[redacted]

AUFGABE 1

a)

ENERGY BALANCE $\dot{W} = 0$

$h_{EIN} = h_F(70°C) = 292.98 \, \frac{kJ}{kg}$

$h_{AUS} = h_F(100°C) = 419.04 \, \frac{kJ}{kg}$

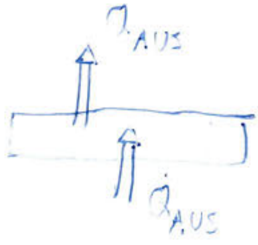
$$0 = -\dot{Q}_{AUS} + \dot{Q}_R + \dot{m}_{EIN}(h_{EIN} - h_{AUS})$$

$$\Rightarrow \dot{Q}_{AUS} = \dot{m}_{EIN}(h_{EIN} - h_{AUS}) + \dot{Q}_R = 62.182 \text{ kW}$$

c) $\overline{T}_{KF} = 295 K$

ENTROPY BALANCE

IN WÄRMEÜBERTRAGER WAND



$$\dot{S}_{ERZ} = \frac{\dot{Q}_{AUS}}{\overline{T}_{KF}} \cong 210.79 \, \frac{W}{K}$$

d)

$$Q_{R12} - Q_{AUS12} = 0$$

$$\Delta E = (m_{GES1} + \Delta m_{12}) u_2 - m_{GES1} u_1 = \Delta m_{12} h_{12EIN}$$

HALF OPEN SYSTEM

$$\Rightarrow \frac{m_{GES1}(u_2 - u_1)}{h_{12EIN} - u_2} = \Delta m_{12}$$

$\cong 3756.9 \text{ kg}$

$u_1 = u_F(100°C) + x_D(u_G(100°C) - u_F(100°C)) =$
$\cong 429.38 \, \frac{kJ}{kg}$

$u_2 = u_F(70°C) = 292.95 \, \frac{kJ}{kg}$

$h_{12EIN} = h_F(20°C) = 83.96 \, \frac{kJ}{kg}$

e) ENTROPY BALANCE HALF-OPEN SYSTEM

$$\Delta S = (m_{GES1} + \Delta m_{12}) s_2 - m_{GES1} s_1 \cong 1387.9 \, \frac{kJ}{K}$$

$s_1 = s_F(100°C) + x_D(s_G(100°C) - s_F(100°C)) \cong 1.3371 \, \frac{kJ}{kgK}$

$s_2 = s_F(70°C) = 0.9549 \, \frac{kJ}{kgK}$

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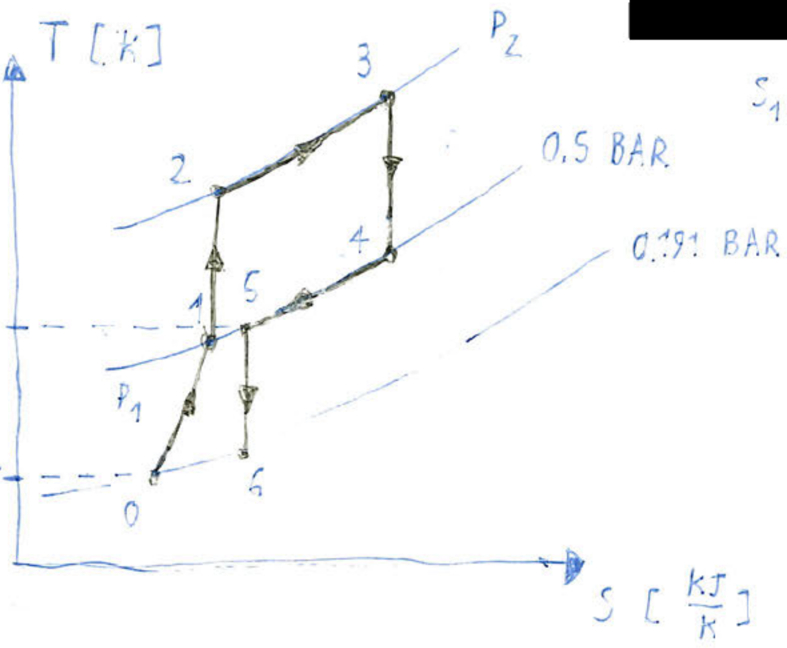
AUFGABE 2

a)



$S_1 = S_2$ $\quad P_2 = P_3$

$S_3 = S_4$

$P_1 = P_4 = P_5$

$P_6 = P_0$

$S_5 = S_6$

b)

ISENTROP: $T_6 = T_5 \left(\frac{p_0}{p_5}\right)^{\frac{k-1}{k}} \cong 328.07\,K$

ENERGY BALANCE (EB) SCHUBDÜSE $\quad \dot{m}_{GES}\left(c^{IG}_{P\,LUFT}(T_5 - T_6) + \frac{(w_5^2 - w_6^2)}{2}\right) = 0$

$\Rightarrow w_6 = \sqrt{2 c^{IG}_{PLUFT}(T_5 - T_6) + w_5^2} \cong 507.25 \quad \frac{m}{s}$

c)

$c^{IG}_{VLUFT} = \frac{c^{IG}_{PLUFT}}{k} = \cong 0.719 \frac{kJ}{kg\,K}$

$R = c^{IG}_{PLUFT} - c^{IG}_{VLUFT} = 0.287 \frac{kJ}{kg\,K}$

$\Delta e_{XSTR} = e_{XSTR6} - e_{XSTR0} =$

$= h_6 - h_0 - T_0(s_6 - s_0) + \frac{(\overset{510\,\frac{m}{s}}{w_6^2} - w_0^2)}{2} =$

$= c^{IG}_{PLUFT}(T_6 - T_0) - T_0\left(c^{IG}_{PLUFT} \ln\left(\frac{T_6}{T_0}\right) - \cancel{R \ln\left(\frac{p_6}{p_0}\right)}\right) + \frac{((510\,\frac{m}{s})^2 - w_0^2)}{2}$ $\quad p_6 = p_0 \; C$

$\cong 122.21 \frac{kJ}{kg}$

d) EXERGY BALANCE $\quad \dot{Q} = 0 \quad \dot{W} = 0$

$\Delta e_{XSTR} = e_{XVERL}$

[redacted]

AUFGABE 3

a) $R = \frac{\bar{R}}{M_G} \cong 0.166 \frac{kJ}{kgK}$ $A = \left(\frac{D}{2}\right)^2 \pi \cong 7.854 \cdot 10^{-3} m^2$

$$p_1 = p_{AMB} + \frac{m_K g}{A} + \frac{m_{EW} g}{A} \cong 1.401 \text{ BAR}$$

$$m_g = \frac{p_1 V_{G1}}{T_{G1} R} \cong 3.428 \cdot 10^{-3} kg$$

b) DER DRUCK p_{G2} MUSS GLEICH WIE ZUSTAND 1 SEIN UM IN GLEICHGEWICHT ZU SEIN MIT KOLBEN UND p_{AMB}.

c) $T_{G2} = 0{,}003°C = T_{EW2}$

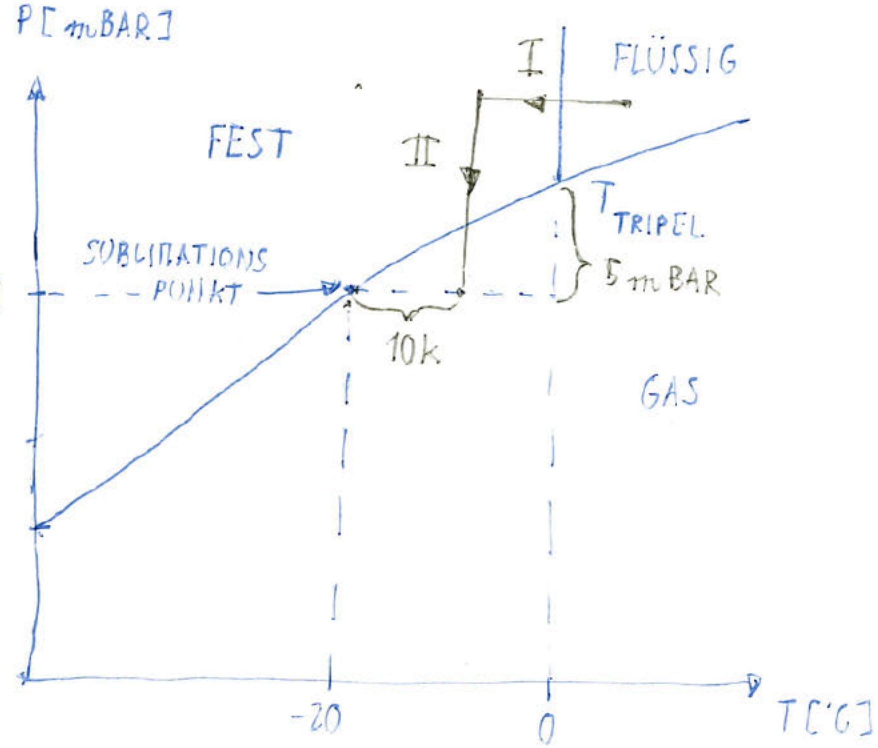
d) ENERGY BALANCE ON HALF OPEN SYSTEM

$$\Delta E = m_{EW} \left(u(0°C) - (u_{FEST}(0.003°C) + x_{EIS2}(u_{FLÜSSIG}(0.003°C) - u_{FEST}(0.003°C)\right) = Q_{12}$$

SOVE FOR x_{EIS2}

AUFGABE 4 [redacted]

a)



c) $\dot{m}_{R134A} = 4 \frac{kg}{h} \quad T_2 = -22°C$

$p_2 = p(-22°C) = 1.2192$ BAR

$p_1 = p_2 \Rightarrow T_1 = T_2$

$h_4 = h_1$ DROSSEL IST ISENTHALP $\quad p_3 = p_4$

$h_4 = h_F(8 \text{ BAR}) = 93.42 \frac{kJ}{kg}$

$x_1 = \frac{h_4 - h_F(-22°C)}{h_{FG}(-22°C)} \approx 0.337$

d) $\varepsilon_K = \frac{|\dot{Q}_K - \dot{Q}_{AB}|}{\dot{W}_K}$

b) $T_1 = -19°C$

$\Rightarrow T_1 = T_2 = -16°C \qquad s_2 = 0.9298 \frac{kJ}{kg \cdot K}$

$s_2 = s_3 \qquad h_2 = h_G(-16°C) = 237.74 \frac{kJ}{kg}$

$$h_3 = \frac{h(8\,BAR, 40°C) - h(8\,BAR, 31.33°C)}{s(8\,BAR, 40°C) - s(8\,BAR, 31.33°C)} (s_2 - s(8\,BAR, 31.33°C) + h(8\,BAR, 31.33°C)$$

$$\approx 271.31 \frac{kJ}{kg}$$

ENERGY BALANCE COMPRESSOR

$$\dot{m}_{R134A} = \frac{-28\,W}{h_2 - h_3} \approx 3 \frac{kg}{h}$$

c) DIE TEMPERATUR WIRD WEITER SINKEN BIS $\dot{W}_K$ NICHT MEHR REICHT UM DIE WÄRMEABFUHR WEITER ZU ERHALTEN