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Thermodynamic characterization of metal dissolution and inhibitor adsorption processes in mild steel/ 2,5-bis(*n*-thienyl)-1,3,4-thiadiazoles/ hydrochloric acid system

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Abstract

The corrosion inhibition of mild steel in 1 M hydrochloric acid solution by some 2,5-bis(*n*-thienyl)-1,3,4-thiadiazoles (*n*-TTH) has been studied in relation to the concentration of the inhibitors as well as the temperature using chemical (weight loss) and electrochemical (ac impedance and dc polarisation) techniques. All the methods employed are in reasonable agreement. The protection efficiency increases with increasing inhibitors concentration and with increasing temperature. The thermodynamic functions of dissolution and adsorption processes were calculated from experimental polarisation data and the interpretation of the results are given. Adsorption of *n*-TTH was found to follow the Langmuir's adsorption isotherm and the ability of the molecule to chemisorb on the steel surface was dependent on the position of the sulphur atom on the thienyl substituent.

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1. Introduction

The damages by corrosion generate not only high costs for inspection, repairing and replacement, but in addition these constitute a public risk, thus the necessity of developing novel substances that behave like corrosion inhibitors. In general, the organic compounds have demonstrated a great effectiveness in inhibiting the aqueous corrosion of many metals and alloys [1,2]. At the present time, these compounds are the frequently used inhibitors and they are generally considered because of their good effectiveness. The effect of inhibitors adsorbed on metallic surfaces in acid solutions, is to slow down the cathodic reaction as well as the anodic process of dissolution of the metal. Such effect is obtained by forming a barrier of diffusion or by means of the blockage of the reaction sites [3]. The molecules that, at the same time, contain nitrogen and sulfur in their structures are of particular importance, since these provide an excellent inhibition compared with the compounds that contain only sulfur or nitrogen [4]. The property of inhibition of the corrosion of these compounds is attributed to their molecular structure. The planarity and the lone electron pairs in the hetero atoms, are important features that determine the adsorption of these molecules on the metallic surface [5]. Heterocyclic compounds containing sulfur and nitrogen atoms and particulary thiadiazole-type compounds are good corrosion inhibitors in aggressive media [6–9].

The aim of this work is to investigate the role played by some 2,5-bis(*n*-thienyl)-1,3,4-thiadiazoles (*n*-TTH) on the corrosion behaviour of mild steel in 1 M HCl hydrochloric acid. Interacting the corrosion of steel in 1 M HCl medium employed the weight loss and electrochemical methods. The thermodynamic parameters for both dissolution and adsorption processes were calculated using Tafel behaviour and discussed.

2. Experimental method

Corrosion tests have been carried out on electrodes cut from sheets of mild steel. Steel strips containing 0.09% P, 0.38% Si, 0.01% Al, 0.05% Mn, 0.21% C, 0.05% S and the remainder iron were used for the measurement of weight loss and electrochemical studies. The surface preparation of the specimens was carried out using emery paper Nos. 600 and 1200, they were degreased with ethanol under ultrasound and dried at room temperature before use. The solutions (1 M HCl) were prepared by dilution of an analytical reagent grade 37% HCl with doubly distilled water.

For weight loss measurements, each run was carried out in a glass vessel containing 100 ml test solution. A clean weighed mild steel electrode ($2 \times 5 \times 0.06$ cm) was completely immersed at inclined position in the vessel. After 24 h of immersion,