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INHIBITION STUDY OF AL 5083 CORROSION IN 1 M HYDROCHLORIC ACID SOLUTION BY 2-CHLORO 3-FORMYL QUINOLINE

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ABSTRACT

The corrosion inhibition study of 2-chloro 3-formyl quinoline was conducted for Al5038 corrosion in 1 M hydrochloric acid solution at a Laboratory temperature by electrochemical measurements. Inhibition efficiency increases with the increase of inhibitor concentration. The polarization measurement reveals that the inhibitor acts as the mixed type and this inhibition effect is attributed to the adsorption of the inhibitor on the surface of Al 5083 from the bulk of the solution. Scanning electron microscopy (SEM) micrographs were used to investigate the surface morphology of the Al sample in presence and absence of inhibitor.

KEYWORDS: 2-Chloro 3-formyl quinoline Al 5083 Acid Media

INTRODUCTION

Al 5083 is one of the most important alloys of Al, which has the wide range of industrial applications. The corrosion of Al is of fundamental, academic and industrial concern that has received a considerable amount of attention [1]. The Al 5083 is handled under acids, alkalis and salt solutions in various industrial processes. Therefore, under these con- ditions chlorides, sulfates and nitrates are aggressive and cause corrosion. Various corrosion controlling methods were used to protect the metals such as protective coat- ings, cathodic protection and the use of corrosion inhi- bitors. Among these methods, the use of corrosion inhibitors is the most convenient and practical method to protect the metals from attack of corrosion [2]. In this method, corrosion inhibitor molecules get adsorbed on the surface of the Al 5083 from the bulk of the solution, which blocks the active corrosion sites, which retards the corrosion [3].

2-Chloro 3-formyl quinoline was selected as a corrosion inhibitor for Al 5083 corrosion in 1 M HCl, which is a heterocyclic organic compound that consists of electron-rich species such as nitrogen, oxygen and p electrons in the heterocyclic ring system. Inhibitor molecule is planar in its structure and free from toxic groups, which gives scope to study it as a potential corrosion inhibitor for Al 5083 in 1 M HCl [4]. Corrosion inhibition effect of the inhibitor on cor- rosion of Al 5083 in 1 M HCl has been investigated by weight loss, electrochemical Tafel polarization and electro-chemical impedance spectroscopy (EIS) measurements.

EXPERIMENTAL

Materials

Al 5083 strips (composition: 0.16 % C, 0.35 % Mn, 0.016 % Si, 0.01 % P, 0.029 % S, 0.06 % Cr, 0.1 % Cu and

the remaining is Al) with a dimension of 5 cm 1 cm 0.1 cm were used for weight loss method, and the same strips with an exposed area of 1 cm2 (re- maining portion was insulated by resin) were used for electrochemical measurements. The strips were abraded with emery papers from grade number 80 up to 2000. AR grade hydrochloric acid and double-distilled water were used to prepare the 1-M HCl corrosive media for all the experiments. 2-Chloro 3-formyl quinoline is having molecular weight 191.61 and a melting point of 144 °C, which is soluble in ethanol. For all the experiments, the inhibitor was first dissolved in 2 ml of ethanol and then added to HCl media. The molecular structure of 2-chloro 3-formyl quinoline is as shown in Figure.1

METHODS

Weight Loss Measurement

Mild steel strips of different weights were immersed in different beakers containing 100 ml of 1 M hydrochloric acid solutions(with 2 ml ethanol) in the absence and presence of different concentrations such as 50, 100, 150 and 200 ppm of 2-chloro 3-formyl quinoline for about 4 h immersion time at room temperature. Mild steel strips were weighed after and before immersion time to record the weight difference. By the help of weight differences corrosion rate and inhibition, efficiency was calculated.

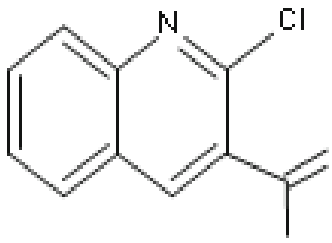


Figure 1: -Chloro 3-Formyl Quinoline

Tafel Polarization Measurement

Tafel polarization measurement was carried out with the use of three electrode system such as the working electrode (Al 5083 strip), a counter electrode (platinum) and a reference electrode (SCE) by using a CHI-608E(USA) electrochemical workstation at a Laboratory temperature . In this measurement potential–current curves were recorded at a scan rate of 0.001 V/s in the given potential range.

Electrochemical Impedance Spectroscopic (EIS) Measurement

The electrochemical impedance spectroscopy (EIS) mea- surement was carried out for the Al 5083corrosion in 1 M HCl at a Laboratory temperature. In this measurement, impedance spectra were recorded by AC signals with amplitude of 5 mV/s at OCP in the frequency range from 0.1 kHz up to 1 Hz.

Scanning Electron Microscopy (SEM)

The SEM micrographs of Al 5083 in the absence and presence 2-chloro 3-formyl quinoline for about 4 h immersion period in 1 M HCl were recorded using scan- ning electron microscopy (JEOL JSM-840A model).

RESULT AND DISCUSSION

Table 1: Corrosion Parameters Obtained from the Weight Loss Measurement for Al5083 in the Absence and Presence of Various Con- Centrations of 2-Chloro 3-Formyl Quinoline in 1 M HCl

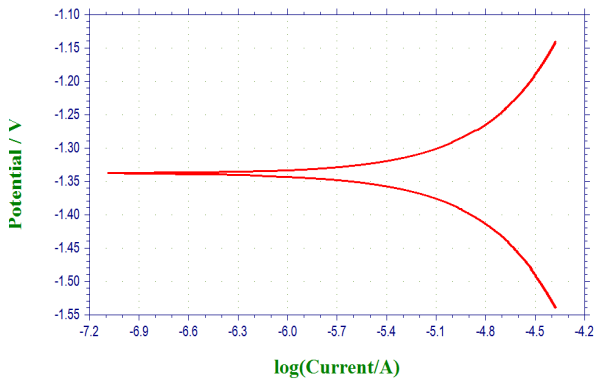
Corrosive Medium of 2-Chloro 3-Formyl Quinoline (ppm)	Corrosion Rate (CR) (g/cm2 h)	Inhibition Efficiency (g*w*)
		(%)
Blank	0.234	–
50	0.156	57.89
100	0.114	71.16
150	0.087	79.44
200	0.032	91.33

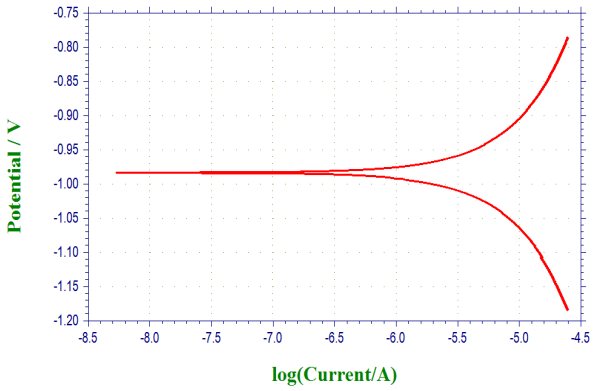
Weight Loss Measurement

The values of corrosion rate (CR) and the inhibition effi- ciency (g*w*) of inhibitor for Al5083 corrosion in 1 M HCl were obtained from weight loss measurement in the absence and presence of various inhibitor concentrations as reported in Table 1, where m and mi are the corrosion rates of Al 5083 in the presence and absence of inhibitors in the solution, respectively. Corrosion rate (CR) of the Al 5083 increases with the increasing of inhibitor concentration (Table 1) due to the blocking of active corrosion sites by the inhibitor molecules on the surface of the Al 5083. The inhibition effi-ciency (gw) of inhibitor increases with the increasing inhibitor concentrations of 50–200 ppm. The inhibition efficiency of QMC (2-chloro quinoline 3-carbaldehyde) for Al 5083 in 1 M HCl was reported as 80 % [5]. Therefore, the present work shows that the 2-chloro 3-formyl quino-line acts as an efficient inhibitor with maximum inhibition efficiency of 88.22 %. This behavior can occur due to the strong interaction of the inhibitor with the metal surface by adsorption. Therefore, continuous adsorption of inhibitor the surface of Al 5083 covers the surface area to protect the metal from attack by corrosion [6].

Tafel Polarization Measurement

The Tafel polarization plots were recorded for the Al 5083 corrosion in the absence and presence of 2-chloro 3-formyl quinoline in 1 M HCl solution at a Laboratory temperature





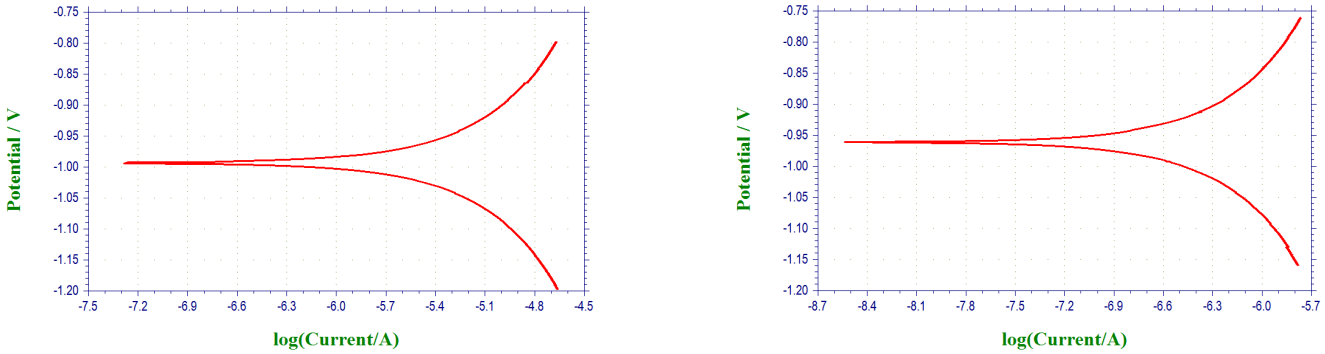


Figure 2: Tafel Plots for Mild Steel in the Absence and Presence of Different Concentrations of 2-Chloro 3- Formyl Quinoline in 1 M HCl Solution

The results obtained by Tafel polarization method reveals that the corrosion current density (icorr) decreases with the addition of inhibitor. It implies that this system reduces the inhibition efficiency of the inhibitor for the corrosion of Al 5083 in 1 M HCl solution at Laboratory temperature. The corrosion inhibitor is usually classified as anodic or cathodic type when the change in corrosion potential (Ecorr) value is greater than 85 mV. The largest displacement in Ecorr value on the blank was 40 mV (after the addition of 2-chloro3-formyl quinoline, indicating that the inhibitor acts as a mixed type inhibitor [7, 8] Therefore, the adsorption of the inhibitor molecule get blocks the corrosion active sites of the Al 5083 surface, which retards the corrosion. It is found that the inhibition efficiency of the some important quinoline derivatives such as CQMFA was 84 %at room temperature

Electrochemical Impedance Spectroscopic (EIS)

The kinetics of the electrode processes and surface properties for the corrosion inhibition study of Al5083 by 2-chloro 3-formyl quinoline in 1 M HCl solution was investigated by the electrochemical impedance spectro - scopic measurement. The Nyquist plots were recorded for Al5083 in the absence and presence of2-chloro 3-formyl quinoline in 1 M HCl at laboratory temperature as shown in Figures. 3.

The obtained semicircles are not perfect semicircles; this is because of the typical behavior of a solid metal electrode that shows frequency dispersion of the impedance data [10,11] which is attributed to the roughness and other inhomogeneities of the solid surface [12–14].The inhibition efficiency (gz) increases with increasing of inhibitor concentration with the range of 50–200 ppm. This increasing inhibition efficiency is attributed to the formation of a protective layer on the surface of the Al 5083. As a result, the 200 ppm of 2-chloro 3-formylquinoline exhibits maximum inhibition efficiency of around 85 % .

The corrosion of Al5083 in 0 50 100 150 200 250Inhibition efficiency obtained by the EIS measurement showed good agreement with the result obtained from Tafel and weight loss measurements. While considering both the measurements, it could be observed that the 2-chloro 3-formyl quinoline acts as a good corrosion inhibitor and shows better inhibition efficiency around85 % or Al 5083 in 1 M HCl.

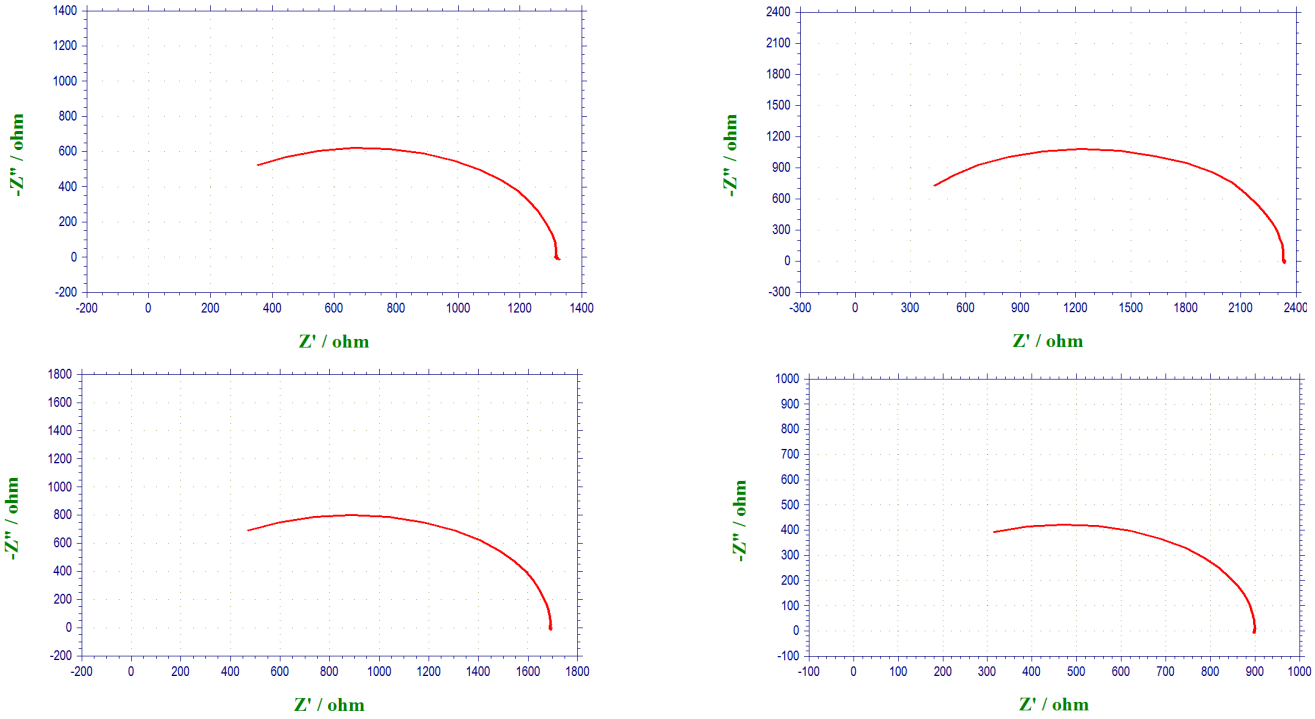


Figure 3: Nyquist Plots for Al 5083 in the Absence and Presence of Different Concentrations of 2-Chloro 3- Formyl Quinoline in 1 M HCl Solution

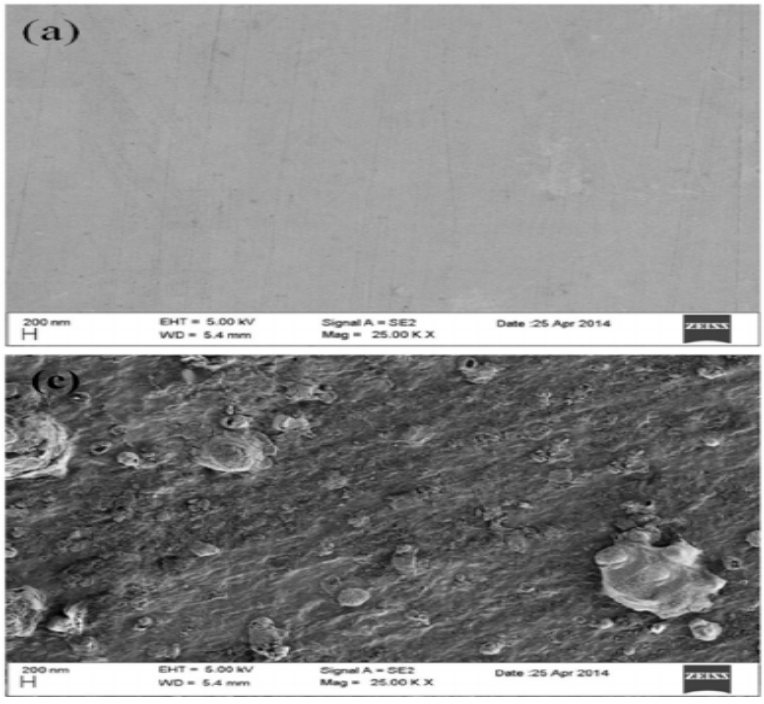


Figure 4: SEM Images of Al 5083 in 1 M HCl Media (a) in the Absence of Inhibitor (b) in the Presence of Inhibitor

Scanning Electron Microscopy (SEM)

Scanning electron microscopic (SEM) images were taken to investigate the surface study the on the Al 5083 surface for the corrosion in the presence and absence of 2-chloro3-formyl quinoline for an immersion period of 4 hr are shown in Fig.4.SEM image of the Al 5083 sample has rough surface and it is completely covered by the inhibitor which

forms smooth surface .Mechanism of inhibition The 2-chloro 3-formyl quinoline drug molecules contain nitrogen, oxygen and fused benzene rings. The present work indicates that this inhibitor is adsorbed on the metal surface predominantly by chemisorption method. 2-chloro3-formyl quinoline gets adsorbed on the Al 5083 surface by donor–acceptor interactions with the vacant d-orbital of metal. Nitrogen and oxygen atoms of the inhibitor may donate a lone pair of electrons to the vacant d orbital of the metal and forms co-ordinate bond. Also, p electrons of the aromatic rings also may form the same type of bond with the metal atom.

CONCLUSIONS

2-Chloro 3-formyl quinoline acts as a good corrosion inhibitor with the maximum inhibition in and around 80 %, corresponding to the optimum concentration at 200 ppm. The inhibition effect of 2-chloro 3-formyl quinoline is attributed to the adsorption process. This inhibitor acts as amixed type inhibitor. Therefore, adsorption process is exothermic in nature . SEM micrograph gives a visual idea about the formation of a protective layer on the Al 5083 surface, which retards the corrosion rate. So 2-chloro 3-formylquinoline shows to be a good inhibitor, as proved by all the chemical and electrochemical measurements.

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