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Agro-derived Inhibitors for Mitigating Chloride-Induced Corrosion

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Abstract

Deicers-induced corrosion is one of the major types of corrosion in bridges that threatens the durability of bridge of infrastructure in the U.S. Deicing salts increase the chloride ion ingress in bridge decks, RC pavements, and bridge steel members that damages the passive protective layer on steels surface and thus accelerate corrosion. A variety of additives (chromates, phosphates, plant extracts, etc.) have been investigated in the past to reduce the corrosivity of deicing salts. However, the field applications of these additives is hampered by their toxicity, cost, and bulk availability. The aim of this study is to reduce the deicer-induced corrosion by employing non-toxic and low-cost polyols namely sorbitol, mannitol, and maltitol in the traditional salt brine deicing solution. Specifically, each of these additives is added to the salt brine deicers (23%wt. NaCl) in weight concentrations ranging from 0.5% to 3.0%. The corrosion performance of polyols-mixed deicers is then assessed for ASTM A572 high strength low alloy steels and steel rebars by conducting accelerated corrosion tests in an environmental chamber and potentiodynamic polarization tests. Moreover, the influence of the polyol corrosion inhibiting additives on the physical and chemical properties of ordinary Portland cement mortar is investigated using different characterization tests. The results obtained from accelerated corrosion tests and potentiodynamic polarization tests revealed that the addition of small amounts of polyols (up to 3.0%) resulted in up to 90% reduction in the steel corrosion rate when compared to the corrosion rate obtained in the case of reference salt brine deicers. The polyols retarded both cathodic and anodic reactions and inhibited corrosion in the steel specimens via physisorption. The results obtained from physical and chemical characterization tests on cement mortar showed that the addition of polyol additives in salt brine did not cause any further deterioration in the mortar compressive strength, scaling behavior, and chemical properties when compared to the NaCl salt brine deicer usage. The results obtained from this study show that the envisioned agro-derived additives can be used to mitigate chloride-induced corrosion in bridge infrastructure without comprising important properties of hardened cement mortar.
