*. Bond dissociation Enthalpy :-

The amount of energy required to break one mole of same type of bonds in gaseous molecules is called bond dissociation enthalpy.

for examples:-

(a) $H_2(g) \longrightarrow 2H(g)$ $\Delta_{H-H} = 435.4$ KJ/mole

(b) $H-Cl(g) \longrightarrow H(g) + Cl(g)$ $\Delta_{H-Cl} = 431.3$ KJ/mole.

In case of poly atomic molecules viz. CH_4, C_2H_4, C_2H_6 etc. the bond dissociation enthalpy of all the C–H bonds is not equal. In such case average of the bond dissociation energy (enthalpy) is taken. Thus,

Mean bond enthalpy :-

The average energy required to break one mole of the same type of bonds in gaseous molecule is called mean bond enthalpy.

for eg-

(a) $CH_4(g) \longrightarrow CH_3(g) + H(g)$ $\Delta H = 427.0$ KJ/mol

(b) $CH_3(g) \longrightarrow CH_2(g) + H(g)$ $\Delta H = 439.0$ KJ/mol

(c) $CH_2(g) \longrightarrow CH(g) + H(g)$ $\Delta H = 452.0$ KJ/mol

(d) $CH(g) \longrightarrow C(g) + H(g)$ $\Delta H = 347.0$ KJ/mol

continue....

Thus, the mean C–H bond enthalpy is given by—

$$\Delta_{C-H} = \left(\frac{427 + 439 + 452 + 347}{4}\right) \text{ kJ/mol}$$

$$\Delta_{C-H} = 416 \text{ kJ/mol.}$$

⇒ **Some facts the bond dissociation enthalpy —**

(1). Bond enthalpies are used to calculate the enthalpy of formation of compounds.

(2). Smaller is the bond length, greater is the bond energy.

The bond length decreases in the order—

$$HI > HBr > HCl > HF$$

Thus, the bond energy decreases in the order—

$$HF > HCl > HBr > HI.$$

(3). Bond energy of a double or triple bond is greater than that of a single bond of the same type.

viz. $-C \equiv C- \; > \; >C=C< \; > \; -\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-$

***. Application of Bond Energies :-**

(1). Determination of enthalpies of reactions :-

The bond energies can be used for determining enthalpy of reactions. This may be shown as —

$$CH_2 = CH_2\,(g) + H_2(g) \longrightarrow CH_3-CH_3\,(g)$$

$\Delta H = ?$

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In this reaction, the four C–H bon in C_2H_4 remains unaffected. A double bond breaks in $CH_2=CH_2$ and an H–H bond in H_2 breaks. One C–C bond and two C–H bonds are formed in CH_3-CH_3.

$$\Delta H = -\Delta H_{C-C} - 2\Delta H_{C-H} + \Delta H_{C=C} + \Delta H_{H-H}$$

$$= -(347.3 + 832.4) + (615.0 + 435.1)$$

$$= -1179.7 + 1050.1$$

$$\Delta H = -129.6 \text{ kJ/mol}$$

Given	(kJ/mol)
ΔH_{C-C}	⇒ 347.3
ΔH_{C-H}	⇒ 832.4
$\Delta H_{C=C}$	⇒ 615.0
ΔH_{H-H}	⇒ 435.1

(2). Determination of enthalpy of formation of Compound :–

The bond energies can also be used for determination of enthalpies of formation of Compounds.

For examples–

$$3C(g) + 6H(g) + O(g) \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-CH_3$$

(Acetone)

This reaction envolves –

(a). breaking of 3 H–H bonds to give 6 atom of H, breaking of half O–O bond to give one atom of O and ~~Sublimati~~ sublimation of three atoms of C(s) to give three atoms of C(g).

(b). formation of two C–C bonds, six C–H bonds and C=O bond.

Thus, the enthalpy of formation is –

$$\Delta H_f = \left[3(\Delta H_{H-H}) + \tfrac{1}{2}(\Delta H_{O-O}) + 3(\Delta H_{C(s)\to C(g)})\right] - \left[2(\Delta H_{C-C}) + \right.$$

$+ 6(\Delta H_{C-H}) + \Delta H_{C=O}]$

$= [3(435.1) + \frac{1}{2}(138.1) + 3(719.6)] - [2 \times 347.3 + 6 \times 416.2 + 711.3]$

$= (1305.3 + 69.05 + 2158.8) - (694.6 + 2497.2 + 711.3)$

$\Delta H_f = 3533.15 - 3903.1$ kJ/mol

$\Delta H_f = -369.95$ kJ/mol.

(3). Determination of Resonance energy :-

If a compound exhibits resonance, there is a considerable difference b/n the two values. This difference gives a measure of resonance energy of the compound.

For example–

$C_6H_6(g) \rightarrow 6C(g) + 6H(g)$

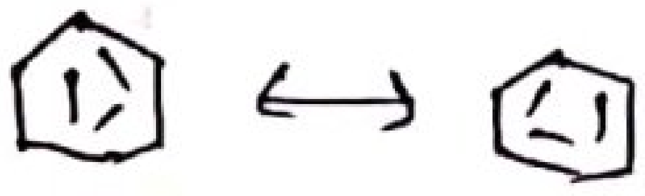
$\Delta H_d = 3(\Delta H_{C-C}) + 3(\Delta H_{C=C}) + 6(\Delta H_{C-H})$

$= (3 \times 347.3 + 3 \times 615.0 + 6 \times 416.2)$ kJ/mol

$= 1041.9 + 1845 + 2497.2$ kJ/mol.

$\Delta H_d = 5384.1$ kJ/mol.

The experimental value is found to be 5535.1 kJ/mol.



This difference gives the resonance energy.

R.E $= 5535.1 - 5384.1$ kJ/mol

$= 151.0$ kJ/mol.

—x—

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