)Int. J. Electrochem. Sci., 8 **(2013)** 9429 - 9434

International Journal of
ELECTROCHEMICAL
SCIENCE
www.electrochemsci.org

Short Communication

Inhibition of Mild Steel Corrosion in 1M HCl Medium by Acid Extract of *Haloxylon scoparium* Pomel

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Received: 12 April 2013 / *Accepted:* 14 June 2013 / *Published:* 1 July 2013

The present work sheds some light on the inhibition effect of acidic extract of *Haloxylon Scoparium pommel* on the corrosion of steel (X52) in acid solution of hydrogen chloride (1M) using the electrochemical measurements (electrochemical polarization resistance, electrochemical impedance spectrum, and scanning electron microscopic studies). The results revealed that the extract could serve as an effective mixed mode inhibitor for mild steel in HCl media. The electrochemical impedance spectroscopy findings showed that the change in the impedance parameters, charge transfer resistance and double layer capacitance, with the variation in extract concentration is due to the adsorption of active molecules leading to the formation of a protective layer on the surface of mild steel. This could be observed on the image obtained by electron microscopic scanning.

Keywords: *Haloxylon scoparium Pomel*, polarization methods, impedance, corrosion inhibition, steel(X52), Acid Medium

1. INTRODUCTION

Corrosion is generally regarded as the deterioration of metals due to chemical attack or reaction with a belligerent environment. It is a constant and persistent problem, often difficult to eliminate completely. The corrosion of mild steel and other metals is accentuated in the presence of an aggressive media such as acid. Therefore industrial process such as acid cleaning, acid descaling, acid pickling, and other oil well acidizing, require the use of corrosion inhibitors [1, 2]. Many types of inhibitors have been thoroughly synthesized and used to combat corrosion problem. Most effective

inhibitors are organic compounds containing N, S and/or O atoms. These compounds can be adsorbed on the metal surface, block the active sites and thereby reduce the corrosion rate. Most of the investigated compounds are generally toxic and cause many severe environmental hazards. Hence the use of natural products as eco-friendly and harmless corrosion inhibitors is gaining an increasing popularity [2,3].

Natural products are nontoxic, biodegradable and readily available. They have been used widely as inhibitors. Many research groups have reported the successful use of naturally plant-derived substances to restrain the metal corrosion. [1-12].

The aim of the present work is to investigate the inhibitive effect of the acid extract of *Haloxylon scoparium* on the hydrochloric acid corrosion of mild steel by polarization measurements.

2. EXPERIMENTAL

2.1. Specimen Preparation

Cylindrical working electrodes of mild steel (MS) containing: 0.1%C, 0.97% Mn, 0.12%Si, 0.002%S, 0.01%Cr and remaining Fe were used for electrochemical polarization and impedance measurements. The surface preparation of the mechanically polished specimens was carried out using different grade of SiC (grade 120-1200) emery papers, repeatedly rinsed with double distilled water and finally dried and kept in a desiccator.

2.2. Extraction of plant materials

The aerial parts of *H. scoparium* were collected from Ghardaia (Barienne region) in November 2007, dried under shade and then ground and stored in closed a container away from light and moisture.

The extract was prepared by soaking 150 g of the plant powder in a 1N HCl solution for 48H. After filtration, different concentrations were prepared as follows: 5%, 15%, 35%, 45%, 55% (v/v)

2.3. Potentiodynamic polarization measurement

Potentiodynamic polarization measurements were carried out using a solatron electrochemical analyzer. The polarization measurements were aimed to assess the corrosion current, corrosion potential and Tafel slopes. Experiments were conducted in a conventional three-electrode cell assembly: the working steel electrode (WE), a pure platinum counter electrode (CE) and a standard calomel electrode (EIS). Acidic solutions were used as electrolytes at 30°C. Potentiodynamic anodic and cathodic polarization curves were obtained with a scan rate of 30 mv/s in the potential range from -200 mv to -750 mv relative to the corrosion potential (E_{corr}). Values of the corrosion current density (I_{corr}) were obtained by extrapolation of the cathodic branch of the polarization curve back to E_{corr} .

Measurements of R_p in the vicinity of E_{corr} were also carried out. Impedance spectra were recorded at E_{corr} in the frequency range 10 mHz to 100 KHz. The values were computed using solatron 1280 B.

3. RESULTS AND DISCUSSION

Table1. Electrochemical parameters at different concentrations of *H. scoparium* extract.

Concentration % V/V	$-E_{corr}$ (mv)	I_{corr} (μAcm^{-2})	b_a (mv/dec)	$-b_c$(mv/dec)	I.E(%)	R_p,Ω	I.E(%)
blank	472.8	103.8946	82.2	72.2	0	122.55	-
5	458.1	38.4401	81.2	131.1	63	496.85	75.33
15	460.1	18.5904	65.2	80.5	82.106	662.71	81.50
35	454.1	11.3787	71.0	94.6	89.17	1320	90.71
45	446.0	11.1875	69.0	100.9	89.23	1420	91.37
55	447.9	9.8554	67.6	94.0	**90.69**	1490	91.77

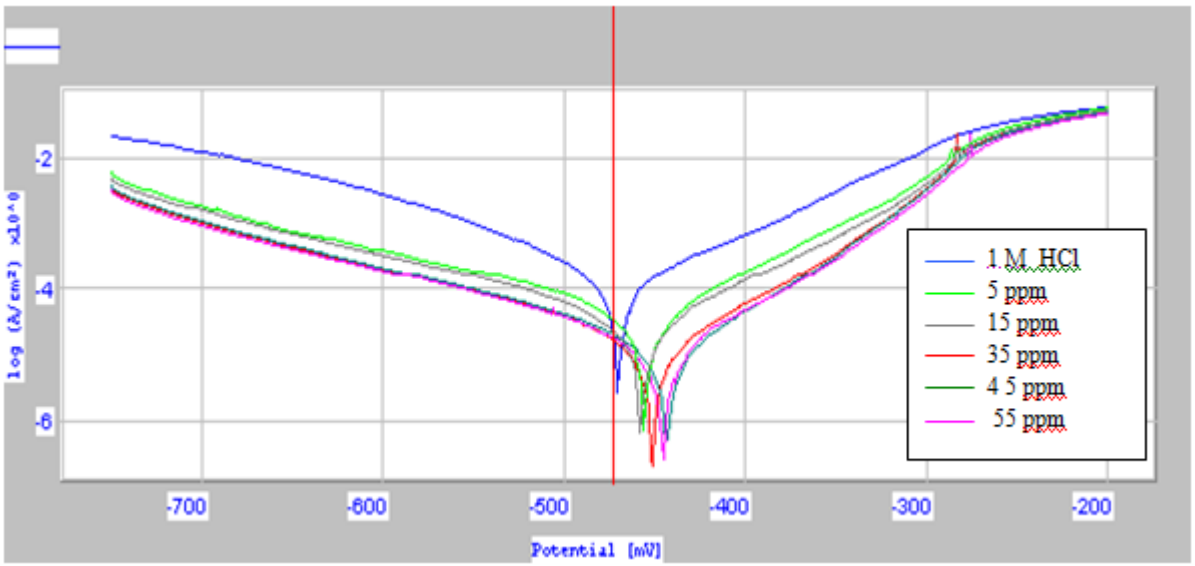

Figure 1. Tafel plots showing effect of *H. scoparium* on corrosion of mild steel in HCl medium

The electrochemical parameters prove that corrosion current (I_{corr}) decreases clearly in the presence of plant extract and the inhibition rate increases with increasing extract concentration. These findings provide evidence for the inhibitive effect of the plant extract in HCl medium. The values of both anodic and cathodic Tafel constants b_a and b_c respectively have clearly changed in the presence of the extract. The extract influences both the anodic and cathodic overpotentials and shifts Tafel lines in

both directions. This result confirms the mixed inhibition mode of the extract. It can also be noted that, the increasing linear polarization (R_p) values corroborate the corrosion inhibitive nature of the extract.

Similar studies have been carried out by our group on some local plant species and revealed moderate corrosion inhibition effect. In this context the inhibitive effect of extracts of *Cotula cinerae*, *Retama retam* and *Artemisia herba alba* plants on the corrosion of X52 mild steel in aqueous 20 % (2.3 M) sulfuric acid was investigated. Weight-loss determinations and electrochemical measurements were performed. Polarization curves indicated that the plant extracts behave as mixed-type inhibitors. The inhibition efficiencies of the extracts were ranging between 84% and 88% [13].

Moreover, the aqueous extract of *Zygophyllum album*. L revealed that it can be used as corrosion inhibitor of steel in acidic medium at room temperature and at a concentration of 1400 ppm to reach an inhibition rate around 98% [14].

In another study, we investigated the inhibitive properties of the methanolic extracts of three parts of the plant *Atractylis serratuloides* towards the corrosion of X52 steel in acidic medium and found that the plant extracts may cause more than 80% of inhibition rate at a concentration around 1200 ppm [15]. Furthermore the inhibitive action of aqueous extract of *tamarix gallica* on the corrosion of mild steel in 1m sulphuric acid was assessed by weight-loss method and polarization techniques and the results show that the inhibition effect is more than 98% at 1400 ppm [16].

Comparing these results to what was found in the present study we can conclude that *H.* scoparium has a good inhibitive potential and can be used to replace toxic chemicals.

The Nyquist plot (figure2) shows semicircles with single capacitive loop and increasing diameter as the concentration of the plant extract increases. The C_{dl} values shown in the table 2 are found to decrease with increasing extract concentration. This confirms that the plant constituents are adsorbed on the metal surface resulting in decrease in double layer capacitance. The increasing charge transfer resistance R_{ct} values imply reduced corrosion rate in the presence of the plant extract. This it is confirmed that the plant extract show good corrosion inhibition efficiency.

Table 2. Impedance parameters at different plant concentrations

No.	Conc, % v/v	R_{ct}, Ωcm^2	C_{dl} , μFcm^{-2}	I.E, %
1	blank	45.86	548.3	**-**
2	5	237.0	424.2	80.65
3	15	464.8	342.3	90.13
4	35	762.1	329.9	93.98
5	45	774.1	324.8	94.07
6	**55**	940.4	267.3	95.12

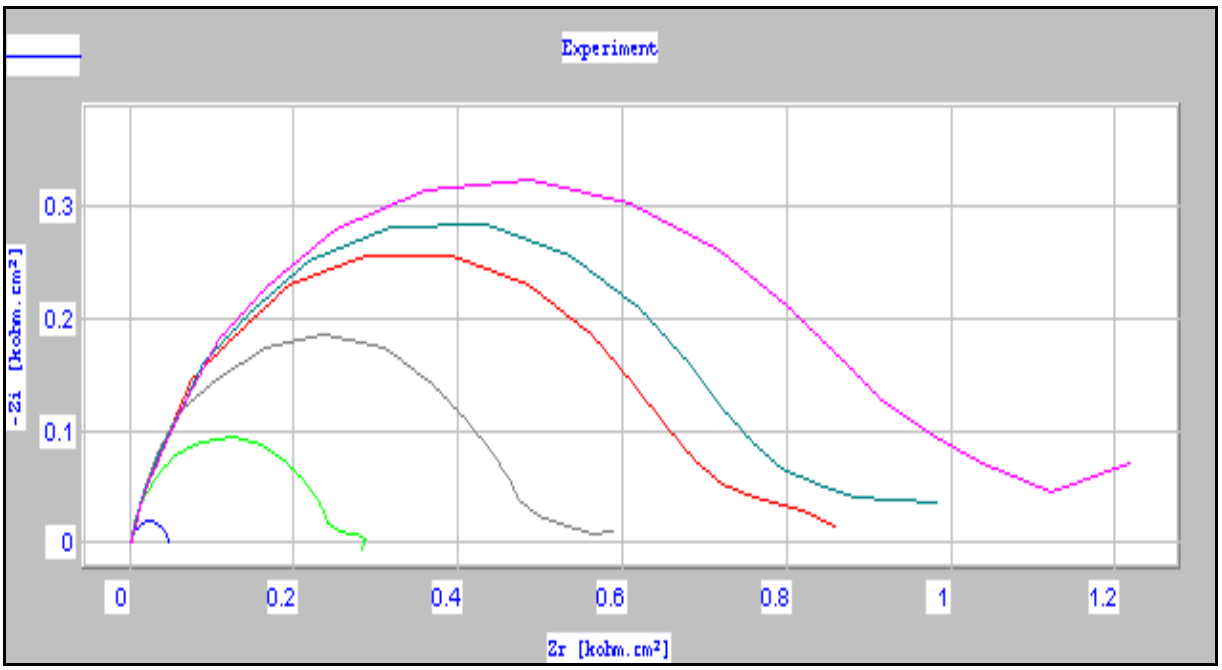

Figure 2. Nyquist plots showing effect of *H. Scoparium* on corrosion of mild steel in HCl medium

Haloxylon scoparium has been reported to contain many heterocyclic compounds such as alkaloids and flavonoids. The presence of such compounds enhances their adsorption on the metal surface and thereby blocking the surface and protecting the metal from corrosion. The results revealed that the acidic extract of the plant can be used as a good corrosion inhibitor for steel in acidic medium at room temperature. To obtain the maximum protection efficiency, critical plant extract concentration should be determined. Polarization studies reveal that the extracts behave as mixed type inhibitors.

4. CONCLUSION

Acid extract of *Haloxylon Scoparium* Pomel aerial part acts as a good corrosion inhibitor for mild steel in 1N HCl. Inhibition efficiency increases with inhibitor concentration and maximum inhibition efficiency was more 90% at the inhibitor concentration 55 % v/v. Corrosion inhibition is mainly be due to the adsorption of the plant constituents on the mild steel surface. Polarization studies indicated that the extract is mixed type inhibiting both cathodic as well as anodic reactions.

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