Thermo I

Aufgabe 2

[redacted]

0: $T_0 = -30°$, $p_0 = 0.19$ bar

0 – 1 : $p \uparrow T$, p_1

1 – 2 : isentrop, $p \uparrow$ p_2

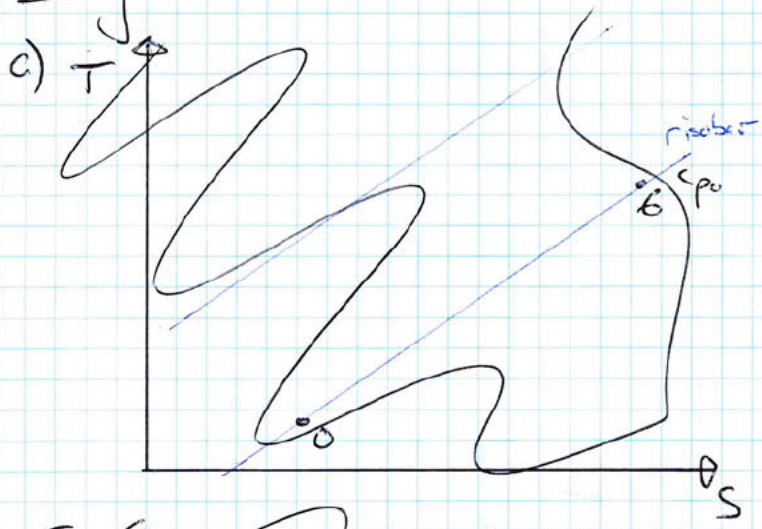
2 – 3 : isobar, $T \uparrow$ $p_2 = p_3$

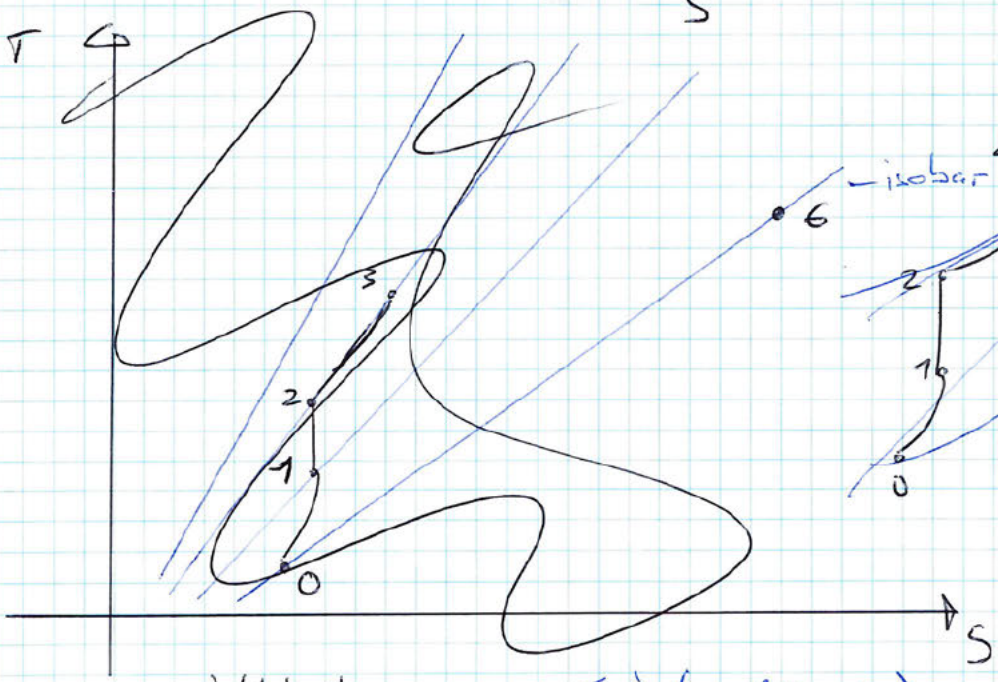
3 – 4 : nicht isentrop, $p_4 \uparrow$

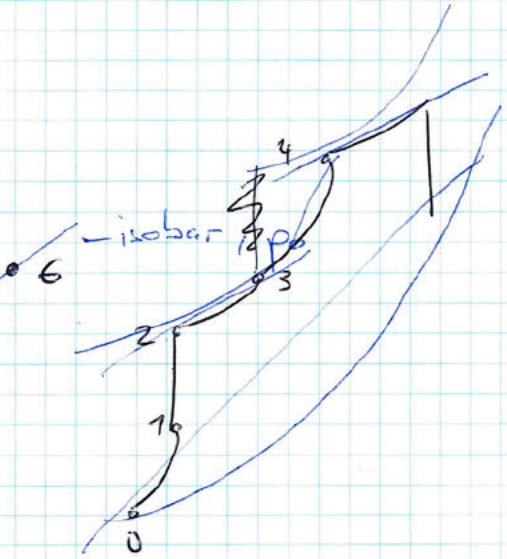
4 – 5 : isobar, $p_4 = p_5$

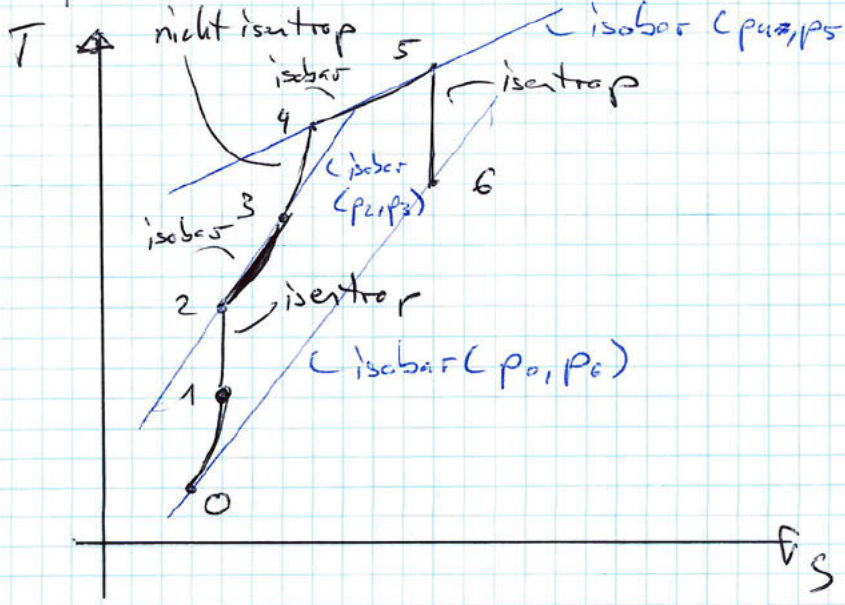
5 – 6 : isentrop, $p_6 = p_0$

a)









b) w_6, T_6

$T_5 = 431.9\,K$, $p_5 = 0.5\,bar$, $p_6 = 0.191\,bar$

$w_5 = 220\,\frac{m}{s}$ $\quad s_5 = s_6 \rightarrow s_6 - s_5 = 0$

$(s_6 - s_5) = c_p \ln\left(\frac{T_6}{T_5}\right) - R \cdot \ln\left(\frac{p_6}{p_5}\right)$

$c_p \ln\left(\frac{T_6}{T_5}\right) = R \cdot \ln\left(\frac{p_6}{p_5}\right)$

$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} \Rightarrow T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} = 431.9\,K \cdot \left(\frac{0.191}{0.5}\right)^{\frac{1.4-1}{1.4}}$

$T_6 = 328.075\,K$

c) $\dot{m} e_{x,str} = \dot{m}\{h - h_0 - T_0(s - s_0) + \dot{k}e^{\,0} + \dot{p}e^{\,0}\}$

$e_{x,str} = h_6 - h_0 - T_0(s_6 - s_0)$

$e_{x,str,6} = c_p(T_6 - T_0) - T_0\left(c_p \cdot \ln\left(\frac{T_6}{T_0}\right) - R \cdot \ln\left(\frac{p_6}{p_0}^{\,0}\right)\right)$

$(328.075 - 243.15)\,K$

$e_{x,str,6} = 1.006\,\frac{kJ}{kg\,K} \cdot 243.15\,K \cdot 1.006\,\frac{kJ}{kg\,K} \cdot \ln\left(\frac{328.075}{243.15}\right)$

$e_{x,str,6} = h_6 - h_0 - T_0(s_6 - s_0) = 12.15\,\frac{kJ}{kg}$

d) $e_{x,verl} = T_0 \dot{S}_{erz} \cdot \dot{m}_{ges}$ $\qquad V = v \cdot \dot{m}$

Thermo I

Aufgabe 3

[redacted]

$A_K = \pi \cdot \left(\frac{D}{2}\right)^2 = \pi \cdot (0.05\,m)^2 = 0.0079\,m^2$

a) $p_{g,1}$, m_g

$p = \frac{F}{A} \Rightarrow F = pA$

$\frac{N}{kg} = \frac{m}{s^2}$

$\frac{P_a}{m^2} = N$

$F_G = F_0 + F_K + F_E$

$p_{G,1} \cdot A_K = p_{amb} \cdot A_K + m_K \cdot g + m_E \cdot g$

$p_{G,1} = p_{Amb} + \frac{m_K \cdot g}{A_K} + \frac{m_E \cdot g}{A_K} = 1 \cdot 10^5 Pa + \frac{32kg \cdot 9.81 \frac{m}{s^2}}{0.0079\,m^2} + \frac{0.1 \cdot 9.81}{0.0079}$

$p_{G,1} = 1.39865\,bar = 1.4\,bar$

$pV = mRT \Rightarrow m_g = \frac{p_{G,1} \cdot V_1}{R_G \cdot T_1} = \frac{p_{G,1} \cdot V_1}{\frac{R}{M_g} \cdot T_1} = \frac{1.397 \cdot 10^5 \cdot 3.14 \cdot 10^{-3}}{\frac{8.314}{50} \cdot 773.15}$

$\frac{J}{mol\,K} \cdot \frac{kmol}{kg} = \frac{J}{g\,mol\,K}$ $\qquad$ $g\,\frac{\frac{Pa \cdot m^3}{J}}{mol\,K} \cdot K$

$m_g = 3.412\,g$

b) $T_{g,2}$, $p_{G,2}$?

Temperatur nimmt ab, da thermodyn. GGW erreicht werden soll, nimmt ab bis $T_G = T_{EW}$

Druck nimmt auch ab, da thermodyn. GGW erreicht werden soll

c) $\frac{dE}{dt} = \sum \dot{Q} - \sum \dot{W}_V$ $\qquad$ $\dot{W}_V =$

d)

Thermo I

Aufgabe 4

a) isobarer Prozess

1-2: isobar, T↓

2-3: p↑, isentrop

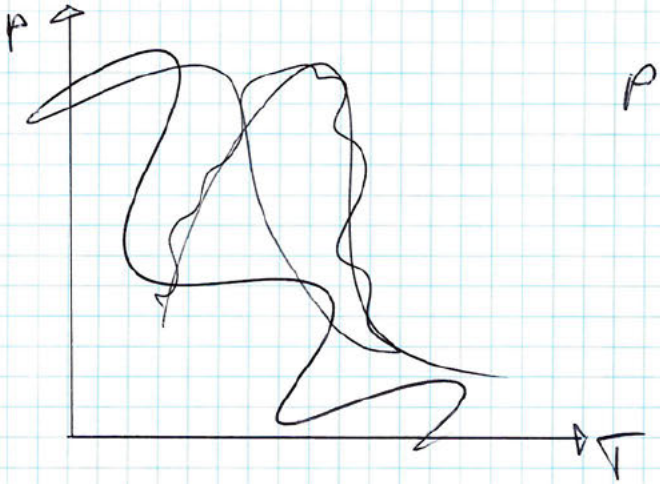
3-4: isobar

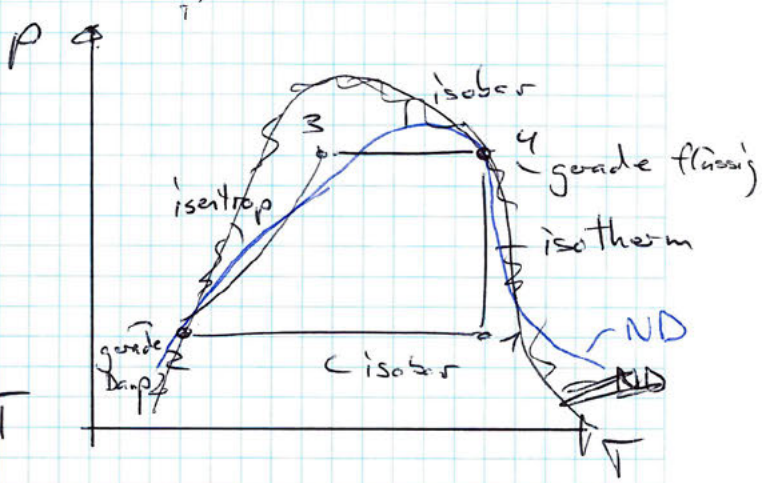
4-1: p↓, isenthalp ⇒ isotherm

4: x=0, flüssig

2: x=1, gas

1:





b) $\dot{w}_u = 28\,W$, isentrop $\Rightarrow s_2 = s_3 =$ ~~s(85°C, x=1)~~

$T_i = 0°C + 10K$

$T_i = 283.15K = 10°C$

$T_v = T_i - 6K = 277.15K$

$= 4°C$

1. FP: $0 = \dot{m}(h_e - h_a) + \dot{Q}^{0} - \dot{w}_u$

$\dot{w}_u = \dot{m}(h_2 - h_3)$

~~$h_2 = h(T_2, x=1)$~~

$\dot{m} = \frac{-\dot{w}_u}{h_2 - h_3}$

$h_3 = h(85°C, x=0) = 264.25 \frac{kJ}{kg}$

$h_2 = h(277.15K, x=1) = 249.53 \frac{kJ}{kg}$ ($\rightarrow 4°C$, x=1)

$\dot{m} = \frac{-28\,\frac{J}{s}}{(249.53 - 264.25)\,\frac{kJ}{kg}} = 1.915\,\frac{g}{s}$

$\frac{J}{s} \cdot \frac{kg}{kJ} = \frac{kJ}{ks} = \frac{J}{s}$

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

e) sie würde sinken

Thermo I

Aufgabe 1

a) St. FP : $0 = \dot{m}(h_e - h_a + \cancel{\dot{k}^0} + \cancel{\dot{p}^0}) + \Sigma \dot{Q} - \Sigma \cancel{\dot{W}^0}$

$\dot{Q}_{aus} = \dot{m}(h_a - h_e)$

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

$h_{ein} = h_{H_2O,f}(70°C) = 292.98 \frac{kJ}{kg}$

$h_{aus} = h_{H_2O,f}(100°C) = 419.4 \frac{kJ}{kg}$

$\dot{Q}_{aus} = 37.9\,kW$

b) $\overline{T} = \frac{\int_e^a T\,ds}{s_a - s_e}$, keine Druckänderung $\Rightarrow \int_e^a T\,ds = q_{rev}$

$\overline{T} = \frac{q_{rev}}{s_a - s_e} = \frac{c^{if}(T_2 - T_1)}{c^{if} \cdot \ln(\frac{T_2}{T_1})} = \frac{T_2 - T_1}{\ln(\frac{T_2}{T_1})} = \frac{(298.15 - 288.15)K}{\ln(\frac{298.15}{288.15})}$

$\overline{T} = 293.12\,K$

c) $0 = \dot{m}(s_e - s_a) + \sum \frac{\dot{Q}}{T} + S_{erz}$

$S_{erz} = \dot{m}(s_a - s_e) - \frac{\dot{Q}_K}{T} - \frac{\dot{Q}_R}{T}$

d)

e) $\Delta S_{12} = m_2 s_2 - m_1 s_1$