[redacted]

a) SFP 1.HS

$$0 = \dot{m}(h_e - h_a) + \sum \dot{Q} - \cancel{\sum \dot{W}}^{\to 0}$$

$$= \dot{m}(h_e - h_a) + \dot{Q}_R + \dot{Q}_{Aus}$$

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

$$h_a = h_2 = h_f(100°C) = 419{,}04 \frac{kJ}{kg} \quad A2$$

$$h_e = h_1 = h_f(70°C) = 292{,}98 \frac{kJ}{kg} \quad A2$$

$$\dot{Q}_{aus} = \dot{m}(h_2 - h_1) - 100kW = -62{,}182 kW$$

Da Qaus als

b) $$\bar{T} = \frac{\int T ds}{s_2 - s_1} = \frac{Q}{s_2 - s_1} = \frac{65 kW}{s_2 - s_1} = \frac{\cancel{m}c_p(T_2 - T_1)}{\cancel{m}c_p \ln(T_2/T_1)}$$

1.HS $Q = \Delta H$

$$dS = \frac{\delta Q}{T}$$

$$\bar{T} =$$

~~s2~~

c) 2.HS . SFP

$$0 = \cancel{\dot{m}(s_e - s_a)}^{\to 0} + \sum \frac{\dot{Q}}{T_j} + \dot{S}_{erz}$$

$$\dot{S}_{erz} = -\sum \frac{\dot{Q}}{T_j} = \frac{Q_{aus}}{T_{KF}} - \frac{Q_{aus}}{T_{Reaktor}}$$

$$= \frac{65 kJ/s}{343K} - \frac{65 kJ/s}{373{,}15K}$$

$$= 0{,}0461\,5 \frac{kJ}{K}$$

d) 1.HS halboffenes System

$$\Delta E = m_2 u_2 - m_1 u_1 = \sum \Delta m_i h_i + \cancel{\sum Q}^{\to 0} \cancel{\sum W}^{\to 0}$$

$$(m_1 + \Delta m) u_2 - m_1 u_1 = \Delta m h_e$$

~~$u_1 = u_f(100°C$~~

$$m_1 u_2 + \Delta m u_2 - m_1 u_1 = \Delta m h_e$$

$$\Delta m = \frac{m_1 u_2 - m_1 u_1}{h_e - u_2}$$

$u_2 = u_f(70°C) = \cancel{2\,?5}\ 292{,}95 \frac{kJ}{kg}$ A2 Aufg. 1

[redacted]

$u_1 = u_f(100°C) + x(u_g(100°C) - u_f(100°C))$ A2

$= 429{,}38\ kJ/kg$

$h_e = h_f(20°C) = 83{,}96\ kJ/kg$ A2

$\Delta m = 2280{,}88\,kg$

e) Halboffenes System:

$\Delta S_{12} = \cancel{m_2}\ m_2 s_2 - m_1 s_1$

$= (\Delta m_{12} + m_1) s_2 - m_1 s_1$

$s_2 = s_f(70°C) = 0{,}9549 \frac{kJ}{kg \cdot K}$ A2

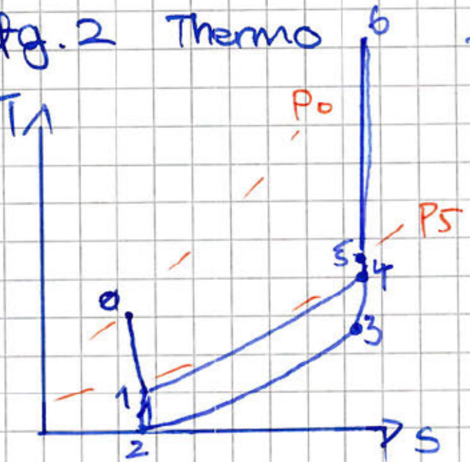
$s_1 = s_f(100°C) = 1{,}3069 \frac{kJ}{kg \cdot K}$ A2

$\Delta S_{12} = (3600\,kg + 5755\,kg)\, s_2 - 5755\,kg\, s_1$

$= \underline{\underline{1412 \frac{kJ}{K}}}$

Aufg. 2 Thermo ~~A~~ [redacted]

a)



b) reversibel adiabat = isentrop

1. HS:

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

$$\hookrightarrow h_e + \frac{w_e^2}{2} = h_a + \frac{w_a^2}{2}$$

isentrop $n = 1{,}4 = \kappa$

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}}$$

$$\hookrightarrow T_2 = T_1 \left(\frac{p_2}{p_1}\right)^{\frac{\kappa-1}{\kappa}}$$

$$T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{\kappa-1}{\kappa}} = 328{,}07\,K$$

$\cancel{h_e - h_a = w_a}$ $\quad h_e - h_a + \frac{w_e^2}{2} = \frac{w_a^2}{2}$

$$w_a = \sqrt{2(h_e - h_a) + \frac{w_e^2}{2}}$$

$$h_e - h_a = h_5 - h_6 = c_p^{ig}(T_1 - T_2) = 1{,}006\,\frac{kJ}{kg}\,(431{,}9\,K - 328{,}07\,K)$$

$w_a =$

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

$$= h_6 - h_0 - T_0(s_6 - s_0) + \Delta ke$$

$$= c_p^{pg}(T_6 - T_0) - T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right) - \cancel{R \ln\left(\frac{p_6}{p_1}\right)}\right) + \Delta ke$$

$$= c_p^{pg}(T_6 - T_0) - T_0 c_p \ln\left(\frac{T_6}{T_0}\right) + \frac{w_6^2 - w_0^2}{2}$$

$T_6 = 340\,K$ $\quad = 121{,}272\,\frac{kJ}{kg}$

$T_0 = 243{,}15\,K$

$w_6 = 510\,m/s$

$w_0 = 200\,m/s$

[redacted]

d) $0 = \dot{m}(\underbrace{h_e - h_a - T_0(s_e - s_a) + \Delta ke + \Delta pe}_{\Delta e_{x,str}}) + \Sigma\left(1 - \frac{T_0}{T_j}\right)\dot{Q}_j - \Sigma \dot{W}_{t,in} - \dot{E}_{x,verl}$

$e_{x,verl} = h_e - h_a - T_0(s_e - s_a) + \Delta ke + \Delta pe$
$+ \Sigma\left(1 - \frac{T_0}{T_j}\right) \cancel{\dot{Q}_j} - \Sigma \cancel{w_{t,in}}$?

In der Brennkammer wird wärme zugeführt

$\dot{m}_K = \cancel{\frac{1}{6{,}293}} \frac{1}{6{,}293} \dot{m}_{ges}$

$\hookrightarrow q_B = \frac{\dot{Q}_B}{\dot{m}_K} = \frac{\dot{Q}_B}{\frac{1}{6{,}293}\dot{m}_{ges}} = 1195 \frac{kJ}{kg}$

q_B auf $\dot{m}_{ges}$ ist $1195 \frac{kJ}{kg} / 6{,}293$

$\overline{T} = 1289K$

$e_{x,verl} = \underset{\uparrow\, 100 kJ/kg}{\Delta e_{x,str}} + \Sigma\left(1 - \frac{293{,}15K}{1289K}\right) \frac{1195 kJ/kg}{6{,}293}$

$= 254{,}073 kJ/kg$

[redacted]

~~Aufg~~)

a) Zylinder hat eine Fläche $A = \pi\left(\frac{d}{2}\right)^2 = 7{,}854 \cdot 10^{-3} m^2$

$p_{1,G} = \frac{mRT}{V}$ wir kennen m & p nicht

$pV = mRT$

d.h $p_{1,G} \cdot A = m_{ew} \cdot g + m_K \cdot g + p_{Atm} \cdot A$

$p_{1G} = \frac{m_{ew} \cdot g}{A} + \frac{m_K \cdot g}{A} + p_{atm}$

$p_{1,G} =$

$m_g = \frac{p_{1G} \cdot V_{g,1}}{R \cdot T_{g,1}}$ $R = \frac{\bar{R}}{M_g} = 0{,}1663 \frac{kJ}{kg \cdot K}$

b)

c) 1.HS geschlossenes System $T_{G,2} = 0{,}003°C$

$\Delta U = Q - W$

$\Delta U_{Gas} = mc_p(T_3 - T_{G1}) = \overset{3{,}6g}{m}\, 0{,}633 \frac{kJ}{kg}(T_{g1} - T_{G1}) = Q - W$

$\Delta U_{wasser} = Q = \Delta U_{gas} = 1{,}14 kJ$

$W =$

d) 1.HSGS $\Delta U = Q - \cancel{W}^{0}$

$Q = \Delta U = mu_2 - mu_1$

$u_1 = u_{Fl} + x(u_{Fe} - u_{Fl}) = -200{,}1168 kJ/kg$

$0°C$

$\hookrightarrow mu_2 = mu_1 + |Q|$

$= 1500 kJ + 0{,}15 kg \cdot (-200{,}1168 \frac{kJ}{kg})$

$= ~~1469{,}982~~ \; -28{,}58 kJ/kg$

Aufg 3

[redacted]

$$u_2 = \frac{\cancel{28}8 - 28{,}518\,kJ/kg}{\underbrace{0{,}15\,kg}_{m}} = -190{,}1168\,kJ/kg$$

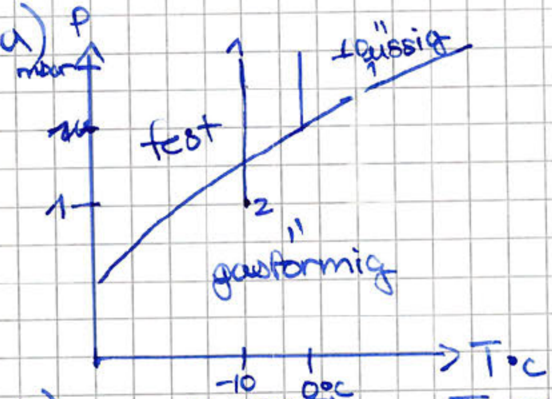
$$x_{Eis,2} = \cancel{u_{Fe}(0{,}003°C) + \frac{u_2 - u_{Fe}(0{,}003°C)}{u_{Fe}(0{,}003) - u_{Fe}(0{,}003°C)}}$$

$$= \frac{u_2 - u_{Fe}(0{,}003°C)}{u_{Fe}(0{,}003°C) - u_{Fe}(0{,}003°C)}$$

$$= \underline{\underline{0{,}570}} \quad 57\%$$

[redacted]

a)



b) ~~$p_1 = 3{,}3765\,bar$ $T_1 = 5$~~

~~$p_2 = 3{,}3765\,bar$~~

$T_1 = -16°C \quad p_1 = 1{,}5748$ A10

$p_2 = 1{,}5748 \quad T_2 = -16°C$

A11/A10

~~SFP $\dot{m}(h_e - h_a) = Q = W$~~

SFP $\dot{m}(h_e - h_a) = \cancel{Q} - W \quad h_a = h_g(8\,bar) = 264{,}15\,\frac{kJ}{kg}$

$W = \dot{m}(h_a - h_e) \quad h_e = h_g(-16°C) = 237{,}74\,\frac{kJ}{kg}$

$\dot{m} = \frac{W}{h_a - h_e} = \frac{0{,}028\,kW}{h_a - h_e} = 1{,}0602 \cdot 10^{-3}\,\frac{kg}{h}$

c) ~~1.HS $\dot{m}(h_e - h_a) = W$~~

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

$h_e = h_a$

$h_f(8\,bar) = h_a = 93{,}42\,kJ/kg$

$x_1 = \frac{h_a - h_f(-16°C)}{h_g(-16°C) - h_f(-16°C)} = 0{,}3076 = 30{,}76\,\%$

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

$\varepsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{Q}_{ab}| - |\dot{Q}_{zu}|}$

$\dot{Q}_{zu} = \dot{Q}_K = \dot{m}(h_a - h_e)$ 208,45 kJ/kg A10

$= \dot{m}(h_{fg}(-16°C))$

$= 4\,kg/h \cdot h_{fg}(-16°C) = 833{,}8\,\frac{kJ}{h}$

$\dot{Q}_{ab} = \dot{m}(h_a - h_e) = \dot{m}(-h_{fg}(8\,bar)) = -738{,}96\,\frac{kJ}{kh}$

$184{,}74\,\frac{kJ}{kg}$ A11

$\varepsilon_K = \underline{8{,}742}$