

Corrosion challenges in CO₂ capture and storage applications under the influence of impurities

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Abstract

Carbon Capture and Storage (CCS) technology plays a pivotal role in mitigating climate change by reducing CO₂ emissions. The process, however, is complicated by phase changes in CO₂ due to temperature and pressure variations, and the presence of impurities such as water, H₂S, SO_x, and NO_x, which can decrease water solubility and lead to water dropout at lower pH levels, thereby increasing corrosivity [1]. Additionally, impurities like oxygen may initiate further cathodic reduction processes that increase the risk of localized corrosion [2]. Traditional methods for predicting and studying corrosion have been an area of focus, however, they often fall short in addressing the complex, multifaceted nature of corrosion processes under varying environmental conditions. The objective of this research is to delineate the impact of impurities on the corrosion rates and mechanisms in different materials, including low-alloy steels, 13% Cr steels, and high-alloy grade materials. These materials were subjected to supercritical impure CO₂ stream as well as electrochemical exposure in a brine solution continuously infused with CO₂ along with impurities. Corrosion rates were determined through electrochemical methods such as polarization resistance and electrochemical impedance, alongside weight loss measurements. Surface analyses of corroded samples were performed using scanning electron microscopy and X-ray diffraction. The extensive data collected were utilized to develop empirical predictive models that estimate the influence of critical variables on corrosion rates and predict corrosion rate.

Keywords CCS, impurities, corrosion, prediction model

Reference

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