RJC

RASĀYAN J. Chem.
Vol. 8 | No.2 |156 -160 | April - June | 2015
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

INVESTIGATION OF INHIBITION EFFECT OF NAPHTHYL CHALCONES ON MILD STEEL CORROSION IN SULPHURIC ACID MEDIUM

S. Velrani * and R. Mahalakshmi
Department of Chemistry, Karpagam University, Coimbatore-21, Tamil Nadu, India
*E-mail: velraniprabu@gmail.com

ABSTRACT

Naphthylchalcones namely (E)-3-(4-chloro phenyl)-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-I), (E)-3-phenyl-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-II), (E)-3-(4-methyl phenyl)-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-III) and (E)-3-(4-methoxy phenyl)-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-IV) have been synthesized and investigated as a corrosion inhibitors in sulphuric acid medium using weight loss measurements. From weight loss measurements, the inhibition efficiency of the naphthyl chalcones were found to dependent on the inhibitors concentration and nature in weight loss and an increase in the percentage inhibition. The order of inhibition efficiency of the compounds from weight loss measurements decreases in the following order: Compound IV> Compound-III > Compound-II > Compound-I. The compound IV (-OCH_3) has the highest inhibition efficiency (99.04%).

Keywords: Mild steel, Corrosion inhibition, Naphthylchalcones, Sulphuric acid, Weight loss measurements

INTRODUCTION

Mild steel is widely applied as the constructional materials in many industries due to its excellent mechanical properties and low cost. Sulphuric acid is also an important mineral acid with many uses in the same systems and leads the researchers to the study of the effect of the corrosion inhibitors[1–5]. The selection of inhibitor is controlled by its economic availability, its efficiency to inhibit the substrate material and its environmental side effects. So most of the excellent acid inhibitors for corrosion of steel in acidic medium are organic compound containing nitrogen, oxygen and/or sulphur atoms[6-10]. Availability of π electron due to the presence of multiple bonds or aromatic rings in the inhibitors molecule would facilitate electron interact with d-orbital of iron[11-13]. Chalcones of are great importance in different field for example medicinal chemistry, antibacterial, antifungal, insecticidal, anesthetic, anti inflammatory, analgesic etc[14-15]. In the view of the various chemical and biological applications, few chalcones have recently been reported as effective corrosion inhibitors for mild steel[16-18]. The aim of this paper is to synthesize the four compounds namely (E)-3-(4-chloro phenyl)-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-I), (E)-3-phenyl-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-II), (E)-3-(4-methyl phenyl)-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-III) and (E)-3-(4-methoxy phenyl)-1-(naphthalen-1-yl) prop-2-en-1-one (Compound-IV) and to study the inhibiting action of four synthesized Naphthylchalcones containing oxygen and aromatic rings and also to discuss the corrosion mechanism of the compounds.

EXPERIMENTAL

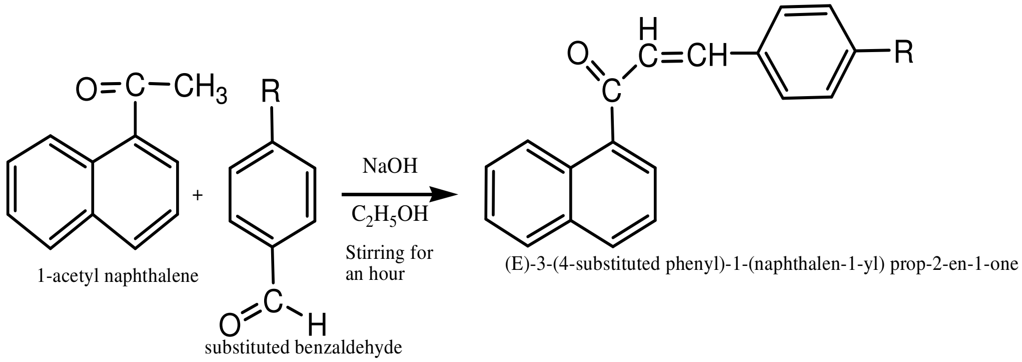
Preparation of Inhibitors

(E)-3-(4-substituted phenyl)-1-(naphthalen-1-yl) prop-2-en-1-one is synthesized by 1-acetyl naphthalene with substituted Benzaldehyde and have the structures are given below (Scheme-1).

Formations of these compounds were established by both elemental and spectral analysis. In general, the IR spectra gave an absorption bands at 1653cm^{-1} and 1608cm^{-1} due to the C=O and C=C respectively. Fresh solutions of the 2M sulphuric acid was prepared for each experiment using analytical grade of sulphuric acid (98%) and diluted with distilled water. The concentration range of inhibitors was 2 x10^{-6}M

Vol. 8 | No.2 |156 -160 | April - June | 2015

to10×10^{-6}M. The composition of mild steel is (wt. %): 0.13% C, 0.18% Si, 0.39% Mn, 0.40% P, 0.04% S, 0.025% Cu and Fe balance. The mild steel specimens of 3x3x0.6 cm dimensions were abraded with different grades of emery papers and then washed with distilled water and acetone. After weighing accurately, the specimens were immersed in solutions containing 2M H_2SO_4 solution without and with the addition of different concentrations of inhibitors. All the aggressive solutions were open to air. After 24 hours, the specimens were taken out, washed, dried, and weighed accurately. In order to get good reproducibility, experiments were carried out in triplicate, and the average weight loss of three parallel mild steel was reported**.**



Where R=-Cl, -H, $-CH_3$, $-OCH_3$ for compounds I, II, III, IV respectively.

Scheme-1

Weight loss measurements

The weight loss method (Gravimetric method) is probably the most widely used method of inhibition assessment. The mild steel coupons were polished by different emery papers, cleaned, weighed and then immersed in test solution. Weight loss measurements were conducted under total immersion using 250ml capacity beakers containing 100 ml test solution at 303K. The coupons were withdrawn from the test solution, washed thoroughly with distilled water followed by alcohol and dried with air, then weighed again. From the weight loss values, the corrosion rate (ρ) and inhibition efficiency (IE) of each concentration was calculated using the following equations (1) and (2) respectively:

$$\rho = \frac{\Delta W}{At} \qquad (1)$$

Where, ΔW is the average weight loss of three mild steel sheets, *A* the total area of one mild steel specimen, and t is the immersion time. With the calculated corrosion rate, the inhibition efficiency (*%IE*) was calculated as follows:

$$\%IE = \frac{\rho_1 - \rho_2}{\rho_1} \times 100 \qquad (2)$$

Where, ρ_1 and ρ_2 are the corrosion rates of the mild steel coupons in the absence and presence of inhibitors, respectively.

RESULTS AND DISCUSSION

Weight loss measurements

The corrosion behavior of mild steel in 2M H_2SO_4 solution was studied both in the presence and absence of inhibitors. Table 1 shows the corrosion rates and inhibition efficiencies at weight loss measurements with and without the concentrations of the inhibitors in sulphuric acid medium. Figure 1 shows variation of Inhibition Efficiency from weight loss measurements at different concentrations of inhibitors in 2M H_2SO_4 medium. From these results it could be found that the corrosion rate decreased with increase in inhibitors concentration.

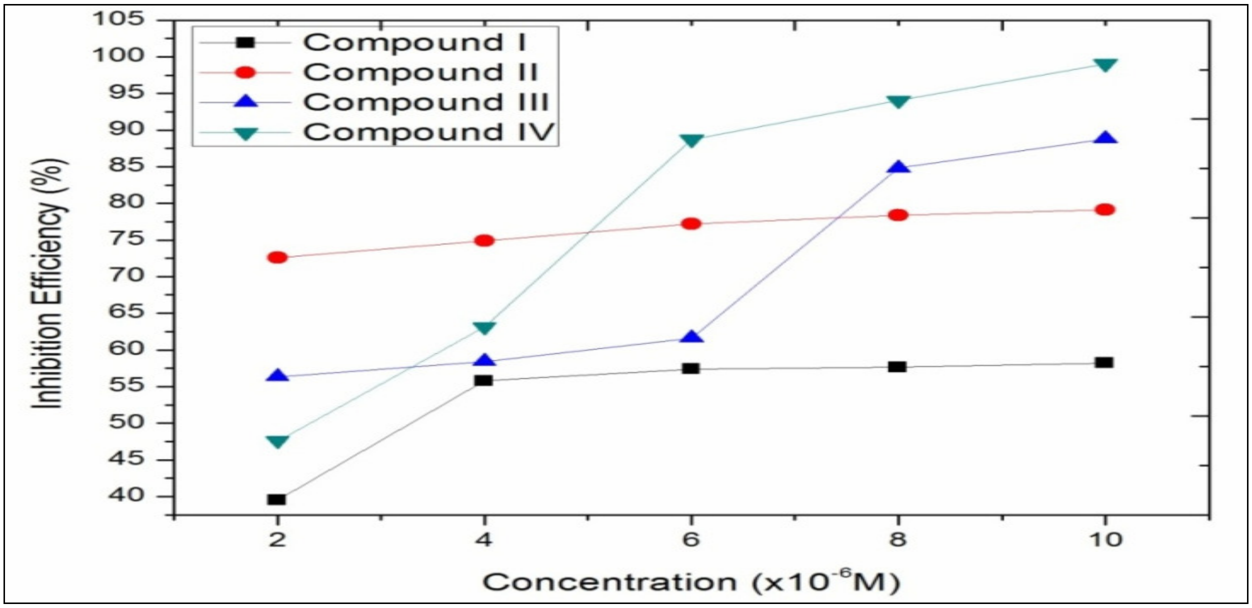


Fig.-1: The Inhibition efficiency with the concentrations of the inhibitors from weight loss measurements in 2M H_2SO_4 medium.

Table-1 show that the inhibition efficiency increased with increasing the concentration of inhibitors. This investigation could be clearly observed in Figure 1. From weight loss measurements, the inhibition efficiency of the compounds was found to dependent on the inhibitor concentration and the nature of the substituents. The increase in the inhibitors concentration was accompanied by a decrease in weight loss and an increase in the percentage inhibition. These results lead to the conclusion that the compounds under investigation are fairly efficient as inhibitors for mild steel dissolution in 2M H_2SO_4 solution. It is obvious that the value of %IE increase with increasing the inhibitor concentration, whereas decrease in the following order: Compound IV (99.04%) > compound III (88.78%) > compound II (79.12%) > compound I (58.23%).

Mechanism of Inhibition

The extent of the adsorption of the inhibitors depends on the nature of the metal, the mode of adsorption of the inhibitors and the surface conditions. The values of inhibition efficiency depend essentially on the electron density at the active center of the inhibition molecule. The subsequent step is to follow the effect of the substituted group weather increases or decreases the inhibition efficiency through its effect on the active center, i.e., electron donating or withdrawing groups. The value of IEs increases with increasing the electro negativity of the substitute. The introduction of nucleophilic (electron donor) substituent's in naphthyl chalcones leads to an increase of adsorbability because of the increase of π-electron density in the aromatic nucleus. Introduction of electron acceptor substituent has the opposite effect. The substituted group studied are $–OCH_3$, $-CH_3$, which are located in the phenyl ring, the overlap between the inhibitor electron rich centers and empty d-orbital increases in case of $–OCH_3$ more than $–CH_3$, due to the lone pair of electron located on the oxygen atom of the $–OCH_3$, H atom has no effect on electron density, Cl group are electron withdrawing group and the order of inhibition depends on the magnitude of the withdrawing characters. The order of inhibition efficiency of these compounds from weight loss measurements decreases in the following order: $-OCH_3$> $-CH_3$> -H > -Cl or Compound IV > III > II > I. Compound IV has the highest inhibition efficiency (99.04%).

Table-1: Corrosion rate and Inhibition efficiency data obtained from weight loss method for mild steel in 2M H_2SO_4 in the presence of inhibitors.

Inhibitors	Inhibitor concentration $\times10^{-6}$(M)	$\rho\times10^{-6}$ (g cm^{-2} min^{-1})	IE (%)
Compound-I	0	33.5	-
	2	9.18	39.53
	4	8.4	55.79
	6	7.64	57.38
	8	7.24	57.66
	10	6.99	58.23
Compound-II	0	33.5	-
	2	20.3	72.59
	4	14.8	74.92
	6	14.3	77.21
	8	14.2	78.39
	10	14.0	79.12
Compound-III	0	33.5	-
	2	14.6	56.38
	4	13.9	58.44
	6	12.9	61.63
	8	5.08	84.83
	10	3.76	88.78
Compound-IV	0	33.5	-
	2	17.6	47.59
	4	12.3	63.15
	6	3.78	88.73
	8	1.99	94.05
	10	0.32	99.04

CONCLUSION

The naphthylchalcones were synthesized and characterized by FT-IR spectroscopy. The naphthylchalcones derivatives showed good performance as corrosion inhibitors in 2M sulphuric acid medium. The inhibition efficiencies obtained from weight loss revealed that there is increase with increasing the inhibitor concentration. The maximum inhibition efficiency is 99.04% for compound IV. The orders of inhibition efficiency of the inhibitors are as follows: Compound IV > compound III > compound II > compound I.

REFERENCES

1. N.O. Eddy, P.A. Ekwumemgbo and A.P. Mamza Paul, *Green Chemistry Letters and Reviews,* **2 (4)**, 223 (2009).
2. T. Sethi, A. Chaturvedi, R.K. Upadhyay and S.P. Mathur, *Polish J. Chem.,* **82 (3)**, 591 (2008).
3. T. Sethi, A. Chaturvedi, R.K. Upadhyay and S.P. Mathur, *J. Chil. Chem. Soc.,* **52**, 1206 (2007).
4. O.E. Nnabuk, A.O. Stevens and N.A. Ibiam., *Green Chemistry Letters and Reviews*, **1**, 1 (2010).
5. A. Nabel, F.M. Negm, S.A. Ghuiba, S.M. Mahmoud and Tawfik, *Engineering in Life Sciences*, **11 (5)**, 496 (2011).
6. A. Kosari, M. Momeni, R. Parvizi, M. Zakeri, M.H. Moayed, A. Davoodi and H. Eshghi., *Corrosion Science.,* **53 (10)**, 3058 (2011).

7. O.A. Paul, M. Ladan and S. Takuma., *African Journal of Pure and Applied Chemistry,* **6 (7)**, 100 (2012).
8. O. Nnabuk Eddy., *Green Chemistry Letters and Reviews,* **3 (4)**, 307 (2010).
9. N.O. Eddy and A.O. Odiongenyi., *Pigment and Resin Technology,* **39 (5)**, 288 (2010).
10. P. Arora, S. Kumar, M.K. Sharma and S.P. Mathur., *E-J. Chem*., **4**, 450 (2007).
11. Ayşe Ongun Yüce and Gülfeza Kardaş., *Corrosion Science,* **58**, 86 (2012).
12. M.K. Sharma, P. Arora, S. Kumar, R. Ratnani, and S.P. Mathur, *Corrosion Engineering, Science and Technology* ,**43 (3)**, 213 (2008).
13. N. Saxena, S. Kumar, S.P. Mathur., *Chemical Engineering Communication*, **196 (12)**, 1451 (2009).
14. S. Srivastava, R. Sonkar, S.K. Mishra , A. Tiwari , V.M. Balaramnavar, Mir S, Bhatia G, A.K. Saxena, V. Lakshmi., *Lipids*., **48(12)**, 1297 (2013).
15. N. Rekha, B. Meena, J. Shubha., *Medicinal Chemistry Research.,* **21(8)**, 1587 (2012).
16. M. Bouklah, B. Hammouti, A. Aouniti, M. Benkaddour, A. Bouyanzer*., Applied Surface Science* **252 (18)**, 6236 (2006).
17. L. Ralston, S. Subramanian, M. Matsuno, *O. Yu, Plant Physiol*., **137,** 1375 (2005).
18. M. Abdullah, H. EMegahed, M.S. Motae, *Mater. Chem. and Phys.,* **118,** 111 (2009)

[RJC-1243/2015]