sp^3d^2 -hybridisation

Geometry of 4-Coordinated Complexes

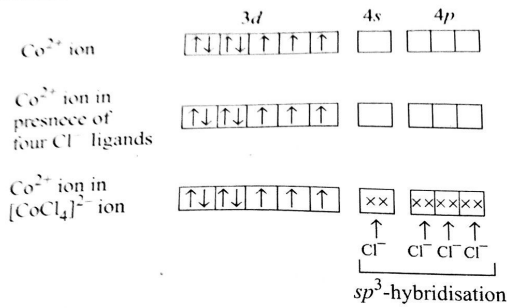
In these complex ions, the coordination number of the central metal cation/atom is four. Such comp
ions or complexes may have either tetrahedral or square planar geometry.

Tetrahedral Complexes

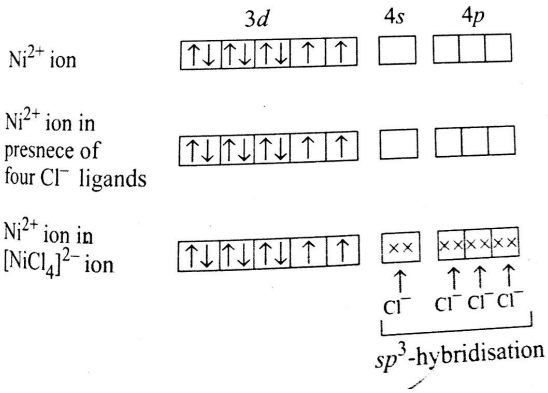
The tetrahedral complexes involve sp^3 or sd^3-hybridisation. The orbitals involve in sp^3-hybridisation
one s and three p (p_x, p_y and p_z). The orbitals involve in sd^3-hybridisation are one s and thre
(d_{xy}, d_{yz} and d_{zx}) orbitals.

Examples of Tetrahedral Complexes

(1) **$[CoCl_4]^{2-}$ ion :** In this complex ion Co(27) is present as Co^{2+} ion. Co atom has valence s
configuration $3d^7 4s^2$ and Co^{2+} has valence shell configuration, $3d^7$. Magnetic measurem
indicate that this ion is paramagnetic and has three unpaired electrons. This is possible only w
this complex ion is formed by sp^3-hybridisation and has tetrahedral geometry.



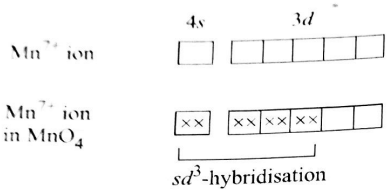
(2) **$[NiCl_4]^{2-}$ ion :** In this complex ion Ni (28) is present as Ni^{2+} ion. Ni atom has valence shell configuration, $3d^8 4s^2$ and Ni^{2+} has valence shell configuration, $3d^8$. Magnetic measurements indicate that this ion is paramagnetic and has two unpaired electrons. In this complex ion, all the eight 3*d*-electrons occupy all the five *d*-orbitals. Since Cl^- is a weak ligand so no pairing occurs in metal 3*d*-orbital. Thus no *d*-orbitals is available which can participate in hybridisation. The orbitals which participate in hybridisation are 4*s* and 4*p* (p_x, p_y and p_z). Thus this complex ion involves sp^3-hybridisation.



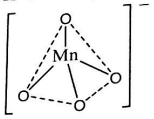
...state. It has valence shell

(3) **$Ni(CO)_4$:** In this complex compound Ni is in zero oxidation state. It has valence shell configuration $3d^8 4s^2$. Magnetic measurements indicate that this complex is diamagnetic (no unpaired electron is present). In free Ni atom two electrons are unpaired and all the 3*d*-orbitals are occupied. In the presence of strong ligand (CO) the 3*d*-electrons become paired and one of the 3*d*-orbitals becomes vacant. Now the two electrons from 4*s*-orbital go to vacant 3*d*-orbital and all the 3*d*-orbitals become doubly filled. Thus the orbital available for hybridisation are 4*s* and 4*p* (p_x, p_y and p_z).

(4) **MnO_4^- ion :** In this complex ion Mn is present as Mn^{7+} ion. Mn atom has valence she configuration, $3d^5 4s^2$. In Mn^{7+} ion, all the $3d$-orbitals are empty. There is sd^3-hybridisation i MnO_4^- ion, which is shown as below:



Shape of this complex is tetrahedral and it is diamagnetic.



(5) **$Cr_2O_7^{2-}$ ion :** In this ion oxidation state of Cr is +6. Valence shell configuration of Cr ($3d^5 4s^1$. Cr^{6+} has no electrons in $3d$-orbitals. Each Cr^{6+} ion in this ion is sd^3-hybridised and sh tetrahedral. sd^3-hybridisation and shape of $Cr_2O_7^{2-}$ is shown below:

$_{24}Cr \rightarrow 1s^2 \cdot 2s^2 \cdot 2p^6 \cdot 3s^2 \cdot 3p^6 \cdot 3d^5 4s^1$

$Cr^{6+} \rightarrow 1s^2 \cdot 2s^2 \cdot 2p^6 \cdot 3s^2 \cdot 3p^6 \cdot 4s^0 3d^0$