A1

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

$\Rightarrow 0 = \dot{m}_{ein}(h_e - h_1) + \dot{Q}_R - \dot{Q}_{aus}$

$h_e(70°C, 1bar) = h_{f_g}(70°C) = 2333,8 \frac{kJ}{kg}$ $h_1(70°C) = 292,98 \frac{kJ}{kg}$

$h_m(100°C, 1bar) = h_{f_g}(100°C) = 2257 kJ/kg$ $h_1(100°C) = 419,04 \frac{kJ}{kg}$

(~~$\Rightarrow$ offenes System $\Rightarrow$ atm. Druck = 1bar~~

~~siedende Flüssigkeit $\Rightarrow$ flüssig-gasförmig-Zustand~~

siedend $\Rightarrow$ flüssig

$\Leftrightarrow \underline{\dot{Q}_{aus} = \dot{m}_{ein}(h_e - h_1) + \dot{Q}_R} = ~~72,5kW~~ ~~76,96kW~~ \underline{62,78kW}$

b) GS: $\bar{T}_{KF}$, $\dot{Q}_{aus} = 65kW$

$\underline{\bar{T}_{KF} = \frac{T_{KF,aus} + T_{KF,ein}}{2} = 293,15K}$

$\rightarrow$ arithmetisch

c) $\Delta S = \frac{\dot{Q}_{aus}}{\bar{T}_{KF}} + S_{CO2}$

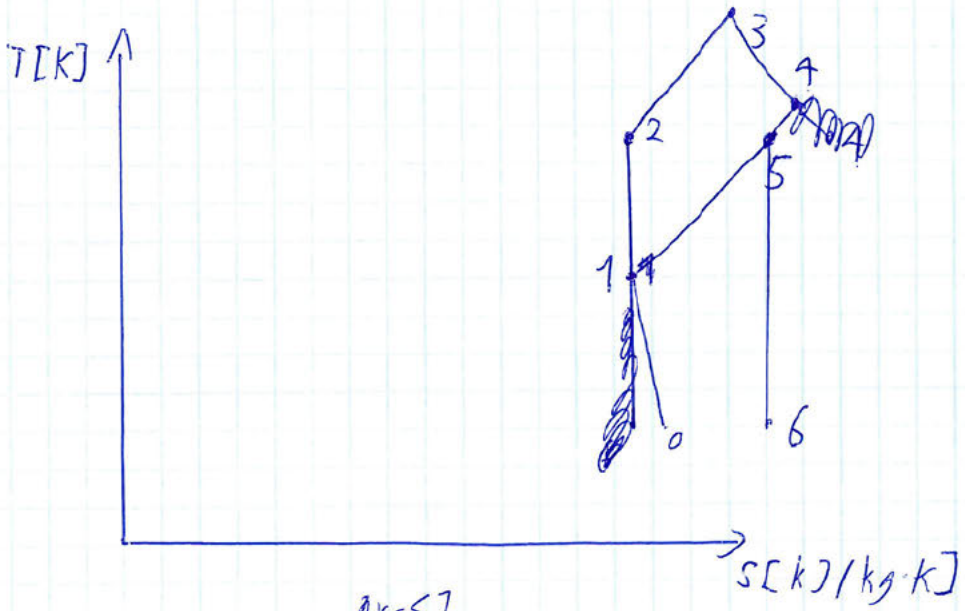
$\Leftrightarrow S_{CO2} = \Delta S - \frac{\dot{Q}_{aus}}{\bar{T}_{KF}}$

d) GS: Δm_{12}

$0 = \dot{m}_w (h_e - h_a) + Q_R \nearrow 0 \quad Q_{aus}$

$\Delta m_{12} = \dot{m}_w \cdot \Delta t$ $\qquad$ $100°C \rightarrow 70°C$

A2a) T-s Diagramm:



0 → 1: adiabat → isentrop, $\eta_{VS} < 1$, kompression
$s_1 \geq s_0$ $\Rightarrow p_1 \geq p_0$
$T_1 \geq T_0$

1 → 2: adiabat + rev $\Rightarrow$ isentrop
$s_1 = s_2$

1 → 5: ~~rev ad.~~ $\Rightarrow$ isentrop, $p_6 = p_0$ isobar

2 → 3: Isobare

3 → 4: nicht rev

---

b) gs: w_6, T_6

$\Rightarrow w_6 =$ ~~w_5~~ $\quad \frac{p_5}{p_0} = 2,678$

$\Rightarrow$ ~~w_6~~ ~~$w_6 = w_5 \cdot \frac{p_0}{p_5} = 84,04 \frac{m}{s}$~~

$w_6 = w_5 \cdot \frac{p_5}{p_0} = 575,96 \frac{m}{s}$

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

$$\dot{E}x_{,str} = \dot{m}_{ges}\left(\underbrace{h_e}_{h_0} - \underbrace{h_1}_{h_6} - T_0(s_e - s_a) + \Delta k_e + \underbrace{\Delta p_e}_{0}\right)$$

A3 d) $|Q_{12}| = 1,5\,kJ$

GS: $x_{Eis,2}$ $\qquad T_{EW,2} = T_{EW,1}$

$Q_{12} = m_2 u_2 - m_1 u_1$ $\qquad m_{EW,1} = m_{EW,2} = m_2 = m_1$

$u_1 = u_f + x_{Eis,1}(u_{fest} - u_f)$

$\Rightarrow$ bei 0°C und Druck $p_{Eis,1} = p_{amb} + \frac{m_K \cdot g}{(\frac{D}{2})^2 \pi} = 1,4\,bar$

$u_f = -0,045 \frac{kJ}{kg}$, $u_{fest} = -333,458 \frac{kJ}{kg}$

$\Rightarrow u_1 = -200,09 \frac{kJ}{kg}$

$\Leftrightarrow Q_{12} = m_{EW,1}(u_2 - u_1)$

$\Leftrightarrow \frac{Q_{12}}{m_{EW,1}} = u_2 - u_1 \Leftrightarrow \frac{Q_{12}}{m_{EW,1}} + u_1 = u_2$

$u_2 = -185,09 \frac{kJ}{kg}$

$\Rightarrow u_2 = u_f + x_{Eis,2}(u_{fest} - u_f)$ $\Leftarrow$ Bei gleichem Temp und Druck

$\Leftrightarrow \frac{u_2 - u_f}{u_{fest} - u_f} = x_{Eis,2} = 0,555$

A3

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

$$p_{g,1} = \frac{m_K \cdot g}{\left(\frac{D}{2}\right)^2 \pi} + p_{amb} + \frac{m_{EW} \cdot g}{\left(\frac{D}{2}\right)^2 \pi} = 1{,}4 \text{ bar}$$

$m_K \cdot g = 313{,}92 \text{ kg m/s}^2$, $m_{EW} \cdot g = 0{,}987 \text{ kg m/s}^2$

$\left(\frac{D}{2}\right)^2 \pi = 0{,}00785 \text{ m}^2$

$$m_g = \frac{p_{g,1} V_{g,1}}{R_g T_{g,1}} = 0{,}0034 \text{ kg} = 3{,}4 \text{ g}$$

$$R_g = \frac{\bar{R}}{M_g} = 166{,}28 \frac{J}{kg\,K}$$

$$M_g = 50 \frac{kg}{kmol}$$

b) Mit $p_{g,1} = 1{,}5$ bar und $m_g = 3{,}6$ g weiterrechnen.

GS: ~~$x_{Eis,2}$~~ $T_{g,2}$, $p_{g,2}$ GG: $x_{Eis,2} > 0$

~~Solange das Eis nicht komplett geschmolzen ist, bleibt~~

$T_{g,2} < T_{g,1}$, da Temperaturausgleich bis $T_{EW,1} \approx T_{g,2} = 0°C$.

~~weil $V_{g,2}$ sinkt, steigt $p_{g,2}$.~~

$p_{g,2} = p_{g,1}$, da keine zusätzlichen Kräften/Drücken wirken bei Zustand 2.

c) Mit $T_{g,2} = 0{,}003°C$ weiterrechnen.

GS: Q_{12}

Es gilt: $0 = $ ~~$m_g \Delta h + \dot{Q}$~~ $m_g \cdot \Delta u + Q_{12}$

$\Leftrightarrow -Q_{12} = m_g \Delta u = 1{,}076 \text{ kJ}$

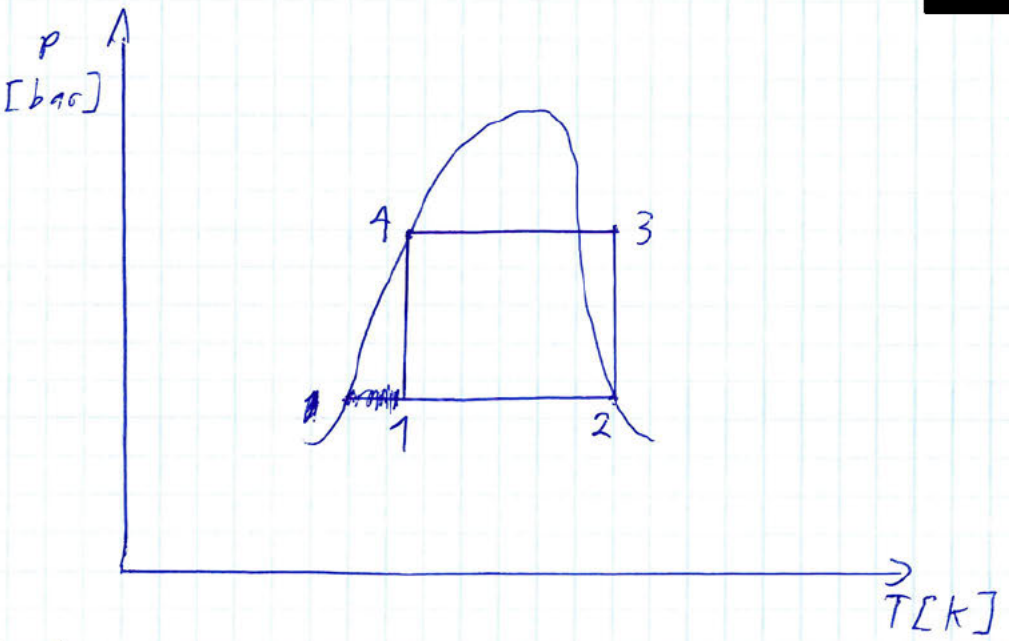
$m_{g,2} = m_{g,1}$

$\Delta u = c_v (T_{g,2} - T_{g,1}) = 376{,}5 \frac{kJ}{kg}$

$\Rightarrow Q_{12} = -1{,}$ ~~076~~ 076 kJ

AA

a)



1 -> 2: isobar

2 -> 3: adiabad rev => isentroop

3 -> 4: isobar

4 -> 1: isentroop

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

~~$0 = \dot{m}_{R134a}(h_3 - h_4) + \dot{Q}_{ab}$~~

$0 = \dot{m}_{R134a}(h_2 - h_3) - \hat{W}_K \Leftrightarrow \dot{m}_{R134a} = \frac{\dot{W}_K}{h_2 - h_3}$

$\Rightarrow h_2 = h_g$, $s_2 = s_3$ ~~$T_2 = 6$ K~~

$h_3(8\text{bar}, T_3)$

c) $\dot{m}_{R134a} = 4 \frac{kg}{h}$, $T_2 = -22°C$

GS: x_1

$s_1 = s_4$

$s_1 = s_f$

$x_1 = \frac{s_1 - s_f}{s_g - s_f}$