Chapter 20
Corrosion Inhibition of Mild Steel in Acidic Pickling Baths: Benzoxazepine Derivatives as Acid Corrosion Inhibitors

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ABSTRACT

In this chapter, the authors investigate recent advancements in the manufacture of chemical compounds containing a benzoxazepine-based heterocycle. Specifically, they synthesized the Benzoxazepine Derivatives using two organic reactions to test its efficacy as an inhibitor against the corrosion of mild steel in acidic pickling baths. The findings reveal that the corrosion inhibitor efficiency increased from 79.4% to 93.3%. This study also employed the Langmuir adsorption model to show that Benzoxazepine Derivatives studied adsorbed spontaneously on the metal surface with a mixed-type nature, forming a coating that is verified by SEM/EDS. The negative free energy of adsorption values and the significant relationship between the inhibitor molecule and the adsorption energy further support our findings. This study demonstrates the potential of benzoxazepine derivatives as effective inhibitors of mild steel corrosion in acidic pickling baths, with significant implications for the manufacturing industry. Continued research in this field is of utmost importance.

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1 INTRODUCTION

Corrosion inhibition of steel samples is a major issue in many industries (Obot et al.,2011, Guo et al., 2018). Steel has significant potential in a variety of sectors due to several characteristics such as low density, high resistance, and cheap cost (Erdoğan et al., 2017, Byars., 1999). The use of inhibitors is a key strategy for protecting metallic substrates against corrosion. Recently, heterocyclic organic molecule derivatives were studied as prospective corrosion inhibitors for steel in a variety of harsh solutions (HCl, H3PO4, H2SO4, HNO3, NaCl, and so on) (Echihi et al., 2021, Boumhara et al., 2018). The most commonly used inhibitors are heterocyclic organic compounds (benzoxazepine, benzodiazepine, benzimidazole, quinoline, moxifloxacin quinoxaline, thiophene, anionic and cationic surfactant, triazepine,...) (Yousefi et al., 2019, Fergachi et al., 2017), polymer composites (Hsissou et al., 2019a, Hsissou et al., 2019b), natural products (Rbaa et al., 2021, Berrissoul et al., 2020, Benhiba et al., 2017), essential oil (Echihi et al., 2021, Chatoui et al., 2018), epoxy resins (Hsissou et al., 2019c),....Various studies have shown that compounds with functional groups, heteroatoms (oxygen, nitrogen, sulfur, phosphorus), heterocyclic aromatic, double and/or triple bonds rings have a higher anticorrosive efficacy in the steel region (Abdallah et al., 2019). These preceding chemicals limit corrosion inhibition of steel substrates by adsorption on the steel surface (Abeng et al., 2020, Hsissou et al., 2021).Previous research has shown that adsorption on steel surfaces enhances the corrosion rate, and the inhibition efficacy follows the sequence of atoms: phosphorus > sulfur > nitrogen > oxygen (Donnelly ., 1978, Tadros et al., 1988, Abd El Haleem et al., 2013). These chemicals are differentiated from the numerous that have an inhibitory action. As you know we have several types of corrosion inhibitors,In this chapter, we are interested in only one type which is the organic inhibitors.

The efficiency of organic inhibitors, which play a significant role in preventing corrosion, is influenced by the composition, concentration, and chemical characteristics of the layer that develops under the required circumstances. Organic inhibitors work by adhering to a material's surface, which causes them to function. They have a dual function after this adsorption to the surface, delaying both the anodic and cathodic processes. The majority of these inhibitors mostly include nitrogen, sulfur, or oxygen atoms in their structures (Galai et al., 2022, Boughoues et al., 2020).

Benzoxazepine derivatives are a promising class of corrosion inhibitors for mild steel in acidic pickling baths due to their high inhibitory efficiency, low toxicity, good solubility, stability, and cost-effectiveness. They have been found to be effective in reducing the corrosion rate of mild steel and provide long-term protection against corrosion. In addition to their technical advantages, Benzoxazepine derivatives are easy to synthesize and have a low production cost, making them an attractive option for industrial applications. Researchers have found that these derivatives exhibit excellent performance as corrosion inhibitors, making them a valuable option for industries that require cost-effective and safe solutions.

2 CORROSION INHIBITION REVIEW HETEROCYCLIC DERIVATIVES

Heterocyclic organic substances, including benzodiazepines, benzimidazoles, benzoxazepines, thriazoles, quinoxalines, and quinolines, have recently been investigated as possible corrosion inhibitors to shield the metal surface in diverse settings (Tang et al., 2005, Saha et al., 2015). Then, one of the most popular methods for preventing steel corrosion in a variety of conditions is to employ derivatives of benzoxazepine.Among the studies and research on benzoxazepine as an inhibitor, we discover the following: