Class – P.G. Sem. I
Subject – Chemistry
Paper – CC-I
Unit – III
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METAL LIGAND EQUILIBRIUM IN SOLUTION - III

Factors affecting the stability of metal complexes –

Properties of the ligand –

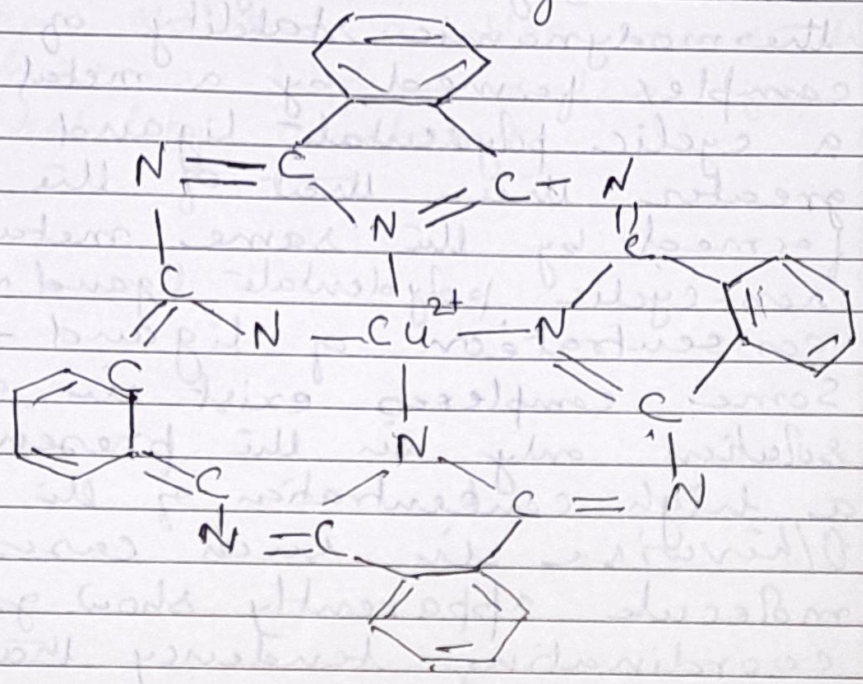
1. Size and charge of ligand – If a ligand is smaller, it can approach the metal ion more closely forming a stable bond. Similarly highly charged ligand could also form a strong bond with metal. Thus the high charge and small size of a ligand also form a strong bond with metal.
2. Dipole moment of the ligand – For the neutral ligands, the larger the magnitude of permanent dipole moment, the greater is the stability of the complexes for example – NH_3 > ethylamine > diethylamine > triethylamine.

(2) Basic character of ligands —
Basic ligands can donate ~~protons~~ ~~more easily~~ electron pairs to the central metal ion more easily. The ligand that bind H^+ formly from ~~poor~~ stable complexes. Thus F^- should form a stable complexes than Cl^-, Br^- or I^-. NH_3 is better ligand than H_2O.

(4) π - bonding capacity of ligand —
The ligands like CN^-, CO, PR_3, AsR_3, SR_3 give more stable complexes.

(5) Steric hinderance due to bulky ligands — When a bulky group is either attached to or is present near a donor atom of a ligand, repulsion between the donor atom of the ligand and the bulky group is produced and this mutual repulsion weakens the metal-ligand bonding and decreases the stability of the complexes. The effect of the presence of bulky group on the stability of a complex is commonly known as steric hinderance.

(6) Forced configuration of ligands — Ligands like porphyrin and phythalcyanine which have completely fused planar ring system, form extraordinary stable complexes with metal ion For example Cu^{2+} complex with phthalocyanine, Fe^{2+} with porphyrin (~~[illegible]~~ are very stable.



Copper (II) phalocyanine complex

7. Macrocyclic ligands and macrocyclic effect — A marocyclic ligand is a nine or more membered cyclic molecule having 3 or more potential donor atoms

which can bind a metal atom inside the cavity of the macrocycle. Many synthetic macrocyclic ligands have only N-donor atoms, some are mixed (N, O), (N, S), (N, O), (N, O, S), (N, O, P) etc. Some macrocyclic ligands have conjugated π system. The thermodynamic stability of a complex formed by a metal with a cyclic polydentate ligand is greater than that of the complex formed by the same metal with non-cyclic polydentate ligand.

8. Concentration of ligand —
Some complexes exist in aqueous solution only in the presence of a high concentration of the ligand. Otherwise in such cases, water molecule apparently show greater coordinating tendency than the groups in which are originally present. For example Co^{2+} in presence of a high concentration thiocyanate (SCN^-) forms stable blue complex ion, $[Co(SCN)_6]^{2-}$. But on dilution, the blue solution gets destroyed and is replaced by a pink hydrated complex $[Co(H_2O)_6]^{2+}$. On further addition of SCN^- ion,

disappears and the original blue colour reappears.

$$\underset{\text{blue}}{[Co(SCN)_4]^{2-}} + 6H_2O \rightleftharpoons \underset{\text{Pink}}{[Co(H_2O)_6]^{2+}} + 4SCN^-$$

(9) Chelate effect → A chelated complex dissociates less than a non-chelated complex and hence has a higher value for its stability constant.