(13) Erdatmosphäre

@ NN/Om : 80 % N_2 — $M_{N_2} = 28$ g/mol
20 % O_2 — M_{O_2} 32 g/mol

$T = 273{,}15\ K$

$R = 8.31446\ kg\ \frac{m^2}{s^2}\ \frac{1}{mol\ K}$

Barometrische Höhenformel

$$p = p_0\, e^{-\frac{h}{H}} \qquad H = \frac{RT}{Mg}$$

M: ~~Drücke~~ molare Masse

$p_{N_2} = x_{N_2} \cdot p = 0{,}80\,p$

$p_{O_2} = x_{O_2} \cdot p = 0.20\,p$

@ 8848 m:

$$p_{N_2} = 0{,}80p \cdot e^{-\frac{h \cdot M g}{RT}} =$$

$$= 0{,}80p \cdot e^{-\frac{8848\,m \cdot 28 \cdot 10^{-3}\,\frac{kg}{mol} \cdot 9{,}81\,\frac{m}{s^2}}{8.31446\,kg\,\frac{m^2}{s^2}\,\frac{1}{mol\,K} \cdot 273{,}15\,K}}$$

$$= 0.80 \cdot 0.34296 \cdot p$$

$$p_{O_2} = 0.20 \cdot p \cdot e^{-\frac{8848 \cdot 32 \cdot 10^{-3} \cdot 9.81}{8.31446 \cdot 273{,}15}}$$

$$= 0.20 \cdot 0.29434 \cdot p$$

Dalton: $p = p_{N_2} + p_{O_2}$

$$x_{N_2} = \frac{p_{N_2}}{p_{N_2} + p_{O_2}} = 0.823344 = 0.82 \qquad \underline{82\ \%}$$

$$x_{O_2} = \frac{p_{O_2}}{p_{N_2} + p_{O_2}} = 0.176655 = 0.18 \qquad \underline{18\ \%}$$

(14) Haber Bosch Verfahren

$V = 4.2\,L = 4.2 \cdot 10^{-3}\,m^3$

$m_{H_2} = 21.2\,g \qquad m_{N_2} = 98.0\,g \qquad T = 720\,K$

$M(H) = 1.008\,u \qquad M(N) = 14.007\,u \qquad 1u = 1.660539 \cdot 10^{-27}\,kg$

a) $21.2\,g \hat{=} n_{H_2} = \dfrac{0.0212\,kg}{2 \cdot 1.008u \cdot 1.660539 \cdot 10^{-27}\,\frac{kg}{u} \cdot 6.02214 \cdot 10^{23}} \approx 10.51587\,mol$

$98.0\,g \hat{=} n_{N_2} = \dfrac{0.0980\,kg}{2 \cdot 14.007u \cdot 1.660539 \cdot 10^{-27} \cdot 6.02214 \cdot 10^{23}} = 3.49825\,mol$

$p_{H_2} \hat{=} n_{H_2} \cdot \dfrac{RT}{V} = 10.51587\,mol \cdot \dfrac{8.31446\,kg\,m^2/s^2\,mol\,K \cdot 720K}{4.2 \cdot 10^{-3}\,m^3}$

$\hat{=} 149,88648\,bar = \underline{150\,bar}$

$p_{N_2} = 3.49825\,mol \cdot \dots = \underline{49.9\,bar}$

$p_{gesamt} = \underline{200\,bar}$

b) $17.9\,g\ NH_3$: $n_{NH_3} \hat{=} \dfrac{0.0179\,kg}{(14.007u + 3 \cdot 1.008u) \cdot \dots}$

$1,051024\,mo$

~~$1,051024\,mol$~~

$p_{NH_3} = n_{NH_3} \cdot \dfrac{RT}{V} = \underline{15.0\,bar}$

$83.3\,g\ N_2$: $n_{N_2} \hat{=} \dfrac{0.0833\,kg \dots}{2 \cdot 14.007u \dots} = 2.97351\,mol$

$p_{N_2} = n_{N_2} \cdot \dfrac{RT}{V} = \underline{42,4\,bar}$

$1g\ H_2$: $n_{H_2} = \dfrac{0.00180\,kg \dots}{2 \cdot 1.008u \dots} = 8.92857\,mol$

$p_{H_2} = \underline{127\,bar}$

(15)

He: 12_g 4.00 g/mol ⇒ 3.0 mol

Ne: 36_g 20.18 g/mol ⇒ 1.78394 mol

Ar: 42_g 39.95 g/mol ⇒ 1.051314 mol

$p = 3.4$ bar

Gesamt-Mol: 3.0 mol + 1.78394 mol + 1.051314 mol, =

$\hat{=}$ 5.835254 mol

$$p_{He} = \frac{3.0\,mol}{5.835254\,mol} \cdot 3.4\,bar = 1.7479936\,bar = \underline{1.7\,bar}$$

$$p_{Ne} = \frac{1.78394\,mol}{5.835254\,mol} \cdot 3.4\,bar = 1.0394399\,bar = \underline{1.0\,bar}$$

$$p_{Ar} = \frac{1.051314\,mol}{5.835254\,mol} \cdot 3.4\,bar = 0.61256\,bar = \underline{0.61\,bar}$$

(16) a) Graz 353 m $p_{N_2} = 0.8\,bar$ $p_{O_2} = 0.2\,bar$

Schöckl 1445 m → $p_{N_2} = ?$ → $p_{O_2} = ?$

$M_{O_2} = 32\ g/mol$

$M_{N_2} = 28\ g/mol$

$T = 299.15\ K$

$\Delta h = 1445m - 353\,m = 1092m$

$$p_{N_2} = p_{0N_2} \cdot e^{-\frac{\Delta h \cdot M_{N_2} g}{RT}} = 0.8bar \cdot e^{-\frac{1092m \cdot 0.028 \frac{g}{mol} \cdot 9.81 \frac{m}{s^2}}{8.31446 \frac{kg\,m^2}{s^2\,mol\,K} \cdot 299.15}}$$

$= 0.8bar \cdot 0.886394 = 0.7091156bar = 0.71\,bar$

$$p_{O_2} = p_{O_2} \cdot e^{-\frac{\Delta h \cdot M_{O_2} \cdot g}{RT}} =$$

$$= 0.2bar \cdot e^{-\frac{1092 \cdot 0.032 \cdot 9.81}{8.31446 \cdot 299.15}} = 0.174251\,bar$$

$= 0.17\,bar$

b) in Graz, weil das schwerere Gas schnelle nach oben abnimmt

quantitativ $\frac{0.2}{0.8} = \frac{1}{4} = 0.25$ $\frac{O_2}{N_2}$ Verhältnis

$\frac{0.17}{0.71} = 0.2394 = 0.24$ $\frac{O_2}{N_2}$ Verhältnis