The initiation and evolution of pitting corrosion of pipeline steel in an alkaline solution and the effect of magnetic fields

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Abstract Pitting corrosion is one of the threatening causes of failure faced by in-service pipeline steel. The pipelines may pass magnetic fields generated by various electromagnetic devices and electricity transmission lines. The magnetic fields may affect the pitting corrosion of pipeline steel. To study the effect of a magnetic field on the pit initiation and evolution of pipeline steel, this paper investigates the critical pitting potential of X70 pipeline steel in 0.02 mol/L Na_2CO_3+0.001 mol/L NaCl solution and the effect of a 0.1 T magnetic field on pitting corrosion evolution. The potentiodynamic polarization curves and potentiostatic polarization testing methods have been used, combined with surface morphology measurements. The conclusions of the study include: (1) When the polarization potential is in the range of 0.30~0.80 V_{SCE}, the evolution of pitting corrosion undergoes a process from initiation and growth at the edges to simultaneous initiation and growth at the edge and center. When the potential is higher than 0.50 V_{SCE}, pitting corrosion occurs along with oxygen evolution reaction. (2) The critical pitting potential of X70 steel is located in the range of 0.25-0.30 V_{SCE}. (3) The results of potentiostatic polarization and surface morphology show that the electrode is in a passive state at 0.20 V_{SCE} and 0.25 V_{SCE} without a magnetic field, and a 0.1 T magnetic field promotes the initiation of pitting corrosion. The magnetic field shows the effect of transforming the electrode from a pre-passive state to an active dissolved state. The effects of magnetic fields on pitting corrosion are rationalized by the interfacial mass-transport kinetics modulated macro- and micro-magnetohydrodynamic effects.

Keywords Pipeline steel, Magnetic field, Pitting corrosion, Pitting potential