Investigation of the Inhibitive Properties of the Aqueous Extract of *Tamarix gallica* L on the Corrosion of Mild Steel in H$_2$SO$_4$ Medium

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ABSTRACT

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 technique. polarization curves revealed that the plant extract behave as mixed-type inhibitors. inhibition efficiency increased with extract concentration up to a critical value. the results show that the extract solution of the plant could serve as an effective inhibitor for the corrosion of steel in sulphuric acid medium.

Keywords: plant extract; *Tamarix gallica;* inhibition; corrosion; mild Steel**.**

INTRODUCTION

Natural compounds such as herb plants are increasingly used as eco-friendly corrosion inhibitors to develop new chemicals for a green environment. Plants extracts, which are used in folk medicine, have been selected because they are environmentally acceptable, readily available, and a renewable source for a wide range of needed inhibitors. The inhibitive action is attributed to their phytochemical constituents which aided the adsorption on the surface of mild steel.

Plants are considered as an incredibly rich source of naturally synthesized chemical compounds that can be isolated by simple extract procedures. Several investigations have been reported using such economic plant extracts to fight corrosion [1-8].

The aim of the present study is to investigate the corrosion inhibition effect of *Tamarix gallica* as a cheap and environment friendly corrosion inhibitor for mild steel in 1N H$_2$SO$_4$ medium by weight loss and polarization measurements.

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EXPERIMENTAL SECTION

Materials used for the study were mild steel sheet of composition (wt %): 0.9710 Mn, 0.1261 Si, 0.0021 S, 0.0020 P, 0.1039 C and remaining Fe. Sheet of mild steel was mechanically cut into Coupons with exposed surface area of 25 cm^2 (2 cm x 5.6cm x 0.2 cm). Each coupon was degreased by washing with ethanol, rinsed with acetone and allowed to dry in the air before preservation in a desiccator. The steel coupons were hung in the test solution (1 M H_2SO_4) before recording the loss of their weights. The corrosion rate was calculated on the basis of the apparent surface area. The inhibition efficiencies calculations were based on the weight loss measurements at the end of the whole exposure period. The results of the weight loss experiments are the mean of three runs, each with a fresh sheet and fresh electrolyte. The percentage of inhibition efficiency was calculated using the following equation:

$$IE (\%) = [(W_1-W_2)/W_1] \times 100$$

Where W_1 and W_2 are weight losses of steel in uninhibited and inhibited solutions.

For potentiostatic experiments, a cylindrical rod of each sample was embedded in araldite leaving an exposed bottom area of 1.0cm^2, and used as working electrode. Each working electrode was polished with different grades of emery papers, degreased with acetone and rinsed with distilled water, before its immersion in the test solution. Potentiostatic polarization studies were carried out using EG&G model 363 Potentiostat/Galvanostat. Three-compartment cell with a saturated calomel reference electrode (SCE) and a platinum foil auxiliary electrode were used. For potentiodynamic experiments, the working electrode was held at the potential of hydrogen evolution for 10 min before the starting of the potential sweep to get rid of any pre-immersion oxide film which may be present on the surface. The electrode was then disconnected from the potentiostat, gently shaken in the solution to release the hydrogen bubbles attached to its surface and left in the test solution until the reach of its steady state potential. Once the electrode acquires its steady state potential it is reconnected to the potentiostat for the polarization experiment procedure. The inhibition efficiency IE was calculated using the following equation:

$$IE\% = [(I - I_i) / I] \times 100$$

Where I and I_i are the corrosion rates in free and inhibited solutions, respectively.

3. Solutions preparation:

Double distilled water and analytical reagent-grade H_2SO_4 were used for preparing solutions. Stock solution of plant extracts was obtained by drying the plant for 15 day and grinding to powdery form. A 10 g of the powder was refluxed in 100 mL double distilled water for 2 hours in an oven at 80C°. The refluxed solution was filtered to remove any contamination. The concentration of the stock solution was determined by evaporating 10 mL of the filtrate and weighing the residue. Before each experiment, 1M H_2SO_4 is added to an appropriate volume of the stock solution and double distilled water to obtain a solution of 1 M H_2SO_4 and the required concentration of the extract. All chemicals used for preparing the test solutions were of analytical grade and the experiments were carried out at room temperature, $27 \pm 1C°$.

RESULTS

4.1. Weight loss measurements
Table 1: the rate of corrosion of X 52 steel in 1M sulphuric with *Tamarix gallica* extract

C(ppm)	50	200	400	600	800	1000	1200	1400	1600	1800	2000
V(mm/an)	23.7288	10.8145	09.6468	07.3613	05.0625	03.8641	02.8205	0.407	0.490	1.3662	1.6725
IE (%)	1.19	55.13	59.97	69.46	78.99	83.96	88.29	98.31	97.96	94.33	93.06

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Fig.1 presents the dependence of corrosion rate and inhibition efficiency IE (%) of mild steel exposed to 1M sulphuric acid on the concentration (ppm) of the plant extract studied at 27 ∘C. The increase of plant extract concentration increased the corrosion inhibition efficiency. The maximum inhibition rate is estimated to 98.31% in 1M sulphuric acid at 1400 ppm.
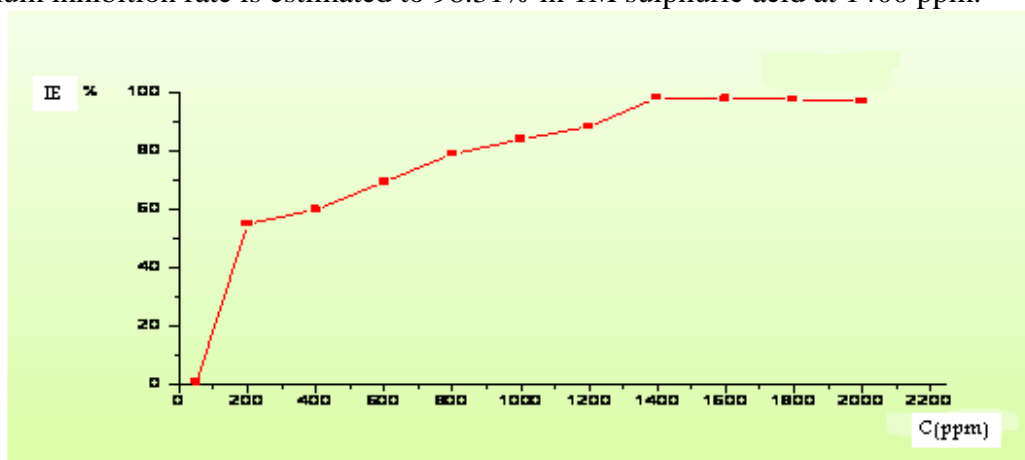

Fig. 1. Corrosion rate efficiency plots of mild steel immersed in 1M sulphuric acid with plant extract at 27 ∘C

4.2. Potentiostatic measurements:

Table 2: Parameters related to the X52 steel in the presence of inhibitor

| Concentration (ppm)	RPR (kΩcm2)	Ba (mv)	Bc (mv)	Icorr (µA/mv)	Ecorr (mv)	Vcorr (mm/an)	Taux (%)
00	21.78	125.2	-210.8	2.0597	-508.1	24.09	
200	36.72	83.6	-176.5	0.9945	-478.4	11.63	55.08
600	183.73	54.30	-79.30	0.0763	-470.3	0.893	96.26
1000	89.61	27.6	-52.8	0.0748	-469.7	0.875	96.36
1400	193.49	46.00	-81.10	0.0398	-470.1	0.465	98.07
1600	170.34	50.50	-60.70	0.0414	-463.4	0.484	97.99
1800	218.45	52.60	-13.20	0.0536	-468.40	0.628	98. 38
2000	80.60	63.60	-88.60	0.1128	-478.30	1.320	94.52
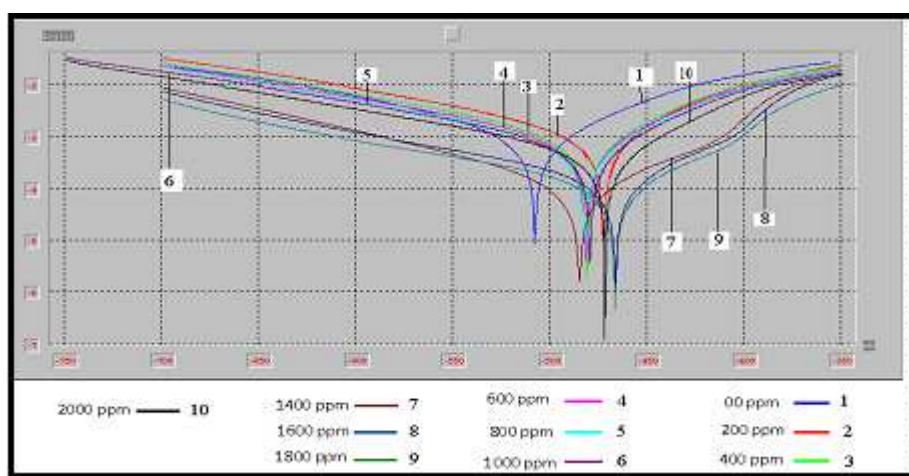
Fig.2-Tafel curves obtained for the plant extract

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According to the results, it is noted that the addition of the plant extract causes a decrease in the rate of corrosion for the concentrations 200, 600, 1000 and 1400 ppm, and an increase in the rate of corrosion for concentration greater than 1400 ppm. The optimal concentration of inhibitor is 1400 ppm for a rate of inhibition equal to 98.07%. The highest corrosion rate (1.320 mm / year) is obtained at a concentration of 2000 ppm of the inhibitor while the lowest was 0.465 mm / year obtained at a concentration of 1400ppm. The corrosion rate increase when the concentration of inhibitor exceeds 1400 ppm may be attributed to the decrease in the effectiveness of the inhibitor when excessively added.

CONCLUSION

The aqueous extract of *Tamarix gallica* can be used as an excellent corrosion inhibitor for steel in acidic medium at room temperature. To obtain the maximum protection efficiency, critical plant extract concentration should be determined. The inhibition mechanism depends on the formation of a stable plant extract-complex on the steel surface. Polarization studies reveal that the extracts behave as mixed type inhibitors.

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