


Chapter 19

Performance of Benzimidazole Derivatives as Potential Corrosion Inhibitors in Phosphoric Acid Solutions

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ABSTRACT

The use of organic compounds as corrosion inhibitors is one of the effective and economical methods to reduce corrosive attacks on metallic materials. In this work, the inhibition ability of two benzimidazole derivatives (SHA and BBC) against the corrosion of mild steel in Phosphoric acid solution was studied using electrochemical techniques, Scanning Electron Microscopy, Energy dispersive X-ray analysis, and Density Functional Theory method. The Potentiodynamic Polarization measurements indicate that the synthesized inhibitors are effective mixed-type inhibitors. SEM/EDX analysis strongly supports the obtained results and confirms the existence of barrier film on the metal surface.

DOI: 10.4018/978-1-6684-7689-5.ch019

1. INTRODUCTION

Phosphoric acid is widely used in the production of fertilizers and various surface treatments in the metallurgical industry, such as polishing, oxide film removal, passivation and surface cleaning (Goyal, 2018). This medium has the unique property of quickly dissolving rust while attacking iron very slowly. The other advantage of phosphoric acid is that it leaves a thin layer of iron phosphate on the metal surface, which prevents corrosion. Metal corrosion is an aggressive and destructive electrochemical process (Tan, 2021; Zhang, 2021). Given the extensive and costly impact of corrosion, discovering strategies to regulate and mitigate the rate of corrosion has become a prominent study focus globally.

Recent research on corrosion inhibitors has focused on the use of organic inhibitors to inhibit the dissolution of metals (Abdallah, 2021). Corrosion inhibition in an aggressive environment can be provided by the addition of these organic compounds containing functional groups such as =N-N=, =N-C, C=O, C=S... etc., and π - π systems in the aromatic ring, which indeed exhibit satisfactory inhibitory properties by providing electrons through the π - π orbitals (Caio, 2019). Hence, these interactions generally operate as a barrier film by the formation of a chelate on the metal surface with the active sites by shifting electrons to the transition metal ions and forming a covalent bond and/or electrostatic interactions between the positively charged inhibitor molecules and the positively charged Fe atoms (Dkhireche, 2020). Indeed, the interaction that can occur between these functional groups usually involving electron-donating heteroatoms such as >N-, -S- or -O- and the surface of the mild steel will have a relevant influence on the inhibition efficiency (Mert, 2011).

At present, imidazole and its derivatives are most commonly used to protect the steel surface from oxidation in acid by the formation of a protected film on the steel surface. These compounds can be broadly divided into imidazole (Ouakki, 2019), benzimidazole (Prashanth, 2021; Salcı, 2022), Oxazole (Moretti, 2013) and triazole (Caldona, 2021) derivatives. Dutta et al., 2017 studied the effect of four benzimidazole derivatives on corrosion inhibition of mild steel and efficiencies as high as 93.7% were achieved in 1.0 M HCl solution. A review by Ech-chihbi et al., 2021, which focused on the general properties and inhibition efficiencies of different triazole derivatives for steel corrosion, provides useful information on inhibitor underlying mechanisms and suitability in various acidic environments.

In this chapter, the kinetics of the corrosion of mild steel in 0.33M phosphoric acid (H_3PO_4) have been studied by potentiodynamic polarization and electrochemical impedance spectroscopy techniques. The benzimidazole concentration and the effect of temperature on mild steel corrosion have been investigated. In addition, SEM/EDS analysis gives an insight into the surface properties of the metal before and after exposure to free acid and acid-containing the inhibitor and confirms the existence of barrier film on the metal surface. The synthesis procedure of the studied inhibitors is already presented in our previous work (Ech-chihbi, 2020).

2. BACKGROUND

Mild steel has been widely used in various industries due to their stable performance. However, they are easily corroded by aggressive media in service environments, which caused high economic losses. Among the different methods for mitigating corrosion, the use of corrosion inhibitors is the most effective and reliable technique. Benzimidazole derivatives have attracted considerable attention in the field of medicinal chemistry due to their use in a number of therapeutic agents. Therefore, this chapter covers

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