



## 2. 化学反应的热效应、方向及限度

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## 2.2.6 利用物质的标准摩尔生成焓计算反应热(Calculate the Enthalpy of Reaction using Standard Enthalpy of Formation)

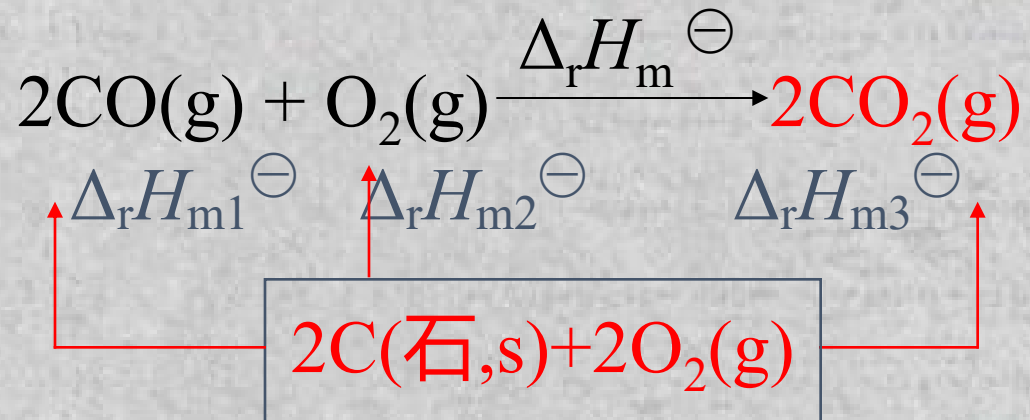
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# 利用物质的标准摩尔生成焓计算反应热(Calculate the Enthalpy of Reaction using Standard Enthalpy of Formation)



$$\Delta_r H_{m3}^\ominus = \Delta_r H_{m1}^\ominus + \Delta_r H_{m2}^\ominus + \Delta_r H_m^\ominus$$

$$\Delta_r H_{m1}^\ominus = 2 \Delta_f H_m^\ominus(\text{CO}, \text{g}),$$

$$\Delta_r H_{m2}^\ominus = \Delta_f H_m^\ominus(\text{O}_2, \text{g}),$$

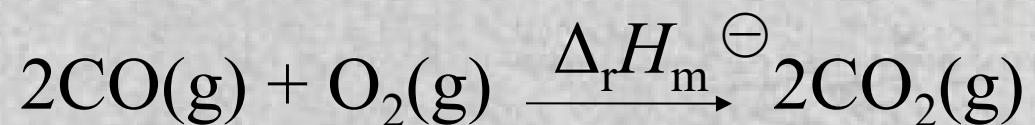
$$\Delta_r H_{m3}^\ominus = 2 \Delta_f H_m^\ominus(\text{CO}_2, \text{g})$$

$$\Delta_r H_m^\ominus = 2 \Delta_f H_m^\ominus(\text{CO}_2, \text{g}) - \Delta_f H_m^\ominus(\text{O}_2, \text{g}) - 2 \Delta_f H_m^\ominus(\text{CO}, \text{g})$$



# 利用物质的标准摩尔生成焓计算反应热(Calculate the Enthalpy of Reaction using Standard Enthalpy of Formation)

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$$\Delta_r H_m^\ominus = 2\Delta_f H_m^\ominus(\text{CO}_2, \text{g}) - \Delta_f H_m^\ominus(\text{O}_2, \text{g}) - 2\Delta_f H_m^\ominus(\text{CO}, \text{g})$$



# 利用物质的标准摩尔生成焓计算反应热(Calculate the Enthalpy of Reaction using Standard Enthalpy of Formation)

在一定温度下，化学反应的标准摩尔焓变等于同温度下反应前后各物质的标准摩尔生成焓与其化学计量数的乘积之和。

$$\Delta_r H_m^\ominus = \sum \nu_B \Delta_f H_m^\ominus(B)$$



# 利用物质的标准摩尔生成焓计算反应热(Calculate the Enthalpy of Reaction using Standard Enthalpy of Formation)

例：计算  $\text{N}_2\text{H}_4(\text{l}) + \text{O}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ ,  $\Delta_r H_m^\ominus = ?$

解：  $\text{N}_2\text{H}_4(\text{l}) + \text{O}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$

$\Delta_f H_m^\ominus$     53.63            0            0            -285.83

$$\Delta_r H_m^\ominus = 2 \times (-285.83) - 53.63 = -622.29 \text{ kJ} \cdot \text{mol}^{-1}$$





# 利用物质的标准摩尔生成焓计算反应热 (Calculate the Enthalpy of Reaction using Standard Enthalpy of Formation)

例：已知  $4\text{Fe}_2\text{O}_3(\text{s}) + \text{Fe}(\text{s}) \rightarrow 3\text{Fe}_3\text{O}_4(\text{s})$ ,  $\Delta_r H_m^\ominus = -58.4 \text{ kJ}\cdot\text{mol}^{-1}$ ,

$\Delta_f H_m^\ominus (\text{Fe}_2\text{O}_3, \text{s}) = -824.2 \text{ kJ}\cdot\text{mol}^{-1}$ , 求  $\Delta_f H_m^\ominus (\text{Fe}_3\text{O}_4, \text{s}) = ?$

解：

$$\Delta_r H_m^\ominus = 3\Delta_f H_m^\ominus (\text{Fe}_3\text{O}_4, \text{s}) - 4\Delta_f H_m^\ominus (\text{Fe}_2\text{O}_3, \text{s})$$

$$\Delta_f H_m^\ominus (\text{Fe}_3\text{O}_4, \text{s}) = [4\Delta_f H_m^\ominus (\text{Fe}_2\text{O}_3, \text{s}) + \Delta_r H_m^\ominus] / 3$$

$$= [4 \times (-824.2 \text{ kJ}\cdot\text{mol}^{-1}) - 58.4 \text{ kJ}\cdot\text{mol}^{-1}] / 3 = -1118.4 \text{ kJ}\cdot\text{mol}^{-1}$$



# 利用物质的标准摩尔生成焓计算反应热(Calculate the Enthalpy of Reaction using Standard Enthalpy of Formation)

## 思考题

火箭发射中高能燃料  $\text{N}_2\text{H}_4(1)$  的化学反应式为  $2\text{N}_2\text{H}_4(1) + \text{N}_2\text{O}_4(g) \rightarrow 3\text{N}_2(g) + 4\text{H}_2\text{O}(l)$ , 计算燃烧 10 kg  $\text{N}_2\text{H}_4(1)$  放出的热量。