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INHIBITION EFFECTS OF A DMPO DERIVATIVE ON THE CORROSION OF ZINC-ALUMINIUM ALLOY IN 0.1NHYDROCHLORIC ACID SOLUTION BY OCP METHOD AT DIFFERENT TEMPERATURES

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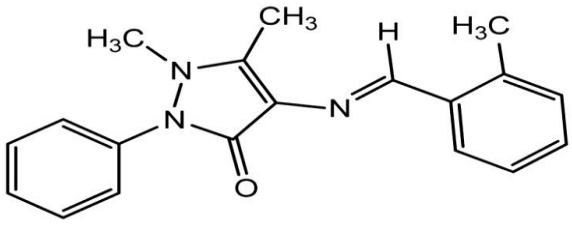
ABSTRACT:*1,5-Dimethyl-4-((2-methylbenzylidene)amino)-2-phenyl-1H-pyrazol-3(2H)-one (DMPO) was synthesized to be evaluated as a corrosion inhibitor. The corrosion inhibitory effects of DMPO on Zinc-Aluminum alloy in 1.0 M HCl were investigated using open circuit potential (OCP). The results showed that DMPO inhibited Zinc-Aluminium alloy corrosion in acid solution and indicated that the inhibition efficiency increased with increasing inhibitor concentration. Changes in the impedance parameters suggested an adsorption of DMPO onto the Zinc-Aluminum Alloy surface, leading to the formation of protective films. The novel synthesized corrosion inhibitor was characterized using UV-Vis spectral analyses.*

KEY WORDS: corrosion inhibitor, open circuit potential (OCP), DMPO

INTRODUCTION

Corrosion inhibitors are of considerable practical importance, as they are extensively employed in reducing metallic waste during production and in minimizing the risk of material failure, both of which can result in the sudden shut-down of industrial processes, which in turn leads to added costs [1]. It is also important to use corrosion inhibitors to prevent metal dissolution and minimize acid consumption [2–4]. The majority of well-known acid inhibitors are organic compounds that contain nitrogen, sulfur and oxygen atoms. The inhibitory action exercised by organic compounds on the dissolution of metallic species is normally related to adsorption interactions between the inhibitors and the metal surface [5,6]. The planarity (p) and lone pairs of electrons present on N, O and S atoms are important structural features that control the adsorption of these molecules onto the surface of the metal. The purpose of this work was to verify the previously established results on the corrosion inhibition effect of various Schiff bases on Aluminum Alloy in acidic media [7]. Many researchers have reported that the inhibition effect depends mainly on some physicochemical and electronic properties of the organic inhibitor related to its functional groups, steric effects, electronic density of donor atoms and orbital character of electrons donor [8]. Schiff bases are organic compounds that have the general formula R–C=N–R-, where R and R- are aryl, alkyl or heterocyclic groups. Schiff bases are formed by the condensation reaction of a primary amine and a ketone or aldehyde and are potential corrosion inhibitors. The greatest advantage of many Schiff base compounds is that they can be conveniently and easily synthesized from relatively cheap materials. Due to the presence of the imine group (–C=N–) and electronegative nitrogen, sulfur and/or oxygen atoms in the molecule,

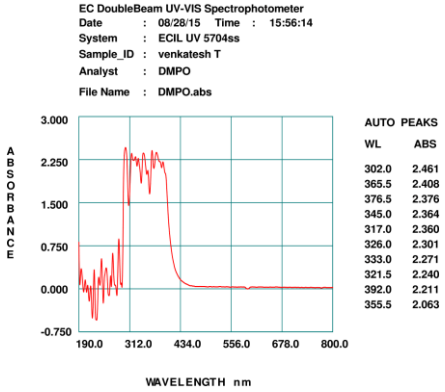
Schiff bases have been reported to be effective inhibitors for the corrosion of steel in acid media by several authors [9–12]. Conversely, the surface state and excess charge of the metal have also been reported to affect the adsorption behavior of inhibitor molecules onto the metal surface [13]. Generally, the tendency to form a stronger coordination bond, consequently resulting in high inhibition efficiency, increases in the order of O < N < S < P [14]. As a continuation of previous studies [15–20], we focused on the synthesis of new heterocyclic compounds as novel organic corrosion inhibitors. Herein, we report the synthesis of 1, 5-dimethyl-4-((2-methylbenzylidene) amino)-2-phenyl-1*H*-pyrazol-3(2*H*)-one, DMPO, and chemical structure elucidation using spectroscopic techniques *i.e.*, UV-Vis. Recent studies have shown that organic compounds containing polar functional groups are quite efficient in minimizing the effect of corrosion in addition to heterocyclic compounds containing polar groups and π-electrons. The molecular design of the DMPO molecule is based on the fact that 4-aminoantipyrine consists of amine, methylamine, carbonyl and π-electron bonds, which would effectively contribute towards the inhibition of Zinc-Aluminium Alloy corrosion in acidic media. Moreover, Schiff bases containing imine groups would contribute more effectively to the inhibition of corrosion of Zinc-Aluminium alloy in acid medium. The proposed structure of the
synthesized novel corrosion inhibitor is shown in below.



Chemical structure of 1, 5-dimethyl-4-((2-methylbenzylidene) amino)-2-phenyl-1*H*-pyrazol-3(2*H*)-one (DMPO).

Experimental Section

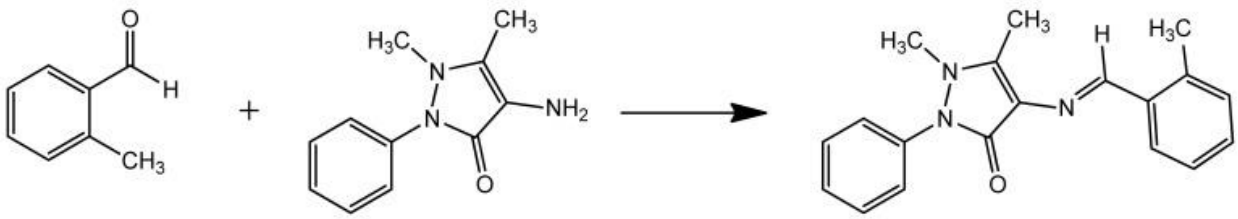
All chemicals used were of reagent grade (supplied by Sigma-Aldrich) and used as supplied without further purification. Uv-Visible spectra were recorded on a double beam Uv-Vis Spectrophotometer Uv 5704SS



Synthesis of Corrosion Inhibitor DMPO

To synthesize the new corrosion inhibitor DMPO, the reaction sequence outlined in was followed, starting from commercially available 4-aminoantipyrine. The synthesis was carried out by refluxing 4-aminoantipyrine with 2-methylbenzaldehyde in the presence of a few drops of acetic acid. The mechanism of this reaction followed the Schiff base mechanism.

A solution of 2-methylbenzaldehyde (0.4 mmol) in 50 mL ethanol was refluxed with 4-aminoantipyrine (0.4 mmol) for 5 h. After cooling to room temperature, a solid mass was separated and recrystallized from ethanol in 87% yield



Open Circuit Potential (OCP) Measurements

RESULT AND DISCUSSIONS:

The OCP of Zinc-Aluminium Alloy was monitored in the presence of 10ppm, 20 ppm, 30ppm and 50ppm of DMPO. Figure 3 presents the effect of the presence of the DMPO inhibitor on the variation of the OCP of Zinc- aluminium alloy in 1.0 M HCl solutions. This preliminary result suggests that DMPO can retard both reactions under open circuit conditions, including the oxidation of the oxide-free iron and the discharge of the hydrogen ions to produce hydrogen gas on the surface of the Zinc-Aluminium Alloy [26,27].

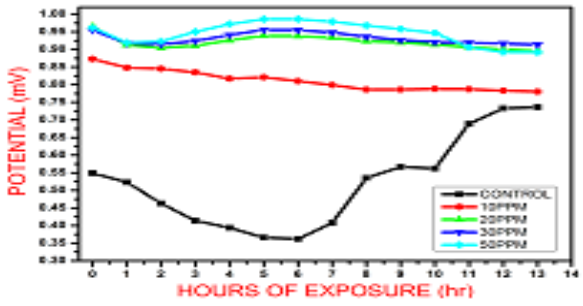


Fig.1. Open circuit potential studies of Zinc Aluminum Alloy in 0.1N HCl solution using DMPO as an Organic inhibitor @ 25°C

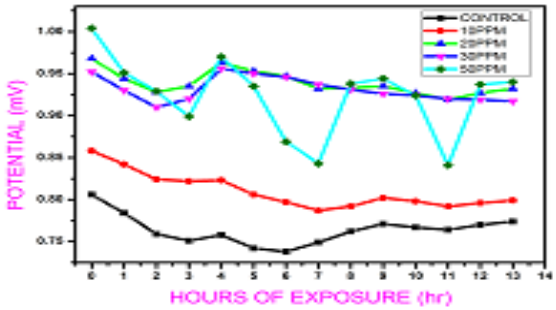


Fig.2. Open circuit potential studies of Zinc Aluminum Alloy in 0.1N HCl solution using DMPO as an organic inhibitor @ 30°C

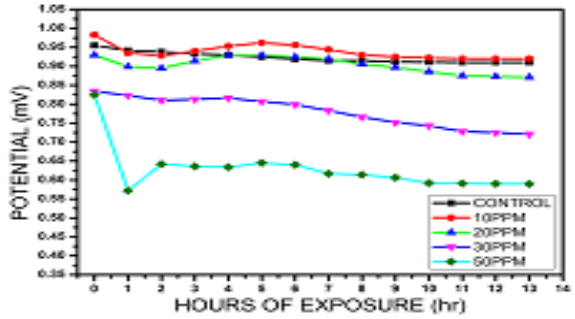


Fig.3. Open circuit potential studies of Zinc Aluminum Alloy in 0.1N HCl solution using DMPO as an Organic inhibitor @ 35°C

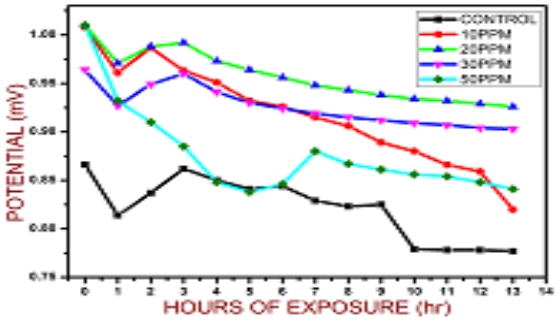


Fig.4. Open circuit potential studies of Zinc Aluminum Alloy in 0.1N HCl solution using DMPO as an organic inhibitor @ 40°C

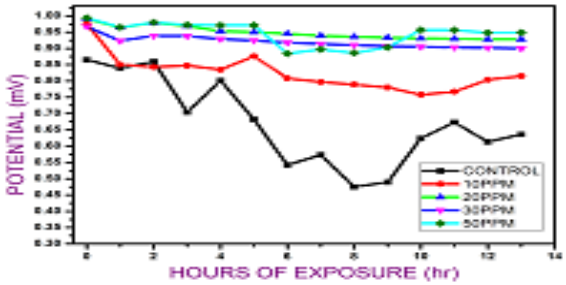


Fig.5. Open circuit potential studies of Zinc Aluminum Alloy in 0.1N HCl solution using DMPO as an Organic inhibitor @ 45°C

SEM AFTER CORROSION TEST

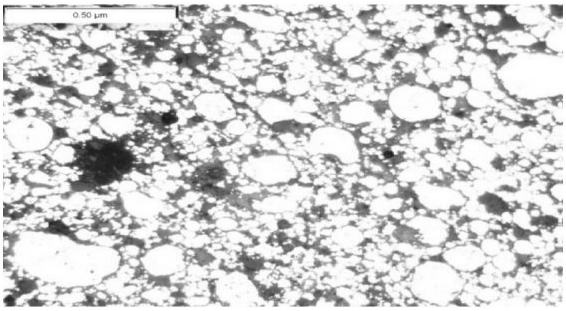


FIG.6 AFTER CORROSION TEST WITH 20PPM OF DMPO INHIBITOR

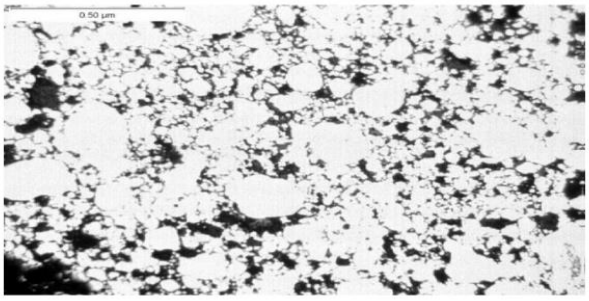


FIG.7 AFTER CORROSION TEST WITH 50PPM OF DMPO INHIBITOR

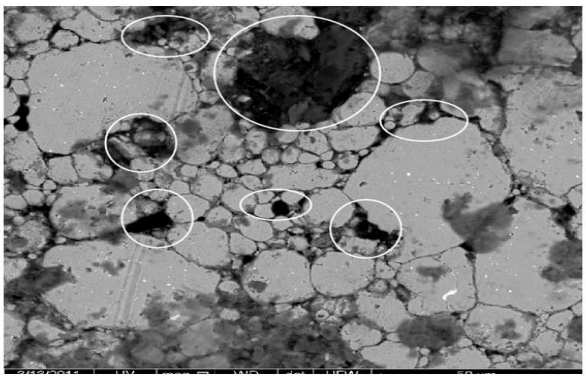


FIG.8 AFTER CORROSION TEST WITH 10PPM OF DMPO INHIBITOR

Conclusions

In this study, 1,5-dimethyl-4-((2-methylbenzylidene)amino)-2- phenyl-1*H*-pyrazol-3(2*H*)-one (DMPO), was sequentially synthesized and characterized using Uv-Vis spectroscopic methods, open circuit potential (OCP) to study the corrosion inhibition of Zinc-aluminium alloy in 1.0 M HCl

solutions at different temperature using different concentrations of DMPO as an inhibitor. This compound exhibited excellent inhibition performance as a mixed-type inhibitor. In general, the acidic corrosion of Zinc- aluminium alloy was reduced upon the addition of an appropriate concentration of DMPO. DMPO acts as an efficient corrosion inhibitor in 1.0 M hydrochloric acid.

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