[redacted]

Aufg 1

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

Energiebilanz Reaktor: $0 = \dot{m}_{ein}(h_{ein} - h_{aus}) + \dot{Q}_{aus}$

$\rightarrow \dot{Q}_{aus} = \dot{m}_{ein}(h_{ein} - h_{aus})$ $h_1 - h_2 \Rightarrow$ reines Wasser, siedend

$h_1(70°C) = h_f(70°C) + x \cdot (h_{fg}) = 304.649 \frac{kJ}{kg}$

$h_2(100°C) = h_f(100°C) + x \cdot h_{fg}(100°C) = 431.4725 \frac{kJ}{kg}$ | TAB A2

$\Rightarrow \dot{Q}_{aus} = \underline{\underline{38.047\, kW}}$

b) $\overline{T}_{KF} = \frac{\int_1^2 T\,ds}{s_2 - s_1} \rightarrow$ $T\,ds = q_{rev} = h_2 - h_1$

$\rightarrow \overline{T}_{KF} = \frac{h_2 - h_1}{s_2 - s_1} = \frac{c^{if}(T_2 - T_1) + \cancel{v^{if}(p_2 - p_1)}}{c^{if} \cdot \ln\left(\frac{T_2}{T_1}\right)} = \frac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)} = \cancel{\ldots}$

$= \underline{\underline{293.122\, K}}$

c) $\dot{S}_{erz}$ zw Reak, Kühlmantel. $\rightarrow$ Entropiebilanz zw. Wand

$\cancel{\Rightarrow \Delta S = m(s_2 - s_1) - \frac{\dot{Q}_{aus}}{\overline{T}_{KF}} + \dot{S}_{erz}}$

$\cancel{m = m_{ges}\, s_1, \; s_2(}$ $0 = \dot{m}(s_1 - s_2) + \frac{\dot{Q}_{aus}}{\overline{T}_{KF}} + \dot{S}_{erz}$

$s_1(70°C, x_D = 0.005) = s_f + x(s_g - s_f) = \underline{0.9889} \frac{kJ}{kg\,K}$

$s_2(100°C, x_D = 0.005) = s_f + x(s_g - s_f) = 1.3371 \frac{kJ}{kg\,K}$ | TAB A2

$\Rightarrow \dot{S}_{erz} = \dot{m}(s_2 - s_1) - \frac{\dot{Q}_{aus}}{\overline{T}_{KF}}$ (mit $\dot{Q}_{aus}$ – 65 kW)

$= \underline{\underline{0.117 \frac{kJ}{K}}}$

d) Δm_{12} für $T_2 = 70°C$? → halboffenes System

$m_2 u_2 - m_1 u_1 = \Delta m h_{ein} + Q_{aus} - W$

$m_{ges} = 5755\,kg = m_1$, $m_2 = (\Delta m_{12} + m_1)$

$u_2 - u_1 = c_v(T_2 - T_1) = c_v(70°C - 100°C)$

e) $\Delta S_{12} = \Delta m s_i + \frac{Q_{aus,12}}{T} + \cancel{S_{erz}}^{0} = \cancel{m_1(s_2 -} m_2 s_2 - m_1 s_1$

$= \Delta m_{12} s_{ein} + \frac{35'000}{T}$

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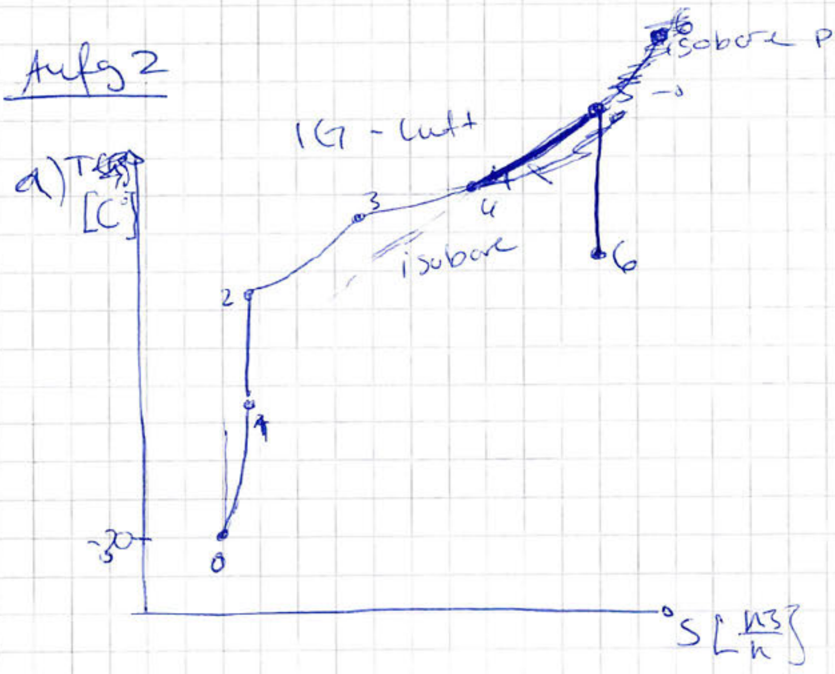
Aufg 2

a)



b) w_6, T_6 ?

$\rightarrow$ isentrop: $n = k = 1.4 \rightarrow \frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{1-\frac{1}{k}} \Rightarrow T_6 = T_5 \cdot \left(\frac{0.191}{0.5}\right)^{1-\frac{1}{k}}$

$\underline{\underline{= 328.0754}}$

Energiebilanz: $\dot{m}\left(h_1 - h_2\right) + \frac{w_5^2 - w_6^2}{2}\Big) + \cancel{Q}^{\text{adiabat}} + W$

$\rightarrow \dot{m}\, c_{p_{Luft}} \cdot \left(T_5 - T_6\right) + \frac{w_5^2 - w_6^2}{2} + \frac{R(T_2 - T_1)}{1-k} = 0$

$R = c_p - c_v \qquad \frac{c_p}{c_v} = 1.4 \rightarrow c_v = \frac{c_p}{1.4} = \underline{0.7186}$

$\underline{R = 0.2874\, \frac{kJ}{kgK}}$

$\rightarrow$ TR: $\dot{m}$? =

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

$= \cancel{\dot{m}}\left(h_6 - h_0 - T_0(s_6 - s_0) + ke\right) = \cancel{\Delta e_{x,str}}\ \Delta e_{x,str}$

$h_6 - h_0 = c_p(T_6 - T_0) = 1.006 \cdot (84.925) = \underline{85.435}$

$s_6 - s_0 = c_p \ln\left(\frac{T_6}{T_0}\right) - \cancel{R \ln\left(\frac{p_6}{p_0}\right)} = 0.301$

$\Rightarrow 85.435 - 243.15 \cdot 0.301 + \frac{w_6^2 - w_0^2}{2} = \Delta e_{x,st}$

$(w_6 = 310 \frac{m}{s}, w_0 = 200 \, m/s)$

$\Rightarrow \cancel{12.387}\ \underline{\underline{110.062 \frac{kJ}{kg}}}$

d) $e_{x,verl} \rightarrow$ ~~Ener~~ Exergiebilanz

stationär: $\dot{m}\,\Delta e_{x,str} + \cancel{E_{x,q}}^{0 \text{ adiabat}} - \dot{W}_t = \dot{E}_{x,verl}$

$\dot{W}_t =$

Aufg 3 [redacted]

a) p_{g1}, m_g?

Da gleichgewicht herrsch muss p_{g1} = Druck von EW = Druck von atm + Kolben

$$\Rightarrow p_{g1} = p_{amb} + \frac{m_K \cdot g}{\pi \cdot 5cm^2} = \frac{32kg \cdot 9.81m}{\pi \cdot (0.05m)^2 s^2} + p_{amb}$$

$$= 100'000pa + 39'969.54\ pa = \underline{1.4 bar}$$

~~m_g~~ $m_g \to$ IGG: $$\frac{pV}{\frac{R}{M_g} \cdot T} = \frac{1.4 \cdot 10^5 \cdot 0.00314m^3}{\frac{8314}{50} \cdot (500 + 273.15)} =$$

$$= \cancel{0.008\ kg\ 18\ kg = 8.18g} \quad = 0.003424kg$$
$$= \underline{3.42g}$$

b) $x_{eis} > 0$, T_{g2}? p_{g2}?

~~Sie bleiben gleich T_{g2} = 500°C ~~1.4 bar~~, p_{g2} = 1.4 bar~~

~~$T_2 = T_1 \left(\frac{v_1}{v_2}\right)^{n-1}$ da v_1 gleich $\to T_2 = T_1$~~

$\to$ Es wird keine Wärme mehr übertragen wenn beide Temperaturen gleich sind $\to T_2 - T_1\ T_{EW1} = \underline{0°C}$

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

$c_v = 0.633$, $R = \frac{8.314}{50} = 0.166 \to c_p = c_v + R = \underline{0.799}$

$\frac{c_p}{c_v} = n = \underline{1.263} \to p_2 = \underline{1.7387\ bar}$

c) Q_{12}: ~~Ges~~ Energiebilanz geschl. Kolben:

$$U_2 - U_1 = Q_j - W_v = m \cdot c_v (T_2 - T_1) + W_v = Q_j$$

$W_v \to$ reibungsfrei: $\frac{R(T_2 - T_1)}{1-n}$

$$\Rightarrow 0.00342g(-500) \cdot 0.633 + \frac{R(-500)}{1 - 1.263} = \underline{+344.50 J}$$

d) $x_{eis\,2}$ $\cancel{\Delta}$ $m_2u_2 - m_1u_1 = \cancel{\Delta U_{ab}}\ Q_{12} + \varnothing$

$\cancel{u_2(}$ $m_2 = (m_{ew}\ \cancel{+ (1-x)}) - x_{ew}$

$m_1 = 0.1kg$

$u_2 = \cancel{u_f + x}\ u_{flüssig} + x(u_{fest} - u_{flüssig})$ bei $T = 0.0°C$

$u_1 = u_{flüssig} + 0.6(u_{fest} - u_{flüssig})$ bei $T = 0.0°C$

$\rightarrow 0.1 \cdot -0.045 + 0.6(-333.458 + 0.045) = m_1u_1$

$= \underline{-20.01}$

$m_2 = 0.1kg + \underline{(1-x_2)\cdot 0.1} - x_{ew} = 0.1(1-x_2)$

$u_2 = -0.045 + x_2(-333.4)$

$\rightarrow m_2u_2 = Q_{12} + m_1u_2$ $\rightarrow$ nach x auflösen

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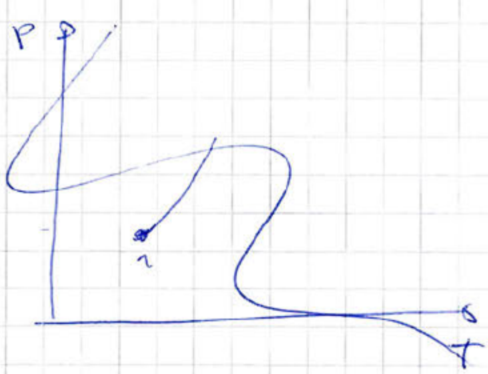
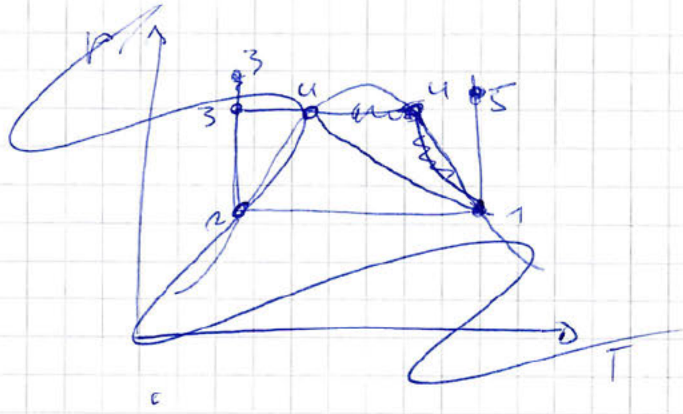
Aufg 4

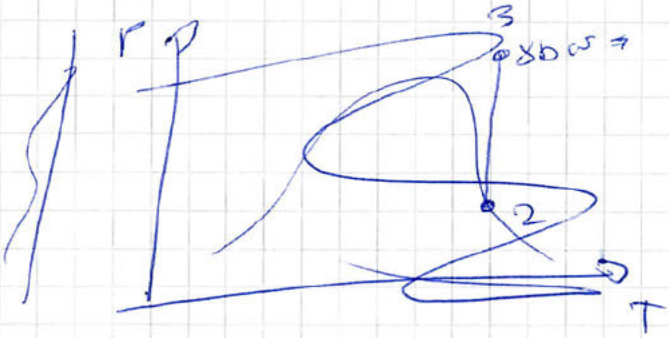
a)

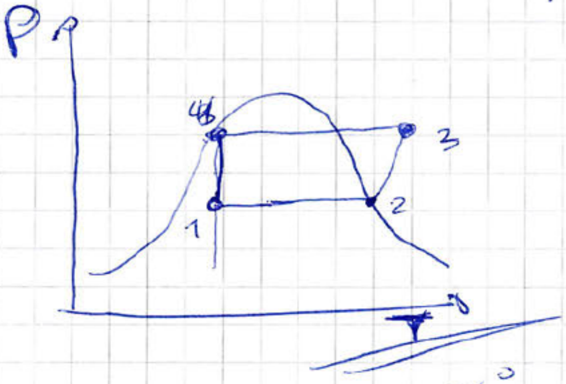




b) ~~$\dot{m}_{R134a}$~~ ?

$\dot{m}(h_1 - h_2)$





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

~~$\dot{m}(h_1 - h_2) + \dot{Q}_K - W_V = 0$~~

~~$h_1($~~

Energiebilanz Prozess 2 – 3

$\rightarrow \dot{m}(h_2 - h_3) + \cancel{\dot{Q}} - W_K = 0$

$h_2(x = 1 \Rightarrow h_g($

$h_3(8bar) = h_3(\cancel{8bar, T_2})$

T_i => 10K über Sublimation → T_i 4.5 mbar unter Tripel = 0°C

~~$\rightarrow \dot{m}(h_1 - h_2) + \dot{Q}_K - W_V = 0$~~

$h_1(T = 0°) =$

~~$\dot{m}$~~

c) x_1 ~~T2~~ $\rightarrow$ ~~gris~~ adiabate Drossel $\rightarrow$ isentrop $\rightarrow$ S konst

$$\underline{s_1 = s_4} \Rightarrow x_1 = \underline{\frac{s_4 - s_{1f}}{s_{g1} - s_{1f}}}$$

$s_4(8\,bar\ x_4 = 0) = \cancel{s_{4f}}\ s_f(8\,bar) = \underline{0.3459}$

$\rightarrow T = 31.33\,°C$

$\rightarrow$

d) $$\varepsilon_K = \frac{Q_z}{Q_{ab} - Q_z} = \frac{Q_z}{w_t} = \cancel{\frac{Q_K}{Q_{ab} - Q_z}} = \frac{Q_K}{28\,W}$$

$Q_K = \dot{m}(-h_1 + h_2)$

~~$h_2($~~ $=$

e) das ~~fluss~~ Wasser würde wieder flüssig werden bevor es gasförmig wird