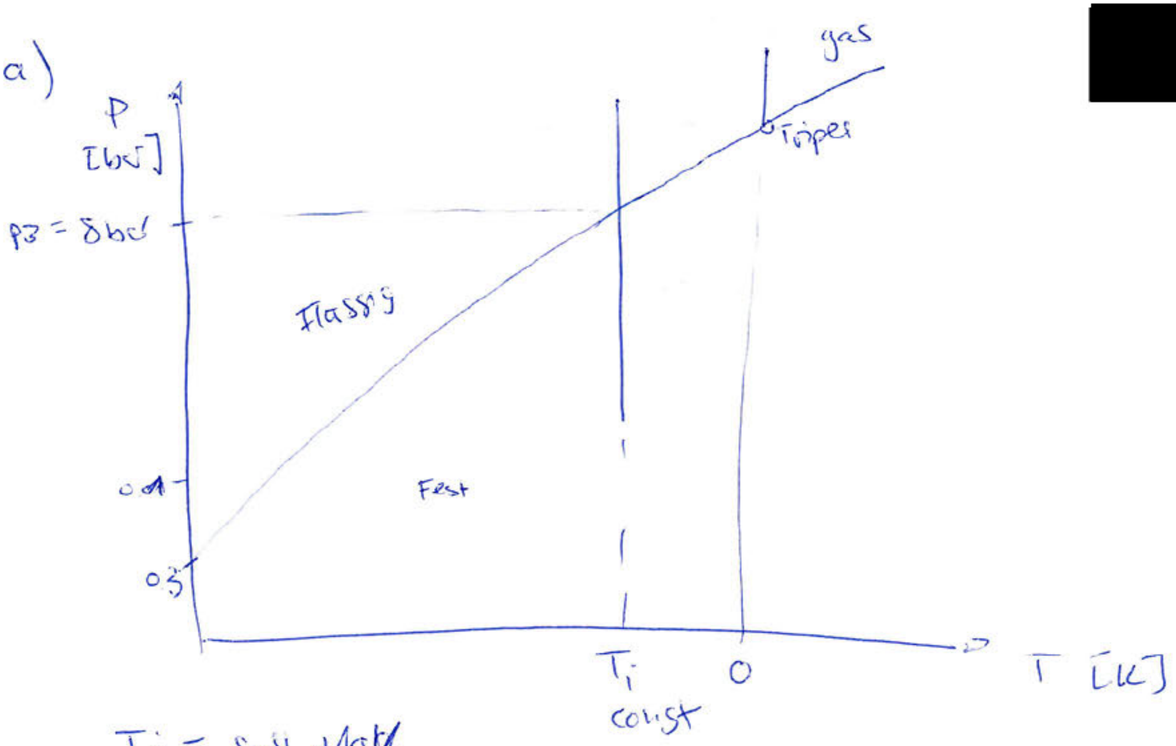
[redacted]

4 a)



T_i = subl + 10 K

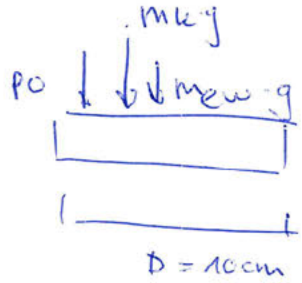
x_a = 0 liquid = sp[illegible]

x_2 = 1 p1 = solid?

[redacted]

3)
a) $p_{g1} = ?$
$m_g = ?$

$A = \pi r^2 = \pi \left(\frac{d}{2}\right)^2 = \pi \cdot \left(\frac{0.1m}{2}\right)^2 = 0.00785 m^2$



GGW: $p_0 \cdot A + m_K \cdot g + m_{EW} \cdot g = p_g \cdot A$

$$\frac{p_0 \cdot A + m_K g + m_{EW} g}{A} = p_g$$

$$= p_g = \frac{1 \cdot 10^5 \frac{N}{m^2} \cdot 0.00785 m^2 + 32kg \cdot 9.81 \frac{m}{s^2} + 0.1kg \cdot 9.81 \frac{m}{s^2}}{0.00785 m^2}$$

$p_g = 128853.0073 Pa$

$p_g = 1.2885 \text{ bar}$

$m_g = ?$ $\quad pV = mRT$ $\quad R = \frac{\bar{R}}{M_g} = \frac{8.314 \frac{J}{mol K}}{50 \frac{kg}{kmol}} = 0.16628 \frac{J}{gK}$

$$m_g = \frac{p_g V_g}{R_s T_{g1}} = \frac{1.2885 \cdot 10^2 \frac{kN}{m^2} \cdot 0.00314 m^3}{0.16628 \frac{kJ}{kgK} \cdot (500 + 273.15)} = 0.0031470 9kg$$

$V_{g1} = 3.14L = 0.00314 m^3$

$m_g = 3.1471 g$

b) $x_{EIS,2} > 0$
$T_{g,2} = ?$ $\quad T_{g2} = T_{EW,2}$
$p_g = ?$

$p_{g2} = p_{g1} = 1.2885 \text{ bar}$

$p_1 v = RT_1$

$$v_1 = \frac{RT_1}{p_1} = \frac{0.16628 \frac{kNm}{kgK} \cdot (500K + 273.15)K}{1.2885 \cdot 10^2 \frac{kN}{m^2}} = 0.997745 \frac{m^3}{kg}$$

$\frac{kNm}{kg} \cdot \frac{1}{kN} \quad \frac{m}{m^2} ? m^3$

$p_1 V_4 =$

$p_{1E} V_{1E} = m_{1E} R T$

$p v = RT \quad \frac{pv}{R}$

$$R = \frac{p_1 v_1}{T_{0°C} \, m_{0,1kg}}$$

$$\frac{p_0 V_0}{R_0} = \frac{p_1 V_1}{T_{0°C} \, m_{0,1kg}}$$

$$\frac{p_0 V_0}{R_0} \cdot T_{0°C} \, m_{0,1kg} = p_1 V_1$$

3)

a) $x_{eis,2} = ?$

$\Delta E = Q - W$

$E = U + \cancel{E_{kin}} + \cancel{E_{pot}} = 0$

$\Delta U = Q - \cancel{W_{ver}}$

$\Delta U = Q_{12} = 1.500\,J$

$m \cdot u = U$

$u_1 =$

$T_1 = 0°C \quad x_1 = 0.6$

TAB. 1 $\quad u_{fest} = -333.458 \frac{kJ}{kg}$

$u_{flüssig} = -0.045 \frac{kJ}{kg}$

$u_1 = u_{fest} + x\,(u_{flüssig} - u_{fest})$

$-333.458 + 0.6\,(-0.045 + 333.458)\frac{kJ}{kg} = -133.6532 \frac{kJ}{kg} = u_1$

$u_2 = u_{fest} + x_2\,(u_{flüssig} - u_{fest})$

$= -333.442 + x_2(-0.033 + 333.442)\frac{kJ}{kg}$

$m_{EW} = 0.1\,kg$

$m_{EW}(u_1 - u_2) = Q_{12}$

$u_1 - u_2 = \frac{Q_{12}}{m_{EW}}$

$u_2 = u_1 - \frac{Q_{12}}{m_{EW}}$

$$x_2 = \frac{u_1 - \frac{Q_{12}}{m_{EW}} - u_{fest}}{u_{flüssig} - u_{fest}}$$

$$x_2 = \frac{-133.6532 \frac{kJ}{kg} - \frac{1.500\,kJ}{0.1\,kg} + 333.442 \frac{kJ}{kg}}{(-0.033 + 333.442 \frac{kJ}{kg})}$$

$x_2 = 0.554$

[redacted]

2d) $\bar{T} = \dfrac{\int_3^2 T\,dS}{s_a - s_e}$

$\bar{T} \cdot s_a - s_e = \int_3^2 T\,dS = T_2 - T_3$?

$\dot{T}$ idk $\ln\left(\frac{T_2}{T_3}\right)$ small? ie 0

$\dfrac{1195\ \frac{kJ}{kg}\ = q_B}{1289K\ = \bar{T}_B} = -8e2\ 6.293$ can't be $s \geq 0$

c) ~~$\dot{m}_{ges}$??~~ $\Delta ex_{str} = ex_{str6} - ex_{str0}$

~~$\frac{dS}{dt} = \sum \dot{m}_i s_i + \int_0 \frac{\delta \dot{Q}}{T_g} + \dot{S}_{er} = \sum \dot{m}_i \cdot s_i(t) + \sum \frac{\dot{Q}_j}{T_j} + \dot{S}_{er}$~~

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

~~$\frac{dE}{dt} = \dot{m}[h_e + pe + ke]$~~

c) $0 = \dot{m}[h_e - h_a - T_0(s_e - s_a) + \Delta ke + \Delta pe] + \sum(1 - \frac{T_0}{T_j})\dot{Q}_j - \sum \dot{W}_n - \dot{E}x_{verl}$

$\Delta Ex_{str} = Ex_{stre} - Ex_{stra} \quad | \frac{1}{\dot{m}}$

$h_e - h_a - T_0(s_e - s_a) + \Delta ke + \Delta pe$ (vernachl.)

$h_0 - h_6 - T_0(s_0 - s_a) + \frac{w_0^2 - w_a^2}{2} = \Delta ex_{str}$

$c_p^{ig}(T_0 - T_6) - T_0(c_p^{ig} \ln(\frac{T_0}{T_6}) - R\ln(\frac{p_0}{p_6})) = \Delta ex_{str}$ ($R\ln(\ldots) = 0$)

$1.006 \frac{kJ}{kgK} \cdot (243.15K - 328.0747K) - 243.15K(1.006 \frac{kJ}{kgK} \cdot \ln(\frac{234.15K}{328.0747K})) + \ldots$

$- 2.933 \frac{kJ}{kg} + \frac{w_0^2 - w_a^2}{2} = 148645.3095$

$(1000) - 2.933 \frac{kJ}{kg} + \frac{200^2 \frac{m^2}{s^2} + 507 \frac{m^2}{s^2}}{2} = 145.5918 \frac{kJ}{kg}$

$145.5918 \frac{kJ}{kg}$ r

$\rightarrow \Delta ex_{str} = 100 \frac{kJ}{kg}$

d) ~~$\dot{m}_{ges}$~~

$ex_{verl} = ?$

$\dot{E}x_{verl} = T_0 \cdot \dot{S}_{erz} \quad \frac{1}{\dot{m}}$

$ex_{verl} = T_0 \cdot s_{erz}$

$q_B = \frac{\dot{Q}_B}{\dot{m}_L}$

$\frac{\dot{m}_M}{\dot{m}_L} = 5.293 \quad \dot{m}_M = 5.293 \dot{m}_L$

$\dot{m}_M + \dot{m}_L = \dot{m}_{ges}$

$(5.293 + 1)\dot{m}_L = \dot{m}_{ges}$

$\dot{m}_L = \frac{\dot{m}_{ges}}{6.293}$

$0 = \dot{m}_L[s_e - s_a] + \frac{\dot{Q}_j}{T_j} + \dot{S}_{erz} \quad | \frac{1}{\dot{m}_L}$

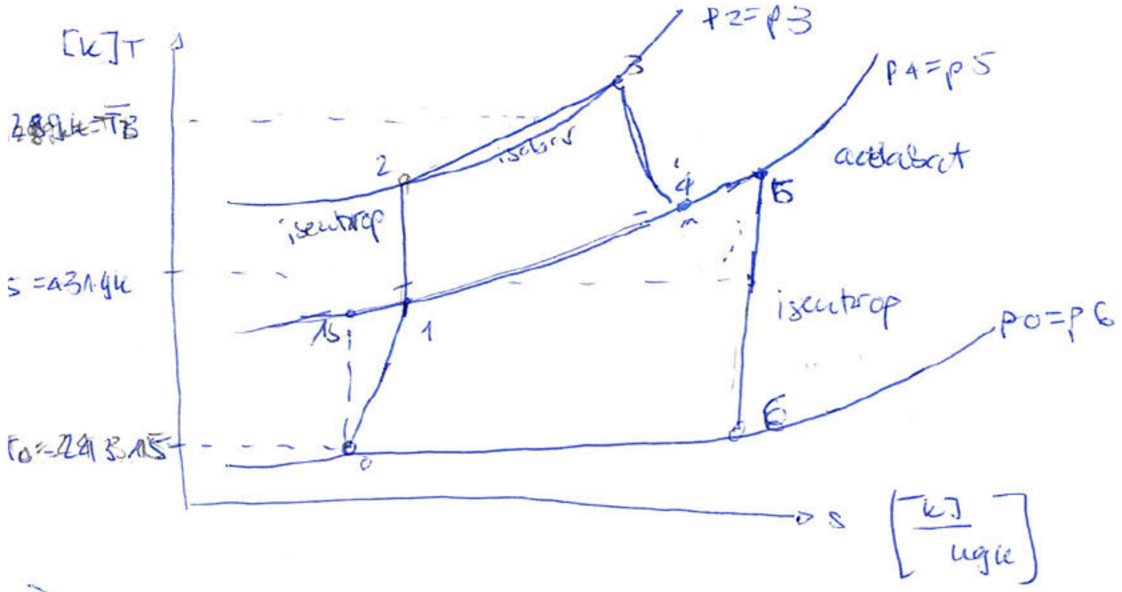
$0 = s_e - s_a + \frac{\dot{q}_B}{T_j} + \frac{\dot{S}_{erz}}{\dot{m}_L}$

$0 = c_p^{ig} \ln(\frac{T_2}{T_3}) - R\ln(\frac{p_2}{p_3}) + s_{erz} \cdot 6.293 + \frac{\dot{q}_B}{T_B}$ ($R\ln(\ldots) = 0$, isobar)

$T_2, T_3 = ?$

[redacted]

Aufg. 2) a)



b) $w_6 = ?$ $T_6 = ?$

$\frac{dE}{dt} = \sum \dot{m}_i [h_{ein} + k_{ein} + p_{ei}] + \sum \dot{Q} - \sum \dot{W}$ keins. (stat., adiabat)

5-6 -

$0 = \sum \dot{m}_{ges} [h_5 - h_6 + \frac{w_5^2 - w_6^2}{2}]$

$0 = h_5 - h_6 + \frac{w_5^2 - w_6^2}{2}$

$2(h_6 - h_5) - w_5^2 = -w_6^2$

$2\, c_{pg}(T_6 - T_5) - w_5^2 = -w_6^2$?

$\frac{T_6}{T_5} = \left(\frac{p_0}{p_5}\right)^{\frac{n-1}{n}}$ $n = 1.4$

$T_6 = T_5 \left(\frac{0.1913\,bar}{0.5\,bar}\right)^{\frac{1.4-1}{1.4}} = 431.9K \left(\frac{0.1913\,bar}{0.5\,bar}\right)^{\frac{0.4}{1.4}} = 328.0747K = T_6$

$\rightarrow 2 \cdot 1.006 \frac{kJ}{kgK} \cdot (328.0747K - 431.9K) - (220 \frac{m}{s})^2 = -48294.1627 \frac{m^2}{s^2}$

$2 \cdot 1.006 \frac{k\,N\,m}{kg\,K}$ ( )K

$2 \cdot 1.006 \cdot 1000 (328.0747K - 431.9K) - (220 \frac{m}{s})^2 = -257296.5036 \frac{m^2}{s^2} = -w_6^2$

$w_6 = 507.244 \frac{m}{s}$

b) $T_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e}$

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

Lösungsmittel

$s_a - s_e \overset{\text{if}}{=} \int_{T_1}^{T_2} \frac{c_{if}(T)}{T}\,dT$ $\quad p = \text{const} \Rightarrow n = 0$?

$\rightarrow T_{KF} = 295\,K$

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

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

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

$\frac{dE}{dt} = \sum \dot{m}_i [h_{ei} + \text{pe} + \text{kin}] + \sum_j \dot{Q}_j - \sum \dot{W}$ — keine Vorhede

Stat.

$0 = \sum \dot{m}_i [h_{ei}] + \sum \dot{Q}_j$

$0 = \dot{m}_{ein} [h_{ein} - h_{aus}] /\!/ + \dot{Q}_{aus} + \dot{Q}_{12}$

$\dot{m}_{ein} [h_{aus} - h_{ein}] = \dot{Q}_{aus} + \dot{Q}_{12}$ — keines Wasser

~~$0.3 \frac{kg}{s} \cdot \left[\int_{T_1}^{T_2} c_f(T) dT + v_f (p_2 - p_1) \right] = \dot{Q}_{aus}$~~

Siedende Flüssigkeit (Wasser)

$T_{ein} = 70°C \rightarrow$ TAB A-2 $\rightarrow$ $p_1 = 0.3119$ bar

$h_f = 292.98 \frac{kJ}{kg}$

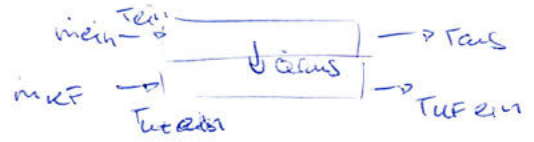
$h_g = 2626.8 \frac{kJ}{kg}$

$T_{aus} = 100°C \rightarrow$ TAB A-2 $\rightarrow$ $p_1 = 1.014$ bar

$h_f = 419.04 \frac{kJ}{kg}$

$h_g = 2676.1 \frac{kJ}{kg}$

~~Das gesamte System~~



$\frac{dE}{dt} = \sum \dot{m} [h_{ei}] + \sum \dot{Q}$

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

nur Reaktor.

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

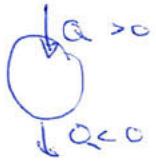
$x = 0.005$

$h_{ein} = h_{f\,70} + x (h_{g\,70} - h_{f\,70}) = 292.98 \frac{kJ}{kg} + 0.005 \left(2626.8 \frac{kJ}{kg} - 292.98 \frac{kJ}{kg}\right)$

$\boxed{h_{ein} = 304.6491 \frac{kJ}{kg}}$

$h_{aus} = h_{f\,100°C} + x (h_{g\,100} - h_{f\,100}) = 419.04 \frac{kJ}{kg} + 0.005 (2676.1 \frac{kJ}{kg} - 419.04)$

$\boxed{h_{aus} = 430.5252 \frac{kJ}{kg}}$



$0.3 \frac{kg}{s} \left[(430.525 - 304.6491) \frac{kJ}{kg} \right] - 100 \frac{kJ}{s} = -\dot{Q}_{aus}$

$-62.23714 \frac{kJ}{s} = -62.237\,kW = -\dot{Q}_{aus}$

$62.237\,kW = \dot{Q}_{aus}$