CHAPTER III

EXPERIMENTAL TECHNIQUES
3. A. General:

A wide variety of methods of variable precision and dependability are available for determining the structure of coordination compounds. These may be roughly divided into three groups: spectroscopic methods, macroscopic methods and chemical methods.

(a) Spectroscopic methods generally provide specific structural information of high precision. The important methods in this group are:
- FT-IR and Raman Spectrophotometry.
- UV-visible (electronic) spectrophotometry.
- Magnetic resonance methods like NMR, NQR, ESR, and Diffraction methods, Mass Spectrometry.

(b) Macroscopic physical methods indicate the general structure type rather than giving structural details. These involve measurements of gross physical properties such as melting point, boiling point, vapour pressure, thermo gravimetric, electrical conductivity, magnetic susceptibility etc.

(c) Chemical methods are based on chemical reactions of the compound. The reliability of these methods is, in
general, low and the information needs to be carefully interpreted.

In the present work, the following methods were used to obtain structural information of the coordination compounds studied.

3. B. **Elemental analyses**:

This involved the estimation of metal, carbon, hydrogen, nitrogen and sulphur in all the solid complexes. Estimation of metal in each compound was carried out by gravimetric oxide method and EDTA titration as described by Flaschka [1]. Carbon, hydrogen, nitrogen and sulphur were estimated on a "Perkin Elmer, Series II, 2400" C-H-N-S analyzer at Central Salt and Marine Chemical Research Institute, Bhavnagar, India.

3. C. **Electrical conductivity measurements**:

The conductivities of the metal chelates in DMF were measured using "Equiptronics EQ-660 digital conductivity meter" and a calibrated conductivity cell at room temperature. The cell constant of the conductivity cell was calculated using standard procedure [2]. The cell constant obtained for the cell is 1.01 cm\(^{-1}\) at 30°C. The conductivity of each solution was measured twice or thrice and the constant value observed was used in further calculations.
3. D. **Magnetic susceptibility measurements**:

The Gouy method [3,4] used for magnetic susceptibility constants essentially of suspending a cylindrical sample of a substance in a non-homogeneous magnetic field with the lower end in the region of maximum field and the upper end in a region of effectively zero field and measurement of the force exerted on the sample is made by the conventional weighing technique.

The Gouy set-up should be calibrated [5-9] in terms of a substance of known susceptibility such as distilled water, benzene, aqueous nickel chloride solution, copper sulphate, mercury tetrathiocyanato cobaltate Hg[Co(CNS)₄], [Ni(en)₃(S₂O₃)], [(NH₄)₂ Fe(SO₄)₂].6H₂O and K₃[Fe(CN)₆].

Magnetic susceptibility measurements in the present work were made at room temperature (30°C) using a Gouy balance (Sartorius, semi-micro, Sardar Patel University, Vidyanagar, India). The Gouy tube was calibrated using mercury tetrathiocyanato cobaltate. Hg[Co(CNS)₄] (\(\chi_g = 16.44 \times 10^{-6}\) c.g.s. units at 20 °C and 0.05 \(\times 10^{-6}\) c.g.s. units decrease per 30 °C rise) and tube constant was verified using highly pure copper sulphate (\(\chi_g = 5.9 \times 10^{-6}\) c.g.s. units at 30°C).
For determining magnetic moment, finely ground sample was carefully packed into a pyrex Gouy tube by introducing small quantity at a time and tapping it down after each addition. This operation was repeated until the sample filled into a fixed mark on the Gouy-tube. The tube was then suspended with its bottom at the center of the gap between the pole faces of the electro-magnet. The tube was weighed with and without applied magnetic field and deviation in weight of the tube (W) containing W gm of sample was determined. The gram susceptibility or specific susceptibility was calculated using the expression.

\[
\chi_g = \frac{\alpha + \beta \cdot dw}{W}
\]

Where \(\alpha\) = correction due to displaced air.

\[= +0.029 \times 10^{-6}\) c.g.s. units \times volume of air.\]

\(\beta\) = Gouy tube constant.

\(dw\) = \((\Delta W - \delta)\) here \(\Delta W\) is apparent change in weight (in mg) of the tube containing W grams of the sample on application of the field and \(\delta\) is the deflection in weight of the empty tube on application of the filed.

In order to minimize error due to packing of the solid into the tube, measurement with each sample was repeated three to four times, emptying the tube and
repacking it a fresh each time and the average change in weight was considered.

The gram susceptibility was multiplied by the molecular weight to obtain the molar susceptibility, \( \chi_M \). A correction was applied for the diamagnetism of the ligands and anions using Pascal’s constants\([10-12]\) to give the corrected molar susceptibility, \( \chi'_M \). The effective magnetic moment \( \mu_{\text{eff.}} \) was then calculated from the expression.

\[
\mu_{\text{eff.}} = 2.84 (\chi'_M \times T)^{1/2}
\]

Where \( T \) = absolute temperature (°K).

3. E. Spectrophotometric measurements:

(a) Electronic spectral measurements:

The electronic spectra of the solid compounds were recorded in DMF (spectral grade) on Perkin-Elmer Lambda-19 UV-Visible spectrophotometer at Sophisticated Instrumentation Centre for Applied Research and Testing (SICART), Vidyanagar, India.

(b) Infrared spectral measurements:

The FT-IR spectra of the compounds studied in the present work were recorded on a Perkin-Elmer Spectrum-GX spectrophotometer in KBr pellets at
(c) $^{13}$C NMR Spectral measurements:

The $^{13}$C NMR spectra in DMSO of all ligands studied in the present work were recorded on a Bruker DRX-300 FT-NMR Spectrophotometer using TMS $[(\text{CH}_3)_4\text{Si}]$ as an internal standard at Central Salt Marine Chemical Research Institute, Bhavnagar, India.

3. F. Thermogravimetric analysis (TGA):

The thermogravomeric analysis techniques were extensively applied in studying of the thermal behaviour of the metal chelates[13-19]. The thermograms of the chelates were recorded on Metler Toledo thermal analyzer at a heating rate $10^\circ$ C min$^{-1}$ in air [Regional Sophisticated Instrumentation Center (RSIC), Nagpur, India.] The thermograms were analysed to obtain the information about the presence of water (lattice or coordinated) in the chelates and also to evaluate the activation energy for the chelates studied in the present work (chapter 4.F).
REFERENCES


