1a

[redacted]

a $\dot{m}(h_e - h_a) + \Sigma\dot{Q} = 0$ $h_e = 292{,}98\ \frac{kJ}{kg}$

$h_a = 419{,}049\ \frac{kJ}{kg}$

$\cancel{0{,}3\frac{kg}{s}}$

$\dot{m}(h_e - h_a) + \dot{Q}_R = \dot{Q}_{aus} = \underline{\underline{62{,}18\ kW}}$

b $\bar{T} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{\cancel{\quad}}{\cancel{c\ln\left(\frac{T_a}{T_1}\right)}} = \frac{\cancel{(s_a - s_e)}\ \int_e^a T\,ds}{c\ln\left(\frac{T_a}{T_{ein}}\right)}$

$= \frac{c(T_a - T_e)}{c\ln\left(\frac{T_a}{T_e}\right)} = \frac{T_a - T_e}{\ln\left(\frac{T_a}{T_e}\right)} = \underline{\underline{293{,}12\,K}}$

c) $0 = \dot{m}[s_e - s_a] + \frac{\dot{Q}_{aus}}{\bar{T}} + \dot{S}$ $\cancel{s_{e} - s_e - s_a} = c\ln\left(\frac{T_a}{T_{ein}}\right)$

$-\dot{S} = 0{,}3\frac{kg}{s} \cdot \left[0{,}9549\frac{kJ}{kgK} - 1{,}3069\frac{kJ}{kg}\right]$ $s_e = 0{,}9549\ \frac{kJ}{kgK}$

$s_a = 1{,}3069\ \frac{kJ}{kgK}$

$+ \frac{62{,}18\,kW}{293{,}12\,K} \Rightarrow \dot{S} = \underline{\underline{0{,}1\ \frac{kJ}{kgK}}}$

d) $Q_{aus\,12} = 35\,MJ$

$\cancel{m_2 u_2 - m_1 u_1 - \Delta m_{12} h_1}$

Energie Wasser in Kessel Zustand 1

$x \cdot m_{ges} \cdot h_g + (1-x) \cdot m_{ges} \cdot h_f =$

100°

$h_g = 2676{,}1\ \frac{kJ}{K}$

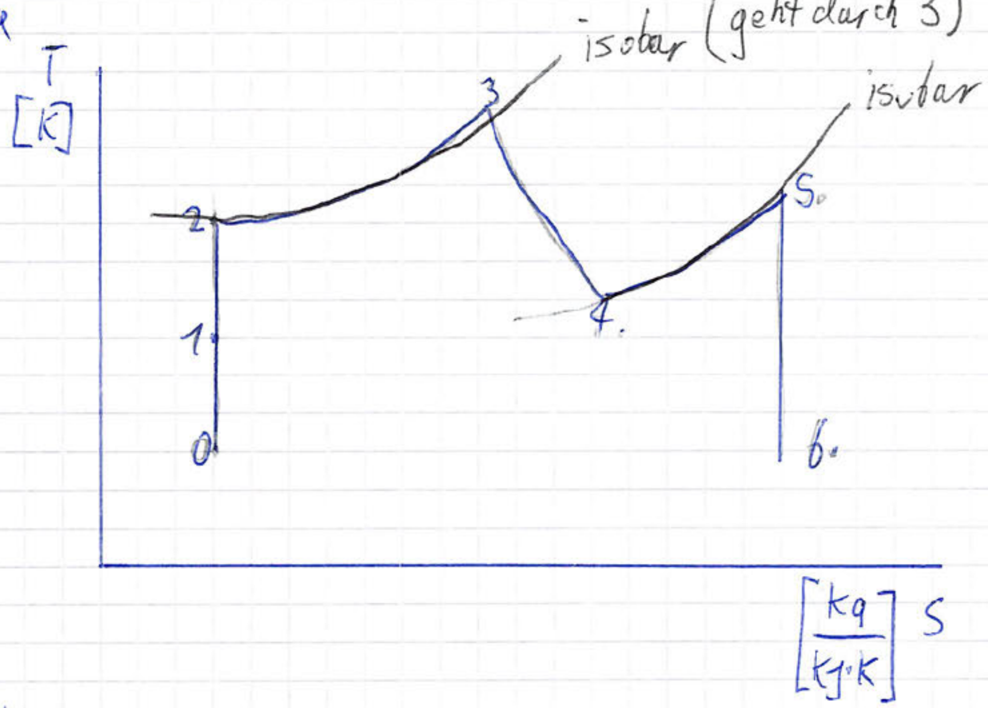
$h_f = 419{,}04\ \frac{kJ}{K}$

$2406988{,}75\ \frac{kJ}{K} = H_{ges\,1}$

$H_{ges\,1}$

2a

[redacted]



b) ges w_6 T_6

$s_5 = s_6$ $p_6 = 0{,}191\,bar$

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} \Rightarrow T_6 = \left(\frac{p_6}{p_5}\right)^{\frac{0{,}4}{1{,}4}} \cdot T_5 = \underline{\underline{328{,}07\,K}}$$

Querschnitt Düse

$V_5 = 220\frac{m}{s} \cdot 1s \cdot A$

[redacted]

3. a) ges. p_{g1} m_g

$$R = \frac{\bar{R}}{M} = 166{,}28 \frac{J}{K\,kg}$$

$$\cancel{p_{g1}} \; \frac{m_{EW} \cdot 9{,}81 m/s^2 + 32 kg \cdot 9{,}81 m/s^2}{(0{,}05 m)^2 \cdot \pi} = 40\,094{,}4 Pa$$

$$p_{g1} = p_{amb} + 40\,094{,}4 Pa = 140\,094{,}43 Pa = \underline{\underline{1{,}4 bar}}$$

$$m_g = \frac{pV}{RT} = \frac{1{,}4 bar \cdot 0{,}00314 m^3}{166{,}28 \frac{J}{kKg} \cdot 773{,}15 K} = \underline{\underline{3{,}4 g}}$$

---

b) $c_p = R + c_v = 799{,}28 \frac{J}{K\,kg}$

Druck bleibt von 1 nach 2 konstant.

$\underline{\underline{p_{g,2} = 1{,}4 bar}}$

$\cancel{c_p \cdot m_g \cdot T_1 T}$

$c_p \cdot m_g \cdot T_{1g} + 0{,}6 \cdot m_{EW}$

$\frac{c_p}{c_v} = n = 1{,}26$

$\cancel{\frac{T_{g2}}{T_{g1}} = p_2}$

Die Temperatur T_{g2} des Gases wird knapp über 0 C° sein, da weiterhin Eis vorhanden ist, und das EWgemisch eine T von ≈ 0°C hat.

3c) $t_{g,2} = 0{,}003°C$ [redacted]

~~$m_g (u_2 - u_1) = Q_{12}$~~

~~$m_g (h_2 - h_1) = Q_{12}$~~

$m_g (h_1 - h_2) = Q_{12}$

$m\, c_p (T_2 - T_1) = -Q_{12} \Rightarrow |Q_{12}| = \underline{\underline{1358{,}7\ J}}$

d) $p_{EW} = \frac{m_K \cdot g}{A} \overset{+p_{amb}}{=} \frac{32kg \cdot 9{,}81 m/s^2}{(0{,}05m)^2 \cdot \pi} = 39969{,}5 Pa + 1bar = \underline{\underline{1{,}399 bar}} \approx 1{,}4 bar$

~~$u = u_f + x_f$~~

$u = u_{flüssig} + x (u_{Fest} - u_{Flüssig}) \Rightarrow x = \frac{u - u_{flüssig}}{u_{Fest} - u_{flüssig}}$

interpolieren

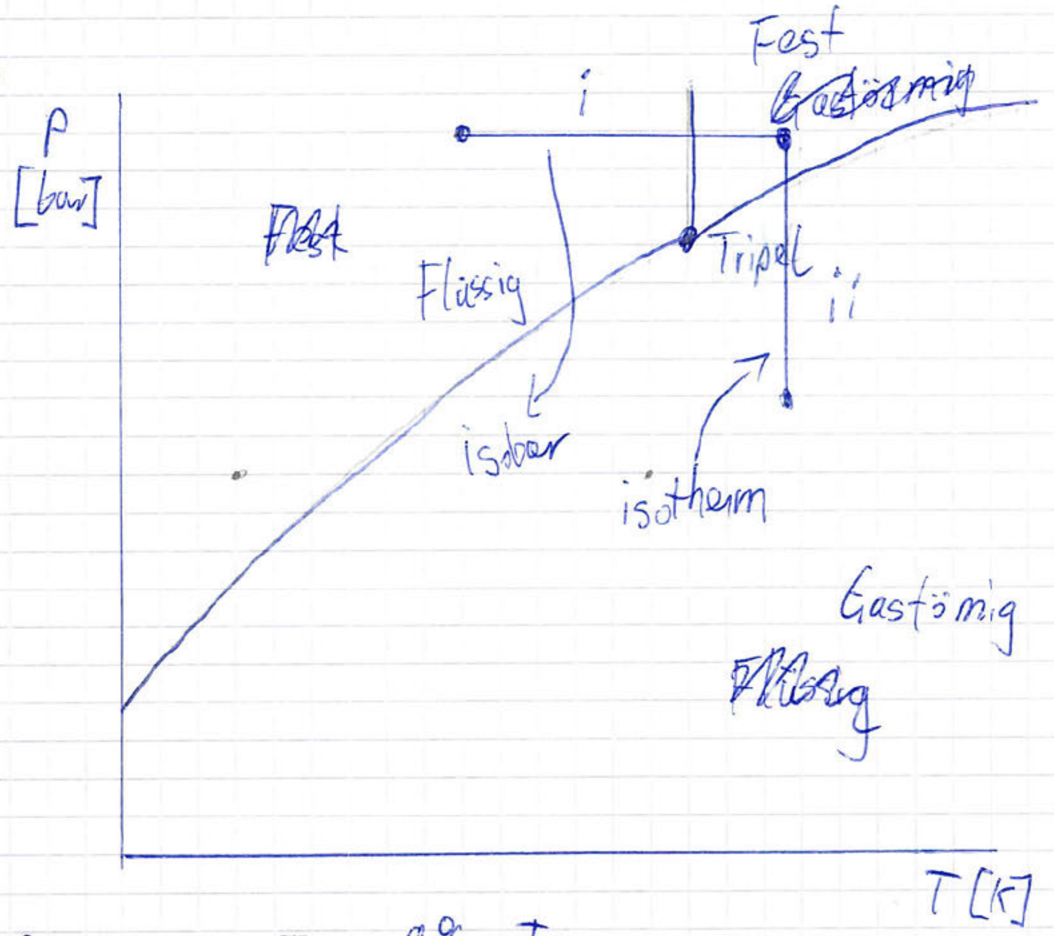
$y = \frac{x - x_1}{x_2 - x_1} (y_2 - y_1) + y_1$

$x_1 = 0{,}003$

$x_2 =$

4. a

[redacted]



b $\dot{m}$ ges   ~~T~~ $9°C = T_i$

T in Verdampfer $= 9°C - 6K = 3°C$ 1. HS um Verdichter

$0 = \dot{m}\left[h_2 - h_3\right] - \dot{W}_k$

$\cancel{\frac{\dot{W}_K}{\dot{m}}}$ $\frac{\dot{W}_k}{h_2 - h_3} = \dot{m}$

h_2 bei $T_2 = -22°C$ vollständig verdampft

$h_2 = \text{bei } -22°C = 234{,}08 \frac{kJ}{kg}$

h_3 aus Tabelle A-12 8bar interpolieren

$y = \frac{x - x_1}{x_2 - x_1}(y_2 - y_1) + y_1$

interpolation zwischen 0°C und 8°C

$y = \frac{x - x_1}{x_2 - x_1}(y_2 - y_1) + y_1$ $y_2 = 249{,}53 \frac{kJ}{kg}$

$y = 248{,}95 \frac{kJ}{kg} = h_2$ $y_1 = 247{,}23 \frac{kJ}{kg}$

$x_1 = 0°C$

$x_2 = 7°C$

$h_3 =$

[redacted]

4.c $T_2 = -22^{\circ}C$

$$s = s_f + x(s_g - s_f)$$

$$\frac{s - s_f}{s_g - s_f} = x$$

~~$s_3 = s_2$ da Verdichtung Isentrop~~

~~s_2 herausfinden durch interpolation zwischen 20 an~~

$$s_2 = 0,9351 \frac{kJ}{kg \cdot K}$$

Drossel = isenthalp

$u_4 = u_2$

$u_4 = 93,42 \frac{kJ}{kg}$

$$u = u_f + x(s_g - s_f)$$

$$x = \frac{u - u_f}{u_g - u_f}$$

u_f und u_g bei Ausgangsdruck

d) $\epsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \underline{\underline{\frac{\dot{Q}_K}{2\,kW}}}$

e) Die Lebensmittel würden weiter Runtergekühlt werden, wenn der Wärmestrom $\dot{Q}_K$ immer konstant bleiben würde, da wäre es am Ende OK kühl