Aufgabe 1)

a) Energiebilanz (fließgleichgewicht): $\frac{dE}{dt} = \sum \dot{m}_i [h_i + k_{ki} + p_{ei}] + \sum \dot{Q}_i - \sum \dot{W}_i$

$0 = \dot{m} [h_2 - h_2] + \dot{Q}_{ab}$, $\dot{Q}_{ab} = \dot{m} [h_2 - h_2]$

$h_2 = h_w (70°C)$ [redacted]

$h_2 = h_w (100°C)$

b) $\bar{T}_{hf} = \frac{\int_1^2 T \, ds}{s_2 - s_1}$

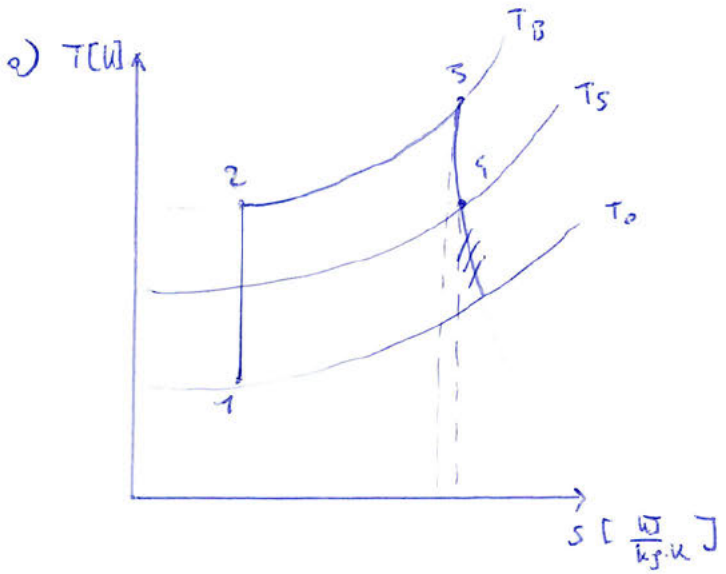
c) Bilanzgleichung: $0 = \dot{m} [s_1 - s_2] + \sum \frac{\dot{Q}}{T} + \dot{S}_{irr}$

$\dot{S}_{irr} = \dot{m} [s_2 - s_1] - \frac{\dot{Q}_{aus}}{T}$

e) $\Delta S_{12} = m_2 s_2 - m_1 s_1 = m_2 (s_2 - (1 - \Delta m_{12}) s_1)$

Aufgabe 2)

a)



Aufgabe 3)

a) $p_{g,1} = \frac{m_{kg}}{A} + \frac{m_{Bw\,3}}{A} + p_{amb}$ $\qquad A = \pi \left(\frac{21}{2} m\right)^2 \approx 7{,}854 \cdot 10^{-3}\,m^2$

$= \frac{32\,kg \cdot 9{,}81\,\frac{N}{kg}}{7{,}854 \cdot 10^{-3}\,m^2} + \frac{0{,}1\,kg \cdot 9{,}81\,\frac{N}{kg}}{7{,}854 \cdot 10^{-3}\,m^2} + \underbrace{1 \cdot 10^5\,\frac{N}{m^2}}_{1\,bar}$

$\approx 0{,}3997\,bar + 1\,bar = 1{,}3997\,bar$

für Messer: $pV = mRT$, $m_g = \frac{p_1 V_1}{RT_1} = \frac{1{,}3998 \cdot 10^5\,\frac{N}{m^2} \cdot 3{,}14 \cdot 10^{-3}\,m^3}{8{,}314\,\frac{J}{mol\,K} \cdot 273{,}15\,K} \cdot 50\,\frac{kg}{kmol}$

$= 3{,}5187 \cdot 10^{-3}\,kg$

b) Der Druck $p_{g,2} = p_{g,1}$ weil die Messer auf die Turbine immer gleich ist.

c) 1HS : $\Delta U_g = Q - W$, $Q = \Delta U_g + W$

- $W = \int_{V_1}^{V_2} p_{1,g}\,dV = (V_2 - V_1)\,p_{1,g}$
- $\Delta U_g = m_g (U_2 - U_1) = m_g (T_2 - T_1)\,c_V^{i3}$

für V_2: $V_2 = \frac{m_g R T_2}{p_{1,g}} = \frac{3{,}5187 \cdot 10^{-3}\,kg \cdot 8{,}314\,\frac{J}{mol\,K} \cdot 273{,}153\,K}{1{,}3997 \cdot 10^5\,\frac{N}{m^2} \cdot 50\,\frac{kg}{kmol}} = 1{,}1094 \cdot 10^{-3}\,m^3$

$W = 3{,}5187 \cdot 10^{-3}\,kg \,|\, 1{,}1094 - 3{,}14) \cdot 10^{-3}\,m^3 \cdot 1{,}3997 \cdot 10^5\,\frac{N}{m^2} = -0{,}2892\,kJ$

$\Delta U_g = 3{,}5187 \cdot 10^{-3}\,kg\,(273{,}153 - 773{,}15)\,K \cdot 0{,}653\,\frac{kJ}{kg\,K} = -1{,}0820\,kJ$

$Q = \Delta U + W = -1{,}3662\,kJ$ Die vom Ges abgegebene Wärme.

$Q_{12} = +1{,}3662\,kJ$

d) $T_2 = 0{,}003\,°C$

1HS: $\Delta U_{12,BW} = Q - W = (1{,}3662 - 0{,}2852)\,kJ = 1{,}082\,kJ$

$\Delta U_{12} = m_{BW}\,(u_2 - u_1)$

f: flüssig
f: fest

$u_2 = \overset{1-x_2}{\overbrace{u_f(0{,}003\,°C)}} + \overset{x_2}{\overbrace{u_f(0{,}003\,°C)}}$

$u_1 = u_f(0\,°C)\,(1 - x_1) + u_F(°C)\,x_1 \quad , x_1 = 0{,}6$

$m_{BW}\,(u_2 - u_1) = x_2\,(u_f(T_2) - u_f(T_2)) + u_f(T_2) - u_1 = \Delta U_{12}$

$x_2 = \dfrac{\Delta U_{12} + u_1 - u_f(T_2)}{u_f(T_2) - u_f(T_2)}$

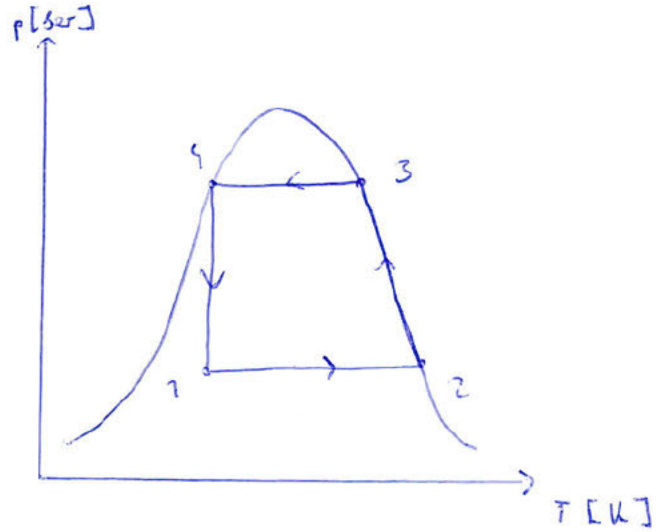
$= \dfrac{\frac{1{,}082\,kJ}{0{,}1\,kg} + (-0{,}043\,\frac{kJ}{kg})\cdot 0{,}4 + (-333{,}458\,\frac{kJ}{kg})\,0{,}6 - (-0{,}033\,\frac{kJ}{kg})}{-333{,}492\,\frac{kJ}{kg} - (-0{,}033\,\frac{kJ}{kg})}$

TAB 1

$= 0{,}5775$

Aufgabe 4) [redacted]

a)



b) Energiebilanz am Verdichter: $0 = \dot{m}\,[h_e - h_a] - \dot{W}_K$

$$\dot{m} = \frac{\dot{W}_K}{h_e - h_a}$$

$h_e = h_2$ ~~(...) = h_g (6K)~~ $= h_g\,(2°C)$ ⇝ Interpolation

$h_a = h_3 = h_g\,(8\,bar) = 264{,}15\ \frac{kJ}{kg}$

$$h_g\,(2°C) = h_g(0°C) + \frac{h_g(4°C) - h_g(0°C)}{4 - 0} \cdot (2 - 0)$$

$= 248{,}38\ \frac{kJ}{kg}$ $\qquad h_g = 248{,}38 + 247{,}23 = 495{,}57\ \frac{kJ}{kg}$

~~[248,38 − 264,15]~~

$$\dot{m} = \frac{28\ \frac{J}{s}}{(495{,}57 - 264{,}15)\,\frac{kJ}{kg}} = \sout{0{,}...\cdot 10^{3}}\ 1{,}2099 \cdot 10^{-4}\ \frac{kJ}{kJ}\,\frac{kg}{s}$$

c) $x_1 = \frac{v_1 - u_4}{v_3 - u_4}$

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

e) Sie würde sinken.