INHIBITION OF CORROSION MILD STEEL IN ACID MEDIA BY TRAZODONE DRUG

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ABSTRACT

The corrosion inhibition of mild steel in acidic media using Trazodone (Tz) was investigated by using weight loss method .The studies showed the increase in inhibition efficiency and decrease in the corrosion rate by increasing the inhibitor concentration. Adsorption isotherms were tested for their relevance to describe the adsorption behaviour of Trazodone (Tz) . Langmuir adsorption isotherm showed that Trazodone (Tz) inhibits through adsorption mechanism. The mechanism of corrosion inhibition is also proposed.

Keywords: Trazodone, corrosion, mild steel, acid inhibition, weight loss, Langmuir adsorption isotherm.

INTRODUCTION

Organic compounds have been widely used as corrosion inhibitors for metals in acidic media[1,2,3].The efficient corrosion inhibitors are those compounds which have π-bonds and contains hetero atoms such as sulphur, nitrogen, oxygen and phosphorous which allows the adsorption of compounds on the metal surface[4,5,6]. The organic inhibitors decrease the corrosion rate by adsorbing on the metal surface and blocking the active sites by displacing water molecules form a compact barrier film on the metal surface. The most of the organic inhibitors are toxic, highly expensive and environment unfriendly. Research activities in recent times are geared towards developing the cheap, non-toxic and environment friendly corrosion inhibitors.

The present paper describes a study of corrosion protection action of Trazodone (Tz) on mild steel in 1M HCl using weight loss measurements. As for as we know no concrete report has been published so for Trazodone (Tz) in 1M HCl . Hence the present study, different concentration of inhibitors were prepared and there inhibition efficiency in acidic media was investigated. However, only a few non-toxic and eco-friendly compounds have been investigated as corrosion inhibitors. Ceftriaxone , Tryptamine , Succinic acid , L-ascorbic acid , sulfamethoxazole , cefazolin , disulfiram and cefatrexyl were found to be effective inhibitors for acid environments. The inhibitive effect of four antibacterial drugs, namely ampicillin, cloxacillin, flucloxacillin and amoxicillin towards the corrosion of aluminium has been investigated [7,8,9,10,] . The inhibition action of these drugs was attributed to blocking the surface via formation of insoluble complexes on the metal surface. The objective of this study is to investigate the corrosion behaviour of mild steel in 1M HCl solution at room temperature in the presence of Trazodone (Tz) using weight loss measurements. The effects of immersion time was also studied. Several isotherms were tested for their relevance to describe the adsorption behaviour of the studied compound.

EXPERIMENTAL

Inhibitor

Stock solution of Trazodone (Tz) was made in 10:1 ratio of water: ethanol mixture by volume to ensure the solubility. All the experiments were carried out using this stock solution.

Material Preparation

The mild steel coupons having composition (Wt%) ; C-0.17, Mn - 0.46, Si - 0.26, S-0.017, P-0.019 and balance Fe of size 1.0 x 4.0 x 0.2 cm (isolated with commercially available lacquer) were used for weight loss measurements . The corrosive solution of 1M hydrochloric acid (AR grade) solution was used for all studies. Double distilled water was used to prepare the acid solution. Trazodone (Tz), is commercially obtained, the trade name Trazalon, purchased from Wyeth Pharmaceuticals, Mumbai. Trazodone is an antidepressant drug with π electrons, hetero atoms such as N and O. The molecular mass is 371.863 and the molecular formula is $C_{19}H_{22}Cl\ N_{50}$ .It is a phenylpiperazine compound. Trazodone is an antidepressant drug .Trazodone also has anti-anxiety (anxiolytic) and sleep- inducing (hyphotic) effects. Its chemical structure is shown in Figure 1. The inhibitor concentration in the weight loss study was in the range $1.1x10^{-4}$M to $8.8x10^{-4}$M.

Weight Loss Experiments

The mild steel samples of size 1.0 x 4.0 x 0.2 cm were abraded and polished with emery paper 400 – 1200 grades, washed thoroughly with double distilled water, degreased with acetone and finally dried and weighed. After weighing accurately, the specimens were immersed in 100 ml beaker containing 100ml of 1M HCl solution with and without different concentrations of inhibitor at room temperature. After 3 hrs (except in immersion time studies), the specimen were taken out, washed, dried and weighed accurately. All the experiments were performed in triplicate and average value reported. The inhibition efficiency (%) ,corrosion rate (C_R) and surface coverage (θ), were determined by using the following equation.

$$\eta_{WL}\% = \frac{W_0 - W_i}{W_0} \times 100 \quad \rightarrow \quad (1)$$

Where, W_0 and W_i are the weight loss value in absence and presence of the inhibitor respectively.

$$C_R\ (mm/y) = \frac{87.6 \times Wgms}{atD} \quad \rightarrow \quad (2)$$

Where W is the average weight loss mild steel specimen, 'a' is the total area of the mild steel specimen 't' is the immersion time (3 hours) and D is the density of mild steel in (g cm^{-3})

$$\theta = \frac{W_0 - Wi}{W_0} \times 100 \quad \rightarrow \quad (3)$$

The weight loss measurements were also carried out at different time intervals and calculated the adsorption isotherm.

RESULTS AND DISCUSSION

WEIGHT LOSS MEASUREMENTS

Effect of inhibitor concentration

The values of weight loss, inhibition efficiency (%) ,corrosion rate (C_R) and surface coverage (θ) obtained from weight loss measurements at different concentrations of Trazodone (Tz) in 1M HCl solution at room temperature are summarized in Table 1.

The variation of inhibition efficiency with increase in inhibitor concentrations is shown in Figure 2. It was observed that Trazodone(Tz) inhibits the corrosion of mild steel in HCl solution, at all the different concentrations used in study. Maximum inhibition efficiency was exhibited at 8.8 x 10^{-4}M Trazodone inhibitor. It is evident from the Table 1.The corrosion rate is decreased from 7.87 mm/y to 0.33 mm/y.

Effect of immersion time

The effect of immersion time was investigated by using optimum concentration (8.8x10^{-4} mol l^{-1}) of Trazodone for 2 to 8 hrs. The effect of immersion time on the inhibition efficiency is shown in Figure 3. It is found that the inhibition efficiency decreases from 96.5% to 86% with increase in immersion time from 2 to 8 hrs.

ADSORPTION ISOTHERM

Adsorption of inhibitor depends mainly on the charge and the nature of the metal surface, electronic characteristics of metal surface, temperature , adsorption of solvent ionic species and on the electro chemical potential at solution interface. The adsorption isotherm study describes the adsorptive behaviour of organic inhibitors in order to know the adsorption mechanism .

The most frequently used adsorption isotherms are Langmuir, Temkin, Frumkin and Freundlich isotherms. In order to obtain the adsorption isotherm, the degrees of surface coverage (θ) were calculated for various concentrations of the inhibitor from the weight loss data. Langmuir adsorption isotherm was tested to fit with the experimental data. Langmuir adsorption isotherm is represented by following equation.

$$\frac{C_{inh}}{\theta} = \frac{1}{K_{ads}} + C_{inh} \qquad \text{.....................} \quad (8)$$

Where K_{ads} is the adsorption equilibrium constant, (θ) is the degree of surface coverage and C_{inh} is molar concentration of inhibitor used in the corrosive solution. A straight line was obtained by plotting C_{inh} Vs $C_{inh}/(\theta)$ for the inhibitor used in study with R^2 almost unity (0.9996) and the slope are close to unity in Figure 4. This suggest that, the Langmuir adsorption isotherm provides the best description of the adsorption behaviour. The degree of surface coverage (θ) for different inhibitor concentrations of Trazodone was evaluated from weight loss data and listed in the Table 1.

Mechanism of inhibition

Corrosion inhibition of mild steel in 1M HCl by Trazodone(Tz) can be explained on the basis of molecular adsorption of inhibitor on to the metal surface. It is generally considered that the corrosion inhibition of a metal is the adsorption of the inhibitor molecules at metal / solution interface [11]. Organic compounds are adsorbed on the metal surface by,

i) Electrostatic interaction between the changed molecules and charged metal

ii) Interaction of electrons with the metal

iii) Interaction of unshared pair of electrons in the molecule with the metal and

iv) The combination of the all the effects[12].

The inhibition efficiency of the inhibitors also depends on many factors such as the adsorption centers, mode of interaction with metal surface, charge density, molecular size, and the formation of the metallic complexes [13,14]. Physical adsoption of the inhibitor molecule requires both electrically charged surface of the mild steel and charged inhibitor species in the corrosive solution. The inhibitor molecule is protonated in the acid medium. Thus they become cation, existing in equilibrium with the corresponding molecular form. It is well known that the steel surface bears positive charge in acid solution [15,16]. The protonated inhibitor molecule could be attached to the mild steel surface by electrostatic interaction between Cl^- and protonated Trazodone. The decrease in the inhibition efficiency obtained with rise in the temperature supports the electrostatic interaction.

CONCLUSION

Trazodone(Tz) acts as a good inhibitor for the corrosion of mild steel in 1MHCl by weight loss studies . The inhibitor showed maximum inhibition efficiency (approx. 96%) at 8.8×10^{-4} M concentration. The inhibitor follows the Langmuir adsorption isotherm in the process of adsorption .The measurements showed that the Trazodone(Tz) has excellent inhibition properties against the mild steel corrosion in hydrochloric acid solution.

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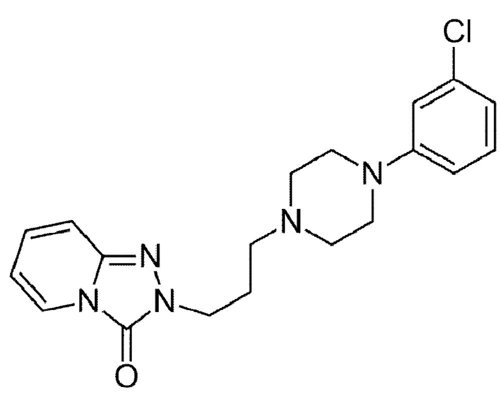

Figure 1- Molecular Structure of Trazodone (Tz)

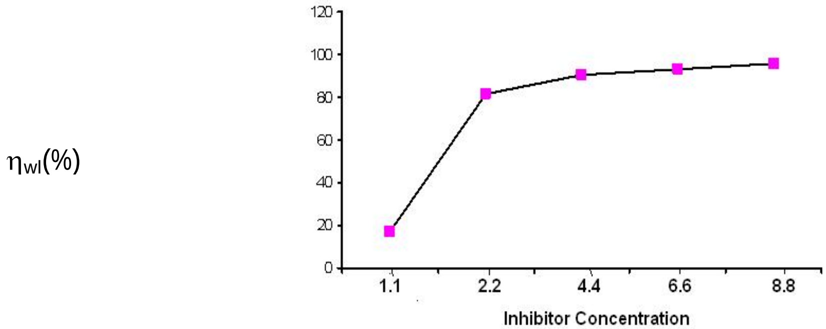

Figure 2- Variation of I.E in 1 M HCl as mild steel at different concentration of inhibitor

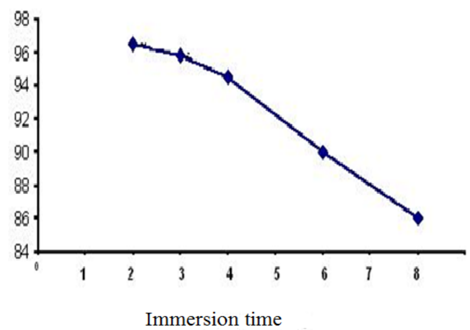

Figure 3- Variation of inhibition efficiency in 1M HCL on mild steel at different immersion time

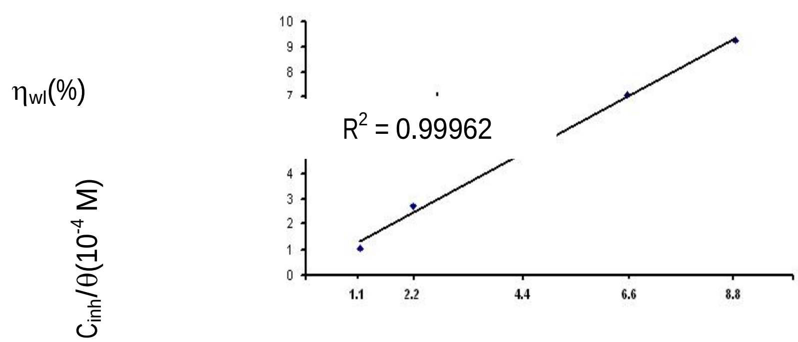

Fig. 4- Langmuir's adsorption isotherm plots for the adsorption of Trazodone in 1M HCl on the surface of mild steel.

$C_{inh}(10^{-4}$ M)

Inhibitor Concentration (10^{-4} x M)	**Weight Loss (mg cm^{-2})**	η **(%)**	**CR (mm/y)**	θ
Blank	22.46	-	7.87	
1.1	18.63	17.05	6.53	0.17
2.2	4.13	81.61	1.44	0.81
4.4	2.16	90.38	0.75	0.90
6.6	1.51	93.27	0.52	0.93
8.8	0.95	95.77	0.33	0.95

Table 1-Corrosion parameters for mild steel in aqueous solution of 1M HCl in absence and presence of different concentrations of inhibitor from weight loss measurements at 308K for 3 hrs.

Legends to figures and Tables.

Fig.1- Molecular Structure of Trazodone (Tz)

Figure 2- Variation of I.E in 1 M HCl as mild steel at different concentration of inhibitor

Fig. 3- Variation of inhibition efficiency in 1M HCL on mild steel at different immersion time.

Fig. 4- Langmuir's adsorption isotherm plots for the adsorption of Trazodone in 1M HCl on the surface of mild steel.

Fig. 5- Tafel Polarisation curves for corrosion Vs SCE of mild steel in 1M HCl in the absence and presence of different concentration of Trazodone.

Fig. 6-Randle Circuit

Fig. 7- Nyquist plot for mild steel in 1M HCl and different concentration of Trazodone

Table 1-Corrosion parameters for mild steel in aqueous solution of 1M HCl in absence and presence of different concentrations of inhibitor from weight loss measurements at 308K for 3 hrs.

Table 2- Potentiodynamic polarization parameters for the corrosion of mild steel in 1M HCl in absence and presence of different concentration of Trazodone(Tz).

Table3- Electrochemical impedance study for mild steel in 1M HCl in absence and presence of different concentration of Trazodone.