Influence of Hydrodynamic Flow Patterns on the Corrosion Behavior of Carbon Steel in a Neutral LiBr Solution

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The present study investigated the corrosion behavior of carbon steel samples using two electrochemical cell types that operate with distinctly different fluid flow patterns. For this purpose, an annular flow cell and a rotating disc electrode were used to investigate the influence of the immersion time on the corrosion kinetics of carbon steel in an aerated 0.5 M LiBr solution. The electrochemical results show good data reproducibility for both experimental cells. In both of these cells, the corrosion rate increases to a maximum value, and it gradually decreases with the immersion time. This shift in the corrosion rate is associated with a series of competing reaction mechanisms, which include a significant oxygen concentration reduction at the metal-solution interface, changes in the corrosion regime and oxide phase transformations. These competing reactions were described in terms of electrochemical kinetic parameters for partial reactions and equivalent circuits determined from polarization curves and electrochemical impedance spectroscopy measurements. The kinetic analysis shows that the oxygen reduction reaction is highly affected by the immersion time in solution, where non-realistic kinetic parameter values are found for long immersion times. Furthermore, the corrosion morphology found on the tested samples confirms the aggressive behavior of bromide ions, which promotes a pitting corrosion with a lateral spread of corrosion products.

Keywords: Carbon steel; Kinetic parameters; Pitting corrosion; Polarization

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