Aufgabe 1

a) 1. HS ~~Kühlmantel~~ : Reaktor:

$$0 = \dot{m}(h_e - h_a) + \dot{Q}$$

$$\dot{Q} = \dot{m}(h_a - h_e) = \dot{m} \cdot c_p \cdot \Delta T$$

$h_a(T_1) = h_{a,f}(T_1) = 292.98 \frac{kJ}{kg}$, A-2

$h_e(T_2) = h_{e,f}(T_2) = 419.01 \frac{kJ}{kg}$, A-2

$\dot{Q} = 0.3 \frac{kg}{s} \cdot (292.98 - 419.01) = \underline{-37.8\ kJ}$

b) Isobar: aus Vorlesung $\frac{h_2 - h_1}{s_2 - s_1} = T$

$$\frac{h_2 - h_1}{s_2 - s_1} = \frac{c \cdot (T_2 - T_1)}{c \cdot \ln\left(\frac{T_2}{T_1}\right)}$$

$$= \frac{298.15 - 288.15}{\ln\left(\frac{298.15}{288.15}\right)} = \underline{293.12\,K = T}$$

c) 2. HS aus Vorlesung:

$$S_{erz} = |Q| \cdot \left(\frac{1}{T} - \frac{1}{T_{Reaktor}}\right) = 37.8\,kJ \left(\frac{1}{293.12} - \frac{1}{373.15\,K}\right)$$

($T_{Reaktor}$ // const.)

$$= 0.027 \frac{kJ}{K}$$

d) 1. HS.

$$\Delta E = \Delta m_{1,2}(h) + \dot{Q}$$

$$m_2 \cdot u_2 - m_1 \cdot u_1 = \Delta m_{12} \cdot h + \dot{Q}$$

$$\Delta m_{12} = \frac{1}{h}\left(m_2 \cdot u_2 - m_1 \cdot u_1 - Q\right)$$

$h = h_f(20°) = 83.96 \frac{kJ}{kg}$, A2

$Q = -35MJ$

$m_2 \cdot u_2 - m_1 \cdot u_1$:

$T_1 = 100°C$, $T_2 = 70°C$

$m_1 = 5755kg$

$m_2 = m_1 + \Delta m$

$u_2 = u_f(T_2) = 292.95 \frac{kJ}{kg}$, A-2

$u_1 = u_f(T_1) = 418.94 \frac{kJ}{kg}$, A2

$$\Rightarrow \Delta m_{12} = \frac{1}{h} \cdot m_1 \cdot u_2 + \frac{1}{h} \Delta m \cdot u_2 - m_1 \cdot u_1 \cdot \frac{1}{h} - Q \cdot \frac{1}{h}$$

$$\Delta m \left(1 - \frac{u_2}{h}\right) = \frac{1}{h}\left(m_1 \cdot u_2 - m_1 \cdot u_1 - \frac{1}{a}\right)$$

$$\underline{\Delta m} = \frac{1}{83.96} \cdot \left(5755 \cdot 292.95 - 5755 \cdot 418.94 - \frac{1}{-35 \cdot 10^3}\right) \cdot \frac{1}{1 - \frac{292.95}{83.96}}$$

$$= \underline{3969.91kg}$$

e) $\underline{\Delta S} = S_2 - S_1 =$

$m_2 \cdot S_2 - m_1 \cdot S_1$

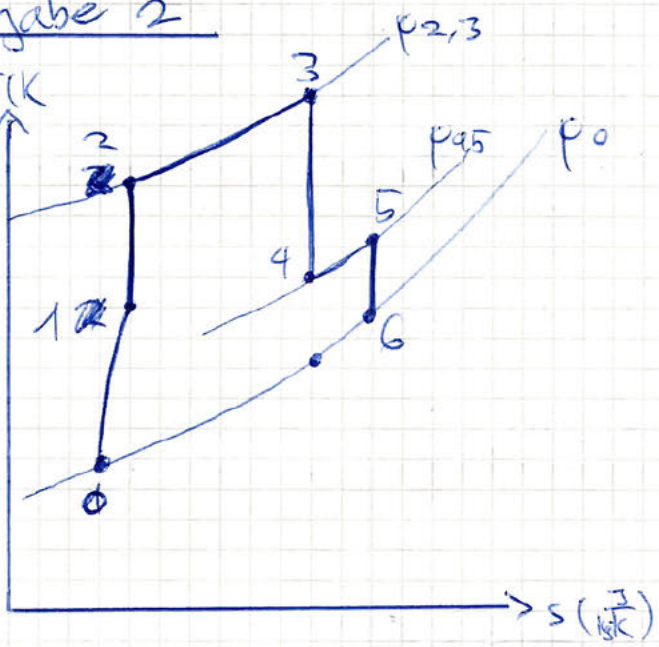
$S_2 = S_f(T_2) = 0.9549 \frac{kJ}{kg \cdot K}$

$S_1 = S_f(T_1) = 1.3069 \frac{kJ}{kg \cdot K}$

$\Rightarrow (5755kg + 3969.91kg) \cdot 0.9549 - 5755kg \cdot 1.3069 = \underline{12.718 \frac{kJ}{K}}$

Aufgabe 2

a)



b) 1. HS Schubdüse:

stationär:

$$Q = \dot{m}_{tot} \cdot \left(h_5 - h_6 + \frac{w_5^2 - w_6^2}{2}\right) - W_t \qquad \text{// isentrop}$$

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

$$w_t = -\int_1^2 v\,dp = -\left(\int_1^2 v\,dp + \Delta ke\right)$$

$$T_6 = T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} \text{ (isentrop)} = 931.9 \cdot \left(\frac{0.191}{0.5}\right)^{\frac{1.4-1}{1.4}} = 328.07\,K$$

$$h_5 - h_6 = c_p (T_5 - T_6) = 1.006 \cdot (931.9 - 328.07) = 104.95 \frac{kJ}{kg}$$

$$\Rightarrow \Delta h + \frac{1}{2} w_5^2 - \frac{1}{2} w_6^2 = -\int_5^6 v\,dp - \Delta ke$$

$$\Delta h + \frac{1}{2} w_5^2 - \frac{1}{2} w_6^2 = -\int_5^6 v\,dp - \left(\frac{1}{2} w_5^2 - \frac{1}{2} w_6^2\right)$$

$$\Delta h + w_5^2 - w_6^2 = -\int_5^6 v\,dp$$

$$\Delta h + w_5^2 + \int_5^6 v\,dp = w_6^2$$

$W_5^2 = (220 \frac{m}{s})^2 = 48400 \frac{m^2}{s^2}$, $W_6^2 = (220 \frac{m}{s})^2$

$$\int_5^6 v\,dp = -n \cdot \int_5^6 \rho\,dv = -n \cdot \frac{R(T_6 - T_5)}{1-n}$$

$$R_L = \frac{\bar{R}}{M_L} = 0.287 \frac{kJ}{kg \cdot K}$$

$$-1.4 \cdot \frac{0.287 \cdot 10^3 (328.07 - 431.1)}{1 - 1.4} = -104.297 kJ/kg$$

$\Rightarrow$ [illegible]

$\Rightarrow$ einsetzen

c) $\Delta e_{x,str} = (h_6 - h_0 - T_0(s_6 - s_0) + \Delta ke)$

$h_6 - h_0 = c_p \cdot (T_6 - T_0) = 1.006 \cdot (328.07 - (-30 + 273.15))$
$= 85.93 kJ/kg$

$T_6 = -30 + 273.15 = 243.15$

$s_6 - s_0 = c_p \cdot \ln\left(\frac{T_6}{T_0}\right) - R \cdot \ln\left(\frac{\rho_6}{\rho_0}\right)$

$= 0.301 \frac{kJ}{kg}$

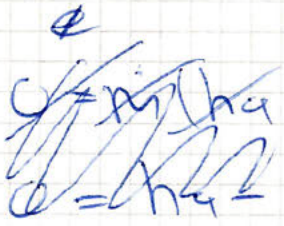
$\Delta ke = \frac{1}{2}(W_6^2 - W_0^2) = \frac{1}{2}(510^2 - 200^2) = 110050 \frac{J}{kg}$

$\underline{\Delta e_{x,str}} = 85.93 kJ/kg - 243.15 (0.301 \frac{kJ}{kg}) + 110050 \cdot 10^{-3} \frac{J}{kg}$

$= \underline{122.29} \frac{kJ}{kg}$

27)

d)



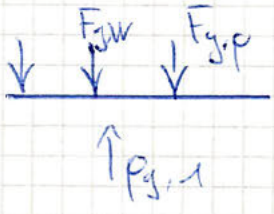
$$0 = -\Delta e_{x,str} + \left(1 - \frac{T_0}{T}\right) \cdot \dot{q} - \cancel{\dot{W}_{vc}} - \dot{W}_c - e_{x,ver}$$

$$e_{x,ver} = -\Delta e_{x,str} + \left(1 - \frac{T_0}{T}\right) \cdot \dot{q} - \dot{W}_c$$

Aufgabe 3

a) $p_{g,1}$:

Kräfteggw. am Membran:



$$A = \left(\frac{d}{2}\right)^2 \cdot \pi \rightarrow \left(\frac{0.01m}{2}\right)^2 \cdot \pi = 0.7854 \cdot 10^{-4}\ m^2$$

$$p_{g,1} \cdot A = m_K \cdot g + 0.1kg \cdot g + 10^5 Pa \cdot A$$

$$\underline{p_{g,1} = 41.0\ bar}$$

$$\underline{m_g} = \frac{p_{1,g} \cdot V_{1,g}}{R_G \cdot T_{g,1}} = \frac{41.0 \cdot 10^5 \cdot 3.14 \cdot 10^{-3}}{0.166 \cdot 10^3 \cdot (500 + 273.15)} = \underline{0.1\ kg}$$

$$R_G = \frac{\bar{R}}{M} = \frac{8.314}{50} = 0.166\ \frac{kJ}{kg \cdot K}$$

b) Ei hat ein ~~kleineres~~ grösseres Volumen

$T_{g2} = 0.003°C$

c) 1. HS:

$$\Delta E_{aas} + \Delta E_{EW} = 0$$

$$m_G(u_2 - u_1) = m_{EW}(u_1 - u_2)$$

$$m_g \cdot c_v (T_2 - T_1) = m_{EW}(u_1 - u_2)$$

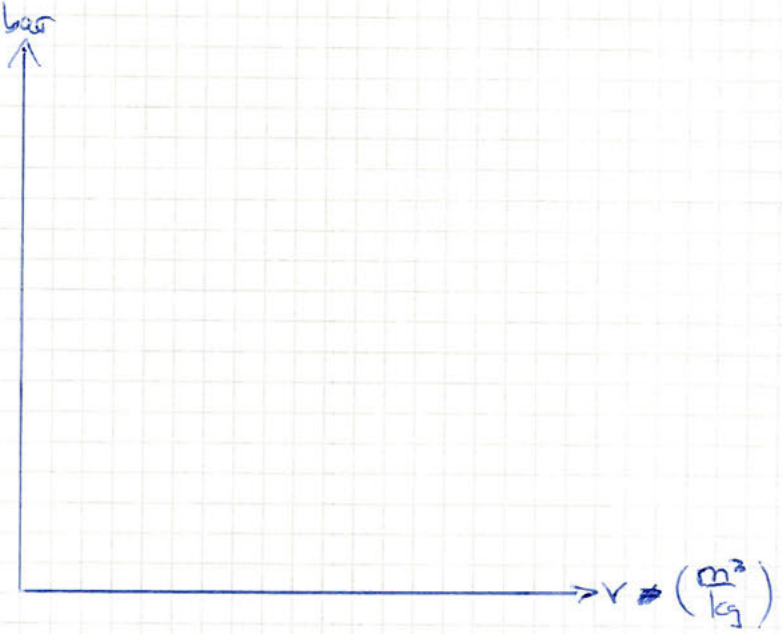
$$\underline{Q} = 0.1kg \cdot 0.633\ \frac{kJ}{kg \cdot K} \cdot (0.003°C - 500°C) = \underline{+31.65\ kJ}$$

a) $\Delta G = 31.65\ kJ$

1. HS.

Aufgabe 4

a)



b) $\dot{m}_{RL3aa}$:

1. HS

c) Drossel isenthalp $\dot{m}_{aa} \rightarrow T$ const