Effect of 3-methyl thio-4-paratolyl-1,2-dithiolium on corrosion inhibition of mild steel in acidic media

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ABSTRACT

An example of a new class of corrosion inhibitors, namely, DTL was synthesized, and its inhibition action on the corrosion of mild steel in 10% sulfuric acid at 30 °C was investigated by various corrosion monitoring techniques. A preliminary screening of the inhibition efficiency carried out using loss measurements at constant acid concentration and potentiostatic polarization studies showed that DTL is an anodic-type inhibitor.

Key words: acidic media, corrosion, mild steel, DTL.

INTRODUCTION

Dithiolethione are five-membered cyclic sulfur-containing compounds with antioxidant, chemotherapeutic, and chemoprotective activities¹. These compounds are used in different domains. Oltipraz, a member of a dithiolethione class, is used to induce phase 2 enzyme response conserved in cells lacking mitochondrial DNA². Sulfarlem is used as choleretic and sialagog³,⁴, and 3-methylthio-1,2-dithiolium is easily reduced in DMF at a mercury electrode⁵. It has been reported that the adsorption of corrosion inhibitors depends mainly on certain physico-chemical properties of the molecule such as functional groups, steric factors, aromaticity, electron density at the donor atoms and π orbital character of donating electrons⁶, as well as on the electronic structure of the molecules⁷⁸. The above mentioned compound, abbreviated as DTL, is an example of a new class of corrosion inhibitors: 3-methyl thio -4-paratolyle-1,2-dithiolium. The aim of the present work is to investigate the efficiency of DTL as corrosion inhibitors of mild steel X52 in 10% sulfuric acid.

EXPERIMENTAL

The tested inhibitor DTL was synthesised according to a previously described procedure⁹. The concentration range of inhibitor employed was varied from 5ppm to 20ppm. Corrosion tests were performed on a mild steel of the following composition 0.30% C, 1.35% Mn, 0.030% S and remaining iron. Pretreatment of the surface of specimens was carried out by grinding with emery paper of 600-1200 grit rinsing with distilled water. Electrochemical measurement were carried out by means of potentiostat equipment (Tacussel Radiometer PGP201) and controlled with Tacussel corrosion analysis software (Voltamaster 4). A solution of 10% H₂SO₄ was prepared by dilution of
Table 1: Corrosion parameters

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Immersion corrosion</th>
<th>Weight loss studies</th>
<th>Electrochemical studies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Métal loss</td>
<td>corrosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time(s)</td>
<td>Δm(mg)</td>
</tr>
<tr>
<td>Blank</td>
<td>3600</td>
<td>0.0037</td>
<td>5.489</td>
</tr>
<tr>
<td>5DTL</td>
<td>3600</td>
<td>0.0020</td>
<td>3.256</td>
</tr>
<tr>
<td>10DTL</td>
<td>3600</td>
<td>0.0007</td>
<td>1.098</td>
</tr>
<tr>
<td>15DTL</td>
<td>3600</td>
<td>0.0005</td>
<td>0.816</td>
</tr>
<tr>
<td>20DTL</td>
<td>3600</td>
<td>0.0005</td>
<td>0.785</td>
</tr>
</tbody>
</table>

analytical grade 98% H<sub>2</sub>SO<sub>4</sub> with double distilled water.

Test procedure

Weight-loss experiments were conducted in 10% H<sub>2</sub>SO<sub>4</sub> for a time period of 3600 S at 40°C±2°C polarization curves were recorded potentiodynamically using a double glass cell equipped with a thermostated cooling condenser. The solution volume was 500ml and consisting of a mild steel working electrode, platinum counter electrode, and a saturated calomel electrode (SCE) as the reference electrode.

The above parameters were obtained from weight loss measurements and electrochemical polarization in 10% H<sub>2</sub>SO<sub>4</sub> containing different concentrations of DTL.

The inhibition efficiency was calculated for a known concentration of each inhibitor by the following relation:

IE % = (1-V/V<sub>0</sub>)

![Fig. 1: -3-méthyl thio-4- paratolyle -1,2-Dithiolium (DTL) Molecular structure of synthesized inhibitor](image1)

![Fig. 2: Variation of IE (%) with different concentrations of DTL in (ppm)](image2)
Where, \( V \) and \( V_0 \) are the corrosion rates with and without inhibitor.

RESULTS AND DISCUSSION

Weight loss studies

Fig. 2 shows the values of metal loss and inhibition efficiency (IE) obtained from weight loss measurements for different concentration of DTL. The IE of DTL at 20 ppm (85.69%) may result from the presence of a single pair of electrons on sulfur atoms, and also for iodide ions are initially adsorbed on the metal.

2-polarization studies

Fig. 3 shows the polarization behavior of mild steel in 10% \( \text{H}_2\text{SO}_4 \) in the absence and presence of different concentration of DTL as corrosion inhibitor. Electrochemical parameters of the synthesized inhibitor such as corrosion current density \( i_{\text{corr}} \), corrosion potential \( E_{\text{corr}} \), and IE (98.98%) may result from the presence of a pair of electron on sulfur atoms which can be strongly absorbed on the metal surface, and also the presence of iodide ions absorbed on the metal and increases the negative charge on the metal surface. The shifting of \( E_{\text{corr}} \) indicates that the corrosion inhibitor is of anodic type.

Fig. 3: Polarization curves of mild steel recorded in 10% \( \text{H}_2\text{SO}_4 \) containing different concentrations of DTL. Keys: (a) blank, (b) 5ppm, (c) 10ppm, (d) 15ppm, (e) 20ppm.

CONCLUSION

DTL seemed to retard corrosion by reducing the number of available surface sites for corrosion, and inhibits the corrosion of mild steel in \( \text{H}_2\text{SO}_4 \) 10%. The adsorbed inhibitor molecules act by slowing the rate of the corrosion reactions. The iodide ions are initially adsorbed on the metal and contribute to the inhibition. The concentration dependence of the inhibition efficiency calculated from weight loss measurement and electrochemical studies has the same tendency.
REFERENCES