## Factors affecting the stability of complexes

The nature of central atom of metal complexes, dimension, its degree of oxidation, electronic structure of these complexes, and so many other properties of complexes are affected by the stability constant. Some of the following factors described are as follows.

### Nature of central metal ion

In the coordination chemistry, metal complexes are formed by the interaction between metal ions and ligands. For these type of compounds, metal ions are the coordination centre, and the ligand or complexing agents are oriented surrounding it. These metal ions mostly are the transition elements. For the determination of stability constant, some important characteristics of these metal complexes may be as given below

### Ionic size

Ligands are oriented around the central metal ions in the metal complexes. The sizes of these metal ions determine the number of ligand species that will be attached or ordinated (dative covalent) in the bond formation. If the sizes of these metal ions are increased, the stability of coordination compound defiantly decreased. Zn(II) metal ions are the central atoms in their complexes, and due to their lower size (0.74A°) as compared to Cd(II) size (0.97A°), metal ions are formed more stable.

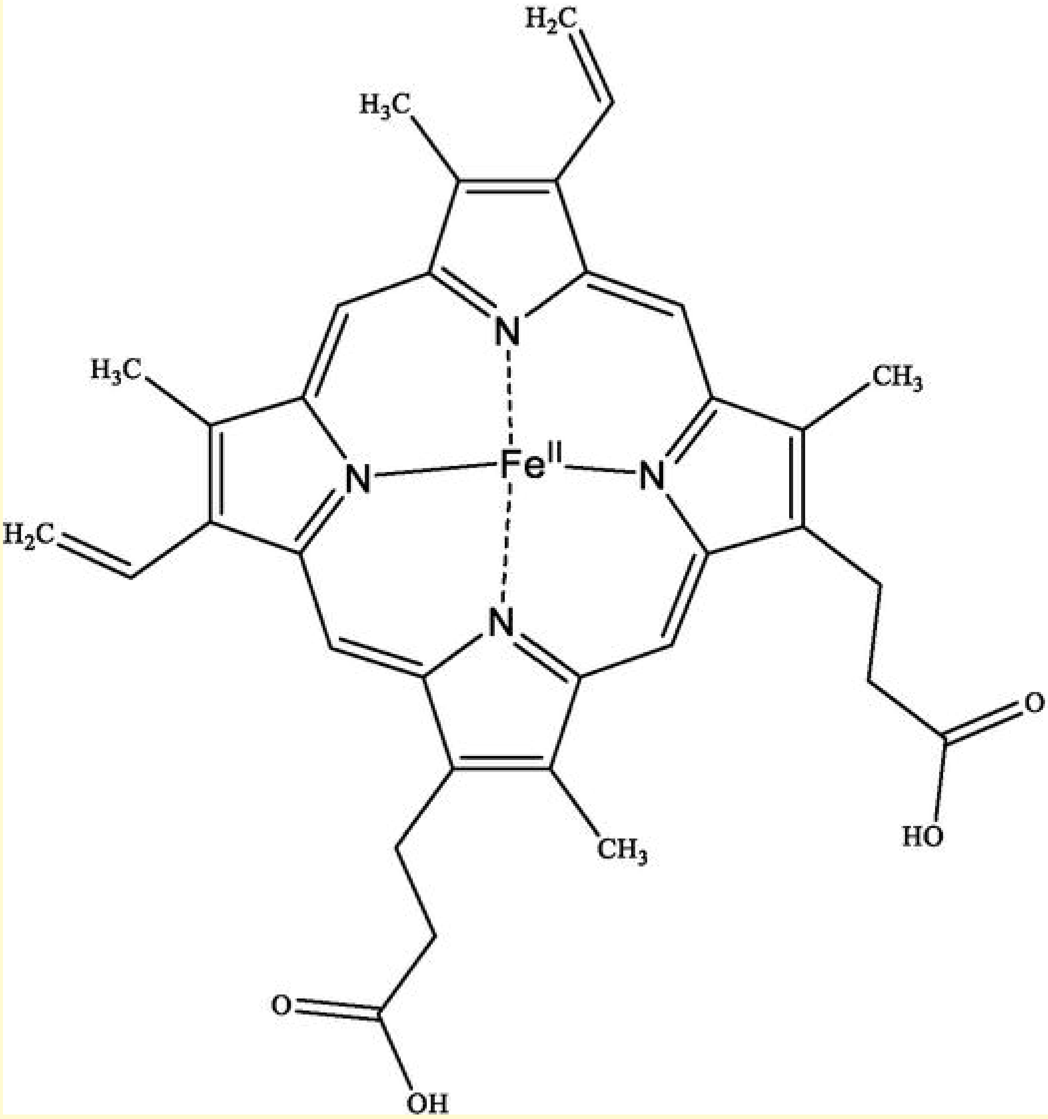
Hence, $Al^{3+}$ ion has the greatest nuclear charge, but its size is the smallest, and the ion $N^{3-}$ has the smallest nuclear charge, and its size is the largest . Inert atoms like neon do not participate in the formation of the covalent or ionic compound, and these atoms are not included in isoelectronic series; hence, it is not easy to measure the radius of this type of atoms.

### Ionic charge

The properties of stability depend on the size of the metal ion used in the complexes and the total charge thereon. If the size of these metal ions is small and the total charge is high, then their complexes will be more stable. That is, their ratio will depend on the charge/radius. This can be demonstrated through the following reaction:

Fe3++6CN−⇆[Fe(CN)6]3−logβ=31 (More Stable)Fe3++6CN−⇆FeCN63−logβ=31More StableE19
Fe2++6CN−⇆[Fe(CN)6]4−−logβ=8.3(Less Stable)Fe2++6CN−⇆FeCN64−−logβ=8.3Less StableE20

An ionic charge is the electric charge of an ion which is formed by the gain (negative charge) or loss (positive charge) of one or more electrons from an atom or group of atoms. If we talk about the stability of the coordination compounds, we find that the total charge of their central metal ions affects their stability, so when we change their charge, their stability in a range of constant can be determined by propagating of error [\. If the charge of the central metal ion is high and the size is small, the stability of the compound is high:




Chelating effect

For a metal ion, chelating ligand is enhanced and affinity it and this is known as chelate effect and compared it with non-chelating and monodentate ligand or the multidentate ligand is acts as chelating agent. Ethylenediamine is a simple chelating agent (Figure 1).


**Figure 1.**

Structure of ethylenediamine.

Due to the bidentate nature of ethylenediamine, it forms two bonds with metal ion or central atom. Water forms a complex with Ni(II) metal ion, but due to its monodentate nature, it is not a chelating ligand (Figures 2 and 3).

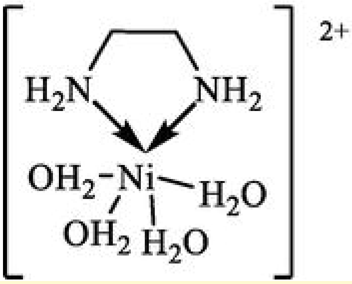



**Figure 2.**

Structure of chelating configuration of ethylenediamine ligand.

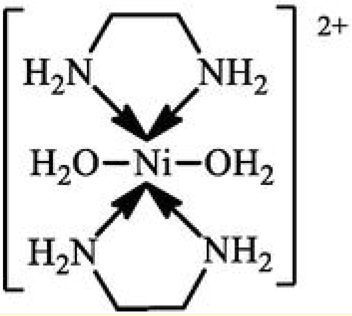



**Figure 3.**

Structure of chelate with three ethylenediamine ligands.

The dentate cheater of ligand provides bonding strength to the metal ion or central atom, and as the number of dentate increased, the tightness also increased. This phenomenon is known as chelating effect, whereas the formation of metal complexes with these chelating ligands is called chelation:

$$\text{Metal}+2\text{Ligand}\leftrightarrow\text{MetalLigand2}$$
$$K=(ML2)[M][L]2$$

Some factors are of much importance for chelation as follows.

Ring size

The sizes of the chelating ring are increased as well as the stability of metal complex decreased. According to Schwarzenbach, connecting bridges form the chelating rings. The elongated ring predominates when long bridges connect to the ligand to form a long ring. It is usually observed that an increased a chelate ring size leads to a decrease in complex stability.

He interpreted this statement. The entropy of complex will be change if the size of chelating ring is increased, i.e., second donor atom is allowed by the chelating ring. As the size of chelating ring increased, the stability should be increased with entropy effect. Four-membered ring compounds are unstable, whereas five-membered are more stable. So the chelating ring increased its size and the stability of the formed metal complexes.

Number of rings

The number of chelating rings also decides the stability of complexes. Non-chelating metal compounds are less stable than chelating compounds. These numbers increase the thermodynamic volume, and this is also known as an entropy term. In recent years ligands capable of occupying as many as six coordination positions on a single metal ion have been described. The studies on the formation constants of coordination compounds with these ligands have been reported. The numbers of ligand or chelating agents are affecting the stability of metal complexes so as these numbers go up and down, the stability will also vary with it.

For the Ni(II) complexes with ethylenediamine as chelating agent, its log $K_1$ value is 7.9 and if chelating agents are trine and penten, then the log $K_1$ values are 7.9 and 19.3, respectively. If the metal ion change Zn is used in place of Ni (II), then the values of log $K_1$ for ethylenediamine, trine, and penten are 6.0, 12.1, and 16.2, respectively. The log βMY values of metal ions are given .

| **Metal ion** | **log βMY (25°C, I = 0.1 M)** |
|---|---|
| $Ca^{2+}$ | 11.2 |
| $Cu^{2+}$ | 19.8 |
| $Fe^{3+}$ | 24.9 |