



Spectral study of Cu(II), Co(II) and Zn(II) metal ion complexes of Schiff Base

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ABSTRACT

Schiff bases are having strong ability to form complexes due to presence of different donor atoms. In continuation with the preparation of Schiff base and their complexes with Cu(II), Co(II) and Zn(II) metal ion, it is necessary to study the nature of bonding in the ligand and their complexes, Infrared spectral study is used.

Key Words: Cu(II), Co(II) and Zn(II) metal ion complexes, Schiff bases, ligand, Infrared spectra.

Introduction: Research survey reveals that Schiff bases forms coordinate compounds^{1, 2} and they have been extensively studied because of their broad spectrum of biological activities^{3,4}. Schiff base metal complexes offer an area of increasing interest. Polynuclear metal complexes containing nitrogen and phenolic oxygen donor atoms are of considerable interest in inorganic and bioinorganic chemistry⁵⁻⁷. It has been also reported that Schiff bases and their metal complexes have application as anti-corrosion agent^{8, 9}, catalytic property^{10,11}, and anti-inflammatory agent^{12,13}. The synthesis, stability study and reactivity of prepared metal complexes are very interesting in the field of research. In continuation with the synthesis of Schiff base and metal complexes, the nature of bonds are studied with the help of Infrared spectra. Infrared radiation is a part of electromagnetic spectrum which is present between visible and microwave region. For chemist Infrared region is of greatest practical value. The rotational, vibrational bands occurring at a particular wavelength or frequency depends on the relative mass of the atoms, the force constant of the bonds and the geometry of the atoms. Since Infrared spectra contain large number of bands, No two compounds will have the same infrared spectrum. Thus infrared spectra may be regarded as the fingerprint of molecule. Infrared spectra of free ligand differ from their metal complexes to certain extent due to introduction of metal ion. Therefore infrared spectroscopic study is an important tool in the study of bonding in metal complex. The system undergoes change in vibrational modes, due to change in bond length, bond angle and force constant of bonds. By correlating the spectra of ligand with the metal complexes, the bonding character in metal complexes can be deduced.

Infra Red spectra of Ligand: The ligand used were Schiff bases obtained by condensing different aromatic amines with salicylaldehyde¹⁴. Infra Red spectra provide complex absorption pattern due to various vibrational modes. However with limited objectives only few absorption frequencies related to groups involved in complex

formation are considered for nature of bonding in complexes. The Infrared spectra of ligand shows peaks due to hydrogen bonded —OH stretching, Azomethine (>C—N-), >C—H stretching frequency, Aromatic C = C vibrational frequency, C—O stretching frequency.

Infrared spectra of ligand shows strong band in the region of 3400 cm^{-1} which assigned to hydrogen bonded —OH frequency. The lowering of normal free —OH stretching frequency between 3600 cm^{-1} and 3500 cm^{-1} to above value expected due to strong intermolecular hydrogen hydrogen bonding of the type O—H—N between enolic —OH and nitrogen of azomethine group. Ligand also shows intense band at 2924 cm^{-1} due to >C—H stretching frequency. In the Infrared spectra the appearance of band at 1647 cm^{-1} attributed to presence of >C=N stretching frequency. Syamal¹⁶ reported C=N at $1660\text{--}1640\text{ cm}^{-1}$ stretching in schiff base of salicylaldehyde and 3-aminothiophenol. Band at 1404 cm^{-1} is due to aromatic C=C vibrational frequency. In the Infrared spectrum of free ligand the C—O band appears at 1215 cm^{-1} .

Infra Red spectra Cu(II) Complex: The C=N frequencies in the Cu(II) complex gives rise to strong band at 1620 cm^{-1} . and in free ligand it is observed at 1647 cm^{-1} .

The blue shift by $20\text{--}30\text{ cm}^{-1}$ is due to participation of Azomethine nitrogen in the complex formation. The band appears at 1215 cm^{-1} in free ligand due to C—O stretch is shifted to 1308 cm^{-1} due to involvement in coordinate bond formation. The band observed in the region 536 cm^{-1} is attributed to metal Oxygen bond stretching. of cu(II) complex.

Infra Red spectra Co(II) Complex: The characteristic of Azomethine stretching vibration of C=N is assigned to the band at 1628 cm^{-1} in the infrared spectra of Co(II) complex. There thus a shift of $15\text{--}20\text{ cm}^{-1}$ on the lower side in relation to ligand frequencies for Azomethine group. This suggest that the ligand is coordinated to metal via Azomethine nitrogen atom as reported in various Schiff base complexes of Co(II) ion.

The C-O band in free ligand appears at 1215 cm^{-1} is slightly shifted to 1311 cm^{-1} in Co(II) complex. New band appears in the region at 516 cm^{-1} attributed to the formation metal Oxygen bond in Co(II) complex.

Infra Red spectra Zn(II) Complex: The band at 1635 cm^{-1} in the infrared spectra of Zn(II) complex is attributed to the characteristic of Azomethine stretching vibration of C=N. There is thus a shift of $10\text{--}15\text{ cm}^{-1}$ on the lower side in relation to ligand frequencies for Azomethine group. This suggest that the ligand is coordinated to metal via Azomethine nitrogen atom as reported in various Schiff base complexes of Zn (II) ion¹⁷. Band of medium intensity for C-O stretching vibration observed at 1215 cm^{-1} in ligand is shifted to higher frequency and observed at 1315 cm^{-1} . This shows the participation of enolic C-O group of the ligand in the formation of Zn(II) complex. The two bands in the region $2900\text{--}3000\text{ cm}^{-1}$ in complex is due to two types of C=C—H stretching vibration. Some new band observed at 522 cm^{-1} in complex assigned to Metal Oxygen stretching¹⁸. The band intensities of various stretching in the complexes are given in the table given below.

Table**Band intensities of various stretching in the complexes**

| Sr.No. | Complexes | Molecular formula | Azomethine >C=N | >C=C-O | M-O- |
|--------|-----------|--|--------------------|--------|------|
| 1. | Cu(II)L | C ₂₀ H ₁₄ N ₂ O ₂ Cu | 1620 | 1308 | 536 |
| 2. | Co(II)L | C ₂₀ H ₁₄ N ₂ O ₂ Co | 1628 | 1311 | 516 |
| 3. | Zn(II)L | C ₂₀ H ₁₄ N ₂ O ₂ Zn | 1635 | 1315 | 522 |

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