Research on the corrosion behavior of carbon steel under cathodic protection and corrosion inhibitor conditions

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Abstract Cathodic protection is widely used for corrosion protection of steel bars in concrete. However, in the concrete contaminated with Cl^-, the protective effect of cathodic protection is reduced. Meanwhile, the cathodic protection at a certain potential accelerates the hydrogen evolution rate and hydrogen permeation rate on the surface of steel bars. This paper uses arginine-trisodium phosphate complex (LA-P) as a migration corrosion inhibitor (MCI) and a simulated concrete solution containing 3.5 wt% NaCl as the corrosion environment. The corrosion behavior of HRB400 steel with the addition of MCI are studied through polarization curves, electrochemical impedance spectroscopy (EIS), and scanning vibration electrode technology (SVET). Besides, the morphological changes of the steel surface before and after corrosion are compared by atomic force microscopy (AFM). The binding of LA-P and Cl^- is confirmed by ion chromatography (IC). Scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), raman spectroscopy, and X-ray photoelectron spectroscopy (XPS) are applied to study the migration characteristics and adsorption behavior of MCI under cathodic polarization conditions. The inhibitory effect of MCI on hydrogen permeation process is verified through the Devnathan-Stachurski double cell technique. The results indicate that the application of cathodic protection enhances the adsorption of LA-P on the surface of steel and reduces the corrosion rate. Moreover, the hydrogen evolution rate on the surface of the steel is decreased, which effectively reduces the hydrogen permeation current. The damage of Cl^- to the passive film of steel is inhibited by the capture effect of LA-P on Cl^-,which reduces the corrosion rate of steel. The excellent synergistic effect of MCI and cathodic protection has broad application prospects in inhibiting steel corrosion in Cl^- polluted concrete environments.

Keywords HRB400 steel; concrete; cathodic protection; migration corrosion inhibitor; hydrogen permeation

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