Aufgabe 1

[redacted]

a) $\dot{Q}_{aus} = ?$ $\quad 0 = \dot{m}_{ein}(h_{ein} - h_{aus}) + \dot{Q}$

$$Q_{aus} = \dot{m}\,(h_{aus} - h_{ein}) + Q_{12} = \dot{m}\int_{T_1}^{T_2} c^{id}(T)\,dT + u^{id}(p_2 - p_1)$$

$$\dot{Q} = 1{,}013\,(419{,}04 - 292{,}98) = 62{,}782\ \text{kW}$$

$h_{aus} = 419{,}04$ kJ/kg $\quad h_{ein} = 292{,}98$ kJ/kg $\quad$ tab. A-2

b) [illegible]

c) $$S_{erz} = m_2 s_2 - m_1 s_1 - \frac{Q_J}{T_J}$$

$m_2 = m_1 = m_{ein} = 1{,}013$ kg/s

$T = 295$ K

$Q_J = 65$ kW

$$m\,(s_2 - s_1) - \frac{65\ \text{kW}}{295\ \text{K}} = S_{erz}$$

$s_1 = 0{,}9549$ kJ/kg·K tab. A-2

$s_2 = 1{,}3069$ kJ/kg·K

$$S_{erz} = 1{,}013\,(1{,}3069 - 0{,}9549) - \frac{65\ \text{kW}}{295\ \text{K}} = 2028{,}42\ \frac{\text{kJ}}{\text{K}}$$

e) $\Delta_{S_{12}} = m_2 S_2 - m_1 S_1$

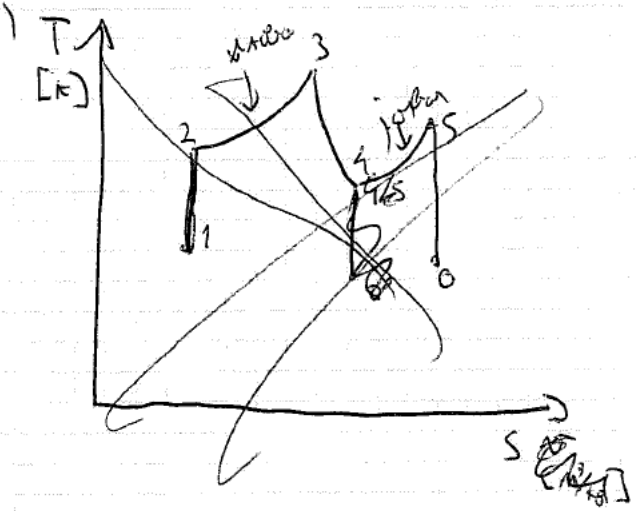
S_1 → see exercise C and also S_2

$m_1 = 5755\ kg \qquad m_2 = \Delta m + m_1 = 9355\ kg$

$\Delta S = 9355 \cdot 1,3069 - 0,9544 \cdot 5755 = 6733,97$

Aufgabe 2

[redacted]

a.) 

$= c_{p0}$

$p_0 = -30\,°C$

$s_1 = s_2$

$p_2 = p_3$

$s_3 = s_4$ adiabat

$s_5 = s_6$

b.) $\left(\frac{T_5}{T_6}\right) = \left(\frac{p_5}{p_6}\right)^{\frac{1,4-1}{1,4}}$ $\quad \frac{437,9}{T_6} = \left(\frac{0,5}{0,191}\right)^{\frac{0,4}{1,4}}$

$T_6 = 328,07\,K$

$0 = \dot{m}\left[(h_5 - h_6) + \frac{w_5^2 - w_6^2}{2}\right] + \cancel{\dot{Q}}^{0} - W$

$\dot{m} = \dot{m}_{ges}$ $\quad (h_5 - h_6) = c_p (T_5 - T_6) = 1,006 \cdot (437,9 - 328,07)$

$h_5 - h_6 = c_p \cdot \Delta T = c_p (T_5 - T_6) = 104,45\,\frac{kJ}{kg}$

b) $w^{rev} = \frac{W_{rev}}{\dot{m}} = -\left(\int_{p_5}^{p_6} v\,dp + \Delta ke\right) = -\left(\frac{R\,(T_6 - T_5)}{1-n} + \left(\frac{w_5^2 - w_6^2}{2}\right)\right)$

$R = c_p - c_v$

$\kappa = \frac{c_p}{c_v}$ $\quad c_v = \frac{c_p}{\kappa}$

$0 = h_5 - h_6 - \frac{w_5^2 - w_6^2}{2} - w^{rev}$

$104,45 - \frac{220^2}{2} - \frac{w_6^2}{2} + \frac{R\,(T_6 - T_5)}{1-1,4} + \cancel{\frac{220^2}{2}} - \frac{w_6^2}{2} = 0$

$104,45 - w_6^2 + \frac{R\,(-109,83)}{-0,4} = 0$

$R = c_p - \frac{c_p}{\kappa} = c_p \cdot \left(1 - \frac{1}{1,4}\right) = 0,29$

$104,45 - \frac{w_6^2}{2} + 74,61 = 0$

$w_6 = 201,7\,\frac{m}{s}$

(2) Aufgabe 2

c)

[redacted]

$ex_{6} = h_6 - h_0(T_6) - T_0(T_6)(s_6 - s_0) + \frac{w_6^2}{2}$

$ex_{100} = h_0 - h_0(T_0) - T_0(T_0)(s_0 - s_0) + \frac{w_0^2}{2}$

$ex_{6} - ex_{100} = h_6 - h_0 - h_0(T_6) + h_0(T_0) - T_0(T_0)(s_6 - s_0) + T_0(T_0)(s_0 - s_0) + \frac{w_6^2 - w_0^2}{2}$

$= c_p(T_6 - T_0) - T_0(s_6 - s_0) + \frac{w_6^2 - w_0^2}{2}$

$= c_p(T_6 - T_0) - T_0\left(c_p \cdot \ln\left(\frac{T_6}{T_0}\right) - R\ln\left(\frac{p_6}{p_0}\right)\right) + \frac{w_6^2 - w_0^2}{2}$ ($\ln\left(\frac{p_6}{p_0}\right) = 0$)

$\Delta ex_{ist} = 110{,}06\ kJ/kg$

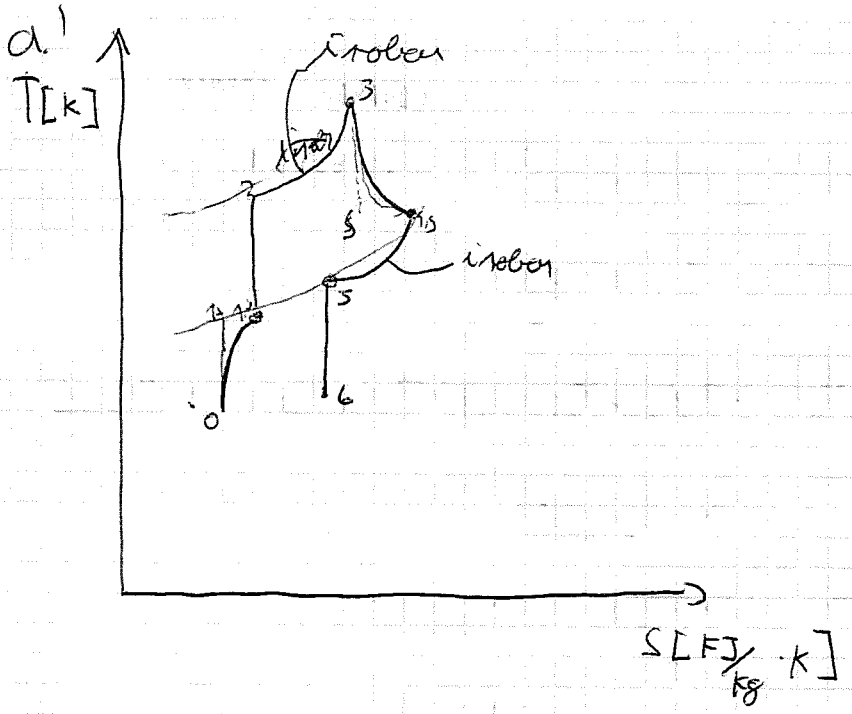
$T_6 = 340\ K$
$T_0 = 243{,}15\ K$
$w_6 = 120\ m/s$
$w_0 = 200\ m/s$

d.) $0 = \sum ex_{zu} + ex_{Q} - W - p_0 \frac{dV}{dt} - ex_{verl}$ ($p_0 \frac{dV}{dt} = 0$)

$\zeta_{xQ} = 1 - \frac{T_0}{T_B} \cdot q_B = 969{,}58\ \frac{kJ}{kg}$

$\zeta_{verl} = 969{,}58 + 100 = 1069{,}58$

a.)



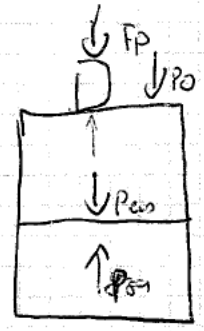
Aufgabe

3)

a.) $T_g = 500°C$ $V_0 = 3,14L$

$P \cdot V = m R T$ $\quad R = \frac{\bar{R}}{M} = \frac{8,314\,J\,Kmol}{30\,kg \cdot mol \cdot K} = 0,16628$

$Pv = RT$ $\quad v = \frac{V}{m}$



$P_{gas} = P_0 + \frac{32kg}{A} \overset{9,81}{=} 1bar + \frac{32 \cdot 5 \cdot 9,81}{2 \cdot \frac{1}{400}\pi m^2} =$

$= 1bar + 0,4 =$ $\quad \approx 0,4\,bar$

$= 1,4\,bar$

$P \cdot V = m R T \quad m = \frac{P \cdot V}{RT} = \frac{1,4 \cdot 10^5 \cdot 3,14 \cdot 10^{-3}}{0,16628 \cdot 773,15} = 3,4g$

c.) thermisch gleichgewicht $\quad \Delta U = U_2 - U_1$

$c_v (T_2 - T_1) = T_2 = T_1 \cdot c_v$

$c_v (T_2 - T_1) = m \cdot (h_1 - h_2) + Q - W$

$T_2 = 0,003$ gleichgewicht

$P_{g2} = 1bar = P_0$ $\quad V_1 = V_2$

$m_1 = m_2$

Exercice 4

4.1

4.2) $0 = \dot{m}(h_2 - h_3) + \dot{Q} - W$ ($\dot{Q} \to 0$)

$W = \dot{m}(h_2 - h_1)$ $\quad \dot{m} = \frac{W}{h_2 - h_3}$

$P_1 = P_2$ $\quad S_2 = S_3$ $\quad P_3 = P_4$

$T_4 = 31,3°C$ $\quad T_2 = T_1 - 6$

$T_2 = -28°C$

$h_2 = 232,85$ kJ/kg $\quad s_2 = 0,9370 = s_3$ kJ/kg K $\quad$ tab A-10

$h_3 \to$ tab A-12

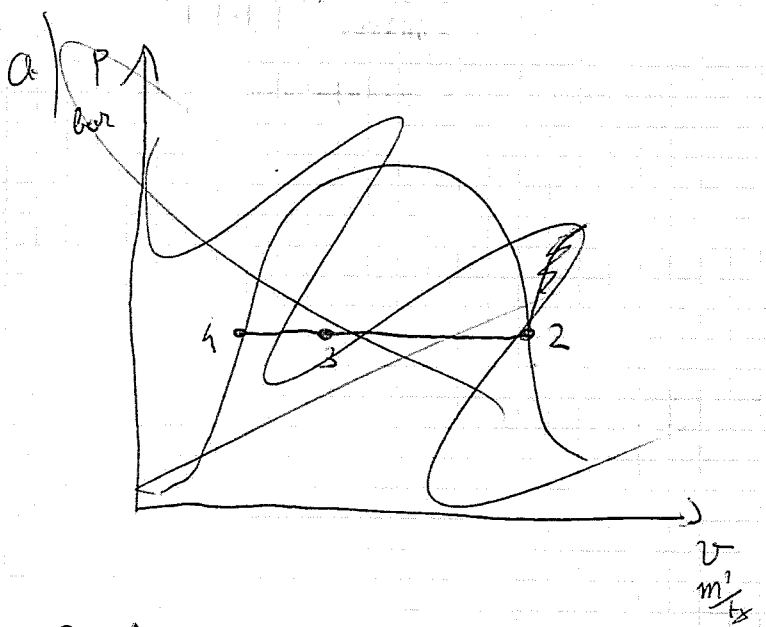
$h_3 = 234,08 + \frac{(0,9351 - 0,9066)(273,66 - 269,15)}{0,9374 - 0,9066} = 242,71$ kJ/kg

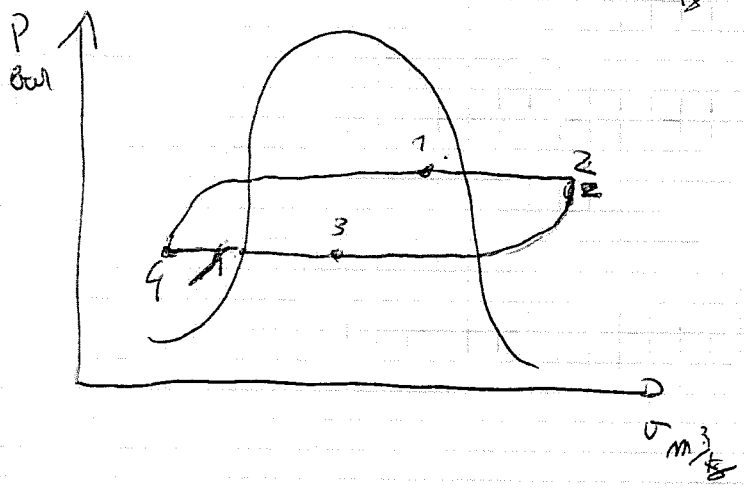
$\dot{m} = \frac{-28}{h_2 - h_3} = 3,24$ kg

$h_3 = 269,15 + \frac{(0,9370 - 0,9066)(273,66 - 269,15)}{0,9374 - 0,9060} = 273,36$ kJ/kg

$\dot{m} = \frac{-28}{h_2 - h_3} = 0,17$ kg/s

a)





4 durch 4

d) $\varepsilon_K = \frac{\dot{Q}_K}{W_K} = \frac{?}{28\,W}$

$\dot{Q}_K =$

$0 = \dot{m}(h_1 - h_2) + \dot{Q} - \cancel{P}^{\to 0}$

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

c) $s_4 = s_1$

$s_4 = s_f(8\,bar) = 0{,}3459\ \frac{kJ}{kg\,K} = s_1 \rightarrow$ Tab A-11

Bei $p_2 = p_1$ $\quad p_2 = 1{,}2196\ bar \approx 12\ kPa$ - A10 ($T = -29°C$)

$p_1 \approx 1{,}2\ bar \rightarrow \quad s_1 = s_f + x_1 (s_g - s_f)$

$x_1 = \frac{s_1 - s_f}{s_g - s_f} = \frac{0{,}3459 - 0{,}0879}{0{,}9354 - 0{,}0879} \approx 30\% = 0{,}3$

d.) $\varepsilon_K = \frac{\dot{Q}_K}{W_K}$

$0 = \dot{m}(h_1 - h_2) + \dot{Q} \qquad \dot{Q} = \dot{m}(h_2 - h_1)$

~~h_2 ablesen~~ $= \quad h_2(T_2 °C)$ Tab A10 $\Rightarrow 234{,}08\ kJ/kg$

$h_1 = h_f + x_1 \cdot (h_g - h_f) = 21{,}32 + 0{,}3 \cdot 212{,}54 = 85{,}082\ kJ/kg$ Tab A-11

$\dot{Q} = 4 \cdot (234{,}08 - 85{,}082) = 596\,W$

$\varepsilon_K = \frac{\dot{Q}_K}{W_K} = 21{,}29$