MULTICOMPONENT SYSTEM BASED ALKANOLAMINE-SUBSTITUTED BENZOIC ACID FOR CORROSION INHIBITION OF IRON IN SALINE MEDIUM

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Abstract

In the past few decades, there has been significant interest from both academia and industry in multicomponent organic crystals constructed from acid-base complexes [1]. Organic salts have been the subject of much research in fields such as corrosion control, medicines, agrochemicals, energetic materials, and protonic conductors. Most well-known organic inhibitors have heteroatoms with polar functional groups, benzene rings, or lone pair electrons (N, O, or S), that act as active sites for adsorption on metal surfaces [2]. According to developments in this field, the inhibitor's structural feature, the corrosive medium's characteristics, and the metal surface's characteristics affect how well corrosion is inhibited.

The present study focuses on the obtaining, structural analysis, and investigation of the anti-corrosive properties of ethylethanolammonium 4-nitrobenzoate (EEA4NB) for iron in 3% NaCl solution, taking into account the trend in the last period towards the development of environmentally friendly corrosion inhibitors [3, 4]. The benzene ring connected to the carboxylate group (COO-) enhances the inhibitor's efficacy and is a crucial functional component that causes adsorption on the metal surface. Additionally, alkanolamines, which combine the chemical and physical properties of amines and alcohols in a single molecule, can form strong and directed hydrogen bonds with benzoic acids [5]. Despite the fact that alkanolamines and substituted benzoic acids are environmentally benign, there aren't many investigations on their application as metallic corrosion inhibitors in $HClO_4$ and chloride solutions in the literature [3, 6]. In this study, a novel environmentally friendly corrosive inhibitor (EEA4NB) was synthesized, purified and structurally characterized by single crystal X-ray diffraction analysis and Fourier transform infrared spectroscopy (FT-IR). All structural data revealed the formation of organic salt with proton transfer from 4-nitrobenzoic acid to nitrogen atom of alkanolamine molecule. Electrochemical assays were used to investigate the inhibitory effect of EEA4NB on iron corrosion in NaCl solution. The values of current density (Jcorr) demonstrate that the EEA4NB layer generated has the ability to inhibit and block the iron surface corrosion sites. The inhibition efficiency (IE), which is calculated from the Jcorr value, exhibits a high percentage of iron surface inhibition above 92% for all concentrations of EEA4NB in solution. At 5 mM, the maximum concentration of EEA4NB, this effect increased to 99.9%. The corrosion resistance (Rcorr) for iron in solution containing 5 mM EEA4NB is 60 times lower than the Rcorr for iron in saline solution alone. The ZEISS STEMI 508 microscope's images show that EEA4NB adsorption has formed a protective coating on the electrode's surface. The image taken on the iron surface at the border between the corroded and exposed areas to saline solution containing 5 mM EEA4NB saline solution is shown in Figure 1.

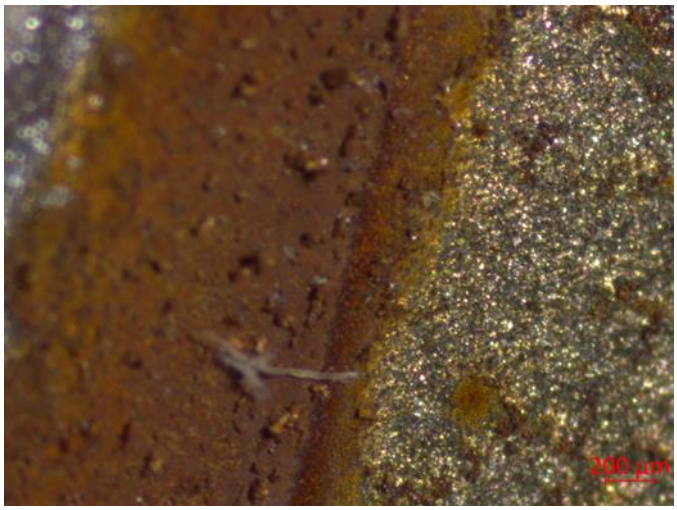

Figure 1. Optical microscope image for surface image with the boundary between exposed area of surface cover with a film formed during exposure to 5 mM EEA4NB and exposed only to saline attack

The results demonstrate the formation of a stable organic layer on the iron surface with anticorrosive properties in the presence of 5 mM EEA4NB [7].

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References
[1] M. Crisan, P. Bouros, Y. Chumakov, M. Petric and G. Ilia, Cryst. Growth Des. 13 (2013), 143.
[2] K.F. Khaled, Appl. Surf. Sci. 256 (2010) 6753.
[3] C. Li, L. Li, C. Wang. Electrochim. Acta. 115 (2014) 531.
[4] Z. Sibel. Turk. J. Chem. 26 (2002) 403.
[5] A.B.E. Rani, B.B.J. Basu. Int. J. Corros. 2012 (2012) Article ID 380217.
[6] B. Elsener, M. Büchler and H. Böhni, Organic Corrosion Inhibitors for Steel in Concrete, Corrosion of Reinforcement in Concrete: Corrosion Mechanisms and Corrosion Protection, EFC Publication No. 31, The Institute of Materials, London, 2000, pp. 61.
[7] Y. Tong, J. Ye, Q. Wang, H. Zhang, H. Yu & A.-O. Seibou, J. Asian Archit. Build. Eng. 22:2 (2022) 415.
[8] M. Crisan, G. Vlase, N. Plesu, M. Petric, L. Croitor, V. Kravtsov, Y. Chumakov, P. Bourosh and T. Vlase, J. Therm. Anal. Calorim. 134 (2018), 343.