

Volume 5, Issue 1(II)

January - March 2018

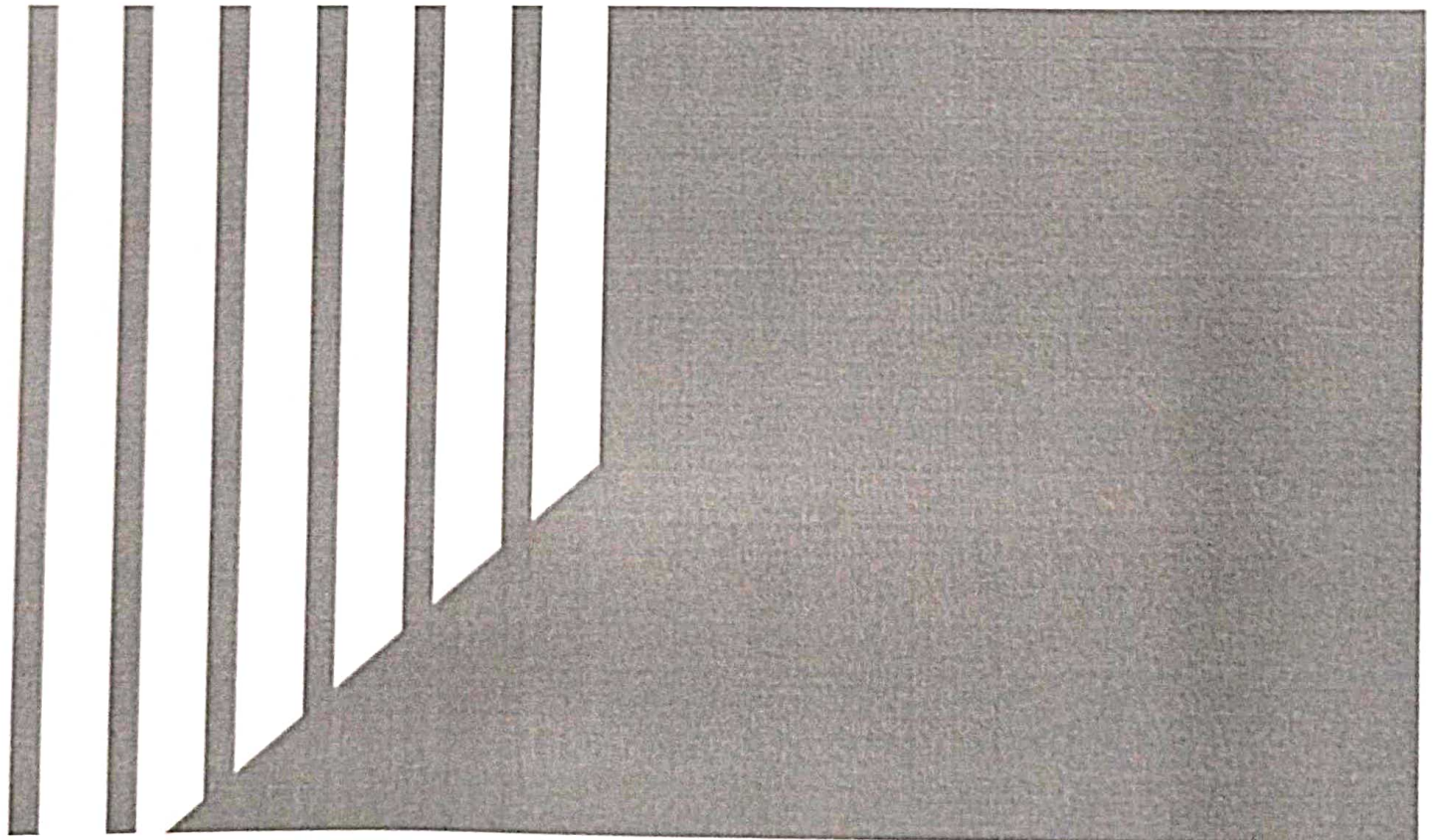
ISSN 2394 - 7780



ज्ञान-विज्ञान विमुक्तये
UGC
University Grants Commission
Journal No.: 63571

International Journal of

Advance and Innovative Research



International Journal of Advance and Innovative Research

Volume 5, Issue 1 (II): January – March 2018

Editor- In-Chief

Dr. Tazyn Rahman

Members of Editorial Advisory Board

Mr. Nakibur Rahman

Ex. General Manager (Project)
Bongaigoan Refinery, IOC Ltd, Assam

Dr. Alka Agarwal

Director,
Mewar Institute of Management, Ghaziabad

Prof. (Dr.) Sudhansu Ranjan Mohapatra

Dean, Faculty of Law,
Sambalpur University, Sambalpur

Dr. P. Malyadri

Principal,
Government Degree College, Hyderabad

Prof.(Dr.) Shareef Hoque

Professor,
North South University, Bangladesh

Prof.(Dr.) Michael J. Riordan

Professor,
Sanda University, Jiashan, China

Prof.(Dr.) James Steve

Professor,
Fresno Pacific University, California, USA

Prof.(Dr.) Chris Wilson

Professor,
Curtin University, Singapore

Prof. (Dr.) Amer A. Taqa

Professor, DBS Department,
University of Mosul, Iraq

Dr. Nurul Fadly Habidin

Faculty of Management and Economics,
Universiti Pendidikan Sultan Idris, Malaysia

Dr. Neetu Singh

HOD, Department of Biotechnology,
Mewar Institute, Jaipur, Ghaziabad

Dr. Mukesh Saxena

Pro Vice Chancellor,
University of Technology and Management, Shillong

Dr. Archana A. Ghatule

Director,
SKN Sinhgad Business School, Pandharpur

Prof. (Dr.) Monoj Kumar Chowdhury

Professor, Department of Business Administration,
Guahati University, Guwahati

Prof. (Dr.) Baljeet Singh Hothi

Professor,
Gitarattan International Business School, Delhi

Prof. (Dr.) Badiuddin Ahmed

Professor & Head, Department of Commerce,
Maulana Azad National Urdu University, Hyderabad

Dr. Anindita Sharma

Dean & Associate Professor,
Jaipuria School of Business, Indirapuram, Ghaziabad

Prof. (Dr.) Jose Vargas Hernandez

Research Professor,
University of Guadalajara, Jalisco, México

Prof. (Dr.) P. Madhu Sudana Rao

Professor,
Mekelle University, Mekelle, Ethiopia

Prof. (Dr.) Himanshu Pandey

Professor, Department of Mathematics and Statistics
Gorakhpur University, Gorakhpur

Prof. (Dr.) Agbo Johnson Madaki

Faculty, Faculty of Law,
Catholic University of Eastern Africa, Nairobi, Kenya

Prof. (Dr.) D. Durga Bhavani

Professor,
CVR College of Engineering, Hyderabad, Telangana



Journal - 63571

UGC Journal Details

Name of the Journal : International Journal of Advance & Innovative Research

ISSN Number :

e-ISSN Number : 23947780

Source: UNIV

Subject: Multidisciplinary

Publisher: Indian Academicians and Researchers Association

Country of Publication: India

Broad Subject Category: Multidisciplinary

CONTENTS

Research Papers

EFFICIENCY AND DIRECTIONAL RETURNS TO SCALE OF INDIAN BANKS	1 – 7
Dr. Gagandeep Sharma and Dr. Divya Sharma	
SOCIO-ECONOMIC STATUS OF TRADITIONAL FISHERMEN COMMUNITY IN THE VEMBAR COASTAL VILLAGE OF TUTICORIN DISTRICT, TAMILNADU, INDIA	8 – 16
R. J. Rathees and V. Ramadas	
A STUDY ON THE SOCIO-ECONOMIC PROFILE OF SCHOOL DROPOUTS IN THE COASTAL VILLAGES OF KARAİKAL DISTRICT, U.T. OF PUDUCHERRY	17 – 23
Sunder Arumugam	
REFORMS OF GST IN INDIAN TAXATION SYSTEM	24 – 31
Harish N.	
FRUIT WINES AND WINE TOURISM IN MEGHALAYA	32 – 38
Ashok Kumar	
THE IMPACT OF EMOTIONAL INTELLIGENCE ON PSYCHOLOGICAL CAPITAL OF EMPLOYEES AND ITS CONTRIBUTION TO WORKPLACE SPIRITUALITY	39 – 63
Dr. Taranjeet Duggal, Ms. Mitali Awasthi and Ms. Vartika Tripathi	
STUDY OF PLANER KINEMATIC CHAINS OF 1F 8LINKS	64 – 68
Dr. Ali Hasan	
EVALUATION OF BASE KITCHEN SANITATION AND HYGIENE AMONG FOOD SERVICE ESTABLISHMENTS IN HYDERABAD	69 – 76
Santoshi Lakshmi N. and Kavita Waghay	
TRANSFORMATION IN LIVELIHOOD: A CASE STUDY OF A PARTICULARLY VULNERABLE TRIBAL GROUP - THE JUANGS OF KEONJHAR DISTRICT, ODISHA	77 – 84
Sampriti Panda	
A STUDY OF OCTAPACE CULTURE AND JOB SATISFACTION OF EMPLOYEES IN EDUCATIONAL SECTOR	85 – 90
Umar Mufeed	
STUDY OF INDOOR ²²²Rn, ²²⁰Rn AND THEIR PROGENY LEVELS USING LR-115 (II) NUCLEAR TRACK DETECTORS IN GUWAHATI, ASSAM	91 – 95
Debajyoti Barooah and Simi Barman	
SYNTHESIS AND CHARACTERIZATION OF A SERIES OF BIOLOGICALLY ACTIVE TRANSITION METAL COMPLEXES INCORPORATING TRIDENTATE ONO DONOR HYDRAZONE LIGAND	96 – 102
N. J. Suryawanshi, A. R. Yaul, G. B. Pethe and A. S. Aswar	

SYNTHESIS AND CHARACTERIZATION OF A SERIES OF BIOLOGICALLY ACTIVE TRANSITION METAL COMPLEXES INCORPORATING TRIDENTATE *ONO* DONOR HYDRAZONE LIGAND

N. J. Suryawanshi, A. R. Yaul, G. B. Pethe and A. S. Aswar

Department of Chemistry, Sant Gadge Baba Amravati University, Amravati

ABSTRACT

A new acid hydrazone (H_2L) derived from the condensation of 2-hydroxy-5-methylacetophenone and salicylhydrazide and its metal complexes of Mn(II), Co(II), Ni(II), Cu(II), Ti(III), Cr(III), Fe(III), Zr(IV) and $UO_2(VI)$ have been prepared. Their structures have been elucidated on the basis of elemental analyses, magnetic moment, spectral (IR and electronic), powder X-ray diffraction and thermogravimetric analysis (TG). The analytical data, indicate 1:1 (metal: ligand) stoichiometry for all complexes. The powder X-ray diffraction suggests orthorhombic crystal system for Cu(II) complex. The complexes exhibit an octahedral geometry around the metal centre except Cu(II) ion. Cu(II) complex shows square planar geometry. The IR spectral data suggest that the ligand behaves as tridentate with *ONO* donor atoms sequence towards central metal ion. Electrical conductivity of the complexes was measured in their compressed pellet form and showed their semiconducting nature over a studied range of temperature. Thermal behaviour of complexes was studied using TG and data have been analyzed for kinetic parameters by Horowitz–Metzger method. The ligand and its complexes were also screened for their antibacterial activity against *E. coli*, *S. typhi*, *P. aeruginosa* and *S. aureus* bacterial strains by disc diffusion method.

Keywords: Acid hydrazine, TGA, Biological Activity, Powder XRD.

INTRODUCTION

The Schiff base metal complexes are in a field of coordination chemistry with increasing interest. These compounds have played a major role in the development of the inorganic chemistry due to easily excellent chelating properties, diversity of structural features and providing the effects of steric interactions on coordination geometry. Hydrazone Schiff bases have received a renewed attention in recent years because of their biological importance such as antimicrobial, antituberculosis, and antitumor activities [1–5]. The coordination compounds of hydrazones have been reported as enzyme inhibitors [6]. The metal complexes of hydrazones are also have been reported as potent inhibitors of DNA synthesis [7]. To the best of our knowledge, reports of substituted acetophenone hydrazones are scarce. Therefore, it is interesting to study complexes of hydrazone Schiff base ligands. In present work, we report the results of our study of 2-hydroxy-1-(2-hydroxy-5-methylphenyl)ethylidene]benzohydrazide and its Mn(II), Co(II), Ni(II), Cu(II), Ti(III), Cr(III), Fe(III), Zr(IV) and $UO_2(VI)$ complexes.

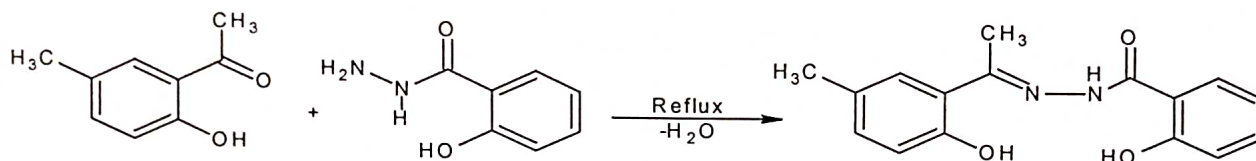
MATERIALS AND METHODS

All the chemicals used as starting materials for the synthesis of the ligand and its metal complexes were of AR grade or chemically pure purchased from Qualigens Chemicals. Solvents were purified and dried before the use by the literature methods. Zirconium (IV) acetate was prepared by the known method [8]. Carbon, hydrogen and nitrogen were estimated on a Carlo Erba 1108 C–H–N–S analyzer. The infrared spectra of the ligand and its complexes were scanned in the region 4000–400 cm^{-1} in KBr pellets on a Perkin Elmer RX–I spectrophotometer. The 1H -NMR spectrum of the synthesized ligand was recorded using the mixture of deuterated chloroform and dimethyl sulfoxide and TMS as an internal standard on a Bruker DRX–300 NMR Spectrophotometer. The magnetic susceptibility measurements of the metal complexes were carried out by Gouy method at room temperature using mercury(II) tetrathiocyanatocobalt(II), $Hg[Co(SCN)_4]$ as the calibrant. Thermogravimetric analysis of the complexes was carried out to study their thermal stabilities. For this a simple manually operated thermobalance set up in our laboratory was used using 50–60 mg sample and temperature upto 700°C in air atmosphere. The balance used was Adico–80 having the sensitivity of 0.01 mg. The TG instrument was calibrated by using sample of copper(II) sulphate pentahydrate from room temperature to 700°C at a heating rate of $\sim 10^\circ C\ min^{-1}$. The antimicrobial activity of the ligand and its complexes was studied by the disc diffusion method against *E. coli*, *S. typhi*, *P. aeruginosa* and *S. aureus*. The media used were nutrient agar and nutrient broth. The plates were inoculated with 24 h cultures. The compounds were tested at a concentration of 500 ppm in DMSO by measuring the zone of inhibition of growth of the microorganisms in millimeter. Electrical conductivity measurements were obtained on the samples in the form of pellets (~ 2 – 3 mm thick and 12 mm diameter) at a pressure of 3 tons cm^{-2} . The surface of each sample was covered by a layer of silver foil,

furnace. The potential across the heater was varied gradually through a varied gradually through a varied transformer to produce a slow rate of increase of temperature measurements. The resistance of samples as a function of temperature was measured in the temperature range (313-403 K) using Zentech electrometer. The temperature was measured by NiCr–NiAl thermocouple.

SYNTHESIS OF LIGAND

A stirred hot ethanolic solution of salicylhydrazide (3.04 g, 0.02 mol) (25 ml) was added to a solution of 2-hydroxy-5-methyl-3-nitroacetophenone (3 g, 0.02 mol) hot ethanol (25 ml). The reaction mixture was refluxed while stirring on a water bath for 5 h. The reaction mixture was then allowed to cool to room temperature overnight. On cooling the reactant media a yellow colored product was separated out. It was filtered off, washed with hot ethanol, diethyl ether followed by recrystallization from DMF and finally dried over vacuo. Yield 68%, m.p. 282°C. (Found: C, 66.68; H, 5.49; N, 9.77 % – Calcd.: C, 67.59; H, 5.67; N, 9.85%); δ 2.27 (3H, s, Ar-CH₃); 2.42 (3H, s, -CH₃, imine); 6.80–7.99 (7H, m, aromatic proton); 11.50 (1H, s, OH); 11.73 (1H, s, -NH); 12.88 ppm (1H, s, OH).



SYNTHESIS OF METAL COMPLEXES

Mn(II), Co(II), Ni(II), Cu(II), Ti(III), Cr(III) and Fe(III) complexes were prepared by using their metal chlorides while for the synthesis of UO₂(VI) complex, uranyl nitrate hexahydrate was used. All the complexes were synthesized using the following general procedure. Equimolar quantities of appropriate metal salt and ligand were dissolved separately in minimum quantity of hot methanol and DMF (40:60 v/v). Both the solutions were filtered and mixed in hot conditions with continuous stirring. The resulting reaction mixture was digested/refluxed on a sand bath for suitable time. In case of Zr(IV) complex, zirconyloxochloride octahydrate (0.64 g, 0.002 mol) was dissolved in methanol (15 ml) and to this a methanolic solution of anhydrous sodium acetate (0.32 g, 0.004 mol in 15 ml) was added and stirred for 5 min. The separated sodium chloride was filtered off. The ligand was dissolved in minimum quantity of hot DMF. To this solution, the solution containing oxozirconium(IV) diacetate was added with continuous stirring and the mixture was refluxed on a sand bath for suitable time. The colored complexes obtained with different metal salts were filtered and washed with methanol, DMF and finally with petroleum ether to remove unreacted ligand. The products were dried in air at room temperature and stored in desiccators over calcium chloride.

RESULTS AND DISCUSSIONS

All the complexes are colored solids, air and moisture stable for an extended period of time and decompose at high temperature. The complexes were found to be insoluble in water and in most of the organic solvents except DMF and DMSO. The physical and electrical conductivity data of the compounds are summarized in Table 1. From the analytical data, the stoichiometry of the complexes was 1:1 (metal: ligand).

INFRARED SPECTRA

The IR spectra of the complexes are compared with the parent ligand in order to determine the coordination sites that may be involved in chelation. The ligand shows a medium broad band at 2913 cm⁻¹ due to ν (OH) vibrations, lowering of the band may be due to the presence of intramolecular hydrogen bonding between phenolic hydrogen and azomethine nitrogen atoms [9]. The other bands at 3217, 1678, 1645 and 1278 cm⁻¹ are assignable to ν (N–H), ν (C=O), ν (C=N) and ν (C–O) (phenolic) respectively. The absence of ν (OH) band in the complexes indicates deprotonation of the phenolic group and coordination of oxygen atom to the metal ion, which is further supported by the appearance of a band due to ν (C–O) phenolic at higher frequency (06–24 cm⁻¹) which indicates coordination of ligand to metal atoms by the oxygen of the hydroxyl group. This shift to higher energy is expected due to maintenance of ring currents arising from delocalization in the chelate ring. On complexation ν (C=N) band is shifted to lower wave number (08–36 cm⁻¹) with respect to free ligand indicating the coordination of azomethine nitrogen in the metal ion [10]. The coordination of the phenolic hydrogen and azomethine nitrogen is further supported by the appearance of non ligand band at 502–512 and 455–498 cm⁻¹ due to ν (M–O) and ν (M–N) stretching vibrations respectively [11]. The downward shift in ν (C=O) band by 12–18 cm⁻¹ in the spectra of Ti(III), Cr(III) and Fe(III) complexes, indicates the involvement of carbonyl oxygen in the complex formation. The spectra of Mn(II), Co(II), Ni(II), Cu(II), Zr(IV) and UO₂(VI) complexes

its enol formed through the enolic carbonyl oxygen [12, 13]. The above facts reveal that ligand behaves as dibasic tridentate in Mn(II), Co(II), Ni(II), Cu(II), Zr(IV) and UO₂(VI) and monobasic tridentate in Ti(III), Cr(III) and Fe(III) complexes. The coordination of H₂O in the Mn(II), Co(II), Ni(II), Ti(III), Cr(III) and Fe(III) complexes is indicated by the appearance of bands at 3210–3394, 1516–1536 and 813–842 assignable to $\nu(\text{OH})$, $\delta(\text{H}_2\text{O})$ and $\rho\omega(\text{H}_2\text{O})$ respectively. The spectra of UO₂(VI) complex $\sim 984 \text{ cm}^{-1}$ indicating presence of methanol group. Additional band at 908 cm^{-1} in the spectra of UO₂(VI) complex may assigned to $\nu_{\text{asy}}(\text{O}=\text{U}=\text{O})$ modes [14].

ELECTRONIC SPECTRA AND MAGNETIC PROPERTIES

The Mn(II) complex shows three bands in the range 17152, 23094 and 26595 cm^{-1} . These bands may be assigned to ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{1g}({}^4\text{G})$, ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{2g}({}^4\text{G})$, ${}^6\text{A}_{1g} \rightarrow {}^4\text{E}_g$, transitions respectively, corresponding to octahedral environment around the Mn(II) ion [15,16]. The magnetic moment value observed for the Mn(II) complex is 5.94 B.M., which is suggestive of high spin arrangement of five unpaired electrons one in each d-orbital. The Co(II) complex shows three peaks around 10787, 16339 and 24096 cm^{-1} , which are assigned to ${}^4\text{T}_{1g}(\text{F}) \rightarrow {}^4\text{T}_{2g}(\text{F})$ and ${}^4\text{T}_{1g}(\text{F}) \rightarrow {}^4\text{T}_{1g}(\text{P})$ and ${}^4\text{T}_{1g}(\text{F}) \rightarrow {}^4\text{A}_{2g}(\text{F})$ transitions, respectively and the position of the bands indicates an octahedral structure. The interelectronic repulsion parameter B for the present Co(II) complex is lower than free ion value (B') of 971 cm^{-1} , which indicates orbital overlap and delocalization of d-orbitals. Co(II) complex is found to have magnetic moment value 4.83 B.M., which characterizes high-spin octahedral type. The electronic spectra Ni(II) of complex shows three bands in the range 10638, 17182 and 25575 cm^{-1} corresponding to ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{2g}(\text{F})$, ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{1g}(\text{F})$ and ${}^3\text{A}_{2g}(\text{P}) \rightarrow {}^3\text{T}_{1g}(\text{P})$ transitions respectively, suggesting octahedral geometry around Ni(II) ion [17]. The Racah interelectronic repulsion parameter β observed is lower than the Ni(II) free ion value which indicates the covalent character in the metal-ligand bonds. The ratio ν_2/ν_1 is found to be 1.61, which is in the range of the octahedral Ni(II) chelates. The magnetic moment value for Ni(II) complex is observed to be 3.12 B.M. which suggests an octahedral geometry around the metal ion. The Cu(II) complex exhibits three bands at 15313, 16920 and 20283 cm^{-1} in their normally expected region for square planar Cu(II) complexes [18]. These bands are assigned as ${}^2\text{B}_{1g} \rightarrow {}^2\text{A}_{1g}$, ${}^2\text{B}_{1g} \rightarrow {}^2\text{E}_g$ and charge transfer transitions, respectively. Magnetic moment value of Cu(II) complex is 1.27 B.M. This subnormal value of magnetic moment may be due metal-metal interaction in dimeric structure. The electronic spectra of Ti(III) complex shows a broad band at 18621 cm^{-1} which may be assigned to ${}^2\text{T}_{2g} \rightarrow {}^2\text{E}_g$ transition towards octahedral geometry around the Ti(III) ion. The magnetic moment value of Ti(III) complex is found to be close to the spin-only value of 1.59 B.M. corresponding to one unpaired electron in an octahedral environment. The electronic spectra of present Cr(III) in the present study exhibited characteristic three bands. The lower energy band 17985 cm^{-1} (ν_1) which may be assigned to transition ${}^4\text{A}_{2g}(\text{F}) \rightarrow {}^4\text{T}_{2g}(\text{F})$. The other bands at 24451 cm^{-1} (ν_2) and 40648 cm^{-1} (ν_3) are due to ${}^4\text{A}_{2g}(\text{F}) \rightarrow {}^4\text{T}_{1g}(\text{F})$ and ${}^4\text{A}_{2g}(\text{F}) \rightarrow {}^4\text{T}_{1g}(\text{P})$ transitions respectively. The Racah interelectronic repulsion parameter 'B' is found to be lower than the free ion value (920 cm^{-1}) suggesting delocalization of electron on metal into molecular orbital covering both the metal and the ligand [19] i.e. the appreciable covalent character in the metal ligand bond. The ν_2/ν_1 is found to be 1.36 which is very close to the value of 1.42 obtained for pure octahedral Cr(III) complexes [19, 20, 21]. The complex exhibits magnetic moment value at 3.92 B.M. which is expected to be normal moment for d³ octahedral complexes at room temperature [22]. Fe(III) complex shows three bands at 13908, 17853 and 23094 cm^{-1} which may be assigned to ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{1g}(\text{G})$, ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{2g}(\text{G})$ and ${}^6\text{A}_{1g} \rightarrow {}^4\text{E}_g$, ${}^4\text{T}_{1g}(\text{G})$, transitions, respectively for octahedral geometry around Fe(III) ion [23,24]. At room temperature the magnetic moment value of the Fe(III) complex is found to be 5.87 B.M. close to 5.92 B.M. indicating high spin state of the complex. The Zr(IV) complex under study is found to be diamagnetic as expected in accordance with the d⁰ configuration of Zr(IV) ion. The room temperature magnetic measurements suggest that the UO₂(VI) complexes is diamagnetic as expected for f⁰ system [25]. The solid state reflectance of UO₂(VI) complexes exhibit an electronic spectral band at 22000 cm^{-1} corresponding to $\Sigma_g^+ \rightarrow {}^3\pi_u$ transition typically O=U=O symmetric stretch frequency [26].

POWDER XRD STUDY

The X-ray diffraction powder diagram was obtained from 6 to 54° with a graphite monochromator crystal and Cu-K α radiation. Parameters of crystal lattice were determined using a set of programs, called PowdMult 2.3, which are based on least-squares approach. Cu(II) complex belong to the orthorhombic crystalline system and the parameters are: a = 12.50 Å, b = 14.31 Å and c = 09.04 Å.

THERMOGRAVIMETRIC ANALYSIS

Horowitz-Metzger method was used to calculate the kinetic parameters of the ligand and its complexes from

with increase in temperature. A careful analysis of the thermograms of Mn(II), Co(II), Ni(II), Ti(III), Cr(III) and Fe(III) complexes indicate that they are stable upto 82°C and are decomposed in three stages whereas Cu(II), Zr(IV) and UO₂(VI) complexes are decomposed in two steps. Elimination of coordinated water molecules takes place in the first step; a part of ligand decomposed in the second stage and complete decomposition of the ligand followed by oxidation-reduction reaction leading to the formation of respective metal oxides in the last stage. The Mn(II), Co(II), Ni(II), Ti(III), Cr(III) and Fe(III), complexes lose their weights in the temperature range 150–220°C corresponding to the loss of four coordinated water molecules for Mn(II) and Co(II), three coordinated water molecule for Ni(II) and one coordinated water molecule for Ti(III), Cr(III) and Fe(III) complexes [27]. [% wt. loss, obs./calcd. Mn(II) : 8.71/8.57; Co(II): 8.59/8.48; Ni(II): 13.83/13.66, Ti(III) : 4.41/4.28; Cr(III) : 4.38/4.24; Fe(III) : 4.37/4.20]. The ligand and Cu(II), Zr(IV) and UO₂(VI) complexes decompose in two stages. The thermograms of these compounds show no weight change upto 150–220°C revealing the absence of any water molecules in them. The continuous and rapid weight loss has been observed above 280°C corresponding to thermal degradation of free part of the coordinated ligand along with the other groups present there in. A gradual weight loss above ~450°C corresponding to the degradation of actual coordination moiety of the ligand. Finally, the horizontal nature of the curve beyond 650°C suggests the formation of final decomposition product with residue corresponding to the metal oxide [% residue, obs./calcd. Mn₃O₄: 20.12/ 20.43; Co₃O₄: 21.39/ 21.27; NiO: 18.78/ 18.90; CuO: 23.72/ 23.43; TiO₂: 19.22/19.01; Cr₂O₃: 18.04/17.91; Fe₂O₃: 18.74/18.65; ZrO₂: 27.98/28.03; and U₃O₈: 48.21/48.03] of the respective metal complexes. The kinetic parameters calculated for the compounds are given in Table 2. The activation energies of decomposition are found in the range 11.35–57.36 kJmol⁻¹. There is no definite trend in the values of E_a. The negative values of ΔS indicate a more ordered activated state that may be possible through the chemisorptions of oxygen and other decomposition products. The more ordered nature may be due to the polarization of bonds in activated state which might happen through charge transfer of electronic transitions.

ELECTRICAL CONDUCTIVITY

The solid state electrical conductivity of the complexes in their compressed pellet form was measured by two probe method over a wide range of temperature i.e. room temperature to 403 K. The temperature dependence of electrical conductivity values are shown in Table 1. A plot of log σ vs 1/T obeys the equation $\sigma = \sigma_0 \exp(-E_a/kT)$ where the symbols have their usual meanings [28]. Linear dependence of log σ vs 1/T was observed, which suggests the semiconducting behavior of the chelates [29]. Electrical conductivity of these chelates lies in the range 6.16 × 10⁻¹² to 1.51 × 10⁻⁰⁸ Ω⁻¹cm⁻¹. The activation energy of conduction of these complexes was found to be in the range 0.145–0.295 eV.

ANTIBACTERIAL ACTIVITY

The synthesized ligand and its complexes were screened for their antibacterial study. The ligand shows bactericidal behavior against the bacterial strains used. The observations show that the compounds exhibit low to moderate activity (Table no. 3). The ligand and the complexes show less zone of inhibition in case of *S. typhi* and show good biological activity against *S. aureus*. The Ni(II) and Zr(IV) complexes possess good activity against *E. coli* while Cr(III) and Fe(III) complexes are found to be of good activity against *P. aeruginosa*. In general, the results reveal that the activity of the ligand was found to be enhanced on complexation with the metal ions. This is because of the chelation. According to Tweedy's chelation theory [30], the chelation reduces the polarity of the metal atom mainly because of the partial sharing of its positive charge with donor groups and possible π electron delocalisation over the whole ring [31, 32].

ACKNOWLEDGEMENT

The authors are thankful to SAIF, Lucknow for providing ¹H-NMR, IR, elemental analysis facilities and SAIF, Chennai for recording electronic spectra.

REFERENCES

1. El-Tabl, A.S., Mohamad, M.E., Shakhofa, A.M.E., (2013), 'Metal complexes of N'-[2-hydroxy-5-(phenyldiazenyl)-benzylidene]isonicotinohydrazide. Synthesis, spectroscopic characterization and antimicrobial activity'. J. Serb. Chem. Soc., 78 (1): 39-55.
2. Mohapatra, R. K., Mishra, U. K., Mishra, S. K., Mahapatra A., Dash D. C., (2011), 'Synthesis and Characterization of Transition Metal Complexes with Benzimidazolyl-2-hydrazones of o-anisaldehyde and Furfural'. J Kor. Chem. Soc., 55(6): 926-31
3. Alagesan, M., Bhuvanesh, N.S.P. and Dharamraj, N., (2013), 'Potentially cytotoxic new copper(ii) hydrazone complexes: synthesis, crystal structure and biological properties'. Dalton Trans. 42: 7210-22

4. Jeewoth, T., Li Kam, Wah, H., Bhowon, M.G., Ghoorohoo, D., Babooram, K., (2000), 'Synthesis and Anti-Bacterial/Catalytic Properties of Schiff Bases and Schiff Base Metal Complexes Derived from 2,3-Diaminopyridine. Synth'. React. Inorg. Met. Org. Chem., 30 :1023-38.
5. Katyal, M., Dutta, Y., (1975), 'Analytical applications of hydrazones'. Talanta, 22 (2) : 151-66.
6. Shibuya, Y., Nabari, K., Kondo, M., Yasue, S., Maceda, K., Uchida, F., Kawaguchi, H, (2008), 'The Copper(II) Complex with Two Didentate Schiff Base Ligands'. Chem. Lette, 37: 78-79.
7. Maurya, M. R., Bharti, N., Nafui, F., Azam, A., (2002), 'Synthesis and antiameobic activity of new cyclooctadieneruthenium(II) complexes with 2-acetylpyridine and benzimidazole derivatives'. Bio-Inorg. Med. Chem. Lett., 10: 2243-45.
8. Suryawanshi, N.J., Pethe, G.B., Yaul, A.R., Aswar, A.S., (2016), 'Transition Metal Chelates:Synthesis. Physicochemical, Thermal, and Biological Studies'. Russ. J. Gene.Chem., 86(4) : 901-06.
9. Jebbar-Sid, S.D., Benali-Baitich, O. and Deloume, J. D., (1997), 'Synthesis, characterization and electrochemical behaviour of some copper(II) complexes with linear and tripodal tetradentate ligands derived from Schiff bases'. Polyhedron, 16 :2175-82.
10. Maurya, M.R., Khurana, S., Schulzke, C., Rehder, D., (2001), 'Dioxo- and Oxovanadium(V) Complexes of Biomimetic Hydrazone *ONO* Donor Ligands: Synthesis, Characterisation, and Reactivity'. Eur. J. Inorg. Chem., 3 :779-88.
11. Nakamota, (1970), Infrared Spectra of Inorganic and Coordination Compounds, New York, Willey.
12. Hay, R.W., Hassan, M.M., (1997), 'Copper(II), nickel(II) and zinc(II) complexes of N,N',N'',N'''-tetrakis(2-hydroxypropyl)-1,4,8,11-tetra-azacyclotetradecane: Rates of formation and dissociation of the copper(II) complex'. Polyhedron, 16 : 2205-16.
13. Adam, D. M. , (1967), Metal Ligand and Related Vibrations, London, Arnold.
14. Nag, J.K., Pal, S., Sinha, C., (2005), 'Synthesis and characterization of cobalt(II), nickel(II), copper(II), palladium(II) and dioxouranium(VI) complexes of the antipyrine Schiff base of 3-formylsalicylic acid'. Trans. Met. Chem., 30 ; 523-26.
15. Howlader, M.B.H, Islam, M.S., Karim, M.R., (2000), 'Synthesis of some 16-membered macrocyclic complexes of chromium(III), manganese(III), iron(III), cobalt(II), nickel(II) and copper(II) containing a tetraoxooctaazacyclohexadecane ligand'. Indian J. Chem., 39A : 407-09.
16. Belal, A.A.M., El-Deen, I.M., Farid, N.Y., Zakaria, R., Refat, M.S., (2015), 'Synthesis, spectroscopic, coordination and biological activities of sometransition metal complexes containing *ONO* tridentate Schiff base ligand. Spectrochim'. Acta Part A: Molecular and Biomolecular Spectroscopy, 149 : 771-87.
17. Ekmekcioglu, P., Karabocek, N, Karabocek, S, Emirik, M., (2015), 'Synthesis, structural and biochemical activity studies of a newhexadentate Schiff base ligand and its Cu(II), Ni(II), and Co(II)complexes. J. Molecular Structure, 1099: 189-96.
18. Demir, S., Guder, A., Yazıcılar, T.K., Caglar, S, Buyukgungor, O., (2015), 'Syntheses, crystallographic, mass-spectroscopic determination andantioxidant studies of Co(II), Ni(II) and Cu(II) complexes of a newimidazol based Schiff base'. Spectrochim. Acta Part A: Molecular and Biomolecular Spectroscopy, 150 :821-28.
19. Aranha, P.E, Santos, M.P.D., Romera, S., Dockal, E.R., (2007), 'Synthesis, characterization, and spectroscopic studiesof tetradentate Schiff base chromium(III) complexes. Polyhedron', 26 : 1373-82.
20. Grisenti, D.L., Smith, M.B., Fang, L, Bishop, N, Wagenknecht, P.S., (2010), 'Aconvenient synthesis of isocyclam and [16]aneN4 and thephotophysics of their dicyanochromium(III) complexes'. Inorg Chim Acta, 363:157-62.
21. Lee, J.D., (1991), 'Concise Inorganic Chemistry', 4th Edⁿ, Elbs, London.
22. Nora, H., Al-Sha, A., (2007), 'Antimicrobial activity and spectral, magnetic and thermal studies of some transition metal complexes of a Schiff base hydrazone containing a quinoline moiety'. Molecules., 12:1080-91.

23. Duelund, L., Hazell, R., Mckenzie, C.J., Nielsen, LP, Toftlund, H., (2001), 'Solid and solution state structures of mono- and di-nuclear iron(III) complexes of related hexadentate and pentadentateaminopyridyl ligands. J. Chem .Soc.', Dalton Trans., 152–54.
24. Yaul, A.R., Dhande, V.V., Yaul, S.R., Aswar, A.S., (2011), 'Transition metal complexes containing tridentatehydrazone Schiff base: Synthesis characterisation and biological activity'. J Ind. Chem. Soc., 88:775–80.
25. Aswar, A.S., Yaul, A.R., Dhande, V.V., (2010), 'Synthesis, characterization, electrical and biological studies of VO(IV), MoO₂(VI), WO₂(VI), Th(IV) and UO₂(VI) complexes with hydrazone ligand'. Rev. Roum .Chim., 55:537–42.
26. Maurya, M.R., Singh, N., (2004), 'Dioxomolybdenum(VI) and dioxouranium(VI) complexes of tetradentate amidate ligands'. Ind. J .Chem., 43A:542–45.
27. Masoud, M.S., Merghany, A.E., Ramadan, A.M., (2010), 'Thermal studies of some purine compounds and their metal complexes'. J Therm Anal Calorim., 101:839–45.
28. EI-Wakiel, N.A., (2004), 'TG, DTA and electrical conductance properties of some Cu(II) and Mn(II) bisazodianils complexes'. J Therm Anal Calorim., 77: 839–49.
29. Sarkar, S., Aydogdu, Y., Dagdelen, F., Bhaumik, B.B., Dey, K., (2004), 'X-ray diffraction studies, thermal, electrical and optical properties of oxovanadium(IV) complexes with quadridentate Schiff bases'. J Mater Chem Phys., 88:357–63.
30. Berrington, A., Gould, F.K., (2001), 'Use of antibiotic locks to treat colonized central venous catheters. J. Antimicrob. Chemother', 48 (5): 597-603.
31. Singh, D.P., Kumar, R., Singh, J., (2009), 'Synthesis and spectroscopic studies of biologically active compounds derived from oxalyldihydrazide and benzil, and their Cr(III), Fe(III) and Mn(III) complexes'. Eur. J. Med. Chem., 44:1731-36.
32. Singh, D.P., Kumar, K., Sharma, C., (2009), 'Antimicrobial active macrocyclic complexes of Cr(III), Mn(III) and Fe(III) with their spectroscopic approach'. Eur. J. Med. Chem., 44: 3299-04.

Table-1: Analytical Data of Metal Complexes

Complex	Elemental Analysis % Found (Calcd)				Electrical conductivity $\Omega^{-1} \text{ cm}^{-1}$	Activation Energy (eV)
	C	H	N	M		
[Mn(L)2H ₂ O] ₂	51.19 (51.48)	4.58 (4.86)	7.23 (7.51)	14.64 (14.72)	6.16×10^{-09}	0.171
[Co(L)2H ₂ O] ₂	50.82 (50.94)	4.72 (4.81)	7.30 (7.43)	15.50 (15.62)	2.04×10^{-10}	0.239
[Ni(L)3H ₂ O]	48.53 (48.65)	5.17 (5.10)	6.98 (7.09)	14.76 (14.84)	2.69×10^{-10}	0.237
[Cu(L)] ₂	55.43 (55.57)	3.92 (4.08)	7.97 (8.10)	17.31 (18.37)	2.51×10^{-11}	0.295
[Ti(L)Cl ₂ ·H ₂ O]	45.58 (45.75)	4.19 (4.08)	6.58 (6.67)	11.08 (11.39)	1.51×10^{-05}	0.146
[Cr(L)Cl ₂ ·H ₂ O]	45.24 (45.30)	4.12 (4.04)	6.47 (6.60)	12.12 (12.26)	1.41×10^{-10}	0.222
[Fe(L)Cl ₂ ·H ₂ O]	44.81 (44.89)	3.91 (4.00)	6.42 (6.54)	13.16 (13.05)	4.67×10^{-09}	0.265
[Zr(OH) ₂ (L)CH ₃ OH]	46.32 (46.45)	4.55 (4.69)	6.19 (6.37)	20.60 (20.75)	1.25×10^{-05}	0.195
[UO ₂ (L)CH ₃ OH]	34.86 (34.94)	3.21 (3.10)	4.68 (4.79)	40.65 (40.73)	6.16×10^{-12}	0.145

Table-2: Thermal Decomposition Data of H₂L Ligand and Its Metal Complexes

Compound	Activation Energy (E _a) (kJmol ⁻¹)	Frequency factor (Z) (sec ⁻¹)	Entropy Change (-ΔS) (Jmol ⁻¹ K ⁻¹)	Free Energy Change (ΔG) (kJmol ⁻¹)
H ₂ L	11.35	20.42	271.6	280.06
[Mn(L)2H ₂ O] ₂	15.69	12.33	276.4	321.14
[Co(L)2H ₂ O] ₂	53.13	60.56	261.9	711.23
[Ni(L)3H ₂ O]	29.28	33.46	268.0	481.10
[Cu(L)] ₂	39.87	40.63	265.1	568.81
[Ti(L)Cl ₂ H ₂ O]	48.51	62.61	261.7	667.78
[Cr(L)Cl ₂ H ₂ O]	40.42	49.04	263.9	584.43
[Fe(L)Cl ₂ H ₂ O]	38.40	41.84	265.7	568.81
[Zr(OH) ₂ (L)CH ₃ OH]	57.36	52.90	263.3	756.61
[UO ₂ (L)CH ₃ OH]	52.56	54.67	276.7	626.65

Table-3: Biological Activity of H₂L Ligand and its Metal Complexes

Compound	E. coli (mm)	S. typhi (mm)	P. aeruginosa (mm)	S. aureus (mm)
H ₂ L	12	11	14	13
[Mn(L)2H ₂ O] ₂	14	13	17	20
[Co(L)2H ₂ O] ₂	15	14	16	16
[Ni(L)3H ₂ O]	17	12	15	19
[Cu(L)] ₂	17	16	18	17
[Ti(L)Cl ₂ H ₂ O]	14	15	16	18
[Cr(L)Cl ₂ H ₂ O]	15	17	19	15
[Fe(L)Cl ₂ H ₂ O]	15	16	19	19
[Zr(OH) ₂ (L)CH ₃ OH]	16	13	17	17
[UO ₂ (L)CH ₃ OH]	15	12	16	15