PANTOPRAZOLE: INHIBITION OF MILD STEEL CORROSION IN IM H_2SO_4 SOLUTION BY WEIGHTLOSS METHOD

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Abstract-*The effect of a Pantoprazole is studied for use as a low cost and eco-friendly corrosion inhibitor for mild steel in acidic environment. The corrosion inhibition effect is investigated using weight loss study. The inhibitor showed 95.77% inhibition efficiency at 8.8x10*$^{-4}$*M concentration of Pantoprazole. The results obtained Pantoprazole acts as a good inhibitor for the corrosion of mild steel in 1M* H_2SO_4 *from weight loss method.*

Key words: Pantoprazole, mild steel, weightloss, corrosion and inhibition.

1. INTRODUCTION

Mild steel is an important category of materials due to their wide range of industrial applications. It is used in many industries due to its excellent mechanical properties. These are used in industries as pipelines for petroleum industries, storage tanks, reaction vessels and chemical batteries. Acids are widely used for Pickling, Descaling, Acid Cleaning, Oil Well acidizing and other applications. Due to their high corrosive nature acids may cause damage to the system components. The use of corrosion inhibitors is most economical and practical method to reduce electrochemical corrosion. Heterocyclic compounds containing hetero atoms such as S, N & O act as effective corrosion inhibitors for mild steel in acid media and have been the subject of many publications [1].

Organic compounds have been widely used as corrosion inhibitors for metals in acidic media [2]. The effective and efficient corrosion inhibitors were 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 .The organic inhibitors decrease the corrosion rate by adsorbing on the metal surface and blocking the active sites by displacing water molecules and 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 [3-4].

The present paper describes a study of corrosion protection action of Pantoprazole on mild steel in 1M H_2SO_4 solution using weight loss method. Pantoprazole is a proton pump inhibitor with antacid activity and heteroatom's such as S, N & O. The molecule is big enough (Molecular Mass; 383.4 g/mol) and sufficiently planar to block more surface area (due to adsorption) on mild steel. These factors favour the interaction of with the metal. As far as we know good concrete report has been published so for Pantoprazole in acidic conditions of copper, zinc and mild steel [5-7]. Different concentrations of inhibitor (Pantoprazole) were prepared and there inhibition efficiency in acidic media was investigated.

2. EXPERIMENTAL METHODS

2.1 Materials preparation

All the tests were performed on mild steel of following composition (wt %) : 0.076% C, 0.192% Mn, 0.012% P, 0.026% Si, 0.050% Cr, 0023% Al, 0.123% Cu and balance Fe. Mild steel specimens with dimensions of 1.0 x 4.0 x 0.2 cm were used for weight loss method. The surface of each specimen was abraded with different emery papers (600-1200) and washed with acetone. The cleaned samples were then washed with double distilled water and finally dried.

2.2 Inhibitor

Pantoprazole Tablets are commercially obtained as a trade name PANTAKIND DSR manufactured by the Division of Mankind Pharma Ltd. The compound is in its purest state, having molecular formula ($C_{16}H_{15}F_2N_3O_4S$). Pantoprazole is an N-S heterocyclic compound containing four oxygen atoms, three nitrogen atoms and one sulphur atom. Hence it is expected to act as a good inhibitor.

Pantoprazole is a substituted Benzimidazole and proton pump inhibitor with antacid activity. It's a potent inhibitor of gastric acidity which is widely used in the therapy of gastroesophageal reflux and peptic ulcer disease. Pantoprazole therapy is associated with a low rate of transient and asymptomatic serum aminotransferase elevations and is a rare cause of clinically apparent liver injury. The range of the concentrations of inhibitor used for the inhibition is from 1.1 x 10^{-4} M to 8.8 x 10^{-4} M. The structure of Pantoprazole is shown in Fig.1.

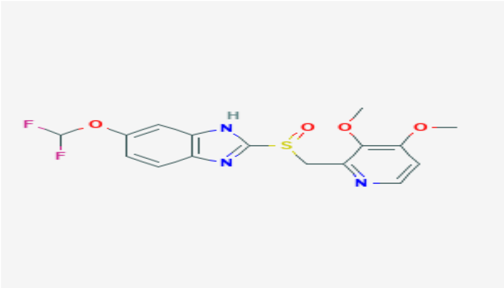

Fig.1 Structure of Pantoprazole

2.3 Weight Loss Measurements

The Mild Steel specimens used had a rectangular shape of 1.0 x 4.0 x 0.2 cm were abraded with series of emery paper (600-1200) and then washed with distilled water and finally washed with acetone. After weighing accurately, the specimens were immersed in beaker which contained 100ml of 1M H_2SO_4 solution in the absence and presence of different concentrations of inhibitor at room temperature. After 3h the specimens were taken out, washed, dried and weighed accurately. Triplicate experiments were performed in weight loss test for each concentration of inhibitor and without inhibitor and average of weight loss is reported. The corrosion rate CR was calculated from the following equation.

$$C_R \ (mm/y) = \frac{87.6 \times Wgms}{atD} \rightarrow (1)$$

Where W is the average weight loss of mild steel specimens, 'a' is the total area of one mild steel specimen, t is the immersion time (3h) and D is density of mild steel in (gcm^{-3}). The inhibition efficiency (IE%) and surface coverage (θ) of inhibitor on the corrosion of MS was calculated as follows.

$$IE\% = \frac{W_0 - W_i}{W_0} \times 100 \rightarrow (2)$$

$$\theta = \frac{W_0 - W_i}{W_0} \rightarrow (3)$$

3. RESULTS AND DISCUSSION

3.1. Weight Loss Studies

The values of inhibition efficiency (IE%) and the corrosion rate (CR) obtained from weight loss method at different concentrations of Pantoprazole are summarized in Table1.It follows from the data that the weight loss decreased and therefore corrosion inhibition increased with increase in inhibitor concentration. It was also observed that corrosion rate decreased with increase in inhibitor concentration.

It is evident from the table that Pantoprazole inhibits the corrosion of mild steel in H_2SO_4 solution at all the concentrations used in the study i.e. 1.1.x 10^{-4}M to 8.8 x 10^{-4}M. Maximum inhibition efficiency was obtained at the concentration 8.8 x 10^{-4}M. The increased inhibition efficiency and decreased corrosion rate might be due to the increased adsorption and increased surface coverage (θ) of inhibitor on mild steel surface with increase in concentration. The variation of inhibition efficiency with increase in inhibitor concentrations is shown in Fig 2.

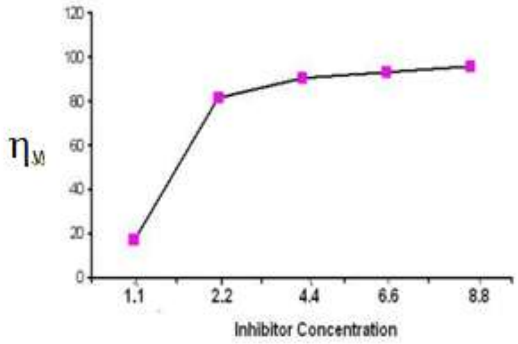

Fig.2 Variation of I.E in 1 M H_2SO_4 as mild steel at different concentration of Pantoprazole

3.2 Effect of immersion time

The effect of immersion time was investigated by using optimum concentration 8.8 x 10^{-4} M of Pantoprazole for 2 to 8 hrs. The effect of immersion time on the inhibition efficiency is shown in Fig.3. It is a round that the inhibition efficiency decreases from 95.77 % onwards with increase in immersion time from 2 to 8 hrs.

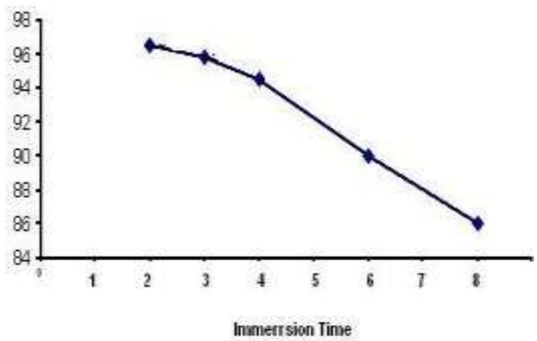

Fig.3 Variation of I.E in 1M H_2SO_4as mild steel at different immersion time of Pantoprazole.

3.3. Mechanism of inhibition

Corrosion inhibition of mild steel in 1MH_2SO_4 by Pantoprazole can be explained on the basis of molecular adsorption of inhibitor on to the metal surface. It is generally considered that the first step in the corrosion inhibition of a metal is the adsorption of the inhibitor molecules at metal / solution interface. Organic compounds are adsorbed on the metal surface by,

i) Electrostatic interaction between the changed molecules and charged metal Interaction of electrons with the metal.

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

iii)The combination of the all the effects.

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. 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. The protonated inhibitor molecule could be attached to the mild steel surface by electrostatic interaction and protonated Pantoprazole [8]. The decrease in the inhibition efficiency obtained with rise in the temperature supports the electrostatic interaction.

4. CONCLUSION

Pantoprazole is a substituted Benzimidazole and proton pump inhibitor with antacid activity. It's a potent inhibitor of gastric acidity. The effect of a Pantoprazole is studied for use as a low cost and eco-friendly corrosion inhibitor for mild steel in acidic environment. The corrosion inhibition effect is investigated using weight loss study. The inhibitor showed 95.77% inhibition efficiency at 8.8×10^{-4}M concentration of Pantoprazole. The results obtained Pantoprazole acts as a good inhibitor for the corrosion of mild steel in 1M H_2SO_4 from weight loss method.

Table-1: Corrosion parameters for mild steel in 1MH_2SO_4 solution in absence and presence of different concentrations of Pantoprazole from weight loss measurements at 308K for 3 hrs.

Inhibitor Concn (10^{-4} x M)	Weight Loss (mg cm^{-2})	IE (%)	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

5. REFERENCES

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