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INHIBITION EFFECT OF POLYMERIC MATERIAL ON THE SURFACE OF ALUMINIUM IN METHANE SULPHONIC ACID

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Abstract:

The corrosion behaviour of aluminium in 1 M Methane sulphonic acid was studied by gravimetric method in absence and presence of poly ethylene glycol as inhibitor. The Inhibition Efficiency was found to increase with inhibitor concentration and decrease as temperature decreased. Data showed that Langmuir adsorption isotherm represents surface coverage versus inhibitor concentration indicating that inhibition is due to monolayer adsorption of inhibitor on aluminium surface.

Keywords: Aluminium, Poly Ethylene Glycol, Inhibition & Adsorption

1. Introduction:

The corrosion behaviour of amorphous metallic alloys is important property to understand their chemical stability against corrosive environment. Corrosion is the process produces a new and less desirable material from the original metal and can result in a loss of function of the component or system.. Usually corrosion consists of a set of redox reactions that are electrochemically in nature. Because of the electrochemical nature of most corrosion processes, electrochemical methods are useful tools for studying corrosion (1-5). More specifically, electrochemical techniques can be used to measure the kinetics of electrochemical processes (e.g., corrosion rates) in specific environment and also to measure and control the oxidizing power of the environment. Aluminium and its alloys are important materials which are used in many engineering applications such as constructions, vehicles, chemical reactors, pipes and batteries. Aluminium forms a protective layer of oxide on its surface but this oxide dissolves and makes the metal susceptible to corrosion in acid, salty and alkaline media. Refinery corrosion is generally caused by a strong acid attacking the equipment surface [6]. The other important field of applications is acid pickling, industrial cleaning, acid descaling, oil-well cid in oil recovery and the petrochemical processes. [7] Mineral acids including H_2SO_4 and HCl are most widely used acids. When compared to other mineral acids, Methane Sulphonic Acid is usually described as a “green acid” due to its environmental advantages [8, 9]. Methane Sulphonic Acid is a colourless liquid with the chemical formula CH_3SO_3H. MSA is far less corrosive and toxic than usual mineral acids employed industrial processes [10]

Corrosion control can be achieved by the use of inhibitors 11]. This phenomenon necessitates the continuous search for better corrosion inhibitors due to vast differences in the media encountered in industry which remains a focal point in corrosion control as inhibitors slow down the corrosion process on metal. A corrosion inhibitor is a chemical additive which when added to a corrosive aqueous environments reduces the rate of metal wastage.A number of organic compounds [12-20] are known to be applicable as corrosion inhibitors for aluminium in acidic environment.

The use of polymers as corrosion inhibitors has attracted considerable attention due to their inherent stability and cost effectiveness. Polymers are used as corrosion inhibitors because through their functional groups, they form complexes with metal ions and on the metal surface these complexes occupy a large surface area, there by blanketing the surface and protection the metal from corrosive agents present in the solution. [21].

The importance of corrosion studies are (i) Economic factor which is the prime motive for much of the current research in corrosion (ii) Improved the design of the operating equipment (iii) Conservation of energy and resources.

Some of the disastrous effects of corrosion are (i) Reduced value of goods due to deterioration of appearance (ii) Contamination of fluids in vessels and pipes (iii) Hazards or injuries to people arising from structural failure or breakdown (e.g bridges, cars, aircrafts etc.) (iv) Reduced mechanical strength of metal, etc.

The purpose of the present work is to study the inhibitive action of poly ethylene glycol on aluminium in IM MSA using weight loss techniques and thermometric method.

2 .Experimental Procedures:

Materials and methods:

Aluminium metal with purity 98.5% was used in the present study. Each sheet was 0.1 cm in thickness and was mechanically press cut into 5cm X 2.5 cm coupons. Each specimens were ground manually under a stream of water starting with 400 grit SiC paper and continued and with 800, 1000, 1200 grit papers. The polished specimen are degreased with trichloroethylene and used for weight loss and thermometric method.

Inhibitor Preparation:

The inhibitor employed in this investigation was Poly ethylene glycol. Five different inhibitor concentrations (200, 400, 600, 800 and 1000 mg/L) were prepared by using distilled water.

Corrosion Measurements:

The polished and pre weighed aluminium specimens of uniform size was suspended in 100 ml test solution with and without inhibitor at different concentration for a period of 3 hours. Then the specimens were washed, dried and weighed. The weight loss was calculated. From this data, corrosion rate (CR) and inhibition efficiency (IE) and Surface coverage (θ) was calculated from the following equation [22]:

$$\text{Corrosion rate} = \frac{\text{Weight loss} \times 100}{\text{Surface area } (dm^2) \times \text{Time (days)}} \quad (1)$$

$$\text{Inhibition Efficiency} = \frac{W_1 - W_2 \times 100}{W_1} \quad (2)$$

Where W_1 and W_2 are weight losses in acids without and with the inhibitor respectively.

$$\text{Surface Coverage} = 1 - \frac{(CR_{\text{with inhibitor}})}{(CR_{\text{without inhibitor}})} \quad (3)$$

Temperature Effects:

The same procedure adapted for weight loss studies at temperature study was varied from 30°C to 60°C in the absence and presence of inhibitor at different concentration.

3. Results and Discussion:

Weight Loss Measurements:

The weight losses for aluminium in various concentrations of poly ethylene glycol were determined. The results obtained are presented in table 1. , it was observed that polyethylene glycol inhibits the corrosion of aluminium in 1M MSA solution at all concentration used in study from 200 to 1000 ppm. Maximum inhibition efficiency was shown at 1000 ppm and it reached 84.2%. It is evident from Table 1, that the corrosion rate is decreased with increasing the concentration of PEG.

Concentration ppm	CR (mdd)	% of I.E	(θ)
Blank	137.6	-	-
200	98.24	28.6	0.29
400	68.14	50.5	0.51
600	47.21	65.7	0.66
800	31.21	77.3	0.77
1000	22.16	84.2	0.84

Table 1: Corrosion parameters of aluminium in 1 M MSA in absence and presence of different concentration of PEG from weight loss measurements

The Corrosion rate values were plotted against the concentration of PEG in Fig 1

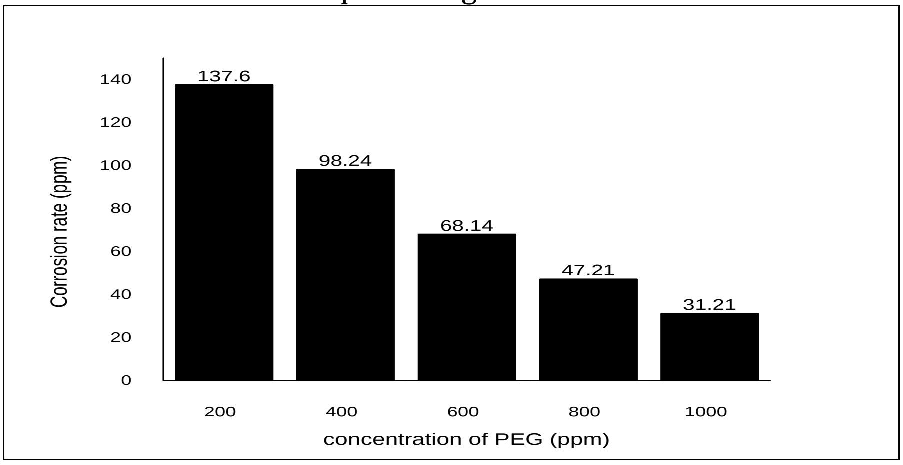

Figure 1: Corrosion rate of aluminium in 1M MSA

Inhibition Efficiency and Surface Coverage:

The characterization of the corrosion rate of aluminium in the different inhibitor solutions will carried out by an assessment of Inhibition Efficiency. The percentage of inhibition efficiency and surface coverage was calculated and represented in table: 1. the results indicate that increase the % of I.E as concentration of inhibitor increases. A parameter (θ) which represents part of metal surface covered by inhibitor molecules were calculated for different inhibitor concentrations. The results show that surface coverage increases as concentration of inhibitor increases. The inhibitor molecule adsorbed at aluminium sample/ solution interface where adsorbed species mechanically screen the coated part aluminium surface from action of corrosive medium.

Adsorption Consideration:

In the present study Langmuir adsorption consideration was found to be suitable for the experimental findings and had been used to describe the adsorption characteristic of inhibitor. According to Trabenelli (1987), physisorption is weak indirect interaction due to electrostatic interaction between inhibiting organic ions or dipoles and the electrically charged surface of the metal. Langmuir adsorption isotherm is expressed in Eq (4).

$$\frac{C_{inhibitor}}{\Theta} = \frac{1}{K} + C_{inhibitor} \qquad (4)$$

The plot of the ratio of the concentration to surface coverage (C/θ) against Concentration displayed a straight indicates that the adsorption of the compound on the composite surface follow Langmuir adsorption isotherm shown in fig.2.

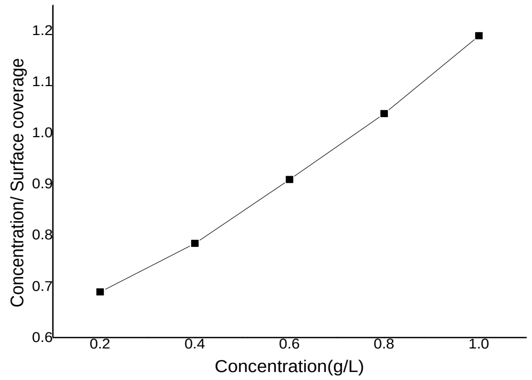

Figure 2: Langmuir isotherm for PEG adsorption on aluminium in 1 M MSA

Effect of Temperature:

The corrosion inhibition of aluminium in 1 M MSA in the presence of PEG at 30 – 60°C was studied using gravimetric techniques.[23].Results obtained indicate that increased in temperature increases the corrosion rate but decreased the inhibition efficiency. Table 2 shows he values of inhibition efficiency obtained at different concentration of PEG.

Table 2: Inhibition efficiency of aluminium in 1 M MSA containing PEG at different temperature:

Concentration (ppm)	Inhibition Efficiency (%)			
	30°C	40°C	50°C	60°C
200	28.6	24.54	18.67	14.53
400	50.5	43.67	34.45	27.60
600	65.7	58.90	51.67	38.45
800	77.3	68.45	59.34	51.12
1000	84.2	76.78	71.56	63.67

Conclusion:

Poly ethylene glycol showed good corrosion inhibition properties of aluminium in 1.0M Methane sulphonic acid. The Inhibition Efficiency increased with increase inhibitor concentration but decreased with increase in temperature. Adsorption of this inhibitor on the aluminium surface can be closely modeled to the Langmuir adsorption isotherm.

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