Chapter 17
Imidazole Derivative as a Novel Corrosion Inhibitor for Mild Steel in Mixed Pickling Bath

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ABSTRACT

Mild steel is a well-known and widely used material in various industries. However, its exposure to aggressive environments limits its use because of its tendency to corrode. This work focuses on the inhibition of corrosion of mild steel by two organic compounds based on Imidazole, namely 2-(4-chlorophenyl)-1,4,5-triphenyl-1H-imidazole and 1,2,4,5-tetraphenyl-1H-imidazole, in mixed pickling bath. The experimental investigation was carried out using several techniques including electrochemical impedance spectroscopy and potentiodynamic polarization. The adsorption process of corrosion inhibitors on the mild steel surface follows Langmuir adsorption model. Surface characterization analysis using scanning electron microscopy coupled with energy dispersive X-ray analysis (EDX), X-ray diffraction analysis (XRD) supported the formation of a barrier layer that covers the mild steel surface. Weight loss measurements were also tested using UV-vis spectrometry (UV-vis).

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1. INTRODUCTION

Corrosion inhibition of steel samples is a serious problem in industry fields (Byars, 1999; Obot, 2015). Steel has an important potential in diverse industries through various advantages such as low density, high resistance, and lower cost (Guo, 2018; Erdoğan, 2017). Inhibitors utilization is an important method to protect metallic substrates against corrosion. Recently, heterocyclic organic compounds derivatives investigated as potential corrosion inhibition for steel in varying aggressive solutions (HCl, H_3PO_4, H_2SO_4, HNO_3, NaCl, etc.) (Zaferani, 2013; Boumhara, 2019; Echihi, 2021). The most employed inhibitors are heterocyclic organic compounds (quinoline, imidazole, benzodiazepine, benzimidazole, thiophene, anionic and cationic surfactant, triazepine, moxifloxacin quinoxaline, …) (Fergachi, 2018 ; Belghiti, 2020 ; Benhiba, 2020 ; Badr, 2009 ; Yilmaz, 2016 ; Ikpi, 2017; Yousefi, 2019), epoxy resins (Hsissou, 2019a), polymer composites (Hsissou, 2018), essential oil (Chatoui, 2018). Different work displayed that the compounds havening functional groups, heteroatoms (oxygen, nitrogen, sulfur, phosphorus), double and/or triple bonds, and heterocyclic aromatic rings have greater anticorrosive efficiency against corrosion of steel area (Alaoui, 2018; Serrar, 2018). These previous compounds inhibit the corrosion inhibition of steel substrates through the adsorption of steel area (Abdallah, 2019; Abeng, 2022). For heterocyclic organic inhibitors, previous studies displayed that the corrosion rate increases by adsorption on steel surfaces and the inhibition efficiency follow the order: phosphorus > sulfur > nitrogen > oxygen (Abd El Haleem, 2013; Tadros, 1988). Based on recent studies, the increases in the concentration of heterocyclic organic compounds can improve the mechanical, physical, chemical and barrier properties.

Especially, azole, oxazole, and thiazole compounds or their derivatives, have shown remarkable protection effectiveness against metallic corrosion in several aggressive media (Edraki, 2019; Fouda, 2016; Farahati, 2019). These compounds are five-atom aromatic ring molecules that contain a nitrogen atom and at least one other nitrogen, oxygen, or sulfur atom as part of the ring (Eicher, 2003). The azole-based compounds can be divided into three major classes, namely, N-, N&O-, and N&S containing azole sets. In addition to their attractive molecular structures, i.e., the presence of heteroatoms, doubles bonds, and their planar structure, azole-based compounds are soluble in almost any polar aggressive environments, particularly in acidic media. Recently, more attention has been focused on the development of new stable anti-corrosion compounds containing imidazole core rings (Hmamou, 2013; Guttierez, 2016).

Various studies reported in the literature suggest that imidazole derivative compounds were used for higher inhibitory efficiency in aggressive solutions and to protect also the steel surfaces against corrosion (Yadav, 2016; Benali, 2010; Gopi, 2014). The utility, reactivity and interaction between the heterocyclic organic imidazole compounds and steel surface are strongly accompanied by adsorption mechanisms.

This potential chapter aims to achieve heterocyclic organic compounds derivatives as potential corrosion inhibition for steel in pickling bath medium with high anti-corrosive performance. The effect of the simultaneous use of heterocyclic organic compounds imidazole-based on the anticorrosive protection was investigated and evaluated by using weight loss (WL), polarization curves (PC), electrochemical impedance spectroscopy (EIS), scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy (EDS), X-ray diffractometer (XRD), and Fourier transform infrared (FTIR) spectroscopy. In the last step, the electrochemical behavior and corrosion detection of the steel was realized in the presence of heterocyclic organic compounds at varying concentrations.