Aufgabe 1

a) stationär: $0 = \dot{m}\,[h_{ein} - h_{aus}] + \dot{Q}_{aus} - \dot{Q}_R - \dot{W}_{th}$

$\dot{Q}_R$ und $\dot{W}_t = 0$

$$\dot{Q}_{aus} = \dot{m}\,[h_{ein} - h_{aus}]$$

$$= 0{,}3\ \frac{kg}{s}$$

$h_{ein} \rightarrow$ TAB - A2 $\quad h_{evap_{ein}} = 2333{,}8\ \frac{kJ}{kg}$

$h_{evap_{aus}} = 2257{,}0\ \frac{kJ}{kg}$

$-100\ kJ/s$

$$\dot{Q}_{aus} = 0{,}3\ \frac{kg}{s}\left[2333{,}8\ \frac{kJ}{kg} - 2257{,}0\ \frac{kJ}{kg}\right]$$

$$= -76{,}86\ kW = 23{,}04 = -76{,}96\ kW$$

b) $T_{LF} = \dfrac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)}$ aus $\quad \bar{T} = \dfrac{\int_e^a T\,ds}{s_e - s_a}$

$$= 357{,}9\ K$$

c) $\dfrac{dS}{dt} = 0 = \dot{m}\,[s_e - s_a] + \dfrac{\dot{Q}_{aus} - \dot{Q}_R}{\bar{T}} = -\dot{S}_{erz}$

stationär

$$\dot{S}_{erz} = \dot{m}\,[s_a - s_e] + \frac{\dot{Q}_R - \dot{Q}_{aus}}{\bar{T}}$$

TAB A2:

$s_{e(70°)} =$

$h_{fg} = h_f + x\,(h_g - h_f) \Rightarrow x = \dfrac{h_{fg} - h_f}{h_g - h_f} = \dfrac{2333{,}8\ \frac{kJ}{kg} - 292{,}98}{2626{,}8 - 292{,}98}$

$$= 0{,}874$$

Aufgabe 1

c) TA2

$s_{vapein} = s_f + x(s_g - s_f) = 0{,}9549 + 0{,}874(7{,}755 - 0{,}9549)$

$= 6{,}898 \frac{kJ}{kgK}$

Dampf h_{vap} (100°C) $= 2257{,}0 \frac{kJ}{kg}$ $\quad x = \frac{h_{vap} - h_f}{h_g - h_f}$

$= 0{,}8143$

(100°C) $s_{vap_{aus}} = s_f + x(s_g - s_f) =$

$= 1{,}3069 + 0{,}814(7{,}3549 - 1{,}3069) = 6{,}2299 \frac{kJ}{kgK}$

$\dot{s}_{erz} = 0{,}3 \frac{kg}{s}\left[6{,}898 \frac{kJ}{kgK} - 6{,}2299 \frac{kJ}{kgK}\right] + \frac{100kJ/s + 76{,}96}{357{,}9K}$

$\underline{\dot{s}_{erz} = 0{,}6948 \frac{kJ}{s}}$

d) $T_2 = 70°C$ $\quad T_1 = 100°C$

$\dot{m}_{12} =$

$T_{ein} = 20°C$

$\Delta E = E_2 - E_1 = \Theta_{E2} m_2 v_2 - m_1 v_1 = \dot{m}_{12}[h_1 - h_2] + \dot{Q}_{aus}$

e) mit bereits berechneten Angaben

$$\Delta S = \dot{m}_{12} [s_1 - s_2] + \frac{\dot{Q}_{aus} - \dot{Q}_R}{\bar{T}} + \dot{S}_{erz}$$

~~$= 3600\,kg$~~

s_1 (100°) TA-2: $s_1 = s_f + 0{,}005 (s_g - s_f) = 1{,}3069 + 0{,}005 (7{,}3549 - 1{,}3$

$= 1{,}33714 \frac{kJ}{kgK}$

s_2 $T = 20°C$ = TA-2 (20°) $s_g = 8{,}6672 \frac{kJ}{kgK}$

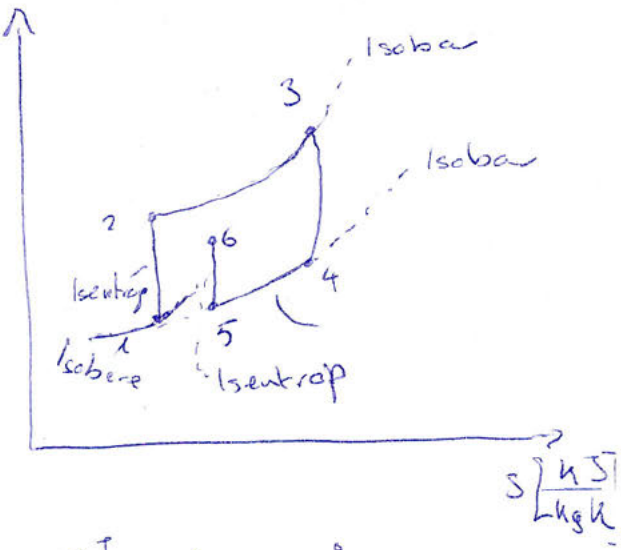
$$\Delta S = 3600\,kg [1{,}33714 - 8{,}6672] + \frac{35\,MJ - 35\,MJ}{T} + \dot{S}_{erz}$$

$$= -2{,}638 \cdot 10^4 \frac{kJ}{K}$$

Aufgabe 2

a)

0 - 1	Isentrop	= q = 0
1 - 2	Isentrop	q = 0
2 - 3	Isobar	w = 0
3 - 4	Q = 0	≠ Isentrop
4 - 5	Isobar	w = 0
5 - 6	Isentrop	



b) $0 = \dot{m}\left[h_0 - h_6 + \frac{(we^2 - wa^2)}{2} + \cancel{p_0}\right] + \dot{Q}_j - \dot{W}_{tn}$

→ nach aussen adiabat → $\dot{Q}_j = 0$

$$\dot{W}_{tn} = m\left[h_5 - h_6 + \frac{(we^2 - wa^2)}{2}\right]$$

$$\left[\frac{\dot{W}_{tn}}{m} + \left[h_6 - h_5\right]\right] \cdot 2 = we^2 - wa^2$$

$$w_6^2 = w_5^2 - \frac{\dot{W}_{tn}}{\dot{m}} + \left[h_5 - h_6\right]$$

$$v_5 = \frac{m R T_5}{p_5} = \frac{0{,}286\,\frac{J}{gK} \cdot 431{,}9K}{0{,}5 \cdot 10^5\,Pa} R = \frac{8{,}314\,\frac{J}{mmol}}{28{,}97\,\frac{kg}{kmol}} = 0{,}2867\,\frac{J}{kgK}$$

$$= 0{,}00247899\,\frac{m^3}{g}$$

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{1{,}4-1}{1{,}4}} \Rightarrow \underline{T_6} = T_5\left[\frac{p_6}{p_5}\right]^{\frac{0{,}4}{1{,}4}} = \underline{328{,}07\,K}$$

$$h_6 - h_5 = c_p\left[T_6 - T_5\right]$$

$$h_5 - h_i - c_p\left[T_5 - T_6\right] = 1{,}006\,\frac{kJ}{kgK}\left[431{,}9K - 328{,}07K\right]$$

$$= \underline{104{,}45\,\frac{kJ}{kg}}$$

Aufgabe 2

b) $w_6^2 = w_5^2 - \frac{\dot{w}_{tn}}{\dot{m}} + [h_5 - h_6]$

$\dot{w}_{tn} = \frac{R[T_6 - T_5)}{1 - l_t 4} = \frac{0{,}2867 \frac{J}{gK}\,[328{,}07K - 431{,}9K]}{0{,}4}$

$= -74{,}42 \frac{J}{g}$

$w_6 = \sqrt{(200 \frac{m}{s})^2 + \frac{74{,}42 \frac{J}{g}}{\dot{m}_{Gas}} + 104{,}45 \frac{kJ}{kg}}$

c) $oe = \frac{\dot{E}}{\dot{m}} = [h_0 - h_6 - T_0(s_0 - s_6) + \frac{1}{2}(w_0^2 - w_6^2)]$

$[h_0 - h_6] = -[h_6 - h_0] = c_p [T_0 - T_6] = 1{,}006 \frac{kJ}{kgK} [293{,}15K - 328{,}0K]$

$= -85{,}359 \frac{kJ}{kg}$

da $P_6 = p_0$

$s_6 - s_0 = \int_{T_1}^{T_2} \frac{c_p(T)}{T} dT - R \ln\left[\frac{P_6}{p_0}\right]$

$= \ln\left(\frac{T_6}{T_0}\right) \cdot c_p = 0{,}3013 \frac{kJ}{kgK}$

$s_0 - s_6 = -s_6 - s_0 = -0{,}3013 \frac{kJ}{kgK}$

$oe = -85{,}359 \frac{kJ}{kg} - 243K \left(-0{,}3013 \frac{kJ}{kgK} + \frac{1}{2}\left((200 \frac{m}{s})^2 - (510 \frac{m}{s})^2\right)\right)$

$= 2{,}67 \cdot 10^7 \frac{kJ}{kg}$

d) Entropiebilanz: $e_{x\,verl} = T_0 \cdot s_{erz}$

$$0 = \dot{m}\,[s_0 - s_6] + \sum_{i} \frac{\dot{Q}_i}{T_i}^{0} + s_{erz}$$

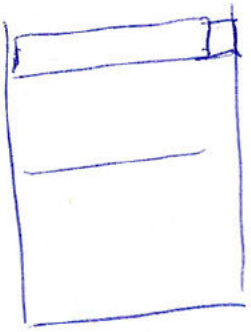
$$\frac{s_{erz}}{\dot{m}} = [s_0 - s_6] = \underline{\underline{-0{,}303}}\ \frac{kJ}{kg\,K}$$

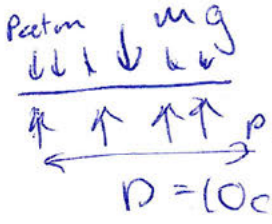
$$e_{x\,verl} = T_0 \cdot s_{erz} = (273{,}15\,K - 30°C) \cdot -0{,}303\,\frac{kJ}{kg\,K}$$

$$= \underline{\underline{-73{,}6}}\ \frac{kJ}{kg}$$

3)

a)





$F_g = m \cdot g = 313{,}9\ N$ $\quad N/m^2$

$F_{atm} = p \cdot (5\,cm)^2 \pi = p \cdot (0{,}005\,m)^2 \pi$

$F_{p_1} = p_1 \cdot (0{,}005\,m)^2 \pi = 7{,}854\ N$

Kräftegleichgewicht

$$F_{p_1} = F_g + F_{atm} \Rightarrow p_1 = \frac{F_g + F_{atm}}{(0{,}005\,m)^2 \pi} = 40{,}96 \cdot 10^5\,Pa$$

$p_1 = 40{,}96\ bar$

$$R = \frac{\bar{R}}{M} = \frac{8{,}314\ \frac{J}{mol\,K}}{50\ \frac{kg}{kmol}} = 0{,}16628\ \frac{kJ}{kg\,K}$$

$p_1 V_1 = m R T_1$

$3{,}14\,L \cdot 10^{-3}\ m^3$

$$m = \frac{p_1 V_1}{R T_1} = \frac{40{,}96 \cdot 10^5\,Pa \cdot [\text{redacted}]}{0{,}16628\ \frac{kJ}{kg\,K} \cdot 779{,}15\,K} = 99{,}27\ g$$

→ da ich denke dass mein Druck falsch ist rechne ich mit den gegebenen Werten weiter

b) $$m = \frac{p_{geg} V_1}{R T_1} = \frac{1{,}5 \cdot 10^5\,Pa \cdot 3{,}14 \cdot 10^{-3}\,m^3}{0{,}16628\ \frac{kJ}{kg\,K} \cdot 779{,}15\,K} = 3{,}635\ g$$

b)

b)

c) $\Delta E = \sum Q_1 - \sum W \qquad \dot{W} = 0$ da inkompressibel

$$\dagger \quad U_2 - U_1 = c_v \left[T_2 - T_1\right] = Q_{12}$$

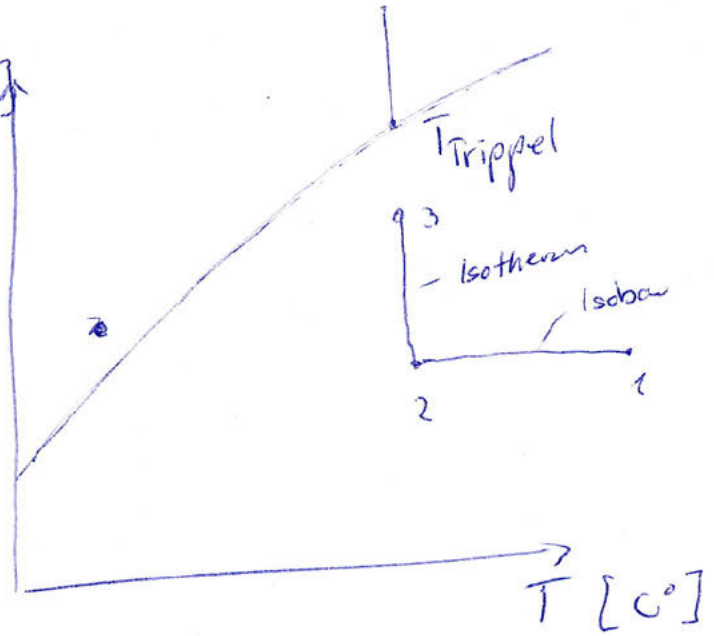
$$0{,}633 \frac{kJ}{kgK} \left[(0{,}005 + 273K) - (273 + 500)^{\circ}C\right]$$

$$\underline{Q_{12} = -316{,}49\,kW}$$

d)

4/

a)



b) 2-3 Kompressor adiabat $\dot{q}_K = 0$

stationär

1 HS $\frac{dE}{dt} = \sum \dot{m} \left[h + k_e + p_e \right] + \dot{Q} - \sum \dot{\omega}_u$

$0 = \dot{m} \left[h_2 - h_3 \right] - \dot{\omega}_u \qquad \dot{m} = \frac{\dot{\omega}_K}{h_2 - h_3}$

$\dot{m} =$

c) mit $\dot{m}_R = 4 \frac{kg}{h}$ und $T_2 = -22°C$