

Electrochemical Impedance Spectroscopy for Prediction of Corrosion Inhibition of CaO Nanoparticles toward Grade 202 Stainless-steel

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Grade 202 Stainless Steel (SS Grade 202) offers excellent corrosion resistant characteristics under mild conditions due to the presence of a relatively high chromium percentage although it is an alloy rich in iron. The impact of various chemical components that are present in the environment on its corrosion behavior, and the potential use of corrosion inhibitors under such situations, has not been extensively studied. Conversely, certain nanoparticles inhibit corrosion by adhering to metal surfaces, thereby creating a protective barrier that blocks the exposure to corrosive agents. NPs of CaO derived from clamshells serve as highly effective corrosion inhibitors due to their minuscule size and expansive surface area, which aid in the passivation of oxide films, including chromium oxide on SS. The abundant availability of clamshells makes them a sustainable source for producing CaO NPs. Application of electrochemical impedance spectroscopy (EIS) on SS Grade 202 in the presence of CaO NPs in acidic medium, with the aid of Nyquist and Bode plots, results in a notable increase in polarization resistance (RP) and total impedance, respectively, demonstrating the corrosion inhibitory behavior. In

particular, change in the concentration of CaO NPs from 1.00 mmol L⁻¹ to 5.00 mmol L⁻¹ in 4.00 mol L⁻¹ acetic acid enhances the extent of corrosion inhibition from 92.1% to 97.6%, as determined from RP values, whilst the change in the phase angle maxima from 50° to 80° demonstrates the formation of a strong passive film in the presence of CaO NPs. EIS provides evidence for corrosion inhibition of SS Grade 202 by CaO NPs in sodium acetate and ammonium acetate solutions as well. Moreover, an increase in the concentration of acetic acid and ammonium acetate enhances the rate of corrosion according to EIS and Bode plots. On the other hand, sodium acetate functions differently, performing as a corrosion inhibitor toward SS.

Keywords:

Bode plots, CaO NPs, corrosion, inhibition, EIS

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