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ANTIOXIDATIVE EFFECT OF SCHIFF BASE & THEIR METAL ION CHELATES ON COPPER METAL IN VARIOUS MINERAL ACID MEDIUM

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ABSTRACT

Corrosion inhibition of Schiff base (AMPNSA) and their metal chelates [Ti (IV), Zr (IV), Cd (II), and Hg (II)] were evaluated using Weight Loss Method in 0.1M, 0.01M and 0.001M (HCl, HNO_3 and H_2SO_4) in various Mineral acid medium solutions for copper metal wire. It was found that Schiff base and their metal complexes promising inhibitory action against corrosion of copper metal. Thus inhibition efficiency was obtained of various Schiff base and their metal chelates. Ligand and its complexes showed high surface activity. Increasing the surface activity of the inhibitor solutions is accompanied by increase in corrosion inhibition efficiency. The purpose of this study is to understand the inhibitor behaviour of specific Ligand and their metal complexes against copper metal corrosion and their adsorption mechanism on the metal surface.

KEYWORDS: Corrosion, Inhibition, Copper metal, Weight loss, Schiff base (AMPNSA) and their metal chelates of [Ti (IV), Zr (IV), Cd (II), and Hg (II)].

INTRODUCTION

Corrosion is a phenomenon resulting from the physicochemical interactions between a metal and its environment, driving to a deterioration of the metals function, the surrounding environment and the technical system of which they make part: the resistance to corrosion is not an intrinsic property of a material; it essentially depends on the surrounding environment. Corrosion control depends on a discriminating choice of the materials and a rigorous control of the chemical composition of the environment.

Due to their importance in industry and wide range of applications, copper and its alloys has been the subject of numerous investigations since the 1920s. These studies aimed at preventing or reducing the corrosion process in aggressive media.[1–7] Copper and its alloys are of great use in modern society because of its high resistance to corrosion, and are often used in refrigeration systems.[8-11] In addition, the copper alloy is widely used in shipbuilding, as well as the development of the petrochemical heat exchangers.[12-16] The use of organic inhibitors is one of the most practical methods for protection against corrosion of metals and their alloys. Generally, numerous organic compounds containing hetero atoms such as nitrogen[17-18], oxygen[19-20], phosphorus[21] and sulphur[22-24] are used as corrosion inhibitors. Schiff bases that contain an imino group (–RC=N–) are formed by the condensation of a primary amine with an active carbonyl group. A number of Schiff bases containing the imino functionality have been shown to have a wide range of biological activities, including antibacterial, antifungal, antidiabetic, antitumor, ant proliferative, anticancer, anticorrosive and anti-inflammatory activities.[25–28] Schiff bases and their metal complexes have been shown to be promising leads for both synthetic and structural research due to their relatively simple synthesis and structural diversity.[29] It has also been reported that metal complexes were more biologically active as compared to non-coordinated Schiff bases.[30-32] There metal complexes are attracting particular attentions because of their capability to offer a large variety of novel and diverse structures, attractive chemical and physical properties and wide range of biological importance and industrial applications.[33-35] One of the industrial applications of such metal complexes is as potential corrosion inhibitors in minimizing metallic waste in engineering materials.[36-38]

The synthesis and characterization Schiff base and metal complexes where published in the research paper. A literature review shows that no data available in different acid medium regarding and Schiff base and various metal complexes for the protection of copper wire against copper in the presence of study, the inhibiting properties of Schiff base their metal complexes where reported by weight loss measurement technique in various acid medium. The present study aims to investigate in inhibition efficiency of Schiff base of 2-[(2-Hydroxy-5-nitrobenzylidene]-amino-4-methyl- phenol (AMPNSA) their metal complexes for the corrosion of copper wire.

EXPERIMENTAL

The inhibition efficiency of Schiff base and their metal complexes simple experiments carried out copper wire. This copper wire washed with distilled water, followed by polished with various grades of regmal papers and cut 5cm pieces and weight of specimen were noted.

In this experiment, beakers were labeled from 1-54 and in beakers having labeled 1-6 20ml 0.1N HCl,7-12 20ml 0.01N HCl,13-18 20ml 0.001N HCl, In beaker no 19-24 20ml 0.1N HNO_3,25-30 20ml 0.01N HNO3 and in beaker no 31-36 20ml 0.001NHNO3.In beaker no 37-42 20ml 0.1N H_2SO_4, 43-48 20ml 0.01N H_2SO_4 ,49.54 20ml 0.001N H_2SO_4 were added.

After the preparation of mixture solution, in different concentration solution wire are immersed in test solution containing various concentration of inhibitor at room temperature. After 48 hours the wire pieces taken out from the beakers. They are washed with water and dried at room temperature and finally its weight was determined on analytical balance as final weight.

The loss in mass was determined using the relation.

$$I.E = \frac{Wu - Wi}{Wu} \times 100$$

Where,

I.E. = Inhibition efficiency.

W_i = Weight loss of metal in inhibitor solution

W_u = weight loss of metal in control solution

RESULT AND DISCUSSION

Table no. 1: Effect of Schiff base (AMPNSA) and their complexes [Ti (IV), Zr (IV), Cd (II), Hg (II)] on corrosion in 0.1N HCl.

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.238	0.225	0.013	5.46	-
AMPNSA	0.239	0.229	0.010	4.18	23.07
Ti(IV)AMPNSA	0.240	0.229	0.011	04.58	15.38
Zr(IV)AMPNSA	0.235	0.225	0.010	04.25	23.08
Cd(II)AMPNSA	0.238	0.229	0.009	3.78	30.76
Hg(II)AMPNSA	0.240	0.233	0.007	2.91	46.15

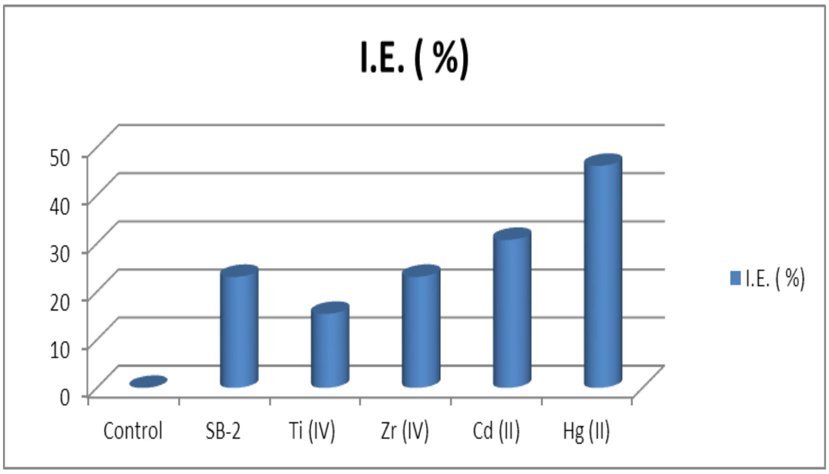

Fig. 1. Variation of weight loss of Copper wire in 0.1N HCl solution containing Schiff base and their metal complexes (Graph no.1).

Table no. 2: Effect of Schiff base (AMPNSA) and their complexes [Ti (IV), Zr (IV), Cd (II), Hg (II)] on corrosion in 0.01N HCl.

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.236	0.232	0.004	1.69	-
AMPNSA	0.237	0.236	0.001	0.42	75
Ti(IV)AMPNSA	0.236	0.235	0.01	0.42	75
Zr(IV)AMPNSA	0.241	0.238	0.003	1.24	25
Cd(II)AMPNSA	0.239	0.236	0.003	1.25	25
Hg(II)AMPNSA	0.241	0.239	0.002	0.82	50

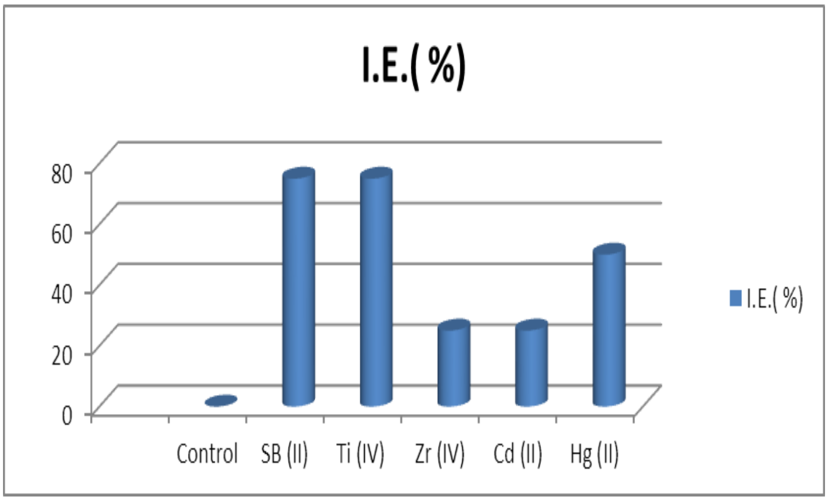

Fig. 2. Variation of Copper wire in 0.01N HCl solution containing Schiff base and their metal complexes (Graph No. 2).

Table no. 3: Effect of Schiff base (AMPNSA) and their complexes [Ti (IV), Zr (IV), Cd (II), Hg (II)] on corrosion in 0.001N HCl.

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.239	0.234	0.005	2.09	-
AMPNSA	0.237	0.235	0.002	0.84	60
Ti(IV)AMPNSA	0.239	0.238	0.001	0.41	80
Zr(IV)AMPNSA	0.240	0.237	0.003	1.25	40
Cd(II)AMPNSA	0.237	0.236	0.001	0.42	80
Hg(II)AMPNSA	0.236	0.234	0.02	0.84	60

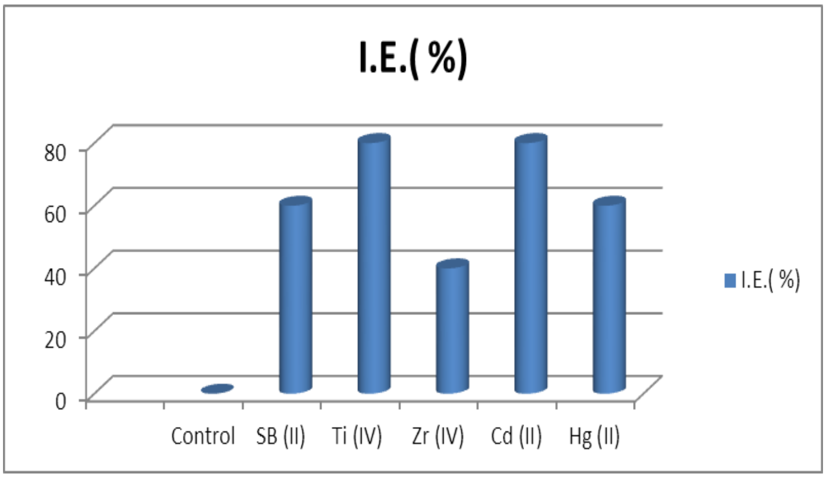

Fig. 3: Variation of weight loss of copper wire in 0.001N HCl solution containing Schiff base and their metal complexes (Graph No. 3).

Table no. 4: Effect of 2-[(2-Hydroxy-5-nitrobenzylidene]-amino-4-methyl- phenol (AMPNSA) and their metal complexes in 0.1 N HNO_3.

Sample	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.234	0.230	0.004	1.70	-
AMPNSA	0.235	0.234	0.001	0.42	75
Ti(IV)AMPNSA	0.236	0.233	0.003	1.27	25
Zr(IV)AMPNSA	0.233	0.230	0.003	1.28	25
Cd(II)AMPNSA	0.231	0.229	0.002	0.85	50
Hg(II)AMPNSA	0.234	0.233	0.001	0.42	75

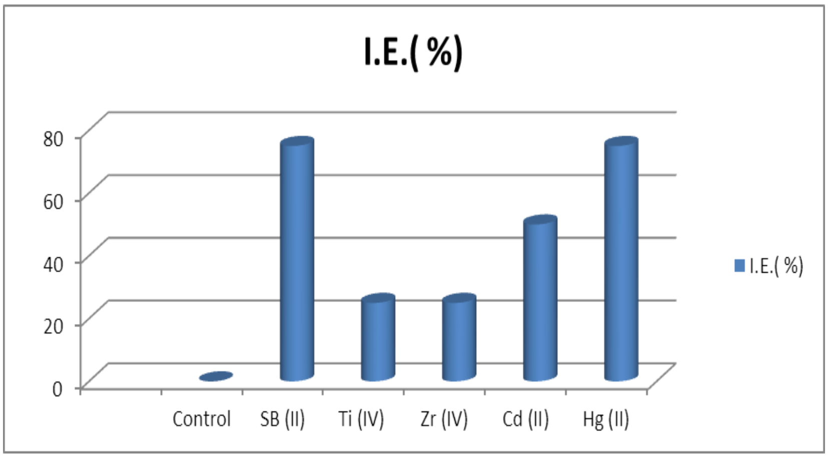

Fig. 4: Variation of Weight of loss of copper wire in 0.1N HNO_3 solution containing Schiff base and their Ti (IV), Zr (IV), Cd (II), Hg (II) Metal complexes(Graph No.4).

Table no. 5: Effect of 2-[(2-Hydroxy-5-nitrobenzylidene]-amino-4-methyl- phenol (AMPNSA) and their metal complexes in 0.01 N HNO_3.

Sample	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.232	0.227	0.005	2.15	-
AMPNSA	0.234	0.233	0.001	0.42	80
Ti(IV)AMPNSA	0.230	0.226	0.004	1.73	20
Zr(IV)AMPNSA	0.233	0.229	0.004	1.71	20
Cd(II)AMPNSA	0.231	0.230	0.001	0.43	80
Hg(II)AMPNSA	0.234	0.231	0.003	1.28	40

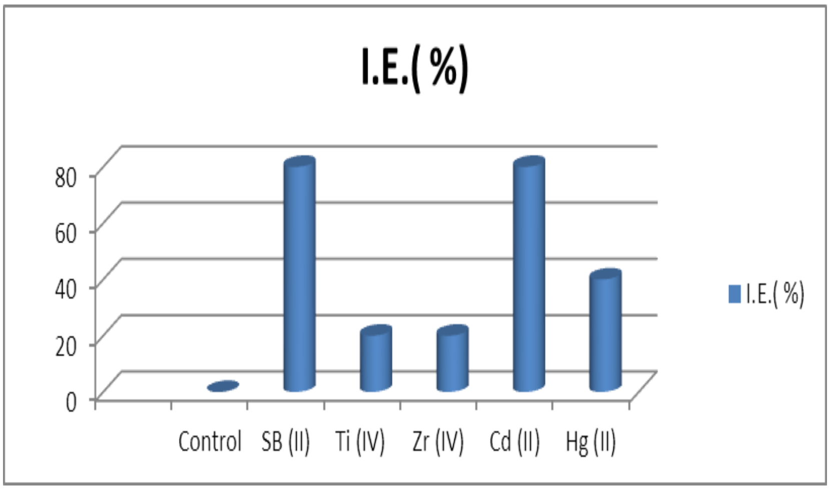

Fig. 5: Variation of Weight of loss of copper wire in 0.01N HNO_3 solution containing Schiff base and their Ti (IV), Zr (IV), Cd (II), Hg (II) Metal complexes(Graph No. 5).

Table no. 6: Effect of 2-[(2-Hydroxy-5-nitrobenzylidene]-amino-4-methyl- phenol (AMPNSA) and their metal complexes in 0.001 N HNO_3.

Sample	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.233	0.226	0.007	3.02	-
AMPNSA	0.237	0.235	0.002	0.84	71.42
Ti(IV)AMPNSA	0.234	0.233	0.001	0.42	85.71
Zr(IV)AMPNSA	0.234	0.233	0.001	0.42	85.71
Cd(II)AMPNSA	0.230	0.227	0.003	1.30	57.14
Hg(II)AMPNSA	0.233	0.232	0.001	0.42	85.71

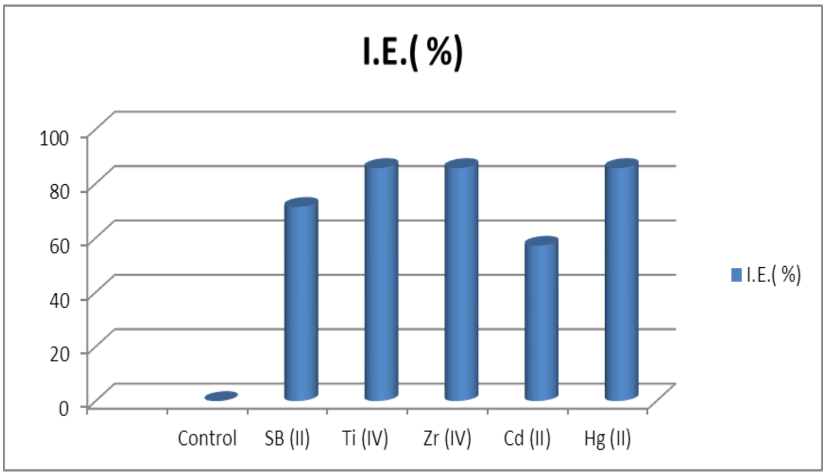

Fig. 6: Variation of Weight of loss of copper wire in 0.01N HNO_3 solution containing Schiff base and their Ti (IV), Zr (IV), Cd (II), Hg (II) Metal complexes.(Graph No. 6)

Table no. 7: Effect of Schiff base (AMPNSA) and their complexes on corrosion in 0.1 N H_2SO_4.

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.235	0.231	0.004	1.70	-
AMPNSA	0.233	0.231	0.002	0.85	50
Ti(IV)AMPNSA	0.226	0.224	0.002	0.88	50
Zr(IV)AMPNSA	0.233	0.230	0.003	1.28	25
Cd(II)AMPNSA	0.231	0.229	0.002	0.86	50
Hg(II)AMPNSA	0.229	0.228	0.001	0.43	75

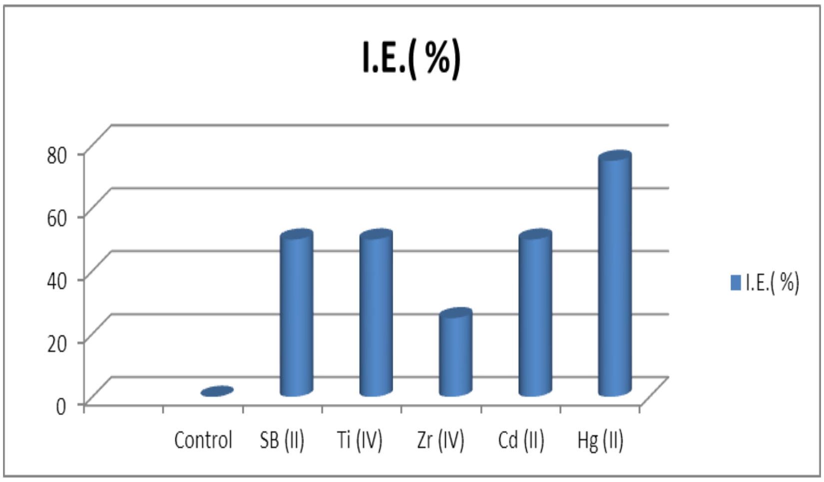

Fig. 7: Variation of weight loss of copper wire in 0.1N H_2SO_4 solution containing Schiff base and their Ti (IV), Zr (IV), Cd (II), Hg (II) Metal complex. (Graph No. 7).

Table no. 8: Effect of Schiff base (AMPNSA) and their complexes on corrosion in 0.01 N H_2SO_4.

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.228	0.224	0.004	1.75	-
AMPNSA	0.229	0.227	0.002	0.87	50
Ti(IV)AMPNSA	0.237	0.234	0.003	1.26	25
Zr(IV)AMPNSA	0.231	0.228	0.003	1.29	25
Cd(II)AMPNSA	0.235	0.233	0.002	0.85	50
Hg(II)AMPNSA	0.228	0.226	0.002	0.87	50

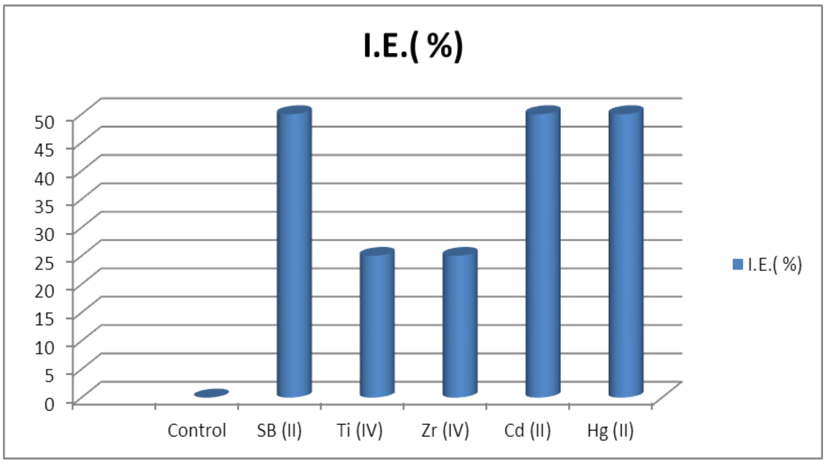

Fig. 8: Variation of weight loss of copper wire in 0.01N H_2SO_4 solution containing Schiff base and their Ti (IV), Zr (IV), Cd (II), Hg (II) Metal complexes. (Graph No. 8)

Table no. 9: Effect of Schiff base (AMPNSA) and their complexes on corrosion in 0.001 N H_2SO_4.

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.229	0.225	0.004	1.74	-
AMPNSA	0.232	0.231	0.001	0.43	75
Ti(IV)AMPNSA	0.227	0.224	0.003	1.32	25
Zr(IV)AMPNSA	0.227	0.225	0.002	0.88	50
Cd(II)AMPNSA	0.228	0.227	0.001	0.43	75
Hg(II)AMPNSA	0.230	0.228	0.002	0.86	50

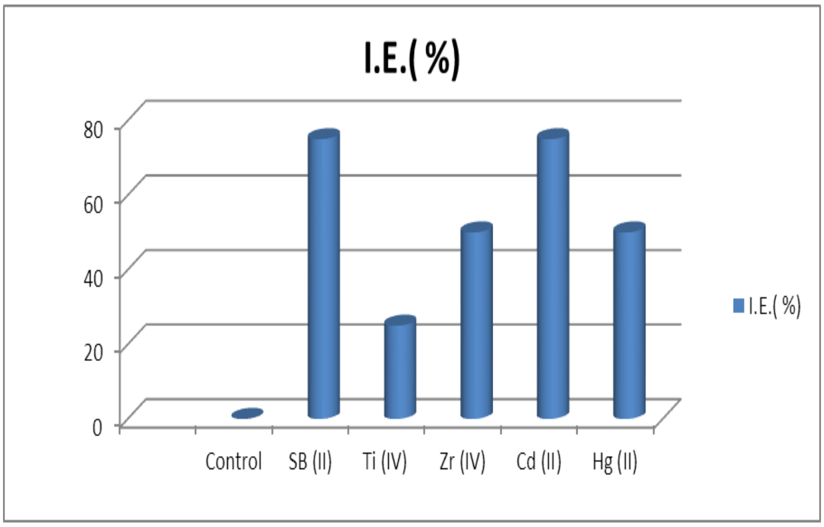

Fig. 9: Variation of weight loss of copper wire in 0.001N H_2SO_4 solution containing Schiff base and their Ti (IV), Zr (IV), Cd (II), Hg (II) Metal complex. (Graph No. 9).

In presence study the in inhibiting properties of Schiff base 2 -[(2-Hydroxy-5-nitrobenzylidene]-amino-4-methyl- phenol (AMPNSA) and their Ti (IV)(AMPNSA) Zr (IV) (AMPNSA) Cd(II) (AMPNSA) and Hg (II) (AMPNSA) metal complexes where investigated on copper wire by weight loss technique at room temperature in inhibition efficiency of Schiff base (AMPNSA) and their metal complexes shown by data and graphical representation also be conclude that the inhibition efficiency depends on oxidizing medium in experimental process. We have to used three types of acidic medium namely 0.1 N , 0.01N, 0.001N HCl, HNO_3 ,H_2SO_4 after the analysis of Schiff base Ligand (AMPNSA) and their metal complexes shows the inhibition efficiency. From the observation table we conclude that the inhibition efficiency shown by Ligand in 0.1 N HCl , 23.07 % , 75 %, in0.01N HCl and 60 % in 0.001N HCl, the maximum in inhibition efficiency exhibit Ti (IV) (AMPNSA) and Cd (II) (AMPNSA) complexes is 80 % and also Hg (II) (AMPNSA) metal complex shows 60 % inhibition efficiency In 0.01 N HCl Ti(IV) (AMPNSA) complexes same inhibition efficiency with Schiff base in 0.1 N HCl the inhibition efficiency is less shown by four metal complexes by graphical representation in H_2SO_4 acid medium . The Schiff base (AMPNSA) shows inhibition efficiency 75 % in 0.1N HNO_3, 80% In 0.01 N HNO_3 and 71.42 % in 0.001 N HNO_3 Ti (IV) Zr (IV) Cd (II) shows less inhibition efficiency in 0.1N HNO_3 from all above study of corrosion in inhibition of Schiff base and metal complexes Ti (IV) (AMPNSA) Zr (IV) Hg (II) (AMPNSA) shows the maximum inhibition efficiency is 85.71%.

The inhibition efficiency of Hg (II) complexes in 0.1 N HNO_3 and Cd (II) complex in 0.01 N HNO_3 shows no of inhibition efficiency in H_2SO_4 acid medium the Schiff base (AMPNSA) of 2-[(2-Hydroxy-5-nitrobenzylidene]-amino-4-methyl-phenol (AMPNSA) shows 50 % in 0.1 and 0.01N H_2SO_4 shows inhibition efficiency 50 % and maximum inhibition efficiency in 0.001 N H_2SO_4 75 % the Hg (II) (AMPNSA) complex shows maximum in efficiency shows good in efficiency 75 % in 0.1 N H_2SO_4 the inhibition of other metal complex is less in dilution of all acid medium.

The inhibition efficiency of HNO_3 solution is higher than HCl than H_2SO_4, the inhibition should follow the sequence that is HNO_3 > HCl > H_2SO_4 the inhibition efficiency increases with the increase concentration of acid medium. The corrosion process is inhibited by the adsorption this molecule on copper wire the Schiff base and metal complex active group and ions which responsible to inhibits corrosion of copper wire in various acid medium.

CONCLUSION

From the experimental and graphical results regarding inhibition efficiency of Schiff base and their metal complexes in various acid medium under study of observe that Schiff base have good inhibition efficiency they inhibit oxidation of copper metal in various acid medium, the inhibition of copper metal corrosion may be due to the adsorption of added Schiff base and their metal complexes. The inhibition efficiency of various acid medium is in the sequence HNO_3 >HCl >H_2SO_4.

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