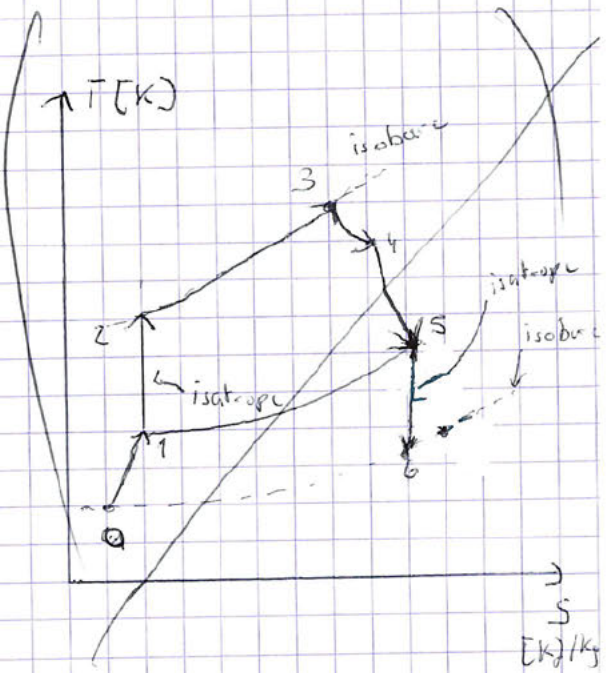
e) $$\frac{dS}{dt} = \sum_i \dot{m}_i(t) s_i(t) + \int_G \frac{\delta \dot{Q}(t)}{T_G(t)} + \dot{S}_{erz}(t)$$

[redacted]

Aufgabe 2







b) w_6 ; T_6

$$\frac{dE}{dt} = \dot{m}\left[h_5 - h_6 + \frac{1}{2}w_5^2 - \frac{1}{2}w_6^2\right] \quad (0, \text{stationär})$$

$$\Leftrightarrow \dot{m}\left[-h_5 + h_6\right] = \dot{m}\left[\frac{1}{2}w_5^2 - \frac{1}{2}w_6^2\right]$$

$$\Leftrightarrow \text{Ideales Gas:}$$

$$c_p\left[-T_5 + T_6\right] = \frac{1}{2}\left[w_5^2 - w_6^2\right]$$

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

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

$$\Leftrightarrow T_6 = 431.5 \cdot \left(\frac{0.191}{0.5}\right)^{\frac{1.4-1}{1.4}}$$

$$= 328,1\,K$$

$$w_6^2 = -\frac{2c_p\left[-T_5 + T_6\right] - w_5^2}{1}$$

$$w_6 = \sqrt{\frac{2c_p\left[T_5 - T_6\right] + w_5^2}{1}}$$

$$= \sqrt{\frac{2 \cdot 1,006 \cdot (431.5 - 328,1) + w_5^2}{1}} = 507,2\,\frac{m}{s}$$

[redacted]

c) Ansatz

$$\frac{d\dot{E}_x}{dt} = \sum \dot{E}_{x,str,j}(t) + \sum \dot{E}_{x,Q,j}(t) - \left(\sum \dot{W}_n(t) - p_0 \frac{dV(t)}{dt} \right) - \dot{E}_{x,verl}(t)$$

Aufgabe 1

$$E_{x,str} = \dot{m} \left[h - h_0 - T_0 (s - s_0) + ke \right]$$

b)

$$e_{x,str} = h_1 - h_0 - T_0 (s_1 - s_0) + ke$$

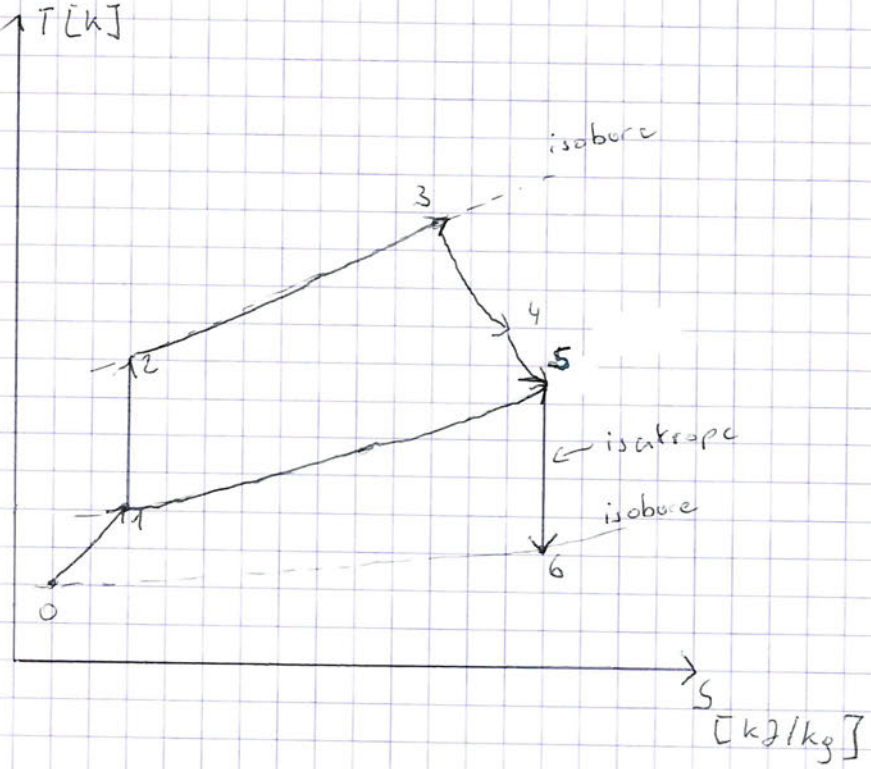
$$= c_p [T_1 - T_0] - T_0 c_p \ln\left(\frac{T_1}{T_1}\right) - R \ln\left(\frac{p_1}{p_1}\right) + \frac{1}{2} w^2$$

d)

$$\frac{dS}{dt}^{\nearrow 0} = \sum \dot{m}_i(t)\, s_i(t) + \int \frac{\partial \dot{Q}(t)}{T_G(t)} + \dot{S}_{erz}(t)$$

=

e)



Aufgabe 1

$p = p_{amb} + F/\pi r^2$ $\quad D = 2r$

$= p_{amb} + \frac{m \cdot g}{\pi r^2}$ $\quad \Rightarrow r = 5\,cm$

$= 10^5 + \frac{52 \cdot 9,81}{\pi \cdot (5 \cdot 10^{-2})^2}$

$= 1,4$ bar

$m = \frac{pV}{RT}$ $\quad R = \frac{\overline{R}}{M} = \frac{8,314}{50 \cdot 10^{-3}} = 166,28 \frac{J}{kg\,K}$

$= \frac{1,4 \cdot 3,12 \cdot 10^5 \cdot 10^{-3}}{166,28 \cdot (500 + 273,15)}$ $\quad V = 3,14 \cdot 10^{-3}\ m^3$

$p = 1,4 \cdot 10^5\ Pa$

$= 3,4\,g$

b) $x_{Eis} > 0$

Die pressio- die das Gas ursprünglich ist die gleiche wie das Eis. $p_{s,L} = 1,4 \cdot 10^5\ Pa = 1,4$ bar. Die Temperatur ist also $0.000°C$, nach der Tabelle.

c) $\frac{dE}{dt} = \dot{m} [h_2 - h_1]^{0} + Q$

$\Delta U = q_{12}$

$(u_2 - u_1) = q_{12}$

$c_v (T_L - T_1) = q_{12}$

$q_{12} = 0.63 \cdot (0.005 - 500)$

$= -316,5 \frac{kJ}{kg}$

$T_L = 0.005°C$

$Q = m \cdot q_{12} = 3,6 \cdot 10^{-3} \cdot 10^3 \cdot -316.5$

$= -1140\,J$

d) x_{eis}

$$\frac{dE}{dt} = \dot{m}[h_2 - h_1] + \dot{Q}$$

$$\Delta U = Q$$

$$U_1(T_1) - U_2(T_2) = Q_{12}$$

$$x_1 \cdot U_{1\,Fest}(0°C) + (1-x)\, U_{Flüssig}(0°) - x_2 \cdot U_{2\,Fest}(0.005°C) - (1-x_2)\, U_{Flüssig}(0.005°C) = Q_{12}$$

$$x_1 \cdot U_{H_1} + (1-x)\, U_{F_1} - x_2 U_{H_2} - (1-x_2)\, U_{F_2} = Q_{12}$$

$$\frac{Q_{12} - x_1 \cdot U_{H_1} - (1-x)\, U_{F_1} + U_{F_2}}{-U_{H_2} + U_{F_2}} = x_2$$

$$x_2 = \frac{-316{,}5 - 0{,}6 \cdot (-333.450) - (1-0.6) \cdot (-0.045) - 0.033}{333.442 - 0.033}$$

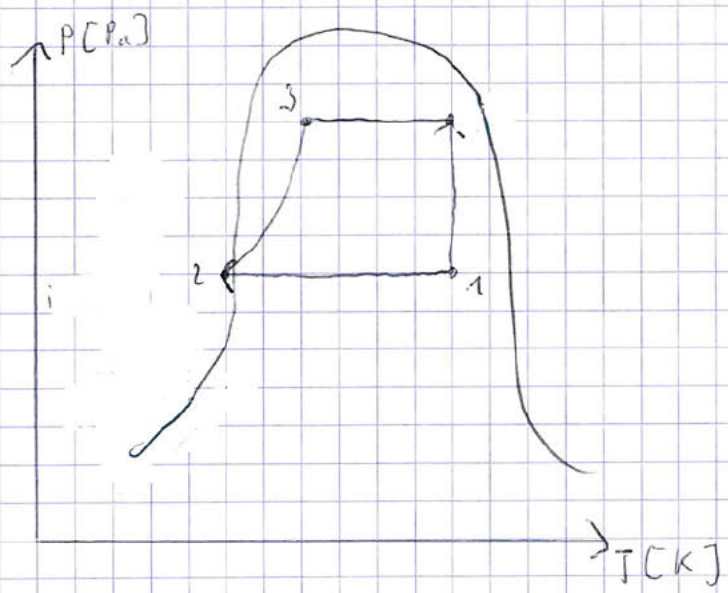
$$= 0.545$$

Die Werte sind alle aus der Tabelle 1

[redacted]

Aufgabe 4

a)



b) $\dot{m}_{R134a}$ $\quad x_2 = 1 \quad h$

Γ_2

$$\frac{dE}{dt} = \dot{m}\,[h_3 - h_2] - \dot{V}_K + \dot{Q}$$

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

$$s_2 = s_3$$

c) ~~$\frac{dx}{dt} =$~~

$$x = \frac{h - h_f}{h_g - h_f}$$

$p_4 = 8\,bar \qquad x_4 = 0 \qquad T = 31.33$

Drossel ist isotherm.

$$\frac{dQ}{dt} = \dot{m}\,[h_4 - h_1] \quad \cancel{\dot{Q} - \dot{W}}$$

$$h_4 = h_1$$

$h_4 = h_f(8\,bar)$ (Table A-11)

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

$T_{Tripel} = 0°C$

$T_i = 0°C + 10 = 10°C$

$T_1 = 4°C$

$$x = \frac{h_4 - h_f(4°C)}{h_g(4°C) - h_f(4°C)} \quad \text{(Table A-10)}$$

$$= \frac{93.42 - 55,35}{249.53 - 55,35}$$

$= 0.196$

[redacted]

d)

Aufgabe 4

$$\varepsilon_K = \frac{\dot{Q}_{zu}}{\dot{W}_t}$$

$$= \frac{\dot{Q}_K}{\dot{W}_K}$$

$$= \frac{}{LR}$$

$$\frac{dE}{dt}^{\nearrow 0} = \dot{m}\,[h_2 - h_1] + \dot{Q}$$

$$\dot{Q}_K = \dot{m}\,[h_1 - h_2]$$

$$= \dot{m}\,[h_1(4°C) - h_2(-22°C)]$$

e) Die Temperatur wird sinken auf -20°C.