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Use of Expired Conivaptan Product as Non-Toxic Inhibitor for Mild Steel in 5 % HCl System: A Complementary Weight loss, Atomic Absorption Spectroscopy and Scanning Electron Microscopy Investigations

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ABSTRACT

Expired Conivaptan product was used for the corrosion inhibition of mild steel in the 5 % HCl solution. The protection efficiency of the expired Conivaptan product was studied by weight loss, atomic absorption spectroscopy (AAS) and scanning electron microscopy (SEM) techniques. The results show that, expired Conivaptan product act as effective mild steel corrosion inhibitor in 5 % HCl solution by hindering the dissolution process. The maximum protection efficiency (screened through weight loss method) of expired Conivaptan product is 97.987 **%.** The adsorption of expired Conivaptan product species over the surface of mild steel was confirmed from the atomic absorption spectroscopy (AAS) and scanning electron microscopy (SEM) techniques.

KEYWORDS: Expired Conivaptan product, Mild steel, 5 % HCl, Atomic absorption spectroscopy, and Weight loss.

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INTRODUCTION

Mild steel (MS) is the become famous alloy in the several industrial uses such as construction, equipment and metal processing. Hydrochloric acid (acid) treatment is applied for the elimination of surface impurities, oxides and scales during the industrial operations. It is needed to control the mild steel dissolution during the exposure of hydrochloric acid systems [1, 2]. The effective approach way for reducing the dissolution rate of mild steel in the hydrochloric acid environment is the introduction of small quantities of organic species to the hydrochloric acid system. Most of the corrosion inhibitors contain the P, S, N and O atoms. The corrosion inhibition property of organic compound is mainly depends on the interaction type between the organic compound and the mild steel surface [3-5]. In last decade, the corrosion protection efficiency of inorganic, organic and polymeric have been thoroughly studied. These compounds show good corrosion protection property, but they are toxic. Hence, these compounds are greatly prohibited by numerous international agencies. Therefore, scientist attention has been recently enhanced towards utilization of non-toxic corrosion inhibitors [6-10]. Most of the expired drug products are not useful for the people and they are ecologically acceptable. The expired drug products strongly interact with the surface of mild steel and exhibits good corrosion inhibition property. Hence, in current investigation, the effect of expired Conivaptan product on the surface of mild steel in the 5 % HCl solution was screened by weight loss, atomic absorption spectroscopy and scanning electron microscopy techniques.

EXPERIMENTAL SECTION

Mild steel and expired Conivaptan product was obtained from the Mangalore and Shivamogga in the Karnataka. The expired Conivaptan product of 0.05 mg/L, 0.1 mg/L, 0.15 mg/L and 0.2 mg/L was prepared for weight loss, atomic absorption spectroscopy (AAS) and scanning electron microscopy (SEM) techniques. Weight loss (mass loss) of mild steel was accurately weighed and submerged in 5 % HCl solution at 313 K for 10, 20, 30 and 40 hours immersion time without and with 0.05 mg/L, 0.1 mg/L, 0.15 mg/L and 0.2 mg/L of Conivaptan product. After the each test, the mild steel metal pieces were withdrawn from the 100 ml of 5 % HCl solution, washed with triple distilled water and acetone followed by air drying. Afterwards, the weight of mild steel was recorded with the help of analytical digital balance. Mild steel surface studies were carried out without and with 0.2 mg/L of expired Conivaptan product with an immersion period of 10 hours.

RESULTS AND DISCUSSION

Weight loss technique:

The mild steel metal is immersed in the 5 % HCl system without and with 0.05 mg/L, 0.1 mg/L, 0.15 mg/L and 0.2 mg/L of Conivaptan product for 10, 20, 30 and 40 hours exposure period at 313 K. The variation in the protection efficiency of the corrosion inhibitor with different immersion period is shown in the **Table 1**. From the table, it is observed that, the weight loss of mild steel decreases with a rise in the Conivaptan product concentration revealed that, the special elements in the Conivaptan product prevents the attack of corrosive ions on the surface of mild steel. The special elements in the Conivaptan product generates protective layer which is responsible for the corrosion inhibition process. It is observed that, the mild steel weight loss in the presence of different amounts of expired Conivaptan product is lower than the bare system, showing that four different amounts of expired Conivaptan product protects the mild steel metal from disintegration process. Further, the rise in the contact time increases the corrosion rate of mild steel (decreases the protection efficiency) due to the increased desorption process. The desorption process increases the direct contact between the mild steel and hydrochloric acid system. This shows that, the efficiency of Conivaptan product decreases with a rise in the exposure period from 10, 20, 30 and 40 hours immersion time. At 0.0 mg/L of Conivaptan product, low protection efficiency observed due to unstable protective layer on the electrode (mild steel) surface. The high protection efficiency observed with rise in the concentration of the expired Conivaptan product from the 0.0 5 mg/L to 0.2 mg/L.

Table 1. Weight loss results

Concentration (mg/L)	Contact time (h)	Protection (corrosion inhibition) efficiency
Bare	10	
0.05		58.432
0.10		63.113
0.15		77.876
0.20	20	97.987
Bare		
0.05		53.110
0.10		61.003
0.15	30	73.143
0.20		93.054
Bare		
0.05		51.235
0.10	40	59.143
0.15		71.815
0.20		90.124
Bare		
0.05		49.125
0.10		53.350
0.15		68.001
0.20		87.152

Atomic absorption spectroscopy (AAS) technique:

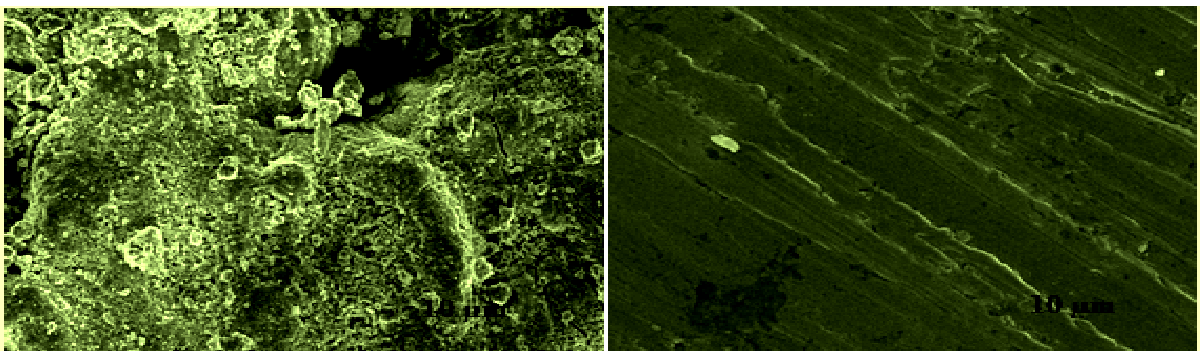
AAS technique was also carried out in order to support the results of gravimetric (mass loss) technique. In mass loss (weight loss) technique, we observed maximum protection efficiency at 10 hour immersion period. Hence, we carried out atomic absorption spectroscopy technique at 313 K with an immersion period of 10 hours. The results of AAS are shown in the **Table 2**. The introduction of four different amounts of expired Conivaptan product decreases the loss in the weight of mild steel in the hydrochloric acid system. The weight loss of mild steel in the hydrochloric acid solution decreases with an increase in the expired Conivaptan product from the 0.0 5 mg/L to 0.2 mg/L clearly is a hint of corrosion protection property of expired Conivaptan product. The adsorption of expired Conivaptan product on the surface of mild steel in the hydrochloric acid system isolates the surface of mild steel from the 5 % hydrochloric acid solution which results in the higher protection efficiency of the expired Conivaptan product on the electrode surface.

Table 2. Atomic absorption spectroscopy results

Concentration (mg/L)	Protection (corrosion inhibition) efficiency
Bare	57.430
0.05	62.117
0.10	77.870
0.15	97.967
0.20	

Scanning electron microscopy (SEM) technique:

Mild steel surface studies were carried out by utilizing the scanning electron microscopy (SEM) technique. The results obtained from the SEM studies are shown in the Figure 1 (a, b). The bare mild steel surface is rough compared to the inhibited mild steel surface. The deviations in the mild steel surface clearly confirm the corrosion protection efficiency of expired Conivaptan product on the mild steel surface.



(a) **(b)**

Figure 1(a, b): SEM images, a) unprotected mild steel surface, b) protected mild steel surface

CONCLUSION

The ability of expired Conivaptan product was successfully quantified against corrosion of mild steel in the 5 % HCl solution via gravimetric (weight loss), atomic absorption spectroscopy (AAS) and scanning electron microscopy (SEM) technique. The results of weight loss studies propagated that, the weight loss of mild steel reduces with increment in the expired Conivaptan product amounts and increases with an increase in the immersion time. Atomic absorption spectroscopy and scanning electron microscopy technique discovered that, adsorption plays important role in the inhibition of mild steel corrosion in the presence of expired Conivaptan product of four different amounts.

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