1)

a) $\dot{Q}^*_{aus} = -\dot{m}[h_e - h_a]$

~~$T_{Luft,ein} = 288.15\,K$, $T_{KF,aus} = 298.15\,K$~~

$T_{ein} = 70°C$, $T_{aus} = 100°C$ → reines Wasser

$\Rightarrow h_e = h_f(70°C)$ / TAB. A-2

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

$h_a = h_f(100°C) + x_D \cdot (h_g(100°C) - h_f(100°C))$

$= 419.04 + 0.005\,(2676.1 - 419.04)\,[\frac{kJ}{kg}]$

$= 430.33 \frac{kJ}{kg}$

$\Rightarrow \dot{Q}^*_{aus} = -0.3 \frac{kg}{s}\left[292.98 \frac{kJ}{kg} - 430.33 \frac{kJ}{kg}\right]$

$= 41.2\,kW$ → $\dot{Q}_R - \dot{Q}^*_{aus} = \dot{Q}_{aus}$

$\dot{Q}_{aus} = 58.8\,kW$

b)

$\bar{T} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{298.15\,K - 288.15\,K}{s_a - s_e}$

A-2 → ~~$s_a = 1.3069$, $s_e = ?$~~ $s_e = 0.9549$

$s_a = s_f + x_D(s_g - s_f)$ /A-2)

$= 1.337$

$\Rightarrow \bar{T} = \frac{298.15 - 288.15\,[K]}{0.9549 - 1.337\,[\frac{kJ}{kgK}]} = -26.17$

umgekehrt

c)

$$\dot{S}_{erz} = -\dot{m}[s_e - s_a] + \sum \frac{\dot{Q}}{T}$$

$\dot{m} = 0.3 \frac{kg}{s}$, $s_e = 0.3549 \frac{kJ}{kgK}$, $\dot{Q} = \dot{Q}_R - \dot{Q}_{aus}$

$s_a = 1.377$ "

d)

$$0 = \dot{m}[h_e - h_a] + \dot{Q}_R + \dot{Q}_{aus}$$

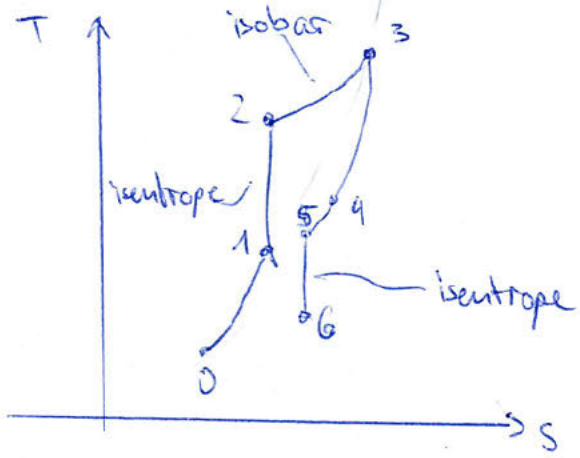
$$\dot{m} = -\frac{\dot{Q}_R + \dot{Q}_{aus}}{(h_e - h_a)}$$

e)

$$\Delta S = m(s_2 - s_1) \qquad / m = 5755\,kg$$

2)

a)



$p_0 = 0.1\,\text{bar}$, $T_0 = 30°$, $s_0 =$

~~$s_1 = s_0$~~ $s_1 \neq s_0$

b)

c) $\dot{E}_{\text{exx, str.}} = \dot{m}\left[h - h_0 - T_0(s - s_0)\right]$

3)

	T_g [°C]	V_g [m³]	T_{EW}
Z_1	500	$3.14 \cdot 10^{-3}$	0
Z_2			

$m_{EW} = 0.1\,kg$; $x_{Eis,1} = \frac{m_{Eis}}{m_{EW}} = 0.6$

$D = 10\,cm$, $g = 9.81\ \frac{m}{s^2}$

a)

$p_{gas} = p_{amb} + p_{Kolben}$

$\longrightarrow$ $p_{gas,1} = 1\,bar + g\,32 / \pi\left(\frac{D}{2}\right)^2 \frac{kg\ \frac{m}{s^2}}{m^2}$ $\Rightarrow$ ~~1 bar~~ + $\frac{32\,kg \cdot 9.81\ \frac{m}{s^2}}{\pi \cdot (0.05)^2} = 39.969 \cdot 10^3\ \frac{N}{m^2} = 399.69\ \frac{N}{m^2}$

$\hat{=} 0.4\,bar$

$\Longrightarrow$ $p_{gas,1} = 1 + 0.4\,[bar] = \underline{1.4\,bar}$

$m_{gas} = \frac{pV}{RT}$ $\quad / R = \frac{\bar{R}}{M_g} \cdot 10^3$

$= \frac{1.4 \cdot 10^5 \cdot 3.14 \cdot 10^{-3}}{\frac{\bar{R}}{M_g} \cdot 10^3 \cdot 773.15} = \underline{3.42\,g}$

b) $p_{gas} = const.$ $\longrightarrow$ weil Thermody. glgw. und das EW inkompressibel leistet das EW ~~nicht mehr~~ kein Beitrag zum Druck, also muss $p_1 = p_2$

c)

$$\Delta E = \Sigma Q_{12} - \Sigma W_{v,12}$$

$$W = \int_1^2 p\,dV = p_{gas}(V_2 - V_1)$$

$$V_2 = \frac{mRT_2}{p} = \frac{3.42 \cdot 10^{-3} \cdot R \cdot 273.153}{1.4 \cdot 10^5} = 0.01110\ m^3 \triangleq 1.11\ L$$

$$\Rightarrow W = 1.4 \cdot 10^5 \left(1.11 \cdot 10^{-3} + 3.14 \cdot 10^{-3}\right) = 594.34\ J$$

~~ΔE~~ $\Delta E = c_v (T_2 - T_1)$

$$= 0.633 \frac{kJ}{kg\,K} (273.153 - 773.15)$$

$$= -316 \frac{kJ}{kg} \longrightarrow \Delta E \cdot m =$$

$$\Rightarrow Q_{12} = \Delta E + W$$

d)

$$x_{2,Eis} = \frac{|u_2| - u_{Test}}{u_{fl.} - u_{Test}} \quad / \text{ mit } T_2 = 0.003\,°C$$

~~$x_{2,Eis}$~~ $u_2 = c_v (T_2 - T_1) + u_1$ $\quad / u_1 = -333.458 + x_1(-0.045 + 333.458) = -133.410 \frac{kJ}{kg}$

$$= 0.633 (273.153 - 773.15) + (-133.410)$$

$$= -449.91 \frac{kJ}{kg}$$

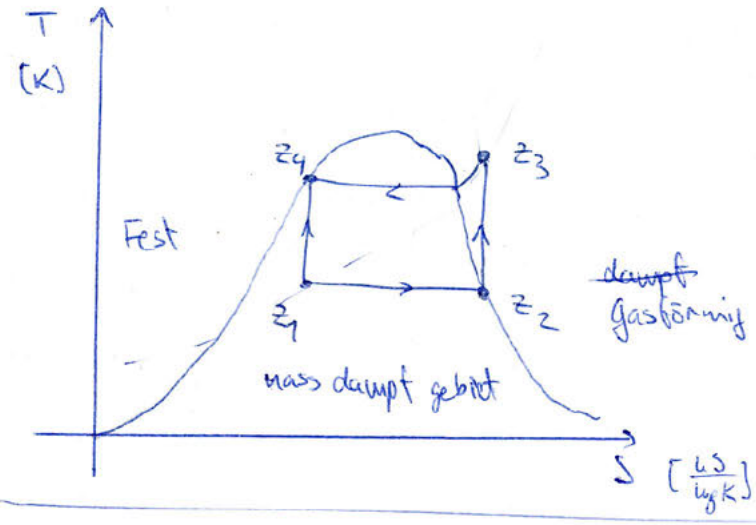
$$\Rightarrow x_{2,Eis} = \frac{|-449.91| - (-333.442)}{-0.033 - (-333.442)} = 0.3493 \Rightarrow \underline{34.9\,w\%}$$

4)

	T	p (bar)	v	h	s
z_1	~~6°C~~	1			
z_2	-6°C			243.72	$s_1 = s_2$ 0.9226
z_3		8			$s_3 = s_2$ 0.9226
z_4		8			

$T_i = 0°C \rightarrow$ ~~z4~~ $T(z_3) = -6°C$

a)



b)

$$0 = \dot{m}_{R134a}[h_2 - h_4] + \dot{Q} - \dot{W}$$

$$\dot{m}_{R-134} = \frac{-\dot{W}_K}{h_2 - h_3}$$

h_2 => Tab. A-10 LERP mit $\frac{y_2 - y_1}{x_2 - x_1}(x - x_1) + y_1$ $\begin{pmatrix} -8, 242.54 \\ -4, 244.50 \end{pmatrix}$

$$h_2 = 243.72 \frac{kJ}{kg}$$

nächste Seite →

~~h_3 => x ~~ finden~~

~~$x = \frac{h_2 - h_f}{h_g - h_f}$ A-10 => LERP h_f 42.145, h_g =~~

4)

b) continued:

LERP $\xrightarrow{A-10}$ $s_{i,3} = 0.5226 \frac{kJ}{kg\,K}$

$\Longrightarrow$ LerP $\begin{pmatrix} 0.9066 \rightarrow 264.15 \\ 0.5374 \quad\quad 273.66 \end{pmatrix}$

$\Longrightarrow h_3 = 269.09 \frac{kJ}{kg}$

$\Longrightarrow \dot{m}_{R134} = \frac{-28\,W}{243.72 - 269.09\ [\frac{kJ}{kg}]} = 1.10 \frac{kg}{s}$

c) ~~rechte Seite $T_2 = 28°C$~~

$\rightarrow$ $x_3 = \frac{h_3 - h_f}{h_g - h_f}$ $\xrightarrow{A-8}$ $x_3 = \frac{269.09 - 63.53}{255.05 - 63.53} = 1.07$

~~kann nicht~~

$x_1 = \frac{h_1 - h_f}{h_g - h_f}$ /A-8

d)

$\varepsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_K|} = \frac{|\dot{Q}_{zu}|}{|\dot{Q}_{ab}| - |\dot{Q}_{zu}|}$ $/\dot{Q}_{zu} = \dot{Q}_K$

=

e)