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ORIGINAL ARTICLE

Electrochemical study on inhibitory effect of Aspirin on mild steel in 1 M hydrochloric acid

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Abstract Aspirin was investigated as a good corrosion inhibitor for mild steel in 1 M hydrochloric acid at a temperature region from 303 to 333 K. The computed inhibition efficiency increases by increasing the inhibitor concentration and decreases by increasing the temperature. The investigation was done by weight loss, electrochemical measurements such as Tafel polarization and electrochemical impedance spectroscopy. Inhibition effect is attributed to the adsorption of inhibitor on the surface of the mild steel. The Tafel method reveals that the Aspirin acts as a mixed type inhibitor. Activation parameters suggest that the adsorption process is exothermic in nature. SEM photographs of mild steel in the absence and presence of inhibitor visualize the adsorption layer on the surface of the mild steel.

1. Introduction

Corrosion is a destructive attack on metal and alloys by chemical or electrochemical reaction whenever it is exposed to a corrosive environment. The mild steel is one of the alloys of iron having good thermal and mechanical properties. So that the mild steel can be used in various industrial and structural applications like acid pickling, acid cleaning, acid descaling, and oil-well acidizing (Chauhan and Gunasekaran, 2007; Khaled, 2008). Acids are used to the removal of initial rust on the surface of the mild in various industrial processes, which gives an aggressive corrosive environment are more susceptible to corrosion (Obot, 2009). To avoid the metal dissolution through the attack of corrosion, it is controlled by various corrosion control techniques such as protective coatings, cathodic protection, and corrosion inhibitors. Among those, the use of corrosion inhibitors is the most convenient and practical method to control the corrosion. Corrosion inhibitors are heterocyclic organic molecules. Which consists of hetero atoms like Nitrogen, Sulfur, Oxygen and π-electrons in heterocyclic ring system in its structure are for its adsorption on the metal

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surface (Pavithra et al., 2010; Ahmad et al., 2010; Obot and Obi-Egbedi, 2010). As a result, the adsorption of the inhibitor on the metal surface retards the metal dissolution. So many researchers were using drugs as inhibitors. Ketoconazole (Obot and Obi-Egbedi, 2010), Tenofovir Disoproxil Fumarate (Hebbar et al., 2014), Hydralazine (Prasanna et al., 2014a), Rabeprazole (Pavithra et al., 2013), Torsemide and Furosemide (Kumar and Karthikeyan, 2013) Ciprofloxacin (Akpan and Offiong, 2013), Metol (Praveen and Venkatesha, 2009), Anthranilic acid (Hebbar et al., 2014), Metronidazole (Obot et al., 2013) are reported to be excellent corrosion inhibitors.

Aspirin is an analgesic, antipyretic and anti-inflammatory drug that comes under the class of Nonsteroidal. It is a white colored, crystalline compound soluble in alcohols. And also it has a planar structure with electron-rich oxygen atom and π-electrons, which favors it to act as an efficient corrosion inhibitor for the mild steel in acid media. The molecular structure of Aspirin is shown in Fig. 1.

The aim of the present work is to determine the inhibitive effect of Aspirin on the corrosion of mild steel in 1 M hydrochloric acid solution by chemical and electrochemical methods. Activation parameters can study the variation of inhibition efficiency with increasing temperature and scanning electron microscopic method was used to discuss the surface analysis.

2. Experimental

2.1. Materials

Corrosion inhibition study of inhibitor was performed for mild steel (Composition: 0.35% C, 0.032% Mn, 0.028% P, 0.03% S and remaining Fe). This mild steel strips of dimensions of 6 cm × 1 cm × 0.1 cm were used for weight loss method, and the same strips with an exposed area of 1 cm^2 (remaining portion covered by the resin) were used for electrochemical studies. Therefore, the mild steel strips used for experiments were abraded with SiC abrasive papers grade no 100, 400, 1500 and 2000 respectively, then washed with acetone, dried at room temperature and kept apart from moisture. Corrosive media of 1 M HCl can be prepared by using Analytical grade HCl and distilled water for all the experiments.

2.2. Weight loss measurement

Mild steel strips with a dimension of 6 cm^2 were used for weight loss measurement. Mild steel strips were processed through an acid pickling (5% H_2SO_4) to the removal of preliminary rust and deposits and digressed by using acetone followed by double distilled water and then dried at room temperature. Different mild steel strips were weighed and immersed in the absence and presence of inhibitor in 1 M hydrochloric solution over an immersion period of 4 h at 303 K temperature. The weight difference was recorded before and after the immersion period.

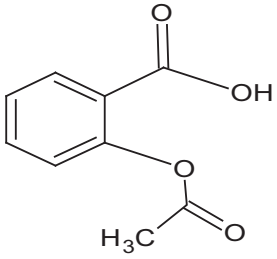

Figure 1 Molecular structure of Aspirin.

2.3. Electrochemical measurements

The electrochemical measurement was carried out by using a three electrode system consisting of working electrode (mild steel strip), reference electrode (saturated calomel) and a counter electrode (platinum). The instrument used for the electrochemical analysis was carried out in atmospheric condition without stirring by using electrochemical system compactstat. e10800 from Ivium Technologies, Netherland.

For the Tafel polarization plots of potential Vs, the current was recorded, in the given potential range of −0.28 V to −0.50 V at a scan rate of 1 mV/s.

The electrochemical impedance spectra were recorded by using AC signals with amplitude 0.01 V/s at OCP in the frequency range from 100 kHz to 0.1 Hz.

2.4. Activation parameters

The variation of inhibition efficiency with elevated temperature was studied by activation parameters of the corrosion inhibition of mild steel. For this analysis, Tafel polarization data were used at a temperature range of 303–333 K in the absence and presence of various concentrations of Aspirin.

2.5. Scanning electron microscopic (SEM) studies

The surface analysis of the mild steel strip was recorded before and after the immersion in 1 M HCl in the absence and presence of Aspirin for about 4 h by using Scanning electron microscopy (JEOL JSM-840A model).

3. Result and discussion

3.1. Weight loss method

Weight loss measurement was studied for the corrosion of mild steel in the absence and presence of various concentrations of Aspirin in 1 M HCl for about the immersion period of 4 h at 303 K temperature. The corrosion rate (v) was calculated by using the following expression:

$$v = \frac{W^0 - W}{ST} \times 100 \quad (1)$$

where W^0 and W are the weights of the mild steel strips in the absence and presence of inhibitor in 1 M HCl respectively. S and T are the surface area of the steel strip and immersion time respectively. The inhibition efficiency (η_w) was calculated by using the following expression,

$$\eta_w = \frac{v^0 - v}{v} \times 100 \quad (2)$$

where v and v_i are the corrosion rates of mild steel in the absence and presence of inhibitor in the bulk of the solution

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