Physik, 62d/e, 15.9.2011

(1) $\frac{p_1 V_1}{p_2 V_2} = \frac{n_1 T_1}{n_2 T_2}$ $\quad p_1 = p_2 \,,\; n_1 = n_2$

$\Rightarrow \quad \frac{V_1}{V_2} = \frac{T_1}{T_2} \quad \Rightarrow \quad V_2 = V_1 \frac{T_2}{T_1}$

$T_2 = T_1 + \Delta T \quad \Rightarrow \quad \frac{T_2}{T_1} = \frac{T_1 + \Delta T}{T_1} = 1 + \frac{\Delta T}{T_1}$

↪ man braucht die absolute Temp., die Differenz allein (ΔT) reicht nicht!

(2) $E_{/l} = 35\ MJ/Liter \Rightarrow E = 35\ MJ = 35 \cdot 10^6\ J.$

$\eta = \frac{E_{Nutz}}{E_{zugef.}} \Rightarrow E_{Nutz} = E_{zug.} \cdot 0.85$

$0.85 \cdot 35 MJ = E = c_{Wasser} \cdot m_{Wasser} \cdot \Delta T$

$29.75 \cdot 10^6\ J = c_W \cdot m_W \cdot \Delta T$

$m_{Wasser} = \frac{29.75 \cdot 10^6\ Joule}{c_W \cdot \Delta T}$

$= \frac{29.75 \cdot 10^6\ J}{4182 \frac{J}{kg \cdot K} \cdot (70°C - 5°C)}$

$= \frac{29.75 \cdot 10^6\ J}{4182 \frac{J}{kg \cdot K} \cdot 65\ K} \approx \underline{\underline{109.44\ L}}$

(3) $m_M = 0.3\,kg$, $T_M = 3°C$

$m_{Dampf} = 28.5\,g = 0.0285\,kg$

$T_{Dampf} = 150°C$

} T = resultierende Mischtemp.

~~$m_M \cdot c_W$~~

$$c_{Wasser} \cdot m_M \cdot (T - 3°C) = c_{Dampf} \cdot m_D \cdot 50K + L_V \cdot m_D + c_W \cdot m_D \cdot (100°C - T)$$

$$c_W \cdot m_M T - c_W m_M \cdot 3K = c_D \cdot m_D \cdot 50K + L_V \cdot m_D + c_W m_D \cdot 100K - c_W m_D \cdot T$$

$$T(c_W m_M + c_W m_D) = c_W m_M \cdot 3K + c_D \cdot m_D \cdot 50K + L_V \cdot m_D + c_W m_D \cdot 100K$$

$$T = \frac{c_W m_M \cdot 3K + c_D \cdot m_D \cdot 50K + L_V \cdot m_D + c_W m_D \cdot 100K}{c_W m_M + c_W \cdot m_D}$$

$$T \approx 60.15°C$$

Dampf 150°C → 100°C: $Q_1 = m_D \cdot c_D \cdot 50K$

$= 0.0285 \cdot 1863 \cdot 50$

$= 2'654.775$ Joule

Phasenwechsel Dampf–Wasser: $Q_2 = L_V \cdot m_D$

$= 64'296$ Joule

$Q_1 + Q_2 = 66'950.775$ J.

$$T = \frac{3763.8 + 2654.775 + 64296 + 11918.7}{1254.6 + 119.187} = \frac{82633.275}{1373.787}$$

(4) $p = 1\,bar,\ T = 25°C = 298K$

$\rho = 80.72\,g/m^3 = 0.08072\,kg/m^3$

$\rho = \frac{pM}{RT} \Rightarrow M = \frac{\rho \cdot R \cdot T}{p} \cong 0.002\,kg/mol$

2g pro Mol $\Longrightarrow$ H_2 (Wasserstoffgas)

(5) 1: $p = 1.9\,atü = 2.9\,atm,\ T = 8°C = 281K$

2: $p = 2.2\,atü = 3.2\,atm,\ T = ?$

$V_1 = V_2,\ n_1 = n_2 \Rightarrow \frac{p_1}{p_2} = \frac{T_1}{T_2}$

$\Rightarrow T_2 = T_1 \cdot \frac{p_2}{p_1}$

$T_2 = 281K \cdot \frac{3.2\,atm}{2.9\,atm} = 281k \cdot \frac{3.2}{2.9}$

$= 310.07K \cong 37.07°C$

(7) 1 Mol H_2O: $M_{H_2O} = 18g/mol$

$pV = n \cdot R \cdot T$; $p = 1\,atm,\ n = 1$

$T = 373K$

$\Rightarrow V = \frac{nRT}{p} \cong 3.061 \cdot 10^{-2}\,m^3$

$= 30.61$ Liter

1 Mol flüssig: $V_1 = 18cm^3 = 0.018L$

" gasförmig: $V_2 = 30.61L$

$\frac{V_2}{V_1} = \frac{30.61}{0.018} \cong$ 1'700-mal grösser!

(6) KGG: $F_{Auftrieb} = F_G + F_{G,Helium}$

$$\rho_{Luft} \cdot V \cdot g = mg + \rho_{He} \cdot V \cdot g$$

$$\rho_{Luft} \cdot V = m + \rho_{He} \cdot V$$

$$V(\rho_{Luft} - \rho_{He}) = m$$

$$V = \frac{m}{\rho_{Luft} - \rho_{Helium}}$$

a) $\rho_1 = \frac{p_1 M}{R T_1}$; $\rho_2 = \frac{p_2 M}{R T_2}$; $p_1 = 1\,atm$, $T_1 = 0°C$

$$\frac{\rho_1}{\rho_2} = \frac{\frac{p_1 M}{R T_1}}{\frac{p_2 M}{R T_2}} = \frac{p_1 T_2}{p_2 T_1}$$

$$\frac{\rho_2}{\rho_1} = \frac{p_2 T_1}{p_1 T_2} \Rightarrow \rho_2 = \rho_1 \cdot \frac{p_2 T_1}{p_1 T_2}$$

Luft: $\rho_1 = 1.293\ kg/m^3$, $T_1 = 273K$, $p_1 = 101325\,Pa$

$T_2 = 268K$, $p_2 = 75000\,Pa$

$$\rho_2 = \rho_1 \frac{p_2 T_1}{p_1 T_2} \approx \underline{0.975\ kg/m^3}$$

He: $\rho_2 = \rho_1 \frac{p_2 \cdot T_1}{p_1 \cdot T_2} \approx \underline{0.135\ kg/m^3}$

b) $V = \frac{m}{\rho_L - \rho_{He}} = \frac{600\,kg}{(0.975 - 0.135)\,kg/m^3} \approx \underline{714.3\,m^3}$