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Evaluation of Expired Varenicline As Corrosion Inhibitor For Mild Steel In 5 % HCl Solution

Narasimha Raghavendra[1], Leena V Hublikar[2], Anjali S Bhinge[3] and Pooja J Ganiger[4]
[1]*Department of Chemistry, K.L.E. Society's P. C. Jabin Science College (Autonomous) Vidyanagar, Hubballi-580031, India.*
Corresponding author: rcbhat3@gmail.com

Abstract- Corrosion of mild steel in 5 % HCl system is an example of dissolution process in an acidic environment. The ongoing research is to develop the novel eco-friendly corrosion inhibitor in order to protect the mild steel metal from the corrosion phenomena. Herein, expired Varenicline drug is selected to study its adsorption property on the mild steel in 5 % HCl solution. The adsorption property of expired Varenicline drug was screened through weight loss, colorimetry, and atomic absorption spectroscopy techniques. All results revealed that, expired Varenicline drug form thick film over the surface of mild steel through physical or chemical interactions. These findings give deeper insights into an exploration of interaction of expired Varenicline drug with the surface of mild steel and helpful to development of novel non-toxic corrosion inhibitor to solve the mild steel dissolution problem.

Keywords- Mild steel, Expired Varenicline, 5 % HCl, Weight loss, Colorimetry

1. INTRODUCTION

Many industrial units are made from the mild steel metal because of its unique physical and chemical property. Acidic conditions (generally hydrochloric acid) usually employed in the several industries for oil well acidizing, pickling and cleaning. The corrosion process for mild steel (MS) is prominent in these operations [1-2]. Hence, search for the chemical species that can reduce the disintegration of mild steel in the acidic system is never –ending mission. Large number of organic compounds possessing special heterocyclic units exhibit potential anticorrosion behavior on the surface of many metals in the different corrosive environments. However, these heterocyclic compounds are not used as a corrosion inhibitor for many metals in different corrosive systems because of its adverse effects [4-9]. Hence, research focused on the expired drug products as a corrosion inhibitor due to their less toxic and cost effective property. Many drug materials retain antitumoral, antimicrobial, analgesic, antifungal, and anti-inflammatory activities even though after their expiry date. The N, O, P and S atoms in the expired drug products facilitate the adsorption process on the electron deficient mild steel centers. Therefore, this systematic approach is very useful for the development of robust species and satisfies the environmental regulation requirements. The current research is attempting to explore the corrosion inhibition of mild steel in the 5 % HCl solution by using the expired Varenicline drug product with the aid of weight loss, colorimetry, and atomic absorption spectroscopy (AAS) techniques. No research work has been carried out and this rarity motivated to report the present case.

2. EXPERIMENTAL SECTION

Table 1 shows the chemical composition of mild steel. The structure of Varenicline drug is shown in the **Figure 1**. The mild steel metal pieces polished by sand papers and thoroughly cleaned by using acetone and triple distilled water. The corrosive solution was made by diluting the 5 % analytical grade of HCl with triple distilled water. The expired Varenicline drug of 0.1 g/L, 0.2 g/L, 0.3 g/L and 0.4 g/L was prepared.

Table 1. Chemical composition (in weight percentage) of mild steel

Element	Si	S	P	C	Mn	Fe
Weight in percentage	0.1	0.05	0.04	0.18	0.6	Remainder (99.03 %)

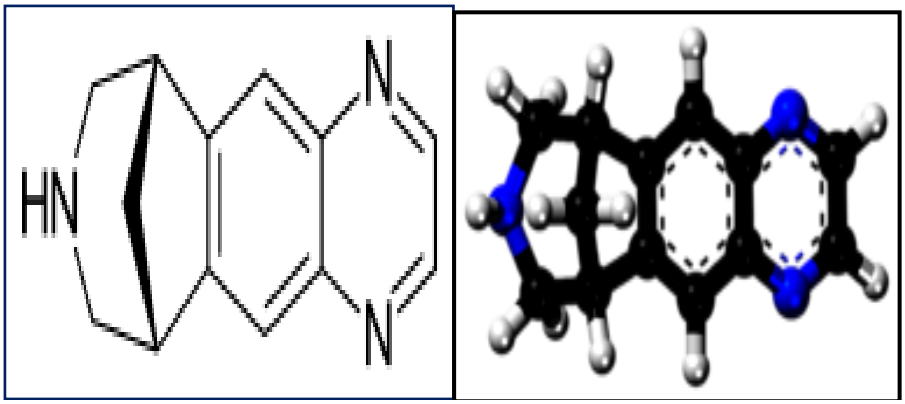

Fig 1 Structure of Varenicline drug

Weight loss, colorimetry and atomic absorption spectroscopy (AAS) technique was carried out on the mild steel surface in the 5 % HCl solution with a contact time of 1, 2, 3, 4, 5 and 10 hours. After each test, the electrodes were withdrawn from the 5 % HCl solution and thoroughly rinsed with triple distilled water and acetone. Finally, the weight of electrode (mild steel) weighted accurately. The entire test was carried out in three times and average values are presented. The protection efficiency can be calculated as reported earlier [10-11].

3. RESULTS AND DISCUSSION

3.1 Weight loss (mass loss) technique

The gravimetric experiment was performed to explore the positive effect of expired Varenicline drug of four different amounts on the corrosion inhibition of mild steel in the 5 % HCl solution. The results obtained from the weight loss technique are summed up in the **Table 1**. The introduction of expired Varenicline drug of 0.1 g/L, 0.2 g/L, 0.3 g/L and 0.4 g/L in the 5 % HCl solution significantly reduces the corrosion rate of mild steel. In contrast, the protection effect was more enhanced at 0.4 g/L of expired Varenicline drug. As the amounts of expired Varenicline drug enhanced, more inhibitive activity gained with the concentration dependent mode. The most likely justification of these results is that at higher amounts, expired Varenicline drug molecules may have a very strong ability to interact with the mild steel surface. The increasing the concentrations of expired Varenicline drug, more and more expired Varenicline drug species moves electrical double layer by replacing the water species.

The protecting effect of expired Varenicline drug was systematically interpreted via adsorption mode on the mild steel surface. The increase in the protection efficiency with a rise in the concentration of the inhibitor adequately explains the process of adsorption of expired Varenicline drug on the mild steel surface in 5 % HCl solution. The decrease in the protection efficiency with a rise in the contact time is due to the desorption of expired Varenicline drug species on the surface of mild steel.

Table 1 Weight loss (mass loss) results

Concentration (g/L)	Contact time (h)	Protection (corrosion inhibition) efficiency
Bare	1	
0.1		62.654
0.2		68.954
0.3		73.904
0.4	2	91.003
Bare		
0.1		55.054
0.2		59.004
0.3	3	72.006
0.4		88.097
Bare		
0.1		54.085
0.2	4	59.987
0.3		71.810
0.4		85.061
Bare		
0.1	5	55.710
0.2		60.350
0.3		69.576
0.4		84.113
Bare	10	
0.1		48.710
0.2		58.350
0.3		65.570
0.4		80.110
Bare		
0.1		45.783
0.2		55.351
0.3		63.575
0.4		78.113

3.2 Colorimetry

Colorimetry technique gives unique information related to the response of surface of mild steel in the 5 % HCl solution and possible influence of corrosion inhibitors on the corrosion resistance. The results obtained from the colorimetry are shown in the **Table 2**. After adding four different amounts of expired Varenicline drug to the 5 % HCl solution, it is observed reduced corrosion rate of mild steel as expected. This positive effect enhanced with a rise in the concentration of the expired Varenicline drug, indicating that, many of active mild steel sites blocked due to the adsorption of expired Varenicline drug species over the mild steel in the 5 % HCl solution. The increased concentration of the expired Varenicline drug greatly decreases the mild steel surface area required for the corrosion process. Further, the rise in the contact time decreases the protection efficiency of the expired Varenicline drug because of dominant desorption process.

Table 2 Colorimetry results

Concentration (g/L)	Contact time (h)	Protection (corrosion inhibition) efficiency
Bare	1	
0.1		60.765
0.2		66.345
0.3		
0.4		72.654
Bare		90.065
0.1		
0.2	2	54.074
0.3		62.006
0.4		70.003
Bare		89.067
0.1		
0.2		50.080
0.3	3	60.980
0.4		68.815
Bare		86.063
0.1		
0.2		49.713
0.3		58.355
0.4	4	60.570
Bare		82.110
0.1		
0.2		45.713
0.3	5	56.351
0.4		59.530
Bare		78.113
0.1		
0.2	10	42.780
0.3		53.343
0.4		57.570
		76.006

3.3 Atomic absorption spectroscopy (AAS) technique

Atomic absorption spectroscopy technique gives important information about the corrosion inhibition property of expired Varenicline drug over the mild steel surface in 5 % HCl solution. The results obtained from the atomic absorption spectroscopy technique are shown in the **Table 3.** The careful observation of **Table 3,** reveals that, the adsorption property of expired Varenicline drug on the mild steel in 5 % HCl solution enhances with concentration of the corrosion inhibitor. Hence, protection efficiency enhances with a rise in the concentration of the expired Varenicline drug. The adsorption process is an effective pathway for the control of disintegration of mild steel process in 5 % HCl solution. The negative effect observed at higher immersion period. The results of weight loss and colorimetry are in good agreement with the atomic absorption spectroscopy results.

Table 3 Atomic absorption spectroscopy results

Concentration (g/L)	Contact time (h)	Protection (corrosion inhibition) efficiency
Bare		
0.1		58.760
0.2		63.340
0.3	1	68.650
0.4		88.063
Bare		56.072
0.1		60.003
0.2	2	66.007
0.3		85.003
0.4		
Bare		53.083
0.1		58.984
0.2	3	63.810
0.3		83.060
0.4		
Bare		
0.1		49.710
0.2	4	56.350
0.3		59.573
0.4		80.111
Bare		
0.1		46.700
0.2	5	54.358
0.3		56.543
0.4		79.163

Bare 0.1 0.2 0.3 0.4	10	43.556 50.340 53.550 75.003

4. CONCLUSION

In summary, this paper investigated the corrosion inhibition property of expired Varenicline drug on mild steel in 5 % HCl solution. An experimental approach has been performed to probe the mild steel corrosion inhibition mechanism. The expired Varenicline drug exhibits good corrosion property on the mild steel surface in the 5 % HCl solution extracted from the weight loss (mass loss), colorimetry and atomic absorption spectroscopy techniques. All studied experiments results show that, the corrosion inhibition property of expired Varenicline drug mainly depends on the concentration of the corrosion inhibitor and contact time.

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