Aufgabe 1: Reaktor:

[redacted]

1a) Wärme

b) $\Rightarrow$ $T_{KF} = \dfrac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)} = \underline{\underline{293.12}}$

from $\int T ds \rightarrow$

from $s_a - s_e$

c) $\dot{S}_{erz}$ = irrev. work

$=$

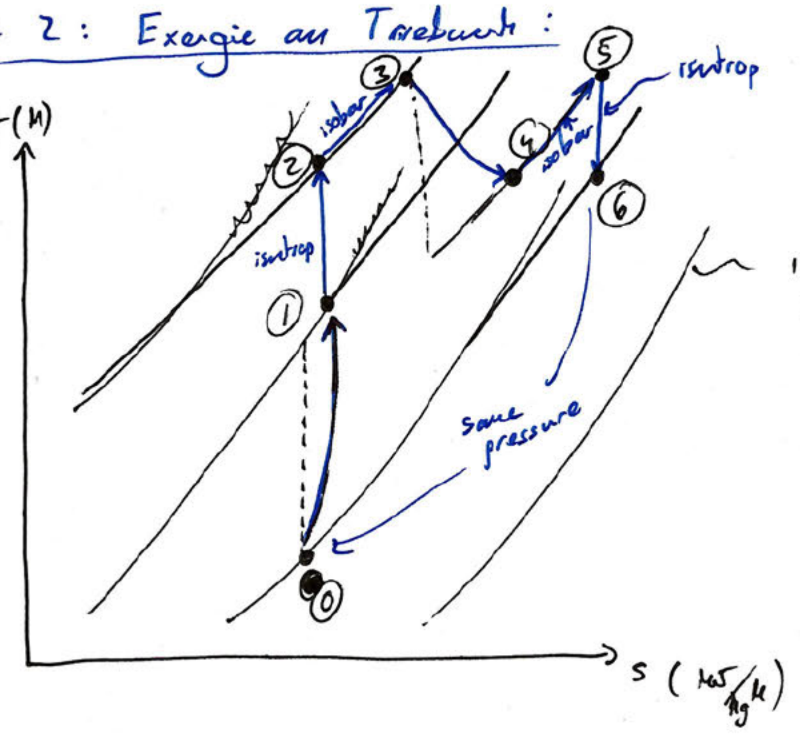
d) stationär,

e) $\Delta S_{12} = m(s_2 - s_1)$

[redacted]

Aufgabe 2: Exergie am Triebwerk:

2a)



isobaren are a little steep, they should probably be more like //

2b)

$w_5 = 220$ m/s $\qquad w_6 = ?$

$p_5 = 0.5$ bar $\qquad p_6 = 0.191$ bar

$T_5 = 431.9$ K $\qquad T_6 = ?$

Schubdüse adiabat + reversibel $\Rightarrow$ isentrop

$\Rightarrow$ ideales Gas: $\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}$ — $n = \kappa = 1.4$

$\Rightarrow T_6 = 431.9 \cdot \left(\frac{0.191}{0.5}\right)^{\frac{1.4-1}{n}}$

$= \underline{\underline{328{,}075 \text{ K}}}$

$\rightarrow$ Energiebilanz: (stationär)

$0 = \cancel{\dot{m}}\left(\underbrace{h_e - h_a}_{c_p(T_6 - T_5)} + \frac{w_e^2 - w_a^2}{2}\right) + \cancel{\dot{Q}} - \cancel{W}$

w_e: 220 m/s; $\dot{Q}$: adiabat; c_p: 1.006; T_5: 431.9; T_6: 328.075

Solve f/ w_a $\Rightarrow$ $\underline{\underline{w_a = }}$

Cont'd $\rightarrow$

2c)

$$\Delta e_x = \dot{m}_{gas}\left[u - u_0 - T_0 (s - s_0) + p_0 (v - v_0)\right] - \left[u - u_6 - T_6 (s-s\right.$$

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

$\Rightarrow \quad e_{x,\,verl.} = T_0 \cdot s_{erz}$

[redacted]

Aufgabe 3 : Perfektes Gas

3a) Pressure consists of weight of fluid + weight + outside pressure :

$$p_{g,1} = \frac{mg}{A} + \frac{m_{EW} g}{A} + p_{amb}$$

$$\left[\begin{array}{l} \varnothing = 10\ cm \\ \quad = 0.1\ m \\ \Rightarrow \underline{A = 0.0314\ m^2} \end{array} \right]$$

$$= \frac{32 \cdot 9.81}{0.0314} + \frac{0.1 \cdot 9.81}{0.0314} + 1\ bar$$

$$= \underline{\underline{1.1002\ bar}}$$

Mass of gas : ideal Gas law $\Rightarrow$ $pV = mRT$

$$\Rightarrow m = \frac{pV}{RT} = \frac{1.10022\ Pa \cdot 0.00314\ m^3}{\frac{8.314 \cdot 10^3}{50} \cdot 773.15\ K} = 0.0027\ kg \Rightarrow \underline{\underline{2.69\ g}}$$

3b) Pressure is equal to $p_{g,1}$ $\Rightarrow$ $\underline{\underline{1.1002\ bar = p_{g,2}}}$ (we still have the same weight pushing down and the system is closed so no gas escapes)

$\rightarrow$ Zustand 2 : Thermodyn. GGW $\Rightarrow$ Equal temp. $T_{2,g} = T_{2,EW}$

~~$\Rightarrow$ Pressure in EW $p_{EW,2}$~~

~~$\rightarrow$ Perfect Gas w/ reversible process (reibungsfrei) $\rightarrow$ polytropic state change~~ $\cancel{\frac{T_2}{T_1} =}$

Cont'd $\rightarrow$

3c) Übertragne Wärmemenge:

→ Energiebilanz: Geschlossenes sys: $\underbrace{\Delta E}_{②} = Q_{12} - \underbrace{W^{rev.}_{V,12}}_{①}$

→①: $W^{rev.}_{12} = \int_{V_1}^{V_2} p_{aussen} \, dV = p_{aussen}(\quad - 0.00314 \, m^3)$

$= p_{g,1}$

V_2 : (using $T_{g,2} = 0.003°C$)

$pV = mRT$

$\Rightarrow V_2 = \frac{m_g R_g T_{g2}}{p_{aussen}}$

$= \underline{1.11 \, L} = 0.00111 \, m^3$

$= \underline{-223.41 \, J}$

②: $\Delta E = m(u_2 - u_1) = m(c_v(T_2 - T_1))$

$= 0.00269(0.633(273.153 - 773.15))$

$= \underline{-851.38 \, J}$

$\Rightarrow \underline{\underline{Q_{12} = -1074.79 \, J}}$

Next page →

3 d) Eisgehalt

Zustand ①: 0.6

Zustand ②: ?

+ ≈ 1075 J Wärme from Gas

Energiebilanz (Geschlossenes Sys): $\Delta E = Q + \cancel{W_{V_{12}}}$ incompressible

$\hookrightarrow \approx 1075\,J$

$\Rightarrow m(u_2 - u_1) = 1075\,J$

0.1 kg

TAB 1: 0°C:

$u_{sol.} = -333.458$

$u_{fl} = -0.045$

$\Rightarrow u_1 = u_{fl.} + x_{Eis}(u_{sol.} - u_{fl.})$

$= -200.0928$

$$\Rightarrow u_2 = \frac{1.075\,kJ}{0.1\,kg} + (-200.0928)$$

$= -189.3448$

$$\Rightarrow u_2 = u_{2,fl} + x_{2,Eis}(u_{2,sol.} - u_{2,fl.}) \quad @\ 0.003°C$$

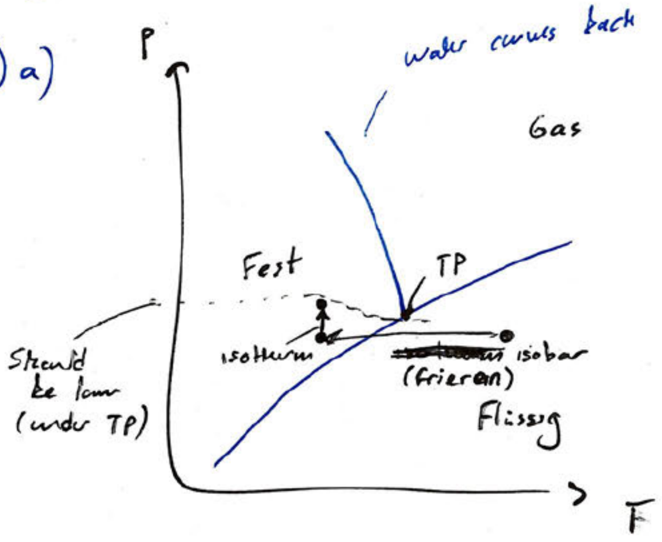
$u_{2,fl} = -0.033$, $u_{2,sol.} = -333.442$, $u_{2,fl.} = -0.033$ → all from TAB 1

$$\Rightarrow x_{2,Eis} = \frac{-189.345 + 0.033}{-333.442 + 0.033} = 0.568$$

[redacted]

Aufgabe 4

4) a)



b)

Energiebilanz um Verdichter: $0 = \dot{m}\,(h_e - h_a) + \cancel{\dot{Q}}^{\,0} - \dot{W}_k$

(stationär)

h_e: Nur Dampf (vollständig verdampft) =>

h_a: Dampf-Flüssig Gemisch (8 bar)

↳ TAB A11: $h_f = 93.42$ kJ/kg
$h_g = 264.15$ kJ/kg

=>

$\dot{W}_k$: 28 W

c) $x = h$

d) $\varepsilon_k = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|}$ → $Q_H - Q_{ab}$; $|\dot{W}_t|$ – 28 W

e) The temperature would go down to absolute 0 and stop there (theoretically, but it gets harder and harder to cool the colder you get)