[redacted]

1)

a)

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

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

Tab A-2

$h_{ein} = 292{,}98 \frac{kJ}{kg}$

Tab A-2

$h_{aus} = 419{,}04 \frac{kJ}{kg}$

$$\dot{Q} = 0{,}3(-419{,}04 + 292{,}98)$$

$$= -37{,}81 kJ$$

c)

$$0 = \dot{m}[s_e - s_a] \frac{\dot{Q}}{T} + \dot{S}_{erz}$$

$$S_{erz} = -\frac{\dot{Q}}{T} + \dot{m}[s_e - s_a]$$

$$= \frac{+37{,}81}{295} + 0{,}3[\ldots]$$

$$= 0{,}022 \frac{kJ}{kgK}$$

$s_{ein} = 0{,}9549 \frac{kJ}{kgK}$

$s_{aus} = 1{,}3069 \frac{kJ}{kgK}$

d)

$$\Delta E = m_2 u_2 - m_1 u_1 = \Delta m_{12}[h_1] + Q_{aus}$$

$$\Delta m_{12} = \frac{m_2 u_2 - m_1 u_1 - Q_{aus}}{h_1}$$

$$=$$

b) $$\bar{T}_{KF} = \frac{\int_e^a T ds}{s_a - s_e} = \frac{\cancel{T(s_e - s_a)}}{s_a - s_e} = \frac{\int_e^a du}{s_a - s_e}$$

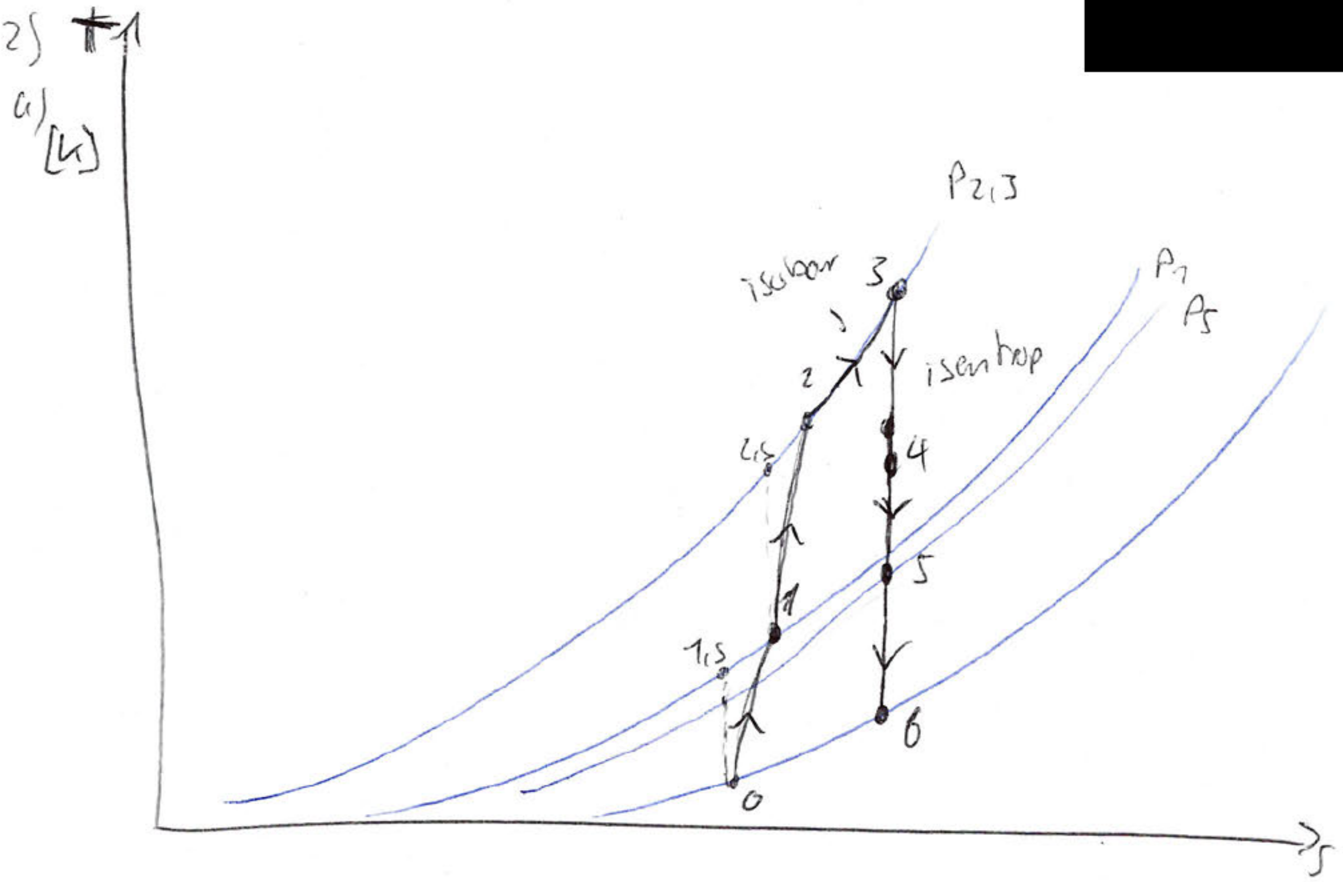
$$= \frac{m(u_a - u_e)}{s_a - s_e}$$

e)

$$\Delta S_{12} = m_2 s_2 - m_1 s_1 = \Delta m_{12} s_i + \frac{Q_{aus}}{\bar{T}_{KF}} + S_{erz}$$

[redacted]

2) a)




b)

~~Exergiebilanz um gesamte Turbine~~

~~$\dot m e_{x,str} = \dot m \left[ h_6 - h_0 - T_0 (s_6 - s_0) + k_e \right]$~~

~~$= \dot m_{ges} [$~~

$T_6 = T_5 \left( \frac{p_0}{p_5} \right)^{\frac{n-1}{n}} = 437{,}94 \left( \frac{0{,}191}{0{,}5} \right)^{\frac{0{,}4}{1{,}4}}$

$= \boxed{328{,}07 K}$

EB um Schubdüse

~~$h_5 = h(437{,}94)$~~

$0 = \dot m_{ges} \left[ h_5 - h_6 + \frac{w_5^2 - w_6^2}{2} \right]$

~~$h_5 = c_p \cdot T_5 = 437{,}9 \cdot 1{,}006$~~

~~$= 434{,}849 \frac{kJ}{kg}$~~

$w_6 = 2\sqrt{c_p (T_5 - T_6) + w_5^2}$

$= \sqrt{2(1{,}006(431{,}9 - 328{,}07\ \ 220^2)}$ $= \boxed{323 \frac{m}{s}}$

c)

$$e_{xst} = \left[h_6 - h_0 - T_0(s_6 - s_0) + ke_6 - ke_0\right]$$

$$= c_p(T_6 - T_0) - T_0(s_6 - s_0) + \frac{w_6^2 - w_0^2}{2}$$

$$= c_p(T_6 - T_0) - T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right) - \cancel{R\ln\left(\frac{p_6}{p_0}\right)}\right) + \frac{w_6^2 - w_0^2}{2} \qquad \overset{0}{\nearrow},\ p_6 = p_0$$

$$= 1{,}006(328{,}07\,K - 243{,}75\,K) - 243{,}75(1{,}006 \cdot \ln\left(\frac{328{,}07}{243{,}75}\right) + \frac{200^2 - 323^2}{2}$$

$$= -77{,}295\,\frac{kJ}{kg}$$

3) [redacted]

a)

ref 1 $P_g = P_{amb} + \frac{4 m_k \cdot g}{D^2 \pi} + \frac{4 m_{ew} g}{D^2 \pi}$ | $A = \frac{D^2}{4} \pi$

$= 1 bar + \frac{4 g}{D^2 \pi} (m_k + m_{ew})$

$= 1 bar + \frac{4 \cdot 9{,}81}{(0{,}7m)^2 \pi} (32kg + 0{,}14 kg)$

$P_g = \boxed{1{,}4 bar}$

$m_g = \frac{P_g V_{v,1}}{\bar{R} \cdot T_{g,1}} M = \frac{1{,}4 bar \cdot 3{,}14 L \cdot 50 \frac{kg}{kmol}}{8{,}314 \frac{kJ}{kmolK} \cdot 773{,}15 K}$

$m_g = \boxed{3{,}43 g}$

b)

$P_{1,g} = P_{2,g}$ da sich gleichung ref 1 nicht verändert

~~da die ma~~

$T_2 = T_1 \left( \frac{P_2}{P_1} \right)^{\frac{n-1}{n}}$ $n = \frac{c_p}{c_v} = \frac{R + c_v}{c_v} = \frac{\frac{\bar{R}}{M} + c_v}{c_v}$

$= 500 (1)^{\frac{0{,}2627}{1{,}2627}}$ $= \frac{\frac{8{,}314}{50} + 0{,}633}{0{,}633} = 1{,}2627$

$\rightarrow 1$

$T_2 = T_1$ da sich der druck nicht ändert bleibt T konstant c)

$$\Delta E = E_2 - E_1 = Q_{12} \qquad m_1 = m_2$$

$$= m_2 u_2 - m_1 u_1 = Q_{12}$$

$$= m_2 c_v (T_{g2} - T_{g1}) \qquad T_{g,2} \text{ aus b)} = 0{,}003°C$$

$$Q_{12} = 3{,}43 g \cdot 0{,}633 \frac{kJ}{kgK} (-500°C + 0{,}003°C)$$

$$\boxed{Q_{12} = -1{,}0856 kJ}$$

d)

$$u_{1EW} = u_{fest} + (1-x_1)(u_{flüssig} - u_{fest}) = u_{fes} + (1-x_1)(u_{flüssig} - u_{fest})$$

$$= -333{,}485 + (1-0{,}6)(-0{,}045 + 333{,}458)$$

$$= \boxed{-200{,}1768 \frac{kJ}{kg}}$$

$$\Delta E = E_2 - E_1 = Q_{12} \qquad u_2 = u_{fest} + (1-x_2)(u_{flüssig} - u_{fest})$$

$$Q_{12} = m_{EW}(u_{2EW} - u_{1EW})$$

$$= m_{EW}(u_{fest} + (1-x_{2EIS})(u_{flüssig} - u_{fest}) - u_1)$$

3) d) continued

[redacted]

$$\frac{Q_{12}}{m_{EW}} = u_{fest} + (1 - x_{2eis})(u_{fl} - u_{fest}) - u_1$$

$$\frac{1}{(u_{fl} - u_{fest})}\left(\frac{Q_{12}}{m_{EW}} - u_{fest} + u_1\right) = 1 - x_{2eis}$$

$$1 - \frac{1}{(u_{fl} - u_{fest})}\left(\frac{Q_{12}}{m_{EW}} - u_{fest} + u_1\right) = x_{2eis}$$

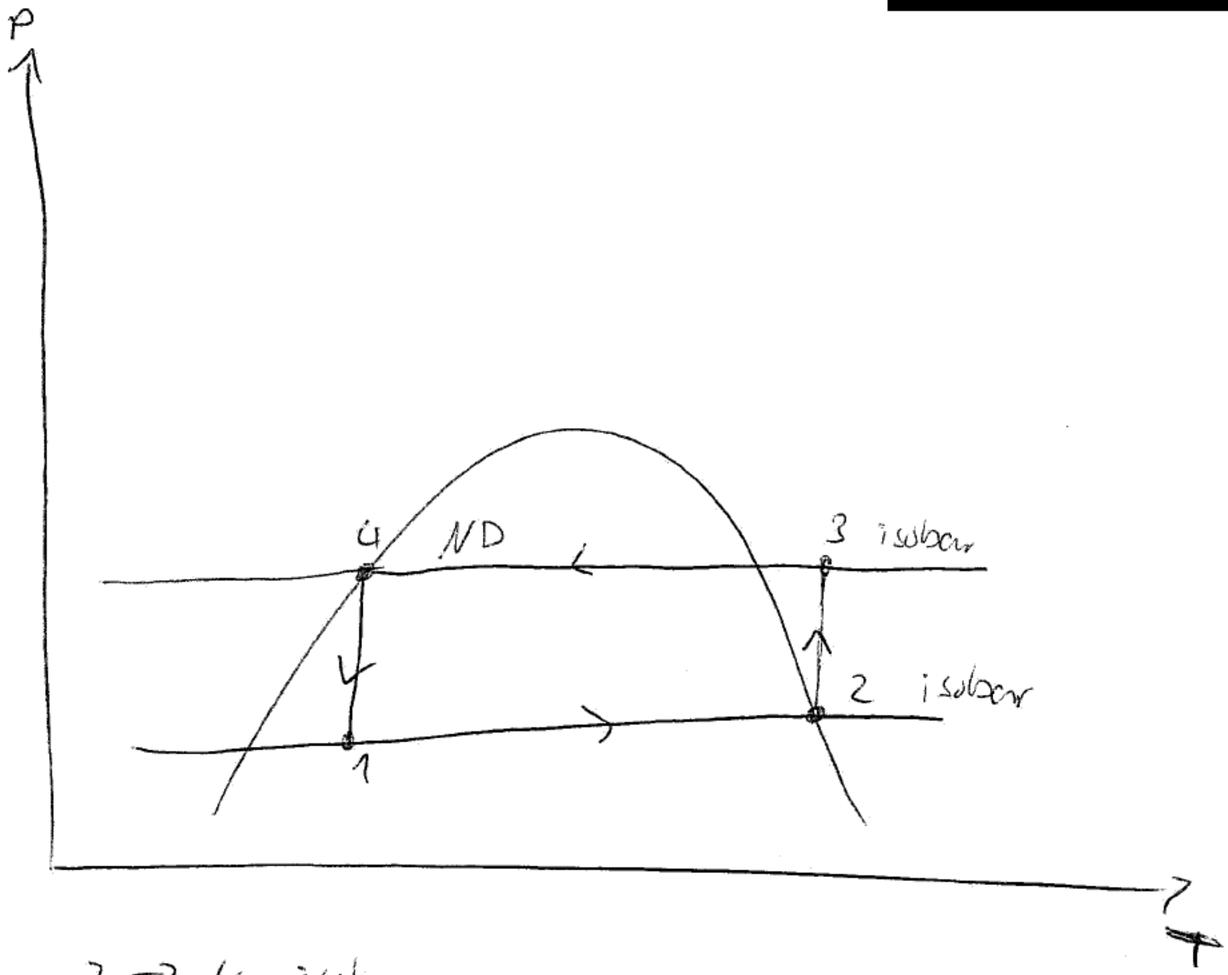
$$x_{2eis} = 1 - \frac{1}{(-0{,}045 + 333{,}485)}\left(\frac{1{,}08564}{0{,}749} + 333{,}458 + 200{,}118\right)$$

$$x_{2eis} = \cancel{\boxed{0{,}6328}} \quad \boxed{0{,}567}$$

[redacted]

4)

a)




3 → 4 isobar

1 → 2 isobar

b)

EB um Kompressor

$\cancel{h_3 = h_2}$ $\underline{\underline{s_3 = s_2 = 0{,}9066 \frac{kJ}{kgK}}}$

$0 = \dot{m}[h_2 - h_3] + \cancel{\dot{Q}}^{0} - \dot{W}_K$

$h_3 = h_g(8 bar) \overset{TAB\ A\text{-}11}{=} \underline{\underline{264{,}15 \frac{kJ}{kg}}}$

$h_2$

EB um ~~Verdampfer~~ drossel

$0 = \cancel{\dot{m}}[h_4 - h_1]$ $\underline{\underline{h_4 = h_1}}$ $\underline{\underline{p_4 = p_3}}$

c) $\dot m_R = \frac{4kg}{h}$ $T_2 = -22°C$ $s_1 = s_4$

TAB A11

$h_4 = h_1$ $h_4 = h_f\ (8bar) = 93{,}42 \frac{kJ}{kg}$

$$x = \frac{h_4 - h_f(P_1, T_1)}{h_g(P_1, T_1) - h_f(P_1, T_1)}$$

$$= \frac{s_4 - s_f(P_1, T_1)}{}$$

d)

$$\varepsilon_K = \frac{|\dot Q_{zu}|}{|\dot W_e|} = \frac{\dot Q_K}{\dot W_K}$$