

GALVANOSTATIC POLARIZATION STUDIES OF PLANTS LEAF EXTRACT ON MILD STEEL CORROSION IN H₂SO₄

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Abstract

Extract of leaves was synthesized by drying leaves in oven and then powdered the leaves. The powdered leaves were used to prepare leaf extract. The effect of extract on the corrosion in 0.5M sulphuric acid was investigated by Galvanostatic studies, potentiodynamic studies indicated that this indicator act as a mixed inhibitor. The corrosion rate of steel and the inhibitor efficiency of the extract were calculated. The result obtained shows that the extract solution of plant serves as an effective inhibitor for the corrosion of mild steel in sulphuric acid media. The experimental results suggest that this plant extract is an efficient corrosion inhibitor and inhibitory efficiency increases with the increase in inhibitor concentration and it decreases with the increase in temperature.

Key words: Leaf Extract, Galvanostatic Studies, Potentiodynamic Studies, Mixed inhibitor, Inhibition efficiency, Corrosion rate

INTRODUCTION

The study of mild steel corrosion phenomena has become important particularly in acidic media because of the increased industrial applications of acid solutions. One of the refining of crude oil results in a variety of corrosive conditions. Refinery corrosion is generally occurring due to strong acid attacking the equipment surface. The majority of well-known inhibitors are organic compounds containing heteroatom, such as O, N or S, and multiple bonds, which allow an adsorption on the metal surface (Behpour et al., 2012). These compounds can absorb on metal surface and block the active surface sites to reduce the corrosion rate.

Although many synthetic compounds show good anti corrosive property but most of them are highly toxic to both human beings and environment. This made the researchers to focus on the use of naturally occurring substances in order to find low-cost and non-hazardous inhibitors (Lebrini et al., 2010). Plant extracts have become important as an environmentally acceptable, readily available and renewable source of materials for wide range of corrosion prevention (Raja and Sethuraman, 2008). Azadirachta indica leaves (Dogon yaro), Alovera for mild steel in H₂SO₄ (Ahmad et al., 2010) and Vernonia amygdalina (bitter leaf) for mild steel in HCl medium. The authors have so far investigated the application of plant extracts against the corrosion of steel in acidic fluids. Lotto had reported the extract of mangifera indica (common name- mango) leaves, bark for corrosion of mild steel in dilute sulphuric acid. The weight loss measurement and electron impedance spectroscopy studies, polarization curves were used to determine the inhibition efficiency of the inhibitors. (Satapathy et al., 2009) studied the methanol extract of the Justicia gendarussa

leaves for corrosion inhibition of mild steel in HCl medium. El-etre investigated the stem extract of *Opuntia* for corrosion inhibition of aluminium in sulphuric acid solution. Sethuraman et al has performed a series of investigation on corrosion inhibition of metal steel in acidic medium using various plant extract for example black pepper, *Dathura* metel. In the present work, inhibitive action of *Sorghum vulgare* extract as a cheap, eco friendly and naturally occurring substance on corrosion behaviour of mild steel in 0.5M sulphuric acid has been investigated through Galvanostatic polarization measurements.

1. Experimental

1.1. Preparation of *Sorghum vulgare* leaf extract

Sorghum vulgare leaves were dried in an oven and crushed. The powered leaves were refluxed with 2N sulphuric acid for three hours. The extracted solution was then filtered and filtrate used as stock solution. The testing solutions of different concentration were prepared from stock solution. The different concentration was 10%, 20%, 30%, 40%.

1.2. Specimen preparation

Mild steel specimens having nominal composition of 0.179% C, 0.165% Si, 0.439% Mn, 0.203% Cu, 0.034% S and Fe balance were used. Coupons were cut into 2 x 2 x 0.2 cm dimensions used for weight loss measurements, whereas specimens with 2 x 2 x 0.7 cm dimensions, sealed by polyester resin, leaving a surface area of 4 cm², were used as working electrode for polarization and EIS measurements. The exposed area was mechanically abraded with 220, 400, 800 and 1000 grades of emery papers, degreased with acetone and rinsed by distilled water before each electrochemical experiment.

1.3 Galvanostatic Polarization Measurements

Linear Polarization resistance were performed in a conventional three electrode cylindrical pyrex glass cell. Pure mild steel specimen was used as the working electrode, platinum electrode as the counter electrode and saturated calomel (SCE) as the reference electrode. Potentiodynamic anodic and cathodic polarization plots for mild steel specimens in 0.5M sulphuric acid solution in the absence and presence of different concentrations of *Sorghum vulgare* extract are shown in Fig. The respective kinetic parameters including corrosion current density (I_{corr}), corrosion potential (E_{corr}), cathodic Tafel slope (bc) and inhibition efficiency (IE %) are given in Table.1. It is illustrated from the data of Table that the addition of *Sorghum vulgare* extract decreases corrosion current density. Also, it can be clearly seen that the inhibition efficiency of *Sorghum vulgare* extract increases with inhibitor concentration. This behaviour shows that *Sorghum vulgare* extract acts as a good inhibitor for the corrosion of mild steel in Sulphuric acid media. The presence of inhibitor results in a marked shift in the cathodic branches and to a lesser extent in the anodic branches of the Polarization curves. Moreover, in the presence of *Sorghum vulgare* extract the values of corrosion potential E_{corr} are nearly constant; therefore, *Sorghum vulgare* extract could be classified as a mixed-type inhibitor with predominant cathodic effectiveness. Inhibition efficiency can be calculated by using the given formula:

$$IE \% = \frac{I_{corr} - I_{corr(inh)}}{I_{corr}} \times 100$$

Table 1. Potentiodynamic polarization parameters for the corrosion of mild steel in 0.5 M H₂SO₄ having different concentrations of Sorghum vulgare leaf extract.

Temp.	Conc.(v/v%)	-E _{corr} (mV)	b _c (Mv/dec)	b _a (mV/dec)	I _{corr} (mA/cm ²)	% IE
298 K	40%	526	108	119	0.06452	94%
	30%	478	108	90	0.1078	89%
	20%	553	120	351	0.2190	78%
	10%	547	114	372	0.3036	70%
	0.5MH ₂ SO ₄	457	114	61	1.017	-
308 K	40%	504	116	159	0.1046	92%
	30%	499	119	173	0.1641	87%
	20%	458	111	43	0.3140	75%
	10%	531	137	329	0.4614	63%
	0.5MH ₂ SO ₄	429	116	61	1.267	-
318 K	40%	517	107	194	0.2023	90%
	30%	484	116	58	0.3027	85%
	20%	514	116	211	0.6059	69%
	10%	596	148	683	0.7863	60%
	0.5MH ₂ SO ₄	474	144	66	1.984	-
328 K	40%	504	115	43	0.4204	86%
	30%	514	119	160	0.6253	79%
	20%	595	132	542	1.075	64%
	10%	485	120	86	1.293	57%
	0.5MH ₂ SO ₄	470	133	63	3.009	-

Conclusion

1. The result presented in this work showed that extract of sorghum vulgare act as a good inhibitor for corrosion of mild steel in 0.5M sulphuric acid solution.
2. Tafel plot shows that inhibition efficiency increase with increase in concentration of extract.
3. The increase of temperature decreases the inhibition efficiency of the extract.
4. Tafel plot shows that this plant extracts act as a mixed inhibitor for corrosion of mild steel.

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