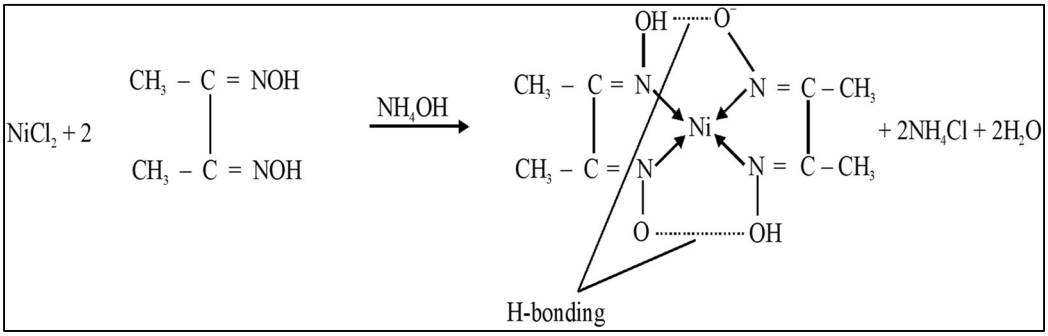
COORDINATION COMPOUNDS

IMPORTANCE AND APPLICATIONS OF COORDINATION COMPOUNDS

❖ APPLICATION OF COMPLEXES

These complexes hold significant importance due to their widespread applications across various fields. The formation of complexes leads to substantial alterations in the properties of the metal atom/ion, and these changes are utilized in the practical applications of metal complexes.

(i) The identification and quantification of Ni^{2+} rely on the creation of a scarlet red complex with dimethyl glyoxime.



(a) Fe^{3+} is detected by formation of a blood red coloured complex with KSCN.

$$Fe^{3+} + 3KSCN \longrightarrow \underset{\text{blood red colour}}{Fe(SCN)_3} + 3K^+$$

or

$$[Fe(H_2O)_5(SCN)]^{2+}$$

(b) Many ligands (organic reagents) are used for the gravimetric estimation of number of metal ions.

Metal ion to be estimated	Cu^{2+}	Ni^{2+}	Fe^{3+}	Al^{3+}	Co^{2+}
Organic reagents used	Benzoin oxime	Dimethyl glyoxime	1,20-phena-nthroline	8-hydroxy quinoline	α- nitroso β-naphthol

(c) EDTA is used as a complexing agent in volumeter analysis of metal ions like Ca^{2+}, Mg^{2+} and Zn^{2+}.

(d) The Coordination compounds involving transition metals showcase a diverse range of colors. This characteristic is employed in colorimetric analysis for the determination of numerous metals.

(ii) **Metallurgical process:**

(a) Complex formation is employed in the extraction of silver and gold. In the process, silver ore is subjected to treatment with a sodium cyanide solution, with a continuous flow of air through the solution. Silver dissolves to form a cyanide complex, and the addition of scrap zinc leads to the precipitation of silver.

$$Ag_2S + 4NaCN \overset{Air}{\rightleftharpoons} 2N[Ag(CN)_2] + NaS \overset{O_2(Air)}{\longrightarrow} Na_2SO_4 + S$$

Argentine sodium argent cyanide

$$2Na[Ag(CN)_2] + Zn \overset{Air}{\rightleftharpoons} Na_2[Zn(CN)_4] + 2Ag$$

sodium tetracyano zincate (II)

(b) Native Gold and Silver also dissolve in NaCN solution in presence of the oxygen (air).

$$4\,Ag + 8\,NaCN + O_2 + 2H_2O \rightarrow 3Na[Ag(CN)_2] + 3NaOH$$

The addition of scrap zinc results in the precipitation of silver and gold. Nickel is extracted by transforming it into a volatile complex, nickel carbonyl, using carbon monoxide (Mond's process). Upon heating, the complex decomposes back into pure nickel and carbon monoxide.

$$Ni + 4CO \rightarrow Ni(CO)_4 \overset{heating}{\longrightarrow} Ni + 4\,CO$$

(iii) **Photography:**

In photography, the fixation of the image on the negative involves dissolving all remaining silver bromide using a hypo solution in the form of a soluble complex.

$$AgBr + 2Na_2S_2O_3 \rightarrow Na_3[Ag(S_2O_3)_2] + NaBr$$

(soluble) (soluble)

(iv) **Electroplating:**

Metal complexes release metal gradually, resulting in an even coating of the metal on the intended object. Cyano complexes of silver, gold, copper, and other metals are utilized for the electrodeposition of these metals.

(v) **Biological processes** Metal complexes play a crucial role in biological processes. Hemoglobin, the red blood pigment serving as an oxygen carrier to various body parts, is a complex involving iron (II). Vitamin B_{12} is a complex containing the metal cobalt. Chlorophyll, the green coloring matter in plants, is a complex of magnesium and acts as a catalyst in photosynthesis.

APPLICATIONS OF CO-ORDINATION & ORGANOMETALLIC COMPOUNDS

(i) Coordination compounds play a vital role in biological systems. Examples include chlorophyll, the green pigment in plants; hemoglobin, the red pigment in blood serving as an oxygen carrier, along with myoglobin, which stores oxygen and regulates respiration; and Vitamin B_{12} (cyanocobalamin), known as the anti-pernicious anemia factor. These compounds involve magnesium, iron, and cobalt, forming macrocyclic porphyrin and corrin ligands.

(ii) Coordination compounds find extensive use in qualitative and quantitative chemical analysis. The recognizable color reactions exhibited by metal ions with various ligands, especially chelating ligands, serve as the foundation for their detection and estimation through classical and instrumental analysis methods. Notable examples of such reagents include ethylenediaminetetraacetic acid (EDTA), dimethylglyoxime, α-nitroso β-naphthol, cupron, etc.

(iii) Several crucial metal extraction processes, such as those for silver and gold, involve complex formation.

For instance, gold combines with cyanide in the presence of oxygen and water to form the coordination entity $[Au(CN)_2]^-$ in aqueous solution. The precipitation of gold from this solution is achieved by the addition of zinc.

(iv) Purification of metals can be accomplished through the formation and subsequent decomposition of their coordination compounds.

For instance, impure nickel is converted into $[Ni(CO)_4]$, which is then decomposed to yield pure nickel.

(v) EDTA is utilized in the treatment of lead poisoning. Some platinum coordination compounds effectively inhibit tumor growth, with examples including cis-platin (cis-$[Pt(NH_3)_2Cl_2]$) and related compounds.

(vi) Organometallic compounds serve as catalysts, falling into either the homogeneous type (soluble in the reaction medium) or the heterogeneous type (insoluble in the reaction medium). The catalyzed polymerization of alkenes at atmospheric pressure and ambient temperature using the Ziegler-Natta catalyst (titanium tetrachloride plus triethylaluminium) is a significant achievement in organometallic chemistry. The first effective homogeneous catalyst, chloridoids (triphenylphosphine) rhodium(I), $[RhCl(PPh_3)_3]$ for hydrogenation, was developed by Wilkinson.

(vii) Tetraethyl lead (TEL) is employed as an antiknock compound in gasoline.