Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

Corrosion Inhibition and Adsorption Behaviour of Thiourea and 3-Mercapto Propionic Acid on Mild Steel in Methane Sulphonic Medium

V.Rajapriya[1], K.Uma[2], Dr.S.Rekha[3]

1. Department of Chemistry, Prathyusha Institute of Technology and Management, Aranvoyalkuppam, Thiruvallur. 2.
2. Department of Chemistry, Prathyusha Institute of Technology and Management, Aranvoyalkuppam, Thiruvallur
3. Department of Chemistry, RMD Engineering College, RSM Nager, Kavaraipettai, Chennai.

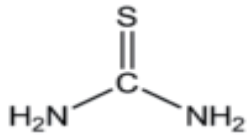
***Corresponding author: E.Mail: priyaflower24@gmail.com**

ABSTRACT

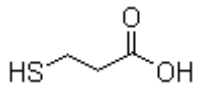
Methanesulphonic acid, an ecofriendly acid, has gained its importance in industrial process due to environmental toxicity of mineral acids like sulphuric acid. The corrosion behavior of mild steel with varied concentration of methane sulphonic acid is studied gravimetrically. The inhibitors are one of the best and simplest option of protecting metals and alloys. 3- Mercapto propionic acid and thiourea is found to inhibit corrosion significantly.

Keywords: Corrosion inhibition, weight loss method, surface coverage, corrosion rate.

Inhibitor Structure:



Thiourea



3- Mercapto propionic acid

INTRODUCTION

Metal are exposed to action of acids in many different ways and for many reasons. The Mild steel finds a variety of applications industrially, for mechanical and structural purposes, like bridge work, building, boiler plates, steam engine parts and automobiles. It finds various uses in most of the chemical industries due to its low cost and easy availability for fabrication of various reaction vessels, tanks, pipes etc. Since it suffers from severe corrosion in aggressive environment, it has to be protected from acid which have been used for drilling operations, pickling baths and in cleaning processes. Corrosion can be minimized by adding suitable inhibitors which retard the corrosion reaction. It is widely accepted that inhibitors especially the organic compounds can effectively protect the metal from corrosion. Organic corrosion inhibitors adsorb on the metal surface by displacing water molecules on the surface and form a compact barrier. The availability of non-bonded (lone pair) and ∏ - electrons in inhibitor molecules facilitate the electron transfer from the inhibitor to the metal. There are many factors influencing the ability of a molecule to inhibit corrosion, through the conjugated bonding, bonding strength to metal substrate, the ability of an inhibitor complex with the metal within the metal lattice and solubility of the inhibitor. Further, the stability of the inhibitor molecule in the corroding medium may become the determining factor. In the present study an attempt has been made to study the influence of varying concentration of thiourea and 3-Mercapto propionic acid on corrosion of mild steel in acid medium using 1.0 N Methane Sulphonic is experimentally investigated and presented. The compound in the present study contains N and S atoms which are quickly adsorbed on the metal surface and thus forming an insoluble stable film on the mild steel surface.

Experimental details: Mild steel specimen used for this study was mechanically pressed, cut into a length of 5 cm x2.5 cm x 0.2cm. The specimens were polished by buffing and rubbing with emery paper to obtain mirror like finishing. They were however degreased in ethanol, dried in acetone and stored in moisture free desiccators before corrosion studies commenced.

Inhibitor and Acid: Thiourea and 3- Mercapto propionic acid are the inhibitors used. Its structural formula is shown in figure (1) and its molecular formula is CH_4N_2S and $C_3H_6O_2S$. It was prepared in various concentration of 100 ppm, 200 ppm, 300 ppm, 400 ppm, 500 ppm. These were used as the inhibiting compound and 1.0 N of methane sulphonic acid (MSA) was prepared with distilled water. The MSA used as corrosive medium was from analar grade and bi- distilled water was used for its preparation.

Test procedure: Each specimen were completely immersed in a glass beaker containing 100 mL of the test solution at room temperature, after the test, specimen was cleaned with brush and running tap water and then dried with hot air drier.

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

The inhibition efficiency (% I) , corrosion rate(mdd) and surface coverage (θ) of the inhibitor were calculated from equations(1) ,(2) and (3) respectively.

I.E (%) = 100 x (W1 - W2)/ W1 (1)

Where W_1 and W_2 are the weight loss of the metal in absence and presence of inhibitor solution, respectively. The corrosion rate (CR) in mdd can be obtained by the following equation [8].

Corrosion rate (mdd) = Δ W / AT (2)

Where ΔW is the weight loss in mg, A is area of specimen in $dm^{2,}$ T is time of exposure in days. The surface coverage can be calculated by the following equation

$\theta = (W_1 - W_2)/ W_1$ (3)

where W_1 and W_2 are the weight loss of the metal in absence and presence of inhibitor solution, respectively.

RESULTS AND DISCUSSION

Gravimetric method: The corrosive behavior of mild steel at different concentration of MSA in absence of inhibitor was compared with inorganic acids like H_2SO_4, HCl. The result obtained from the table -1 revealed that mild steel was highly corroded in inorganic acids than in MSA. Gravimetric studies have been carried out for various concentrations (100-500 ppm) of thiourea as inhibitor. Percentage inhibition efficiency, corrosion rate and surface coverage for different concentration of thiourea are provided in the table-2. It can be observed from the data that inhibition efficiency of thiourea increases with increasing concentration of inhibitor and it shows a maximum inhibition efficiency of 94.8% at 500 ppm.

Inhibition studies of various concentrations (100 – 500 ppm) of 3- Mercapto propionic acid are given in the table- 3. It is observed that inhibition efficiency of inhibitor increases with increasing concentration of 3- Mercapto propionic acid. From the results, it is clear that *thiourea* shows better inhibition efficiency of mild steel in MSA than 3- Mercapto propionic acid.

Table.1.Corrosion rate of Mild steel in H_2SO_4, HCl and MSA

Normality	H_2SO_4		HCl		MSA	
	24 hrs	48 hrs	24 hrs	48 hrs	24 hrs	48 hrs
0.1 N	1135.5	1065.1	482.4	810.9	281.9	191.5
0.5 N	2364.5	1644.8	1772.8	981.7	1447.2	886.4
1.0N	3569.5	2755.6	2231.4	1316.2	2122.2	1199.1
1.5N	5622.3	3653.9	3764.1	2604.7	3220.1	2113.3
2.0 N	5969.8	5593.6	5670.0	4690.2	5090.3	3075.2

Table.2.Weight loss and percentage inhibition efficiency (I.E %) for mild steel in 1.0 N MSA with different concentration of thiourea

Conc.ofthe inhibitor (ppm)	I.E. (%)	CR (mdd)	Surface Coverage (θ)	Corrosion current * 10^{-3} Amp /cm^{-2}
Blank	-	2909.3	-	
100	34.4	190.7	0.34426	0.76308
200	61.2	1383.1	0.51202	0.55324
300	65.7	1049.2	0.65792	0.4196
400	81.2	492.8	0.81256	0.19712
500	94.5	158.9	0.94535	0.06356

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

Table.3.Weight loss and percentage inhibition efficiency (I.E %) for mild steel in 1.0N with different concentration of 3- Mercapto propionic acid

Concentration of the inhibitor (ppm)	I.E. (%)	CR (mdd)	Surface Coverage (θ)	Corrosion current*10^{-3} Amp cm^{-2}
Blank	-	2909.3	-	-
100	12.5	2543.7	0.1256	1.0174
200	20.1	2352.9	0.2012	0.94116
300	25.7	2102.1	0.2568	0.86484
400	31.2	2003.2	0.3120	0.80128
500	35.2	1780.6	0.3525	0.71222

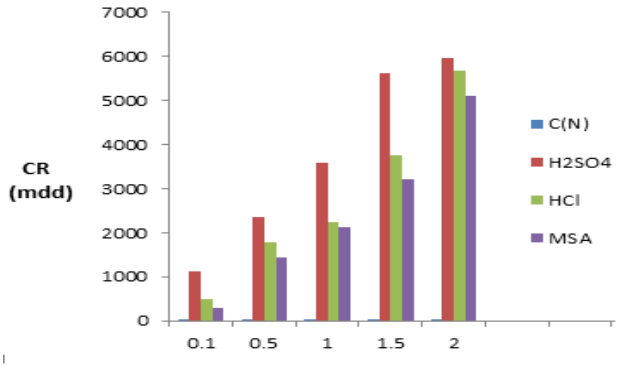


Figure.1.Corrosion rate of Mild steel in H_2SO_4, HCl & MSA

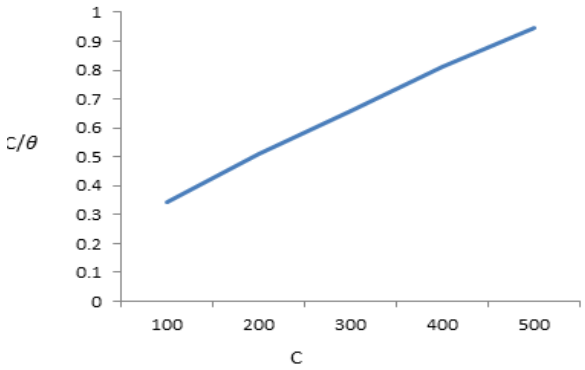


Figure.2.Relationship between C/ θ and Inhibitor concentration C for thiourea

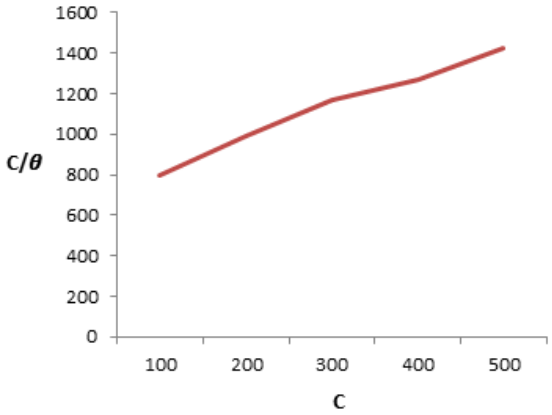


Figure.3.Relationship between C/Θ and Inhibitor concentration C for 3- Mercapto propionic acid

For an inhibitor to have a high surface coverage, a chemical bond between the inhibitor and the metal atom should be stronger. The nature of inhibitor interaction on the corroding surface during corrosion inhibition of metals and alloys has been deduced in terms of adsorption characteristics of the inhibitor. The adsorption behavior of the inhibitor molecules on the metal surface can be applied to explain the inhibition mechanism of inhibitors. Several adsorption isotherms can be used to assess the adsorption behavior of the inhibitor. The Langmuir adsorption isotherm was found to be the best description of the adsorption behavior. Langmuir adsorption isotherm is given by the following equation:

$$\log(C/\Theta) = \log C - \log K \quad (4)$$

Figure (2&3) shows the linear relationship with values. The results indicate that the values were very close to unity indicating strong adherence of adsorption which fits to the Langmuir adsorption isotherm for thiourea and 3- mercapto propionic acid which is similar to the results obtained in literature.

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

CONCLUSIONS

Corrosion of mild steel in methane sulphonic acid is lesser than inorganic acids. 3- mercapto propionic acid and thiourea can be used as efficient inhibitor for mild steel in the methane sulphonic medium. Thiourea shows a better inhibition property of 94.5% for 500 ppm concentration. Thiourea inhibits better than 3- mercapto propionic acid on mild steel in MSA medium. Lone pair of electrons present on nitrogen atom in thiourea act as stronger electron donor. Therefore thiourea strongly adsorbed on the metal surface and protects the metal efficiently than 3- mercapto propionic acid.

REFERENCES

A. I. Onen1, O. N. Maitera1, J. Joseph1, E. E. Ebenso, Corrosion Inhibition Potential and Adsorption Behaviour of Bromophenol Blue and Thymol Blue Dyes on Mild Steel in Acidic Medium, Int. J. Electrochem. Sci., 6, 2011, 2884 - 2897

J.Hmimou,A.Rochdi, R.Touir, M.Ebn Touhami, E.H, Rifi, Study of corrosion inhibition of mild steel in acidic medium by 2-propargyl-5-p-chlorophenyltetrazole, Part I, J.Mater Environ.Sci.,3 (3), 2012, 543 -550.

Kavita Kendre , Girish Pande , Rajewar Vaishali and Pingalkar S. R., Corrosion inhibition effect of dpd-lanthanide complexes on mild steel in nitric acid, Golden Research Thoughts, 3(10), 2014.

M.D.Gernon, M.Wu.T.Buszta, P.Janney, Conductivity studies on PMMA- Methanesulfonic acid based proton conducting polymer electrolytes. Green chem, 1, 1999, 127- 140.

Michael D.Gernon, Min Wu, Thomas Bustza and Patrick Janney, Environmental benefits of methanesulfonic acid. Comparative properties and advantages, Green chem., 1999, 127 -140.

Neha Patni, Shruti Agarwal, and Pallav Shah, Greener Approach Towards Corrosion Inhibition, Hindawi publishing corporation, volume 2013, Article ID 784186

S.A.Umoren, U.M.Eduok and E.E.Oguzie, Corrosion Inhibition of Mild Steel in 1 M H_2SO_4 by Poly vinyl Pyyrolidine and Synergetic Iodide Additives, Portugaliae Electrochimica Acta 26/6 (228) 533-546

Tripathi R, Chaturvedi A, and Upadhayay R.K.Department of Chemistry, Corrosion Inhibitory Effects of Some Substitued Thiourea on Mild Steel in Acid Media, Research Journal of Chemical Sciences, 2(2), 2012, 18-27.