Electrochemical Corrosion Behavior of X70 Steel in Sand Soil Contaminated by Copper(II)

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doi: 10.20964/2016.11.07

Received: 11 July 2016 / Accepted: 2 September 2016 / Published: 10 October 2016

X70 steel, a common pipeline material for the long distance transport, has been extensively used in many domestic and overseas underground projects, for example “West-East” project of P. R. China. In order to study the effect of heavy metal copper(II) on the corrosion performance of X70 steel, electrochemical corrosion tests were conducted on X70 steel in sand soil for 35 d. The macro-/micro-morphology, surface composition, polarization curve, electrochemical impedance spectroscopy (EIS) of X70 steel were characterized by scanning electron microscope (SEM), energy dispersive spectrometer (EDS), and electrochemical workstation, respectively. Five different concentrations of copper(II) were added into the sand soil simulated medium. The macro-/micro-morphology acquired by Canon 6D SLR cameras and SEM. The testing results showed that the copper(II) significantly affected the corrosion performance of X70 steel in sand soil. And corrosion products of X70 steel in sand soil contaminated by copper(II) exhibited colors such as yellow, red-brown, brown, black etc. It was the mixture of compound with Fe, Cu and pure Cu and sand particles. And with the increase of concentration of copper(II) in sand soil, corrosion current density, corrosion rate of X70 steel in sand soil contaminated by copper(II) dramatically increased firstly and then decreased by two orders of magnitude and 0.340% was the threshold, while the corrosion potential positively shifted. At low concentration of copper(II) in sand soil (0.034% and 0.068%), electrochemical impedance spectroscopy (EIS) of X70 steel presented the smaller incomplete capacitive arc in high frequency and the flat capacitive arcs in low frequency. With the concentration sequentially increase of copper(II), the smaller incomplete capacitive arc in high frequency disappeared gradually and the diffusion phenomenon also emerged. Besides, the sum of Rs, Rt and W decreased first and then increased and the minimum value (267.6 Ω) acquired at copper(II) of 0.340%. In general, the addition of increased the corrosion degree of X70 steel in sand soil due to the formation of Cu/Fe micro cell.
Keywords: X70 steel; sand soil; copper(II); corrosion performance; corrosion degree; EIS

FULL TEXT

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