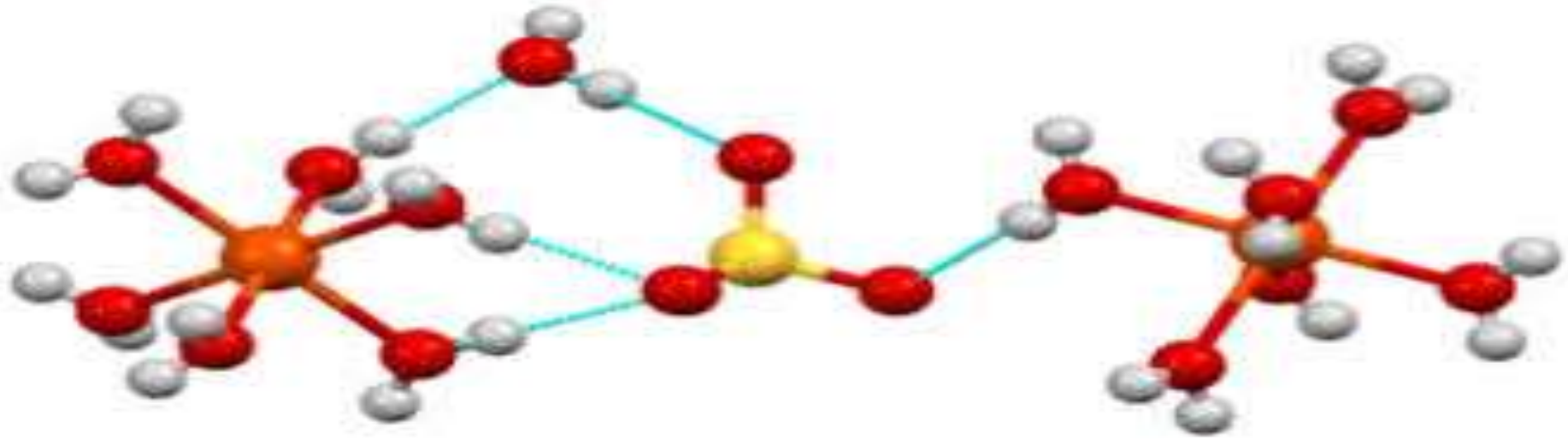
Valence Bond Theory



Programme : BSc.

Course : Inorganic Chemistry-III

Course Code : CHE-311

Sem : V

Year : 2020-21

Unit : 1

Topic : Metal-ligand complexes

Sub-topic : Valence Bond Theory

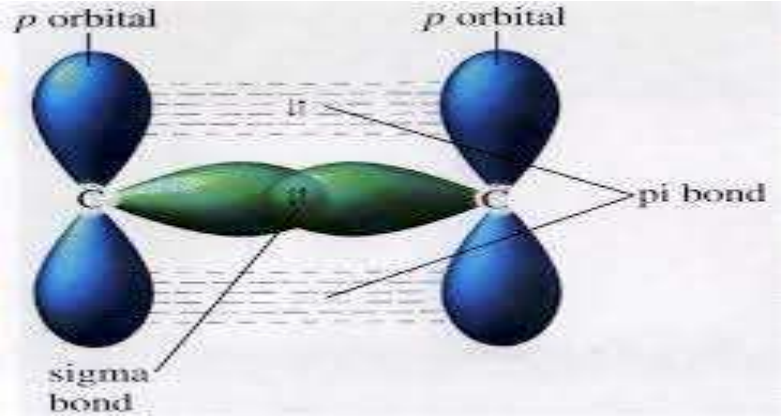
Faculty : Dr. Sourobhi Datta

E-mail : hod.chemistry@monad.edu.in

POSTULATES OF VBT

- The overlapping of two half-filled valence orbitals of two different atoms results in the formation of the covalent bond. This gives the property of stability to the molecule.
- Atomic orbitals possess more than one unpaired electron, more than one bond can be formed and electrons paired in the valence shell cannot take part in such a bond formation.
- A covalent bond is directional and such bond is also parallel to the region of overlapping atomic orbitals.

- Based on the pattern of overlapping, there are two types of covalent bonds: sigma bond and a pi bond. The covalent bond formed by sidewise overlapping of atomic orbitals is known as pi bond whereas the bond formed by overlapping of atomic orbital along the inter nucleus axis is known as a sigma bond.

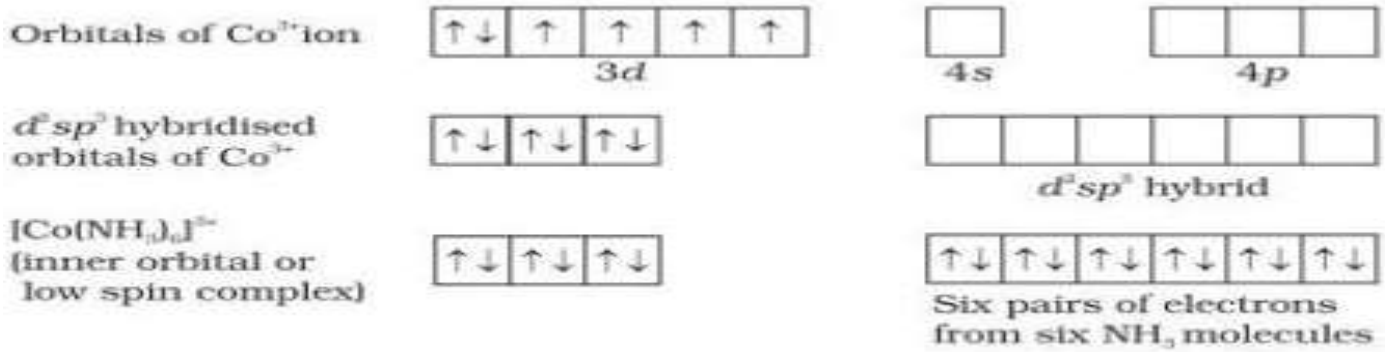


https://d1whtlypfis84e.cloudfront.net/guides/wp-content/uploads/2018/03/30122810/pi.jpg

- Complexes formed by using inner d orbital contain smaller number of unpaired electron known as inner orbital and when outer d orbital is used it is known as outer orbital.
- Each ligand must have at least one lone pair of electron.
- When ligand and metal approach they will overlap and formed metal-ligand co-ordinate bond.
- If the complex contain one or more unpaired electron, it is paramagnetic and if it is contain all the electron paired it is diamagnetic.
- During complex formation, Hund's rule of maximum multiplicity is strictly followed. The electron may be forced to pair up against Hund's rule when the ligands are strong.

METAL- LIGAND BONDING IN OCTAHEDRAL COMLEXES

Hexaaminecobalt(III) ion: $[Co(NH_3)_6]^{3+}$ (STRONG LIGAND)



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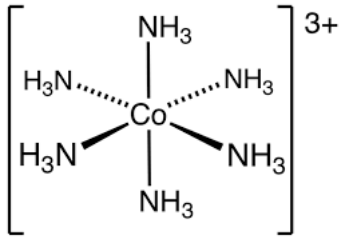
Hybridization –d^2sp^3
Structure- Octahedral
Diamagnetic in nature



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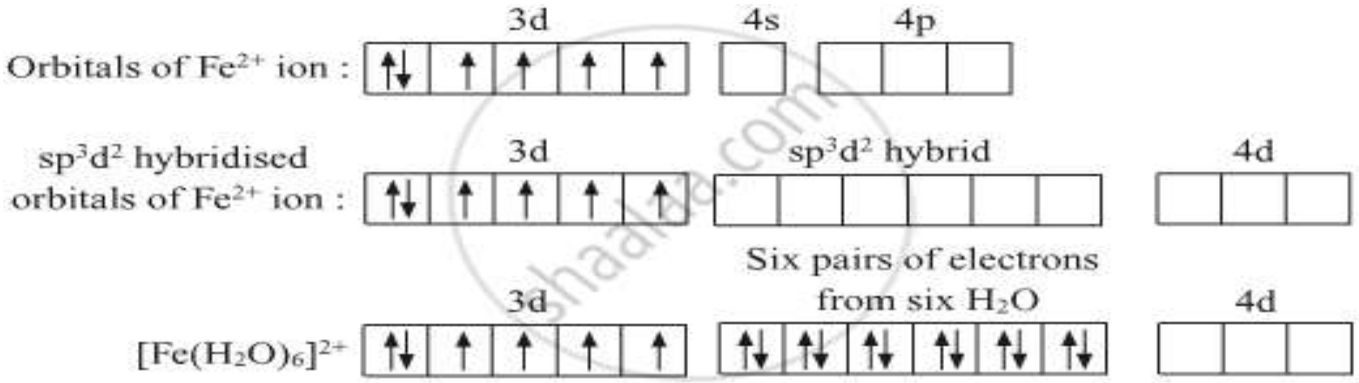
Hexaquoiron(II) ion: $[Fe(H_2O)_6]^{2+}$ (WEAK LIGAND)



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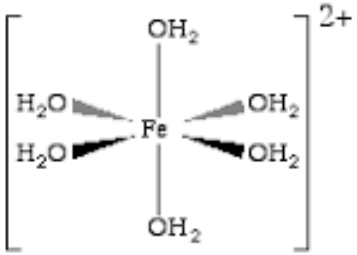
Hybridization –sp^3d^2
Structure- Octahedral
Paramagnetic in nature



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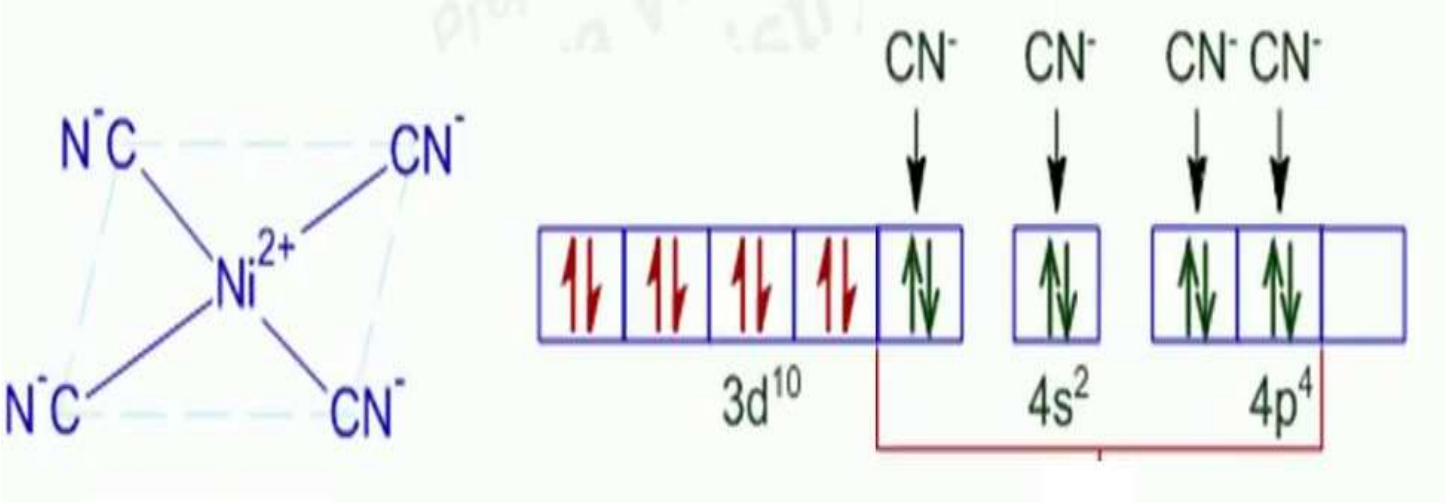
METAL- LIGAND BONDING IN SQUARE PLANNAR COMLEXES

Tetracyanonickelate(II) ion: $[Ni(CN)_4]^{2-}$ (STRONG LIGAND)



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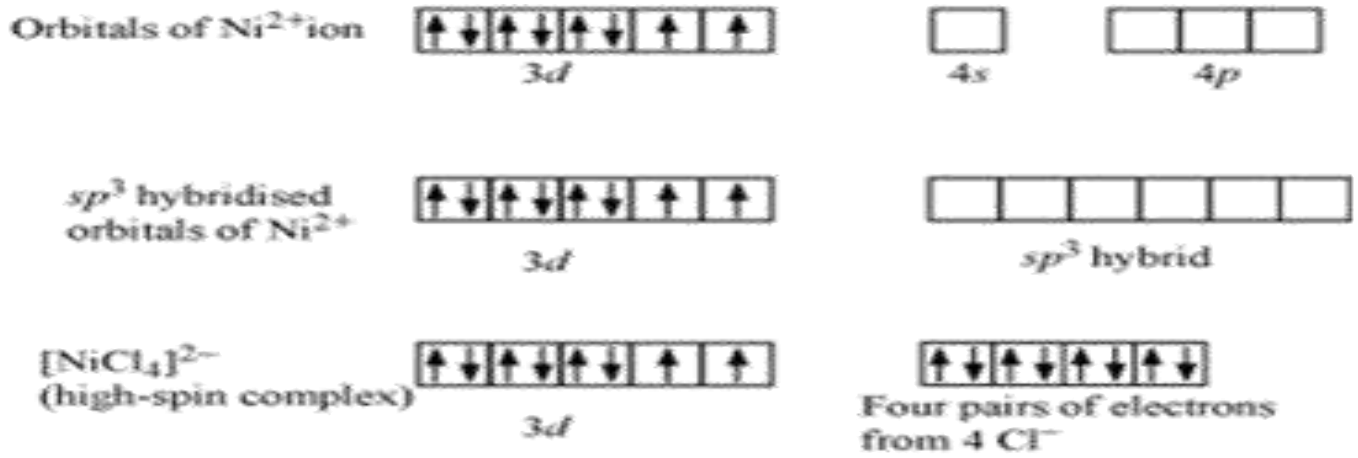
Hybridization –dsp^2
Structure- square plannar
Diamagnetic in nature

METAL- LIGAND BONDING IN TETRAHEDRAL COMLEXES

Tetrachloronickelate(II) ion: $[NiCl_4]^{2-}$ (WEAK LIGAND)



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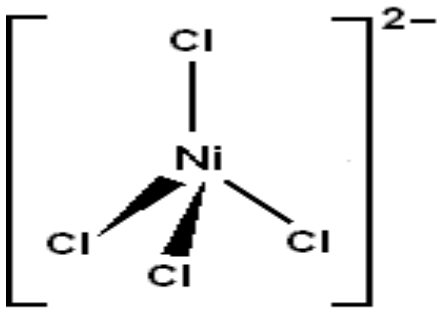
Hybridization –sp^3
Structure- Tetrahedral
Paramagnetic in nature



Limitation

- It does not explain spectra of complex.
- It does not give any satisfactory information for inner and outer orbit complexes.
- It does not explain the geometry of complexes satisfactorly.
- This theory does not explain the reaction rate and mechanism of reaction.
- It does not give any idea about splitting of d orbital.
- It does not explain any distortion in symmetrical complex compound.

References

- Inorganic chemistry vol-III by “H.C. Khera” Pragati Prakashan
- Chemistry for Degree Students by “R.L. Madan” S.Chand Publication