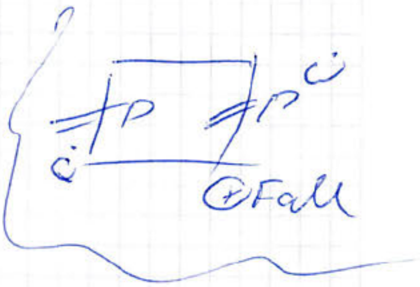
[redacted]

Aufgabe 1



1a) 1. HS: $0 = \dot{m}(h_e - h_a) + \dot{Q} - \cancel{\dot{W}}^{0}$

$\dot{Q}_{ab} = \dot{m}(h_a - h_e)$

$h_a = h_g @ T = 100°C = 2676.1 \frac{kJ}{kg}$

$h_e = h_g @ T = 70°C = 2626.8 \frac{kJ}{kg}$

} TAB A-2

$\dot{Q}_{ab} = 0.3 \frac{kg}{s}\left(2676.1 \frac{kJ}{kg} - 2626.8 \frac{kJ}{kg}\right) = 14.79 \text{ kJ}$

1b)

$$\overline{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e}$$

1c) $\Delta S = \frac{\dot{Q}_{ab}}{T_{KF}} + \dot{S}_{erz}$

$\Delta S - \frac{\dot{Q}_{ab}}{T_{KF}} = \dot{S}_{erz}$

1d) 1. HS Reaktor: $0 = \dot{m}_{12}(h_e - h_a) + \dot{Q}_{aus12} - \dot{W}^{0}$

$h_e = h_g$ @ 20°C TAB A-2: 2538.9 $\frac{kJ}{kg}$

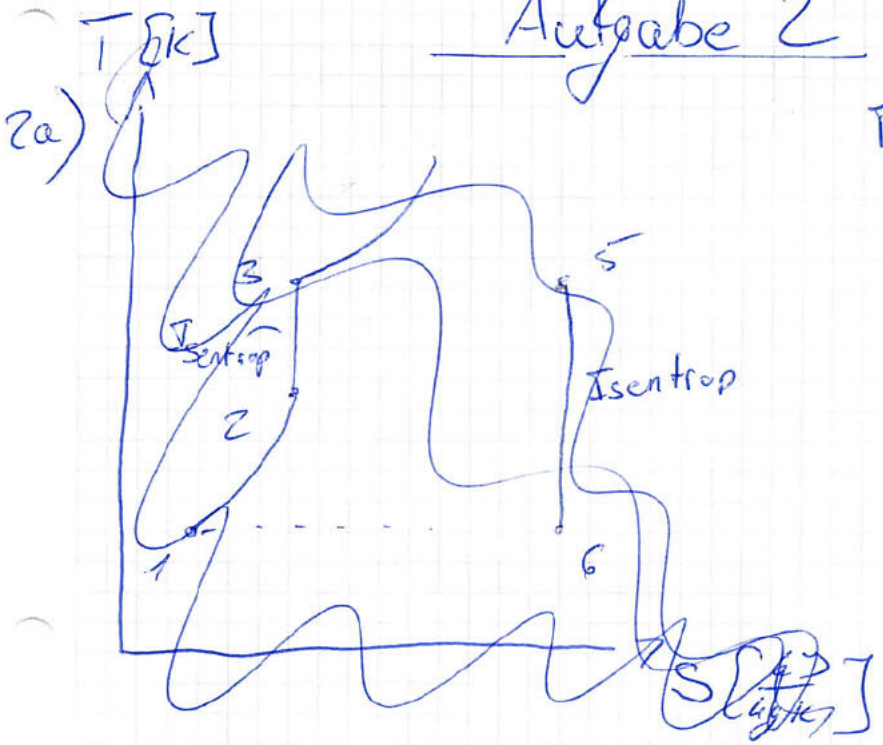
$h_a = h_g$ @ 100°C TAB A-2: 2676.1 $\frac{kJ}{kg}$

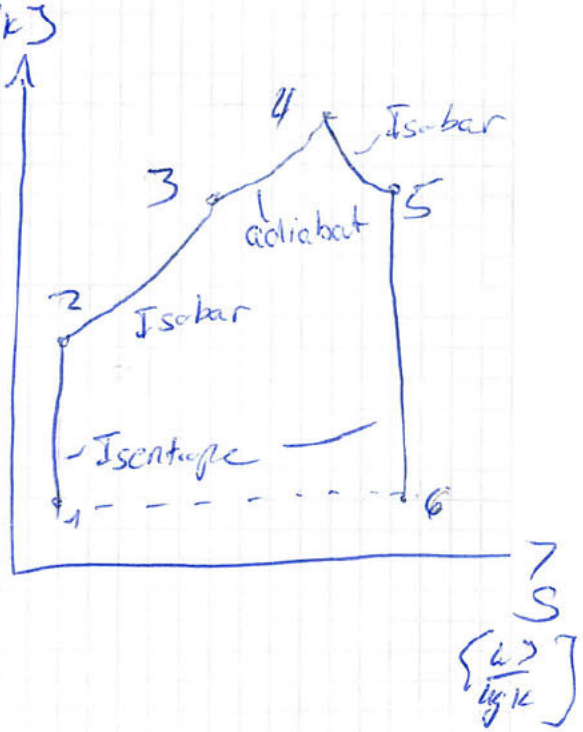
$\dot{m}_{12} = \frac{\dot{Q}_{aus12}}{h_a - h_e} = \frac{35 \cdot 10^6 J}{(2676.1 - 2538.9)\frac{kJ}{kg}} = 0.2551 \frac{kg}{s}$

1e) $\Delta S_{12} = m_2 s_2 - m_1 s_1$

Aufgabe 2

2a)





2b) 1. HS um Triebwerke:

~~$0 = \dot{m}(h_0 - h_6) + \dot{Q} - \dot{W}$~~

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

$$0 = h_0 - h_6 + \frac{w_{ult}^2 - w_6}{2}$$

$$w_6 = 2(h_0 - h_6) + w_{ult}^2 \quad // \; h_6 - h_0 = \int_{T_0}^{T_6} c_p(T)\,dT$$

$\Rightarrow$ T_6 bestimmen um weiter zu machen:

$$T_6 = T_5\left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} = 413.9\,K\left(\frac{0.191\cdot 10^5\,Pa}{0.5\cdot 10^5\,Pa}\right)^{\frac{0.4}{1.4}}$$

$$\underline{T_6 = 328.075\,K}$$

$$\Rightarrow h_6 - h_0 = c_p(T_6 - T_0) = 1.006\,\frac{kJ}{kg\,K}\cdot\left(328.075\,K - 243\,\frac{K}{1.8}\right)$$

$$h_6 - h_0 = 85.43455\,\frac{kJ}{kg}$$

$\Rightarrow \Delta w_G = -85.4355 \frac{kJ}{kg} \cdot 2 + \left(200 \frac{m}{s}\right)^2 =$ ~~39814.56 $\frac{m^2}{s^2}$~~

$= -130871 \frac{m}{s}$ muss aber (+) sein, da gleiche Richtung wie w_e

$\Rightarrow \Delta w_e = 130871 \frac{m}{s}$

2c

$w_G = 510 \frac{m}{s}$, $T_G = 340K$; $R = c_p^{ig} - c_v^{ig}$, $n = \frac{c_p^{ig}}{c_v}$

$c_v = \frac{c_p^{ig}}{n}$

$c_v = \frac{1.006 \frac{kJ}{kgK}}{1.4}$

$c_v = 0.71857$

$\Delta e_{isf} = h_G - h_0 - T_0 (s_G - s_0)$

$s_G^{ig} - s_0^{ig} = \int_{T_0}^{T_G} \frac{c_p(T)}{T} dT - R \ln\left(\frac{p_G}{p_0}\right)$

$= c_p(T)\left(T_G - T_0\right) - R \ln\left(\frac{p_G}{p_0}\right) =$ ~~$1.006 \cdot 10^3 \frac{J}{kgK} (340K - 243.15K)$~~

$- \left(1.006 - 0.7185\right) \frac{kJ}{kgK} \ln\left(\frac{0.191 \cdot 10^5 Pa}{0.191 \cdot 10^5 Pa}\right)$

$= 1.006 \cdot 10^3 \frac{J}{kgK} (340K - 243.15K) = 97443.21 \frac{J}{kg}$

$s_G^{ig} - s_0^{ig} = c_p \ln\left(\frac{T_G}{T_0}\right) = 1.006 \cdot 10^3 \frac{J}{kgK} \cdot \ln\left(\frac{340K}{243.15K}\right) =$

$= 337.27868 \frac{J}{kgK}$

$\Rightarrow \Delta e_{isf} = 85.4355 \frac{kJ}{kg} - 243.15K \cdot 337.27868 \frac{J}{kgK}$

$\Delta e_{isf} = 3426.188958 \frac{J}{kg}$

2d) $e_{x,vol} = T_0 \cdot s_{erz}$

~~$s_{erz} = s_2 - s_1$~~ ~~$s_2 - s_1 = \frac{q}{T}$~~

~~$s_2 - s_1 = q$~~ $s_2 - s_1 = \frac{q}{T} + s_{erz}$

$\left(s_2 - s_1 - \frac{q}{T}\right) = s_{erz}$

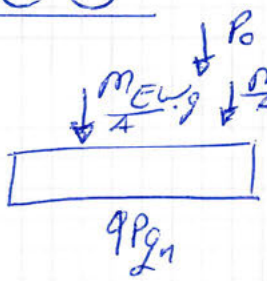
$\Rightarrow \left(s_6 - s_0\right) - \frac{q_B}{T_B} = s_{erz} = 337.27868 \frac{J}{kg\,K} - \frac{1195 \cdot 10^3 \frac{J}{kg}}{1289\,K}$

$= -589.79 \frac{J}{kg\,K}$

$\Rightarrow e_{x,vol} = 243.15\,K \cdot \left(-589.79 \frac{J}{kg\,K}\right) = -143407.4385 \frac{J}{kg}$

Aufgabe 3

3a) p_{g1}: Gleichgewicht



$r = 0.05\,m$

$A = r^2 \pi = 0.05\,m \cdot \pi$

$A = 0.00785\,m^2$

$\Rightarrow p_{g1} = p_0 + \frac{m_{EW}}{A} \cdot g + \frac{m_K}{A} \cdot g$

$= 10^5\,Pa + 0.1\,kg \cdot 9.81\,\frac{m}{s^2} \cdot \frac{1}{A} + 32\,kg \cdot 9.81\,\frac{m}{s^2} \cdot \frac{1}{A}$

$= \underline{140114.78\,Pa}$; (rechne mit anderen Werten wie hier immer jede Aufgabe)

m_g: $pV = mRT$ $\quad R = \frac{\bar{R}}{M} = \frac{8.314\,\frac{J}{mol\,K} \cdot 10^3}{50\,\frac{kg}{kmol}}$

$\frac{p_{g1} V_{g1}}{R \cdot T_{g1}} = m_g$ $\quad R = 166.28\,\frac{J}{kg\,K}$

$\Rightarrow \frac{1.40114.78\,Pa \cdot 3.14 \cdot 10^{-3}\,m^3}{166.28\,\frac{J}{kg\,K} \cdot (273.15 + 50)\,K} = \underline{\underline{3.422\,g}}$

3b

1.HS: $\Delta E = \Delta U = \int_{T_1}^{T_2} c_v^{ig}(T)\, dT$

$\Delta U = m_g c_v^{ig} (T_2 - T_1)$

3c

1.HS um Gas: $\Delta E = \Delta U = Q - W$

~~$Q = \Delta U$~~ $\Delta U = c_p^{ig} (T_2 - T_1)$

$R = c_p^{ig} - c_v^{ig}$

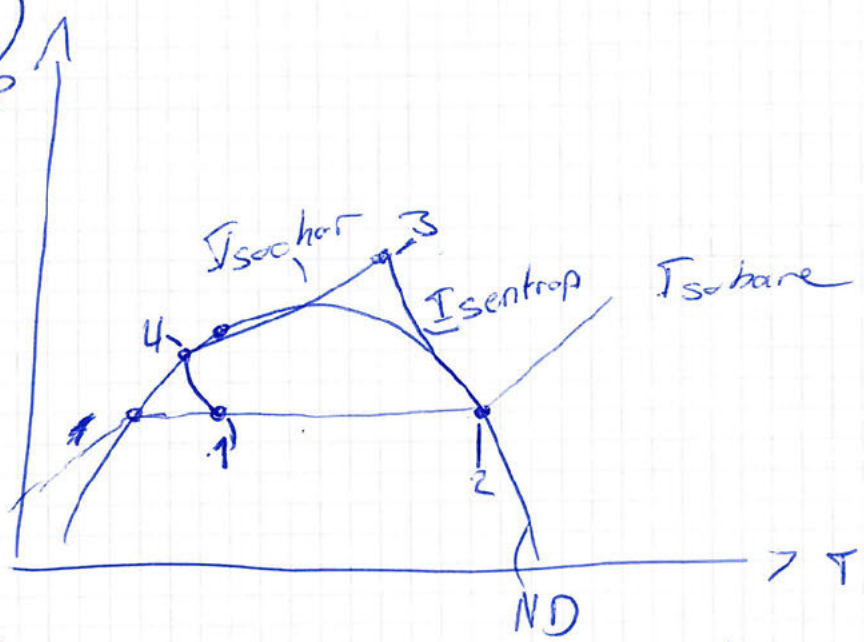
$R - c_v^{ig} = c_p^{ig} = 166.28 \frac{J}{kgK} - 0.633 \cdot 10^3 \frac{J}{kgK} = c_p^{ig} =$

$\Delta U = m_g c_p^{ig} (T_{2g} - T_{1g}) = Q_{12}$

3d

Aufgabe 4

4a)



4b) 1. HS Verdichter: ~~$0 = \dot{m}_R (h_1 - h_2) + \dot{Q}_k - \dot{W}_{12}$~~

$$0 = \dot{m}_R (h_2 - h_3) + \dot{Q} - \dot{W}_{12} \quad ; \; s_2 = s_3$$

~~$h_2 = h_{2g}$ weil $x = 1$~~ $h_2 = h_{2g}$ weil $x = 1$

~~$T_1 = 283{,}15\,K$ $T_2 = 371{,}45\,K$~~

4b) $\varepsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_K|} = \frac{|\dot{Q}_K|}{|W_K|} = \frac{}{28\,W}$

$\dot{Q}_{zu}$: 1. HS f. Wärmeübertrager

$0 = \dot{m}(h_e - h_a) + \dot{Q}_u - \cancel{\dot{Q}_{10}}$

$0 = \dot{m}(h_1 - h_2) + \dot{Q}_u$

$\dot{Q}_u = \frac{\dot{m}}{h_2 - h_1}$

4c) ~~$S_4 = S_{4l}$~~ $S_4 = S_{4g}$ @ $p = 8\,bar$

~~$x =$~~ $S_1 = S_{l1} + x(S_{g1} - S_{l1})$

$x = \frac{S_1 - S_{l1}}{S_{g1} - S_{l1}}$

4c) Die Temperatur würde weiter sinken.
Bei gleichem Druck.