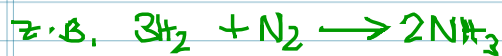


19.05.17

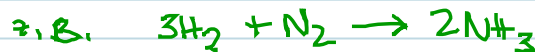
### 5.6 Beschreibung des Reaktionsfortgangs



$\nu_i$ : stöchiometr. Koeff. Prod. pos  
Ed. neg



Reaktionsfortgang?  $d\xi = \frac{dn_i}{\nu_i}$   
↑  
Reaktionszahl



$$d\xi = \frac{-3 \text{ mol}}{-3} = \frac{-1 \text{ mol}}{-1} = \frac{+2 \text{ mol}}{+2} = 1 \text{ mol}$$

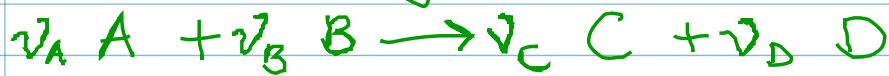
$$dn_i = n_i - n_i^0 = \nu_i d\xi$$

$$H = f(p_i, T, \xi)$$

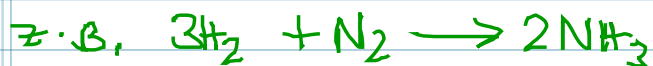
$$\hookrightarrow dH = \left(\frac{\partial H}{\partial p}\right)_{T, \xi} dp + \left(\frac{\partial H}{\partial T}\right)_{p, \xi} dT + \left(\frac{\partial H}{\partial \xi}\right)_{p, T} d\xi$$

Komb. d. HS:  $dH = dq + Vdp$

## 5.6 Beschreibung des Reaktionsfortschritts

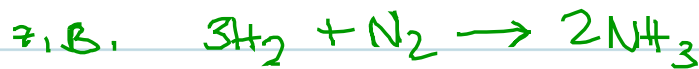


$\nu_i$ : stöchiometr. Koef. Prod. pos  
Ed. neg



$$\nu = 3 \quad -1 \quad +2$$

Reaktionsfortschritt?  $d\xi = \frac{dn_i}{\nu_i}$   
 $\uparrow$   
 Reaktionszahl



$$d\xi = \frac{-3 \text{ mol}}{-3} = \frac{-1 \text{ mol}}{-1} = \frac{+2 \text{ mol}}{+2} = 1 \text{ mol}$$

$$dn_i = n_i - n_i^0 = \nu_i d\xi$$

$$H = f(p_i, T, \xi)$$

$$\hookrightarrow dH = \left( \frac{\partial H}{\partial p} \right)_{T, \xi} dp + \left( \frac{\partial H}{\partial T} \right)_{p, \xi} dT + \left( \frac{\partial H}{\partial \xi} \right)_{p, T} d\xi$$

Komb. 1. HS:  $dH = dq + V dp$

$$p, T = \text{const} \rightarrow dq = \left( \frac{\partial H}{\partial \xi} \right)_{p, T} d\xi$$

$$\left( \frac{dq}{d\xi} \right)_{p, T} = \left( \frac{\partial H}{\partial \xi} \right)_{p, T} = \Delta_R H = \sum_i \nu_i \tilde{H}_i$$

↓  
 $\frac{\partial}{\partial \xi} \rightarrow$  Operator

5.7. Temperaturabhängigkeit der Rktsenth.

Wärme kap.  $\tilde{C}_p = \left( \frac{\partial \tilde{H}}{\partial T} \right)_p$

mehrere Komponente  $\left( \frac{\partial \Delta_R H}{\partial T} \right)_p = \Delta_R C_p = \sum_i \nu_i \tilde{C}_{p,i}$

Druckabh. gering  $\boxed{\frac{d \Delta_R H}{dT} = \Delta_R C_p \quad \frac{d \Delta_R U}{dT} = \Delta_R C_v}$

Kirchhoffscher Satz

falls  $\hat{C}_p$  temp. abh., dann

$$\tilde{C}_p(T) = a + bT + cT^{-2} \quad (a, b, c \text{ tabelliert})$$

Integration zw.  $T_1$  u.  $T_2$

$$\Delta_R H(T_2) = \Delta_R H(T_1) + \int_{T_1}^{T_2} \tilde{C}_p(T) dT$$

z.B. Verdampfung von Wasser



$$\frac{d\Delta_R H}{dT} = \Delta C_p = \tilde{C}_p(g) - \tilde{C}_p(l)$$

$$\left. \begin{array}{l} 0^\circ - 100^\circ\text{C} : \tilde{C}_p(g) \approx 8 \frac{\text{cal}}{\text{mol K}} \\ \tilde{C}_p(l) \approx 18 \frac{\text{cal}}{\text{mol K}} \end{array} \right\} \Delta C_p \approx -10 \frac{\text{cal}}{\text{mol K}}$$

$$\rightarrow \frac{d\Delta_R H}{dT} \approx -10 \frac{\text{cal}}{\text{mol K}} \approx -42 \frac{\text{J}}{\text{mol K}}$$

6. Adiab. Zustandsgleichung u. Effekt

6.1 ~~Vorbereitung~~ Vorbereitung.

isotherm, rev. Exp. eines id Gas

$$\text{1.H.S.} \quad dU = C_v dT + \underbrace{\left(\frac{\partial U}{\partial V}\right)_T}_{=0} dV = dq + dw$$

$$\rightarrow \begin{array}{l} dT = 0 \\ \rightarrow dU = 0 \end{array}$$

$$\boxed{dq = -dw}$$

> isoth. rev. Exp. eines realen Gases

$$\left(\frac{\partial u}{\partial v}\right)_T > 0 \quad (\text{WW. Kräfte!})$$

$$\hookrightarrow \boxed{dq = -dw + \left(\frac{\partial u}{\partial v}\right)_T dv}$$

↑ zusätzliche Wärmezufuhr

6.2 Adiab. Exp. u. Komp.

adiab.: kein Wärmeaustausch mit Umgebung

$$dq = 0 \rightarrow \boxed{du = dw}$$

$$\underline{\text{id. Gas}}: du = C_v dT + \underbrace{\left(\frac{\partial u}{\partial v}\right)_T}_{=0} dv = C_v dT$$

$$\Delta u = \int_{T_1}^{T_2} C_v dT = C_v \Delta T = W$$

Bsp: Exp.

$$W = -p_{\text{außen}} \Delta V = C_v \Delta T$$

$$\hookrightarrow \boxed{\Delta T = \frac{p_{\text{außen}} \Delta V}{C_v}}$$

Realisierung?

1). Isolierung des Systems  $\rightarrow$  kein Wärmeaustausch (Dewar)

2). Prozess ist sehr schnell  $\rightarrow$  " " (Luftpumpe)

Adiab. Exp. id Gases (rev.)

$$dU = dW = -pdV \quad dU = C_V dT$$

$$C_V dT = -pdV$$

id Gasgesetz:  $C_V dT = - \frac{R_n T}{V} dV$

$$\cancel{V} \tilde{C}_V dT = - R_n T \frac{dV}{V}$$

$$R = \tilde{C}_p - \tilde{C}_v \quad \tilde{C}_v dT = - (\tilde{C}_p - \tilde{C}_v) T \frac{dV}{V}$$

$$\frac{dT}{T} = - \underbrace{\left( \frac{\tilde{C}_p}{\tilde{C}_v} - 1 \right)}_{\gamma} \frac{dV}{V}$$

$$\frac{dT}{T} = -(\gamma - 1) \int_{V_1}^{V_2} \frac{dV}{V}$$

Arisson'sche Gl.

$$T \cdot V^{\gamma-1} = \text{const}$$

$$\ln \frac{T_2}{T_1} = \ln \frac{V_1^{\gamma-1}}{V_2^{\gamma-1}}$$

$$\rightarrow \frac{T_2}{T_1} = \left( \frac{V_1}{V_2} \right)^{\gamma-1}$$

Bsp.: 1 atm id Gas (3

$\frac{1}{10}$  seines Anfangsvol. kompr.  $T = ?$

$$T_1 = 300 \text{ K} \quad \gamma = \frac{\tilde{C}_p}{\tilde{C}_v} = \frac{5/2}{3/2} = \frac{5}{3} = 1,6667$$

$$T_2 = T_1 \cdot 10^{0,6667} \quad \underline{\underline{\approx 90 \text{ K}}}$$