Study of Complex Formation Reactions of 2,6-Bis (6-Methoxy-Methylimino Phenol) Pyridine and Bis-(Phenolic) Schiff Base with Metal Ions

Sepideh Azizi Nejad[1*], Mahmoud Paye Ghadar[2], Abdolmohammad Attaran[3]

[1]Department of chemistry University of payame noor, karaj, iran.

Abstract

In this study, the formation constants (K_f) and thermodynamic functions (ΔH, ΔS) of the complexation reactions of the ligands 2,6-bis (6-methoxy-methylimino phenol) pyridine and bis-(phenolic) Schiff base with certain metal ions (Ag^{1+}, Zn^{2+}, Cu^{2+}, Co^{2+}, Cd^{2+}, and Ni^{2+}) in acetonitrile solvent were determined at different temperatures using conductometry and UV-Vis spectroscopy methods. In the conductometric method, a solution of metal ions with a concentration of 5×10^{-5} M was titrated stepwise with a ligand solution with a concentration of 5×10^{-3} M. After each addition of the ligand, the conductivity was recorded. These reactions were conducted at three constant temperatures: 15, 25, and 35 degrees Celsius. The molar conductivity (Λ) versus ligand-to-metal concentration ratio ($[L]/[M^{n+}]$) was plotted using Excel software, and the data obtained from the experiments were fitted using KINFIT software to determine the formation constants (K_f) of the complexes at different temperatures. Using the Van't Hoff equation, the thermodynamic functions (ΔH, ΔS) were calculated. In another section, using the UV-Vis spectroscopy method, a solution of the discussed metals with a concentration of 1.25×10^{-3} M was titrated with a ligand solution with a concentration of 5×10^{-5} M over 20 steps, and the corresponding spectra were plotted using Excel software. The absorption versus metal-to-ligand concentration ratio ($[M^{n+}]/[L]$) was plotted using Excel software, and the data obtained from the experiments were fitted using KINFIT software to determine the formation constants (K_f) of the discussed ligand complexes with each metal. The data obtained from both methods confirm each other.

Keywords: Complex, 6-Methoxy-Methylimino Phenol, Pyridine Schiff Base, Bis-(Phenolic) Schiff Base.

DOI Number: 10.48047/nq.2025.23.3.NQ25030 **NeuroQuantology 2025; 23(3): 257-271**

Introduction

Complex compounds refer to a group of compounds in inorganic chemistry that contain a metal and a ligand. The number of metal and ligand atoms in these compounds varies. The structure of these compounds was first proposed by Alfred Werner [1-3]. Macrocyclic ligands are multidentate ligands that contain electron-donating heteroatoms such as oxygen, sulfur, and nitrogen in their cyclic structure. In 1902, Van Euler and Bodländer were the first to work on determining stability constants [4]. However, the classical stepwise measurement of stability constants for monodentate amine ligands with various metals was initiated by J. Bjerrum. These investigations essentially marked the beginning of using mathematics for mass balance equations to calculate equilibrium constants [5].

There are several techniques for measuring the protonation constants of ligands and the stability constants of complexes, including potentiometry, spectrophotometry, polarography, colorimetry, conductometry, ESR, NMR, and more. Numerous studies have been conducted on the complex formation reactions between metal ions and different ligands. Among the various physicochemical methods for studying complex equilibrium reactions in solution, UV-Vis spectrophotometry under laboratory conditions and computer processing of experimental data is a powerful and highly sensitive method.

The formation of complexes between cations and ligands is influenced by various factors. The most important parameters affecting complex formation include the number and type of donor atoms in the ligand [6-7], the size, charge, and hardness of the cation [8-9], the physical and chemical properties of the solvent [10], the basicity of the ligand [11-12], the anion associated with the metal cation [13-14], and the presence of substituents in the ligand structure [15-16].

Due to the significant role of the solvent in the

eISSN 1303-5150

thermodynamics of complex formation reactions, examining solvent properties is essential. The structure of macrocyclic complex compounds in solution is not limited to lattice forces alone; the configuration and structure of complexes are also influenced by the polarization of both cations and anions. The properties of solvents are determined by their chemical and physical nature. The chemical properties of a solvent are defined by its molecular structure and the type of atoms present. Based on these properties, solvents are chemically classified into electron-pair donating and electron-pair accepting solvents. Since most metal cations are electron-pair acceptors, reactions occur between metal cations and electron-donating solvent molecules. The result of this reaction is the formation of solvated metal cations.

The higher the dielectric constant of a solvent, the weaker the attractive forces between the dissociated ions in the solution, and the less likely they are to bond with each other. In other words, the dissociation of ions from each other becomes easier, thereby reducing the likelihood of forming ion pairs or ionic aggregates [17]. The nature of the solvent significantly affects the formation constants of complexes and the electrochemical behavior of dissolved species. Therefore, the solvent not only acts as a uniform medium but also often intervenes as a reactant [18].

Acetonitrile (methyl cyanide, cyanomethane) is a chemical compound with the formula CN3CN. This colorless substance is mainly used as a polar aprotic solvent in chemical synthesis. Due to its low viscosity and low chemical reactivity, it is a suitable choice for liquid chromatography (HPLC). Acetonitrile is primarily used as a solvent that is miscible with water [19]. On its own, this substance has low toxicity, but it produces hydrogen cyanide upon metabolism, which has been observed to have toxic effects [20 & 21].

On the other hand, the electrical conductivity of solutions is provided by the movement of ions between two floating electrodes in the solution. In this movement, ions with positive charges (cations) and ions with negative charges (anions) oscillate between the anode and cathode. The amount of conductivity or conductivity of solutions depends on the number of charged particles present in the solution, and its amount can be evaluated based on the current intensity resulting from applying a specific alternating potential difference between two electrodes (the alternating potential difference is applied to prevent possible changes in the composition of the solution due to the passage of current). The extent of ion participation in creating electrical conductivity depends on their electric charge density and mobility. Continuous measurement of electrical conductivity during the progression of chemical reactions serves as a means to identify the endpoint and is known as conductivity titration. However, the accuracy and efficiency of conductivity titration decrease in cases where the total concentration of the electrolyte in a solution is high. This is due to the ambiguity of minor changes in the conductivity of the environment in the face of its very high conductivity during the progression of the titration reaction. The conductivity method cannot be used to study the multiple charges of ions or solutions with high ionic strength. Therefore, it can only be studied in a limited number of systems where complexes are formed between ions with the same charge in dilute solutions.

On the other hand, spectrophotometers are directly used to measure the intensity of light at different wavelengths and can represent the percentage of transmitted or absorbed radiant light. By using this information and comparing it with the obtained densities and data, spectroscopy can be used as a tool. Comparing spectra to determine the concentration of dissolved substances in the solvent is a good example. By recording the intensity of transmitted and received light at a specific wavelength and examining the wavelength absorbed by the solvent, the concentration can be determined. Then, the solution with unknown concentration is compared with known data, and the concentration is calculated using a proportion. This can also be used for solutions containing multiple types of solvents, but it requires greater accuracy in analyzing wavelengths.

One of the common methods of spectrophotometry is UV-Vis molecular absorption [22]. In this technique, the source of absorption can be π, σ, and n electrons (non-bonding electrons) present in organic compounds and inorganic anions. The absorption by these electrons leads to broad bands. Charge transfer absorption is another type of absorption that exists in both organic and inorganic complexes. This type of absorption is a type of internal redox system absorption, where absorption occurs due to the transfer of an electron from an electron donor (typically a ligand) to an electron acceptor (typically a metal ion or other compounds). This

eISSN 1303-5150

type of absorption has a very high molar coefficient ($\varepsilon \geq 10^4$), making it a highly sensitive method for detecting and determining absorbing species [23]. Given the mentioned points, this research aims to study the complex formation reaction of the ligands 2,6-bis (6-methoxy-methyl-imino phenol) pyridine and bis-(phenolic) Schiff bases with metal ions.

Materials and Methods

The solvent used in this study is high-purity acetonitrile, whose characteristics and properties are listed in Table 1.

Table 1: Acetonitrile Solvent Used in the Research

Molecular formula	C_2H_3N
Molecular weight	41.05
Appearance	Liquid and colorless
Boiling point	82ºC
Melting point	-45ºC

The molecular structure of the solvent is shown in Figure 1.

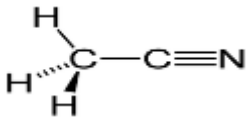

Figure 1: Molecular Structure of the Solvent

Table 2: Salts Used in the Research

Substance Name	Molecular Formula	Molecular Weight	Purity Percentage	Manufacturer
Nickel Nitrate	$NiN_2O_6.6H_2O$	290.81	99%	Merck
Zinc Nitrate	$Zn(NO_3)_2.4H_2O$	261.44	98.5 %	Merck
Copper Nitrate	$CuN_2O_6.3H2O$	241.60	≥ 99%	Merck
Silver Nitrate	$AgNO_3$	169.87	99.8 %	Merck
Cobalt Nitrate	$CoN_2O_6.6H_2O$	291.04	97%	Merck
Cadmium Nitrate	$Cd(NO_3)_2.4H_2O$	308.47	99%	Merck

The ligands used in this study are listed in Table 3.

Table 3: Ligands Used in This Research

Substance Name	Molecular Formula	Molecular Weight
Bis – (Phenolic) Schiff Base	$C_{27}H_{22}N_2O_4$	438.481
2,6-bis (Methoxy-6-Methylimino phenol) pyridine	$C_{21}H_{19}N_3O_4$	377.389

The molecular structure of the bis-(phenolic) Schiff base ligand is shown in Figure 2.

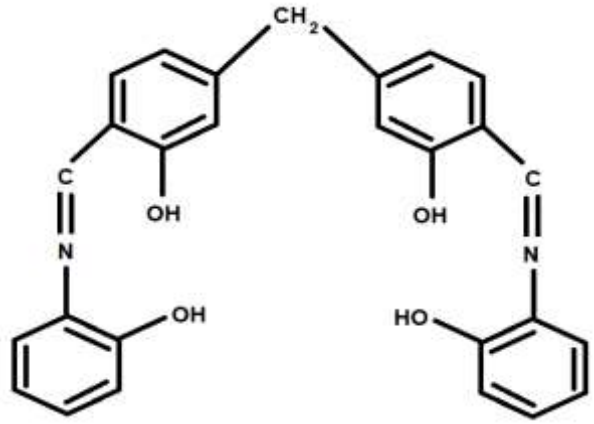

Figure 2: Molecular Structure of Bis-(Phenolic) Schiff Base Ligand

The molecular structure of the 2,6-bis (methoxy-6-methyliminophenol) pyridine ligand is shown in Figure 3.

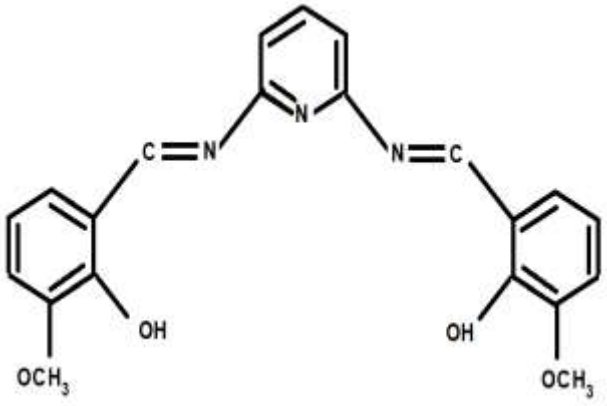

Figure 3: Molecular Structure of 2,6-bis (methoxy-6-methyliminophenol) Pyridine Ligand

Conductometric Method

First, 10 mL of a metal ion solution with a

eISSN 1303-5150

concentration of 5×10^{-5} M in acetonitrile solvent is placed into a double-walled conductivity cell. After setting the circulator temperature to 15°C, the conductivity of the solution is measured and recorded. Then, using a Hamilton syringe, 10 µL of a ligand solution with a concentration of 5×10^{-3} M in acetonitrile is gradually added to the metal solution. After each addition of the ligand, the solution is stirred using a magnetic stirrer, and its conductivity is measured. This process continues until the changes in the conductivity become constant or negligible (in this study, ligand addition was continued until three times the concentration of the metal ion was reached). The titration was repeated at temperatures of 15, 25, and 35°C. The specific conductivities obtained from the conductivity meter are converted to equivalent conductivities, and molar conductivity graphs are plotted as a function of the molar ratio of ligand to metal.

Spectrophotometric Method

First, the spectrophotometer is prepared, and the scanning range is set from 300 to 600 nm. To remove background radiation, a quartz cell is filled with acetonitrile solvent and placed in the device to set its absorbance to zero. In the next step, 2 mL of the desired ligand solution with a concentration of 5×10^{-5} M is placed in another cell, and its absorbance in the range of 300 to 600 nm is recorded. In subsequent steps, 10 µL of a metal solution with a concentration of 1.25×10^{-3} M is added to the ligand solution cell using a micro-Hamilton syringe, the solution is stirred, and then the absorption spectrum of the ligand and cation solution is recorded over 20 addition steps. During all steps, the ligand concentration remains constant, while the concentration of the cation changes in each step. The cell must be clean during all stages of the experiment, as any grease stain from contact with the transparent part of the cell can cause measurement errors. Using the molar ratio method and plotting the measured absorbance at a selected wavelength as a function of the molar ratio of the metal ion to ligand ([M]/[L]), the stoichiometry of the reaction can be determined. By using nonlinear fitting and software such as KINFIT, the formation constant for the reaction of each metal with the desired ligands can be calculated. Finally, using the Van't Hoff equation, the values of ΔH, ΔS, and ΔG were calculated.

Findings

1. **Conductometric Study of Bis-(Phenolic) Schiff Base Ligand:**

The results are recorded in Tables (4) to (9).

Table 4: Conductometric Data for Bis-(Phenolic) Schiff Base and Metal Cd^{2+}

[L]/[M]	LIGAND ADDITION	15 °c	Λ	25 °C	Λ	35 °C	Λ
0	0	15.16	303.2	8.27	165.4	6.27	125.4
0.1	0.01	15.27	305.4	8.56	171.2	6.39	127.8
0.2	0.02	15.64	312.8	8.94	178.8	6.79	135.8
0.3	0.03	15.99	319.8	9.29	185.8	7.09	141.8
0.4	0.04	16.63	332.6	9.68	193.6	7.63	152.6
0.5	0.05	17.3	346	10.28	205.6	8.19	163.8
0.6	0.06	18.42	368.4	10.77	215.4	8.69	173.8
0.7	0.07	18.75	375	11.14	222.8	9.2	184
0.8	0.08	18.91	378.2	11.27	225.4	9.39	187.8
0.9	0.09	19.39	387.8	11.36	227.2	9.56	191.2
1	0.1	19.78	395.6	11.76	235.2	9.96	199.2
1.1	0.11	20.2	404	12.19	243.8	10.33	206.6
1.2	0.12	20.9	418	12.62	252.4	10.59	211.8
1.3	0.13	21.5	430	13.47	269.4	11.23	224.6
1.4	0.14	22.2	444	13.94	278.8	11.87	237.4
1.5	0.15	23.2	464	14.66	293.2	12.49	249.8
1.6	0.16	24.2	484	15.18	303.6	13.35	267
1.7	0.17	25.3	506	15.69	313.8	13.95	279
1.8	0.18	26	520	16.32	326.4	14.62	292.4
1.9	0.19	26.6	532	16.97	339.4	15.76	315.2
2	0.2	27	540	17.6	352	16.43	328.6
2.1	0.21	27.2	544	18.2	364	16.66	333.2
2.2	0.22	27.3	546	18.63	372.6	16.65	333
2.3	0.23	27.5	550	19.2	384	16.7	334
2.4	0.24	27.7	554	19.6	392	16.89	337.8
2.5	0.25	28.1	562	19.8	396	17	340
2.6	0.26	28.2	564	20	400	17.22	344.4
2.7	0.27	28.3	566	20.2	404	17.49	349.8
2.8	0.28	28.3	566	20.2	404	17.77	355.4
2.9	0.29	28.3	566	20.5	410	17.8	356
3	0.3	28.3	566	20.7	414	17.89	357.8

Table 5: Conductometric Data for Bis-(Phenolic) Schiff Base Ligand and Metal Co^{2+}

[L]/[M]	LIGAND ADDITION	15 °c	Λ	25 °C	Λ	35 °C	Λ
0	0	14.69	293.8	8.62	172.4	6.68	133.6
0.1	0.01	16.43	328.6	9.38	187.6	7.29	145.8
0.2	0.02	17.79	355.8	10.4	208	7.67	153.4
0.3	0.03	19.49	389.8	11.36	227.2	8.16	163.2
0.4	0.04	20.8	416	12.18	243.6	8.28	165.6
0.5	0.05	21.9	438	12.93	258.6	8.51	170.2
0.6	0.06	23.2	464	13.68	273.6	8.84	176.8
0.7	0.07	24.1	482	14.49	289.8	8.99	179.8
0.8	0.08	24.9	498	15.27	305.4	9.12	182.4
0.9	0.09	25.6	512	15.87	317.4	9.28	185.6
1	0.1	26.4	528	16.59	331.8	9.48	189.6
1.1	0.11	27.1	542	17.34	346.8	9.71	194.2
1.2	0.12	27.8	556	17.79	355.8	9.9	198
1.3	0.13	28.4	568	18.43	368.6	10.09	201.8
1.4	0.14	29	580	19.03	380.6	10.48	209.6
1.5	0.15	29.8	596	19.74	394.8	10.85	217
1.6	0.16	30.78	615.6	20.3	406	11.31	226.2
1.7	0.17	31.4	628	20.7	414	11.74	234.8
1.8	0.18	31.9	638	21.2	424	11.9	238
1.9	0.19	32.5	650	21.4	428	12.09	241.8
2	0.2	32.5	650	21.9	438	12.27	245.4
2.1	0.21	32.7	654	22.6	452	12.45	249
2.2	0.22	32.6	652	22.9	458	12.66	253.2
2.3	0.23	32.8	656	23.1	462	12.85	257
2.4	0.24	32.8	656	23.5	470	13.01	260.2
2.5	0.25	33	660	23.6	472	13.19	263.8
2.6	0.26	33.2	664	23.8	476	13.33	266.6
2.7	0.27	33.4	668	23.9	478	13.5	270
2.8	0.28	33.5	670	24.1	482	13.9	278
2.9	0.29	33.5	670	24.2	484	14.08	281.6
3	0.3	33.5	670	24.2	484	14.1	282

eISSN 1303-5150

Table 6: Conductometric Data for Bis-(Phenolic) Schiff Base Ligand and Metal Cu^{2+}

[L]/[M]	LIGAND ADDITION	15 °c	Λ	25 °C	Λ	35 °C	Λ
0	0	8.8	176	10.9	218	14.88	297.6
0.1	0.01	9.54	190.8	11.6	232	15.64	312.8
0.2	0.02	10.26	205.2	12.5	250	16.33	326.6
0.3	0.03	10.86	217.2	13.25	265	16.94	338.8
0.4	0.04	11.47	229.4	14.16	283.2	17.57	351.4
0.5	0.05	12.11	242.2	15.1	302	18.07	361.4
0.6	0.06	12.57	251.4	15.84	316.8	18.48	369.6
0.7	0.07	13.19	263.8	16.71	334.2	19.09	381.8
0.8	0.08	13.61	272.2	17.3	346	19.45	389
0.9	0.09	13.96	279.2	17.88	357.6	19.99	399.8
1	0.1	14.58	291.6	18.4	368	20.7	414
1.1	0.11	15.08	301.6	19	380	21.3	426
1.2	0.12	15.56	311.2	19.5	390	21.7	434
1.3	0.13	16	320	20	400	22.12	442.4
1.4	0.14	16.43	328.6	20.5	410	22.6	452
1.5	0.15	16.87	337.4	20.9	418	22.8	456
1.6	0.16	17.42	348.4	21.4	428	23.3	466
1.7	0.17	17.9	358	21.9	438	23.9	478
1.8	0.18	18.42	368.4	22.3	446	24.3	486
1.9	0.19	18.79	375.8	22.6	452	24.9	498
2	0.2	19.2	384	23.2	464	25.2	504
2.1	0.21	19.56	391.2	23.4	468	25.8	516
2.2	0.22	19.59	391.8	23.8	476	26.4	528
2.3	0.23	19.6	392	24	480	27.1	542
2.4	0.24	19.66	393.2	24.2	484	27.3	546
2.5	0.25	19.76	395.2	24.5	490	27.3	546
2.6	0.26	19.86	397.2	24.5	490	27.3	546
2.7	0.27	20	400	24.6	492	27.4	548
2.8	0.28	20	400	24.8	496	27.4	548
2.9	0.29	20	400	24.8	496	27.4	548
3	0.3	20	400	24.9	498	27.3	546

Table 7: Conductometric Data for Bis-(Phenolic) Schiff Base Ligand and Metal Ni^{2+}

[L]/[M]	LIGAND ADDITION	15 °c	Λ	25 °C	Λ	35 °C	Λ
0	0	24.70	494	12.69	253.8	6.92	138.4
0.1	0.01	25.6	512	13.01	260.2	7.36	147.2
0.2	0.02	26.7	534	13.27	265.4	7.52	150.4
0.3	0.03	27.6	552	13.59	271.8	7.78	155.6
0.4	0.04	28.2	564	13.96	279.2	8.20	164
0.5	0.05	28.8	576	14.27	285.4	8.51	170.2
0.6	0.06	29.5	590	14.63	292.6	8.97	179.4
0.7	0.07	30	600	15.02	300.4	9.30	186
0.8	0.08	30.6	612	15.32	306.4	9.77	195.4
0.9	0.09	31.3	626	15.69	313.8	9.87	197.4
1	0.1	31.6	632	16.03	320.6	9.90	198
1.1	0.11	32.6	652	16.35	327	10.10	202
1.2	0.12	33.2	664	16.78	335.6	10.17	203.4
1.3	0.13	33.9	678	17.03	340.6	10.75	215
1.4	0.14	34.4	688	17.38	347.6	11.17	223.4
1.5	0.15	35.3	706	17.56	351.2	11.67	233.4
1.6	0.16	36.4	728	18.14	362.8	12.22	244.4
1.7	0.17	37.3	746	18.83	376.6	12.76	255.2
1.8	0.18	38.5	770	19.18	383.6	13.20	264
1.9	0.19	38.9	778	19.67	393.4	13.58	271.6
2	0.2	39.2	784	19.99	399.8	14.12	282.4
2.1	0.21	39.7	794	20.34	406.8	14.57	291.4
2.2	0.22	40.2	804	20.98	419.6	14.91	298.2
2.3	0.23	40.6	812	21.42	428.4	15.54	310.8
2.4	0.24	41	820	21.65	433	15.70	314
2.5	0.25	41.1	822	21.99	439.8	15.84	316.8
2.6	0.26	41.4	828	22.1	442	15.93	318.6
2.7	0.27	41.6	832	22.5	450	16.20	324
2.8	0.28	41.6	832	22.6	452	16.28	325.6
2.9	0.29	41.9	838	22.6	452	16.40	328
3	0.3	41.9	838	22.6	452	16.50	330

Table 8: Conductometric Data for Bis-(Phenolic) Schiff Base Ligand and Metal Ag^{1+}

[L]/[M]	LIGAND ADDITION	15 °c	Λ	25 °C	Λ	35 °C	Λ
0	0	7.43	148.6	9.63	192.6	10.99	219.8
0.1	0.01	7.66	153.2	9.83	196.6	11.22	224.4
0.2	0.02	7.87	157.4	9.99	199.8	11.71	234.2
0.3	0.03	8.2	164	10.45	209	12.39	247.8
0.4	0.04	8.7	174	11	220	13.05	261
0.5	0.05	9.4	188	11.5	230	13.73	274.6
0.6	0.06	10.35	207	12.3	246	14.46	289.2
0.7	0.07	11.25	225	13.12	262.4	15.2	304
0.8	0.08	11.98	239.6	13.99	279.8	16.04	320.8
0.9	0.09	12.66	253.2	14.87	297.4	17	340
1	0.1	13.32	266.4	15.12	302.4	17.32	346.4
1.1	0.11	13.76	275.2	15.68	313.6	18.02	360.4
1.2	0.12	14.23	284.6	16.13	322.6	18.5	370
1.3	0.13	15	300	17	340	19.2	384
1.4	0.14	15.54	310.8	17.66	353.2	19.73	394.6
1.5	0.15	16.23	324.6	18.42	368.4	20.6	412
1.6	0.16	17.12	342.4	19.4	388	21.6	432
1.7	0.17	18.1	362	20.12	402.4	21.9	438
1.8	0.18	19	380	21.13	422.6	22.5	450
1.9	0.19	19.66	393.2	21.87	437.4	23.2	464
2	0.2	20.7	414	22.4	448	23.7	474
2.1	0.21	21.4	428	23	460	24.2	484
2.2	0.22	21.9	438	23.7	474	24.9	498
2.3	0.23	22.3	446	24.3	486	25.3	506
2.4	0.24	22.6	452	24.99	499.8	25.8	516
2.5	0.25	22.9	458	25.72	514.4	26.4	528
2.6	0.26	23.3	466	26.1	522	27	540
2.7	0.27	23.4	468	26.2	524	27.4	548
2.8	0.28	23.5	470	26.4	528	27.7	554
2.9	0.29	23.6	472	26.8	536	27.9	558
3	0.3	23.7	474	27	540	28.3	566

Table 9: Conductometric Data for Bis-(Phenolic) Schiff Base Ligand and Metal Zn^{2+}

eISSN 1303-5150

[L]/[M]	LIGAND ADDITION	15 °c	Λ	25 °C	Λ	35 °C	Λ
0	0	30.3	606	10.08	201.6	6.78	135.6
0.1	0.01	31.7	634	10.65	213	7	140
0.2	0.02	32.7	654	11.24	224.8	7.23	144.6
0.3	0.03	33.5	670	11.95	239	7.65	153
0.4	0.04	34.3	686	12.59	251.8	8.14	162.8
0.5	0.05	35	700	13.35	267	8.6	172
0.6	0.06	35.7	714	13.98	279.6	8.81	176.2
0.7	0.07	36.4	728	14.62	292.4	9.12	182.4
0.8	0.08	36.9	738	15.56	311.2	9.56	191.2
0.9	0.09	37.4	748	16.2	324	10.31	206.2
1	0.1	37.6	752	16.42	328.4	10.86	217.2
1.1	0.11	38	760	17.04	340.8	11.11	222.2
1.2	0.12	38.3	766	17.45	349	11.37	227.4
1.3	0.13	38.6	772	17.99	359.8	11.87	237.4
1.4	0.14	39	780	18.4	368	12.33	246.6
1.5	0.15	39.3	786	18.81	376.2	12.78	255.6
1.6	0.16	39.7	794	19.21	384.2	13.21	264.2
1.7	0.17	40.1	802	19.77	395.4	13.54	270.8
1.8	0.18	40.4	808	20.2	404	14.13	282.6
1.9	0.19	40.8	816	20.8	416	14.97	299.4
2	0.2	41.3	826	21.7	434	15.8	316
2.1	0.21	41.8	836	22.1	442	16.17	323.4
2.2	0.22	41.9	838	22.2	444	16.27	325.4
2.3	0.23	42	840	22.4	448	16.75	335
2.4	0.24	42.2	844	22.8	456	16.79	335.8
2.5	0.25	42.3	846	23.1	462	17.16	343.2
2.6	0.26	42.7	854	23.2	464	17.21	344.2
2.7	0.27	42.8	856	23.2	464	17.3	346
2.8	0.28	43.2	864	23.25	465	17.4	348
2.9	0.29	43.2	864	23.5	470	17.53	350.6
3	0.3	43.2	864	23.9	478	17.6	352

The data obtained from the conductometric measurements have been analyzed using nonlinear fitting with KinFit software. (O) indicates calculated points, (X) indicates experimental points, and (=) denotes the overlap of calculated and experimental points.

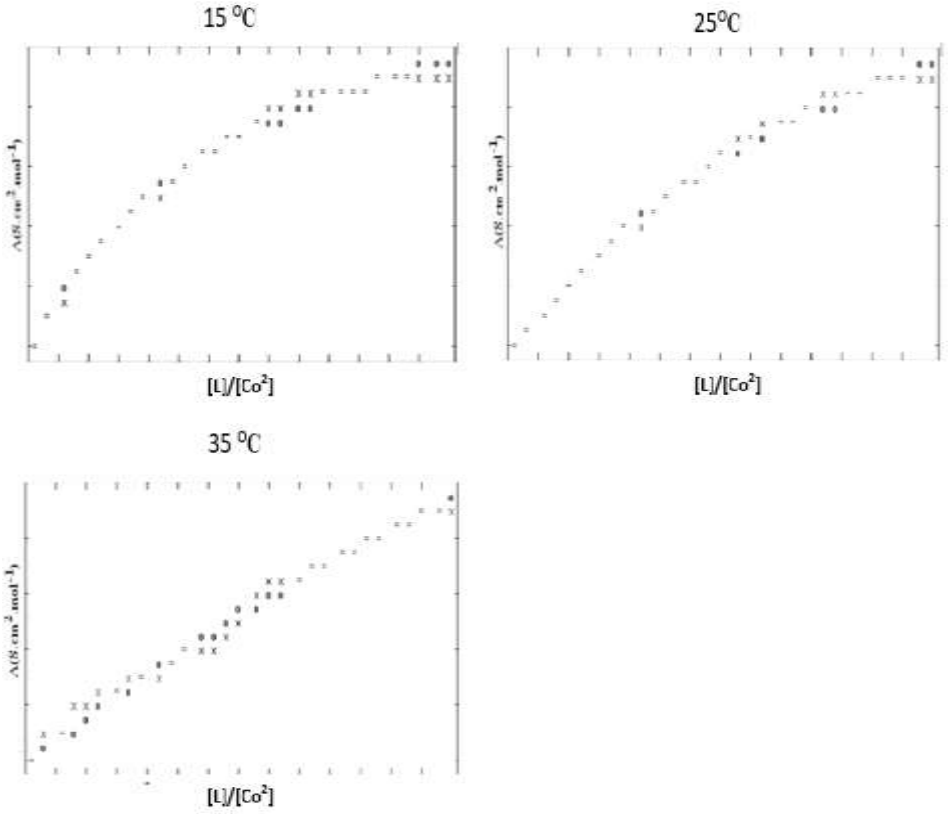

Figure 4: Computer Fitting of Molar Conductivity Results for Bis-(Phenolic) Schiff Base Ligand in Reaction with Cobalt Metal

Table 10: Log K_f Values and [L]/[M] for Bis-(Phenolic) Schiff Base Ligand Complex in Acetonitrile Solvent

Cation		Cd^{2+}	Ag^{1+}	Zn^{2+}	Cu^{2+}	Co^{2+}	Ni^{2+}
Log k_f	15 ºC	Log k_1 4.01±0.86	Log k_1 4.81±0.56	Log k_1 5.81±0.2	Log k_1 9.7±0.94	Log k_1 5.27±0.5	Log k_1 4.26±0.31
		Log k_2 4.91±1.3	Log k_2 4.99±0.3	Log k_2 5.99±0.1	Log k_2 9.99±0.3	Log k_2 5.99±0.7	Log k_2 4.69±0.7
	25 ºC	Log k_1 4.71±0.4	Log k_1 5.1±0.2	Log k_1 5.80±0. 2	Log k_1 9.77±0.65	Log k_1 4.55±0.72	Log k_1 4.17±0.14
		Log k_2 5.31±0.9	Log k_2 5.81±0.3	Log k_2 6.29±0.4	Log k_2 9.9±0.3	Log k2 5.19±0.9	Log k_2 4.4±0.8
	35 ºC	Log k_1 4.1±0.66	Log k_1 4.9±0.46	Log k_1 5.41±0.12	Log k_1 9.38±0.8	Log k_1 4.28±0.8	Log k_1 4.51±1.08
		Log k_2 5.71±0.5	Log k_2 5.21±0.7	Log k_2 6.89±0.6	Log k_2 9.59±0.1	Log k_2 4.99±0.6	Log k_2 5.69±0.1
	[L] / [M]	MLML2	MLML2	MLML2	MLML2	MLML2	MLML2

The log K_f versus 1/T plots for each complex were created, and in all cases, linear graphs were obtained. The entropy and enthalpy of complex formation were calculated using the Van't Hoff plot (Equation 3-1) and recorded in Table (3-7).

$$2.303 \log K_f = -\frac{\Delta H}{RT} + \frac{\Delta S}{R} \qquad (3\text{-}1)$$

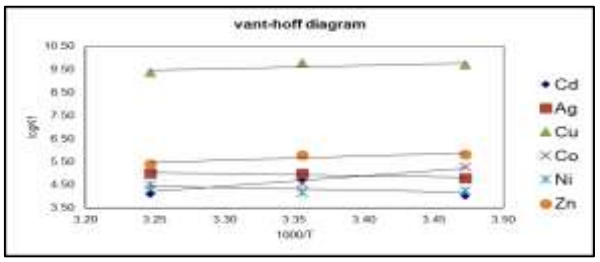

Figure 5: Van't Hoff Plot for the Bis-(Phenolic) Schiff Base Ligand Complex in Acetonitrile Solvent

Table 11: ΔH and ΔS Values for the Bis-(Phenolic) Schiff Base Ligand Complex in Acetonitrile Solvent

Cation	Cd^{2+}	Ag^{1+}	Zn^{2+}	Cu^{2+}	Co^{2+}	Ni^{2+}
ΔH(Kj/mol)	8.88	16.33	-33.59	-26.73	-84.47	20.81
ΔS(j/mol.K)	111.6	149.2	-4.6	94.3	-19	152.4

K)	6	3	19	7	3.67	9

2. Conductivity Study of the 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine Ligand

The results are recorded in Tables (12) to (17).

Table 12: Conductivity Data for 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine with Cd^{2+} Metal

eISSN 1303-5150

[L]/[M]	LIGAND ADDITION	15 °C	Λ	25 °C	Λ	35 °C	Λ
0	0	6.94	138.8	7.92	158.4	8.37	167.4
0.1	0.01	7.63	152.6	8.8	176	9.2	184
0.2	0.02	8.17	163.4	9.48	189.6	10.04	200.8
0.3	0.03	8.72	174.4	10.09	201.8	10.87	217.4
0.4	0.04	9.24	184.8	10.55	211	11.48	229.6
0.5	0.05	9.66	193.2	11.11	222.2	12.12	242.4
0.6	0.06	10.24	204.8	11.63	232.6	12.8	256
0.7	0.07	10.76	215.2	12.21	244.2	13.36	267.2
0.8	0.08	11.4	228	12.72	254.4	13.71	274.2
0.9	0.09	11.83	236.6	13.15	263	13.99	279.8
1	0.1	12.34	246.8	13.45	269	14.19	283.8
1.1	0.11	12.86	257.2	13.69	273.8	14.31	286.2
1.2	0.12	13.37	267.4	14	280	14.51	290.2
1.3	0.13	13.7	274	14.2	284	14.61	292.2
1.4	0.14	14.12	282.4	14.32	286.4	14.69	293.8
1.5	0.15	14.6	292	14.51	290.2	14.71	294.2
1.6	0.16	14.85	297	14.66	293.2	14.76	295.2
1.7	0.17	14.99	299.8	14.7	294	14.76	295.2
1.8	0.18	15.11	302.2	14.85	297	14.76	295.2
1.9	0.19	15.16	303.2	14.96	299.2	14.77	295.4
2	0.2	15.2	304	14.99	299.8	14.78	295.6
2.1	0.21	15.2	304	15	300	14.78	295.6
2.2	0.22	15.2	304	15.12	302.4	14.78	295.6
2.3	0.23	15.2	304	15.11	302.2	14.8	296
2.4	0.24	15.2	304	15.2	304	14.8	296
2.5	0.25	15.2	304	15.15	303	14.8	296
2.6	0.26	15.2	304	15.2	304	14.8	296
2.7	0.27	15.2	304	15.2	304	14.8	296
2.8	0.28	15.2	304	15.2	304	14.8	296
2.9	0.29	15.2	304	15.2	304	14.8	296
3	0.3	15.2	304	15.1	302	14.8	296

Table 13: Conductivity Data for 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine with Co^{2+} Metal

[L]/[M]	LIGAND ADDITION	15 °C	Λ	25 °C	Λ	35 °C	Λ
0	0	14.62	292.4	12.57	251.4	10.16	203.2
0.1	0.01	15.33	306.6	13.32	266.4	10.84	216.8
0.2	0.02	16.25	325	13.82	276.4	11.42	228.4
0.3	0.03	16.77	335.4	14.3	286	11.93	238.6
0.4	0.04	17.54	350.8	14.8	296	12.45	249
0.5	0.05	17.93	358.6	15.33	306.6	13.23	264.6
0.6	0.06	18.58	371.6	15.83	316.6	13.92	278.4
0.7	0.07	19.07	381.4	16.47	329.4	14.63	292.6
0.8	0.08	19.71	394.2	17.12	342.4	15.22	304.4
0.9	0.09	20.4	408	17.37	347.4	15.46	309.2
1	0.1	20.9	418	17.59	351.8	15.6	312
1.1	0.11	21.5	430	17.6	352	15.7	314
1.2	0.12	21.8	436	17.61	352.2	15.77	315.4
1.3	0.13	22.1	442	17.71	354.2	15.8	316
1.4	0.14	22.5	450	17.92	358.4	15.85	317
1.5	0.15	22.7	454	18.23	364.6	15.85	317
1.6	0.16	23.2	464	18.4	368	15.85	317
1.7	0.17	23.4	468	18.6	372	15.8	316
1.8	0.18	23.7	474	18.63	372.6	15.85	317
1.9	0.19	23.7	474	18.63	372.6	15.77	315.4
2	0.2	23.7	474	18.62	372.4	15.6	312
2.1	0.21	24	480	18.61	372.2	15.53	310.6
2.2	0.22	24.1	482	18.6	372	15.51	310.2
2.3	0.23	24.1	482	18.6	372	15.45	309
2.4	0.24	24.1	482	18.61	372.2	15.34	306.8
2.5	0.25	24.2	484	18.6	372	15.33	306.6
2.6	0.26	24.3	486	18.61	372.2	15.32	306.4
2.7	0.27	24.4	488	18.62	372.4	15.26	305.2
2.8	0.28	24.4	488	18.61	372.2	15.24	304.8
2.9	0.29	24.4	488	18.6	372	15.17	303.4
3	0.3	24.4	488	18.6	372	15.17	303.4

Table 14: Conductivity Data for 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine with Cu^{2+} Metal

[L]/[M]	LIGAND ADDITION	15 °C	Λ	25 °C	Λ	35 °C	Λ
0	0	13.9	278	15.93	318.64	18.44	368.839
0.1	0.01	15.27	305.4	17.3	346.04	19.81	396.239
0.2	0.02	16.5	330	18.53	370.64	21.04	420.839
0.3	0.03	17.5	350	19.53	390.64	22.04	440.839
0.4	0.04	18.35	367	20.38	407.64	22.89	457.839
0.5	0.05	18.96	379.2	20.99	419.84	23.50	470.039
0.6	0.06	19.47	389.4	21.5	430.04	24.01	480.239
0.7	0.07	19.84	396.8	21.87	437.44	24.38	487.639
0.8	0.08	20.4	408	22.43	448.64	24.94	498.839
0.9	0.09	20.7	414	22.73	454.64	25.24	504.839
1	0.1	21	420	23.03	460.64	25.54	510.839
1.1	0.11	21.3	426	23.33	466.64	25.84	516.839
1.2	0.12	21.4	428	23.43	468.64	25.94	518.839
1.3	0.13	21.5	430	23.53	470.64	26.04	520.839
1.4	0.14	21.7	434	23.73	474.64	26.24	524.839
1.5	0.15	21.9	438	23.93	478.64	26.44	528.839
1.6	0.16	21.9	438	23.93	478.64	26.44	528.839
1.7	0.17	21.9	438	23.93	478.64	26.44	528.839
1.8	0.18	21.9	438	23.93	478.64	26.44	528.839
1.9	0.19	21.9	438	23.93	478.64	26.44	528.839
2	0.2	21.9	438	23.93	478.64	26.44	528.839
2.1	0.21	22.12	442.4	24.15	483.04	26.66	533.239
2.2	0.22	22.22	444.4	24.25	485.04	26.76	535.239
2.3	0.23	22.33	446.6	24.36	487.24	26.87	537.439
2.4	0.24	22.33	446.6	24.36	487.24	26.87	537.439
2.5	0.25	22.33	446.6	24.36	487.24	26.87	537.439
2.6	0.26	22.33	446.6	24.36	487.24	26.87	537.439
2.7	0.27	22.33	446.6	24.36	487.24	26.87	537.439
2.8	0.28	22.33	446.6	24.36	487.24	26.87	537.439
2.9	0.29	22.33	446.6	24.36	487.24	26.87	537.439
3	0.3	22.33	446.6	24.36	487.24	26.87	537.439

Table 15: Conductivity Data for 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine with Ni^{2+} Metal

[L]/[M]	LIGAND ADDITION	15 °C	Λ	25 °C	Λ	35 °C	Λ
0	0	20.7	414	14.38	287.6	12.89	257.8
0.1	0.01	22.1	442	15.68	313.6	14.12	282.4
0.2	0.02	22.8	456	16.51	330.2	14.6	292
0.3	0.03	23.5	470	17.28	345.6	14.9	298
0.4	0.04	24.2	484	17.78	355.6	15.23	304.6
0.5	0.05	24.9	498	18.52	370.4	15.35	307
0.6	0.06	25.3	506	18.98	379.6	15.42	308.4
0.7	0.07	25.7	514	19.38	387.6	15.63	312.6
0.8	0.08	25.8	516	19.48	389.6	15.72	314.4
0.9	0.09	26	520	19.68	393.6	15.89	317.8
1	0.1	26.1	522	19.78	395.6	15.96	319.2
1.1	0.11	26.3	526	19.98	399.6	16.17	323.4
1.2	0.12	26.5	530	20.18	403.6	16.23	324.6
1.3	0.13	26.7	534	20.38	407.6	16.23	324.6
1.4	0.14	26.7	534	20.38	407.6	16.23	324.6
1.5	0.15	26.7	534	20.38	407.6	16.23	324.6
1.6	0.16	27	540	20.64	412.8	16.23	324.6
1.7	0.17	27	540	20.72	414.4	16.23	324.6
1.8	0.18	27.3	546	20.78	415.6	16.23	324.6
1.9	0.19	27.3	546	20.68	413.6	16.35	327
2	0.2	27.3	546	20.98	419.6	16.32	326.4
2.1	0.21	27.3	546	20.98	419.6	16.33	326.6
2.2	0.22	27.3	546	20.98	419.6	16.33	326.6
2.3	0.23	27.6	552	21.25	425	16.33	326.6
2.4	0.24	27.6	552	21.27	425.4	16.33	326.6
2.5	0.25	27.6	552	21.28	425.6	16.33	326.6
2.6	0.26	27.6	552	21.29	425.8	16.33	326.6
2.7	0.27	27.6	552	21.29	425.8	16.33	326.6
2.8	0.28	27.6	552	21.29	425.8	16.32	326.4
2.9	0.29	27.6	552	21.29	425.8	16.31	326.2
3	0.3	27.6	552	21.29	425.8	16.31	326.2

eISSN 1303-5150

Table 16: Conductivity Data for 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine with Ag^{1+} Metal

[L]/[M]	LIGAND ADDITION	15 °C	Λ	25 °C	Λ	35 °C	Λ
0	0	11.72	234.4	11.09	221.8	10	200
0.1	0.01	11.62	232.4	11.05	221.1	9.93	199
0.2	0.02	11.61	232.2	10.95	219.1	9.92	198
0.3	0.03	11.56	231.2	10.94	218.9	9.87	197
0.4	0.04	11.52	230.4	10.89	217.9	9.83	197
0.5	0.05	11.48	229.6	10.85	217.1	9.79	196
0.6	0.06	11.44	228.8	10.81	216.3	9.75	195
0.7	0.07	11.4	228	10.77	215.5	9.71	194
0.8	0.08	11.34	226.8	10.73	214.7	9.65	193
0.9	0.09	11.28	225.6	10.67	213.5	9.59	192
1	0.1	11.24	224.8	10.61	212.3	9.55	191
1.1	0.11	11.21	224.2	10.57	211.5	9.52	190
1.2	0.12	11.19	223.8	10.54	210.9	9.5	190
1.3	0.13	11.15	223	10.52	210.5	9.46	189
1.4	0.14	11.09	221.8	10.48	209.7	9.4	188
1.5	0.15	11.03	220.6	10.42	208.5	9.34	187
1.6	0.16	11	220	10.36	207.3	9.31	186
1.7	0.17	11	220	10.33	206.7	9.31	186
1.8	0.18	11	220	10.33	206.7	9.31	186
1.9	0.19	11	220	10.33	206.7	9.31	186
2	0.2	10.95	219	10.33	206.7	9.26	185
2.1	0.21	10.85	217	10.28	205.7	9.16	183
2.2	0.22	10.75	215	10.18	203.7	9.06	181
2.3	0.23	10.65	213	10.08	201.7	8.96	179
2.4	0.24	10.55	211	9.984	199.7	8.86	177
2.5	0.25	10.45	209	9.884	197.7	8.76	175
2.6	0.26	10.3	206	9.784	195.7	8.61	172
2.7	0.27	10.15	203	9.634	192.7	8.46	169
2.8	0.28	10.02	200.4	9.484	189.7	8.33	167
2.9	0.29	9.89	197.8	9.354	187.1	8.2	164
3	0.3	9.64	192.8	9.224	184.5	7.95	159

Table 17: Conductivity Data for 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine with Zn^{2+} Metal

[L]/[M]	LIGAND ADDITION	15 °C	Λ	25 °C	Λ	35 °C	Λ
0	0	22.3	446	17.43	348.6	12.9	258
0.1	0.01	22.9	458	17.9	358	13.4	268
0.2	0.02	23.1	462	18.3	366	13.8	276
0.3	0.03	23.6	472	18.6	372	14.5	290
0.4	0.04	23.7	477	18.97	379.4	14.72	294.4
0.5	0.05	24.4	488	19.18	383.6	15.24	304.8
0.6	0.06	24.9	498	19.49	389.8	15.43	308.6
0.7	0.07	25.5	510	19.75	395	15.74	314.8
0.8	0.08	25.9	518	19.84	396.8	15.95	319
0.9	0.09	26.2	524	19.92	398.4	16.15	323
1	0.1	26.3	526	19.82	396.4	15.99	319.8
1.1	0.11	26.1	522	19.67	393.4	15.78	315.6
1.2	0.12	25.9	518	19.54	390.8	15.58	311.6
1.3	0.13	25.7	514	19.45	389	15.44	308.8
1.4	0.14	25.43	508.6	19.33	386.6	15.28	305.6
1.5	0.15	25.28	505.6	19.18	383.6	15.13	302.6
1.6	0.16	25.13	502.6	19	380	14.99	299.8
1.7	0.17	24.99	499.8	18.86	377.2	14.88	297.6
1.8	0.18	24.88	497.6	18.77	375.4	14.83	296.6
1.9	0.19	24.83	496.6	18.66	373.2	14.79	295.8
2	0.2	24.7	494	18.6	372	14.68	293.6
2.1	0.21	24.58	491.6	18.5	370	14.44	288.8
2.2	0.22	24.44	488.8	18.4	368	14.29	285.8
2.3	0.23	24.29	485.8	18.3	366	14.12	282.4
2.4	0.24	24.12	482.4	18.15	363	14	280
2.5	0.25	24	480	18	360	13.88	277.6
2.6	0.26	23.88	477.6	17.8	356	13.75	275
2.7	0.27	23.75	475	17.57	351.4	13.56	271.2
2.8	0.28	23.56	471.2	17.35	347	13.32	266.4
2.9	0.29	23.32	466.4	17.18	343.6	13.25	265
3	0.3	23.25	465	17.07	341.4	13.17	263.4

The data recorded using the conductivity method were calculated using nonlinear fitting with Kinfit software, and the corresponding graphs for each metal are shown in Figure 6. (O) indicates calculated points, (X) indicates experimental points, and (=) denotes the overlap of calculated and experimental points.

eISSN 1303-5150

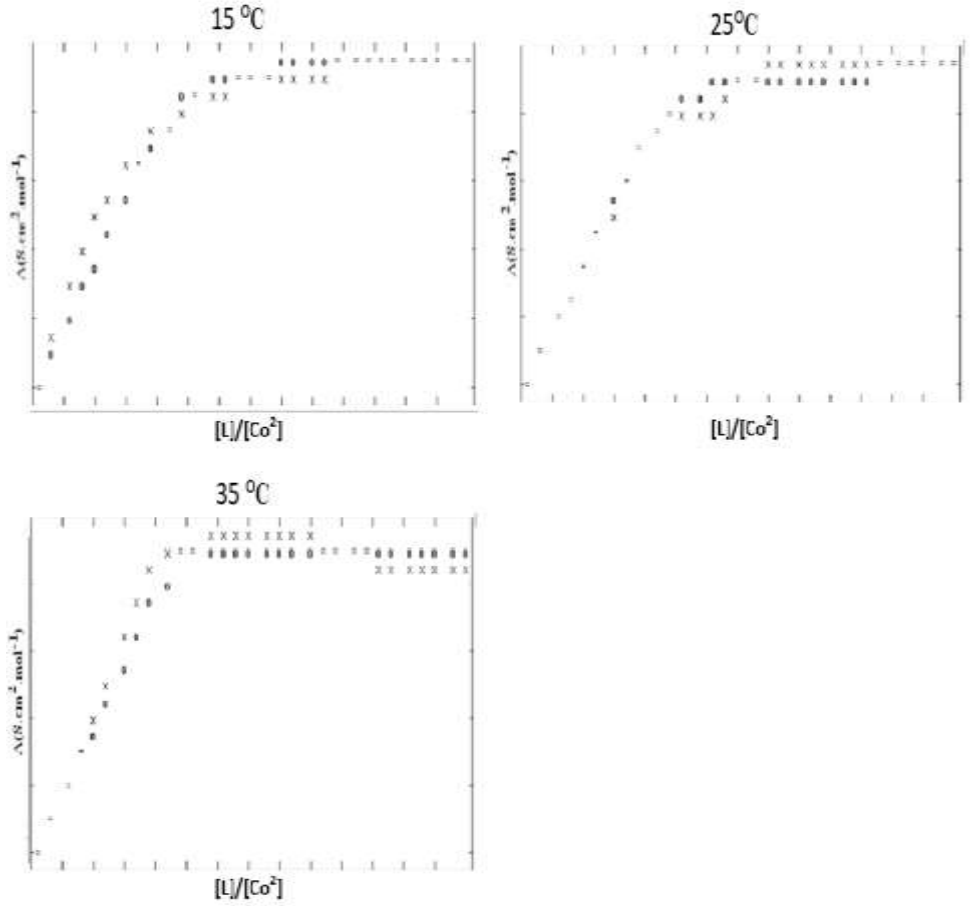

Figure 6: Computer fitting results of molar conductivity in the reaction of 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine with Cobalt Metal

Table 18: Values of Log K_f and [L]/[M] for the 2,6-Bis (Methoxy-6-Methylimino Phenol) ligand complex in acetonitrile solvent

Cation		Cd^{2+}	Ag^{1+}	Zn^{2+}	Cu^{2+}	Co^{2+}	Ni^{2+}
Log k_f	15 ºC	8.15±0.15	5.2±0.60	It is not possible to calculate with the software	7.0±0.58	Log k_1 6±1.03 Log k_2 8.2±1.8	5.4±0.29
	25 ºC	8.5±0.73	5.6±0.54		6.69±0.79	Log k_1 6.2±0.8 Log k_2 7.2±1.0	5.3±0.4
	35 ºC	9.1±0.43	6.0±0.21		6.88±0.65	Log k_1 5.4±0.7 Log k_2 6.3±1.7	5.02±0.3
	[L] / [M]	ML	ML	ML	ML	$MLML_2$	ML

The log K_f vs. 1/T plots for both complexes were drawn and all resulted in linear graphs. The entropy and enthalpy of complex formation were calculated using the Van't Hoff plot (Equation 3-1)

eISSN 1303-5150

and recorded in Table (19).

$$2.303 \log K_f = -\frac{\Delta H}{RT} + \frac{\Delta S}{R} \qquad (3\text{-}1)$$

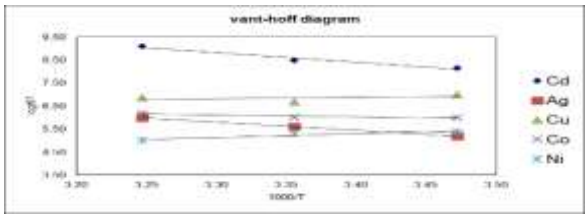

Figure 7: Van't Hoff plot for the 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine ligand complex in acetonitrile solvent

Table 19: Values of ΔH and ΔS for the 2,6-Bis (Methoxy-6-Methylimino Phenol) Pyridine ligand complex in acetonitrile solvent

Cation	Cd^{2+}	Ag^{1+}	Zn^{2+}	Cu^{2+}	Co^{2+}	Ni^{2+}
ΔH(Kj/mol)	80.41	67.91	A	-10.66	16.79	-32.09
ΔS(j/mol.K)	443.37	335.29	A	95.48	172.54	-7.42

A: Calculation with the software is not possible.

3. Spectrophotometric Study of the Bis-(Phenolic) Schiff Base Ligand

In this section, the graphs of absorbance changes as a function of the molar ratio of metal ions to ligand at the maximum wavelength **λ**max of the complex and the ligand are shown in Figures 8 to 13. Using this method, the stoichiometry of the reaction was determined, and subsequently, the complex formation constant was calculated using KINFIT software.

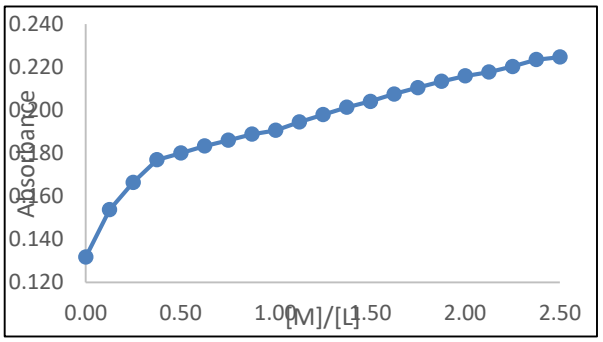

Figure 8: Absorbance changes as a function of the mole fraction of zinc metal and the bis-(phenolic) Schiff base ligand at 430 nm

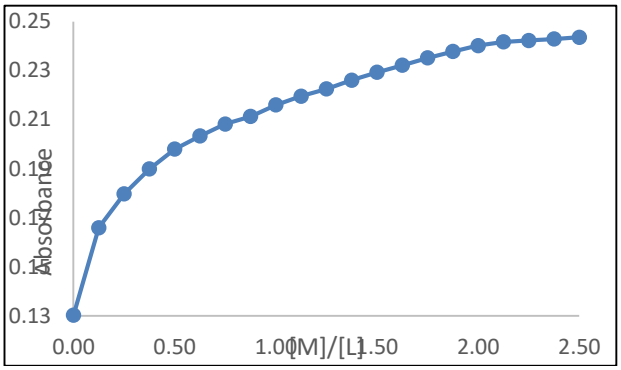

Figure 9: Absorbance changes as a function of the mole fraction of nickel metal and the bis-(phenolic) Schiff base ligand at 424 nm

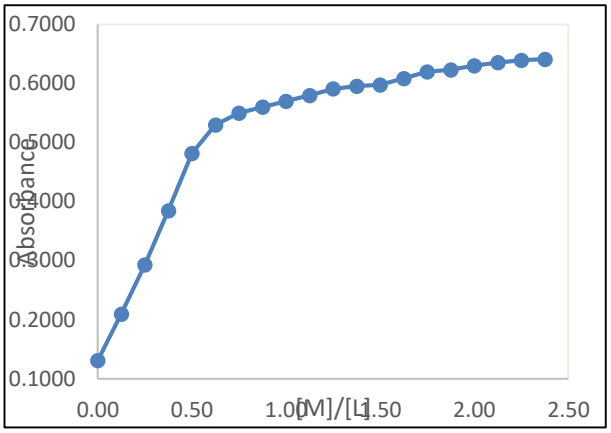

Figure 10: Absorbance changes as a function of the mole fraction of copper metal and the bis-(phenolic) Schiff base ligand at 424 nm

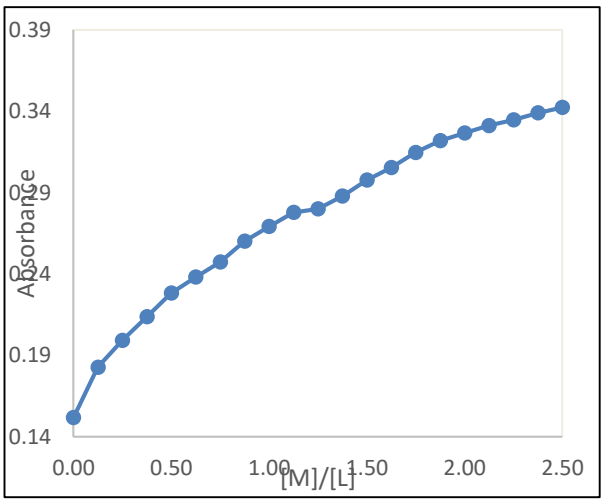

Figure 11: Absorbance changes as a function of the mole fraction of cobalt metal and the bis-(phenolic) Schiff base ligand at 420 nm

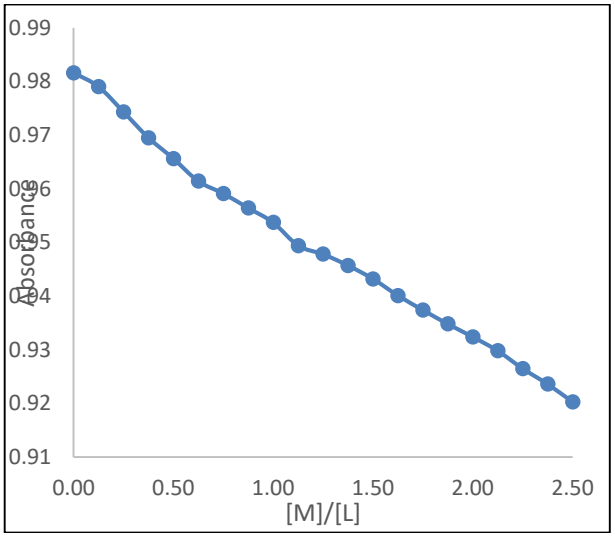

Figure 12: Absorbance changes as a function of the mole fraction of cadmium metal and the bis-(phenolic) Schiff base ligand at 330 nm

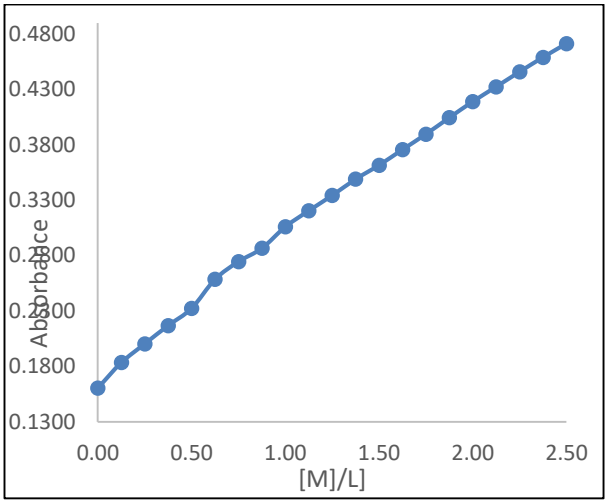

Figure 13: A graph showing the changes in absorption as a function of the mole fraction of silver metal and Bis-(phenolic) Schiff base ligand at 430 nm

To obtain the stability constants of the formed complexes and their molar absorptivity coefficients, the KINFIT software was used based on the sum of squares. The complex formation constants are summarized in Table 20.

Table 20: Values of Log K_f and [M]/[L] for the 2,6-Bis (methoxy-6-methylimino phenol) ligand complexes in acetonitrile using spectrophotometric methods.

Cation		**Cd^{2+}**	**Ag^{1+}**	**Zn^{2+}**	**Cu^{2+}**	**Co^{2+}**	**Ni^{2+}**
Log k_f	**25 ºC**	Log k_1 4.91±0.6	Log k_1 5.8±0.5	Log k_1 5.40±0. 3	Log k_1 9.77±0.65	Log k_1 4.85±1.02	Log k_1 5.17±0.13
		Log k_2 5.71±1.9	Log k_2 5.91±0.9	Log k_2 5.9±0.8	Log k_2 9.9±0.3	Log k2 5.0±0.78	Log k_2 5.7±0.4
	[L] / [M]	**$MLML_2$**	**$MLML_2$**	**$MLML_2$**	**$MLML_2$**	**$MLML_2$**	**$MLML_2$**

Spectrophotometric Study of the 2,6-Bis (methoxy-6-methylimino phenol) Pyridine Ligand

In this section, the graphs of absorbance changes as a function of the molar ratio of metal ions to ligand at the maximum wavelength **λ**max of the complex and the ligand are shown in Figures 14 to 19. Using this method, the stoichiometry of the reaction was determined, and subsequently, the complex formation constant was calculated using KINFIT software.

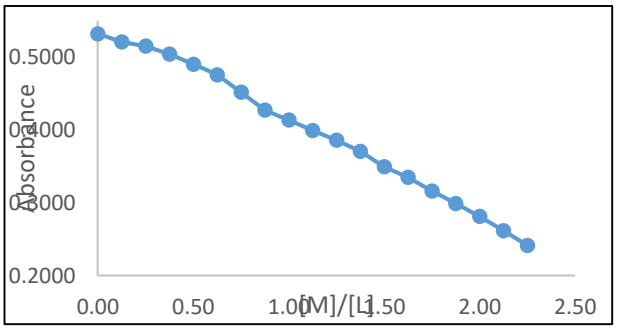

Figure 14: Absorbance changes as a function of the mole fraction of zinc metal and 2,6-bis (methoxy-6-methylimino phenol) ligand at 370 nm

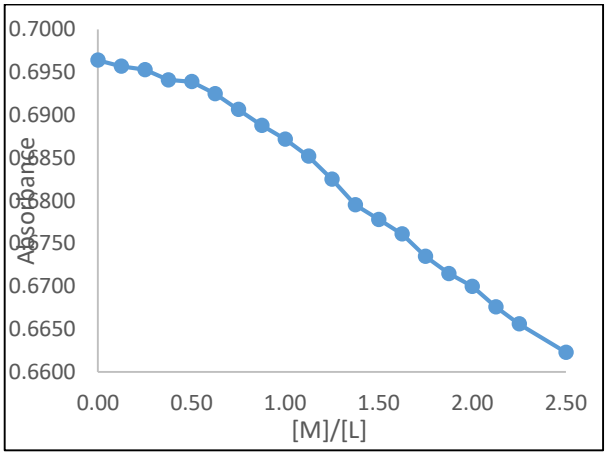

Figure 15: Absorbance changes as a function of the mole fraction of nickel metal and 2,6-bis (methoxy-6-methylimino phenol) ligand at 371 nm

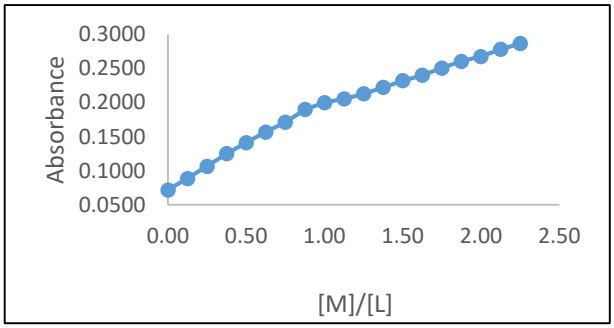

Figure 16: Absorbance changes as a function of the mole fraction of copper metal and 2,6-bis (methoxy-6-methylimino phenol) ligand at 491 nm

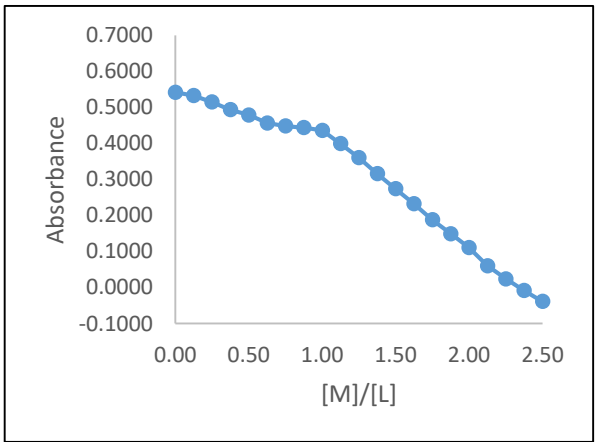

Figure 17: Absorbance changes as a function of the mole fraction of cobalt metal and 2,6-bis (methoxy-6-methylimino phenol) ligand at 340 nm

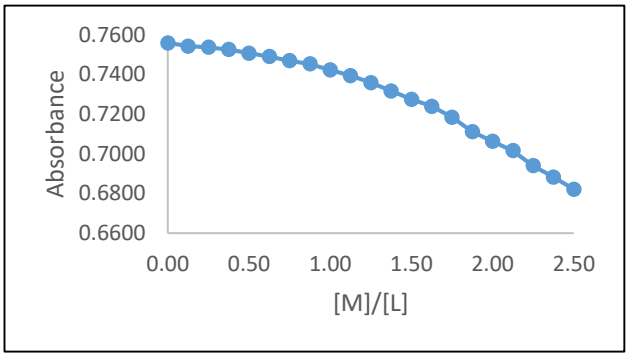

Figure 18: Absorbance changes as a function of the mole fraction of cadmium metal and 2,6-bis (methoxy-6-methylimino phenol) ligand at 340 nm

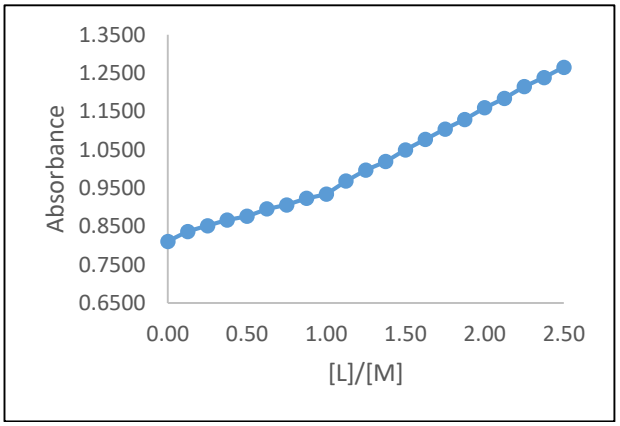

Figure 19: Absorbance changes as a function of the mole fraction of silver metal and 2,6-bis (methoxy-6-methylimino phenol) ligand at 340 nm

Table 21: Values of Log K_f and [M]/[L] for the 2,6-bis (methoxy-6-methylimino phenol) ligand complexes in acetonitrile using spectrophotometric methods

Cation		Cd^{2+}	Ag^{1+}	Zn^{2+}	Cu^{2+}	Co^{2+}	Ni^{2+}
Log k_f	25 ºC	7.9±0.51	5.9±1.04	5.6±0.7	5.99±0.32	Log k_1 6.8±0.4 Log k_2 7.12±1	5.8±0.6
	[L]/	ML	ML	ML	ML	ML	ML

	[M]						

Conclusion

Based on the data obtained from conductivity measurements and UV-Vis spectroscopy of the complexes formed from the reaction of ligands L and L' with metals Ag^{1+}, Zn^{2+}, Cu^{2+}, Co^{2+}, Cd^{2+}, and Ni^{2+}, the stability order is as follows:

For ligand L:

$Cd^{2+} > Ni^{2+} > Ag^{+} > Co^{2+} > Zn^{2+} > Cu^{2+}$

For ligand L':

$Zn^{2+} > Ni^{2+} > Ag^{+} > Co^{2+} > Cu^{2+} > Cd^{2+}$

For ligand L, negative values of ΔH indicate an exothermic reaction, while positive values indicate an endothermic reaction. Considering the stability order of the complex for the bis-(phenolic) Schiff base ligand, we observe that the reaction ML+L⇆ML2 is endothermic, and it opposes a decrease in temperature, leading to reduced complex stability.

The investigation of the complex formation reaction for ligand L showed that negative values for ΔH indicate an exothermic reaction, while positive values indicate an endothermic reaction. Considering the stability order of the complex for the ligand 2,6-bis (methoxy-6-methyliminophenol), we observe that the reaction M+L⇆ML for Ag^{1+} and Cd^{2+}, and the reaction ML+L⇆ML2 for Co^{2+} is endothermic and oppose a decrease in temperature, resulting in decreased complex stability. Additionally, the reaction M+L⇆ML is exothermic for Ni^{2+} and Cu^{2+}.

References

1. Dizaji, Javid. "Determination of Stability Constants of Complexes of Some Transition Metal Cations with a Series of New Synthetic Ligands." Urmia: Payam Noor University, 2010.
2. J. Sabolović, K. R. Liedl, Inorganic Chemistry, Why Are Copper(II) Amino Acid Complexes Not Planar in Their Crystal Structures. An ab Initio and Molecular Mechanics Study 38, (1999) , 2764-2774.
3. F. A. Cotton, G. Wilkinson, C. A. Murillo, Advanced Inorganic Chemistry, 6th, Journal of Chemical Education, 3 (2000), 310-311.
4. M. Wriedt, C. Näther, A Systematic Sudy on the Thermal Decomposition Reactions of Coordination Polymers Based on Metal(II) Selenocyanates and 4,4'-Bipyridine: Directed Synthesis of a μ-1,3 Bridging Selenocyanate, Inorganica Chimica Acta , 379 (2011) , 129-137
5. J. Bjerrum, Metal Amine Formation In Aqueous Solution, Thesis, Copenhagen, (1941), 52-54.
6. V. S. Ijeri, A. K. Srivastava, Voltammetric Determination of Lead at Chemically Modified Electrodes Based on Crown Ethers, Chemical & Engineering Data, 42, (2001), 605-608.
7. S. Akabori, M.Ohtomi, Chemical Society of Japan, 48, (1975), 2991.
8. V. S. Ijeri, A. K. Srivastava, Complexation of Macrocyclic Compounds with Mono-, Di- and Tri-Valent Transition and Heavy Metal Ions in 90% (v/v) DMSO Water Medium, Polyhedron, 22, (2003), 569-573.
9. R. M. Izatt, D. G. Eatough, C. Christensen, Alkali Metal Complexes with Organic Ligands, Structure and Bonding, 16, (1973), 161-189.
10. J. L. Pierre, H. Handel, R. Perraud, The Effect of Cations on Nucleophilic Additions to Carbonyl Compounds: Carbonyl Complexation Control Versus Ionic Association Control, Tetrahedron, 31, (1978), 2597-2605.
11. J. M. Lehn, Cryptate Inclusion Complexes Effects on Solute-Solute and Solute-Solvent Interactions and on Ionic Reactivity, Pure and Applied Chemistry, 52, (2009), 2303-2321.
12. G. Wipff, P. A. Kollman, Molecular Dynamics Simulations on the Protonated, New Journal of Chemistry, 9, (1991), 71-88
13. A. Knochel, R. D. Wilken, Isotope Effects in the Formation of Sodium Cryptates, Journal of Radioanalytical Chemistry, 32, (1976), 345-356.
14. T. Katsukik. B. Sharpless, The First Practical Method for Asymmetric Epoxidation, Journal of the American Chemical Society, 102, (1980), 5974-5976.
15. M. Jozwiak, Studies of Contact and Solvent-Separated Ion Pairs of Carbanions. Effect of Temperature Counterion and Solvent, The Journal of Chemical Thermodynamics, 88, (1966), 307-318.
16. E. D. Glendening, D. FellerMark, A. Thompson, An Ab Initio Investigation of the

eISSN 1303-5150

Structure and Alkali Metal Cation Selectivity of 18-Crown-6, International Journal of Mass Spectrometry, 116, (1994), 10657-10669.

17. A. E. ShilovGeorgiy, B. Shul'pin, Activation of C−H Bonds by Metal Complexes, Journal of the American Chemical Society, 96, (1997), 2879-2932.
18. J. L. Wankowski, M. J. Kaula, M. L. Dietz, Micelle Formation as a Factor Fnfluencing the Mode(s) of Metal Ion Partitioning Into N-Alkylpyridinium-Based Ionic Liquids, Green Chemistry, 23, (2017), 5674-5682.
19. S. Abdurrahmanoglu, C. Gunduz, U. Cakri, B. Cicek, M. Bulut, The Synthesis and Complexation Study of Some Coumestan and Coumestan Analog Derivatives of Crown Ethers Using Conductometry, Dyes and Pigments, 65, (2005), 197-204.
20. Chemical and Engineering News, 86, (2008), 27.
21. D. V. Soldatov, I. S. Terekhova, Supramolecular Chemistry and Crystal Engineering, Journal of Structural Chemistry, 12, (2005), 79-85.
22. C. G. Pierpont, R. M. Buchanan, Transition Metal Complexes of O-Benzoquinone, O-Semiquinone, and Eatecholate Ligands, Coordination Chemistry Reviews, 38 (1981) 45-87.
23. C. N. R. Rao, Ultra- Violet and Visible Spectroscopy, London, Butter Worth, (1975), 33.