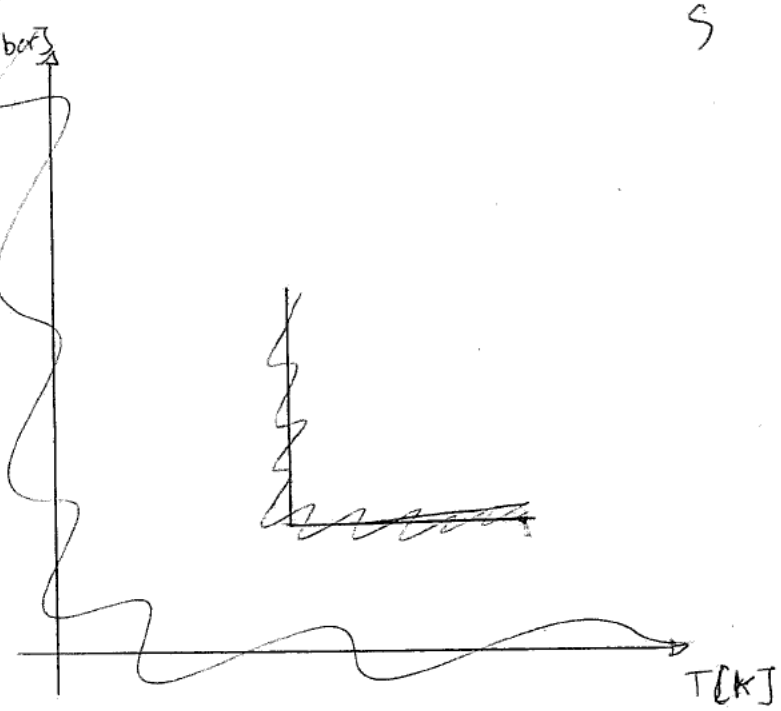
Aufgabe 4

5

a)

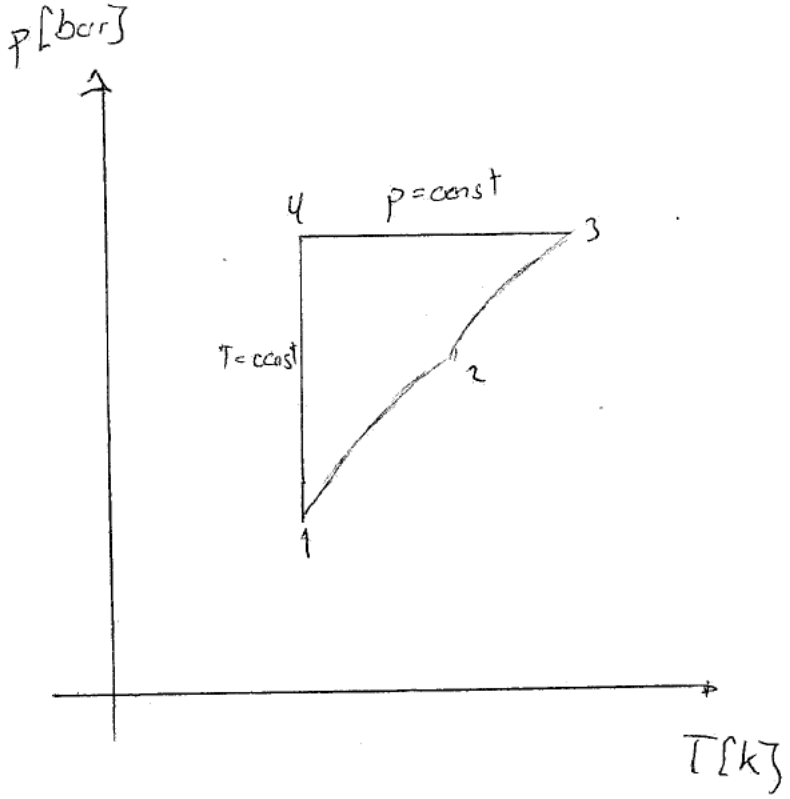


1-2: ~~p~~ T ↗ p ↗

2-3: $s_2 = s_3$ p ↗

3-4: isobar T ↘ p = const.

4-1: isenthalpe $h_4 = h_1$ p ↘ T = const.



Aufgabe 4

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

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

$s_2 = s_3$

~~$h_3 = h_3(\ldots) = \ldots s_3$~~

$s_3 = s_2 = 0.9066$

c)

d)

e) $\varepsilon_k = \frac{|\dot{Q}_{zu}|}{|\dot{W}_{ab}|} = \frac{|\dot{Q}_k|}{\dot{W}_k}$

$\dot{Q}_k = -\dot{m}($

Aufgabe 3

a) $pV = mRT \quad (m_{EW} + m_{eis} = 0{,}16\,kg)$

$\Sigma F = 0$

$p_{g,1} \cdot A - 0{,}1 \cdot g - 32 \cdot g - p_{amb} \cdot A = 0$

$p_{g,1} = \frac{(0{,}1 + 32) \cdot g}{A} + p_{amb}$

$A = \left(\frac{D}{2}\right)^2 \cdot \pi = \left(\frac{10 \cdot 10^{-2}}{2}\right)^2 \cdot \pi = 0{,}0078\,m^3$

$= \frac{(0{,}1 + 32) \cdot 9{,}81}{0{,}0078} + 1 \cdot 10^5 = 1{,}4\,bar$

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

$R = \frac{\bar{R}}{M} = \frac{8314}{50} = 166{,}28$

$= \frac{1{,}4 \cdot 10^5 \cdot 3{,}14 \cdot 10^{-3}}{166{,}28 \cdot 773} = 0{,}0034\,kg = 3{,}4\,g$

b) $h_{gas} = h_{EW}$

c) Aufgabe 3

Energiebilanz

$$Q - W = \Delta U + \Delta KE^{\nearrow 0} + \Delta PE^{\nearrow 0}$$

$$Q_{12} = W_{12} + \Delta U_{12}$$

$$\Delta U_{12} = U_2 - U_1 = m_g(u_2 - u_1) = m_g\left(c_v\left(T_{g,2} - T_{g,1}\right)\right)$$

$$= 3.6 \cdot 10^{-3} \cdot 0.633\,(0.003 - 500)$$

$$= -1.14\,kJ$$

d) $T_{g,2} = T_{EW,2} = 0.003\,C^\circ$

$$Q_{12} = \Delta U = m \cdot \Delta u = (m_{EW} + m_{eis})(x_{eis} \cdot u_{Fest} + (1 - x_{eis}) \cdot u_{flüssig})$$

$$1500\,J = 0.16\,kg\,(x_{eis}(u_{Fest} - u_{flüssig}) + u_{Fest})$$

$$x_{eis} = \frac{\frac{1500\,J}{0.16} - u_{Fest}}{u_{Fes} - u_{flüssig}} = \frac{\frac{1.5\,kJ}{0.16} + 333.4}{-333.4 + 0.033} =$$

$$Q_{12} = \Delta U = u_2 - u_1$$

$$\frac{U_2}{m_{tot}} = x_{eis,2} \cdot u_{Fest} + (1 - x_{eis,2}) \cdot u_{flüssig}$$

$$\frac{U_1}{m_{tot}} = x_{eis,1} \cdot u_{Fest} + (1 - x_{eis,1}) \cdot u_{flüssig}$$

Please go on another page

c)

$$-\Delta e_{x,str} = h_0 - h_6 - T_0(s_0 - s_6) + \Delta h_k + \Delta p_e^0$$

$h_6(340k) = 340.42$

$s_6^0(340k) = 1.8279$

$$h_0(243k) = \frac{250.05 - 240.02}{250 - 240}(243 - 240) + 240.02$$

$$= 243.03 \frac{kJ}{kg}$$

$$s_0^0(243k) = \frac{1.51917 - 1.47824}{250 - 240}(243 - 240) + 1.47824$$

$$= 1.490519 \frac{kJ}{kg\,k}$$

$$-\Delta e_{x,str} = h_0 - h_6 - T_0\left(s_0^0 - s_6^0 - R \ln\left(\frac{p_0}{p_6}\right)\right) + \frac{w_0^2}{2} - \frac{w_6^2}{2}$$

$$= 243.03 - 340.42 - 243\left(1.490519 - 1.8279 - 287 \ln\left(\frac{0.191}{0.5}\right)\right) + \frac{200^2}{2} + \frac{510^2}{2}$$

$$= -95 \frac{kJ}{kg}$$

$$\Delta e_{x,str} = 95 \frac{kJ}{kg}$$

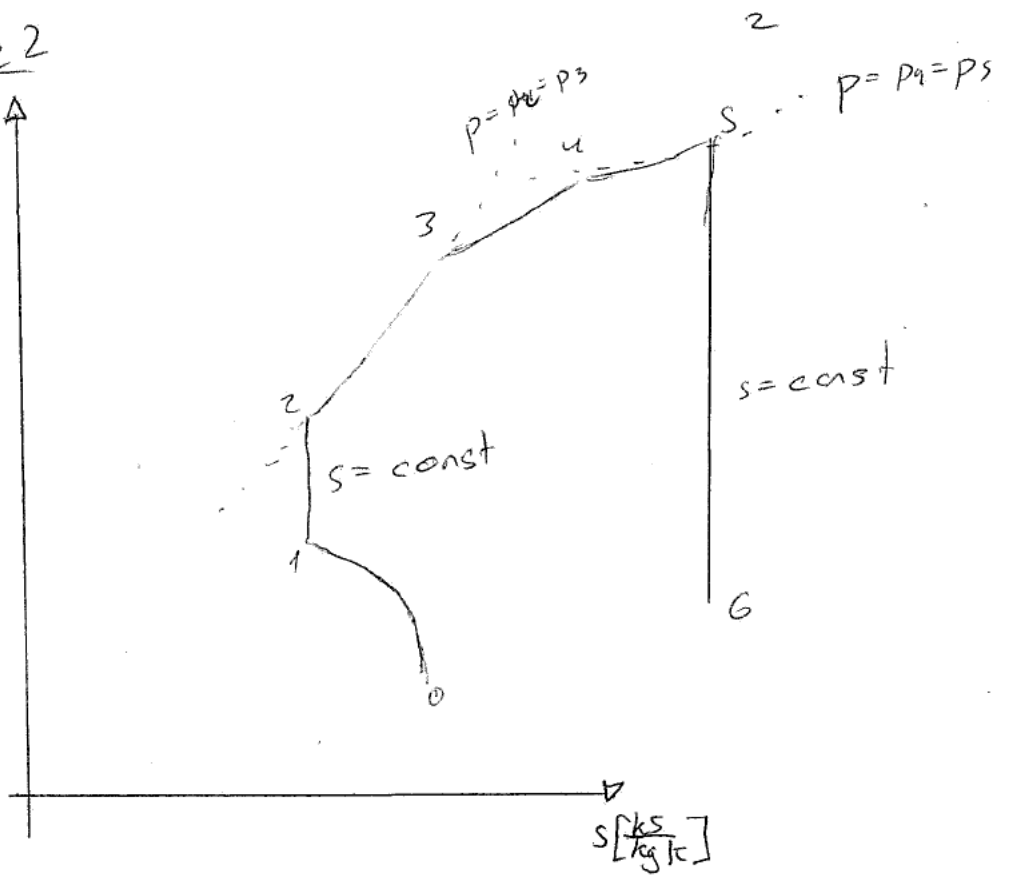
d)

$$\dot{E}_{x,verl} = T_0 \cdot \dot{S}_{erz}$$

$\dot{S}_{erz} =$

Aufgabe 2

a)



0 → 1: s ↘ T ↗

1-2: isentrope $s_1 = s_2$

2-3: isobar T ↗

3-4: s ↗

4-5: $p_4 = p_5$

5-6: $s_5 = s_6$

Aufgabe 2

b) Energie bilanz

$$0 = \dot{m}\left(h_5 - h_6 + \frac{w_5^2 - w_6^2}{2} + g(z_5 - z_6)\right) + \dot{Q}^{\,0} - \dot{W}^{\,0}$$

isentrope $s_5 = s_6$

$$s_5^\circ(431.9k) = \frac{2.0887 - 2.06533}{440 - 430}(431.9 - 430) + 2.06533$$

$$= 2.06977 \quad \text{(Wert von A-22)}$$

$$s_6 - s_5 = s_6^\circ - s_5^\circ - R\ln\left(\frac{p_6}{p_5}\right) = 0 \qquad R = \frac{8314}{28.97} = 287$$

$p_6 = p_0 = 0{,}191$ bar

$p_5 = 0{,}5$ bar

$$s_6^\circ = s_5^\circ + R\ln\left(\frac{p_6}{p_5}\right)$$

$$= 2.06977 + 287 \cdot \ln\left(\frac{0{,}191}{0.5}\right) \cdot 10^{-3}$$

$$= 1.7935 \frac{kJ}{kg \cdot K}$$

$s^\circ(T = 325k) = 1{,}78249$ $\qquad$ $s^\circ(T = 330k) = 1.79783$

$$T_6 = \frac{330 - 325}{1.79783 - 1.78249}(1.7935 - 1.78249) + 325 \quad \text{(Wert von A-22)}$$

$$= 328.5\,K$$

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

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

$$h_5 = \frac{441.61 - 431.43}{440 - 430}(431.9 - 430) + 431.43 \quad \text{(Wert von A-22)}$$

$$= 433.36 \frac{kJ}{kg}$$

$$h_6 = \frac{330.34 - 325.31}{330 - 325}(328.5 - 325) + 325.31 \quad \text{(Wert von A-22)}$$

$$= 328.83 \frac{kJ}{kg}$$

$$w_6 = \sqrt{2}\sqrt{433.36 \cdot 10^3 - 328.83 \cdot 10^3 - \frac{220^2}{2}} = 507 \frac{m}{s}$$

[redacted]

Aufgabe 1

a) Energiebilanz:

$$0 = \dot{m}(h_e - h_a) + \dot{Q}_{IZ} - \dot{Q}_{aus}$$

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

$$h_{ein} = 292.98 \frac{kJ}{kg}$$

$$h_{aus} = 419.04 \frac{kJ}{kg}$$

$$\dot{Q}_{aus} = 0.3\,(292.98 - 419.04) + 100$$

$$= 62.182\ kW$$

b)

$$\dot{Q}_{aus} = 65\,kW$$

$$\bar{T}_{kF} = \frac{\int_{ein}^{aus} T\,ds}{s_{aus} - s_{ein}}$$

Aufgabe 1

c) $T_{kF} = 295\,k$

$$0 = \dot{m}[s_e - s_a] + \sum \frac{\dot{q}_j}{T} + \dot{S}_{er2}$$

$$\dot{S}_{er2} = -\dot{m}(s_e - s_a) - \sum \frac{\dot{q}_j}{T_j}$$

d) $\Delta m[h] + Q - W = \Delta U + \Delta KE + \Delta PE$

c) $\Delta S = m_2 s_2 - m_1 s_1 \qquad m_2 = m_1 + \Delta m_{12}$