



## Bond Energies and their Calculation $\Rightarrow$

Bond Energy  $\Rightarrow$

Bond Energy for any particular type of bond in a compound may be defined as the average amount of energy required to dissociate (i.e., break) one mole, viz., Avogadro's number of bonds of that type present in the compound. Bond energy is also called, sometimes, the enthalpy of formation of the bond.

It has been found by experiment that isomeric compounds have the same value for enthalpy of formation. Also in any homologous series, the increase in the enthalpy of formation for each  $\text{CH}_2$  group is almost constant. This shows that enthalpy of formation of a bond of a particular type is largely an additive property.

## Calculation $\Rightarrow$

In order to calculate bond energies (i.e., enthalpies of formation of bonds) of different types of bonds, it is necessary, in the first instance, to know the enthalpies of dissociation of molecules of common elements into atoms. These values have been obtained spectroscopically.

For one mole of an ideal gas,

$$PV = RT \quad \text{--- (I)}$$

When the temperature is raised by  $1^\circ\text{C}$  from  $T$  to  $T+1$  so that ~~that~~ the volume is  $v + \Delta v$ , then

$$P(v + \Delta v) = R(T+1) \quad \text{--- (II)}$$

$$P(v + \Delta v) - Pv = R(T+1) - RT \Rightarrow P(v + \Delta v - v) = R(T+1 - T) \Rightarrow$$

$$P\Delta v = R \quad \text{--- (III)}$$

This, the work done by one mole of an ideal gas in expansion at constant pressure ( $C_p$ ) and at constant volume ( $C_v$ ) is equal to the gas constant  $R$ , viz.,  $1.987 \text{ Cal}$  or  $8.314 \text{ J}$ . When heated through  $1^\circ\text{C}$  is equal to  $R$ . Hence,

$$C_p - C_v = R \quad \text{--- (IV)}$$

This, the difference between the molar heat capacity of a gas at constant pressure ( $C_p$ ) and at constant volume ( $C_v$ ) is equal to the gas constant  $R$ , viz.,  $1.987 \text{ Cal}$  or  $8.314 \text{ J}$ .

$$\begin{aligned} \Delta H &= \Delta E + P\Delta v \\ C_p \Delta T &= C_v \Delta T + R\Delta T \quad (P\Delta v = R\Delta T) \\ C_p \Delta T &= C_v \Delta T + R\Delta T \\ \Delta T(C_p) &= \Delta T(C_v + R) \\ C_p - C_v &= R \end{aligned}$$

Calculation from ~~single~~ <sup>Langmuir Process</sup> ~~single~~.

### Relation between $C_p$ and $C_v$ $\Rightarrow$

When a gas is heated at constant volume, no external work is done by the gas. In other words, all the heat supplied to gas is used in increasing its internal energy. Thus, if the temperature of one mole of a gas is raised through  $1^\circ\text{C}$  (say from  $T$  to  $T+1$ ), the increase in its internal energy itself gives the molar heat capacity at constant volume. However, when a gas is heated at constant pressure, there will be increase in its volume, that is, the gas will expand and do some external work. Therefore some extra heat in addition to the heat required by it to increase the internal energy of its molecules must be supplied to the gas to enable it to perform this external work. Hence, the molar heat capacity of a gas at constant pressure must be greater than that at constant volume, i.e.,  $C_p > C_v$ . The difference between the two, evidently, gives the work done by one mole of the gas in expansion when heated through  $1^\circ\text{C}$  at constant pressure. Thus,  $C_p - C_v = \text{Work done by one mole of the gas in expansion when heated through } 1^\circ\text{C at constant pressure.}$

As we know, the work done by the gas in expansion at constant pressure is numerically given by  $w = P\Delta V$ .