[redacted]

(1)

$\dot{Q}_{aus} = ?$

$\dot{m}_w [h_{ein} - h_{aus}] \pm \dot{Q}_{aus}$

$\dot{m}_w = \dot{m}_w (h_{aus} - h_{ein})$

im Rührkessel

$s_{ein} = s_f (78°C)$ $\quad s_{aus} = s_f (121°C)$

$m_d = m_{ges} \cdot x \cdot 0.05 = 28.775\,kg$

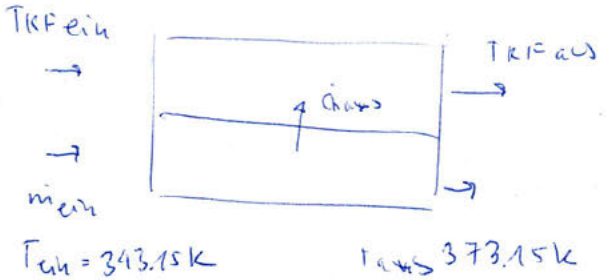
$m_f = m_{ges} (1 - x) = 572623\,kg$

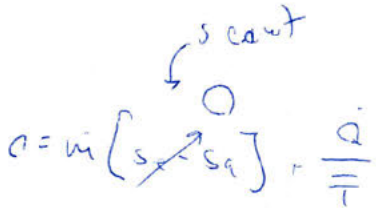
$h_{KF\,ein} - h_{KF\,aus} = c_{KF} (T_{KF\,ein} - T_{KF\,aus})$

$\int_e^a T\,ds = h_{aus} - h_{ein} = \frac{\dot{Q}}{\dot{m}} = 216.6$

b) $\bar{T} = \frac{\int_e^a T\,ds}{s_e - s_a} = \frac{T_{KF\,aus} - T_{KF\,ein}}{\ln\left(\frac{T_{KF\,aus}}{T_{KF\,ein}}\right)} = \underline{293.12\,K}$

c) $\dot{S}_{erz} = ?$





A2 $\begin{cases} s(70°C): & s_f(70°) = 0.9549\ kJ/kg\,K \\ & s_g(70°) = 7.7553\ kJ/kg\,K \end{cases}$

$\left(\frac{\dot{Q}_{aus}}{T_{KF}} - \frac{\dot{Q}_{aus}}{T_W}\right) = \dot{S}_{erz}$

$T_W = 100°C$

$\begin{cases} s(100°C): & s_f(100°C) = 1.3069\ kJ/kg\,K \\ & s_g(100°C) = 7.3599\ kJ/kg\,K \end{cases}$

$= 0.096\ \frac{kJ}{kg\,K}$

(@100°C)

$s = s_f + x\,(s_g - s_f) = 1.33719\ kJ/kg\,K$

---

d) $T_1 = 100°C = 373.15\,K$ $\quad T_2 = 343.15\,K$

$\Delta m = ?$ $\quad T_u = 20°C = 293.15\,K$ $\quad Q_{aus} = 35'000\,kJ$

siedendes Flüssigkeit $\Rightarrow x = 0$

$m_1 = 575\,kg$ $\quad \Delta E = m_2 u_2 - m_1 u_1 = \Delta m\,(h_\Delta) + Q_{aus}$ $\quad m_2 = (m_1 + \Delta m)$

$(m_1 + \Delta m)\,u\,(u_f(70°C) - m_1\,(u_f(100°C)) = \Delta m\,(h_f(20°C)) + Q_{aus}$

$= \Delta$

$= \Delta m\,(h_f - u_f(70°C))$

A2 $\begin{cases} u_f(70°C) = 292.95\ kJ/kg \\ u_f(100°C) = 418.94\ kJ/kg \\ h_f(20°C) = 83.96\ kJ/kg \end{cases}$

$\Delta m = \frac{m_1(u_f 70) - m_1(u_f 100) - Q_{aus}}{h_f - u_f(70°)} = 3637.9\,kg$

e) $\Delta S_{12} = ?$

~~$\Delta S_{12} = m_2 s_2 - m_1 s_1 = \Delta m \cdot s_f(20°C) + \frac{Q}{T} + S_{erz}$~~

$$\Delta S_{12} = m(s_2 - s_1) = \frac{Q}{T} + S_{erz}$$

$s_2 = s_f(70°C) = 0.9549$ kJ/kgK

$s_1 = s_f(100°C) = 1.3069$

$S_{erz} =$

[redacted]

Luft

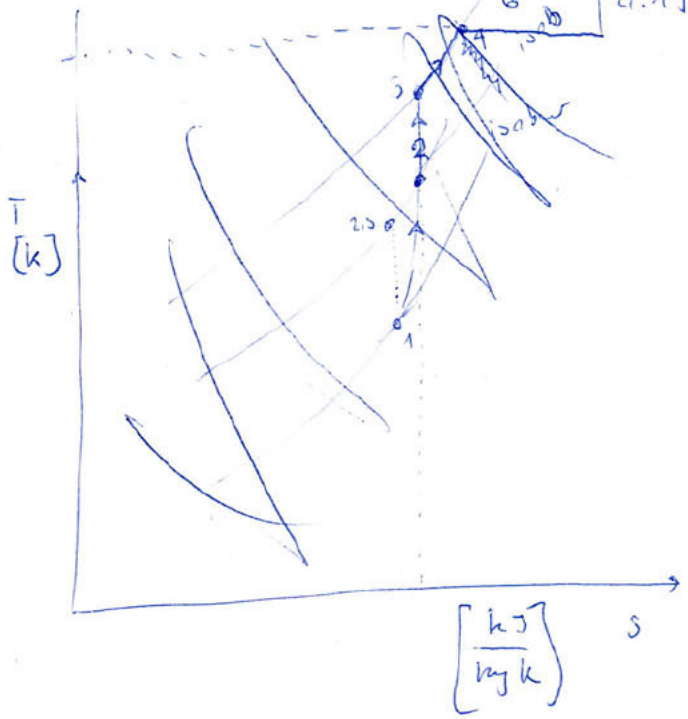
(2)

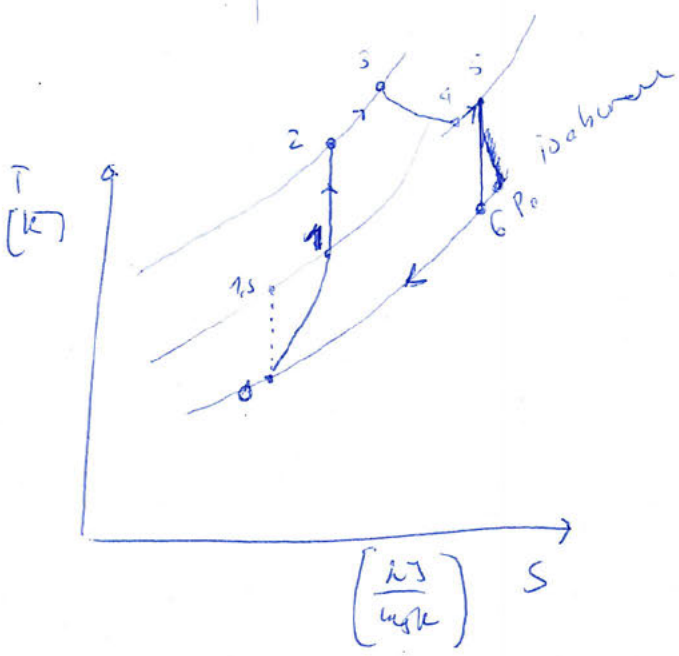
$k = 1.4$

$c_p = 1.006 \frac{kJ}{kg\,K}$

	p	T	w
0	0.191 bar	243.15 K	
1			
2			
3			
4			
5	0.5 bar	431.9 K	220 m/s
6	0.191 bar		

a)





[redacted]

(2)

b) ω_6 T_6 $\omega_5 = 220\ m/s$

EB 5 → 6

$$0 = \dot{m}\left[(h_5 - h_6) + \frac{\omega_5^2 - \omega_6^2}{2}\right] - \dot{W}_{düse} \rightarrow \omega_6 = \ldots$$

~~$\dot{W}^{rev}_{düse} = -\dot{m}\int_1^2 v\,dp$~~

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{k-1}{k}} \Rightarrow T_6 = T_5\left(\frac{p_6}{p_5}\right)^{\frac{k-1}{k}} = \underline{\underline{328.07K}}$$

ExB 5 → 6

$$0 = \dot{m}\left[h_5 - h_6 - T_0(s_5 - s_6)\right] + ~~(1 - \tfrac{T_0}{T})\dot{Q}~~ = \dot{W}_{düse}$$

$$\dot{W}_{düse} = \dot{m}\left[c_p(T_5 - T_6) - T_0\left(c_p \ln\left(\frac{T_5}{T_6}\right) - R \ln\left(\frac{p_5}{p_6}\right)\right)\right]$$

[redacted]

(2)

c) $\omega_6 = 510\ m/s$ $T_6 = 340\ K$

niges

$\Delta ex_{str.} = ex_{str,6} - ex_{str,0}$

$\Delta ex_{str} = \dot{m} \left[h_6 - h_0 - T_0(s_6 - s_0) + (\omega_6 - \omega_L) \right] + (\ )$

$\Delta ex_{str.} = c_p(T_6 - T_1) - T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right)\right) + \omega_6 - \omega_L$

$= 335.42\ \frac{kJ}{kg}$

d) $ex_{verl} = ?$

$0 = ex_{str} - \dot{W} = ex_{verl}$

[redacted]

③

a) $p_{g,1} = ?$ $m_g = ?$ $A = \left(\frac{D}{2}\right)^2 \pi = 0.00785\ m^2$

~~p_g~~

~~F_G~~ $p = \frac{F}{A}$

$p_{g1} = \frac{F}{A} + p_{amb} = $ ~~$40114.8\ Pa$~~ $F = (m_K + m_{Gew})\, g = 314.9 N$

$140114.8 Pa = 1.4 bar$

$m = \frac{p_1 V_1}{R T_1}$ $R = \frac{\bar{R}}{M} = \frac{8.314\ kJ/kmol K}{50\ kg/kmol} = 0.16628 \frac{kJ}{kg K}$

$= \underline{\underline{3.4 g}}$

$p_{2g} = 1.5 bar$

b) $T_{eis_2} = T_{gas_2}$ p_{2g} = gleich wie p_{g1} da Massen von Gas nicht ändert (p0 auch nicht)

$T_{eis_2} = \frac{p_{2g} V_1}{m R}$

~~$V_{gas} = m_{gas} R T_{gas,2}$~~

c) $\Delta E = E_2 - E_1 = Q - W_{V_1}$

$W_V + m(u_2 - u_1) = Q$

$W_V =$

d) $u = u_{f_L} + x(u_{fg} - u_{f_L}) - m_g(u_2 - u_1) + Q = W_v$

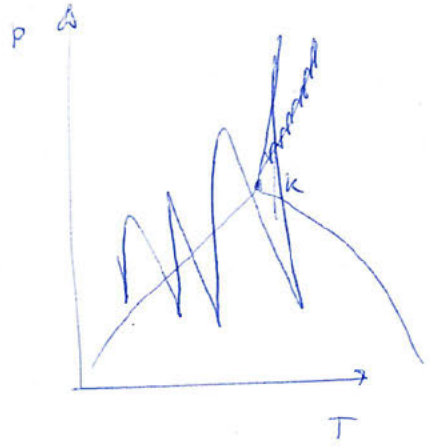
$u(0.003°C) \Rightarrow u_{Fe} = -333.492 \qquad u_{Fe} = -0.033$

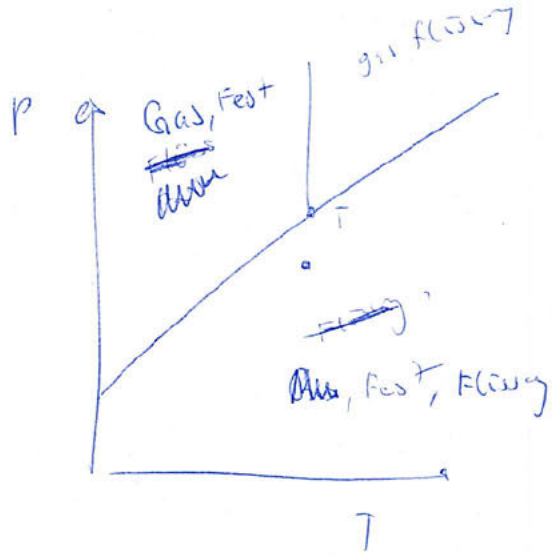
$x_{ej} = \dfrac{u_{mt_2} - u_{f_2}}{u_{g_2} - u_{f_2}}$

[redacted]

a)

e)





Temp Verdampfer = −16 °C

$T_i \rightarrow p_{T_i} = 1\,\text{bar}$

$T_i = -10\,°C$

EB 1 → 2

b) $Q = \dot{m}\,[h_1 - h_2] + \dot{Q}_K$

$= h_2 = h_g(-22) = 234.08\ \text{kJ/kg}$ (A10)

EB 2 → 3

$Q = \dot{m}\,[h_2 - h_3] - \dot{W}_K$

c) $h_1 = h_4$ $\quad h_4 = h_f(\delta_{bar}) = 93.42\ \text{kJ/kg}$ (A11)

$h_f(\ldots)$

$h_g(\ldots)$

$$x = \frac{h_4 - h_f}{h_g - h_f}$$

d)

$$\eta_K = \frac{\dot{W}_{nutz}}{\dot{Q}_{zu}}$$

e) wird Wärme durch die Lebensmittel

auch Wärme beitragen