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Potentiodynamic investigation of the anticorrosive action of Cotula cinerae extracts on mild steel X 52 in 20 % H_2SO_4 Solution

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ABSTRACT

The effect of Cotula cinerae extract on the corrosion rates of mild steel X52 in 20% H_2SO_4 solution has been elucidated at 25 C° by potentiodynamic polarization method.The maximum inhibition efficiency (%η_{Pol}) was about 95 %. As far as we know, the anticorrosive behavior of this plant has never been undertaken in literature.

Key Words: mild Steel, Cotula cinerae, corrosion inhibitors, Tafel plots.

INTRODUCTION

The use of chemical inhibitors to decrease the rate of corrosion processes is quite varied. In the processing industries, inhibitors have always been considered as the first line of defense against corrosion. A great number of scientific studies have been devoted to the subject of corrosion inhibitors. However, most of what is known has grown from trial and error experiments; both in the laboratories and in the field. Although many synthetic compounds show good anticorrosive action, most of them are highly toxic to both human beings and environment. These inhibitors may cause temporary or permanent damage to organ system .The toxicity may manifest either during the synthesis of the compound or during its applications. These lead investigations to focus on the use of natural substances in order to find low-cost and non-hazardous inhibitors.

Harnessing naturally occurring substances as corrosion inhibitors is a subject of great practical significance [1-8]. Catula cineara, a herb which has interesting dyeing properties and used for centuries in the South-East of Algeria (Ouargla) for traditional usages, is readily available, renewable material source.In this short communication , we present our investigation regarding

the corrosion behavior of mild steel X52 in 20 % H_2SO_4 in the presence of Cotula cinerae (figure 1) at ambient temperature.

Figure 1: Cotula cinerae plant.

EXPERIMENTAL SECTION

2.1. Preparation of Cotula cinerae extract:

Cotula Cinerae leaves were crushed and extracted in water for 24 h. The extracted solution was then filtered and concentrated until the water evaporates from the extract. A qualitative analysis of the solid extract is given in the following table.

Table 1: qualitative composition of Catula cinerae

Flavnoids	Alkaloids	Saponins	Essential oils	Tanins	Steroids and terpenoids
+++	None	++	+	++	++

Table 2: 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	< 0.98

2.2. Specimen preparation:

The nominal composition of mild steel specimen involved in this study is given in table 2.Specimens were cut into 2 cm × 0.5 cm × 1.5 cm dimensions, sealed by polyester resin, leaving a surface area of 1cm^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.

2.3. Apparatus and experiment conditions.

Polarization measurements were conducted in a thermally jacketed conventional three electrode Pyrex cell with an overall volume of 500 cm^2. A platinum foil and saturated calomel electrode (SCE) were used as auxiliary and reference electrodes respectively. Measurements were carried out using a PC controlled Volta Lab PGZ 201 system with and voltmeter 3.04 soft ware.

The potentials were scanned at 30 mV/min from the corrosion potential (E_{corr}) in the cathodic direction subsequently in the anodic direction. The electrode was held in the test environment for 30 min prior to each experiment, which proved sufficient for E_{corr} to attain a reliable stable value. Inhibition efficiencies, **$(\%\eta_{Pol})$,** were calculated using the following relation:

Where I and I' are the uninhibited and inhibited corrosion rates (current density) respectively.

$$\left\{ \frac{I - I'}{I} \times 100 \right\}$$

RESULTS AND DISCUSSION

3.1 .Polarization measurements:

Potentiodynamic anodic and cathodic polarization plots for mild steel specimens in 20% H_2SO_4 solution in the absence and presence of different concentrations of Cotula cinerae extract are shown on Fig.2.

The respective kinetic parameters including corrosion current density (I_{corr}), corrosion potential (E_{corr}), polarization resistance R_p , cathodic and anodic Tafel slopes (βc, βa) and inhibition efficiency ($\%\eta_{Pol}$) are given in Table 3.

It is illustrated from data of figure 2 and table 3 that the addition of Cotula cinerae extract leads to a marked shift in the anodic branches and to a lesser extent in the cathodic branches of the polarization curves. More ever, in the presence of catula extract the values of corrosion potential $\mathbf{E_{corr}}$ are approximately constant. Accordingly, catula extract might be considered as an inhibitor with predominant anodic effectiveness. As it can be seen from table 3 that the cathodic Tafel slopes $\boldsymbol{\beta c}$ are nearly constant, indicating that the inhibitory action occurred by simple blocking of the available surface areas. It can be seen also that the polarization resistance values are proportional to the concentration of the extract.

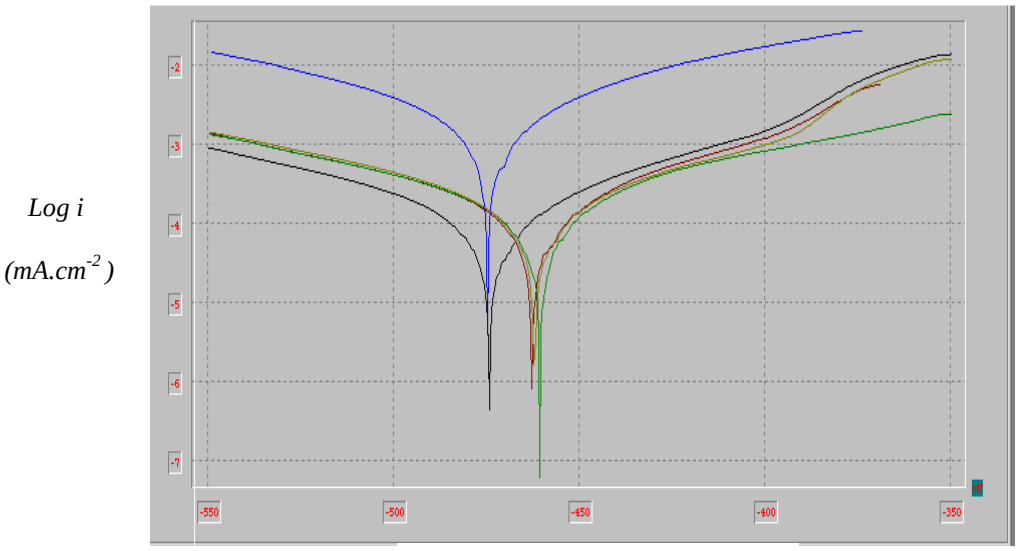

Figure 2: Tafel curves obtained in the presence of cotula cinerea at different concentrations

1. *The bleu curve: 0 ppm .*
2. *The black curve: 400 ppm.*
3. *The red and yellow curves: 600ppm.*
4. *The green curve: 800 ppm.*

Table 3: Kinetic parameters of mild steel X52 corrosion at different concentrations of. Cotula cinerea

Entries	medium	-βc (mV/dec)	βa (mV/dec)	$-E_{corr}$ (mV)	I_{corr}(mA/Cm^2)	Rp(Ohm .Cm^2)	%ηPol
(1)	H_2S0_4 20 %	89	99.1	473.6	2.8963	7.34	0
(2)	(1)+400ppm	90.2	70.8	472.9	0.12	122.51	95.85
(3)	(1)+600ppm	94.7	67.6	461.5	0.139	101.58	95.20
(4)	(1)+800ppm	97.5	109.7	459.3	0.219	150.24	92.43

CONCLUSION

This non-exhaustive study shows an appreciable inhibitory effect of catula cinerae extracts on the corrosion of mild steel X52 in 20% H_2SO_4 solution. More evidence is needed to elucidate the mechanism by which acts this plant. It would concern on one hand the determination of the extract constituents .And on the other hand, the involvement of other techniques such as electrochemical impedance spectroscopy and adsorption isotherms.

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