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RESEARCH ARTICLE

Effect of *Launaea Resedifolia* Aqueous Extract as Eco-Friendly Inhibitor on the Corrosion of Steel in Sulphuric Acid Medium

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Abstract: The anticorrosive effect of the aqueous extract of *Launaea resedifolia* on the corrosion of carbon steel X52 in 1.0 M H_2SO_4 solution was investigated electrochemically, and by weight loss experiments at room temperature. The percentage inhibition increased with the increase of the inhibitor concentration. The studies reveal that the plant extract act as a good inhibitor. Tafel polarization method indicated that the plant extract behaves as mixed mode inhibitor. The inhibition was assumed to occur via adsorption of the inhibitor molecules on the metal surface.

Keywords: *Launaea resedifolia*, Corrosion inhibitor, Steel, Acid medium

Introduction

The investigation of corrosion inhibition of mild steel in acid media is a subject of pronounced technological significance. Mild steel is an extensively used fabrication material in many industries. The importance of corrosion study lies on two important aspects. The first is economic, including the reduction of material losses resulting from the washing away or sudden failure of piping, tanks, metal components of machines, ship hulls, marine structures, *etc*. The second is conservation, applied primarily to metal resources, the world's supply of which is limited and the wastage of which includes corresponding losses of energy and water reserves accompanying the production of metal and fabrication of metal structures[1-3]. Use of inhibitors is one of the most practical methods for protection against corrosion especially in acid solutions to prevent unexpected metal dissolution and acid consumption[4]. Mild steel corrosion in acid solution has been effectively controlled by the use of organic substances containing nitrogen, oxygen, or sulphur in the conjugated system as inhibitors[5-6]. These organic compounds can adsorb on the metal surface, block the active sites on the surface and thereby reduce the corrosion rate. Most of investigated compounds are toxic and cause severe environmental hazards. Plant extracts have become important because they are environmentally acceptable, inexpensive, readily available and renewable sources of materials, and ecologically acceptable[7]. The use of natural products as corrosion inhibitors was well documented[8-11].

In continuation of our studies on the anticorrosion properties of some Algerian Sahara plants[12–14], we report here the findings of the corrosion inhibition effect of the aqueous extract of *L. resedifolia* on mild steel X52 in 1 M sulphuric acid medium.

Experimental

0.5 kg of the aerial parts of the plant material in natural condition was air dried for 10 days in shade, then grained and powdered. 30 g of finely powdered material was taken in a 100 mL of double distilled water. The solution was left 48 hours and then filtered. The concentration of the solution was determined by evaporating 10 mL of the filtrate under vacuum and weighing the residue. A mother solution containing 0.28 g of the plant extract dissolved in 100 mL of acidic solution (2800 ppm) was prepared and used to prepare the other concentrations.

Specimen preparation

The nominal composition of mild steel specimen involved in this study is given in Table 1. Specimens were cut into 2 × 0.5 × 1.5 cm dimensions, sealed by polyester resin, leaving a surface area of 1 cm^2, were used as working electrode for polarization. The exposed area was mechanically abraded with 180, 400, 600, 1000 and 4000 grades of emery papers, degreased with acetone and rinsed by distilled water before each electrochemical experiment. All chemicals purchased were of analytical reagent grade and were used without further purification. The solutions were prepared using double distilled water.

Table 1. Chemical composition of mild steel X52

Nominal composition			
Element	W, %	Element	W, %
C	0.1038	Al	0.032
Si	0.1261	Co	<0.05
Mn	0.971	Cu	<0.01
P	<0.0021	Nb	0.0419
S	0.0021	Ti	0.0025
Cr	<0.0021	V	<0.005
Mo	<0.005	W and Si	<0.005
Ni	<0.005	Fe	< 98.7

Electrolyte

Analytical reagent-grade H_2SO_4 was used for preparing solutions. Appropriate concentrations of acid were prepared by using double distilled water. The concentration of plant extract was varied from 800 to 2000 ppm.

Weight loss method

Pre weighed mild steel specimens were suspended in 1 M H_2SO_4 with and without the inhibitor in different concentrations ranging from 800 to 2000 ppm. After 1 hour, the coupons were removed from test solution, washed with $NaHCO_3$ and well dried before being weighed. The percentage of inhibitor efficiency (IE %) for various concentrations of the inhibitor were calculated as:

$$I.E.\% = [(W_0 - W)/W] \times 100$$

Where W_0 and W are the weight losses in the corroding (blank) and corroded inhibitor systems. The corrosion rate in mmpy (millimetre per year) can be obtained by:

$$\text{Corrosion rate (mmpy)} = (\text{Mass loss} \times 87.6)/(\text{Area} \times \text{Time} \times \text{Metal density})$$

Where mass loss is expressed in mg, area is expressed in cm^2 of exposed metal surface, time is expressed in hours of exposure, metal density is expressed in g/cm^3 and 87.6 is a conversion factor.

Potentiodynamic polarization studies

For the potentiodynamic polarization studies, the cell used was a conventional three electrode system with platinum auxiliary electrode, saturated calomel as reference electrode and polished mild steel specimen as working electrode. The working electrode was lacquered so as to expose $1cm^2$ area to contact with the solution.

The polarization curves were recorded by using computer controlled Gamry electrochemical system. The potential increased with the speed of 30 $mv.min^{-1}$. Experiments were carried out from -550 to -350 mv potential range. The percentage inhibition efficiency was calculated as:

$$I\% = (I_{corr} - I_{inh}) / I_{corr}$$

Where, I_{corr} and I_{inh} are the corrosion current density values without and with inhibitor, respectively**.**

Results and Discussion

Weight loss results

The inhibition efficiency or inhibition rate, calculated from the mass loss measurements for 1 M sulphuric acid and inhibitor is given in Table 2.

Table 2. Inhibiting effect after 1 hour

C en ppm	Δm	V (mm/year)	I.E %
800	0,0219	11,7364	65,02
1000	0,0212	11,6305	65,34
1200	0,0038	3,2464	90,32
1600	0,0029	2,4761	92,62
1800	0,0037	3,1483	90,61
2000	0,0031	2,6274	92,17

Figure 1 presents the dependence of inhibition rate and efficiency IE (%) of mild steel exposed to 1 M sulphuric acid on the concentration (ppm) of the plant extract studied at 20 °C. The increase of plant extract concentration increased the corrosion inhibition efficiency. The maximum inhibition rate is estimated to 92.62% at 1600 ppm.

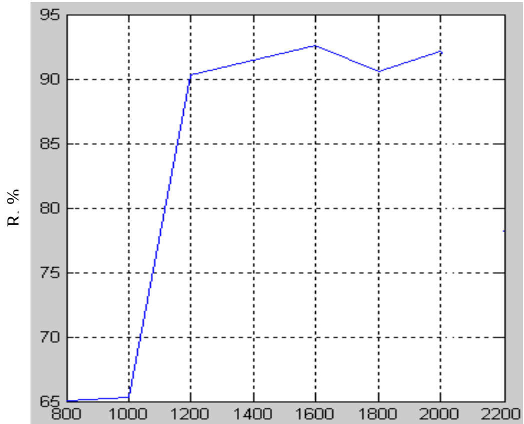

Figure 1. Efficiency plots *versus* extract concentration

Polarization results

Polarisation behaviour of mild steel in 1 M H_2SO_4 in the presence of the plant extract is shown in the Table 3 and Figure 2. From the shape of the polarization curves, it is seen that both the anodic and cathodic reactions are inhibited.

The Tafel regions of the plot further indicate that the electrode reactions are kinetically controlled. The values given in the Table 3 show that corrosion current (I_{corr}) decreases with increasing extract concentration. This confirms the inhibitive action of the extract in H_2SO_4 medium. The values of both anodic and cathodic Tafel constants ba and bc respectively are markedly changed in the presence of the extract. This confirms the mixed mode of inhibition of the extract.

Table 3. Electrochemical parameters of mild steel in 1 M H_2SO_4 and plant extract

C (PPM)	$E_{CORR.}$ (mV)	I (mA)/cm^2	B_a(mV)	B_c(mV)	V_{corr}(mm/year)	R%
0	-414.2	3.478	85.8	-80.9	0.71	-
1200	-462,8	0,1974	99,7	-123,4	2,309	92,94
1600	-480,9	0,1610	86,7	-76,9	1,884	94,43

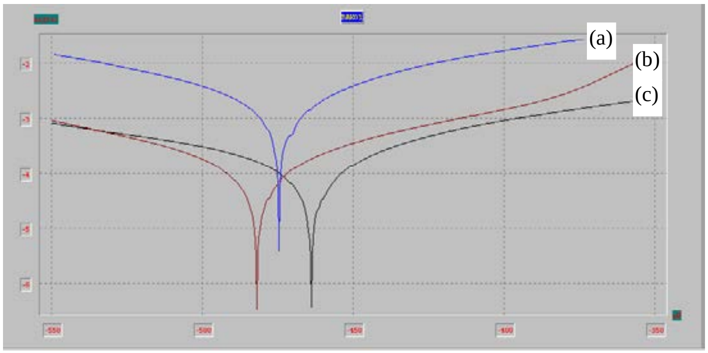

Figure 2. Polarization curves of mild steel in 1 M H_2SO_4 solution (1200 ppm, 1600 ppm) (a:without inhibitor; b: 1200 ppm; c: 1600 ppm)

Conclusion

Water extract of *Launaea resedifolia* visible parts acts as good corrosion inhibitor for mild steel in 1 M H_2SO_4 medium. Inhibition efficiency increases with inhibitor concentration and maximum inhibition efficiency was 92.62% at the inhibitor concentration 1600 PPM. Corrosion inhibition may be due to the adsorption of the plant constituents on the mild steel surface. Polarisation studies indicate the inhibitor to be of a mixed type inhibiting both cathodic and anodic reactions.

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