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بعض الوثائق الأصلية تالفة

بالرسالة صفحات
لم ترد بالأصل

New Trends for Corrosion Inhibition of Steel

Thesis
Submitted for the degree of
Doctor of Philosophy
In Materials Science

By

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To my Family
and my Son

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SUMMARY

Mild steel is considered to be the main constructing materials in industry. There is a great need to protect mild steel material from corrosion by using corrosion inhibitors. However the use of chemical inhibitors has been limited because of the environmental threat. A recent trend is devoted to employ environmentally friendly compounds as corrosion inhibitors for mild steel

In this study different extract of herbs were investigated as corrosion inhibitors for mild steel during acid cleaning process and that used in reinforcing concrete. The environmentally friendly investigated compounds in this study were *Arghel, Coriander, Thyme, Marjoram, Fennel and Henna.*

The inhibition efficiency of these herbs extract and its action on the corrosion of mild steel was investigated using spectophotometry, potentiodynamic polarization, and electrochemical impedance spectroscopy (EIS) techniques.

The iron count measurements in the presence of herbs extract showed that the dissolution of mild steel was characterized by a prolonged induction period and retardation of dissolution of mild steel in sulfuric acid solution.

Potentiodynamic polarization curves indicated that the studied inhibitors exhibited Tafel-type behaviour. The presence of this herbs shifted of the corrosion potential into the anodic direction depending on the type of herbs and its concentration. The addition of the inhibitors studied did not alter the mechanism of either the proton discharge reaction or the anodic reaction step.

The a.c measurements of mild steel at rest potential in sulfuric acid solution containing different concentrations of herbs extract showed that the dissolution process was under activation controlled. Bode and theta diagrams showed only one time constant (τ). The increased concentration of the inhibitors leads to increase the charge-transfer resistance and decrease the capacitance of the double layer in μF units, indicating adsorption of inhibitor molecules at the metal surface. The inhibition action of the extract was discussed in view of different adsorption isotherm models. It was found that the adsorption of the extracts on mild steel surface was occurred through formation of multi-layers film.

The inhibition efficiency was correlated to the change in the constituent of the active materials of the extracted compounds. *Arghel* offers excellent protection, 96%, for mild steel exposed to acidic medium.

The effect of temperature on the inhibition efficiency of *Arghel* on mild steel in acidic medium was also studied. It was found that the presence of *Arghel* extract increases the activation energy of the corrosion reaction. Moreover, the thermodynamic parameters of the adsorption process were also calculated and discussed.

The Arghel extract as an inhibitor was investigated aiming to control the corrosion of reinforced mild steel in concrete. This investigation was performed in the presence of chloride ions, using electrochemical impedance measurements. It was found that addition of *Arghel* has a pronounced effect on the diffusion process rather than charge transfer or the concrete resistance

Chapter I

INTRODUCTION

I. INTRODUCTION

GENERAL

An increased use of steel, within all fields of technology made it necessary to devote more attention to steel corrosion. Corrosion is the destructive result of chemical or electrochemical reaction between a metal and its environment. The serious consequences of corrosion process have become a problem of worldwide significance. The cost and problems associated with the use of corrosion resistance materials means that, in many cases, the use of corrosion inhibitors is a practical and economic alternative.[1] The cost of use of corrosion inhibitors in USA is $ 1.1 Billion/year.

I.1.The Electrochemical Nature of Corrosion [2]

Nearly all metallic corrosion processes involve transfer of electronic charge at metal – solution interface, which means that corrosion reactions are considered to be electrochemical in nature. Most of the corrosion reactions involve water in either the liquid or condensed vapor phases. For corroding metals, the anodic reaction invariably is of the form:

$$M \longrightarrow M^{n+}_{interface} + ne^- \text{ (charge transfer step)} \qquad (I.1)$$

$$M^{n+}_{interface} \longrightarrow M^{n+}_{bulk} \text{ (mass transfer step)} \qquad (I.2)$$

In steel corrosion, electrochemical reaction may take place as follows:

The anodic dissolution reaction

$$Fe \longrightarrow Fe^{3+} + 3e$$

This reaction is rapid in most media. When iron corrodes, the rate is usually controlled by the cathodic reaction, which in general is much