International Journal of Scientific Research in Chemical Sciences **Research Paper**
Vol.6, Issue.4, pp.1-3, October (2019) **E-ISSN:** 2455-3174

Expired Ixabepilone as a Corrosion Inhibitor on Copper Metal Protection in 5 M HCl Medium

Raghavendra N.[1*], Leena V. Hublikar[2], Pooja J. Ganiger[3]

[1,2,3]Dept. of Chemistry, K.L.E. Society's P. C. Jabin Science College (Autonomous) Vidyanagar, Hubballi-580031, India

**Corresponding author: rcbhat3@gmail.com*

Available online at: www.isroset.org

Received: 10/Sept/2019, Accepted: 06/Oct/2019, Online: 31/Oct/2019

***Abstract*-**Expired Ixabepilone drug was tested as a nontoxic corrosion inhibitor on the copper in the 5 M HCl environment with the help of weight loss, electrochemical and scanning electron microscopy (SEM) studies. Weight loss studies show that, expired Ixabepilone drug protects the copper corrosion with an inhibition efficiency of 96 % at 0.4 mg/L during two hour immersion period. Similarly, Tafel plot and AC impedance spectroscopy confirm the corrosion inhibition property of expired Ixabepilone drug over the copper electrode surface in 5 M HCl solution. The rough and smooth copper surface observed in the absence and presence of expired Ixabepilone drug respectively as monitored by SEM technique.

***Keywords*-** Expired Ixabepilone drug; Copper; 5 M HCl; Weight loss; Tafel plot

I. INTRODUCTION

Aggressive hydrochloric acid solutions directly contact with copper during several industrial exercises like oil well acidizing, acid descaling, cleaning and metal scale removal. Use of corrosion inhibitor is one of the best methods for copper corrosion control [1-5]. The corrosion inhibitors classified into organic, inorganic and polymeric materials. The performance of all these inhibitors is based on their adsorption over the metal surface [6-8]. An adsorption process occurs through physical (electrostatic forces between inhibitor molecules and copper metal surface) and chemical (sharing of electrons with the copper surface) adsorption mode. Nowadays corrosion researchers are not comfortable with many synthetic organic, inorganic and polymeric corrosion inhibitors due to their high prices and toxic property [9-11]. The last few years witnessed the use of expired medicinal compounds as nontoxic corrosion inhibitors. Hence, in this study selected expired Ixabepilone and studied corrosion inhibition property over the copper surface with the aid of weight loss, Tafel plot and AC impedance spectroscopy studies. SEM technique used to visualize the surface morphology of copper surface in protected and unprotected systems.

II. EXPERIMENTAL SECTION

Materials and solution

The copper metal having 99 % purity is used in the present investigation. The expired Ixabepilone drug of 0.1 mg/L, 0.2 mg/L, 0.3 mg/L and 0.4 mg/L was prepared for weight loss, Tafel plot and AC impedance spectroscopy studies. The surface studies were carried out by scanning electron microscopy (SEM) technique. Weight loss studies were performed in the 100 ml of 5 M HCl solution without and with 0.1 mg/L, 0.2 mg/L, 0.3 mg/L and 0.4 mg/L of expired Ixabepilone drug over the copper surface in the 5 M HCl solution with an immersion period of 2, 4, 6, 8 and 10 hours. The protection efficiency can be calculated from the equation below:

$$\text{Protection efficiency in percentage} = \frac{(W_1 - W_2)}{W_1} \times 100,$$

Where, W_1= Electrode weight loss in unprotected system and W_2= Electrode weight loss in protected system.

The electrochemical studies carried out with CHI660C instrument. The potential used for electrochemical studies is ± 250 mV with an amplitude of 0.1 v/S.

The corrosion protection efficiency of the expired Naftifine drug was calculated from the below relations:

$$\text{Corrosion protection efficiency} = [\,1 - \frac{i'_{corr}}{i_{corr}}\,] \times 100,$$

$$\text{Corrosion protection efficiency} = \frac{R_{ct(inh)} - R_{ct}}{R_{ct(inh)}} \times 100,$$

Where, i'_{corr} = Protected copper corrosion current density, i_{corr} = Unprotected copper corrosion current density, R_{ct} = Unprotected copper charge transfer resistance, $R_{ct\ (inh)}$ = Protected copper metal charge transfer resistance.

The topography of copper metal in the 5 M HCl solution was visualized by scanning electron microscopy (SEM) technique.

III. RESULTS AND DISCUSSION

Weight loss technique

Expired Ixabepilone drug as a green corrosion inhibitor was examined on the copper metal in the 5 M HCl solution by mass loss (weight loss) technique. The mass loss technique results are shown in the **Table 1**. From the table, it is proved that, expired Ixabepilone drug act as good corrosion inhibitor on the copper surface in the hydrochloric acid environment (5 M HCl solution). The corrosion inhibition property of expired Ixabepilone drug is due to the adsorption property of expired drug over the copper electrode in the 5 M HCl solution. The protection efficiency of the corrosion inhibitor was enhanced with rise its amount. As the amount of expired product rises, it covers the more copper surface area and results in the decrement in the corrosion rate values. The maximum adsorption observed at two hours immersion time. As a result of this, maximum protection efficiency observed at two hours immersion time. It is also observed that, the increase in the contact time decreases the protection efficiency of the corrosion inhibitor, which is due to instability of protective film formed by expired drug at a higher immersion time of copper metal in the 5 M HCl solution. Hence, protection efficiency decreases with an increase in the contact time.

Table 1. Gravimetric results

Concentration (mg/L)	Contact time (hours)	Protection efficiency in percentage
Bare	2	
0.1		82.500
0.2		85.000
0.3		87.500
0.4		90.000
Bare	4	
0.1		72.580
0.2		79.032
0.3		82.258
0.4		85.483
Bare	6	
0.1		63.953
0.2		69.767
0.3		70.930
0.4		73.255
Bare	8	
0.1		54.368
0.2		58.252
0.3		61.165
0.4		66.019
Bare	10	
1.0		54.330
2.0		60.629
3.0		68.503
4.0		76.377

Tafel plots (potentiodynamic polarization)

The electrochemical studies carried out to confirm the corrosion inhibition role of expired Ixabepilone over the copper surface in the 5 M HCl solution. The results of Tafel plot studies shown in the **Figure 1** and **Table 2**. The introduction of expired Ixabepilone of different amounts to the 5 M HCl solution (containing copper electrode) decreases the copper corrosion current density values to the lower region. The decrease in the corrosion current density values with a rise in the inhibitor concentration is due to the accumulation of inhibitor molecules on the copper surface in the 5 M HCl solution. Further, no much variation in the cathodic and anodic Tafel slope values. Hence, expired Ixabepilone classified as a mixed copper corrosion inhibitor.

Table 2. Potentiodynamic polarization results

Concentration (mg/L)	Corrosion potential (mV)	Cathoidc Tafel slope (V/dec)	Anodic Tafel slope (V/dec)	Corrosion current (A)	Protection efficiency
Bare	-245	2.490	1.592	0.01258	
0.1	-120	2.320	1.070	0.0003200	97.456
0.2	-119	2.431	1.073	0.0003168	97.481
0.3	-117	2.568	1.710	0.0003106	97.531
0.4	-117	2.602	1.018	0.0003020	97.599

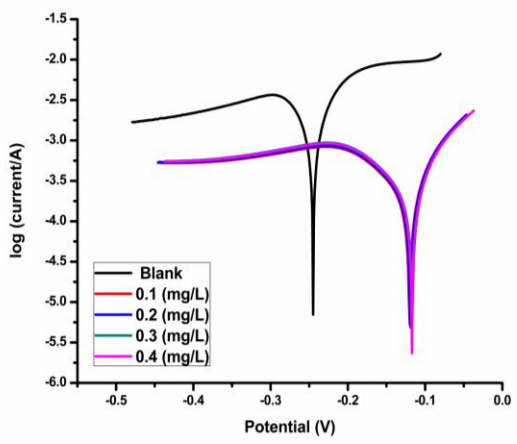

Figure- 1 Tafel plots without and with corrosion inhibitor

AC impedance spectroscopy technique

Figure 2 and **Table 3** are the Nyquist plot results. From these, it is clear that, the area of a depressed semi circle enhances with a rise in the concentration of the expired Ixabepilone molecules over the copper in 5 M HCl solution. The increase in the area of the depressed semicircle with rise in the concentration of the inhibitor fully supports the corrosion inhibition role of expired Ixabepilone over the copper surface in 5 M HCl solution. The corrosion inhibition property of expired Ixabepilone drug is due to charge transfer process. The maximum protection efficiency obtained from AC impedance spectroscopy technique is 86. 246 %.

Table 3. Nyquist plot results

Concentration (mg/L)	Charge transfer resistance (Ω)	Protection efficiency (%)
Bare	49.91	
0.1	252.4	80.225
0.2	256.4	80.534
0.3	280.3	82.194
0.4	362.9	86.246

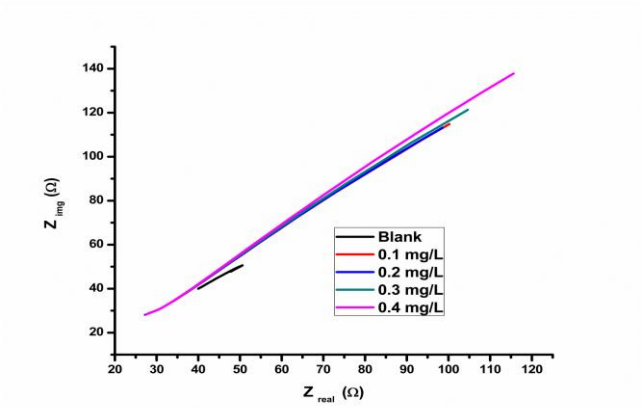

Figure-2 Nyquist plots without and with corrosion inhibitor

Scanning electron microscopy (SEM) technique:
The photography of copper in 5 M HCl solution without and with 0.4 mg/L of corrosion inhibitor (expired Ixabepilone) is shown in the **Figure 3 (a, b)**. It is observed that, the attack of copper in the presence of expired Ixabepilone (0.4 mg/L) in 5 M HCl solution was less compared to with the attack in 5 M HCl solution without corrosion inhibitor. The SEM topography of protective invisible layer over the copper electrode surface confirms the robust corrosion inhibition property of expired Ixabepilone drug.

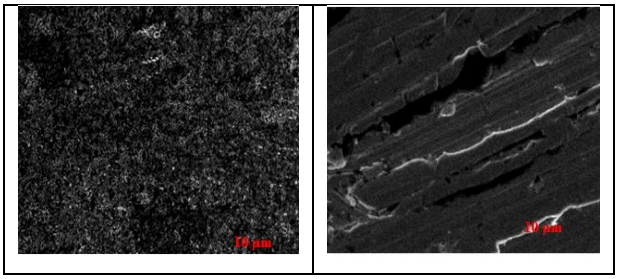

Figure- 3 SEM images without inhbitor (a) and with inhibitor (b)

IV. CONCLUSION

The expired Ixabepilone drug acts as good corrosion inhibitor for copper corrosion in the 5 M HCl solution. The protection efficiency found to be increased with a rise in the concentration of the inhibitor. The increase in the contact time shows the negative impact on the protection efficiency values. Mixed corrosion inhibition property of expired Ixabepilone drug was confirmed from the Tafel plot studies. The Nyquist plot and SEM studies fully support the copper corrosion inhibition property of expired Ixabepilone drug in 5 M HCl solution.

REFERENCES

[1] J.Wu, Zheng, W.Li , L.Yin , S.Zhang " Copper corrosion inhibition by combined effect of inhibitor and passive film in alkaline solution", Research on Chemical Intermediates, Vol 41, p. p. 8557–8570,2015

[2] D.Q. Zhang, L.X. Gao, G.D. Zhou, "Inhibition of copper corrosion in aerated hydrochloric acid solution by amino-acid compounds",Journal of Applied Electrochemistry, issue.35, p.p 1081–1085, 2005

[3] K.K.Anupama, K.M. Shainy, A. Joseph, "Excellent anticorrosion behavior of Ruta Graveolens extract (RGE) for mild steel in hydrochloric acid: electro analytical studies on the effect of time, temperature, and inhibitor concentration", Journal of Bio and Tribo- Corrosion,volume. 2, p.p. 2,2016

[4] N. Raghavendra, "Corrosion studies of carbon steel in 3% NaCl solution in presence of expired Ceftin: Investigation of environmental friendly corrosion inhibitor," Iranian Journal of Energy and Environment, volume.9, p.p. 295-298,2018

[5] B.M. Mistry, N.S. Patel, M.J.Patel, S .Jauhari, " Corrosion inhibition performance of 1,3,5-triazinyl urea derivatives as a corrosion inhibitor for mild steel in 1 N HCl," Research on Chemical Intermediates, volume.37, p. p.659–67,2011

[6] J. Aljourani, K. Raeissi, M.A. Golozar , " Benzimidazole and its derivatives as corrosion inhibitors for mild steel in 1 M HCl solution," Corrosion Science, volume.51, p.p. 1836–1843,2009

[7] E.M. Sherif, S.M. Park, "Effects of 1, 4-naphthoquinone on aluminum corrosion in 0.5M sodium chloride solutions," Electrochimica Acta,volume. 51, p.p. 1313–132,2006

[8] N. Raghavendra, J.Ishwara Bhat, " An environmentally friendly approach towards mitigation of Al corrosion in hydrochloric acid by yellow colour ripe areca nut husk extract: Introducing potential an sustainable inhibitor for material protection," Journal of Bio and Tribo Corrosion, volume.4, p.p.2,2018

[9] M.J. Bahrami, S.M.A. Hosseini, P. Pilvar, "Experimental and theoretical investigation of organic compounds as inhibitors for mild steel corrosion in sulfuric acid medium," Corrosion Science, volume.52, p. 2793–2803,2010

[10] F.S. De Souza, A. Spinelli, "Caffeic acid as a green corrosion inhibitor for mild steel" Corrosion Science, volume.51, p. p.642–649,2009

[11] N.Raghavendra, J.Ishwara Bhat, " Chemical components of mature areca nut husk extract as a potential corrosion inhibitor for mild steel and copper in both acid and alkali media," Chemical engineering communications, volume.205, p.p. 145-160,2018

