S5 [redacted]

1a) $\dot{Q}_{aus} = \dot{Q}_R - \overset{= 0.3\,kg/s}{\dot{m}_{ein}}(h_{aus} - h_{ein})$

$= \dot{Q}_R - \dot{m}_{ein} = 100\,kW - \overset{42.18}{\cancel{57.8}}\,kW = 57.82\,kW$

$h_{ein} \overset{A\text{-}3}{=} 1267.0\,\frac{kJ}{kg}$

$h_{aus} = 1107.6\,\frac{kJ}{kg}$

b) $\cancel{\bar{T}}$

$\cancel{0 = \dot{m}(s_e - s_a) + \frac{\dot{Q}}{T}}$

$\cancel{\frac{\dot{Q}}{T} = \dot{m}(s_a - s_e)}$

$\cancel{\bar{T} = \frac{\dot{Q}}{\dot{m}(s_a - s_e)}}$

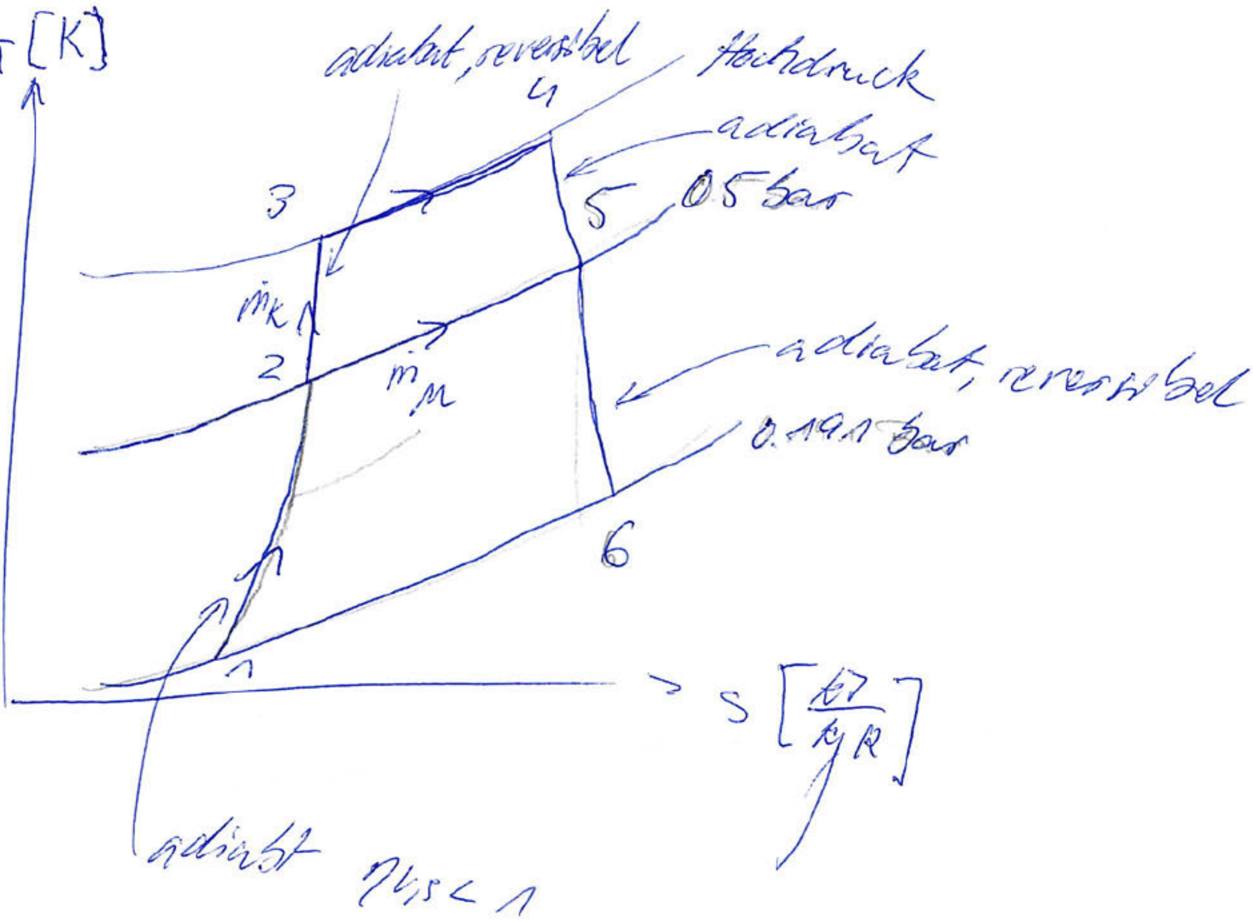
$\bar{T} = \frac{\int_{ein}^{aus} T\,ds}{s_a - s_e} = \frac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)}$

$= 293.112\,K$

c) $\dot{S}_{erz} = \frac{\dot{Q}}{T} = \frac{65\,kW}{295\,K} = 0.22\,\frac{kW}{K}$

S4 [redacted]

a)



b)

$$T_6 = T_5 \left(\frac{p_6}{p_1}\right)^{\frac{1.4-1}{1.4}} = 328.075\,K$$

~~$\Delta KE =$~~

$$\cancel{0 = \Delta m_i \left(h_i + \frac{w_i^2}{2}\right)}$$

$$\cancel{w = \sqrt{2(h_6 - h_5)}}$$

$$\cancel{KE = W = \int_5^6 p\,dV}$$

$$\cancel{\frac{w^2}{2} = \frac{1}{1-n}(T_2 - T_1)}$$

$$ke = e$$

$$\frac{w^2}{2} = c_p^{ig} \cdot \Delta T = 92.95 \frac{kJ}{kg}$$

$$w^2 = 18590 \frac{kJ}{kg} \qquad w_6 = 430 \frac{m}{s}$$

c)

$$\Delta e_{x,str} = e_{x,str,6} - e_{x,str,0} \qquad R_{Luft} = \frac{8.314 \frac{J}{mol\,K}}{28.97 \frac{J}{mol}} = 287.02$$

$$\Delta e_{x,str} = h - h_0 - T_0(s - s_0) + ke$$

$$\Delta e_{x,str,6} = h_6 - h_0 - T_0(s_6 - s_0) + ke_{,6} - ke_{,0}$$

$$= c_p \cdot \Delta T_{6,0} - T_0 c_p \ln\left(\frac{T_6}{T_0}\right) \cancel{- T_0 R \ln\left(\frac{p_6}{p_0}\right)} \quad 0,\ p_6 = p_0$$

$$\cancel{= 1.006 \cdot (340 - 431.9) - (293.15)\left(1.006 \ln\left(\frac{340}{431.9}\right) + 287.02 \ln\left(\frac{0.191}{0.5}\right)\right)}$$

$$\cancel{= 67.126 \frac{kJ}{kg}}$$

$$= c_p\left(\Delta T_{6,0} - T_0 \ln\left(\frac{T_6}{T_0}\right)\right) + ke$$

$$= 1.006 \frac{kJ}{kg\,K}\left(340\,K - (273.15 - 30)\,K - (273.15 - 30)\,K \ln\left(\frac{340}{273.15 - 30}\right)\right)$$

$$= 15.42 \frac{kJ}{kg} + \frac{\left(510 \frac{m}{s}\right)^2}{2} = 145.47 \frac{kJ}{kg}$$

d)

$$e_{x,verl} = e_{x,str,06} + e_{x,q_b} - ke = 100 \frac{kJ}{kg} + 969.582 \frac{kJ}{kg} - 130.05 \frac{kJ}{kg}$$

$$e_{x,q_b} = \left(1 - \frac{T_0}{T}\right) q = 969.582 \frac{kJ}{kg} \qquad = 939.55 \frac{kJ}{kg}$$

$$k_e = 130.05 \frac{kJ}{kg}$$

 [redacted]

3a)

$p_{g,1}$ $\quad m_g$ $\quad m_g = \frac{pV}{RT}$ $\quad R = \frac{\bar{R}}{M_g} = 166.3$

$p_{g,1} = \frac{F_G}{A} + p_{aussen} = 140094\,Pa \approx 1{,}4\,Bar$

$F_g = (m_K + m_{EW}) \cdot g$

$A = (0.05\,m)^2 \pi = 0.00785\,m^2$

$$m_g = \frac{1.40094\,Pa \cdot 3.14 \cdot 10^{-3}\,m^3}{\frac{8314\,\frac{J}{mol\,K}}{50\,g/mol} \cdot (273.15 + 500)\,K} = 3{,}422\,g$$

b) $p_{g,2} = p_{g,1}$, da $p_{g,2} = \frac{F_G}{A} + p_{aussen}$

$T_{G,2} = T_{EW,1}$, da thermodynamisches Ggw entsteht

~~$dU_{EIS} = dQ$~~ und noch nicht alles an Eis geschmolzen ist.

c) ~~$dU_{EIS} = Q_{12}$~~ $\quad m \cdot \Delta u = Q_{12}$

$= m_g \int_{T_1}^{T_2} c_v^{ig}(T)\,dT = Q_{12}$

$= 3.422\,g \cdot 0.633\,\frac{kJ}{kg}\,(500°C - 0.003°C)$

$= 1082.998\,kJ$

 [redacted]

3d) $x_{Eis} = \cancel{\frac{\phi - \phi_f}{\phi_g - \phi_f}}$

$= \cancel{\frac{u_2 - u_f}{u_g - u_f}} = \cancel{\frac{-185.090 \frac{kJ}{kg} + 333.458 \frac{kJ}{kg}}{}}$

Zustand 1

0.06 kg Eis
0.04 kg Wassser

$x_{Eis} = \frac{u_2 - u_{flüssig}}{u_{Fest} - u_{flüssig}} = \frac{-185.090 + 0.045}{-333.458 + 0.045} = 0.555$

$U_1 = -333.458 \frac{kJ}{kg} \cdot 0.06 kg - 0.045 \frac{kJ}{kg} \cdot 0.04 kg = -20.009 kJ$

$Q_{12} = \Delta U = U_2 - U_1$

$U_2 = Q_{12} + U_1 = 15007 - 20009 J$
$= -18.509 kJ$

$u_2 = \frac{U_2}{m} = -185.090 \frac{kJ}{kg}$

4c) ges.: x_1

An: $h_4 = h_g(8bar) = 264.71 \frac{kJ}{kg}$

$\dot{m} = \frac{4kg}{h}$

$x_1 = \frac{s_4 - s_{1g}}{s_{1g} - s_{1,f}}$

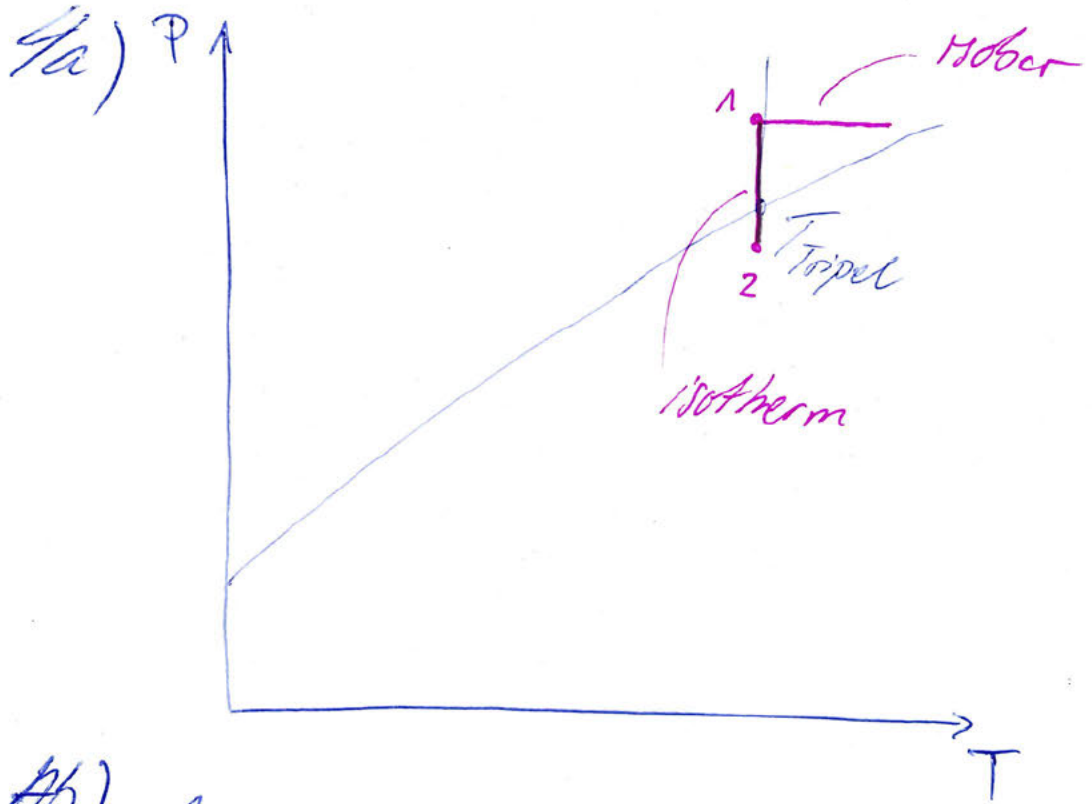
4d) $\varepsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \frac{|\dot{Q}_K|}{|\dot{W}_K|}$

$\dot{Q}_K = \dot{m}(h_2 - h_1)$

e) Die Temperatur im Innenraum würde weiterhin sinken, da der Innenraum des Gefriertrockners nach aussen hin adiabat ist.

Seite 1 [redacted]

4a)



4b) ges.: m_{R134a}

$\dot{W}_K = \dot{m}(h_2 - h_3)$

$h_3 \overset{A\text{-}11}{=} h_f(8\,bar) = 93.42 \frac{kJ}{kg}$

$h_2 \overset{A\text{-}10}{=} h_g(-22°C) = 235.31 \frac{kJ}{kg}$

$s_2 = s_3 = 0.9066 \frac{kJ}{kg\,K}$

$h_4 = h_g(8\,bar) = 264.15 \frac{kJ}{kg}$

$\frac{\dot{W}_K}{h_2 - h_3} = \dot{m} = \frac{28\,W}{235.31 - 93.42 \frac{kJ}{kg}} = 0.197 \frac{kg}{s}$