Correlation Analysis Between Microalloying Elements and Electrochemical Characteristics of Low-Alloy Steels in Chloride-Containing Environments

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Abstract This study investigates the corrosion behavior of six types of Q345 low-alloy steel in chloride-containing environments to explore the relationship between microalloying element content and electrochemical characteristics. NaCl solutions with concentrations of 0.01M, 0.1M, 1M, and saturated were used to simulate refinery and chemical process corrosion conditions. The polished steel samples were immersed for durations of 50 hours, followed by electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization tests. The results reveal that during the early stages of corrosion, microalloying elements have impact on the anodic process, dominated by iron dissolution. However, the cathodic behavior is significantly influenced by microalloying elements, particularly as NaCl concentration increases. Spearman correlation analysis between the alloying elements (Mn, Nb, Cr, Ti, Zr, N, P, S, Cu, Ni) and electrochemical parameters (corrosion potential and current, charge transfer resistance) demonstrated that elements such as Mn, Nb, Cr, Ti, Zr, and N enhance corrosion resistance, while P and S negatively affect it. These findings provide insights into the optimization of microalloying elements for developing more corrosion-resistant low-alloy steels in industrial applications.

Keywords

Microalloying elements, Low-alloy steel, Corrosion resistance, Chloride-containing environments

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