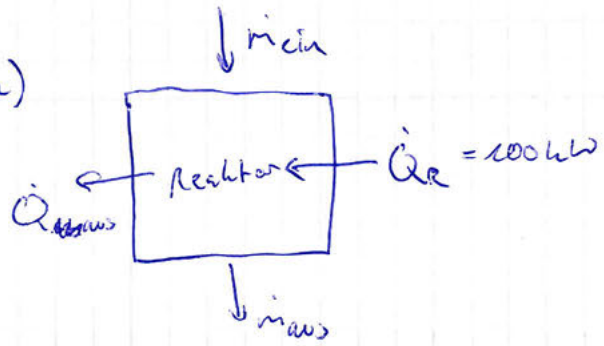
1)

a)



$$\rightarrow 0 = \dot{m}(h_{ein} - h_{aus}) + \dot{Q}_R - \dot{Q}_{aus}$$

$h_{ein} = 292.98 \frac{kJ}{kg}$ (TAB A-2, 70°C)(h_f)

$h_{aus} = h_f(100°C) = 419.04 \frac{kJ}{kg}$ (TAB A-2)

$$\rightarrow \dot{Q}_{aus} = \dot{m}(h_{ein} - h_{aus}) + \dot{Q}_R = \underline{62.182\,kW}$$

b) ~~$\bar{T} = \frac{\int \delta Q}{\int dS}$~~

$$\bar{T} = \frac{T_{aus,a} - T_{aus,e}}{s_a - s_e}$$

$s_a - s_e = c_{aus} \ln\left(\frac{T_a}{T_e}\right)$

~~$\delta Q = \dot{m}_{kw} c_{kw} dT$~~

$$0 = \dot{m}_{kw}(h_e - h_a) + \dot{Q}_{aus}$$

$$\dot{Q} = \dot{m}_{kw} c_{kw} \Delta T + \dot{Q}_{aus}$$

$\dot{Q}$: c_{kw}

$\Delta T = -10\,K$

$$\rightarrow \bar{T} = \frac{\int_e^a T\,ds}{s_a - s_e}$$

fehlt diese angabe in der aufgabenstellung?

c) $$\dot{S}_{erz} = -\left(\dot{m}_{kw} c_{kw} \ln\left(\frac{T_{aus}}{T_{ein}}\right) + \frac{\dot{Q}_{aus}}{295\,K}\right)$$

T_{ein}: vom KF

Zu 1)

d) $m_{ges1} = 5755\,kg$ @ $100°C$, $x = 0.005$

$\rightarrow m_{ges2}$ @ $70°C$, $m_{ges2} = m_{ges1} + \Delta m_{12}$

$\rightarrow m_{2ges} u_2 - m_{1ges} u_1 = \Delta m_{12} + Q_{aus,12}$

$u_1 = 418.95 + 0.005\,(2506.5 - 418.95)$ (TAB A-2, $u_{f,g}$ ← 100°C)

$u_2 = 292.95 + 0.005\,(2465.6 - 292.95)$ ← 70°C

$\rightarrow \Delta m_{12} = \dfrac{m_{1ges}(u_2 - u_1) - Q_{aus,12}}{1 - u_2} = 2501.405\,kg$

e) $s_1 = m_{1ges}\,(1.3069 + 0.005\,(7.3549 - 1.3069))$

$s_2 = m_{2ges}\,(0.9549 + 0.005\,(7.7553 - 0.9549))$

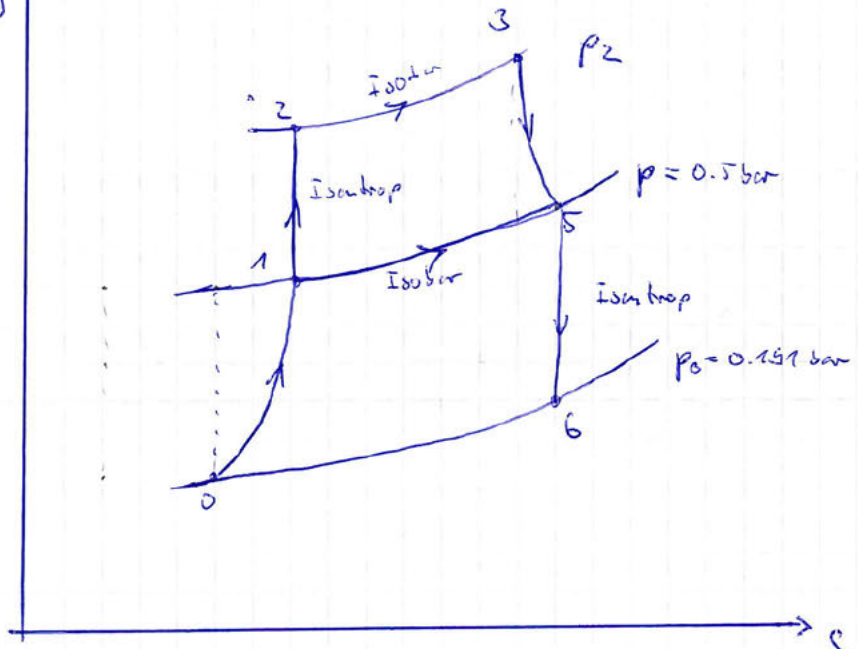
(werte für s_f, s_g aus TAB A-2, für s_1 @ 100°C, für s_2 @ 70°C)

$m_{2ges} = 8256.405\,kg$

$\Delta S_{12} = S_2 - S_1 = 269.53\,\frac{kJ}{K}$

2)

a) T [K]



S $\left[\frac{kJ}{kg\,K}\right]$

b)

$$pv = \frac{\bar{R}}{M_L} T \qquad M_L = 28.57 \frac{kg}{kmol} \quad (\text{TAB A1})$$

1. HS um Schaufeldüse:

$$0 = \dot{m}_L \left(h_5 - h_6 + \frac{w_5^2 - w_6^2}{2} \right) + \dot{Q} - \dot{W}_t \qquad \dot{Q}: \text{adiabat}$$

$$0 = h_5 - h_6 + \frac{w_5^2 - w_6^2}{2} - \frac{\bar{R}}{M_L} \frac{n}{1-n} T_6 - T_5$$

$$T_6 = T_5 \left(\frac{p_6}{p_5} \right)^{\frac{0.2}{1.2}} = 328.07\ K$$

$$w_6 = \sqrt{c_p (T_5 - T_6) + \frac{w_5^2}{2} - 2 \frac{\bar{R}}{M} \frac{(T_6 - T_5)}{1-n}} =$$

c_p: 2

2)

c) $\Delta e_{x,str} = e_{x,str,6} - e_{x,str,0}$

$e_{x,str,0} =$

$$\Delta e_x = h_6 - h_0 - T_0 (s_6 - s_0) + \frac{\omega_6^2 - \omega_0^2}{2}$$

$$= c_p (T_6 - T_0) - T_0 \left(c_p \ln \left(\frac{T_6}{T_0} \right) + \frac{\omega_6^2 - \omega_0^2}{2} \right)$$

h_3

h_3

$T_6, \omega_6 = 340\,K,\ 510\,\frac{m}{s}$

$$= 110065.4\ \frac{J}{kg} = 110\ \frac{kJ}{kg}$$

c)

d) stat. FP: $0 = \Delta e_{x,str} + \underbrace{1 - \frac{T_0}{T} \frac{\dot{Q}}{\dot{m}}}_{=0,\ \text{adiabate Turbine}} - \dot{w}_t - e_{x,verl}$

$$\dot{w}_t = \dot{w}_{turb} - \dot{w}_{ver}$$

$$\dot{w}_{turb} = \underbrace{h_4 - h_5}_{c_p (T_4 - T_5)} + \frac{\omega_{ab1}^2 - \omega_4^2}{2} + q_B$$

3)

a)

$$p_{g,1} = p_{amb} + \frac{1}{A}(m_{kg} + m_{EW} g) = 120053\,Pa = \underline{1.405\,bar}$$

$$A = \pi \cdot (0.05m)^2 = 0.007855\,m^2$$

$$m_g = \frac{p_{g,1} \cdot V_{g,1}}{\bar{R} \cdot T_{g,1}} \cdot M_g = \underline{3.422\,g}$$

b) $T_{g,2} = T_{EW,1} = 0.0\,°C$

$p_{g,2} = p_{g,1}$

→ der druck von aussen ist gleich wie in Zustand 1.

→ da sich immer noch Eis im Wasser befindet, wird alle wärme zum Schmelzen verwandet. Es in gleichgewicht ändert sich die Temperatur & der Eisgehalt nicht weiter.

c) E.bil um Gas

$$\rightarrow \Delta U + W_V = Q_{12}$$

$$\rightarrow m_g c_V (-500\,K) + \int_{V_1}^{V_2} p_g \, dv = -1.367\,kJ$$

$$\int_{V_1}^{V_2} p_g \, dv = p_g (V_2 - V_1)$$

$$V_2 = \frac{m_g \bar{R} T_{g2}}{p_g M_g} = 1.105\,L$$

3) d)

$$U_{EW_1} = m_{EW}\left(u_{fe} + x_{1EW}\left(u_{fl} - u_{fe}\right)\right) = -13.348\ kJ$$

$$\longrightarrow u_{fe} = -333.458\ \frac{kJ}{kg} \quad \left(T = 1,\ p_{sat} = 1.400\ bar\right)$$

$$u_{fl} = -0.045\ \frac{kJ}{kg}$$

$$\longrightarrow U_{EW_2} = U_{EW_1} + |Q_{12}| = -11.848\ kJ \qquad (|Q_{12}| = 1500\ J)$$

$$\longrightarrow x_{2EW} = \frac{U_{EW_2}/m_{EW} - u_{fe}}{u_{fl} - u_{fe}} = \underline{0.645}$$