

Evaluation of Date Palm Seed Extract as a Green Inhibitor for Aluminium in Hydrochloric Acid Solution

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Structured Abstract

Background: Corrosion is a major challenge that adversely affects metallic structures and causes significant economic losses. Although conventional inorganic corrosion inhibitors are effective, their toxicity and environmental impact necessitate the development of sustainable alternatives. This study investigates the efficacy of Date Palm Seed Extract (DPSE) as a green corrosion inhibitor for aluminium in acidic media, addressing the urgent need for eco-friendly solutions across various industries.

Methods: The research started with the extraction of bioactive compounds from DPSE, followed by their characterization using Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy and phytochemical analysis. The inhibition performance of DPSE on aluminium in a 1 M HCl solution was evaluated using the weight-loss method, Open Circuit Potential (OCP), and Scanning Electron Microscopy (SEM).

Results: The phytochemical screening confirmed the presence of flavonoids, tannins, and alkaloids, which are known for their corrosion-inhibiting properties. ATR-FTIR analysis further identified key functional groups, including hydroxyl, carbonyl, and aromatic rings. These functional groups are crucial for the adsorption mechanism on the metal surface and the formation of a protective layer. The aluminium samples were immersed in 1 M HCl in the presence of different concentrations of DPSE (800-1400 ppm) for 3 days. Weight-loss measurements showed a significant reduction in corrosion rate as DPSE concentration increased. The optimum DPSE concentration was 1200 ppm with over 96% inhibition efficiency. This was supported by Open Circuit Potential (OCP) results, indicating a positive shift in potential due to the inhibitor's presence. SEM analysis provided visual images of a protective film formed on the aluminium surface, effectively shielding it from corrosive attack.

Conclusion: This study suggests that DPSE is a potential environmentally friendly corrosion inhibitor for aluminium. It provides an economical and sustainable alternative to crude chemical products used as inhibitors in the industries. This study contributes valuable insights into sustainable corrosion prevention strategies, particularly for aluminium applications in harsh acidic environments and aligns with global efforts towards greener industrial practices.

Keywords: Green inhibitor, date palm seed extract, weight loss method, bioactive compounds, corrosion inhibitor

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