Effect of temperature on corrosion behavior of X70 pipeline steel in 3.5% NaCl solution

Meijun Wu, Zhiming Gao^{*}, Shixiong Wu, Yingjie Liu, Wenbin Hu

Tianjin Key Laboratory of Composite & Functional Materials, School of Materials Science and Engineering, Tianjin University, Tianjin, 300072, China *E-mail: <u>gaozhiming@tju.edu.cn</u>

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Effect of temperature on the corrosion behavior of X70 pipeline steel in 3.5% NaCl solution was studied by the immersion test, polarization curves, electrochemical impedance spectroscopy (EIS), scanning electron microscope (SEM), and X-ray diffraction (XRD). The corrosion potential (E_{corr}) decreases, and the corrosion current density (I_{corr}) increases with the increase of temperature, so the corrosion rate increases. With the increase of temperature, the size of the capacitive semicircle of the Nyquist plots and the modulus of the impedance decreases at the same immersion time. Moreover, the characteristic frequency in the phase Angle plots decreases. The double charge layer capacitance (O_{dl}) increases with the increase of temperature and the immersion time. With the increase of temperature, the solution resistance (R_s) , the charge transfer resistance (R_t) and the adsorption resistance of the corrosion product (R_f) decreases, the adsorption capacitance of the corrosion product (Q_f) increases, the surface of the X70 steel was covered by a large amount of the gathered corrosion products, and the amount and the size of corrosion products significantly increases. With the increase of immersion time, Rt, the trend of the modulus of the impedance at low frequency, and Rf decreases at 25°C, 40°C, and 60°C, a small amount of corrosion products covered the surface of the X70 steel and more cracks were appeared on the corrosion products. However, at 80°C and 95°C, these increases, a large amount of corrosion products covered the surface of the X70 steel, which is consistent with the increase of R_f that inhibits the corrosion process. At different temperatures and immersion time, the main composition of the corrosion products is similar, with Fe₃O₄, FeOOH and Fe₂O₃.

Keywords: X70 pipeline steel; Temperature; Immersion test; Corrosion behavior; EIS.

FULL TEXT

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