4

4

a)

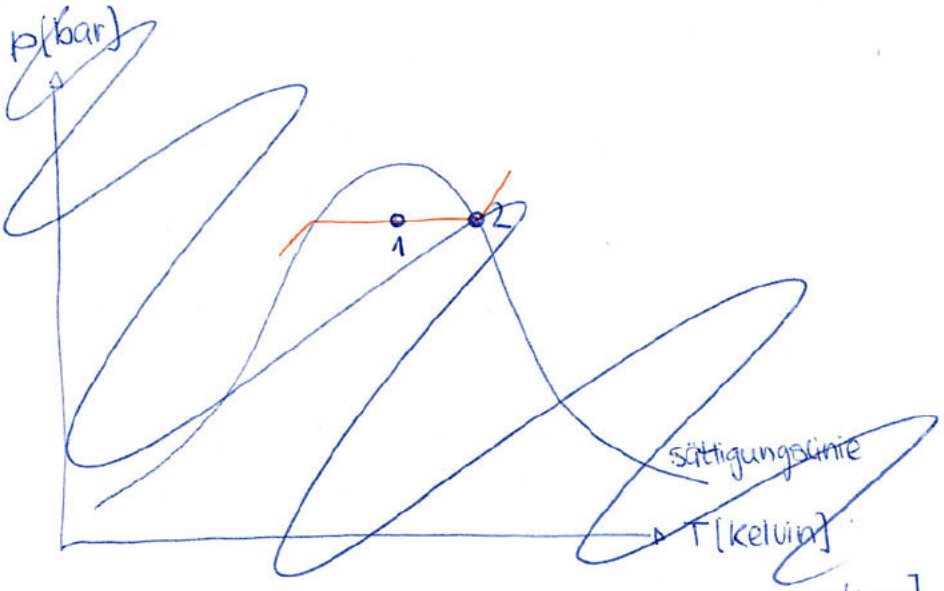
~~tel verdampft~~

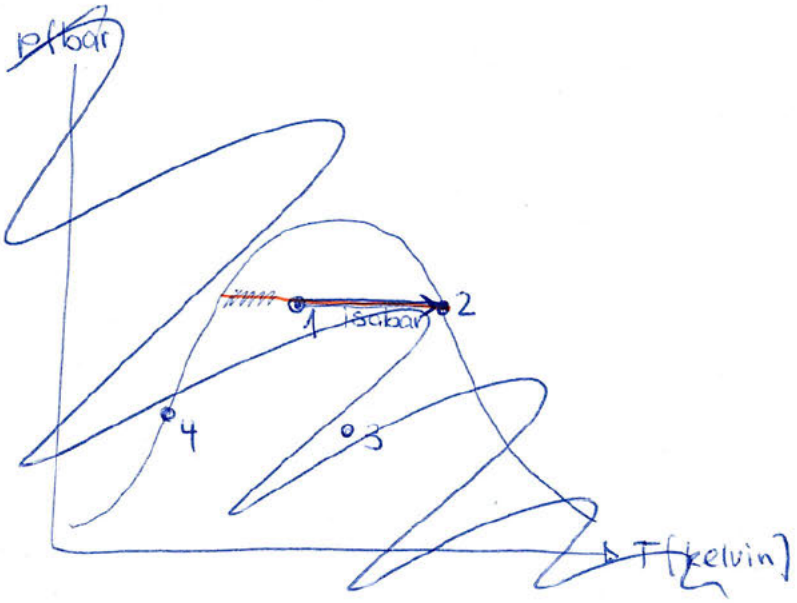
	p	T	V	W	S	Q
1	$p_1 < 8\,bar$					$-\dot{Q}_K$
2	$p_1 = p_2$	$T_1 - 6K$		$\dot{W}_K$	"	
3	8 bar					
4	8 bar					

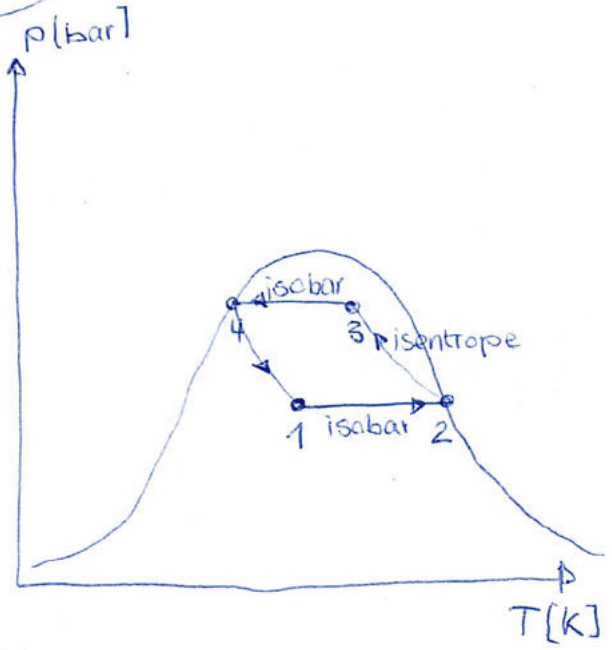
Gasförmig, gesättigt

flüssig

$p_1 = p_2$ $\quad S_2 = S_3$







b) $\dot{m}_{R134a}$

Verdichter

1 HS.

$$0 = \dot{m}(h_e - h_a) + \dot{Q}^{0} - \dot{W}_k$$

$s_2 = s_3$

$T_2 = T_1 - 6K$

$T_1 = 273{,}15K + 10K = 283{,}15K$

$T_2 = 277{,}15K$

$$\dot{W}_k = \dot{m}_{R134a}\,(h_2 - h_3)$$

$h_2(T = 277{,}15k)$ — gasförmig gesättigt

TAB A-10 4°C

$h_{2g}(4°C) = 249{,}53\ \frac{kJ}{kg}$ $\qquad s_{2g} = 0{,}9169\ \frac{kJ}{kg \cdot k}$

$h_3(8bar, s_2)$

Nassdampf : $s_3 = s_f(8bar) + x\,(s_g(8bar) - s_f(8bar))$

A-11

$s_f = 0{,}3459$

$s_g = 0{,}9066$

$x = 0{,}29999$

TAB A-11 $h_3(8bar) = h_f(8bar) + x\,(h_g(8bar) - h_f(8bar))$

$h_f = 93{,}42$

$h_g = 264{,}15$

$h_3(8bar) = 144{,}637\ \frac{kJ}{kg}$

$h_3 = h_4$

$$\frac{\dot{W}_k}{h_2 - h_3} = \dot{m}_{R134a} = \frac{28 \cdot 10^{-3}\ \frac{kJ}{s}}{h_2 - h_3\ (\frac{kJ}{kg})} = 2{,}669 \cdot 10^{-4}\ \frac{kg}{s} = \dot{m}_{R134a}$$

~~$1{,}9067 \cdot 10^{-4}\ \frac{kg}{s} = \dot{m}_{R134a}$~~

$\dot{W}_k = 28W = 28\ \frac{J}{s}$

[redacted]

(4)

c) x_1

4–1 $\quad 0 = \dot{m}(h_4 - h_1)$ — da $\dot{W} = 0$ $\dot{Q} = 0$

$h_4 = h_1$

$h_4 = h_f(8\,bar)$ TAB A-11

$h_4 = 93{,}42 \frac{kJ}{kg} = h_1$

$h_1 = h_f + x(h_g - h_f)$

$p_1 = p_2$ TAB A-10

$p_2(4°C) = 3{,}3765\,bar$ TAB A-11

$h_f(3{,}3765\,bar) = \frac{h_f(3{,}6bar) - h_f(3{,}2\,bar)}{3{,}6 - 3{,}2} \cdot (3{,}3765 - 3{,}2) + h_f(3{,}2bar)$

$h_f = 55{,}3 \frac{kJ}{kg}$

$h_g(3{,}3765bar) = \frac{h_g(3{,}6bar) - h_g(3{,}2bar)}{3{,}6 - 3{,}2} \cdot (3{,}3765 - 3{,}2) + h_g(3{,}2bar)$

$h_g = 249{,}5072$

$x = \frac{h_1 - h_f}{h_g - h_f} = 0{,}1963 = x_1$

d) $\varepsilon_k = \frac{|\dot{Q}_{zuk}|}{|\dot{Q}_{ab}| - |\dot{Q}_{zuk}|} = \frac{|\dot{Q}_k|}{|\dot{W}_k|} = 2{,}0836 = \varepsilon_k$

$\dot{Q}_k = \dot{m}(h_2 - h_1)$

$\dot{Q}_k = 41{,}6718 \frac{J}{s}$

$= 0{,}04167 \frac{kJ}{s} = \dot{Q}_k$

$= \frac{1{,}9667 \cdot 10^{-4}\,kg}{2{,}668 \cdot 10^{-4} \frac{kg}{J}} \cdot \left(249{,}53 \frac{kJ}{kg} - 93{,}42 \frac{kJ}{kg}\right) = 0{,}029765\,kJ = \dot{Q}_k$

b) (3)

[redacted]

c) $T_1 = 773{,}15\,K$ $\quad T_{g2} = 0{,}003\,^\circ C = 273{,}153\,K$

Q_{12}

~~1HS~~

$c_v = 0{,}633\,\frac{kJ}{kgK}$

$c_v \cdot m \cdot \Delta T = Q_{12} = 0{,}633 \cdot 2{,}81 \cdot 10^{-3}\,kg \cdot 773{,}147\,K =$

$= 1{,}375\,kJ = Q_{12}$

d) $x_{Eis} = \frac{m_{eis}}{m_{ew}}$

$m_{ew} = 0{,}1\,kg$

$T_{EW} = 0\,^\circ C$

$p_{aussen} = 1{,}4\,bar$

$p_{EW}_{aussen} = p_{amb} + \frac{F}{A}$

$F = m_k \cdot g \quad A = r^2 \cdot \pi = (0{,}05\,m)^2 \cdot \pi = 7{,}854 \cdot 10^{-3}\,m^2$

$p_{EW} = 1'000'00 + \frac{F}{A} =$ ~~$39'969{,}44\,Pascal$~~

~~$T_{EW_g}(1{,}4\,bar)$~~

$= 139'969{,}44 \triangleq$ ~~$1{,}3$~~ $1{,}4\,bar = p_{aussen}$

~~$h_2 = h_f + x\,(h_{solid} - h_f)$~~

$V_2 = V_f + x\,(V_{solid} - V_f)$

3

	T °C	V	p	m
1 Gas	500	3,14	1,15	~~0,1kg~~
1 Wass	0°C			0,1kg
2 Gas				
2 Wass				

a) p_{g1} , m_g

$M_g = 50 \frac{kg}{kmol} = 50 \cdot 10^{-3} \frac{kg}{mol}$ $\quad R = \frac{\bar{R}}{M_g} = 166{,}28 \frac{J}{molK}$

$pV = RT$ $\quad T = 500°C = 773{,}15\,K$ $\quad V = 3{,}14\,L = 3{,}14 \cdot 10^{-3}\,m^3$

~~$\frac{V}{m} = v$~~ $\quad V = v \cdot m$

~~$n = M$~~ $\quad n = \frac{M}{m}$

b) $p \cdot V = \frac{M}{m} \cdot \bar{R} \cdot T$

~~$p =$~~ $\quad m = \frac{M \cdot \bar{R} \cdot T}{p \cdot V}$

↳ $pV = \frac{M \cdot \bar{R} \cdot T}{p \cdot V} \cdot R \cdot T$

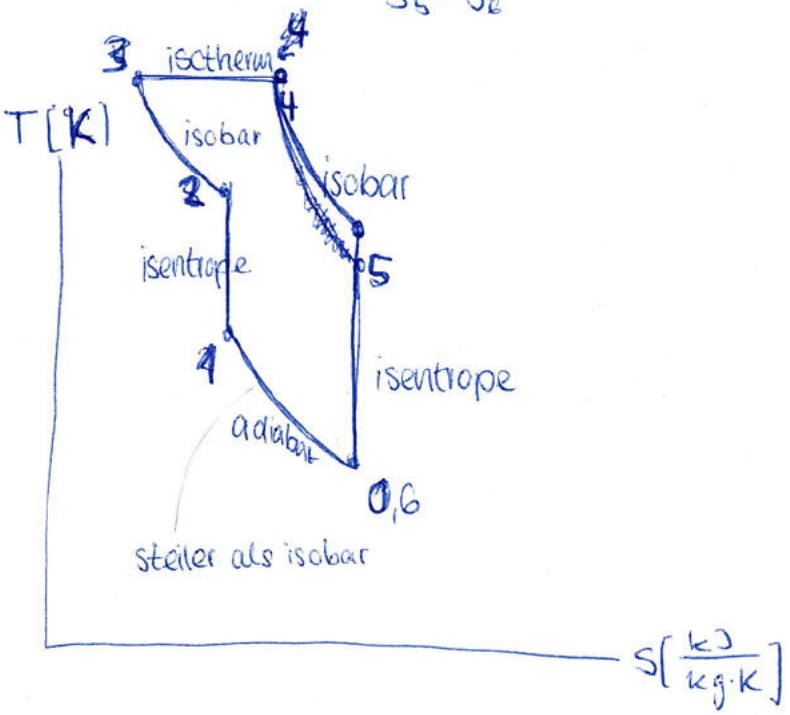
$p^2 = \frac{M \cdot \bar{R} \cdot T^2 \cdot R}{V^2} \rightarrow p = 114'712{,}03\,pascal \triangleq 1{,}15\,bar = p_{g1}$

m_g: $pV = mRT$

$m = \frac{pV}{RT} = 2{,}81 \cdot 10^{-3}\,kg = 2{,}81\,g = m_g$

2)

		T	s
0			
1	$< p_0$		
2			$s_2 = s_1$
3		$> T_2$	
4			
5	0,5 bar	431,9	
6			$s_5 = s_6$



b) $\omega_5 = 220 \frac{m}{s}$ isentrop

$p_5 = 0{,}5$ bar 5–6

$T_5 = 431{,}9$ K

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{1,4-1}{1,4}} \qquad n = \kappa$$

$$T_6 = \left(\frac{0{,}191 \text{ bar}}{0{,}5 \text{ bar}}\right)^{\frac{0,4}{1,4}} \cdot 431{,}9 \text{ K} = 328{,}07 \text{ K} = T_6$$

1. HS.

$$0 = \dot{m}\left[h_5 - h_6 + \frac{(\omega_5^2 - \omega_6^2)}{2}\right] + \dot{Q}^{0} - \dot{W}^{0}$$

$$\sqrt{-2 \cdot (h_6 - h_5) + \omega_5^2} = \omega_6$$

h_6 h_5

c)

$$0 = \dot{m}_{ges}\left[h_1 - h_6 - T_0\,(s_1 - s_6)\right] = 0$$