[redacted]

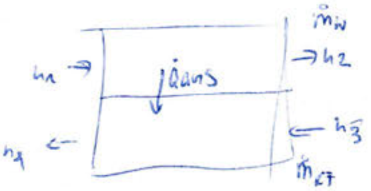
1 a) weiter

$$\dot{Q}_{aus} = \dot{m}(h_1 - h_2) + \dot{Q}_R$$

$$\overset{!}{=} \underbrace{0.3\,(-125.67)\,\frac{kg}{s}\frac{kJ}{kg}}_{\text{aufheizen Strom ein}} + 100\,\frac{kJ}{s} \Rightarrow \boxed{\dot{Q}_{aus} = 62.29\,kW}$$

1b) $$\bar{T}_{KF} = \frac{\int_3^4 T\,ds}{s_3 - s_4} = \frac{\cancel{c_p}\,(T_4 - T_3)}{\cancel{c_p}\,\ln\left(\frac{T_4}{T_3}\right)} = \frac{298.15 - 288.15}{\ln\left(\frac{298.15}{288.15}\right)} \Rightarrow 293.12 = \bar{T}_{KF}$$

1c)

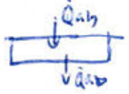


$$-\dot{S}_{erz} = \dot{m}_W\,(s_2 - s_1) + \dot{m}_{KF}\,(s_4 - s_3) + \frac{\dot{Q}_{ab}}{\bar{T}_{KF}}$$ ← aus (a) ← aus B

$$(s_2 - s_1) = s^\circ(T_2) - s^\circ(T_1) - \cancel{R\ln\left(\frac{p_2}{p_1}\right)}^{\,0}$$

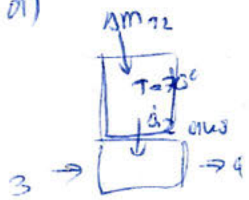
$$(s_4 - s_3) = s^{if}_4(T_4) - s^{if}(T_3)$$

$$\overset{!}{=} c^{if}\cdot\ln\left(\frac{T_4}{T_3}\right)$$



$$\dot{S}_{erz} = \dot{Q}_{ab}\cdot\frac{T_R - \bar{T}_{KW}}{T_R \cdot \bar{T}_{KW}} = 62.29\,kW \cdot \frac{373.14 - 293.12}{373.14 \cdot 293.12} = 48.91\,\frac{W}{K}$$

d)



Energiebilanz in Reaktor / Halboffenes System

$$\Delta E = \Delta m_{12}\,(h_{in}) + \dot{Q}_{2aus,12} \cancel{W}^{\,0} + m_{1}\,(h_{inside}^{\,100°}) - m_{tot}\,(h_{inside\,2}^{\,70°})$$

$$h_{in} = h(20°C) \overset{A2}{=} 83.96\ kJ/kg$$

$$h_{inside} = 430.32\ kJ/kg$$ (aus (a), 100°C) (inkl. x_2)

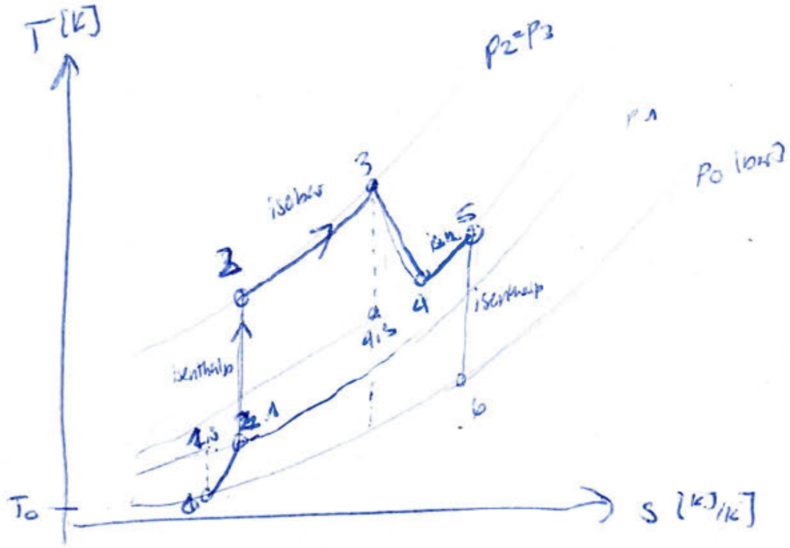
$$\Delta m_{12} = \left(-\dot{Q}_{aus} + m_{tot}\,(h_{inside} - h_{inside\,2})\right) / h_{in}$$

$$\overset{!}{=} \left(-35000\,\frac{kJ}{s} + \left(5755\,kg \cdot (430.32 - 309.64)\right)\right) / 83.96 = 8175.8\ kg$$

[redacted]

② Exergie am Flugzeug Triebw

a) T-s



$c_p = 1.006$

$\kappa = 1.4$

	T [K]	p [bar]
0	243.15	0.191
↓ isentrop $\eta < 1$		
1		
↓ isentrop $\eta = 1$ ~~adiabat~~		
2		
↓ isobar		
3		
↓ $\Lambda \neq 0$		
4		
↓		
5	431.9	0.5
↓		
6	314.48	0.191

[redacted]

plug into Energiebilanz gesamt

$$2\dot{m}(h_6-h_0) = -w_6^2 + w_{Luft}^2 \Rightarrow w_{Luft}^2 - 2\dot{m}(h_6-h_0) = w_6^2$$

$$\sqrt{200^2 \frac{m^2}{s^2} + 2\cdot 5.8 \cdot 71.9} = \boxed{w_6 = 202.07\ m/s}$$

$\dot{m}$ might be wrong
$\Rightarrow$ way too small!

c) $\dot{m}$

$$\Delta e_{xstr} = e_{xstr6} - e_{xstr0}$$

Exergiebilanz

$$\dot{E}_{xstr} = \dot{m}\left(h_6 - h_0 - T_0(s_6-s_0) + \left(\frac{w_{Luft}^2 - w_6^2}{2}\right)\right)$$

$$e_{xstr} = h_6 - h_0 - T_0(s_6-s_0) + \frac{w_{Luft}^2 - w_6^2}{2}$$

$$e_{xstr} = 71.9 - 293.15\overbrace{(s_6-s_0)}^{0.362} + \left(\frac{200^2 - 510^2}{2}\right)$$

$$\overset{!}{=} 96{,}8656\ kJ/kg \cdot s$$

$$s_6 - s_0 \overset{ig}{=} s^\circ(T_6) - s^\circ(T_0) - \cancel{R\ln\left(\frac{p_0}{p_0}\right)} \to 0$$

$$= c_p \cdot \ln\left(\frac{T_6}{T_0}\right) - \cancel{R\ln\left(\frac{p_0}{p_0}\right)} \to 0$$

$$\frac{c_p}{c_v} = n \Rightarrow c_p = n \cdot c_v = 1.4 \cdot 1.006 \overset{!}{=} 1.4084$$

$$= 1.4084 \cdot \ln\left(\frac{314.95}{293.1}\right) = \boxed{0.362\ kJ/kgK} = s_6 - s_0$$

d) $e_{x,verl} = T_0 \cdot \dot{S}_{erz}$

$$\dot{S}_{erz} = \dot{S}_{Ververd.} + \dot{S}_{Brennkammer} + \dot{S}_{Turbine}$$

$$= \dot{m}_{ges}(s_1-s_0) + \dot{m}_K(s_4-s_3) + \frac{\dot{Q}_B}{T_B}$$

$$:\dot{m}$$

$$s_{erz} = (s_1-s_0) + 1/6.293\,(s_4-s_3) + \frac{\dot{q}}{T_B}$$

$$\dot{m}_{ges} = \dot{m}_K + \dot{m}_H$$

$$\dot{m}_{ges} \overset{!}{=} \dot{m}_K + 5.293\,\dot{m}_K$$

$$\boxed{\dot{m}_K = \dot{m}_{ges} / (6.293)}$$

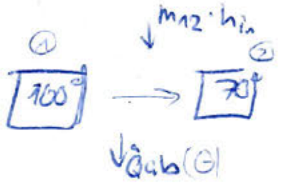
$$(s_1-s_0) = c_p \cdot \ln\left(\frac{T_1}{T_0}\right) - R\ln\left(\frac{p_1}{p_0}\right)$$

$$(s_4-s_3) = c_p \ln\left(\frac{T_4}{T_3}\right) - R\ln\left(\frac{p_4}{p_3}\right)$$

[redacted]

1e) ΔS_{12}

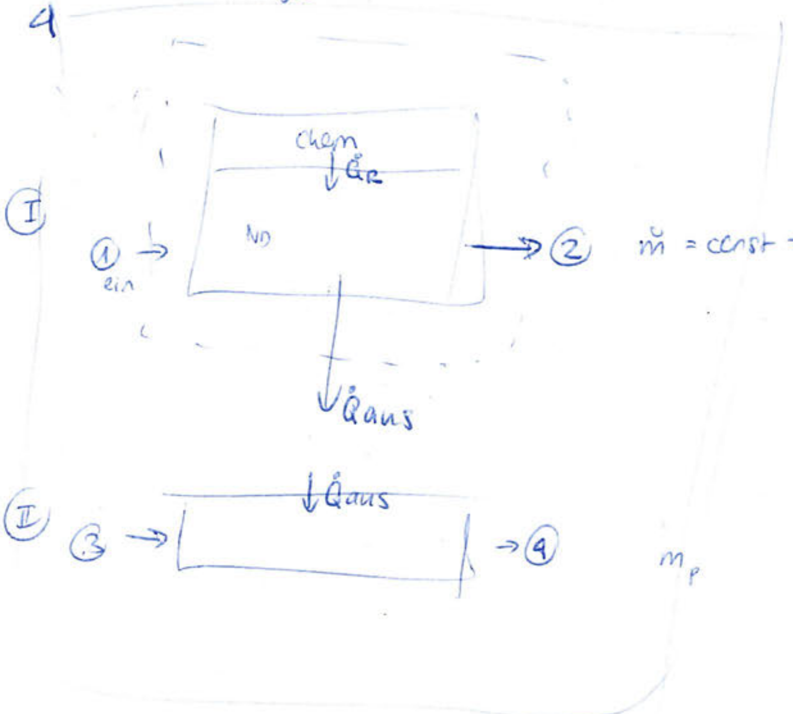
Entropiebilanz



$$\Delta S = \left(m_{tot} + m_{12} \right) s_2 \,(at\ T = 70°) - m_1 s_1\, (at\ T = 100) + \frac{\dot{Q}_{ab}}{T_{KW}} \cancel{\cdot Zeit}$$

Aufg. 1

	T [K]	p [bar]	x
1	343.14		0.005
2	373.14		0.005
3	288.15	p_B	
4	298.15	p_B	



$\dot m = const = 0.3\ kg/s$ $m_{ges} = 577.5$ (stationär)

a) $\dot Q_{aus}$ mit Energiebilanz (I)

$$\boxed{0=\underset{geg}{\dot m}(h_1-h_2)+\dot Q_R-\cancel{\dot W_t}^{\,0}-\dot Q_{aus}}$$

$$(h_1-h_2)^{Wasser} = h_1(T\overset{70°}{=}343.14) - h_2(T\overset{100°}{=}373.14)$$

Dampfanteil $x_1=x_2$

$h_1=h_{f1}+x_1(h_{g1}-h_{f1})$ bei T_1

$h_{f1}=292.98$ $h_{f2}=419.04$ $=x_1=x_2$

$h_{g1}=2626.8$ $h_{g2}=2676.1$ $\boxed{m}$ → $\dot m$

kJ/kg

$h_1=304.649$

$h_2=h_{f2}+x_2(h_{g2}-h_{f2})$

$h_2=430.82$

⇒ Seite 3

[redacted]

3

b) w_6^2 with $5 \to 6$

$$0 = \dot{m}(h_6 - h_5) + \cancel{\dot{Q}_{56}}^{0} + \dot{m}\left(\frac{w_5^2 - w_6^2}{2}\right)$$

$$2(h_6 - h_5) = w_5^2 - w_6^2 \quad \Rightarrow \quad w_6^2 = w_5^2 - 2(h_6 - h_5)$$

$$(h_6 - h_5) = c_p (T_6 - T_5) = 1.006 \cdot (319.4 - 431.9) = -118.25$$

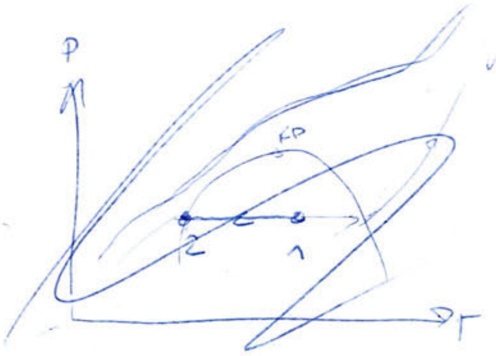
$$w_6 = \sqrt{220^2 - 2 \cdot -118.25} = 220.26 \text{ m/s}$$

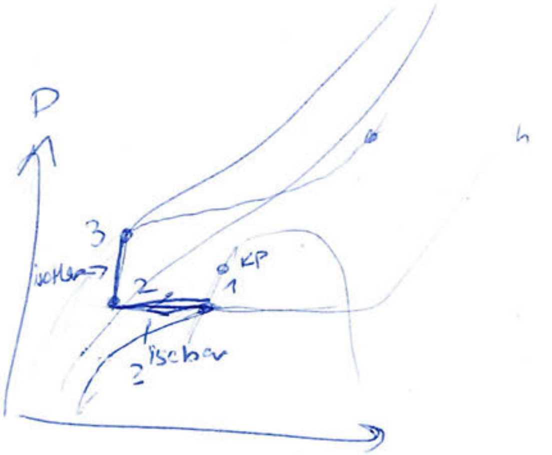
[redacted]

d) $\varepsilon_K = \frac{\dot{Q}_{zu}}{\dot{W}_T} = \frac{|\dot{Q}_K|}{|\dot{Q}_{ab}| + |\dot{W}_K|}$

e) die Temperatur würde die ~~...~~ bei der gleichen Temp wie das Kühlmedium im Gleichgewicht sein. $(T^* = T_i - 6)$
Kalt kann wegen des 2. HS nicht ~~...~~ zu warm übertragen werden.

~~3 ers~~





b) $\dot{m}$. durch ~~Energiebilanz~~ um ~~gesamt system~~ verdichter

~~...~~ $\frac{\dot{W}_K}{\dot{m}} = w_K^{rev}$ $\quad w_K^{rev} = \int_1^2 v\,dp \quad \Rightarrow \dot{m} = \frac{\dot{W}_K}{w_K^{rev}}$

~~Temp Umverdichter:~~

~~$\frac{T_3}{T_2} = \frac{p_3}{p_2}$~~

~~...~~ $\Delta U = \Delta q - w$

c) x_1 direkt nach drossel $\quad T_{verd} = T_1 - 6K =$

$\boxed{T_1 = T_i - 6K}$ $\quad$ $\boxed{4 \to 1 \text{ adiabat}}$

$X = \frac{s_1 - s_{if}}{s_{ig} - s_{if}}$

$\frac{dS}{dt} = \dot{Q}\,\frac{T_H - T_K}{T_H \cdot T_K} = S_{erz}$

$\frac{1}{1 - \frac{Q_{ab}}{Q_{zu}}}$ $\quad \frac{1}{1 - \frac{T_K}{T_H}}$

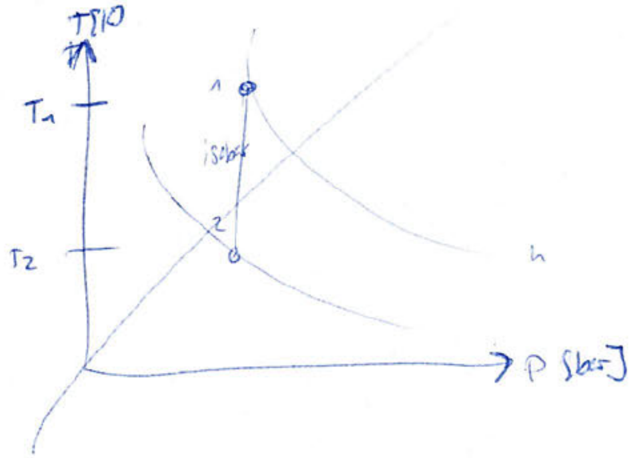
[redacted]

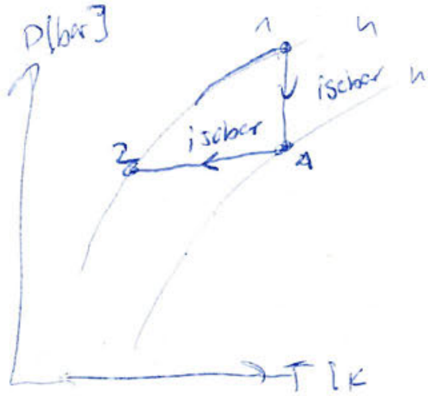
~~(3) Eis~~

~~a) P01~~

(4) TAB A-10

a)





~~b) $\dot{m}_R$ mit Energiebilanz um~~

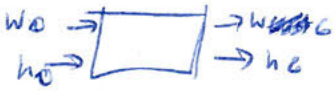
	T K	p
1 NP ~~vap sat~~		
2 vap sat	Austab A10 bei sat	$p_2 = p_1$
3 Vsupeh.	TAB A15 bei 8bar,	8
4 liq sat	31.33	8

[redacted]

b) w_6

Energiebilanz um Gesamtsystem

$w_0 = w_{Luft} = 200 \frac{m}{s}$



$$0 = \dot m \left(h_0 - h_6 + \left(\frac{w_{Luft}^2 - w_6^2}{2}\right) + \cancel{\dot Q}^0 - \cancel{\dot W}^0\right.$$

$$h_0 - h_6 \overset{ig}{=} h(T = 243.14) - h(T = T_6)$$

$$\overset{!}{=} c_p (T_6 - T_0) = 1.006 \cdot (314.4 - 243.14) = \boxed{71.9 \frac{kJ}{kg} = (h_6 - h_0)}$$

$\Rightarrow$ find T_6 via Schubdüse $5 \to 6$

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

$$\overset{!}{=} 431.9 \cdot \left(\frac{0.191}{0.5}\right)^{\frac{0.4}{1.4}} = 314.4 \text{ K} = T_6$$

$\dot m_{ges}$ finden mit ~~...~~ $2 \to 3$, $\dot m_k$

$$\frac{\dot m_H}{\dot m_K} = 5.293$$

Energiebilanz um Brennkammer

$$0 = \dot m_k (h_2 - h_3) + \dot q_B$$

$$(h_2 - h_3) = c_p (T_2 - T_3) = c_p (T_B) = 1.006 \cdot 1289 \, [kJ/kg] \overset{!}{=} 1296.7 \, [kJ/kg]$$

$$\dot m_K = \frac{q_B}{h_2 - h_3} = \frac{1195}{1296.7} = 0.9215 \text{ kg/s}$$

$$\dot m_H = 5.293 \dot m_K = 4.8778 \text{ kg/s}$$

$$\dot m_{tot} = \dot m_K + \dot m_H = 5.799 \text{ kg/s} \approx \boxed{5.8 \text{ kg/s} = \dot m}$$