[redacted]

Aufgabe 1.

1. a) stationär Fließprozess

$$0 = \dot{m}_{Ein} (h_e - h_a) - \dot{Q}_{aus} + \dot{Q}_R$$

$$h_e \overset{\text{Tab A2}}{=} h_f(70°C) = 292{,}98 \ \frac{kJ}{kg}$$

$$h_a = h_f(100°C) = 419{,}04 \ \frac{kJ}{kg}$$

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

$$= 62{,}182 \ kW$$

1. b)

$$\overline{T}_{hF} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{\frac{T_{hFaus} + T_{hFein}}{2}(s_e - s_a)}{s_e - s_a}$$

$$= \frac{T_{hFaus} + T_{hFein}}{2} = 293{,}15\,K$$

[redacted]

1. c)

$$0 = \dot{m}_{ein}(s_e - s_a) - \frac{\dot{Q}_{aus}}{\overline{T}_{KF}} + \dot{S}_{erz}$$

$$s_e = s_f(70\,°C) = 0{,}9549\ \frac{kJ}{kg \cdot K}$$

$$s_a = s_f(100\,°C) = 1{,}3069\ \frac{kJ}{kg \cdot K}$$

$$\dot{S}_{erz} = -\dot{m}_{ein}(s_e - s_a) + \frac{\dot{Q}_{aus}}{\overline{T}_{KF}}$$

$$= 0{,}3177\ \frac{kJ}{K \cdot s}$$

1. d)

$$\cancel{\Delta E = \Delta m_{12} (u_2 - u_1)}$$

$$\Delta E = \Delta m_{12} [h_2 - h_1] - \underbrace{\dot{Q}_{aus,12} + \dot{Q}_{R,12}}_{=0}$$

$$= m_2 u_2 - m_1 u_1 = (m_1 + \Delta m_{12}) u_2 - (m_1) u_1$$

$$h_1 = h_f (20°C) = 83{,}96 \frac{kJ}{kg}$$

$$h_2 = h_f (70°C) = 419{,}04 \frac{kJ}{kg}$$

$$u_1 = u_f (20°C) = 83{,}95 \frac{kJ}{kg}$$

$$u_2 = u_f (70°C) = 292{,}95 \frac{kJ}{kg}$$

$$m_1 = 5755 \, kg$$

$$\Delta m_{12} [h_2 - h_1] = m_1 u_2 + \Delta m_{12} u_2 - m_1 u_1$$

$$\Delta m_{12} = \frac{m_1 u_2 - m_1 u_1}{h_2 - h_1 - u_2}$$

$$= 28549 \, kg$$

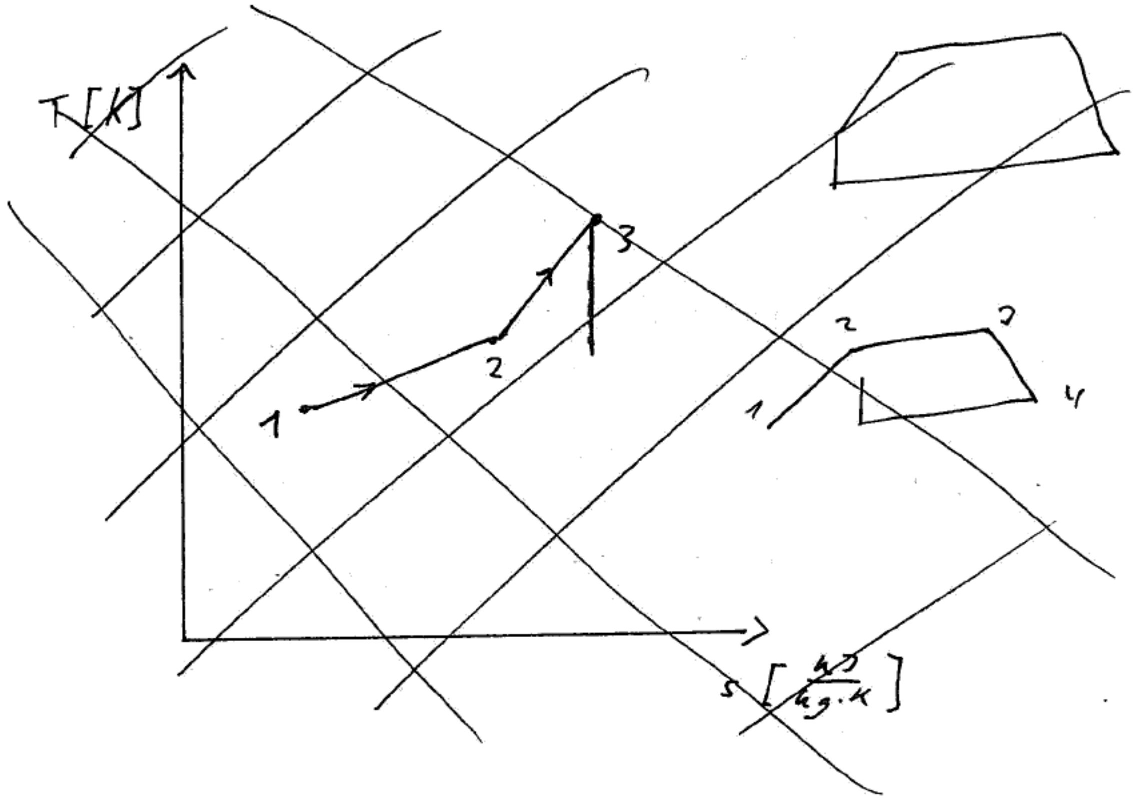
[redacted]

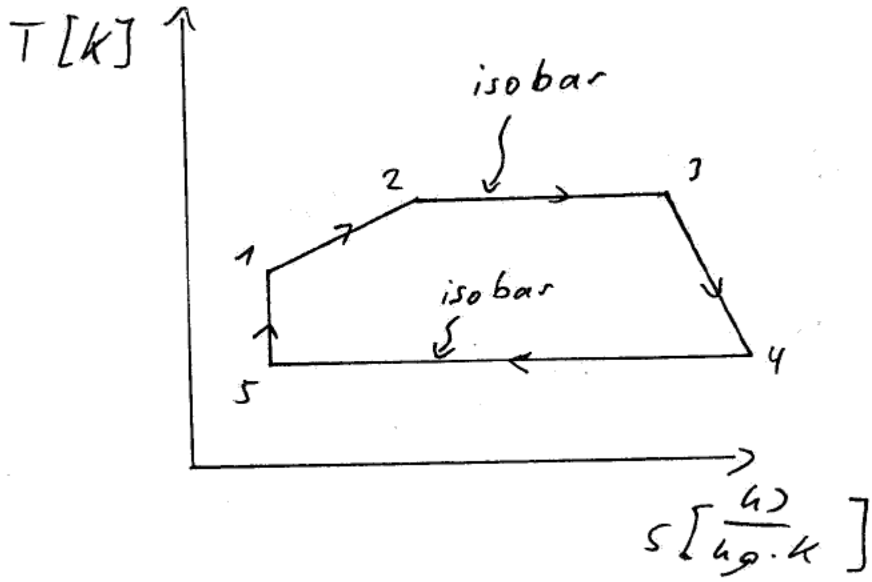
1. e) $\Delta S = m_2 s_2 - m_1 s_1 = \sum_i \Delta m_i s_i + \sum_j \frac{Q_j}{T_j} + S_{erz}$

[redacted]

Aufgabe

2. a)





2. b) Energiebilanz (stationärer Fließprozess)

$$0 = \dot{m}\left(h_0 - h_6 + \frac{w_{Luft}^2 - w_6^2}{2}\right) + q_B \cdot m_K$$

$$m_K = 8{,}\cancel{\ldots} \cdot \frac{1}{5{,}293} \cdot m_M$$

$$h_0 = h[T_0] = h[243{,}15\,K]$$

$$\overset{\text{Tab. A22}}{=} h[240] + \frac{h[250] - h[240]}{250 - 240}(243{,}15 - 240)$$

$$= 243{,}18 \,\frac{kJ}{kg}$$

$$h_5 = h[430] + \frac{h[440] - h[430]}{440 - 430}(431{,}9 - 430)$$

$$= 433{,}37 \,\frac{kJ}{kg}$$

$$h_6 = h_0$$

$$\Rightarrow \quad 0 = \dot{m}\left(\frac{v_{Luft}^2 - w_6^2}{2}\right) + q_B \cdot m_K$$

$$w_6 = \sqrt{\frac{2\, q_B \cdot m_K}{\dot{m}} + v_{Luft}^2}$$

[redacted]

2. c) $$\overset{m}{e}_{x,str} = [h - h_0 - T_0(s - s_0) + \frac{w^2}{2}]$$

$$e_{x,str,6} = [h_6 - h_0 - T_0(s_6 - s_0) + \frac{w_6^2}{2})$$

$$e_{x,str,0} = [h_0 - h_0 - T_0(s_0 - s_0) + \frac{w_0^2}{2})$$

$$= \frac{w_0^2}{2} = 20\,000\ \frac{m^2}{s^2}$$

2. d)

$$\dot{E}_{x,verl} = \dot{m}\left[h_e - h_a - T_0(s_e - s_a) + \Delta ke\right] + \sum_j \left(1 - \frac{T_0}{T_j}\right)\dot{Q}_j = e_{x,ver} \cdot \dot{m}$$

$$0 = \dot{m}\left[h_e - h_a + \Delta ke\right] + \sum_j \dot{Q}_j$$

$$\Downarrow$$

$$\dot{E}_{x,verl} = \dot{m}\left[-T_0(s_e - s_a)\right] + \sum_j \left(1 - \frac{T_0}{T_j}\right)\dot{Q}_j - \sum_j \dot{Q}_j$$

$$= e_{x,verl} \cdot \dot{m}$$

$$e_{x,verl} = -T_0(s_e - s_a) + \frac{\sum_j \left(1 - \frac{T_0}{T_j}\right)\dot{Q}_j - \sum \dot{Q}_j}{\dot{m}}$$

[redacted]

Aufgabe 3.

3. a) $p_{1,g} = \frac{m_g \; R \; T_{g,1}}{V_{g,1}}$

$R = \frac{\bar{R}}{M}$ $\bar{R} = 8{,}314 \frac{J}{mol \cdot K}$

$= 166{,}28 \frac{J}{kg \cdot K}$

$m_g = \frac{p_{1,g} \cdot V_{g,1}}{R \cdot T_{g,1}}$

$p_{1,g} = \frac{\pi}{4} D^2 \cdot (m_K + m_{EV}) + p_{amb}$

$= \cancel{1{,}00\,bar}\; 1{,}00\,bar$

$m_g = 5{,}84\,g$

3. b) $p_{g,2} = p_{g,1}$

Da festes und flüssiges Wasser hier inkompressibel ist und deswegen eine Änderung ~~auf~~ von x_{Eis} keinen Einfluss auf ~~den~~ den Druck p_g hat, kann man so wie in a) vorgehen.

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

Da für ideale Gase Temperatur und Druck gekoppelt sind.

[redacted]

7. c) $\frac{\Delta E}{mg} =$

3. d) $x = \frac{u - u_f}{u_g - u_f}$

Da der Membran Wärme übertragend ist:

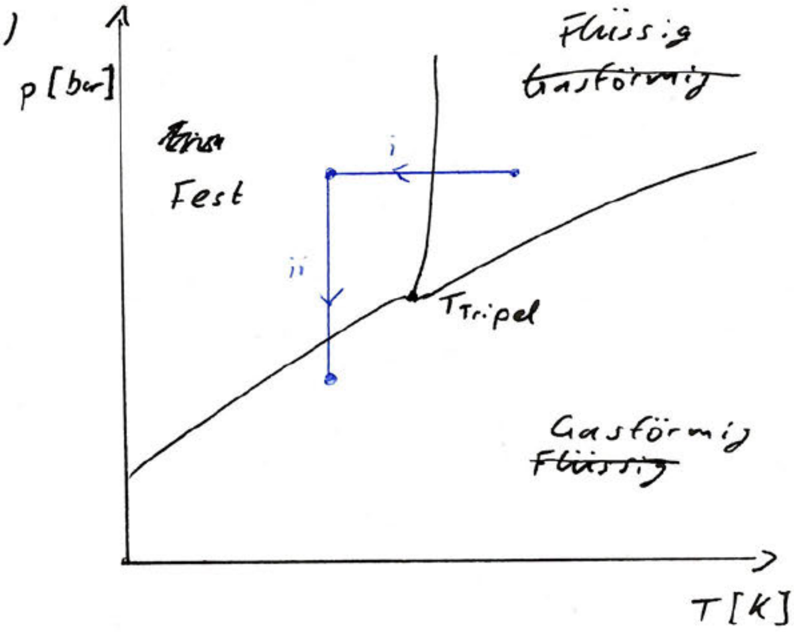
$T_{g,2} = T_{EW,2} = 0{,}003\,°C$

$\Delta E = -Q_{12}$ $\qquad \frac{\Delta E}{m_{EW}} = u = -15 \frac{kJ}{kg}$

$\Rightarrow x \overset{\text{Tab 1}}{=} \frac{15 - (-0{,}033)}{-333{,}442 + 0{,}033} = 0{,}0449$

[redacted]

4. a)


p [bar]
Fest
Flüssig
~~Gasförmig~~
i
ii
T_{Tripel}
Gasförmig
~~Flüssig~~
T [K]

4. b) stationärer Fließprozess

$$0 = \dot{m}_{R134a} \left(h_2 - h_3 \right) + \dot{W}_K$$

$$\dot{m}_{R134a} = - \frac{\dot{W}_a}{h_2 - h_3}$$

$s_2 = s_3$ $\quad$ $p_3 = 8\,bar$ $\quad$ $x_2 = 1$

$p_2 = p_4$

$T_2 = T_i - 6K$

[redacted]

4. c) $x_1 = \dfrac{\phi - \phi_f}{\phi_g - \phi_f}$ $\phi = v, u, h, s$

4.

d) $\epsilon_K = \frac{|\dot{Q}_{ab}|}{|\dot{W}_E|} = \frac{-\dot{Q}_{ab}}{-\dot{W}_K}$