[redacted]

Aufgabe 1

a) Ges. $\dot{Q}_{aus}$

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

$$-\dot{Q}_{aus} = \dot{m}(h_{ein} - h_{aus}) + \dot{Q}_R \quad | \cdot(-1)$$

$$\dot{Q}_{aus} = \dot{m}(h_{aus} - h_{ein}) - \dot{Q}_R$$

AZ $h_{ein} = 292.98 \frac{kJ}{kg}$, $h_{aus} = 419.04 \frac{kJ}{kg}$

$$= 0.3 \frac{kg}{s}\left(419.04 \frac{kJ}{kg} - 292.98 \frac{kJ}{kg}\right) - 100 \frac{kJ}{s}$$

$$= -62.18 \frac{kJ}{s}$$

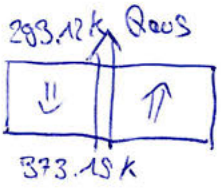
Da Mantelstrom aufnimmt VZW $\dot{Q}_{aus} = 62.18 \frac{kJ}{s}$

b)

$$T_{KF} = \frac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)} = \frac{298.15K - 288.15K}{\ln\left(\frac{298.15K}{288.13K}\right)} = 293.12K$$

c)

~~$0 = \dot{m}(s_e - s_a) + \frac{\dot{Q}_{aus}}{T_{KF}} + \dot{S}_{erz}$~~



$$0 = \dot{S}_{erz} + \frac{\dot{Q}_{aus}}{T_{Reak}} - \frac{\dot{Q}_{aus}}{T_{KF}}$$

$$-\dot{S}_{erz} = \frac{\dot{Q}_{aus}}{T_{Reak}} - \frac{\dot{Q}_{aus}}{T_{KF}}$$

$$\dot{S}_{erz} = \dot{Q}_{aus}\left(\frac{1}{T_{Reak}} - \frac{1}{T_{KF}}\right)$$

$$= 62.18 \frac{kJ}{s}\left(\frac{1}{373.15K} - \frac{1}{293.12K}\right)$$

$$= -0.0455 \frac{kJ}{s \cdot K}$$

d)

$$m_2 u_2 - m_1 u_1 = \Delta m_i h_i$$

Tabelle A2
u_2, u_{1g}, u_{1f}
h_{zu}

$m_2 = 5755\,kg$
$u_2 = 292.95\ \frac{kJ}{kg}$

$m_D = 5755\,kg \cdot 0{,}005 = 28.775\,kg$
$u_{1g} = 2506.5\ \frac{kJ}{kg}$
$m_f = 5755\,(1-0.005)\,kg = 5726.23\,kg$
$u_{1f} = 418.94\ \frac{kJ}{kg}$

$h_{zu} = 83.96\ \frac{kJ}{kg}$

$m_2 u_2 - m_D u_{1g} - m_f u_{1f} = \Delta m \cdot h_{zu}$

$$\Delta m = \frac{m_2 u_2 - m_D u_{1g} - m_f u_{1f}}{h_{zu}}$$

$$= \frac{5755\,kg \cdot 292.95\ \frac{kJ}{kg} - 28.775\,kg \cdot 2506.5\ \frac{kJ}{kg} - 5726.23\,kg \cdot 418.94\ \frac{kJ}{kg}}{83.96\ \frac{kJ}{kg}}$$

$$= -9351.40\,kg$$

e) $\Delta m_{12} = 3600\,kg$ Tabelle A2

$m_{D1} = 28.775\,kg$, $m_{f1} = 5726.23\,kg$, $s_{f\,100°C} = 1.3069\ \frac{kJ}{kg \cdot K}$, $s_{g\,100°C} = 7.3549\ \frac{kJ}{kg \cdot K}$

$$S_1 = m_{D1} \cdot s_{g1} + m_{f1} \cdot s_{f1}$$

$$= 28.775\,kg \cdot 7.3549\ \frac{kJ}{kg \cdot K} + 5726.23\,kg \cdot 1.3069\ \frac{kJ}{kg \cdot K}$$

$$= 7695.247\ \frac{kJ}{K}$$

$s_{f20C} = 0.2966\ \frac{kJ}{kg \cdot K}$

$$S_2 = (m_{ges} + \Delta m_{12}) \cdot s_{f20°C}$$

$$= (5755\,kg + 3600\,kg) \cdot 0.2966\ \frac{kJ}{kg \cdot K} = 2774.693\ \frac{kJ}{K}$$

$$\Delta S_{12} = S_2 - S_1 = 2774.693\ \frac{kJ}{K} - 7695.247\ \frac{kJ}{K}$$

$$= -4920.554\ \frac{kJ}{K}$$

Aufgabe 3

a) Ges. p_{g1}, m_g $\quad A = (0.05m)^2 \cdot \pi = 7{,}854 \cdot 10^{-3} m^2$

$$p_{g1} = 1\,bar + \frac{32\,kg \cdot 9.81 \frac{m}{s^2}}{7{,}854 \cdot 10^{-3} m^2} + \frac{0{,}1\,kg \cdot 9{,}81 \frac{m}{s^2}}{7{,}854 \cdot 10^{-3} m^2}$$

$$= 140094\,Pa = 1{,}4\,bar$$

$$pV = mRT \Rightarrow m = \frac{pV}{RT} \qquad Q = \frac{\overline{R}}{M} = \frac{8{,}314 \frac{kJ}{kmol \cdot K}}{50 \frac{kg}{kmol}} = 0.1663 \frac{kJ}{kg \cdot K}$$

$$m_g = \frac{140094\,Pa \cdot 0.00314\,m^3}{0.1663 \frac{J}{kg \cdot K} \cdot 773{,}15\,K} = 3{,}42g$$

b)

c) $T_{g12} = 0.003°C$

$$m_2 u_2 - m_1 u_1 = \dot{Q} - \dot{W}^{0}$$

$m_1 = m_2$

$$m(u_2 - u_1) = \dot{Q} - \dot{W}^{0}$$

$$m c_v (T_2 - T_1) = \dot{Q}$$

$$3{,}42g \cdot 0{,}633 \frac{kJ}{kg \cdot K} \cdot (273.153K - 773.15K) = \dot{Q}$$

$$\dot{Q}_{12} = -1{,}082\,kJ$$

d)

$p_1 = 1,4$ bar

$m_{EW} = 0.1\,kg$ $\quad m_{EIS} = 0.06\,kg$ $\quad m_{WAS} = 0.04\,kg$

Tab1

$$u_1 = u_{fest\,1,1\,4} \cdot m_{fest} + u_{flüs} \cdot m_{was}$$

$$= -333.438\,\frac{kJ}{kg} \cdot 0.06\,kg + (-0.045\,\frac{kJ}{kg}) \cdot 0.04\,kg$$

$$= -20.01\,kJ$$

$$u_2 = u_1 + \dot{Q}_{1,2}$$

$$= -20.01\,kJ + 1,082\,kJ$$

$$= -18.927\,kJ$$

$$u_{2S} = \frac{-18.927\,kJ}{m_{EW}} = -189.273\,\frac{kJ}{kg}$$

$$x = \frac{u_{2,S} - u_{FEST\,0.003RC}}{u_{FLÜSSIG\,0.003°C} - u_{fest}} = 4.32 \cdot 10^{-1}$$

c)

Strömungsexergie

$$e_{x,str6} = \left(1 - \frac{T_0}{T_6}\right) \cdot q_B$$

$$= \left(1 - \frac{243.15\,K}{1289\,K}\right) \cdot 1195\,\frac{kJ}{kg}$$

$$= 969.58\,\frac{kJ}{kg}$$

$$e_{x,str6} = \dot{m} \cdot ke = \frac{1}{2}\dot{m}\,(w_{Luft})^2$$

$$= \frac{1}{2} \cdot$$

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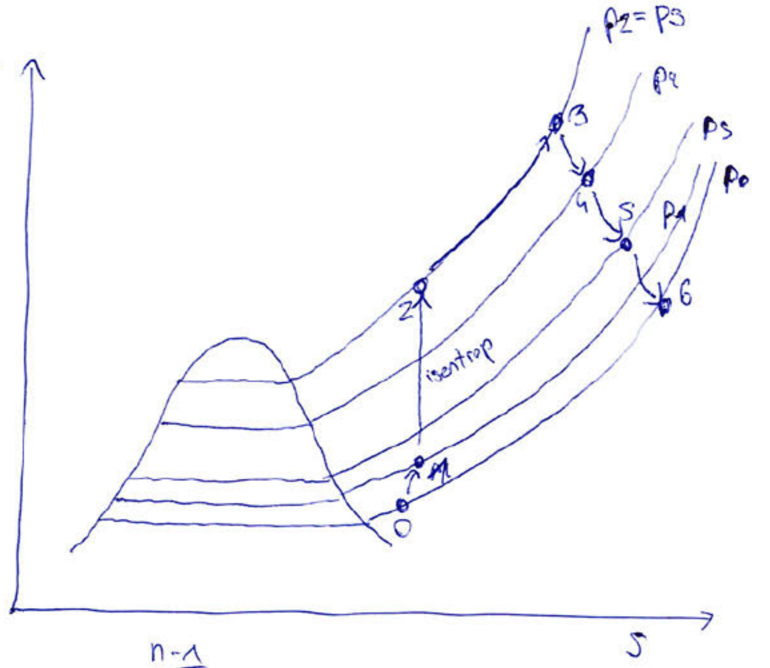
Aufgabe 2

a)



b)

$$T_6 = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} \cdot T_5$$

$$= \left(\frac{0.191\,bar}{0.5\,bar}\right)^{\frac{0.4}{1.4}} \cdot 431.9\,K = 328.07\,K$$

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

$$= \dot m(h_5 - h_6) + \frac{1}{2}\dot m w_5^2 - \frac{1}{2}\dot m w_6^2 \quad | + \frac{1}{2}\dot m w_6^2$$

$$\frac{1}{2} m w_6^2 = \dot m(h_5 - h_6) + \frac{1}{2} m w_5^2 \quad | \cdot \frac{2}{\dot m}$$

$$w_6^2 = 2(h_5 - h_6) + w_5^2 \quad | \sqrt{}$$

$$w_6 = \sqrt{2(h_5 - h_6) + w_5^2}$$

$$= \sqrt{-2\,c_p(T_6 - T_5) + w_5^2}$$

ohne $\cdot (1006) \frac{J}{kg \cdot K}$

$$= \sqrt{-2 \cdot 1.006 \frac{kJ}{kg \cdot K}(328.07\,K - 431.9\,K) + \left(220\,\frac{m}{s}\right)^2}$$

$$= 507.25\,\frac{m}{s}$$

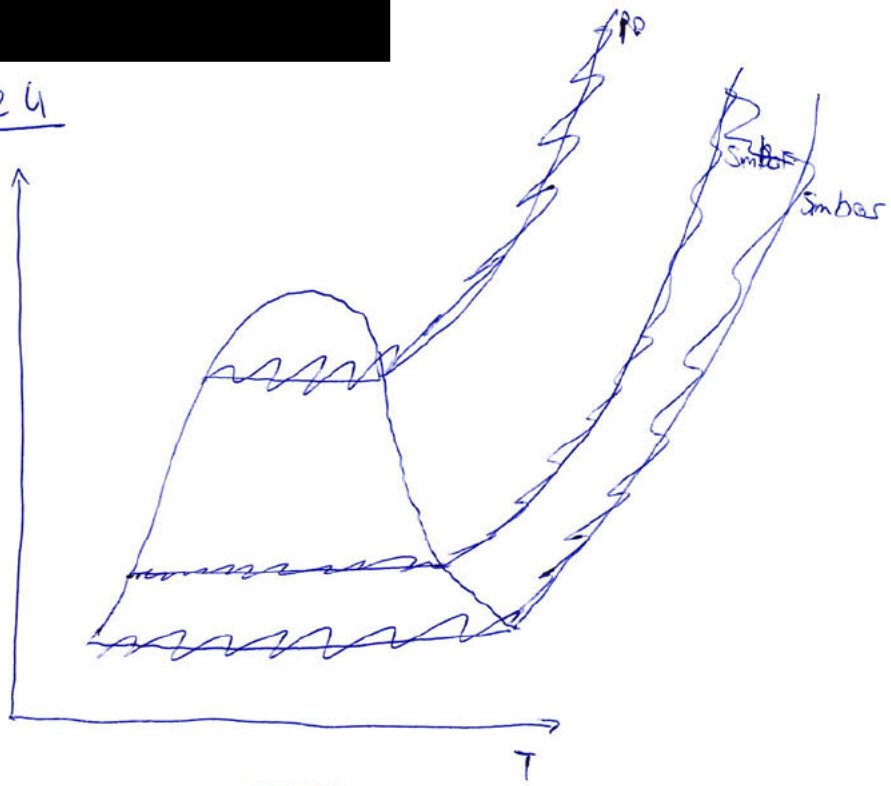
c)

$$0 = \dot{m}(h_1 - h_2$$

[redacted]

Aufgabe 4

a)



b) $T_1 = -89°C$ (A-10)

$T_1 = -35°C$

$p_1 = p_2 = \frac{-35°C + 36°C}{-32°C + 36°C} (0.7704\,bar - 0.6832\,bar) + 0.6332\,bar$

$= 0.6675\,bar$

Inter selbe wie bei p_1/p_2

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

$s_2 = 0.98925 \frac{kJ}{kg\,K}$

AG

Inter 0,8bar

$h = \left(\frac{s_2 - 0.9821}{0.9941 - 0.9821} (282.1 - 278.26) + 278.26 \right) \frac{kJ}{kg} = 280.348 \frac{kJ}{kg}$

$\dot{m} = \frac{-20\,\frac{J}{s}}{(226.03\,\frac{kJ}{kg} - 280.348\,\frac{kJ}{kg})} = 0,514\,\frac{g}{s}$

BZF