Aufgabe 1:

a) $\dot{Q}$ aus

$0 = \dot{m}\,[h_{ein} - h_{aus}] + \dot{Q}_{aus}$

$= \dot{m}\,[h(70°C) - h(100°C)] + \dot{Q}_{aus}$

1 HS am Kühlmantel

$0 = \dot{m}\,[h(288{,}15\,K) - h(298{,}15\,K)] + \dot{Q}_{aus}$

$\dot{Q}_{aus} = \dot{m}_{KF}\,[h(298{,}15\,K) - h(288{,}15\,K)]$

$= \dot{m}_{KF}\; c^{KF}\,(298{,}15\,K - 288{,}15\,K)$

1 HS am Reaktor

$0 = \dot{m}\,[h_{ein} - h_{aus}] + \dot{Q}_R - \dot{Q}_{aus}$

$h_{ein} = 292{,}98 + 0{,}005\,(2626{,}8 - 292{,}98)$ TAB A-2

$= 304{,}64\ \frac{kJ}{kg}$

$h_{aus} = 419{,}04 + 0{,}005\,(2676{,}1 - 419{,}04)$ TAB A-2

$= 430{,}325\ \frac{kJ}{kg}$

$\dot{Q}_{aus} = 0{,}3\ \frac{kg}{s}\,(304{,}64 - 430{,}325)\ \frac{kJ}{kg} + 100\,kW$

$= 62{,}2945\,kW$

b) $\bar{T}_{KF} = \frac{h_a - h_e}{s_a - s_e} = \frac{125{,}68 \frac{kJ}{kg}}{0{,}34824 \frac{kJ}{kg\,K}}$

$= \boxed{360{,}9\ K}$

$s_a = (\text{TAB A-2}) = 1{,}33714 \frac{kJ}{kg\,K}$

$s_e = (\text{TAB A-2}) = 0{,}9889 \frac{kJ}{kg\,K}$

c) $0 = \dot{m}\,[s_e - s_a] + \frac{\dot{Q}_{aus}}{295K} + \dot{S}_{erz}$

$\dot{S}_{erz} = \dot{m}\,[s_a - s_e] + \frac{\dot{Q}_{aus}}{295K}$

$= 0{,}1044 \frac{kJ}{sK} + \frac{65\ kJ}{295\ sK}$

$= 0{,}3248 \frac{kW}{K}$

Aufgabe 2

a)

0 - 1 adiabate Verdichtung $p = 0{,}191$ bar

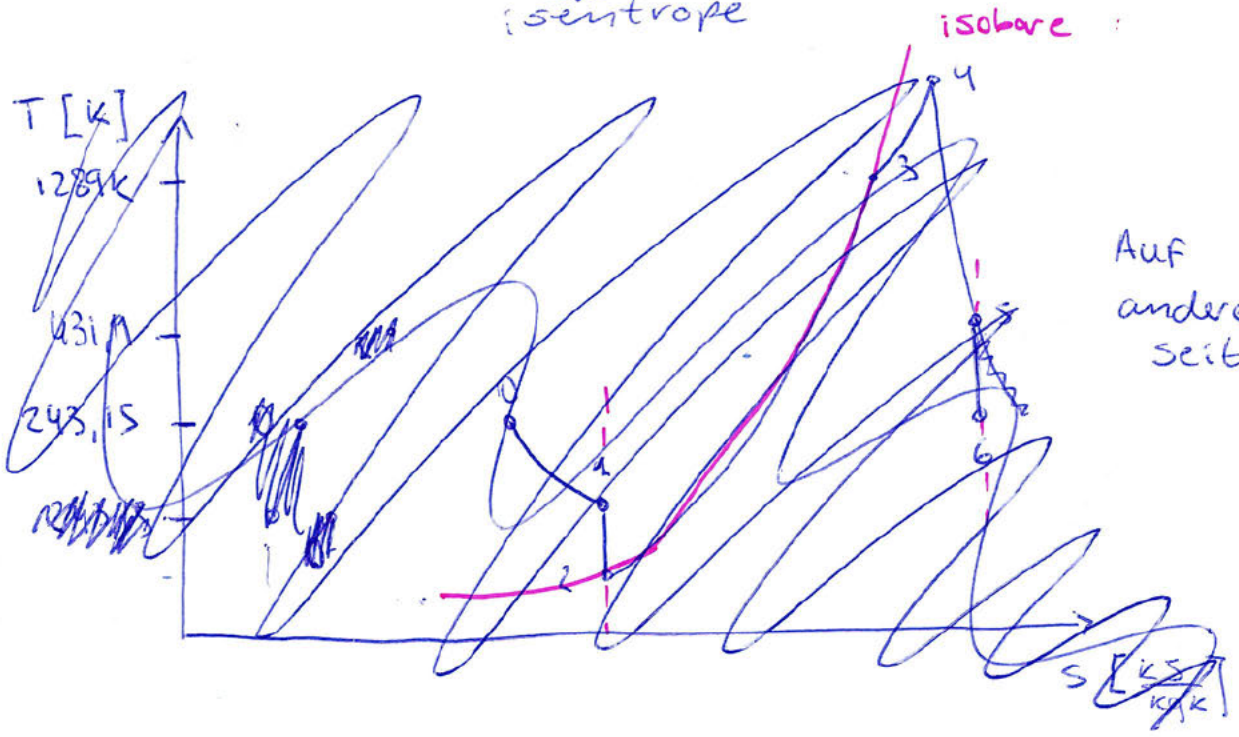
1 - 2 adiabate - reversible Verdichtung
isentrope

2 - 3 isobare Wärmezufuhr

3 - 4 adiabate - irreversible Turbine
Entropie Erzeugung

4 - 5 isobare Mischkammer $p = 0{,}5$ bar

5 - 6 reversible - adiabate Düse $p = 0{,}191$ bar
isentrope



Auf anderer Seite

b) 1. HS am Düse

$$0 = \dot{m}\left[h_e - h_a + \frac{(w_e^2 - w_a^2)}{2}\right]$$

isentrope Düse

$$0 = h_5 - h_6 + \frac{w_5^2 - w_6^2}{2}$$

$$\rightarrow h_5 - h_6 = c_p (T_5 - T_6)$$

$$s_5 - s_6 \overset{!}{=} 0 = c_p \int_{T_6}^{T_5} \frac{1}{T}\, dT - R \ln\left(\frac{p_5}{p_6}\right)$$

$$0 = 1{,}006 \frac{kJ}{kg\,K} \ln\left(\frac{T_5}{T_6}\right) - R \ln\left(\frac{p_5}{p_6}\right)$$

$$R = c_p - \frac{c_p}{n} = 0{,}2874 \frac{kJ}{kg\,K}$$

$p_5 = 0{,}5\ bar \qquad p_6 = 0{,}191\ bar$

$$0{,}276575 \frac{kJ}{kg\,K} = 1{,}006 \frac{kJ}{kg\,K} \ln\left(\frac{431{,}9\,K}{T_6}\right)$$

$$0{,}274925 = \ln\left(\frac{431{,}9\,K}{T_6}\right)$$

$$1{,}316433 = \frac{431{,}9\,K}{T_6}$$

$$\rightarrow T_6 = 328{,}08\,K$$

$$\rightarrow h_5 - h_6 = c_p (T_5 - T_6)$$

$$= 1{,}006 \frac{kJ}{kg\,K} (431{,}9\,K - 328{,}08\,K)$$

$$= 104{,}44 \frac{kJ}{kg}$$

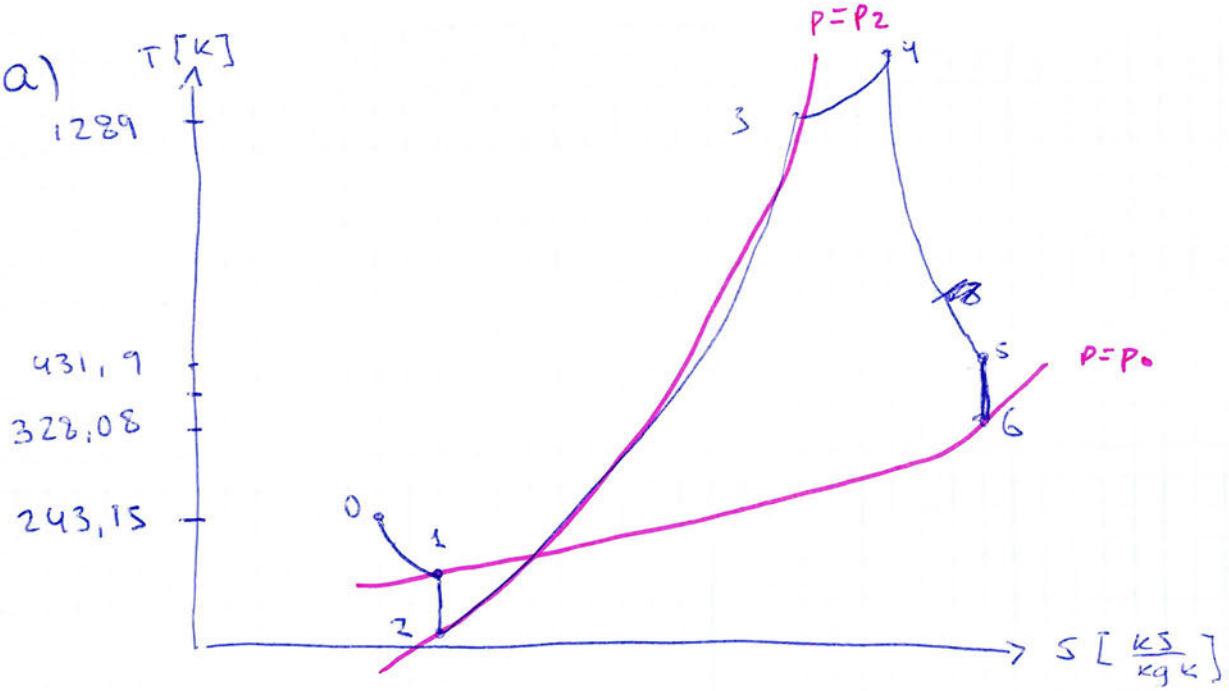
$$-104{,}44 \frac{kJ}{kg} = \frac{w_5^2 - w_6^2}{2}$$

$$w_6^2 = 2\left(\frac{w_5^2}{2} + 104{,}44 \frac{kJ}{kg}\right)$$

$$= 48608{,}88$$

$$\rightarrow w_6 = 220{,}47 \frac{m}{s}$$

a)



c) $\dot{e}_{xstr} = \dot{m} [h_e - h_a - T_0 (s_e - s_a)]$

[redacted]

Aufgabe 3

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

$T_{g,1} = 500°C$ $V_{g,1} = 3{,}14\,L$

$pV = mRT$ $\qquad R = \frac{8{,}314\,\frac{kJ}{kmol\,K}}{50\,\frac{kg}{kmol}} = 0{,}1663\,\frac{kJ}{kg\,K}$

$p_{g,1} \cdot 3{,}14 \times 10^{-3}\,m^3 = m_g \cdot 0{,}1663\,\frac{kJ}{kg\,K} \cdot 773{,}15\,K$

$p_{EW} \overset{!}{=} p_{amb} + m_{kg}/A$

$= 1\,bar + 32\,kg \cdot 9{,}81\,\frac{m}{s^2} / \pi \left(\frac{0{,}1\,m}{2}\right)^2$

$= 1\,bar + 32\,kg \cdot 9{,}81\,\frac{m}{s^2} / \frac{\pi}{400}\,m^2$

$\neq$ ~~$0{,}8\,\frac{N}{m^2}$~~

$= 1\,bar + 0{,}39969\,bar = 1{,}3997\,bar$

$p_g \overset{!}{=} p_{EW} + \frac{m_{EW} \cdot g}{A}$

$= 1{,}3997\,bar + \frac{0{,}1\,kg \cdot 9{,}81\,\frac{m}{s^2}}{\pi/400\,m^2}$

$= 1{,}401\,bar$

$\rightarrow m_g = \frac{1{,}401 \times 10^5\,\frac{N}{m^2} \cdot 3{,}14 \times 10^{-3}\,m^3}{0{,}1663\,\frac{kJ}{kg\,K} \cdot 773{,}15\,K}$

$= 3{,}4215\,g$

b) $x_{Eis} = \frac{m_{Eis}}{m_{EW}} > 0 \longrightarrow m_{Eis} \neq 0$

$T_{EW,2} = T_{g2} = T_{GGW}$

$\Delta E = \sum_j Q_j - \sum_n W_{V,n}$

c) ~~MEMA~~

$Q_{12} = m_g \cdot c_V \cdot \Delta T$

$Q_{12} = 3{,}6\,g \cdot 0{,}633 \frac{kJ}{kg\,K} \cdot (-499{,}997\,K)$

$Q_{12} = -1{,}1394\,kJ$

d) $T_{g,2} = T_{ggw} = 0{,}003°C$

$u_{2EW} =$

[redacted]

Aufgabe 4

b) 1 HS am Verdichter

$$0 = \dot{m}\,[h_2 - h_3] - \dot{W}_K$$

isentrop
$s_2 = s_3$!

$$28\,W = \dot{m}\,[h_2 - h_3]$$

c) $p_4 = p_3 = 8\,bar$

Zustand 4 → vollständig kondensiert

$$h_4 = h_f(8\,bar) = 93{,}42\ \frac{kJ}{kg}$$

Drossel → $h_4 = h_1 = 93{,}42\ \frac{kJ}{kg}$

$T_1 = T_i - 6K$

a)