Valence Bond Theory

by L. Pauling & J.L Slater

This theory is based on idea of Hybridization.

Following are the main Postulates of this theory:—

(i) The central metal ion in the complex makes available a number of empty orbitals for the formation of co-ordinate bonds with the suitable ligands.

The number of empty orbitals made available for the purpose, gives the co-ordination number of the central ion.

(ii) The empty orbitals i.e. 's', 'p' and 'd' of metal ion hybridised to give an equal number of new orbitals of equivalent energy called hybride orbitals.

(iii) Each ligand has at least one σ-orbital containing a lone pair of electrons.

(iv) The empty hybride orbitals of metal ion overlap with filled σ-orbitals of the ligand forming ligand-metal co-ordinate bond, the number of empty orbitals made available by central ion.

(v) The d-orbitals involved in hybridisation may be $d_{(x^2-y^2)}$, d_{z^2} (inner) or d_{xy} and d_{xz} in case of outer.

(vi) The non bonding metal electrons occupy the inner d-orbitals which does not participate in hybridisation.

(vii) A substance which does not contain any unpaired electron is not attracted by magnet. It is said to be diamagnetic.

On the other hand a substance which contains one or more unpaired electrons electrons is attracted by the magnetic field, and such substances are called paramagnetic.

Hence knowing this it is possible to predict the type of hybridisation involving during the formation of complex and its geometry.

The valence bond theory in some complexes is illustrated below:-

(i) Octahedral Complexes:-

Octahedral complexes are the result of sp^3d^2 (outer) or d^2sp^3 (inner) orbital hybridisation.

(a) Ferro Cyanide ion $[Fe(CN)_6]^{4-}$

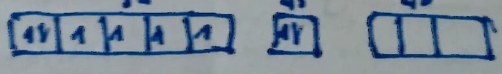
O.S. of central metal ion Fe is 2 i.e. Fe^{2+}

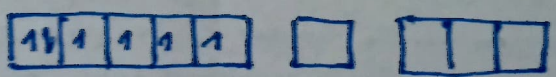
$x - 6 = -4$

$x = 6 - 4 = 2$

In this complex Iron is in Fe^{2+} state. Whose valence shell configuration is written as (b) in the diagram.

$_{26}Fe \rightarrow 1s^2 2s^2 p^6 3s^2 p^6 d^6 4s^2$

(a) Fe atom:- 

(b) Fe^{2+} atom:- 

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