Synthesis of Corrosion Inhibitor Based on Polymethyl Methacrylate and Studying of Its Inhibition Efficiency on Carbon Steel in a 1 M HCl Medium

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Abtract.

The newly composite corrosion inhibitors have been synthesized from monoethanolamine, methyl methacrylate and phosphoric acid and their inhibition efficiency were studied. In this case, the mole ratio of the initial substances was maintained 1:2:2 respectively and the temperature was also remained between 35 ^{0}C and 40 ^{0}C, and 48 hrs. time duration has also been followed. The composition of this obtained composite corrosion inhibitor was analyzed by spectroscopic techniques and also quantum chemical calculation. In addition that the decomposition rate was determined using DTA and TGA processes. Moreover, the inhibition efficiency of this corrosion inhibitor (**MMF-1**) was studied using electrochemical measurements at different temperatures and concentrations. Polarization measurements have been carried out and according to results it has been treated as a mixed-type inhibitor. Furthermore, the formation of protective films on carbon steel surfaces was confirmed by analyzing scanning electron microscopy and also atomic force microscopy. Specially inhibition mechanism of this corrosion inhibitor was widely studied at temperatures of 298, 303, 313, and 323 K and clearly confirmed that it follows the langmuir adsorption isotherm.

Keywords: methyl methacrylate, monoethanolamine, phosphoric acid, corrosion, carbon steel.

1. Introduction

Corrosion is a reversible process, which converts pure metal to different chemical compounds [1]. Nowadays, corrosion is turning into a major issue in many

industries, building materials, infrastructure, tools, ships, trains, vehicles, machines, and appliances [2]. Carbon steel experiences extensive corrosion during the cleansing process with acids. The NACE 2016 reported that across the world about 2.5 trillion U.S. dollars economic fall due to corrosion and Every year 10% of metal is lost due to corrosion which severely affects the country's economy [3]. Corrosion is not only responsible for an economic loss but also related with safety issues because it decreases the shelf life of steel [4]. It has already been recognized as a major issue for the entire world, so researchers are trying to protect the corrosion process in various ways [5]. Mostly inhibitor is typically used to protect metal from corrosion and environmental friendly inhibitors have wide application in corrosion fields and it is generally added in the metal as a low concentration [6]. We believe this study is a small initiative to find a suitable corrosion inhibitor which can able to protect materials form corrosion process. According to this study, a corrosion inhibitors were prepared based on poly(methyl methacrylate-maleic anhydride)P(MMA-MAH)s accompanied with different percentage of methyl methacrylate and maleic anhydride and the inhibitory potentiality of this inhibitor has checked on simple carbon steel in a 0.5 M HCl [7-10].

2. Materials: To synthesize this composite corrosion inhibitor, monoethanolamine and methyl methacrylate monomers (purified by driving in inert nitrogen atmosphere) and phosphoric acid, such as 1 M HCl for aggressive environments, were used. Steel composition: Fe 97.755-97.215%, C 0.17-0.24%, Si 0.17-0.37, Mn 0.35-0.65%, Ni 0.3%, S 0.04 %, P 0.035 %, Cr 0.25 %, Cu 0.3 %, As 0.08 %. 2×2.5 cm^2 samples of steel with this composition were taken, the surface was cleaned with sandpapers, washed several times in acetone and dried.

3.Methods: Analytical results are obtained using different types of analytical instruments which are mentioned with specification in below:

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Infrared Spectroscopic (IR) technique - IR Spectra, Specially synthesized Corrosion Inhibitors are checked by "IRTracer-100" (SHIMADZU CORP., Japan, 2017) Spectrometer.

Scanning Electron Microscope (SEM, SmartSEM software SEM-EVO MA 10 (Carl Zeiss, Germany),). and thermal stability in differential-thermal and thermogravimetric methods of France analyzed on a LABSYS EVO STA devices are used.

NMR spectra on JNM-ECZ600R spectrometer (JEOL, Japan), Atomic force microscopy (AFM) were used and electrochemical studies were performed using devices such as the CS-350 Cossion test.

4. Conclusion:

The MMF-1 corrosion inhibitor based on methyl methacrylate, monoethanolamine, and phosphoric acid was obtained with a yield of 87% and its structure was firmly established by spectroscopic techniques. Thermal and electrochemical properties have been studied as well. The main target of this works is to establish a newly corrosion inhibitor in terms of efficiency against corrosion process. The noteworthy observation was that the obtained composite corrosion inhibitor revealed 94.72% Inhibitor efficiency (IE) through the electrochemical analysis method. Moreover, the inhibition mechanism of the composite corrosion inhibitor was studied and it was evident that its inhibition efficiency increased with the increase of concentration and its effect on the metal surface was also examined thoroughly by SEM and AFM on the inhibited steel surface. Finally, MMF-1 corrosion inhibitor can easily use it commercially as a corrosion inhibitor based on its efficiency. However, the authors have suggested that further testing of the inhibitor's efficiency should be done before prior to establish as a corrosion inhibitor.

5.Acknowledgments
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6.References

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