

Advancing sustainable corrosion control: elucidating the protective mechanism of chitosan-pectin biopolymers against acidic corrosion of stainless-steel Grade 202

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Stainless steel (SS) Grade 202 possesses strong corrosion resistance characteristics in mild acidic conditions owing to the formation of a passive chromium oxide film. However, the stability of the material in more aggressive acidic conditions requires further understanding. The present study thus aims at the investigation of the corrosion behavior of SS Grade 202 in different HCl solutions, and corrosion inhibitory characteristics of eco-friendly biopolymers, namely, chitosan and pectin toward SS Grade 202. Chitosan and pectin, having electronegative functional groups such as O–H/N–H, carbonyl and C–O groups with band positions at 3200 – 3400 cm^{-1} , 1739 cm^{-1} and 1217 cm^{-1} , respectively, enhance the corrosion resistance, as determined through mass loss measurements, electrochemical impedance spectroscopy (EIS) and Tafel slope determinations. Mass loss measurements depict that SS Grade 202 in the presence of chitosan in the corrosive medium of HCl at 1% strength shows an absolute mass loss of 18-19% compared to the uninhibited system having mass loss of 22-27%.

Chitosan at 3% strength results in even a lower mass loss of 17-18%. On the other hand, pectin (1%) shows lower mass losses ranging from 10-11%, to 9-10% in 3% pectin. Thus, pectin of 3% strength exhibits the highest level of effectiveness in protecting SS Grade 202 from corrosion. Increase in charge transfer resistance to 12-35 $\Omega \text{ cm}^{-2}$ in the presence of 3% pectin, which is 5-8 times higher than that for the blank system, and the reduction of current density to $\sim 10^{-5} \text{ A cm}^{-2}$ by 90% in the same inhibitory system. The results of the techniques used prove the effectiveness of inhibitors in the decreasing order of 3% pectin > 1% pectin > 3% chitosan > 1% chitosan. Practical application of these findings would require further research to design effective coatings incorporating the inhibitor and suitable polymeric material.

Keywords:

Corrosion rate, chitosan, inhibition, pectin