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Study of Formazan Derivative Inhibitor Used to Prevent the Mild Steel Material Used in the Construction of Ship Material

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Formazan of *p*-dimethyl amino benzaldehyde (FD) has been prepared as an inhibitor to control the rate of corrosion. This compound has been studied as corrosion inhibitor for mild steel in hydrochloric acid and citric acid by weight loss method at different time interval at room temperature. The result showed that the corrosion inhibition efficiency of these compounds was found to vary with different time interval and different acid concentration. It was also found that the corrosion inhibition behaviour of formazan of *p*-dimethyl amino benzaldehyde is greater in 2 N hydrochloric acid than 2 N citric acid. So formazan of *p*-dimethyl amino benzaldehyde can be used as good inhibitor for preventing mild steel material which is used in the construction ship material. The surface analysis study also confirms the corrosion of the mild steel and its inhibition by the formazan of *p*-dimethyl amino benzaldehyde.

Key Words: Mild steel, Corrosion Inhibitors, Weight loss method, Formazan of *p*-dimethyl amino benzaldehyde.

INTRODUCTION

Concentrated mineral acids are used in many chemical industry for pickling, cleaning, descaling and oil well acidising of metallic materials cause damage of corrosion. The addition of corrosion inhibitors effectively secures the metal against an acid attack. Many studies in this regards using organic inhibitors have been reported[1-5]. It has been speculated that organic inhibitors are more effective with iron and that the polar organic compounds containing sulphur and nitrogen are good corrosion inhibitors for the acidic solutions of metals[6]. Due to the strong behaviour of hydrochloric acid and sulphuric acid in the solution against structural materials, such as carbon steel, the use of corrosion inhibitor is usually required to minimize the corrosion attack[7-10]. Therefore, in this investigation, the corrosion inhibition of mild steel in 2 N HCl and 2 N citric acid solution is studied in absence and presence of formazan of *p*-dimethyl amino benzaldehyde (FD) at 1 h at room temperature by weight loss method.

EXPERIMENTAL

According to ASTM method as reported already[11], cold rolled mild steel strips were cut into pieces of 5 cm × 1 cm having the following composition (%) of Fe = 99.687, Ni = 0.012, Mo = 0.017, Cr = 0.041, S = 0.013, P = 0.010, Si = 0.008, Mn = 0.193 and C = 0.019. They were pickled in pickling solution (5 % H_2SO_4) for 3 min and washed with distilled water followed by polished with various grades of emery papers and degreased using trichloroethylene. The weight of specimen were noted and then immersed in test solution containing various concentrations of inhibitors at room temperature. After the duration of 1 h in hydrochloric acid and citric acid, the specimens were removed from test solutions and pickled in pickling (5 % sulphuric acid) solution, dried and finally weighed. The differences in weights were noted and the corrosion rates were calculated.

Solutions: All the solutions were prepared using NICE brand AR grade chemicals in double distilled water and bubbling purified by nitrogen gas for 0.5 h to carry out de-aeration of the electrolytes. 2 N hydrochloric acid and 2 N citric acid solutions were prepared by double distilled water. The corrosion inhibitor solution of 0.1 % formazan of *p*-dimethyl amino benzaldehyde was prepared by dissolving 0.1 g of *p*-dimethyl amino benzaldehyde in 100 mL of test solution. And also, 0.02, 0.04, 0.06, 0.08 and 0.10 % solutions of formazan of *p*-dimethyl amino benzaldehyde were prepared.

RESULTS AND DISCUSSION

The corrosion behaviour of mild steel in 2 N hydrochloric acid and 2 N citric acid with formazan of *p*-dimethyl amino benzaldehyde was given in Fig. 1, which was studied by weight loss method at 1 h at room temperatures. From the graph, it was observed that the weight loss of mild steel in the acid

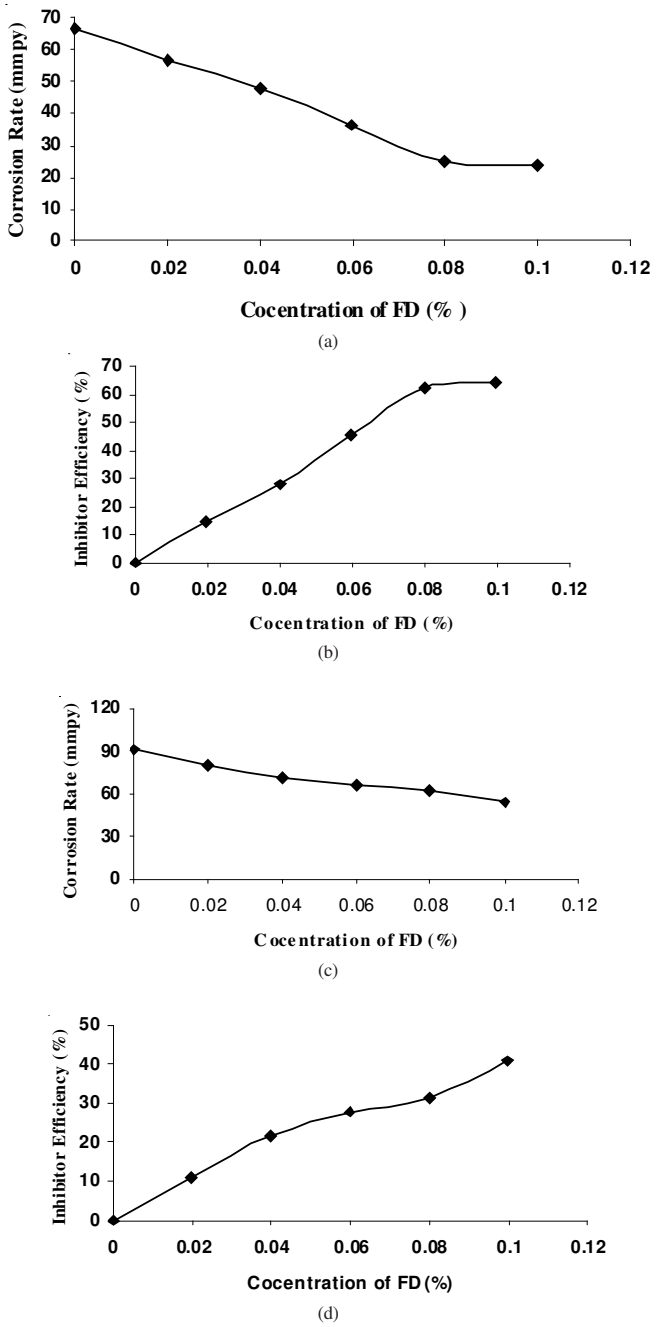


Fig. 1. (a) Variation of corrosion rate with concentration of formazan of *p*-dimethyl amino benzaldehyde (FD) (%) in HCl solution at 1 h at room temperature, (b) Variation of inhibition efficiency (IE) with concentration of (FD) (%) in HCl solution at 1 h at room temperature, (c) Variation of corrosion rate with concentration of (FD) (%) in citric acid solution at 1 h at room temperature, (d) Variation of inhibition efficiency with concentration of (FD) (%) in citric acid solution at 1 h at room temperature

decreases with increasing concentration of additives. This phenomena suggests that the additives are corrosion inhibitor for mild steel in 2 N HCl and 2 N citric acid. From the data of weight loss method, the corrosion rate (CR) was calculated using the equation:

$$\text{Corrosion rate (CR)} = \frac{(87.6 \times W)}{(D \times A \times T)}$$

where W, D, A and T are weight lose (mg), density of mild steel (7.86 g/cc), area of the specimen in cm square and exposure time in hours, respectively.

Similarly, inhibition efficiency was calculated using the equation,

$$\text{Inhibition efficiency (IE) (\%)} = \left[\frac{(W_o - W_i)}{W_o}\right] \times 100$$

where W_o and W_i are the values of the weight loss (g) of mild steel in the absence and presence of inhibitor, respectively. The values of corrosion rate and inhibition efficiency in absence and presence of difference concentration of inhibitor used in 2 N HCl and 2 N citric acid solution at room temperature for 1 h were given in Table-1.

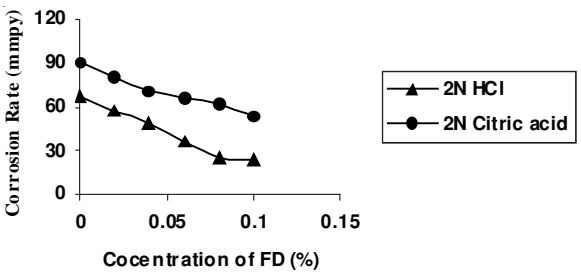
From Table-1, it was clear that the corrosion rate was decreased with increasing concentration of inhibitor and inhibition efficiency increased with increasing the concentration of the inhibitor. In addition, the maximum corrosion inhibition efficiency of formazan of *p*-dimethyl amino benzaldehyde (FD) was 64.09 % at 2 N HCl and 41.03 % at 2N citric acid, respectively at 0.10 % solution of inhibitor in 1 h at room temperature. It was also concluded that the inhibitor was best inhibitor in mild steel corrosion in 2 N HCl and 2 N citric acid. But when comparing with acids the inhibitor efficiency was best in 2 N hydrochloric acid than 2 N citric acid.

Comparison of corrosion inhibitory behaviour of formazan of *p*-dimethyl amino benzaldehyde (FD): Since formazan of *p*-dimethyl amino benzaldehyde is a organic compound which has been used a best inhibitor in the field of corrosion. Hence, formazan of *p*-dimethyl amino benzaldehyde acts as a best inhibitor in both HCl and citric acid. Thus, inhibition behaviour of formazan of *p*-dimethyl amino benzaldehyde increases tremendously in when compared to HCl and citric acid at 1 h at room temperature (Fig. 2).

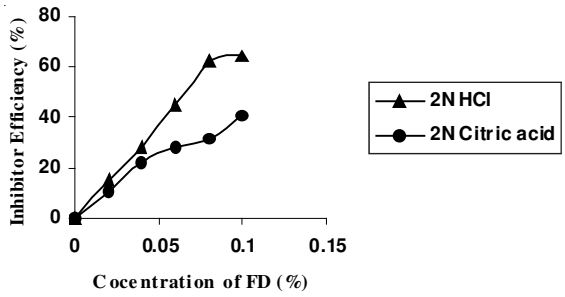
Surface analysis: The polished specimen of mild steel and the test specimens which are immersed in the blank (2 N HCl and 2 N citric acid) and in the inhibitor formazan of *p*-dimethyl amino benzaldehyde for 48 h, then the specimens were observed under scanning electron microscope are shown in Fig. 3 (a and b). It showed a polished specimen which is kept in the blank solution of (2 N HCl and 2 N citric acid),

TABLE-1
CORROSION INHIBITION BEHAVIOUR OF MILD STEEL IN 2 N HCl AND 2 N CITRIC ACID SOLUTION IN ABSENCE AND PRESENCE OF FORMAZAN of *p*-DIMETHYL AMINO BENZALDEHYDE IS STUDIED BY WEIGHT LOSS MEASUREMENT

Corrosion inhibitors	Conc. of inhibitor (%)	Corrosion rate (mm/y)		Inhibitor efficiency (%)	
		2 N HCl	2 N citric acid	2 N HCl	2 N citric acid
Formazan of *p*-dimethyl amino benzaldehyde	Blank	66.4244	90.7206	–	–
	0.02	56.6167	80.9129	14.76	10.81
	0.04	47.9236	70.8824	27.85	21.86
	0.06	36.3328	65.5328	45.30	27.76
	0.08	24.9648	62.1893	62.41	31.44
	0.10	23.8503	53.4961	64.09	41.03

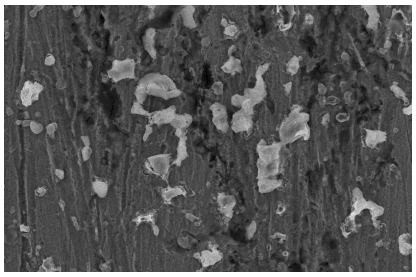


(a)

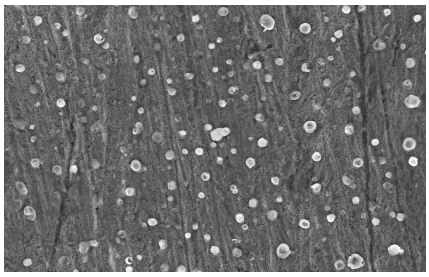


(b)

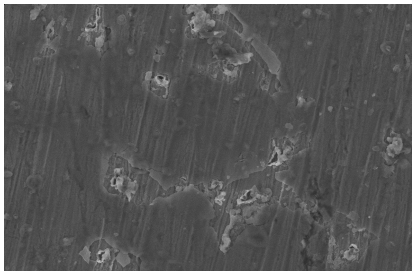
Fig. 2. (a) Comparison of corrosion rate with concentration of FD (%) in HCl and citric acid solution at 1 h at room temperature, (b) Comparison of inhibition efficiency with concentration of FD (%) in HCl and citric acid solution at 1 h at room temperature



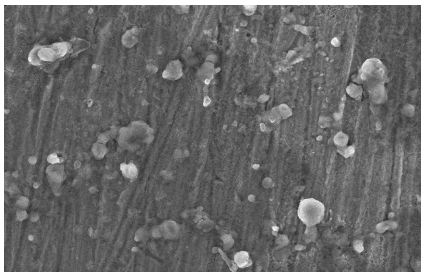
(a) 2 N HCl (blank)



(b) 2 N citric acid (blank)



(c) 2 N HCl (with inhibitor)



(d) 2 N citric acid (with inhibitor)

Fig. 3. Mild steel samples immersed in blank solution and inhibitor solution

which is associated with polishing scratches. Fig. 3 (c and d) showed a specimen which is kept in the (0.10 % concentration of inhibitor solution with 2 N HCl and 2 N citric acid) depends upon the concentration of the inhibitor solution suggesting that the presence of adsorbed layer of the inhibitor on mild steel surface which impedes corrosion rate of metal appreciably.

Conclusion

The formazan of *p*-dimethyl amino benzaldehyde showed good performance as corrosion inhibitor in 2 N HCl and 2 N citric acid solution medium. The inhibition efficiency increased with increase in concentration of inhibitors for 0.02-0.10 % at 1 h at room temperature. The maximum inhibition efficiencies of formazan of *p*-dimethyl amino benzaldehyde were 75.86 % in 2 N HCl and 40.00 % in 2 N citric acid, respectively in room temperature [0.10 %] for 1 h of immersion time. From the comparative studies, it was concluded that the inhibitor efficiency is better in 2 N HCl than 2 N citric acid. So that the mild steel material which has been used in the construction of ship can be prevented by using this inhibitor. Surface analysis study confirms the corrosion of mild steel and its inhibition effect by the inhibitor formazan of *p*-dimethyl amino benzaldehyde.

REFERENCES

1. M. El Achouri, M.R. Infante, F. Izquierdo, S. Kertit, H.M. Gouttoya and B. Nciri, *Corrros. Sci*., **43**, 19 (2001).
2. N.E. Hamner and C.C. Nathan, Corrosion Inhibitors, NACE Houston, Texas, USA, p. 1 (1973).
3. S. Rengamani, S. Muralidharan, M.A. Kulamdainathan and S. Venkatakrishnan, *J. Appl. Electrochem*., **24**, 355 (1994).
4. F. Bentisss, M. Traisnel and M. Lagrenee, *Corros. Sci*., **42**, 127 (2000).
5. S.T. Arab and E.A. Noor, *Corrosion*, **49**, 122 (1993).
6. S.J. Zakvi and G.N. Metha, *Trans. SAEST*, **23**, 4 (1988).
7. L.L. Shreir, Corrosion, George Newnes Ltd., London, Vol. 2 (1963).
8. H.H. Uhilg, Corrosion and Corrosion Control, p. 40 (1964).
9. G. Trabanelli, F. Zucchi and G. Brunoro, *Werkst. Korros*., **39**, 512 (1988).
10. O.K. Abiola, N.C. Oforka and E.E. Ebenso, *Bull. Electrochem.*, **20**, 409 (2004).
11. K. Orubite-Okorosaye and N.C. Oforka, *J. Appl. Sci. Environ*., **8**, 57 (2004).