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Aluminum Corrosion Inhibitors in Acidic Media

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ABSTRACT

Aluminum is actually a very active metal, meaning that its nature is to oxidize very quickly.While a weakness for most metals; this quality is in fact the key to its ability to resist corrosion.
The effect of new corrosion inhibitors, on the corrosion of Al surface in acidic media was investigated by weight less measurements.
Results showed that the inhibition occurs through adsorption of the inhibitor molecules on the metal surface. In present study the inhibition efficiency of thiourea molecule and pyridine molecule and Bis-and mono-azo dyes molecule, in different concentrations HCl solution has been calculated by weight loss measurements. It was found that the corrosion of aluminum in 0.2M HCl solution was considerably reduced in presence of such inhibitors.
KEY WORDS: Aluminum , corrosion inhibition , organic compounds.

1. INTRODUCTION

Aluminum and its alloys have a remarkable economic and attractive materials for engineering placations owing to its low cost, light weight, high thermal and electrical conductivity [1].The corrosion of aluminium is a fundamental academic and industrial concern that has received a considerable amount of attention [2] .The use of inhibitors during acid pickling procedure is one of the most practical methods for protection against corrosion in acidic media. Most of the effective and efficient organic inhibitors are those compounds containing hetero-atoms such as oxygen, nitrogen, sulphur, and phosphorus which allowed adsorption on the metal surface [3,4].

The effectiveness of organic compounds as corrosion inhibitors can be ascribed to the adsorption of molecules of the inhibitors through their polar functions on the metal surface [5]. The adsorbed molecules mechanically screen the coated part of the aluminium surface and therefore protect it from the action of the corrosion medium, and their adsorption in the double layer does not affect the mechanism of hydrogen evolution. The higher inhibition efficiency of the thiourea, pyridine and azo dye additives in acidic than in alkaline media may be due to the less negative potential of Al in HCl, favouring adsorption of the additive. The presence of chloride ions (HCl) has been proposed to facilitate the adsorption of organic cations, due to the fact that they form intermediate bridges in which the negative charge of the Al-Cl dipoles may be oriented towards the solution. Formation of such dipoles also increases with increase of chloride concentration[6].

Inhibitors, which reduce corrosion on metallic materials, can be divided into three kinds: (i) inorganic inhibitors, (ii) organic inhibitors and (iii) mixed material inhibitors [7,8]. The extent of adsorption depends on the nature of the metal, the metal surface condition, the mode of adsorption, the chemical structure of the inhibitor, and the type of corrosive media [9]. The purpose of the present investigation is to look for economic and environmentally acceptable alternatives to the expensive and systems in common use [10].

2. EXPERIMENTAL

The experiments were performed with aluminum sheets of 2 mm thickness was mechanically press-cut into 3 × 3 cm coupons. They were mechanically polished with emery paper (a coarse paper was used initially and then progressively finer grades were employed), ultrasonically degreased in alkaline degreasing mixture, washed with distilled water and dried and weighed. Aluminum pieces were immersed in test solution of HCl of different concentrations with and without the inhibitors for 15,30,45,60,75 and 90 min.
Corrosion rates (weight loss per cm^2 per hour) were calculated using following expression.

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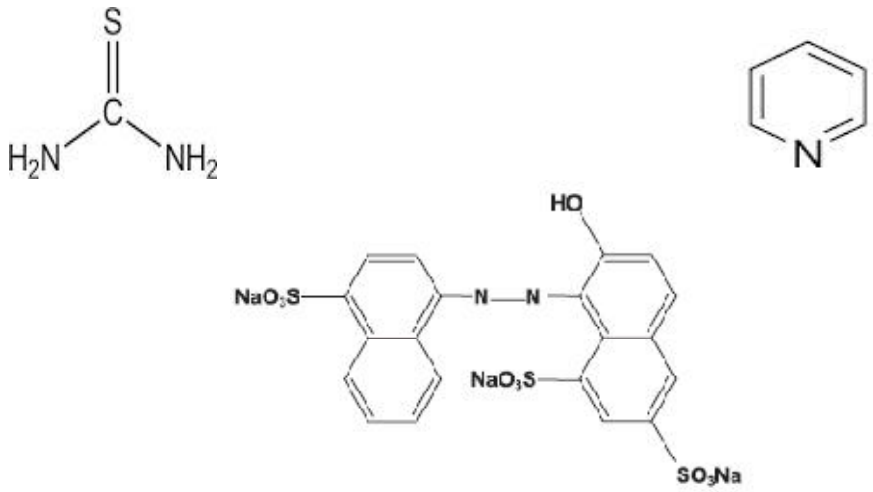
$$\text{Corrosion rate } (g.cm^{-2}\ h^{-1}) = \frac{W_1 - W_2(g)}{Surfacearea(cm^2) \times Time(h)}$$

W1 = initial weight of coupon
W2 = weight of coupon after treatment
W1 - W2 = weight loss (g)

3. DISCUSSION AND RESULTS

The inhibition efficiency depends on parameters of system: metal composition, pH and structure of inhibitor molecule. It is well known that organic compounds containing nitrogen, oxygen, sulphur atoms are good corrosion inhibitors for many metals in various acidic media [11, 12]. Recently, it was reported that of thiourea molecule and pyridine molecule and Bis-and mono-azo dyes, has been used as corrosion inhibition of the aluminum electrode.



Molecular Structure of Thiourea, pyridine and Mono-azo dye

Corrosion rate of aluminum increased with increasing the concentration of HCl solution. Figure 1 shows the weight loss (g/cm^2) with exposure time plots for different concentrations of HCl solution. Figure 2 shows the weight loss (g/cm^2) with exposure time plots for 0.2 M HCl solution in presence and absence of inhibitors.

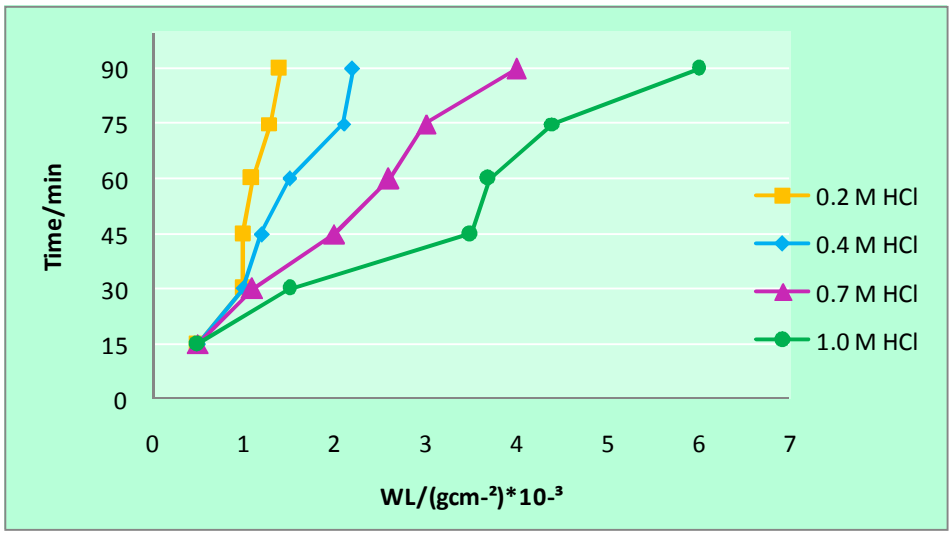


Fig.1: Weight loss versus time plots for the corrosion of aluminum in HCl of various concentrations.

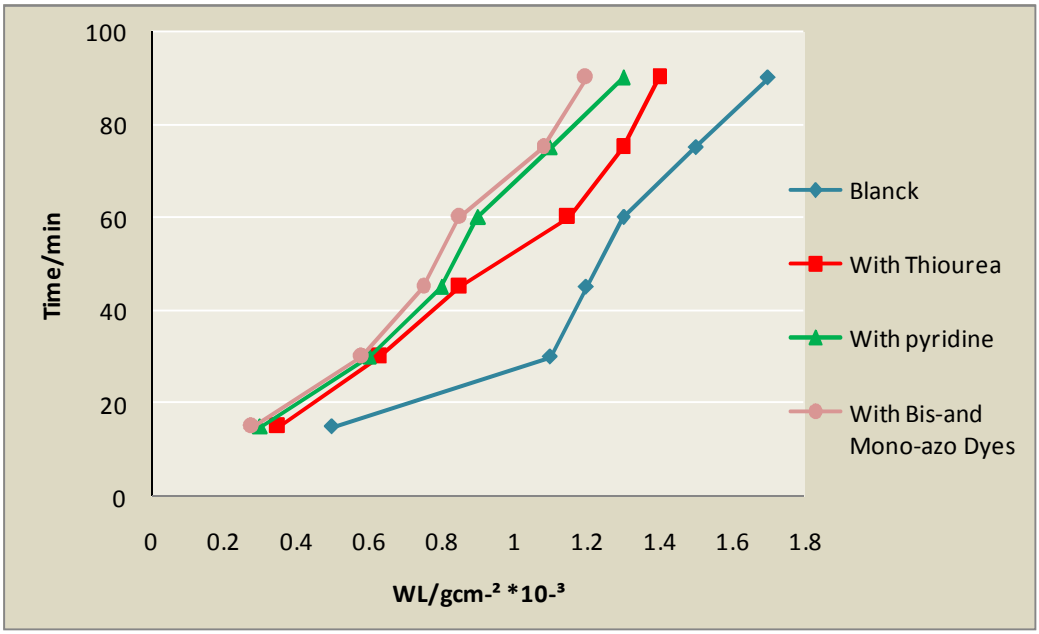


Fig.2: Weight loss versus time plots for the corrosion of aluminum in 0.2 M HCl in absence and presence of inhibitors.

4. Conclusion

A number of organic compounds have been introduced as aluminium corrosion inhibitors in acidic and media. Their inhibitory action is connected with several factors: (i) the structure of molecules, (ii) the number and type absorption sites, (iii) the distribution of charge in the molecules. This work is aimed to investigate the inhibitory effect of some bis- and mono-azo dye derivatives and thiourea and pyridine on corrosion of aluminium in HCl solution by weight-loss, thermometric and polarization measurements.

The inhibiton efficiencies of these organic compounds increase with increasing concentration molecular weight and immersion time. Results obtained from the chemical and electrochemical measurements are in good agreements.

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