Aufgabe 1

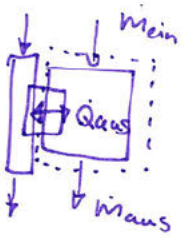
$\dot{m}_{ein} = 0.3 \frac{kg}{s}$

$T_{ein} = 70°C$

$x_{ein} = 0.005$

$T_{aus} = 100°C$

$x_{aus} = 0.005$



$m_{ges} = 5755\,kg$

$x_D = 0.005$

$T_{R,1} = 100°C$

$\dot{Q}_R = 100\,kW$

~~$Q = \dot{m}_{ein}(h_e) - \dot{m}_{aus}$~~

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

$\dot{Q}_{aus} = \dot{m}_{ein}(h_a - h_e) - \dot{Q}_R = -62.297\,kW \Rightarrow Q_{aus} = 62.297\,kW$

$h_e = x_{ein} \cdot h_g + (1 - x_{ein}) h_f$ aus Tab A-2

$= 304.6491 \frac{kj}{kg}$

$h_a = x_{aus} \cdot h_g + (1 - x_{aus}) h_f$

$= 430.325 \frac{kj}{kg}$

b)

$$\overline{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{q_{ea}}{s_a - s_e} = \frac{h_a - h_e}{s_a - s_e} = \frac{c_p (T_a - T_e)}{c_p \cdot \ln\left(\frac{T_a}{T_e}\right)}$$

$$= \frac{T_a - T_e}{\ln\left(\frac{T_a}{T_e}\right)} = \frac{T_{KF,aus} - T_{KF,ein}}{\ln\left(\frac{T_{KF,aus}}{T_{KF,ein}}\right)} = 293.12157\,K = \overline{T}_{KF}$$

c) Entropiebilanz um ~~Kühlmantel~~ Reaktor

$$0 = \dot{m}\,(s_e - s_a) + \frac{\dot{Q}}{T} + \dot{S}_{erz}$$

$$= \dot{m}_{ein}\,(s_{ein} - s_{aus}) + \frac{\dot{Q}_{aus}}{T_{KW}} + \dot{S}_{erz}$$

$$\dot{S}_{erz} = \dot{m}_{ein}\,(s_{aus} - s_{ein}) + \frac{\dot{Q}_{aus}}{T_{KW}} = \underline{0.317\ kW = \dot{S}_{erz}}$$

$s_{aus} = x_{aus}\ s_g + (1 - x_{aus})\ s_f$ aus TAB A-2

$= 1.33714\ \frac{kj}{kg\,K}$

$s_{ein} = x_{ein}\ s_g + (1 - x_{ein})\ s_f$ aus TAB A-2

$= 0.988902\ \frac{kj}{kg\,K}$

d)

$$\Delta E = Q - W$$

~~$- m_{ges} \cdot u_1$~~

$$-m_{ges} \cdot u_1 + (m_{ges} + \Delta m_{12})\,u_2 = Q_{aus,12}$$

$$m_{ges}\,(u_2 - u_1) + \Delta m_{12}\,u_2 = Q_{aus,12}$$

$$\Delta m_{12} = \frac{Q_{aus} + m_{ges}\,(u_1 - u_2)}{u_2} = \underline{2799.5971\ kg}$$

$u_1 = x_D \cdot u_g + (1 - x_D)\,u_f$ aus TAB A-2

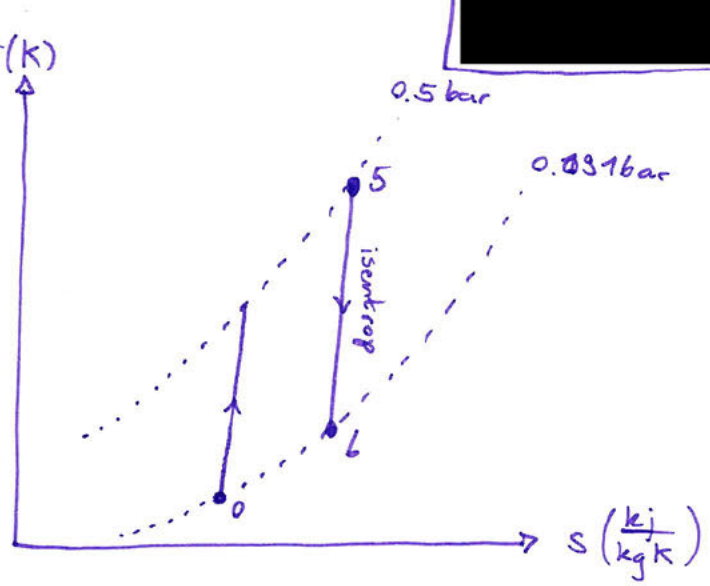
$= 429.3778\ \frac{kj}{kg}$

$x_{sieden} = 0$

$u_2 = 292.95\ \frac{kj}{kg}$ aus TAB A2

Aufgabe 2

a)



b)

$\omega_{Luft} = 200 \frac{m}{s}$

$p_0 = 0.191\,bar$

$T_0 = -30°C = 270.15\,K$

$s_0 =$

$\dot{m}_{ges} = \dot{m}_M + \dot{m}_K$

$s_1 = s_0 =$

$T_1 =$ $\quad T_2 =$ $\quad T_3 =$ $\quad T_4 =$

$p_1 =$ $\quad p_2 = p_3$ $\quad p_3 = p_2$ $\quad p_4 =$

$s_5 =$

$T_5 = 431.9\,K$ $\xrightarrow{\text{isentrop}}$ $s_6 = s_5 =$ $\quad T_6 = 328.0747\,K$

$p_5 = 0.5\,bar$ $\quad p_6 = p_0 = 0.191\,bar$

$\omega_5 = 200 \frac{m}{s}$

$$T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} = \underline{328.0747\,K}$$

$$Q = \dot{m}_{ges}\left(h_5 - h_6 + \frac{\omega_5^2 - \omega_6^2}{2}\right)$$

$$c_p(T_5 - T_6) + \frac{\omega_5^2}{2} = \frac{\omega_6^2}{2}$$

$$\omega_6 = \sqrt{2c_p(T_5 - T_6) + \omega_5^2} = \underline{507.244 \frac{m}{s}}$$

$$s_0^\circ = s_1^\circ = 270.26 \frac{kJ}{kgK}$$

Aufgabe 3

a) $R = \frac{\overline{R}}{M} = 0.166289 \frac{J}{kgK}$

Kräftegleichgewicht

$p_{amb} \cdot A$ ↓, $m_K g$ ↓, $(m_{EW} + m_{Eis}) g$ ↓

$p_{g,1} \cdot A$ ↑

$m_{Eis} = x_{Eis} \cdot m_{EW} = 0.06 kg$

$A = \pi \frac{D^2}{4} = 0.007853982 \, m^2$

$(m_K + m_{EW} + m_{Eis}) g + p_{amb} \cdot A = p_{g,1} \cdot A$

$p_{g,1} = \frac{(m_K + m_{EW} + m_{Eis}) g}{A} + p_{amb} = 1.40155 bar$

$m_{g,1} = \frac{p_{g,1} \cdot V_{g,1}}{R T_{g,1}} = 3.42304 g$

b) zustand 2

keine arbeit

~~$\Delta E = Q - W$~~

masse bleibt gleich vom gas

~~$m_{g,2} u_2 - m_{g,1} u_1 = 0$~~

~~$m_g u_2 = m_g u_1$~~

~~$u_2 = u_1$~~

~~$u_2 - u_1 = 0$~~

~~$c_v (T_2 - T_1) = 0$~~

c)

$$\Delta E = Q_{12}$$

$$m_g u_2 - m_g u_1 = Q_{12}$$

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

$$m_g c_v (T_2 - T_1) = Q_{12} \quad *$$

$$\underline{|Q_{12}| = 1083.38\,J}$$

d) mit $T_{g,2} = 0.003°C$

$$p_{g2} = \frac{R T_{g,2}}{}$$

Aufgabe 4

$T_1 =$ $\xrightarrow{Q_K}$ isobar $T_2 =$ $\xrightarrow{\dot{W}_K}$ isentrop $T_3 =$

$p_1 =$ $p_2 = p_1 =$ $p_3 = 8\,bar$

$h_1 = 93.42 \frac{kj}{kg}$ $x_2 = 1$ $S_2 =$ $S_3 =$

$T_4 = 31.33\,°C$

$p_4 = 8\,bar$

$x_4 = 0$

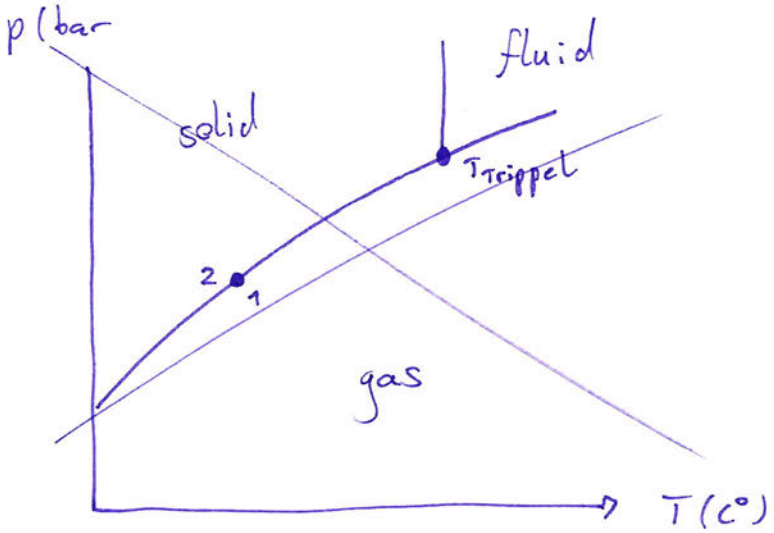
$h_4 = 93.42 \frac{kj}{kg}$

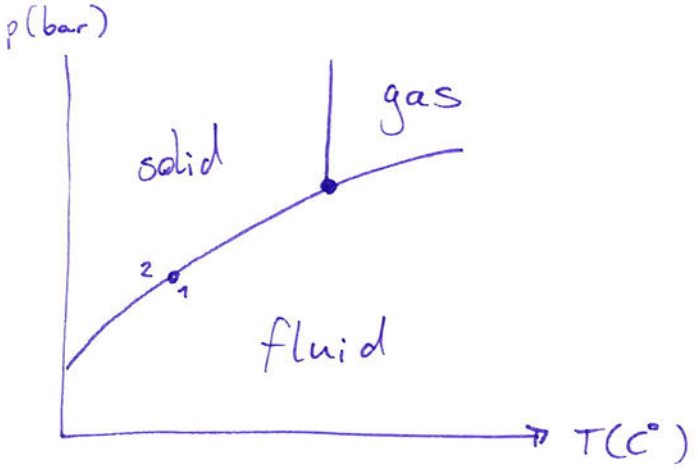
$\dot{m}_{R134a} (h_2 - h_3) = \dot{W}_K$

c) mit $T_2 = -22\,°C$

$p_2 = p_1 = 1.2192\,bar$ aus TAFB A-10

$\frac{h - h_f}{h_g - h_f} = x_1 = \underline{0.33747}$


p (bar
fluid
solid
T Tripel
2
1
gas
T (C°)


p (bar)
gas
solid
2
1
fluid
T(C°)