
Mechanisms of corrosive behavior of L80-13Cr steel in simulated CO₂ sequestration wellbore casing-cement in environment containing impure supercritical CO₂

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Abstract

Given the risks of casing corrosion failure and CO₂ leakage at the casing-cement interface in CO₂ sequestration technology, along with the limited purity of carbon sources and the unclear corrosion mechanisms and crevice corrosion sensitivity of L80-13Cr in this system, this study investigated the corrosion behavior and crevice corrosion sensitivity of L80-13Cr in a simulated cement pore solution environment containing impurities (SO₂, NO₂, O₂) at 10 MPa and 80°C. The results indicated that, in the absence of crevice structures, carbon source impurities had no significant impact on corrosion behavior of L80-13Cr steel, with a very low uniform corrosion rate. The surface of the samples was predominantly covered by protective Cr-containing products. However, notable pitting behavior is observed. In the presence of crevice structures, localized corrosion occurred within the crevice. Additionally, pitting was more pronounced than in the absence of crevices. Besides Cr-containing products, FeCO₃ was also formed within the crevice. The introduction of different concentrations of impurity gases did not significantly alter the crevice corrosion behavior, which may be related to the Ca²⁺-rich environment and the interactions between the impurity gases. The destabilization and failure of the passivation film within the crevice pose a potential risk of crevice corrosion failure and CO₂ leakage for L80-13Cr in this system.

Keywords CCUS; Crevice corrosion; Stainless steel; Well integrity