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Acidic Corrosion of Mild Steel in the Presence of Acetic Acid: mechanism and prediction

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Abstract

The mechanism and the kinetics of mild steel corrosion in deaerated aqueous acetic acid solutions was investigated. The behavior of the steady state voltammograms, obtained at pH 3 to pH 5 and acetic acid concentrations up to 41.5 mM, showed that the direct reduction of undissociated acetic acid is not significant, in contrast to what is commonly reported in the literature. Nevertheless, acetic acid was shown to influence the corrosion process, first by increasing the cathodic limiting current through buffering the hydrogen ion concentration at the metal surface, and second by inhibiting the rates of both anodic and cathodic charge transfer reactions by chemically adsorbing onto the metal surface. Considering these mechanistic observations, a comprehensive mathematical model was developed and verified, using the experimental results. The counterpoising effect of acetic acid on the limiting current and the rate of electrochemical reactions was shown to be able to justify the inconsistent and sometimes contradictory behavior previously reported in the literature. Additionally, increasing the temperature was shown to have a synergistic effect with acetic acid concentration on the observed corrosion rates. This behavior is a result of shifting corrosion currents towards the mass transfer controlled range at elevated temperatures, where acetic acid has a determinant effect.

Key words

Corrosion, acidic, mild steel, acetic acid, mechanism