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Corrosion Inhibition of Mild Steel by Date Seeds in 1.0 M Hydrochloric Acid Solution

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Structured Abstract

Background: Corrosion, responsible for estimated damages of 3.4% of the global Gross Domestic Product (GDP), poses a significant threat to industries. Corrosion inhibitors can mitigate the effects of corrosion. While inorganic corrosion inhibitors are effective, their environmental impact raises concerns. In contrast, green inhibitors from renewable sources, such as Date Palm Seed Extract (DPSE), offer an eco-friendly alternative. Date palm seeds, often considered waste, are rich in fatty acids and bioactive compounds like lauric, myristic, oleic, phthalic, caprylic, and palmitic acids. These compounds, along with heteroatom compounds, readily adsorb on metal surfaces. Additionally, the seeds boast bioactive elements such as polyphenols, flavonoids, and condensed tannins, notably gallic acid, enhancing antioxidant activities. This study explored the corrosion inhibition potential of date seeds on mild steel immersed in 1.0 M hydrochloric acid (HCl) solution.

Methods: The extraction process of bioactive compounds from date palm seeds involved sequential steps, including seed drying, grinding, and dissolution in 1.0 M HCl. Subsequently, the extracted compounds underwent characterization using Attenuated Total Reflection Fourier-Transform Infrared Spectroscopy (ATR-FTIR). The methodology also encompassed the assessment of corrosion inhibition through the weight loss method and the use of Field Emission Scanning Electron Microscopy (FESEM).

Results: Characterization of the extract through ATR-FTIR confirmed the presence of organic compounds such as aromatic rings and C=C groups in DPSE, emphasizing its potential as an effective corrosion inhibitor. The efficiency of DPSE as a corrosion inhibitor was assessed using the weight loss method, and the results revealed a concentration-dependent inhibition trend, with an optimal concentration of 1200 ppm exhibiting the highest inhibition efficiency of 97.16%. The corrosion rate (C_R) was remarkably lowered from 11.28 mm/year in the absence of a corrosion inhibitor to 0.32 mm/year with the addition of 1200 ppm DPSE in 1.0 M HCl solution. Increasing DPSE concentrations enhanced inhibition efficiencies on mild steel corrosion, peaking at 1200 ppm over three days. FESEM images depicted the protective film formed by DPSE, mitigating corrosion-induced surface deterioration.

Conclusion: The study emphasizes DPSE as a green corrosion inhibitor, providing a sustainable solution for acidic environments, and calls for additional exploration of date palm-derived compounds in eco-friendly corrosion management practices.

Keywords: Date Palm Seed Extract, Corrosion Inhibitors, Green Corrosion Inhibitor, Mild Steel

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