[redacted]

$p_{Kein} = p_{Kaus} = \text{konst}$

1) $T_{ein} = 70°C$ $\quad T_{Kein} = 298.15\,K$ $\quad$ Wasser TABs

$T_{aus} = 100°C$ $\quad T_{Kaus} = 288.15\,K$ $\quad$ Kühl: perf. fluid

$\frac{V}{V} = m$

$\frac{1}{\rho} = v$

$T_{Reakt} = 100°C$

$w\,\frac{A}{v} = \dot{m}$

$m_{ges} = 5755\,kg$

$x_D = 0.005 = m_D / m_{ges}$

$\frac{\Delta H}{\dot{Q}} = \Delta +$

$\dot{Q}_R = 100\,kW$

a) $\dot{Q}_{aus} = ?$

$$\begin{bmatrix} \text{stat.} \\ 2\times \dot{m} \end{bmatrix} \quad 0 = \dot{m}_{ein}(h_e - h_a) + \underbrace{\dot{m}_{aus}}_{\dot{m}_{ein}}(h_e - h_a) + \dot{Q}_R + \dot{Q}_{aus} - \underbrace{\cancel{\sum \dot{W}}}_{=0}$$

2626.8

$$\curvearrowright \dot{Q}_{aus} = 2\dot{m}_{ein}(h_e - h_a) + \dot{Q}_R \qquad \leftarrow h_e = h_f(70°C) = 292.98\,\tfrac{kJ}{kg}$$

$$h_a = h_f(100°C) = 419.04\,\tfrac{kJ}{kg}$$

2676.1

$$\dot{Q}_{aus} = 2\cdot 0.3\,\tfrac{kg}{s}\,(292.98 - 419.04)\,\tfrac{kJ}{kg} + \dot{Q}\,100\,kW$$

$$= \underline{\underline{24.364\,kW}}$$

TAB A2

b) $$\bar{T}_{KF} = \frac{\int_e^e T\,ds}{s_e - s_a}$$

$$\longrightarrow s_e - s_a = \int_a^e c\,\frac{1}{T}\,dT = c\cdot \ln(T_e/T_a)$$

$$\longrightarrow \int_e^e T\,ds = \Delta H = h_e - h_a = \int_a^e c\,dT + v^{i3}\underbrace{\cancel{(p_e - p_a)}}_{=0 \text{ konstant}} = c\,(T_e - T_a)$$

$$\longrightarrow \frac{c\,(T_e - T_a)}{c\,\ln(T_e/T_a)} = \bar{T}_{KF} \quad |:c \qquad \begin{cases} T_{Kein} = 288.15 \\ T_{Kaus} = 298.15 \end{cases}$$

$$\frac{288.15 - 298.15}{\ln(288.15/298.15)} = \underline{\underline{293.12\,K = \bar{T}_{KF}}}$$

c) $\dot{S}_{erz} = ?$

$$\begin{rcases} \text{stat.} \\ 2\times \dot{m} \end{rcases} \quad 0 = \dot{m}_{ein}(s_e - s_a) + \underbrace{\dot{m}_{aus}}_{\dot{m}_{ein}}(s_e - s_a) + \dot{Q}_{aus}/\bar{T}_{KW} + \dot{S}_{erz}$$

8.7614

$$\curvearrowright \dot{S}_{erz} = 2\dot{m}_{ein}(s_a - s_e) - \left(\dot{Q}_{aus}/\bar{T}_{KW}\right) \qquad \leftarrow s_e = s_f(15°) = 0.2245\,\tfrac{kJ}{kgK}$$

$$s_a = s_f(25°) = 0.3674\,\tfrac{kJ}{kgK}$$

8.5580

$$= 2\cdot 0.3\,\tfrac{kg}{s}\,(0.3674 - 0.2245)\,\tfrac{kJ}{kgK} - \frac{65\,kW}{295\,K}$$

$\frac{\dot{Q}_{aus}}{\bar{T}}$ } vorgegebene Werte

$$= \underline{\underline{-0.354\,kW/K}}$$

d) T
1 ~~70°C~~ 20°C
2 ~~2~~70°C

Δm_{12}
$Q_{aus} = 35 \cdot 10^3 \, kJ$

Zufluss gestoppt

d) $\frac{dE}{dt} = \cancel{\dot{m}_{12}(h_1 - h_2)} + \sum \dot{Q} - \underbrace{\cancel{\sum \dot{W}_t}}_{=0}$

$m_2 u_2 - m_1 u_1 = \cancel{\dot{m}_{12}(h_1 - h_2)} + \dot{Q}_{aus}$ ← $h_1 = h_g(20°C) = 83.96$

m_2

$h_2 = h_g(70°C) = 292.98$
$u_2 = u_g(70°C) = 1.0228 \cdot 10^{-3}$
$u_1 = u_g(20°C) = 1.0018 \cdot 10^{-3}$

[redacted]

$w_5 = 220\ m/s$

2) $w_6 = 200\ m/s$

$\dot{m}_{ges}$

$\eta_{LV,s} < 1 \leftarrow$ isentrop

$\frac{\dot{m}_H}{\dot{m}_K} = 5.293$

$q_B = \frac{\dot{Q}_B}{\dot{m}_K} = 1195\ \frac{kJ}{kg}$

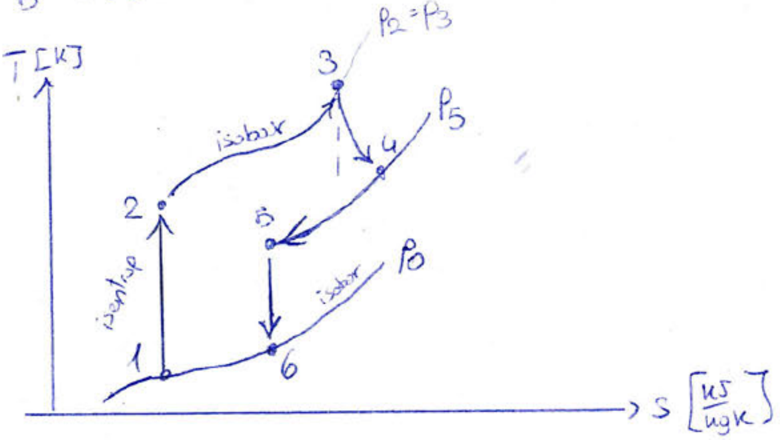
$\bar{T}_B = 1289$

	p	T
0	0.191 bar	-30°C
5	0.5 bar	431.9 K

$c_p = 1.006.$

$n = \kappa = 1.4$

a)



b) $w_6 = ?$ $T_6 = ?$

~~$w_{60}^{rev} = \int_0^6 p\,dv = R$~~

$\frac{T_6}{T_0} = \frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}$ $\leftarrow$ isentrop $n = \kappa = 1.4$

$\curvearrowright \underline{T_6} = T_5 \left(\frac{p_0}{p_5}\right)^{\frac{n-1}{n}}$

$= 431.9\,K \left(\frac{0.191\,bar}{0.5\,bar}\right)^{\frac{0.4}{1.4}} = \underline{\underline{328.075\,K}} = T_6$

stat. $1 \times \dot{m}$ $\Big\}$ $0 = \dot{m}\left(h_e - h_a + \frac{w_e^2 - w_a^2}{2}\right) + \sum \dot{Q} - \sum \dot{W}_t$

c) $\dot{m}_{ges} = ?$

$\Delta e_{x,str} = ?$

$$\dot{m}_{ges}\left(h_0 - h_6 + \frac{w_2^2 - w_6^2}{2}\right) + \underbrace{\cancel{\sum \dot{Q}}}_{=0} + \sum W_t \quad \leftarrow W_t = \frac{\dot{W}_t}{\dot{m}} = \int_0^6 v\,dp + \Delta ke + \underbrace{\cancel{\Delta pe}}_{=0}$$

$$= -n \int p\,dV + \Delta ke$$

$$= -n \frac{R(T_6 - T_0)}{1-n} + \frac{1}{2}\dot{m}(w_2 - w_6)^2$$

$$\dot{m}_{ges}\left(h_6 - h_0 - T_0(s_6 - s_0) + \Delta ke + \underbrace{\cancel{\Delta pe}}_{=0}\right) = \Delta e_{x,str}.$$

d) $ex_{verl} = T_0 \dot{S}_{erz}$

$\cancel{= T_0}$

$\longrightarrow \dot{S}_{erz} = \dot{m}_{ges}(s_6 - s_0) \mp \underbrace{\cancel{\frac{\dot{Q}}{T}}}_{=0}$ adiabat

[redacted]

3) a) $p_{G1} = ?$ $m_g =$

$A = (D/2)^2 \pi = 0.007854\ m^2$

$p_{neu} = F/A = m_K g/A + m_{EW} g/A$

$= 32 \cdot 9.81 / 0.007854 + 0.1 \cdot 9.81 / 0.007854$

$= 40'0094.35\ Pa$

$= 0.4\ bar$

$p_{G1} = p_0 + p_{neu} = \underline{\underline{1.4\ bar}}$

$m_g = ?$

$R = \frac{\bar{R}}{M} = \frac{8.314}{50} = 0.16628$

$pV = mRT \curvearrowright m = \frac{pV}{RT} =$

$p = p_{G1}$

$m_g = \frac{p_{G1} V}{R T} = \frac{1.4\ bar \cdot 10^2\ kPa \cdot 3.14\ L}{0.16628\ \frac{kJ}{kgK} \cdot (500 + 273.15)\ K \cdot 1000}$

$= 0.00342\ kg$

$= \underline{\underline{3.42\ g}}$

b) Wenn $x = 0$ dann ist Eis = Wasser

Wenn $x = 1$ dann ist Eis = Dampf

$\longrightarrow$ T_2 muss kleiner werden

c) $\frac{dE}{dt} = \sum \dot{Q} - \sum \dot{W}$

$\Delta E = \Delta Q - \cancel{\Delta W}$ keine Arbeit

~~$m_2 = m_1$~~

vernachlässigen

$m_2 u_2 - m_1 u_1 + \cancel{\Delta KE} + \cancel{\Delta PE} = \Delta Q$

~~mit~~ $u_1 (500°C, 1.4 bar)$

$u_2 (\quad , 0.003°C)$

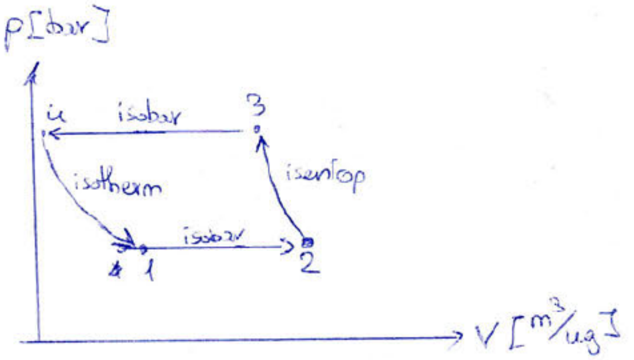
[redacted]

4) R134a

	p	T			
1	$\boxed{}$	$\boxed{\cancel{31.33}°C}$			
2		$\boxed{s_2, s_3}$	$x_2 = 1$	gas	← isentrop ← $\cancel{\dot W_k = 28k}$ isobar
3	$\boxed{8\,bar}$				
4	$\boxed{8\,bar}$	$31.33°C$	$x_4 = 0$	flüssig	← isenthalp + isotherm

$T_i - 6k = T_2$

a)



$T_i = 10k + T_{tripel}$
$= 10k + 273.15$
$= 283.15$
$T_2 = T_i - 6k = 277.15$
$=$

b) $\dot m = ?$

$\left.\begin{matrix}\text{stat.}\\ 1 \times \dot m\end{matrix}\right\} \; 0 = \dot m (h_e - h_a) + \sum \dot Q - \sum \dot W$
$=$

~~PREP~~ $s_2 = s_g(6k) =$
$s_4 = s_g(\quad = 0.3459$
$T_4 = 31.33°C$
$s_3 = s_g(\cancel{8\,bar}) = 0.9066$
$h_1 = h_4 = h(31.33°C,$

c) $\dot m_R \quad T_2 =$

$x_1 = \dfrac{h_1 - h_f}{h_g - h_f}$ $\longrightarrow T_1 = T_4 = 31.33°C$

d) $\varepsilon_K = \dfrac{\dot Q_{zu}}{\dot W_t} = \dfrac{|\dot Q_{zu}|}{|\dot Q_{ab}| - |\dot Q_{zu}|} =$

$\longrightarrow \dot Q_{zu} = \dot Q_K = \dot m (h_2 - h_1)$
$\longrightarrow \dot Q_{ab} = \dot m (h_4 - h_3)$

$\leftarrow h_1 = h(T_1, p_1)$
$\leftarrow h_2 = h_g(T_2 = -22°C) = 234.08$
$\leftarrow h_3(8\,bar, T_3)$
$\leftarrow h_4 = h_{\cancel{g}f}(8\,bar) = 93.42$

d) T_i würde immer niedriger werden bis es "unmöglicherweise" zum absoluten Nullpunkt erreicht