[redacted]

Aufgabe 1:

$m_{ges,1} = 5775\,kg$ $\dot{m} = 0{,}3\,\frac{kg}{s}$ $\dot{Q}_R = 100\,kW$

$T_{aus} = 100°C$ $T_{ein} = 70°C$ $\Rightarrow h_e = 292{,}98\,\frac{kJ}{kg}$ aus A-2

$p_{aus} = 1{,}014\,bar$ $p_{ein} = 0{,}3119\,bar$ $x_D = 0{,}005$

$T_{Reaktor} = 100°C$ $\Rightarrow h_a = 419{,}04\,\frac{kJ}{kg}$ aus A-2

$T_{KF,ein} = 298{,}15\,K$

$T_{KF,aus} = 298{,}15\,K$

a) ~~Die abgegebene Wärme~~

stationärer Fließprozess:

$0 = \dot{m}\left[h_e - h_a\right] + \dot{Q}_R - \dot{Q}_{aus}$

$\dot{Q}_{aus} = 62{,}182\,kW$ $\Rightarrow d_K \neq \frac{\dot{Q}_{aus}}{T}$

b) thermodynamische Mitteltemperatur: $s_e =$

$s(T_2) - s(T_1) = \int_{T_1}^{T_2} \frac{c}{T}\,dT$

c) ~~$0 = \dot{m}\left[s_a - s_e\right] + \frac{\dot{Q}_{aus}}{T} + \dot{S}_{erz}$~~

d) $T_2 = 70°C \Rightarrow \Delta T = 30K$ $\quad \Delta m_{12}$ $\quad T_{ein,77} = 20°C$ Siedend

$Q_R = Q_{aus} = 35 MJ$ $\quad u_f(100°C) = 418,94 \frac{kJ}{kg}$ $\quad u_g(100°C) = 2506,5 \frac{kJ}{kg}$

aus A-2

~~$\Delta E_{zu} = m \cdot (u_2 - u_1) = Q_{aus} \Rightarrow m_{ges} = \frac{Q_{aus}}{\Delta u} = 25,53 kg$~~

$u_1 = u_f + 0,005 \cdot (u_g - u_f) = 429,3779 \frac{kJ}{kg}$

$u_2 = u_f(70°C) = 292,95 \frac{kJ}{kg}$ aus A-2

$u_3 = 93,95 \frac{kJ}{kg}$

$\Rightarrow$ ~~$Q_{zu} =$~~

~~$= m_{ges,1} \cdot u_1 + u_3 \cdot m_{ges} + u_2 \cdot \Delta m_{12} = Q_{aus}$~~

$= (m_{ges} + \Delta m) \cdot u_2 - m_{ges} \cdot u_1 - \Delta m \cdot u_3 = Q_{aus}$

$\Leftrightarrow Q_{aus} - m_{ges} u_2 + m_{ges} u_1 = \Delta m \cdot (u_2 - u_3)$

$$\Delta m = \frac{Q_{aus} - m_{ges} u_2 + m_{ges} \cdot u_1}{u_2 - u_3}$$

$\Delta m = 3559,196 kg$

e) $\Delta S_{12} = m_2 \cdot s_2 - m_1 \cdot s_1$

$\Delta S_{12} = 1227,53 \frac{kJ}{K}$

$s_f(T = 100°C) = s_f + x \cdot (s_g - s_f)$

$s_f(T = 100°C) = 7,3069 \frac{kJ}{kg\,K}$

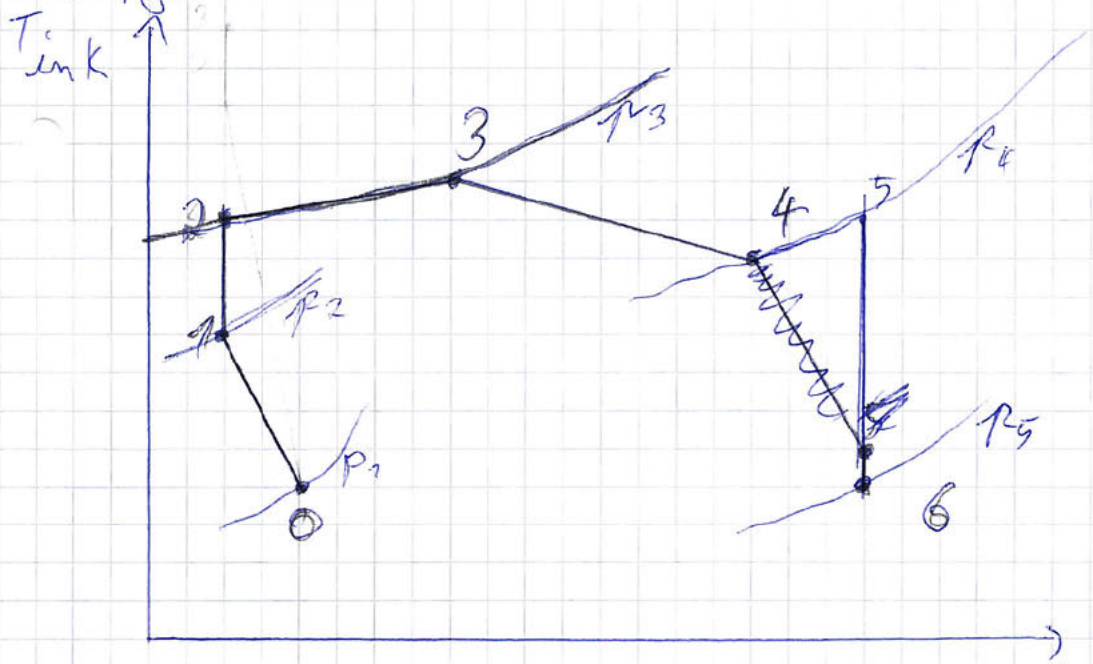
$s_g(T = 100°C) = 7,3509 \frac{kJ}{kg\,K}$

$s_2(T = 70°C) = 0,9549 \frac{kJ}{kg\,K}$

$m_2 = m_{ges} + \Delta m$

$m_1 = m_{ges}$

Aufgabe 2:



b) $w_{Luft} = 200 \frac{m}{s}$ $\quad w_6 = ?$

$p_5 = 0{,}5$ bar $\quad T_5 = 431{,}0$ K

$p_6 = p_0 = 0{,}197$ bar $\quad T_0 = -30°C$ $\quad n = 1{,}4$

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}$$

$$T_6 = T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{0{,}4}{1{,}4}} = 329{,}07\,K$$

adiabat & reversibel $\quad s_5 = s_6$ $\quad c_{p,Luft} = 1{,}006 \frac{kJ}{kg \cdot K}$

1. HS $\quad 0 = \dot{m}\left[h_e - h_a + \frac{w_0^2 - w_a^2}{2}\right]$

$$-w_a = \sqrt{2(h_e - h_a) - w_e^2}$$

$$h_e - h_a = \int_{T_5}^{T_6} c_{p,Luft}\, dT$$

$$-w_a = \sqrt{2 \cdot (c_p \cdot (T_6 - T_5) - w_e^2}$$

$w_e = w_5 = 220 \frac{m}{s}$

$$= c_p \cdot (T_6 - T_5)$$

$$w_a = \sqrt{2 \cdot (c_p \cdot (T_5 - T_6) + w_e^2}$$

$$= 507{,}25 \frac{m}{s}$$

c) $e_{x,ein} = h - h_0 - T_0 \cdot (s - s_0) + \frac{c_0^2}{2}$

$= h_6 - h_0 - T_0 \cdot (s_6 - s_0) + \frac{c_6^2 - c_0^2}{2}$

$c_6 = 507{,}25 \frac{m}{s}$

$c_0 = 100 \frac{m}{s}$

$h_6 - h_0 = \int_{T_0}^{T_6} c_p \, dT = c_p (T_6 - T_0)$ $\quad T_0 = 243{,}15\,K$

$s_6 - s_0 = \int_{T_0}^{T_6} \frac{c_p}{T} dT - R \cdot \ln\left(\frac{p_6}{p_0}\right) = s^\circ(T_6) - s^\circ(T_1) - 0$

$s_0(243{,}15\,K) = s_0(240) + \frac{s^\circ(250K) - s^\circ(240K)}{10K}$

$= 2{,}7033 \frac{kJ}{kg\,K}$

$s_0\ 243{,}15 - 24$

$e_{x,ein} = 133{,}61 \frac{kJ}{kg}$

$s_0(329{,}07\,K)$

$= s^\circ(325) + \frac{s^\circ(330K) - s^\circ(325K)}{5K} \cdot (329{,}07 - 325$

$= 2{,}454 \frac{kJ}{kg \cdot K}$

d) $e_{x,zu} = 100 \frac{kJ}{kg}$

$0 = -e_{x,zu} + \left(1 - \frac{T_0}{T_B}\right) \cdot q_B + e_{x,verl}$

$e_{x,verl} = -e_{x,zu} + \left(1 - \frac{T_0}{T_B}\right) \cdot q_B$

$= 69{,}58 \frac{kJ}{kg}$

~~Aufgabe 3:~~

Aufgabe 7:

a) $T_{g,1} = 500°C$ $V_{g,1} = 3,7\,l$ $c_v = 0,633 \frac{kJ}{kg\,K}$ $M = 50 \frac{kg}{mol}$

$$p_g = p_0 + \frac{m_K \cdot g}{\pi \left(\frac{D}{2}\right)^2} + \frac{m_{EW} \cdot g}{\pi \left(\frac{D}{2}\right)^2} = 1,4\,bar$$

$$p \cdot V = m \cdot R \cdot T$$

$$m = \frac{M \cdot p \cdot V}{R \cdot T} = 3,479\,g$$

d) $\delta q = 0$

$$1500\,J = \Delta Q = q_g \cdot (u_2 - u_1) \cdot m$$

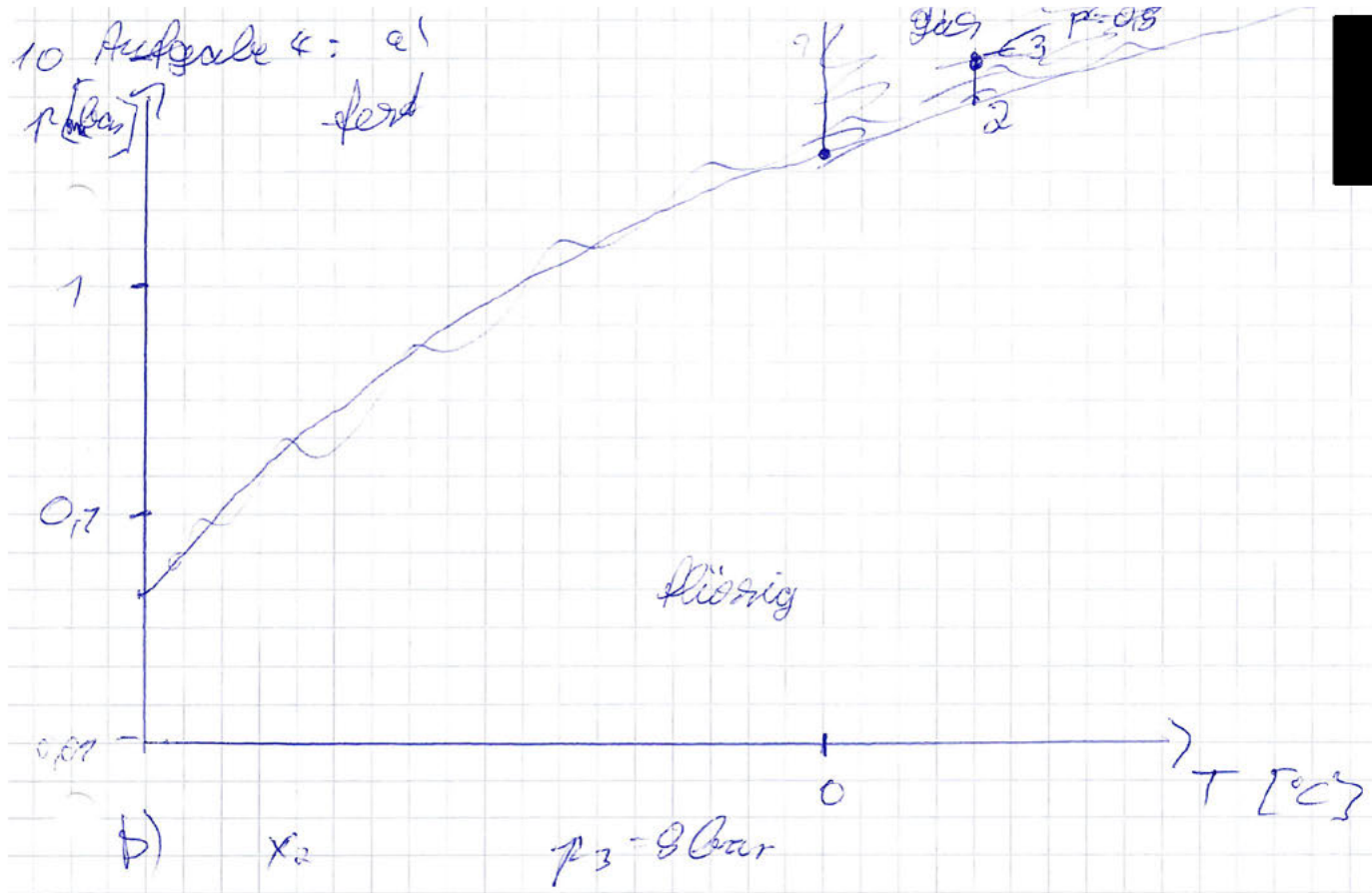
$$u_1 = 2375,3 \frac{kJ}{kg} = 950,12 \frac{kJ}{kg}$$

$$u_2 = \frac{\delta Q}{m} + u_1 = -239,639$$

$$u_2 = u_{fL} + x \cdot (u_f - u_{fL})$$

$$x = 0,7153 = \frac{u_2 - u_{fL}}{u_f - u_{fL}}$$

10 Aufgabe 4: a)



b) x_2 $p_3 = 8\,bar$