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COORDINATION COMPOUNDS

BONDING IN METAL CARBONYLS

ORGANO METALLIC COMPOUNDS Introduction

Organometallic compounds are defined as those compounds in which the carbon atoms of organic (usually alkyl or aryl) groups are directly bonded to metal atoms. The compounds of elements such as boron, phosphorus, silicon, germanium and antimony with organic groups are also included in organometallics. Many organometallic compounds are important reagents which are used for the synthesis of organic compounds.

Classification of Organometallic Compounds

Organometallic compounds are classified in three classes.

- (i) Sigma bonded organometallic compounds: In these complexes, the metal atom and carbon atom of the ligand are joined together with a sigma bond, For Examples:
- (a) Grignard reagents, R Mg X where R is an alkyl or aryl group and X is a halogen.
- (b) Zinc compounds of the formula R₂Zn such as (C₂H₅)₂Zn. (Isolated by Frankland).
 Other similar compound are (CH₃)₄Sn, (C₂H₅)₄Pb, Al₂(CH₃)₆, Al₂(C₂H₅)₆, Pb(CH₃)₄ etc.



 $Al_2(CH_3)_6$ is a dimeric compound and has a structure similar to diborane, (B_2H_6) . It is an electron deficient compound and two methyl groups act as bridges between two aluminum atoms.

(ii) Pi-bonded organometallic compounds: These are the compounds of metals with alkenes, alkynes, benzene and other ring compounds. In these complexes, the metal and ligand form a bond that involves the π -electrons of the ligand. Three common examples are Zeise's salt, ferrocene and benzene chromium.

These are shown below.

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Chemistry



The number of carbon atoms bonded to the metal in these compounds is indicated by the Greek letter $\eta(eta)$ with a number. The prefixes η^2 , η^5 and η^6 indicate that 2, 5 and 6 carbon atoms are the metal in the compound.

(iii) Sigma and Pi bonded organometallic compounds : Metal carbonyl compounds formed between metal and carbon monoxide, belong to this class. These compounds possess both σ -and π -bonding. Generally, oxidation state of metal atoms in these compounds is zero. Carbonyls may be mononuclear, bridged or polynuclear.



In a metal carbonyl, the metal-carbon bond possesses both the σ -and π -character. A σ -bond between metal and carbon atom is formed when a vacant hybrid orbital of the metal atom overlap with an orbital on C atom of carbon monoxide containing a lone pair of electrons.

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Formation of p-bond is caused when a filled orbital of the metal atom overlaps with a vacant antibonding π^* orbital of C atom of carbon monoxide. This overlap is also called back donation of electrons by metal atom to carbon.



The π -overlap is perpendicular to the nodal plane of σ -bond.

In olefinic complexes, the bonding π -orbital electrons are donated to the empty orbital of the metal atom and at the same time to the back bonding p-orbital of the olefin.