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Corrosive Behavior of Metal Alloy in Acidic Medium Presence of Inhibitor

[a]Ganesh D. Thorat* ,[b]Deepak. M. Nagrik,[c]Shrikant. S. Patil,
[a]Department of Applied Science and Humanities MGI-COET, Shegaon, Buldhana -444602, India
[b]Department of Chemistry, G.S.Scinece, Arts and Commerece College Khamgaon-443001,Distt. Buldana
[c]Department of Chemistry,B.B. Arts,N.B. Commerce and B.P. Science College,
Digras-445203,Distt.Yavatmal
*(Corresponding author email: *thoratganesh9@gmail.com*) (Mob No. 9763516119)

Abstract: Amoxicillin is a corrosive inhibitor of metal alloys in acid medium was studied by Non electrochemical techniques (weight loss method) and electrochemical techniquesby polarization techniques, and electrochemical impedance spectroscopy, corrosive product of metal alloys analyzed by XRD, field emission microscopy and energy dispersive spectroscopy results obtained revealed that the amoxicillin is good corrosive inhibitor in acidic medium.Polarization studies showed that the amoxicillin compound is mixed type of corrosive inhibitor, the electrochemical impedance studies showed that the decrease the corrosion rate of metal alloys,these amoxicillin were adsorbed on metal alloys surface follow Langmuir adsorption isotherm.The effect of oxygenation on the corrosion behavior of metal alloys in acidic medium in presence of definite concentration of the amoxicillin.

***Keyword**: Metal corrosion; Potentiodynamic polarization; electrochemical impedance.*

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I. INTRODUCTION

Copper is metal that has an extensive variety of utilizations because of its great properties. It is utilized as a part of hardware, for generation of wires, sheets, tubes, furthermore to shape combinations. Copper is safe toward the impact of environment and numerous chemicals, then again[1-4], it is realized that in forceful media it is corrosion resistance. Copper was the first metal to extracted form alloys of metal and used by human, copper is importance role in improving the society of civilization[5-8], copper was the first metal used in manufacturing of coin and ornaments, copper is easily stretched, molded and shaped and good corrosion resistant towards corrosion in corrosive environments, that used in conduct heat and electricity, copper are widely used in today domestics, industrialization and high application technology[9-13].

The copper are widely used in construction of building, power generation and transmission, industries machinery and transmission vehicles, electronic product manufacturing, copper wiring and pluming, heating and cooling system, telecommunication link in home and business, copper is essential component in car, truck , motors, radiator. Copper have a excellent properties of alloying manufacturing the Zink mixed with copper to form brass alloys, tin mixed with copper to form bronze and nickel–copper alloys, these alloys are desirable properties and special characteristics and used in specified application[14-18]. Copper-nickel alloys used in manufacturing hulls of ship because of copper- nickel alloys are corrosive resistant towards the sea water and protect the hulls of ship form corrosion[19-22], the brass is more malleable as comparative to pure zinc and copper and as a used in consequently musical instrument, including the trumpets, trombones, bells, and cymbals[23-27]. The copper used in domestics, industrialization and high technology application resulted the increased the use of copper is known as a global consumption of copper[28-32], the copper used in India, China and Untied State 2.4 million of tons, and hence the world production and consumption of copper have been rapidly increases in last 25 years[33-35].

Materials: Material having compositions of 0·05% lead, 0·10% iron, 4.2% tin, 0.30% zinc, 0.03% phosphorus, and the remaining Cu were used for the electrochemical polarizations and impedance measurements. The samples of 1×1 cm area were ground with different emery papers of grades 120, 320, 400, 800, 1000 and 2000; they were degreased with AR grade ethanol, acetone and dried at room temperature, and then stored in desiccators before use.

Solutions: All the chemicals used in the present investigation, for the preparation of solutions were of analytical grade. Glass doubly distilled water was for the preparation of all the solutions**.**

II. EXPERIMENTAL METHOD

2.1 Weight loss method

The weight loss method is Non-electrochemically, the rate of corrosion is determined by the conventional weight loss technique Using this technique, the loss of a metal due to corrosion is measured by exposing the metal specimen of known area to the corrosive environment for a

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particular period and finding the difference in weight before and after exposure The expression 'mils per year' (mpy) is the most widely used way of expressing the corrosion rate, Corrosion rate is calculated using the formula,

$$\text{Corrosion Rate (mpy)} = \frac{534\ W}{DAT}$$

Where,

W = weight loss in mg.

D = density of the specimen in g/cm.

A = Area of the specimen in sq.

T = exposure time in hours.

The weight loss measurements were carried out by weighing the prepared material before and after immersion for 24,48,72,96, 120 hours in 50 ml various concentration of inorganic acidic solutions (HCI, H_2SO_4, HNO_3) in the presence and absence of various concentrations of Amoxicillin, the percentage inhibition efficiency (IE %) was calculated at different concentrations at 30◦.

III. ELECTROCHEMICAL METHOD

Electrochemical measurements were made by Zive SP5 potentiostat/Galvanostat. In the electrochemical measurements, platinum was used as the counter electrode, saturated calomel electrode (SCE), as the reference electrode, and copper as the working electrode. The surfaces of the working electrode were covered with polyester, except for the parts connected to the solutions. Before measuring, the surface of the working electrode was polished to a mirror finish with a polishing device using, 800 and 1200 mesh sandpaper. Polarization curves were obtained between −1.00 and +1.00 Vat a 1 mV/s scan rate. During the measurement, the solutions were mixed with a magnetic mixer. All the above experiments were carried out using freshly polished specimens in aerated solutions.

IV. RESULT AND DISCUSSION

4.1Weight loss method

Acid	Weight loss of copper in gm. (48 Hours in 2 N Solution)		
	O_2fullySaturated (Inhibitor)	O_2Saturated (Inhibitor)	O_2Absent (Inhibitor)
HCI	0.52	0.51	0.50
H_2SO_4	0.56	0.54	0.54
HNO_3	0.29	0.28	0.28

From above table observation weight loss of copper in inorganic acidic medium are decreases in presence of organic inhibitor (Amoxicillin). Weight loss of copper are maximum in fully saturated oxygenation as comparative to saturated oxygenation and absence of oxygenation in absence of organic inhibitor Amoxicillin.

4.2 Electrochemical Method

4.2.1 Potentiodynamic polarization method

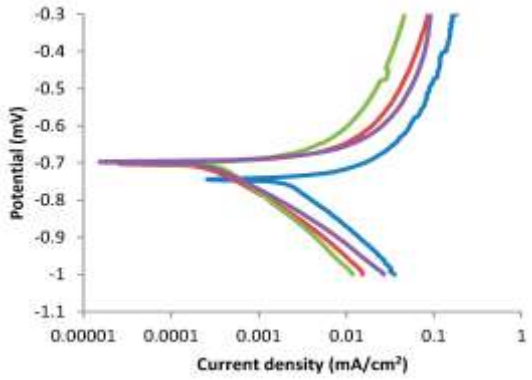

Fig.1 Polarization curve of copper in HCI

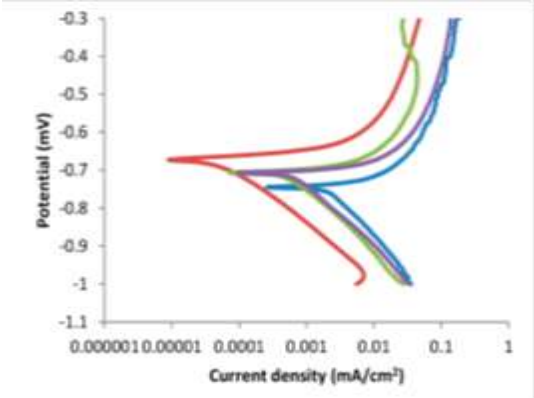

Fig. 2 Polarization curve copper in H_2SO_4

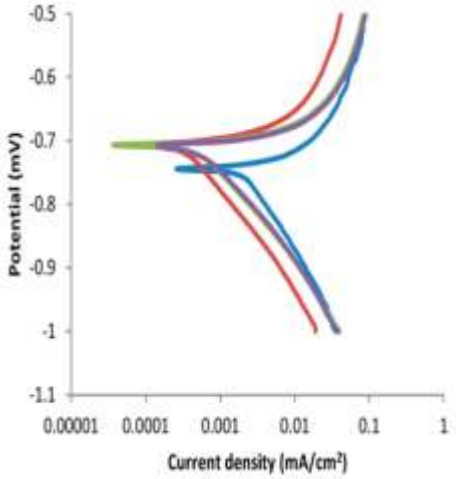

Fig. 3 polarization curve of copper in HNO_3

Table1.Polarization parameter of copper in HCI

HCI Acid	Corrosion Current I_{corr}(μ A cm^{-2})	Corrosion Potential E_{corr}(V_{SCE})	Inhibition Efficiency IE (%)
Blank	630	-0.48	0

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0.10 gm	**17.2**	**-0.50**	**97.2**
0.20 gm	**16.1**	**-0.51**	**97.4**
0.30 gm	**15.5**	**-0.54**	**97.5**

Table 2.Polarization parameter of copper in H_2SO_4

H_2SO_4 Acid	Corrosion Current I_{corr}(μ A cm^{-2})	Corrosion Potential E_{corr}(V_{SCE})	Inhibition Efficiency IE (%)
Blank	**644**	**-0.54**	**0**
0.10 gm	**19.8**	**-0.56**	**96.9**
0.20 gm	**18.7**	**-0.57**	**97.0**
0.30 gm	**17.4**	**-0.59**	**97.2**

From the above Fig. 1, 2, 3 and table observation in Potentiodynamic polarization study of copper corrosion in inorganic acidic solution, potential increases progressively by increasing the concentration of inhibitor Amoxicillin in inorganic acidic solution, and corrosion current decreases progressively by increasing the concentration of inhibitor Amoxicillin in inorganic acidic solution. By using the inhibitor Amoxicillin control the corrosion of metal and metal alloys in inorganic acidic medium

Table 3. Polarization parameter of copper in HNO_3

HNO_3 Acid	Corrosion Current I_{corr}(μ A cm^{-2})	Corrosion Potential E_{corr}(V_{SCE})	Inhibition Efficiency IE (%)
Blank	**620**	**-0.43**	**0**
0.10 gm	**16.5**	**-0.45**	**97.3**
0.20 gm	**15.7**	**-0.47**	**97.4**
0.30 gm	**14.6**	**-0.49**	**97.6**

4.2.2 Electrochemical Impedance Spectroscopy

Electrochemical impedance spectroscopy measurements of copper in inorganic acidic medium were carried out using A Volta lab Zive SP5 Fitting with analysis program. Impedance spectra were obtained in the frequency range between 100 k Hz and 50 m Hz using 10 steps per frequency decade at corrosion potential after 30 min. of immersion in inorganic acidic solution without and with different concentrations of the studied inhibitor (Amoxicillin) in inorganic acidic solution acts as corrosive environment. AC signal with 10 mV amplitude peak to peak was used to perturb the system. The following EIS diagrams 4, 5, 6 and table of EIS parameter are given in the Nyquist representation of copper in inorganic acidic solution acts as a corrosive environment. As seen from Table, the Rct values of inhibited substrates are increased with the concentration of inhibitors Amoxicillin in inorganic acidic solution. On the other hand, the values of Cdl are decreased with increase in inhibitor Amoxicillin concentration in inorganic acidic solution, which is most probably, is due to the decrease in local dielectric constant and or increase in thickness of the electrical double layer. The value of inhibition efficiency calculated.

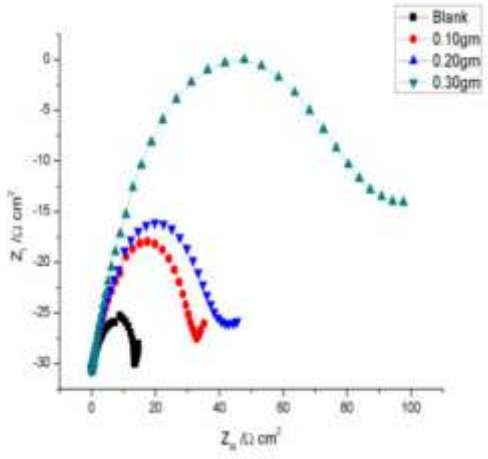

Fig. 4 EIS of copper in HCI

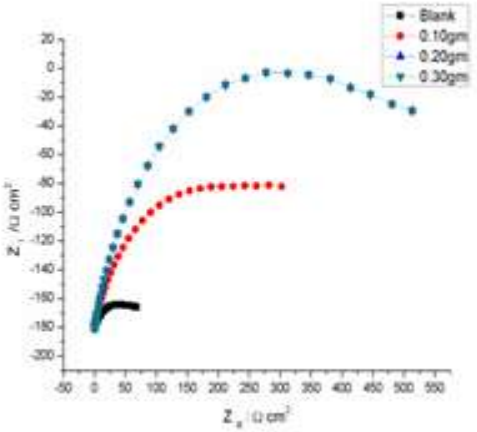

Fig.5 EIS of copper in H_2SO_4

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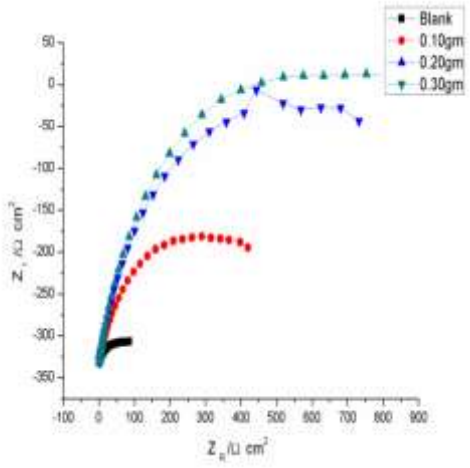

Fig.6 EIS of copper in HNO_3

Table.4 EIS parameter of copper in HCI

HCI Acid	R_{Ct} (Ωcm^{-2})	C_{dl} ($\mu\Omega^{-1} cm^{-2}$)	Inhibition Efficiency IE (%)
Blank	171.2	2316	0
0.10 gm	309.1	1710	44.6
0.20 gm	410.3	1620	58.2
0.30 gm	427.5	1521	59.9

Table. 5 EIS parameter of copper in H_2SO_4

H_2SO_4 Acid	R_{Ct} (Ωcm^{-2})	C_{dl} ($\mu\Omega^{-1} cm^{-2}$)	Inhibition Efficiency IE (%)
Blank	192.6	2410	0
0.10 gm	354.4	1822	45.6
0.20 gm	423.6	1708	54.5
0.30 gm	478.5	1621	59.7

Table. 6 EIS parameter of copper in HNO_3

HNO_3 Acid	R_{Ct} (Ωcm^{-2})	C_{dl} ($\mu\Omega^{-1} cm^{-2}$)	Inhibition Efficiency IE (%)
Blank	152.4	2218	0
0.10 gm	298.4	1645	48.9
0.20 gm	356.4	1534	57.2
0.30 gm	387.9	1522	60.7

V. CONCLUSIONS

The results obtain form weight loss measurement, Potentiodynamic polarization method and electrochemical impedance spectroscopy explained that the inhibition efficiency of amoxicillin increased with the increasing the concentration in acidic medium (HCI, H_2SO_4, HNO_3), which indicated that amoxicillin maintained stable passivity even in the presence of the acidic medium (HCI, H_2SO_4, HNO_3). Amoxicillin act as good inhibitor in presence of acidic medium.

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