The Asian Journal of Experimental Chemistry, (June, 2011); Vol. 6 Issue (1) : 38-41

Research Paper :

Diamines as corrosion inhibitors for aluminium alloy in organic acid

ARVNABH MISHRA, D.R. GODHANI **AND** ANIL SANGHANI

See end of the paper for authors' affiliations

Correspondence to:

ARVNABH MISHRA
Department of Chemistry, Advance Research Institute of Basic and Appied Sciences, New Vallabh Vidyanagar, ANAND (GUJARAT) INDIA

ABSTRACT

Aluminium and its alloys are light weight and corrosion resistant material and vitally preferred as materials of construction in many chemical and engineering fields. Nitrogen-containing organic compounds, such as amines and diamine derivatives on the corrosion for many metals in acidic solutions offer good protection of metallic materials. In the present investigation of corrosion inhibition of aluminium alloys of grade 1060, 1100 and 3003 in trichloroacetic acid are analysed by using conductivity and potentiostatic polarization in different inhibitors of diamine such as ethyl amino ethylamine, di-methyl amino ethylamine, 1:3 di-amino propane, tetra methyl ethylene di-amine. Cathodic and anodic polarization curves are showing diamines are acting as mixed inhibitors in the case of alloy of 3003 grade.

KEY WORDS : Diamnes, Conductance, Cathodic and anodic polarization, Trichloroacetic acid

How to cite this paper : Mishra, Arvnabh, Godhani, D.R. and Sanghani, Anil (2011). Diamines as corrosion inhibitors for aluminium alloy in organic acid. *Asian J. Exp. Chem.*, **6** (1): 38-41.

Received : *23.03.2011;* **Revised :** *25.04.2011;* **Accepted :** *19.05.2011*

Aluminium and its alloys are light weight and corrosion resistant material and vitally preferred as materials of construction in many chemical and engineering fields. [1,2]. In every day applications the pure aluminium is not used but an intimate blend of aluminium and other elements are preferred.

Nitrogen-containing organic compounds, such as amines[3-8] and diamine derivatives[9-11] on the corrosion for many metals in acidic solutions offer good protection of metallic materials. Diamine holds two NH_2 groups having the presence of electronegative nitrogen atom in the molecule amines should show good corrosion inhibition.

In the present investigation of corrosion inhibition of aluminium alloys of grade 1060, 1100 and 3003 in trichloroacetic acid are analysed by using conductivity and potentiostatic polarization were measured in different inhibitors of diamine such as ethyl amino ethylamine, di-methyl amino ethylamine, 1:3 di-amino propane, tetra methyl ethylene di-amine.

EXPERIMENTAL METHODOLOGY

Potentiostatic polarization experiments [12] were carried out using a Wenking Potentiostate. The working electrodes for polarization studies were flag-shaped, 2 cm^2, with a side tag of length 40 mm. Part of the tag was blocked off with paraffin wax leaving the upper part bare to make electrical contact. The experiments were carried out in a 200 ml pyrex glass cell containing 100 ml test solution 0.1 N chloro substituted acetic acids, without and with concentration of inhibitors at which maximum efficiency was observed. Platinized platinum foil was used as the auxiliary electrode. Standard calomel electrode with Luggin capillary was used for the measurement of electrode potentials.

EXPERIMENTAL FINDINGS AND ANALYSIS

To measure the effect of concentrations of the inhibitor molecules on the corroding surface the conductance has been determined in the presence of different compounds at the concentration of 2, 4, 6, 8, 10 and 15 ppm for a fixed immersion period of 24 hours at 30^0C.

Table 1 shows that the conductance of the solution in the presence of different concentrations of the compounds before dipping the specimens.

It is evident from the Table that a fall in the conductance of the solution has been noticed. From the Table it can be seen further that the added compound affects the conductance of the solution. Conductance

Table 1 : Conductivity of the solutions in the presence of the nhibitors at 30^{0}C in 0.1N trichloroacetic acid

Inhibitor (ppm)	Conductivity (micromhos) Before specimen	After specimen
Blank	10.50×10^4	
Ethyl amino ethylamine		
2	9.54×10^4	6.2×10^4
4	8.28×10^4	5.96×10^4
6	8.22×10^4	5.46×10^4
8	7.6×10^4	4.68×10^4
10	6.72×10^4	4.62×10^4
15	5.7×10^4	4.46×10^4
Dimethyl amino ethylamine		
2	8×10^4	6.62×10^4
4	5.8×10^4	5.02×10^4
6	3.92×10^4	4.72×10^4
8	2.58×10^4	4.6×10^4
10	2.58×10^4	4.64×10^4
15	2.58×10^4	4.76×10^4
1:3 di amino propane		
2	8.4×10^4	7.74×10^4
4	7.48×10^4	7.04×10^4
6	4.6×10^4	6.1×10^4
8	4.28×10^4	5.16×10^4
10	3.4×10^4	4.92×10^4
15	1.82×10^4	4.8×10^4
Tetra methyl ethylene diamine		
2	8.48×10^4	9.82×10^4
4	7.4×10^4	9.16×10^4
6	5.52×10^4	8.34×10^4
8	4.36×10^4	8.1×10^4
10	3.26×10^4	6.84×10^4
15	1.82×10^4	4.6×10^4

decreases with the rise of the concentration of the compounds. The decrease in corrosion rate with increase in the additive concentration may be due to the oxide film on the aluminium alloys of impervious nature. The rate of migration of Al^{3+} from base metal, on this account, slows down with a consequent decrease in the corrosion rate. Surprisingly, the change in the conductance and corrosion of 1060, 1100 and 3003 aluminium with the concentration of additive is quite similar. The conductance decreases as the concentration of the compound increases. Any change in the corrosion rate may therefore, be attributed to the change in the conductance of electrolyte.

Variation of the steady state corrosion potentials of all the alloys with the concentration of additive is reproduced in the Table 2. It is seen from the Table that the steady state corrosion potentials in the presence of almost all the compounds have shifted towards a more negative direction with the increase in the concentration of added. The fact, that the compounds inhibit corrosion and shift of the potential in the active direction in conjunction with the weight loss studies, indicates that the inhibitors are predominantly effective on the local cathodic corrosion cells. Maximum shift in the 15 mg/l of

Table 2 : Steady state corrosion potential of the 1060, 1100 and 3003 alloys in different concentrations of the compounds Temperature: 30^{0}C

Compound and concentrations (mg/l)	Electrode potential, mV (S.C.E) 1060	1100	3003
Blank	618	630	622
Ethyl amino ethylamine			
4	621	623	633
8	698	643	652
15	716	718	717
Dimethyl amino ethylamine			
4	620	631	620
8	745	718	712
15	862	852	725
1:3 Diamino propane			
4	628	653	659
8	671	680	678
15	684	682	682
Tetra methyl ethylene diamine			
4	683	684	690
8	736	751	702
15	754	780	751

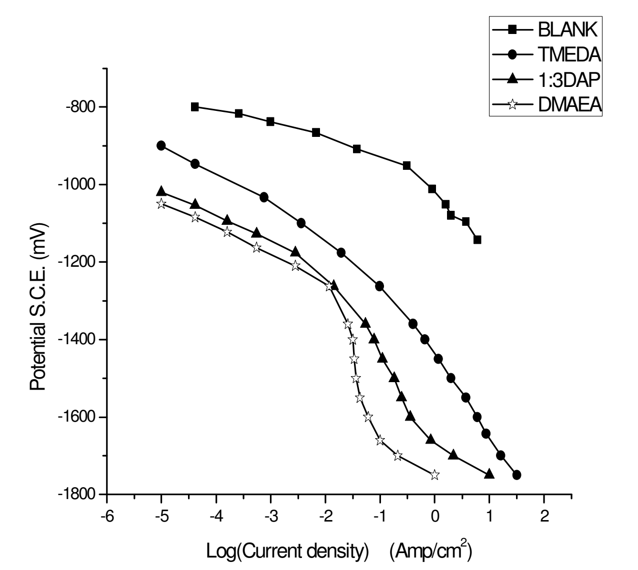

Fig. 1 : Cathodic polarization in the presence of 15 mg/l concentration of the inhibitors for 1060 aluminium alloy

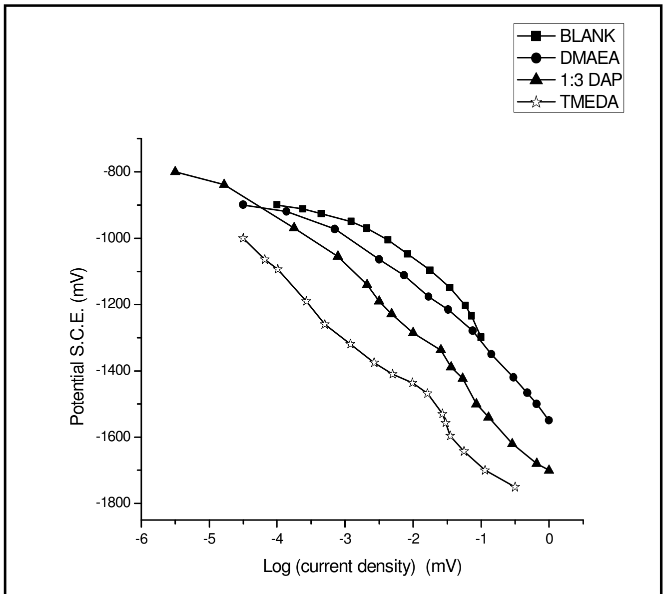

Fig. 2 : Cathodic polarization in the presence of 15 mg/l concentration of the inhibitors for 1100 aluminium alloy

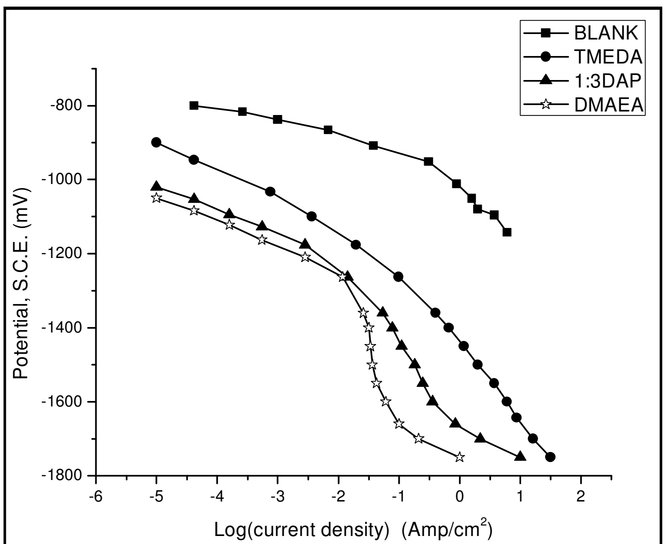

Fig. 3 : Cathodic polarization in the presence of 15 mg/l concentration of the inhibitors for 3003 aluminium alloy

di-methyl amino ethylamine is observed in the case of 1060 alloy. Interestingly, this compound shows maximum efficiency towards this alloy.

Cathodic polarization plots for the alloys have been shown in Fig. 5 to 7. The curves for the other alloys show the same features. Figure shows that the inhibitors are predominantly effective on the local cathodes [13].

The anodic polarization plots of the alloys at various concentrations of di-methyl amino ethylamine, 1:3 diamino propane and tetra methyl ethylene di-amine at 30°C for all the alloys have been shown in Fig. 4 to 6. It was evident from the figures that although the curves in presence of all the inhibitors have been shifted towards a lower current density region, it was most pronounced in the presence of di-methyl amino ethylamine for 3003 alloy which appear to be best inhibitor. This indicates that the diamines act as mixed inhibitors [13,14].

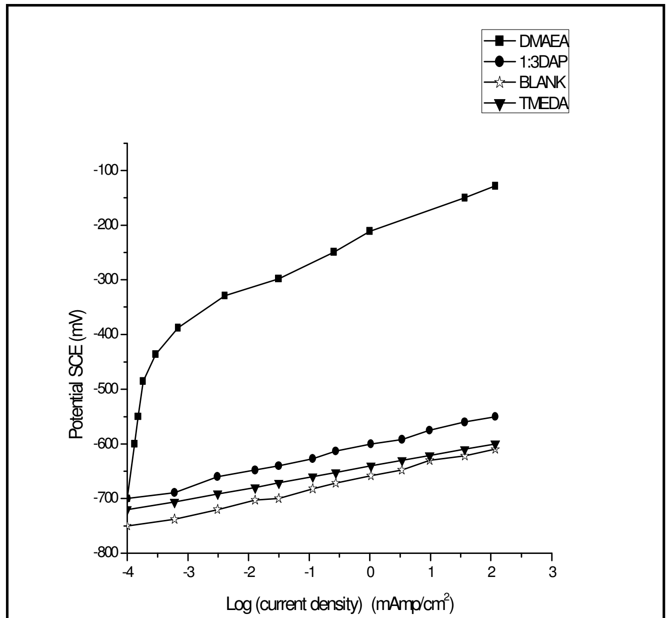

Fig. 4 : Anodic polarization in the presence of 15 mg/l concentration of the inhibitors for 1060 aluminium alloy

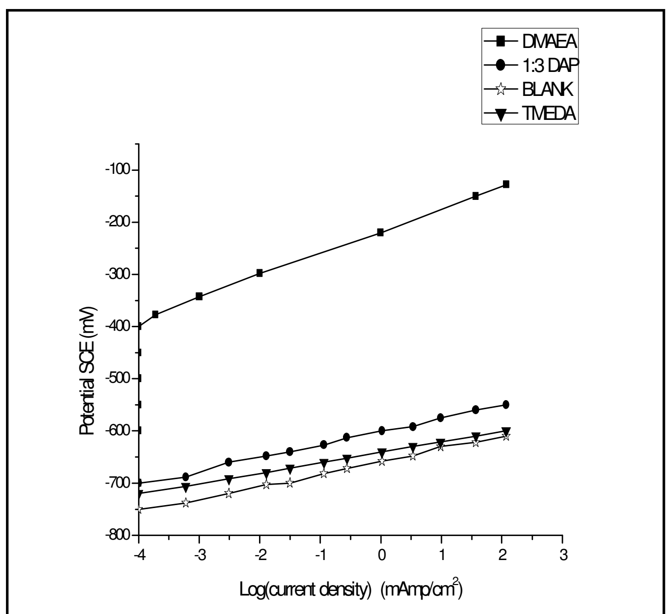

Fig. 5 : Anodic polarization in the presence of 15 mg/l concentration of the inhibitors for 1100 aluminium alloy

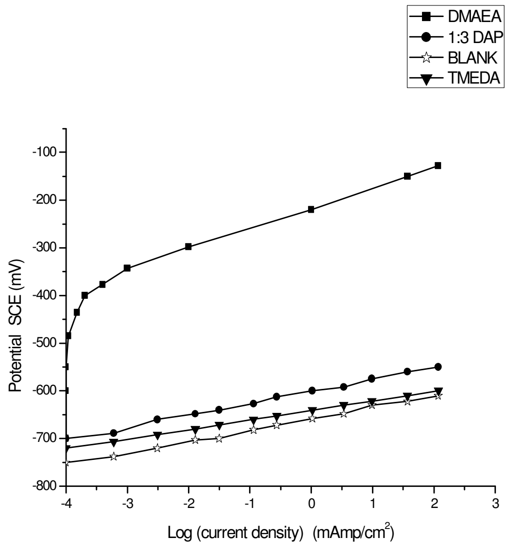

Fig. 6 : Anodic polarization in the presence of 15 mg/l concentration of the inhibitors for 3003 aluminium alloy

Conclusion:

From the above investigation it is observed that dimethyl amino ethylamine effectively controls the dissolution of aluminium alloys in blank trichloroacetic acid. The inhibition efficiencies of the inhibitors increase with the concentrations. These compounds are partially effective on the anodes as they are found to suppress the cathodic reaction.

Acknowledgement:

Authors are thankful to Head. Department of Chemistry. Bhavnagar University, Bhavnagar, for providing research as well as instrumental facilities. Authors are also thankful to Dr. V. D. Bhatt Head. Department of Chemistry. N.V.Patel College of Pure and Applied Sciences at V.V.Nagar for providing his valuable suggestions and lab facility.

Authors' affiliations:

D.R. GODHANI AND ANIL SANGHANI, Department of Chemistry, Bhavnagar University, BHAVNAGAR (GUJARAT) INDIA

REFERENCES

1. **Mishra, A .**, Sanja, D.B.,Sanghani, A.M. and Godhani, D.R. (2008). *Int. J. Chem. Sci.*, **6**(2) : 665-675.
2. **Godhani, D.R.**, Mishra, A., Sanghani, Anil and Sanja, Divyesh (2008). TAJEC, **3**(1&2) : 36.
3. **Tebbji, K**., Bouabdellah, I., Aouniti, A., Hammouti, B., Oudda, H., Benkaddour, M. and Ramdani, A. (2006). *Material Letters*, **61** : 804.
4. **Alsabagh, A.M.**, Migahed, M.A. and S. Awad, Hayam (2006). *Corro. Sci.,* **48** : 813.
5. **Migahed, M.A.**, Abd-E1-Raouf, M., Al-Sabagh, A.M. and Abd-E1-Bary, H.M. (2006). *J. App. Electrochein*, **36** : 395.
6. **Fouda, A.S.**, Mostafa, H. A., El-Taib, F. and Elewady, C.Y. (2005). *Corro. Sci.,* **47** : 1988.
7. **Sathiyanarayanan, S.,** Marikkannu, C. and Palaniswamy, N. (2005). *Appl. Surf. Sci.,* 241.
8. **Ashassi-Sorkhabi, H.** and Nabavi-Amri, S. A. (2002). *Electrochi, n. Acta*, **47** : 2239
9. **Ouchrif, A.**, Zegmout, M., Hammouti, B., Dafali, A., Benkaddour, M.A. and Ramdani, S. Elkadiri, (2005). *Frog. Org'. Coat.,* **53** : 292.
10. **Au, Sk. A.** and Saeed, M.T. (2001). *Polymer*, **42** : 2785.
11. **Shokry, H.,** Yuasa, M., Sekine, I., Issa, R. M., El-baradie, H.Y. and Comma, G.K. (1998). *Corro. Sci*., **40** : 2173.
12. **Gatos, H.C.** (1956). *Corrosion*, **12** : 23.
13. **Ajmal, Mohammad,** Rawat, Jaya and Quraishi, M.A. (1998). *J. Anti-corrosion Methods & Materials*, **45** (6) : 419.
14. **Herrag, Hammoutiet** *et al.* (2007). *Acta Chim. Slov.,* **54** : 419.

****
******
***