Webinar: Thermodynamik
Thema: Zustandsgleichung ideales Gas

Note Title 30.11.2016

$$p \cdot V = m \cdot R_i \cdot T$$

$$p \cdot v = R_i \cdot T$$

p – Druck

V – Volumen

m – Masse

R_i – Individuelle Gaskonstante

T – Temperatur

$$pV = n \cdot R \cdot T$$

n – Stoffmenge

R = Universelle Gaskonstante

$$R = 8314{,}47 \ \frac{J}{kmol \cdot K}$$

$$R = \frac{R_i}{M}$$ -Zusammenhang

Gesetz von Boyle-Mariotte

n = konstant , T = konstant

$$\frac{p_1}{p_2} = \frac{V_2}{V_1}$$

$$p \cdot V = \text{konst.}$$

$$p_1 \cdot V_1 = p_2 \cdot V_2$$

Gay-Lussac

n = konstant, p = konstant

$$\frac{V}{T} = \text{konstant} \qquad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\boxed{\frac{V_1}{V_2} = \frac{T_1}{T_2}}$$

Gesetz von Amontons

$n = \text{konstant}$, $V = \text{konstant}$

$$\frac{p}{T} = \text{konstant} \qquad \frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$\boxed{\frac{p_1}{p_2} = \frac{T_1}{T_2}}$$

1) $t_1 = 25\,^\circ C$

$V = \text{const.}$

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

$$p_2 = 2\,p_1$$

$$T_1 = 25 + 273{,}15 = 298{,}15\,K$$

$$\frac{p_1}{p_2} = \frac{T_1}{T_2} \qquad p_2 = 2 \cdot p_1$$

$$\frac{p_1}{2 \cdot p_1} = \frac{298{,}15\,K}{T_2}$$

$$\frac{1}{2} = \frac{298{,}15\,K}{T_2}$$

$$T_2 = 596{,}3\,K$$

$$t_2 = 596{,}3\,K - 273{,}15 = 323{,}15\,°C$$

2) $t_1 = 15\,^\circ C$ $\quad t_2 = 50\,^\circ C$

$p_1 = 1{,}5\,bar$ $\quad V = const.$

$p_2 = ?$

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

$$\frac{1{,}8\ \text{bar}}{p_2} = \frac{(15 + 273{,}15)\ \text{K}}{(50 + 273{,}15)\ \text{K}}$$

$$p_2 = 1{,}8\ \text{bar} \cdot \frac{323{,}15\ \text{K}}{288{,}15\ \text{K}}$$

$$\boxed{p_2 = 2{,}02\ \text{bar}}$$

$p_1 = 2{,}02$ $\quad T_1 = 50\,°C + 273{,}15$

$T_2 = 15 + 273{,}15$

$$\frac{p_1}{p_2} = \frac{T_1}{T_2} \qquad \frac{2{,}02}{p_2} = \frac{50 + 273{,}15}{15 + 273{,}15}$$

$$\boxed{p_2 = 1{,}8\ \text{bar}}$$

3) $n = 4\,mol$

$t_1 = 30\,^{\circ}C$

$p_1 = 1\,bar$

$$\boxed{p \cdot V = n \cdot R \cdot T} \qquad R = 8\,314{,}47\ \frac{J}{kmol \cdot K}$$

Einheiten

1 mol = 0,004 kmol

1 bar = 100 000 Pa = 100 000 $\frac{kg}{m \cdot s^2}$

8314,47 $\frac{J}{kmol \cdot K}$

$1\,J = \frac{kg \cdot m^2}{s^2}$

$$R = 8.314,47 \; \frac{kg \cdot m^2}{s^2 \cdot kmol \cdot K}$$

$$p \cdot V = n \cdot R \cdot T$$

$$100.000 \cdot V = 0,004 \cdot 8.314,47 \cdot (30 + 273,15)$$

$$\boxed{V = 0,1008 \; m^3}$$

$$\frac{kg}{m \cdot s^2} \cdot V = kmol \cdot \frac{kg \cdot m^2}{s^2 \cdot kmol \cdot K} \cdot K$$

$$V = kmol \cdot \frac{kg \cdot m^2}{s^2 \cdot kmol \cdot K} \cdot K \cdot \frac{m \cdot s^2}{kg} = m^3$$

$$V = 6{,}1005\ m^3 = 1006{,}8\ dm^3$$

$$V = 1006{,}8\ Liter$$

4)

$p_1 = 3\,bar$

$t_1 = 20\,^\circ C$

$\rho = 7{,}17\ \frac{kg}{m^3}$

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

$$V_2 = 2 \cdot V_1$$

$$\frac{V_1}{2 \cdot V_1} = \frac{(20 + 273{,}15)\,K}{T_1}$$

$$T_1 = 293{,}15\,K \cdot 2$$

$$\boxed{T_1 = 586{,}3\,K}$$

$$t_1 = 586{,}3\,K - 273{,}15 = 313{,}15\,^{\circ}C$$

Dichte

$$\rho = \frac{1}{V}$$

$$V = \frac{V}{m}$$

$$\boxed{\rho = \frac{m}{V}}$$

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

$$V = \frac{m}{\rho}$$

$$\boxed{V_1 = \frac{m}{\rho_1} \qquad V_2 = \frac{m}{\rho_2}}$$

$$\frac{\frac{m}{\rho_1}}{\frac{m}{\rho_2}} = \frac{T_1}{T_2}$$

$$\frac{m}{\rho_1} \cdot \frac{\rho_2}{m} = \frac{T_1}{T_2}$$

$$\rho_2 = \frac{T_1}{T_2} \cdot \rho_1$$

$$\rho_2 = \frac{293{,}15\,\text{K}}{586{,}3\,\text{K}} \cdot 2{,}7\,\frac{\text{kg}}{\text{m}^3}$$

$$\rho_2 = 1{,}35 \; \frac{kg}{m^3}$$