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New thio-compounds as corrosion inhibitor for steel in 1 M HCl

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Abstract

Some S-containing compounds newly synthesised have been tested as inhibitors for the corrosion of steel in 1 M HCl solution. Weight loss measurements, potentiodynamic polarisation and impedance spectroscopy (EIS) methods are used. The inhibiting action increases with the concentration of the compounds tested. The highest efficiency 95% is obtained at 10^{-4} M of [(11-hydroxyundecyl)thio]acetic acid (**3** and **4**). We note good agreement between gravimetric and electrochemical methods (potentiodynamic polarisation and EIS). Polarisation measurements show also that **3** and **4** act as mixed inhibitors. The cathodic curves indicate that the reduction of proton at the steel surface happens with an activating mechanism. **3** adsorbs on the steel surface according to Langmuir adsorption model. Effect of temperature is also studied between 308 K and 353 K.

Keywords: Thio-compound; Inhibition; Corrosion; Steel; Acid

1. Introduction

Addition of inhibitor remains the necessary procedure to secure the metal against acid attack in chemical cleaning and pickling to remove mill scales (oxide scales) from the metallic surface. Inhibitors should be effective even under severe conditions in concentrated hydrochloric acid (20%) at temperatures up to 60 °C [1–3]. Organic compounds rich in heteroatoms such sulphur, nitrogen and oxygen generally exhibit the best protection

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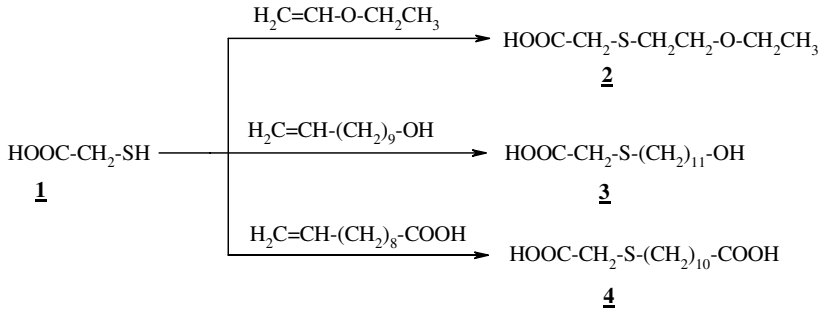

1 : 2-mercaptoethanol

2 : [(2-ethoxyethyl)thio]acetic acid

3 : [(11-hydroxyundecyl)thio]acetic acid

4 : 11-[(carboxymethyl)thio]undecanoic acid

Scheme 1. Molecular structure of the thio-compounds studied.

among corrosion. Their adsorption is generally explained by the formation of an adsorptive film of a physical and/or chemical character on the metal surface. Adsorption of inhibitors may blocks either cathodic, anodic, or both reactions. Inhibition may also involve either physisorption or chemisorption of inhibitors onto the metal surface and subsequent interference with occurring at the adsorption sites. The electrostatic attraction between the charged inhibitor molecules and the charge-active centers on the metal surface leads to physisorption. Data in the literature show that most organic inhibitors adsorb on metals by displacing water molecules on the surface and forming a compact barrier film [4–6].

The synthesis of new organic molecules offers various molecular structures containing several heteroatoms and substituents. Research in these latest decennia has permitted to classify several series containing S atom such aminoacid and aminoester [7–11], azole [12–18] and pyridine [19–22] as effective corrosion inhibitors. The continuation of our work on development of organic compounds as acid inhibitors is oriented to a new series of thio-compounds containing a length carbon chain also called telechelic compounds [23]. These thio-compounds lead to thermoplastic elastomer block copolymers by reacting with vinyl aromatic or di-acid monomers in the presence of a coinitiator. Recently, encouraging results obtained by telechelic compounds [24] has permitted to obtain 92% at 10^{-3} M of methyl 4-{2-[(2-hydroxyethyl)thio]ethyl}benzoate (T2).

In the present work, we investigate the corrosion of steel in 1 M HCl by thio-compounds, Scheme 1. Weight loss tests and electrochemical techniques (potentiodynamic polarisation and impedance measurements) have been used to study the effect of addition of these compounds on the corrosion of steel in hydrochloric acid solution in 1 M HCl in the 308–353 K range.

2. Experimental

2.1. Inhibitors

The thio-compounds were synthesised from 2-mercaptoethanol (**1**) according to the Scheme 1, purified and characterised by NMR and IR spectroscopies and element analysis