

Industrial application of tetradentate Schiff base Metal Complexes

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Abstract

The newly synthesized Schiff base have been prepared by condensation of 2-hydroxy-5-bromo acetophenone with ethylene diamine. The synthesized Tetradentate Schiff base metal complexes are Co(II), Ni(II), Cu(II), Cr(III), Mn(III), Fe(III) VO(IV), Zr(IV) and UO₂(VI). The Schiff base metal complexes have been characterized on the basis of elemental analysis, infrared, molar conductance and magnetic susceptibilities. The industrial application of Schiff base and their complexes have been studies.

Keywords: Tetradentate Schiff base, Spectra, Molar conductance, Industrial application

Introduction

The lone pair of electrons on the nitrogen atom plays a crucial role in coordination chemistry and biological interactions. Due to their versatile chemical nature, Schiff bases are widely utilized in medicinal chemistry, coordination chemistry, and industrial processes. Schiff bases exhibit a wide range of pharmacological activities, including antibacterial, antifungal, anticancer, anti-inflammatory, and antidiabetic properties. Synthesize mechanism and biological application¹ Synthesis, characterization and biological activity of metal complexes and their Schiff base ligands². This paper discusses the molar conductance, magnetic susceptibilities and industrial application for Schiff base metal complexes of Co (II), Ni (II), Cu (II), Cr (III), Mn (III), Fe (III) VO (IV), Zr (IV) and UO₂ (VI).

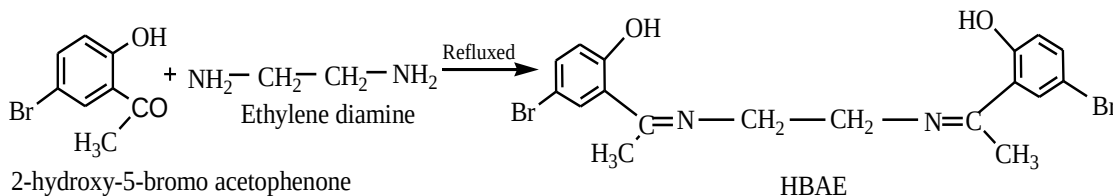
Experimental

All the chemicals were of A.R. grade and used as received ethylene diamine and 2-hydroxy-5-bromo acetophenone (HBA) was prepared by known methods³. The solvents were purified by standard methods⁴.

Synthesis of 2-Hydroxy-5-bromoacetophenone-N, N'-ethylenediimine (HBAE):

A hot ethanolic solution of ethylene diamine (0.05 mol) was added to an ethanolic solution of respective acetophenone (0.05 mol). The reaction mixture was refluxed in a water-bath for 4-5 h. The colour product was filtered off and recrystallised.

Yield 70%. M. P. 270⁰C



Preparation of complexes: All the metal complexes were prepared in a similar way by following method. To a hot solution of ligand HBAE (0.02M) in 25ml of ethanol a suspension of respective metal salts was added drop wise with constant stirring. The reaction mixture was refluxed on a water bath for 4-6 h. The precipitated complexes were filtered, washed with ethanol followed by ether and dried over fused calcium chloride. Yield: 45-50%

Table 1. Analytical data and molar conductance of the compounds.

Compounds	Colour	Mol.wt.	Analysis % Found (calc.)					μ_{eff} B.M.	Λ_{M} ($\Omega^{-1} \text{cm}^2$ mol^{-1})
			M	C	H	N	Cl		
$\text{C}_{18}\text{H}_{18}\text{N}_2\text{O}_2\text{Br}_2$	Yellow	453.8	--	47.83 (47.59)	3.85 (3.96)	6.07 (6.17)	--	--	--
$[\text{CoL}(\text{H}_2\text{O})_2] \cdot \text{H}_2\text{O}$	Brown	564.7	10.32 (10.43)	38.12 (38.25)	3.72 (3.89)	4.80 (4.95)	--	4.27	6.1
$[\text{NiL}] \cdot \text{H}_2\text{O}$	Black	528.5	11.02 (11.10)	40.72 (40.87)	3.25 (3.40)	5.17 (5.29)	--	Dia	5.6
$[\text{CuL}(\text{H}_2\text{O})_2] \cdot 2\text{H}_2\text{O}$	Brown	587.3	10.61 (10.81)	36.61 (36.77)	3.95 (4.08)	4.62 (4.76)	--	2.02	18.8
$[\text{CrL}(\text{H}_2\text{O})\text{Cl}] \cdot 2\text{H}_2\text{O}$	Yellow	593.3	8.66 (8.76)	36.22 (36.40)	3.52 (3.70)	4.58 (4.71)	5.77 (5.98)	3.86	21.2
$[\text{MnL}(\text{OAc})] \cdot 2\text{H}_2\text{O}$	Brown	601.7	9.02 (9.12)	39.78 (39.88)	3.62 (3.82)	4.53 (4.65)	--	5.6	12.8
$[\text{FeL}(\text{H}_2\text{O})\text{Cl}] \cdot \text{H}_2\text{O}$	Green	579.2	9.58 (9.65)	37.13 (37.29)	3.32 (3.45)	4.72 (4.83)	6.02 (6.12)	6.0	18.8
[VOL]	Green	518.8	9.41 (9.83)	41.12 (41.63)	3.01 (3.08)	5.09 (5.39)	--	1.78	14.5
$[\text{ZrL}(\text{OH})_2] \cdot 2\text{H}_2\text{O}$	Yellow	613.0	14.72 (14.87)	35.08 (35.23)	3.47 (3.58)	4.38 (4.56)	--	Dia	31.9
$[\text{UO}_2\text{L}]$	Orange	721.9	32.87 (32.98)	29.82 (29.92)	2.08 (2.21)	3.75 (3.87)	--	Dia	23.6

The complexes are soluble in DMSO and DMF but insoluble in water and common organic solvents. The metal chloride content of complexes were analyzed by standard methods.

The ^1H NMR spectra of ligand was recorded and obtained from RSIC Chandigarh. IR spectra of the compounds were recorded on Perkin Elmer 842 spectrophotometer in the region $400\text{--}4000\text{cm}^{-1}$. Carbon, Hydrogen and Nitrogen analysis were carried out at RSIC, Punjab University, Chandigarh. The molar conductance of the complexes at 10^{-3} M dilution in DMF were determined using equiptronic digital conductivity meter EQ-660 with a cell constant 1.00 cm^{-1} at room temperature. The magnetic moment measurement were made on a Gouy balance at room temperature using $[\text{HgCo}(\text{SCN})_4]$ as the calibrant. The thermogravimetric analysis were performed on laboratory set up apparatus in air atmosphere at $10^\circ\text{C min}^{-1}$ heating rate. The molecular weights of the complexes were determined by Rast method.

Result and Discussion

The Schiff base ligand HBAE and its complexes have been characterized on the basis of ^1H NMR, IR spectral data, elemental analysis, molar conductance and magnetic susceptibility. All these values and analytical data is consistent with proposed molecular formula of ligand. All the compounds are coloured solid and stable in air. They are insoluble in water but soluble in coordinating solvents like DMF and DMSO. The molar conductance values in DMF (10^{-3} M) solution at room temperature (Table 1) shows all the complexes are non-electrolytes. The ^1H NMR spectra of ligand HBAE show signals: δ 15.97 (1H, s, phenolic OH); 8.06 (1H, s, phenyl); 7.67 and 7.31 (2H, m, phenyl), 3.29 (4H, s, $\text{CH}_2\text{--CH}_2$); 2.51 ppm (3H, s, methyl) ⁵⁻¹¹

Table 2. IR spectra of ligand and metal complexes.

Compound	$\nu(\text{O} \cdots \text{H})$ hydrogen bonded	$\nu(\text{C}=\text{N})$ imine	$\nu(\text{C}=\text{O})$ phenolic	$\nu(\text{M} \cdots \text{O})$	$\nu(\text{M} \cdots \text{N})$	ν_{asym}
$\text{C}_{18}\text{H}_{18}\text{N}_2\text{O}_2\text{Br}_2$	2900	1614	1480	--	--	-----
$[\text{CoL}(\text{H}_2\text{O})_2] \cdot \text{H}_2\text{O}$	--	1589	1440	520	455	3400, 1640, 815, 770
$[\text{NiL}] \cdot \text{H}_2\text{O}$	--	1586	1460	510	495	3326, 1630
$[\text{CuL}(\text{H}_2\text{O})_2] \cdot 2\text{H}_2\text{O}$	--	1595	1440	590	490	3406, 1642, 818, 780
$[\text{CrL}(\text{H}_2\text{O})\text{Cl}] \cdot 2\text{H}_2\text{O}$	--	1600	1436	570	460	3390, 1635, 830, 745
$[\text{MnL}(\text{OAc})] \cdot 2\text{H}_2\text{O}$	--	1590	1446	580	495	3330, 1628
$[\text{FeL}(\text{H}_2\text{O})\text{Cl}] \cdot \text{H}_2\text{O}$	--	1602	1463	530	425	3395, 1638, 845, 740
[VOL]	--	1600	1455	525	480	-----
$[\text{ZrL}(\text{OH})_2] \cdot 2\text{H}_2\text{O}$	--	1601	1440	565	460	3335, 1628
$[\text{UO}_2\text{L}]$	--	1590	1420	560	470	-----

Industrial Application of Schiff base and Metal complexes

Schiff Base are organic compounds containing C=N functional group. It highly versatile building blocks in modern chemical engineering, heavy manufacturing, and green technologies. Their diverse chemistry arises from their ability to function as powerful chelating agents that securely bind transition metals, forming structurally stable metal complexes. Schiff base transition metal complexes are widely deployed as highly efficient catalysts for both homogeneous and heterogeneous industrial reactions. It applicable in industry as a industrial catalysis, polymer production, corrosion inhibitors, materials science, environmental remediation, wastewater treatment, heavy metal removal, analytical sensors, quality control and ion-selective sensors. Schiff base metal complexes of copper, cobalt, zirconium, Manganese, chromium iron, vanadium, zirconium and nickel complexes act as highly efficient, recyclable catalysts for industrial reactions like benzyl alcohol oxidation, oxygenation, and polymer decomposition. Uranium is also use as a radioactive material in industries, As well as Schiff base metal complexes of iron, zinc, and copper^{12,13} Schiff base complexes form protective molecular films on metal surfaces, significantly reducing acid and industrial solvent corrosion.

Conclusion

The analysis of magnetic moment data shows characterization and structural changes in metal complexes. Industrial application are uses in different industries and also doing novel research in industrial various purposed.

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