

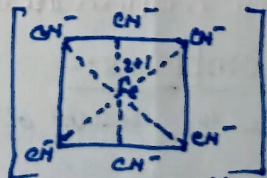
Valence bond diagram showing the formation of octahedral complex, $[Fe(CN)_6]^{4-}$ involving d^2sp^3 hybridisation.

As the six ligands approach towards central metal ion Fe^{2+} , the energy thus made available forces the pairing of unpaired electrons in 3d orbitals by rearranging them, it is shown in (c). Thus in 3d out of four unpaired electrons, two becomes paired and two becomes vacant, which are used for hybridisation with one 4s orbital and three 4p orbitals to give six equivalent d^2sp^3 hybrid orbitals.

These hybrid orbitals which are directed towards six (6) corners of a regular octahedron, accept six electron pairs donated by six CN^- ligands and thus form $[Fe(CN)_6]^{4-}$ as shown at diagram (d).

Since the complex is result of d^2sp^3 hybridisation, it has one octahedral shape as shown in fig.

Since there is no unpaired electron in the centre so, the nature of the complex is Diamagnetic.



From the valence bond diagram, it is evident that inner d-orbitals have been used in the hybridisation, so, complex is called inner orbital complex. In general inner orbital complexes use $(n-1)d$, ns and np orbitals by d^2sp^3 hybridisation scheme.

These complexes have been also called Low spin (L.S) complex (Oggel) and sply paired (Nyhlowe) complex.

In case of $[Fe(CN)_6]^{4-}$, five unpaired electrons in Fe^{2+} give a calculated value of magnetic moment is 5.91 magneton. But experimental value of magnetic moment is 2.3. In order to explain the magnetic moment of $[Fe(CN)_6]^{4-}$, pairing suggested that the unpaired 3d electrons in the Fe^{2+} undergo pairing to give the arrangement as shown in fig. The resulting complex would have one unpaired electron and goes in d^2sp^3 hybridisation as given below. *

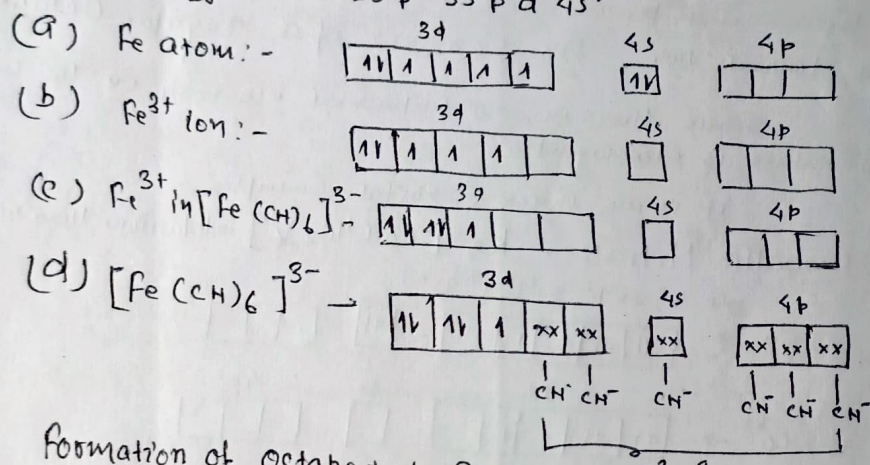
Examples of inner orbital complexes are: $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$, $[Co(NO)_6]^{3-}$, $[Fe^{IV}(NH_3)_6]^{4+}$, $[Co^{III}(NH_3)_6]^{3+}$, $[Cr(CN)_6]^{4-}$, $[Mn^{III}(CN)_6]^{3-}$, $[Fe(H_2O)_6]^{2+}$

(i) $K_3[Fe(CN)_6]$:- [Potassium hexa Cyano Ferrate(III)]

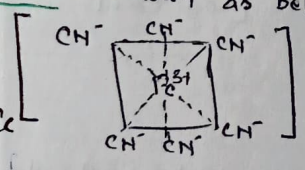
Ionization of $K_3[Fe(CN)_6] \rightleftharpoons 3K^+ + [Fe(CN)_6]^{3-}$
 It shows three potassium ion is attached with $[Fe(CN)_6]^{3-}$

On the basis of d^2sp^3 hybridization the nature of bonding in complex can be easily explained

The electronic configuration of Fe atom and Fe^{3+} ion is given below:



Formation of Octahedral Complexes by d^2sp^3 hybridization
 From the above diagram it is evident that $[Fe(CN)_6]^{3-}$ by d^2sp^3 hybridization there is one unpaired electron in complex. So complex is paramagnetic.
 The complex can be shown as below



(ii) $[Co(NH_3)_6]Cl_3$ Luteo Cobaltic Chloride
 (Hexa ammine Cobalt(III) Chloride) :-

It is an orange yellow crystalline compound ionised as $[Co(NH_3)_6]^{3+} + 3Cl^-$
 The nature of bonding in this complex is shown below.

