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Thermo I - Winter 24

1) Reaktor

a)
ges: $\dot{Q}_{aus}$

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

kann Arbeit

$\dot{W} = 0$

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

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

$\dot{m}_{ein} = 0{,}3\ kg/s$
$\dot{Q}_R = 100\ kW$

h_e @ $T = 70°$ "siedende Flüssigkeit"

$h_f = 292{,}98$
$h_g = 2626{,}8$ kJ/kg

$\rightarrow h_e = h_f(70°)$.

(neg. da $\dot{Q}$ aus Sys raus)

$$\dot{Q}_{aus} = -62{,}182\ kW$$

TA-2

h_a @ $T = 100°$

$h_f = 419{,}04$
$h_g = 2676{,}1$ kJ/kg

$h_a = h_f(100°)$

$$-\dot{Q}_{aus} = 0{,}3\ kg/s\ (292{,}98 - 419{,}04)\ kJ/kg + 100\ kW = 62{,}182\ kW$$

b) ges: $\overline{T}_{KF}$

$T_{KF\,aus} = 298{,}15\,K = T_{K2}$

$T_{KF\,ein} = 288{,}15\,K = T_{K1}$

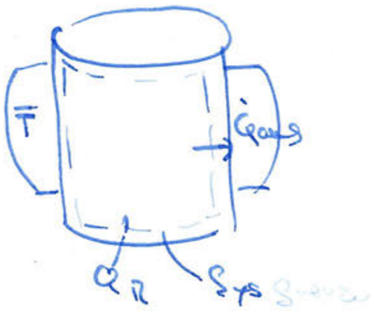
$$\overline{T} = \frac{\int_e^a T\,ds}{s_a - s_e} \Rightarrow \frac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)} = \underline{293{,}12\,K}$$

c)

ges: $\dot{S}_{erz}$ zw. Reaktor und Kühlmantel

→ nur $\dot{S}_{erz.}$ aufg. $\dot{Q}$
geschl. System

$$0 = \cancel{\dot{m}}\,(\cancel{s_e - s_a}) + \sum \frac{\dot{Q}}{\overline{T}} + \dot{S}_{erz}$$



$$-\dot{S}_{erz} = \cancel{\dot{m}}\,(\cancel{s_e - s_a}) + \cancel{\frac{\dot{Q}_R}{\overline{T}_v}} + \frac{\dot{Q}_{aus}}{\overline{T}_v}$$

$\overline{T} = 293{,}12\,K$

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

$\dot{Q}_{aus} = -62{,}182\,kW$

$\dot{m} = 0{,}3\,kg/s$

$$-\dot{S}_{erz} = \frac{-62{,}182\,kW}{293{,}12\,K} = \underline{-0{,}2121}\ kW/K$$

$$\underline{\dot{S}_{erz} = 0{,}2121\ kW/K}$$

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e)

ges ΔS_{12}

$$\cancel{\Delta S_{12} = \sum \Delta \dot{m}\, s + \sum \frac{Q}{T_j} + S_{erz}}$$

$$\Delta S = S_2 - S_1 = m\,(s_2 - s_1) = \sum \frac{Q}{T} + S_{erz}$$

$m_{ges1} + \Delta m_{12}$

$m = 5755 + 3600\,kg$

$= \underline{9355\,kg}$

?

s_2

s_1

d) ?

ges: Δm_{12}

$$\Delta E = \Delta m_{12} [h_{12}] + \sum Q_{12} - \sum W_n$$

↳ kein Antrieb

$$m_2 \cdot u_2 - m_1 \cdot u_1 = \Delta m_{12} h_{12} + Q_R$$

$| Q_R = -35 MJ$

$$\underbrace{m_2 - m_1 \cdot (h_2 - h_1)}_{m_2 \cdot h_2 - m_1 h_1}$$

$| m_1 = 5755 kg$

u_1 @ $x_D = 0{,}005$, @ 70°C ?

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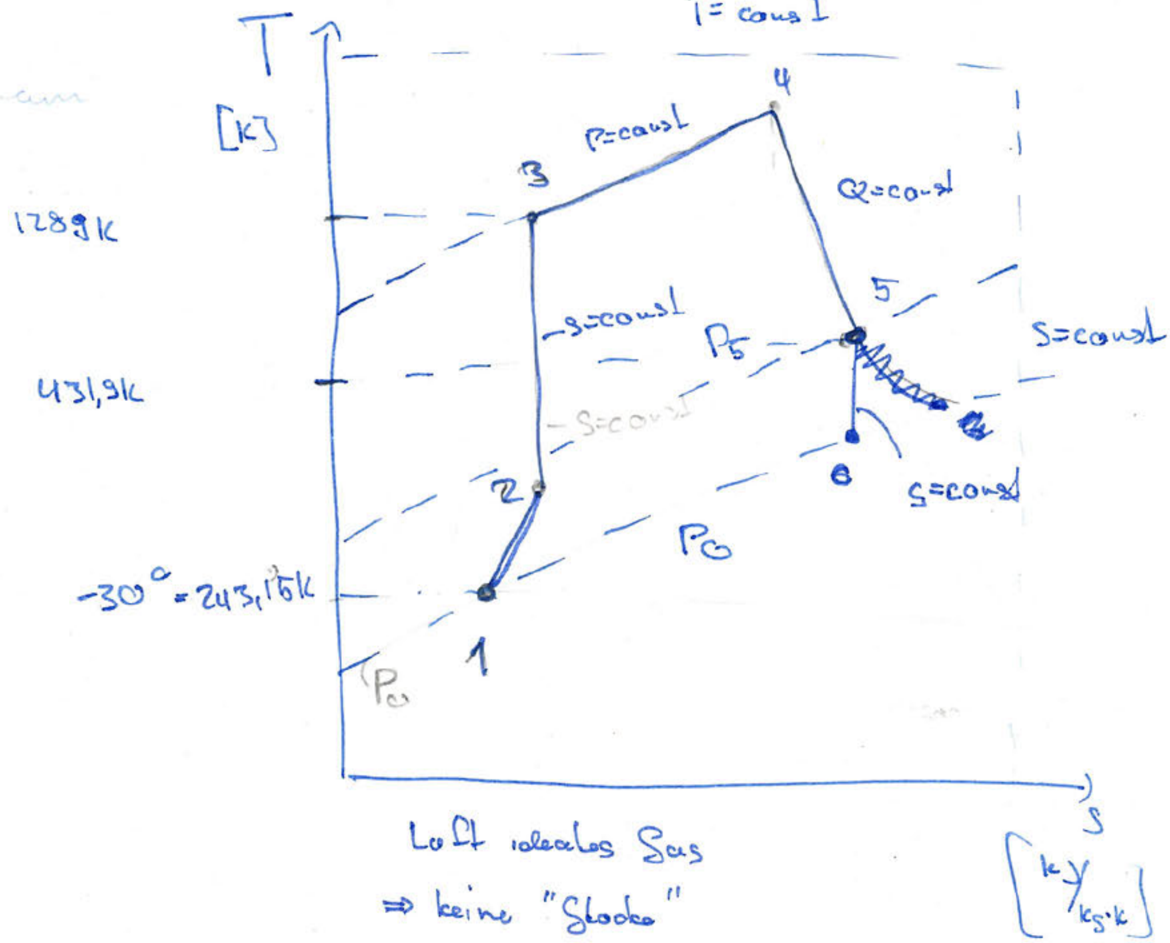
2a)

ges: T-s Diagramm



Luft ideales Gas
⇒ keine "Stoße"

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3)

Ges: p_{g1}

m_g

$V_{g_1} = 3{,}14L = 3{,}14 \cdot 10^{-3} m^3$

$T_{1g} = 500°C = 773{,}15K$

$$\frac{V_g}{v_g} = m$$

$$pV = mR \cdot T$$

p_{g1} :

$$\underbrace{\overbrace{m_k \cdot g \cdot A}^{F_{Skolben}}}_{P_{kolben}} + P_{amb} + m_{EW} \cdot g \cdot A = P_g$$

$$A = \pi \cdot r^2 = \pi \left(\frac{d}{2}\right)^2 = \pi \cdot \left(\frac{10 \cdot 10^{-2}}{2}\right)^2 m^2$$

$$= \pi \cdot \frac{1}{400} m^2$$

$m_k = 32kg$

$g = 9{,}81 \, m/s^2$

$D = 10cm$

$= 10 \cdot 10^{-2} m$

$P_{amb} = 1 \cdot 10^5 Pa$

$m_{EW} = 0{,}1kg$

$$(m_k + m_{ew}) g \cdot A + P_{amb} = P_{g1}$$

$$= 32{,}1kg \cdot 9{,}81 \, m/s^2 \cdot \frac{\pi}{400} m^2 + 1 \cdot 10^5 Pa = 100'002{,}47 Pa$$

$\approx 1 bar$

$$\rightarrow m = \frac{pV}{R \cdot T}$$

$$R = \frac{\bar{R}}{M} \quad J/molK$$

$M \leftarrow 50 \frac{kg}{kmol}$

$166{,}28$

$= \cancel{0{,}16628}$

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

$= 0{,}00244\,kg = 2{,}4\,g$

$= \cancel{0{,}409\,kg}$

$R = \cancel{0{,}16628}\ 166{,}28\ J/_{kg \cdot K}$

$T = 773{,}15\,K$

$p = 1\,bar = 10^5\,Pa$

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

b)

ges: $T_{g2} =$

$$pV = m \cdot R \cdot \boxed{T} \text{ — ges}$$

$T_{g2} = T_{EW} \rightarrow$

?

$P_{g2} = P_{g1}$

[redacted]

c)

ges: Q_{12}

$0{,}003\,^\circ C \equiv 273{,}153\,K$

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

$\Delta E = Q - W$

$\Delta U = Q - W$

$c_v (T_2 - T_1)$

$= 0{,}633 (273{,}153 - 500\,K)$

$= -143{,}59\,kJ$

$\int p\,dV$

$P_{amb} (V_2 - V_1)$

$V_2 = \dfrac{m R T_2}{P_2}$

$V_2 = \dfrac{3{,}6 \cdot 10^{-3}\,kg \cdot 166{,}28 \cdot 273{,}153\,K}{1{,}5 \cdot 10^5\,Pa}$

$= 0{,}00109\,m^3$

$= 1{,}1\,L$

$W = P_{amb} (V_2 - V_1)$

$= 1 \cdot 10^5 (0{,}00109 - 3{,}14 \cdot 10^{-3}) = -204{,}99\,J$

$=$

$Q = \Delta U + W \quad = -143{,}799\,kJ$

?

d)

ges:

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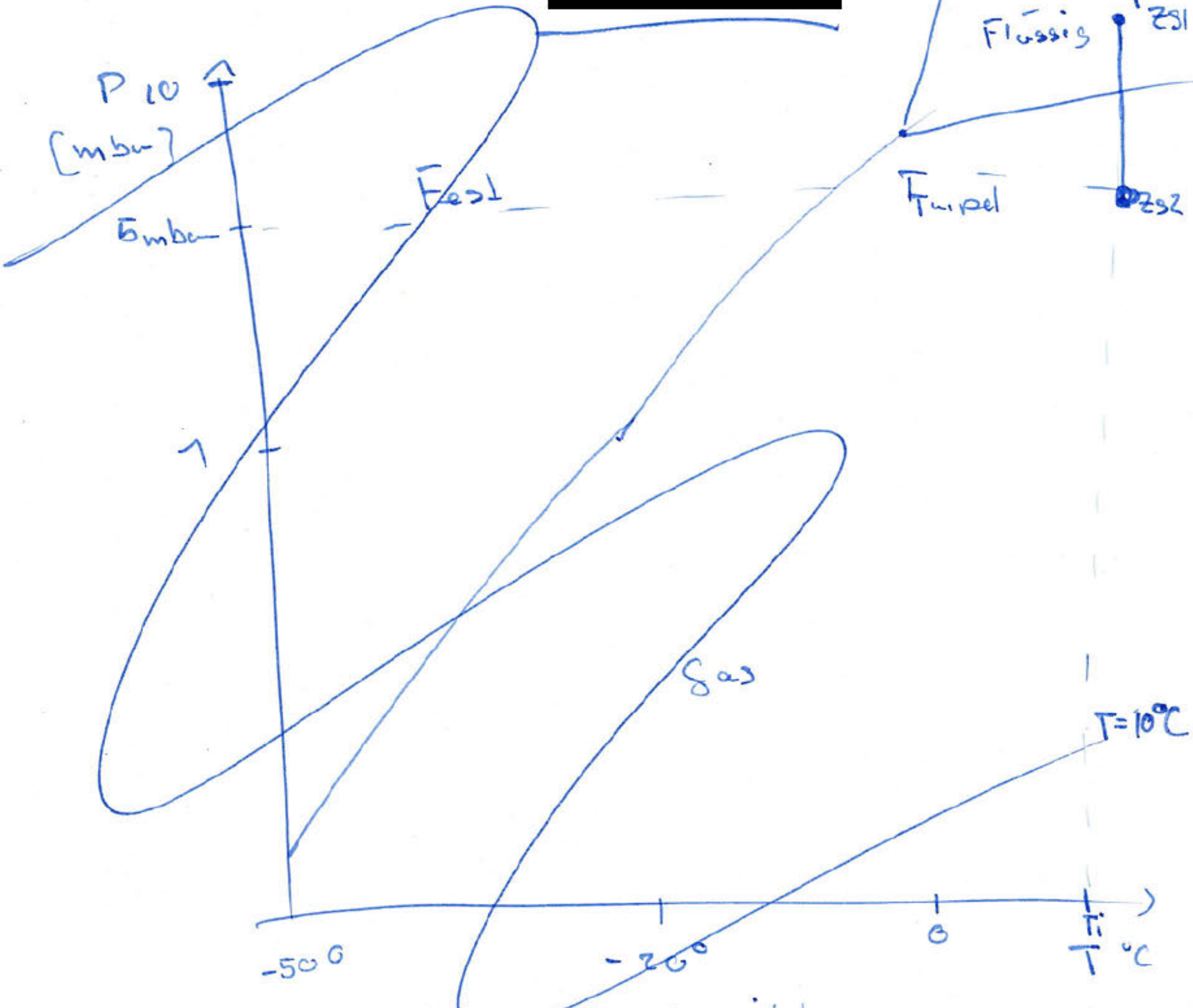
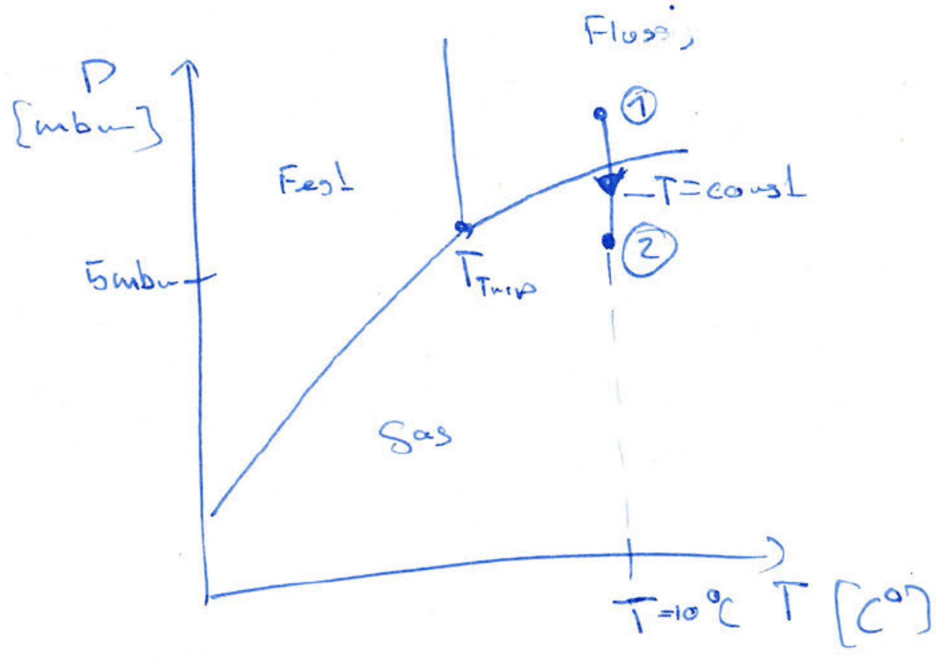
4a)

ges: P–T



Wasser in Lebensmittel



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4d)

$$\varepsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \frac{\text{Nutz}}{\text{Aufwand}}$$

25 W

Gas

Ü1)

4b)

Gas: $\dot{m}_{R134a}$

adiabat

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

$$\frac{\dot{W}_K}{h_e - h_a} = \dot{m} \Rightarrow \dot{m} = \frac{\dot{W}_K}{h_2 - h_3}$$

h_2 @ $x_2 = 1$ @ $\boxed{T_2}$?

h_3 @ $p_3 = 8\,\text{bar}$ @ $\boxed{T_3}$?

4c) $\phi = \phi_f + x\,(\phi_g - \phi_f)$

$$x = \frac{\phi - \phi_f}{\phi_g - \phi_f}$$

4e)

Die Temperatur würde langsamer sinken

Gase lassen sich leichter kühlen als Flüssigkeiten

Falls der Druck