Aufgabe 1

a). $h = h_f + x_D \cdot (h_g - h_f) = h_f + x_D \cdot h_{fg} = 419.04\,kJ/kg + 0.005 \times 2257.0\,kJ/kg$

$= 430.325\,kJ/kg$

$\dot{Q}_{aus} = \dot{m}_{aus}\, h = 0.3\,kg/s \cdot 430.325\,kJ/kg = 129\,kW$

b). $c = \text{const.} \Rightarrow S(T = 298.15K) - S(T = 288.15K) = \int_{T_1}^{T_2} \frac{1}{T} dT \cdot c = c \cdot \ln\left(\frac{T_2}{T_1}\right)$

$$\overline{T}_{KF} = \frac{\int_e^a T\, ds}{s_a - s_e} = \frac{T_a s_a - T_e s_e}{c \cdot \ln\left(\frac{298.15K}{288.15K}\right)} = [\ldots] \approx 295K$$

c). $\dot{S}_{erzeugt} = -\dot{m}[s_e - s_a] - \frac{\dot{Q}_{aus}}{\overline{T}_{KF}}$

$= -0.3\,kg/s \cdot \left(c \cdot \ln\left(\frac{T_1}{T_2}\right)\right) - \frac{65kW}{295K}$

$=$

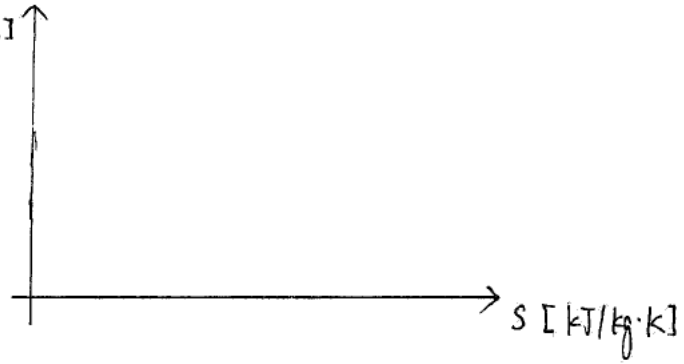
d). $U_1 = (1 - x_D)\, m_{ges,1}\, h_f + x_D \cdot m_{ges,1}\, h_g + \int \dot{Q}_R dt - \int \dot{Q}_{aus}\, dt$

$= (1 - 0.005) \cdot 1755\,kg \cdot$

[redacted]

Aufgabe 2

a).




b). Exergiebilanz: $\dot{m} e_{x,str} = \dot{m} [h$

# Aufgabe 3

a). $A = \pi \cdot (\frac{D}{2})^2 = 25\pi\,cm^2 = 25\pi \times 10^{-4}\,m^2$

$$p_{oben} = \frac{(m_K + m_{EW})\,g}{A} + p_{amb} = \frac{(32kg + 0.1kg)\cdot 9.81 N/kg}{25\pi \times 10^{-4} m^2} + 1\times10^5 Pa \approx 140 kPa = 1.4 bar$$

Mechanische Gleichgewicht: $p_{g,1} = p_{oben} \approx 1.4\,bar$

$$R_g = \frac{\bar{R}}{M_g} = \frac{8.314 J/mol\cdot K}{50\times10^{-3} kg/mol} = 166.28\,J/kg\cdot K$$

$$m_g = \frac{p_{g,1} V_{g,1}}{R_g T_{g,1}} = \frac{1.4\times10^5 Pa \cdot 3.14\times10^{-3} m^3}{166.28 J/kg\cdot K \cdot 773.15 K} \approx 0.0034 kg = 3.4 g$$

b). $T_{g,2} = 0°C = 273.15K$

Da $x_{Eis,2} > 0$, ist die Temperatur vom EW im Zustand 2 0°C. Da Zustand 2 schon der Gleichgewichtszustand (Endzustand) ist, ist die Temperatur vom Gas gleich wie die vom EW, also 0°C.

$p_{g,2} = p_{g,1} = 1.4\,bar$

Da die obige Masse unverändert ist, muss der Druck gleich bleiben, sodass das Gas die Masse „tragen" könnte, d.h. Gleichgewichts-Zustand bleiben.

c). $C_p = R_g + C_v = 166.28 J/kg\cdot K + 633 J/kg\cdot K = 799.28 J/kg\cdot K$

$$\Delta U_g = C_p m_g \Delta T = 799.28 J/kg\cdot K \cdot 0.0034 kg \cdot (273.15K - 773.15K) \approx -1358.8 J$$

$$V_{g,2} = \frac{m_g R_g T_{g,2}}{p_{g,2}} = \frac{0.0034 kg \cdot 166.28 J/kg\cdot K \cdot 273.15 K}{1.4\times10^5 Pa} \approx 1.103\,L$$

$$\Delta h = \frac{\Delta V}{A} = \frac{(1.103L - 3.14L)\cdot 1\times10^{-3} m^3/L}{25\pi\times10^{-4} m^2} \approx -0.26 m$$

$$W = (m_K + m_{EW})\,g\Delta h = (32kg + 0.1kg)\cdot 9.81 N/kg \cdot (-0.26m) \approx -81.9 J$$

$$Q_{12} = \Delta U_g + W = -1358.8 J - 81.9 J = -1440.7 J$$

$$|Q_{12}| = 1440.7 J$$

d).

$$x_{Eis,1} = \frac{m_{Eis,1}}{m_{EW}} = \frac{m_{Eis,1}}{0.1\,kg} \overset{!}{=} 0.6 \iff m_{Eis,1} = 0.06\,kg \Rightarrow m_{FL,1} = m_{EW} - m_{Eis,1} = 0.04\,kg$$

$$U_{EW,1} = m_{Eis,1}\,u_{Fest} + m_{FL,1}\,u_{FL} = 0.06\,kg\,(-333.458\,kJ/kg) + 0.04\,kg\,(-0.045\,kJ/kg)$$

$$\approx -20\,kJ$$

$$U_{EW,2} = U_{EW,1} + |Q_{12}| = -20\,kJ + 1440.7\,J = -18.56\,kJ$$

$$\overset{!}{=} m_{Eis,2}\,u_{Fest} + m_{FL,2}\,u_{FL} = m_{Eis,2}\cdot(-333.458\,kJ/kg) + (0.1\,kg - m_{Eis,2})(-0.045\,kJ/kg)$$

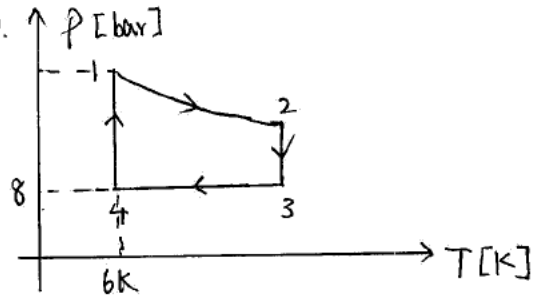
$$= m_{Eis,2}\cdot(-333.458\,kJ/kg + 0.045\,kJ/kg) - 0.1\,kg\cdot 0.045\,kJ/kg$$

$$\iff m_{Eis,2} = \frac{0.1\,kg\cdot 0.045\,kJ/kg - 18.56\,kJ}{-333.458\,kJ/kg + 0.045\,kJ/kg} \approx 0.0557\,kg$$

$$\Rightarrow x_{Eis,2} = \frac{m_{Eis,2}}{m_{EW}} = \frac{0.0557\,kg}{0.1\,kg} = 0.557$$

# Aufgabe 4

a).




Zustand 1: $T = 6K$

Zustand 2: $x_2 = 1$

Zustand 3: $p_3 = 8bar$

Zustand 4: $p_4 = 8bar$ $x_4 = 0$

b).