Polarisation Behaviour of Some Aluminium alloys in Ethylamine and Effect Thereof

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Polarisation behaviour of 1060, 1100 and 3003 aluminium alloys in ethylamine shows that nitrogen atom of ethylamine containing lone pair of electrons influences the polarisation behaviour of these alloys. The alloys become passive by the adsorption of ethylamine on their surfaces. They are cathodically polarised to maximum extent in 0.1 % ethylamine.

Amines are known as effective inhibitors for the corrosion of metals in acid medium because of their adsorption behaviour [1-6]. The potentiostatic method has been used to understand the mechanism of adsorption of ethylamine from aqueous medium on aluminium surface.

EXPERIMENTAL

Aluminium alloys (supplied by HINDALCO, Renukoot, Sonbhadra, India) were found to have the composition shown in the Table 1. Flag shaped electrodes (area 2 cm^2) of the above alloys were used in the study.

Table 1

Composition of the Aluminium Alloys Used in the Present Study

Grade	Si%	Fe%	Mn%	Mg%	Cu%	Al%
1060	0.12	0.02	0.04	-	-	99.82
1100	0.13	0.52	0.068	0.021	0.01	99.251
3003	0.16	0.58	0.78	-	-	98.48

Ethylamine solutions were prepared in distilled water. Steady state potential attained in solutions at 35±0.2° were recorded wrt SCE. The specimens were polarised at first cathodically and then anodically. The details of experimental procedure is described earlier [6].

RESULTS

The anodic polarisation curves in presence of different concentrations of ethylamine are given in Fig 1A B & C. The derived values are presented in Table 2.

Cathodic polarisation curves of alloy 1060 are given in Fig 2 (Note that here X axis is log current density unlike in Fig 1). For the other two alloys the cathodic polarisation curves are very close to the curves in Fig 2.

It is obvious from the Table that steady state corrosion potential for all alloys increases with decreasing concentration of ethylamine but critical current density decreases. In the case of 1060 alloy, primary passivation potential remains constant

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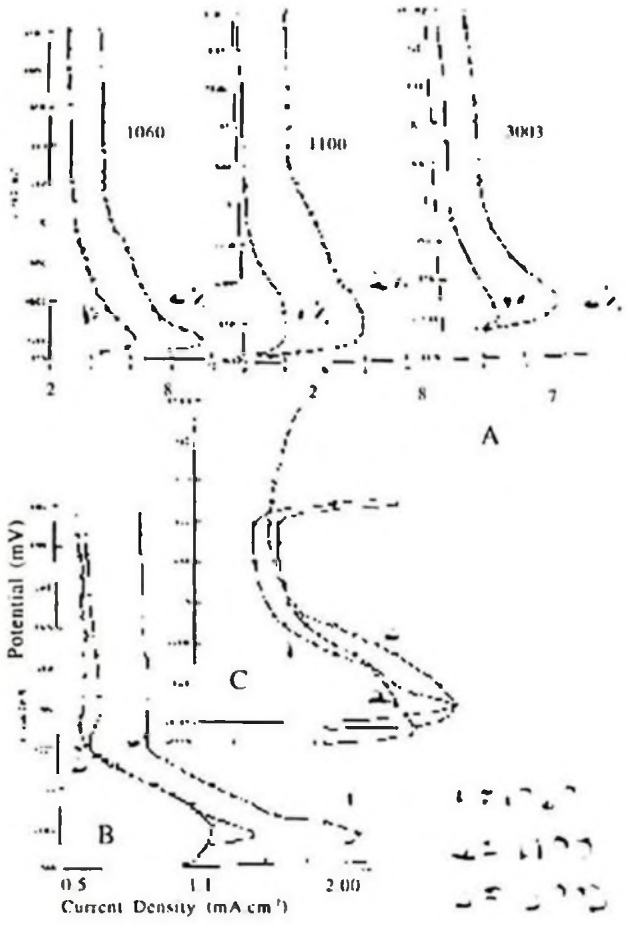


Fig.1 - Anodic Polarisation Curves for 1060, 1100 and 3003 Alloys
Temperature 35°C
A 1% and 2% Ethylamine; B 0.5% Ethylamine; C 0.1% Ethylamine

(-1200 mV) upto 0.5% ethylamine and increases thereafter. This potential change for 1100 aluminium are similar. The maximum value observed is for 3003 alloy in 0.1% ethylamine. It is further seen from the table that breakdown potentials in presence of 0.5% ethylamine for the alloys are -100, -100 and -300 mV. In presence of 0.1 % amine the values are +1000, +600 and +600 mV. Anodic curves (Fig 1) show active passive behaviour of aluminium electrodes in different compositions of ethylamine. In case of 2% and 1% ethylamine, the film formed on the metal surface

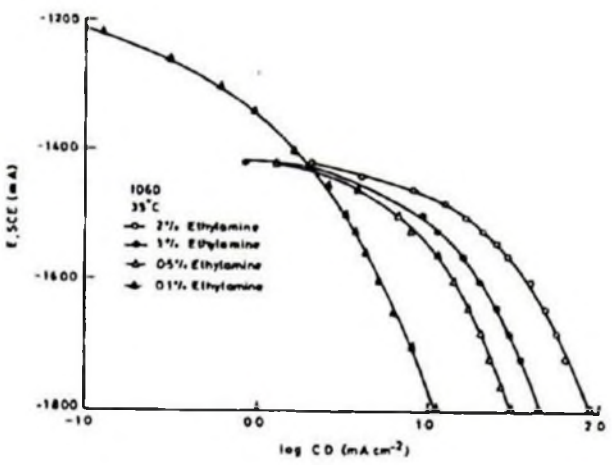


Fig.2 - Cathodic Polarisation Curves for 1060 Aluminium
Temperature 35°C

Table 2

Derived Corrosion Parameters of Alloy in Presence of Inhibitors

Steady State Corrosion Potential (Ecp in mV);
Primary Passivation Potential (Epp in mV)l
Break down Potential (Eb in mV);
Critical Current Density (Ic in mA/cm²);

Amine Concen.	Parameter Ecp	Epp	Eb	Ic
	Alloy 1060			
2%	-1370	-1200	-	9.5
1%	-1360	-1200	-	6.25
0.5%	-1340	-1200	- 100	1.95
0.1%	-1140	-1000	+1000	0.2
	Alloy 1100			
2%	-1540	-1200	-	8.00
1%	-1520	-1100	-	4.275
0.5%	-1450	-1000	- 300	1.195
0.1%	-1440	-1000	+ 600	0.17
	Alloy 3003			
2%	-1380	-1000	-	6.7
1%	-1340	-1200	-	3.81
0.5%	-1320	-1200	- 100	1.45
0.1%	-1240	- 900	+ 600	0.195

does not rupture even at a potential of 2000 mV, while such type of behaviour is not observed in 0.5% and 0.1% ethylamine. Both anodic and cathodic polarisation curves move towards lower region of current density with dilution of ethylamine. Maximum cathodic polarisation behaviour of the electrodes is found in 0.1% ethylamine. The extent of cathodic polarisation increases in the order : 1060 < 3003 < 1100.

DISCUSSION

The electron density on N atom is higher in ethylamine, than in ammonia because of the presence of ethyl group. Thus ethylamine is protonated easily. In protonated ethylamine, three H atoms bonded to N atom are available for hydrogen bonding with oxygen atoms of water molecules.

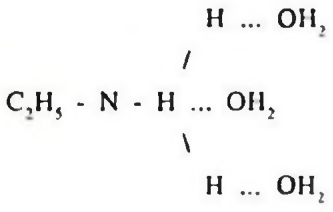


Table 3

Amine Concen.	pH of the -	solutions after polarisation in 1060	1100	3003
2%	11.58	11.21	11.20	11.00
1%	11.32	10.95	10.82	10.78
0.5%	11.15	10.64	10.51	10.48
0.1%	10.77	10.10	10.10	10.05

It seems that such hydrated ethyl ammonium ion gets adsorbed on aluminium surface *via* oxygen atom when the electrode is made anode with respect to the auxiliary electrode. As a result of this, a film is brought into existence on aluminium surface. Therefore, current density decreases with potential. It is due to this fact active-passive nature of electrode is seen. During cathodic polarisation, the protonated ethylamine associated with water molecules is adsorbed on the cathodic sites of the electrode *via* N atom having positive charge and covers large surface area. Because of this reason, both anodic and cathodic polarisation curves move towards low region of current density by diluting ethylamine. The pH of the test solution (Table 3) measured after polarisation also supports the above explanation. The presence of non-breakable film on aluminium (in 2% and 1% ethylamine) even at a potential of 2000 mV may be due to the higher rate of adsorption than desorption of ethylamine.

CONCLUSIONS

Anodic curves showing active-passive region have been obtained in all compositions of ethylamine. Lone pair electron of nitrogen atom of $C_2H_5NH_2$ is responsible for the adsorption of the molecule on metallic surface.

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