Evaluating Cement-Metal Interface chemistry and corrosion issues under CO_2 conditions

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Abstract

The repurposing of non-productive oil wells for CO_2 storage offers a viable solution for reducing greenhouse gas emissions and combating climate change. Due to applied pressure and stresses, micro-annuli—small gaps between the cement sheath and casing is formed, that can act as channels for corrosive agents to interact with both cement as well as metal and the ions released could promote material degradation [1]. Furthermore, corrosion of cement-metal interface can also occur after the abandonment process (injecting a specialized cement slurry to seal the wellbore) could hamper the integrity of safe storage and allow leakage into surrounding formations [2]. This poses significant risks to the long-term durability and safety of the storage sites. This study aims to thoroughly investigate the chemical interactions and corrosion mechanisms at the cement-metal interface under diverse CO_2 conditions (Dense phase CO_2 and CO_2 saturated brine), utilizing a broad spectrum of electrochemical and analytical techniques. Methods such as optical microscopy, scanning electron microscopy, Fourier-transform infrared spectroscopy, transmission electron microscopy, and X-ray tomography are employed to examine the formation of reaction products and detect any phase debonding at the interface. Additionally, Inductively Coupled Plasma - Optical Emission Spectroscopy analysis and Thermogravimetric analysis are employed to assess dissolution and carbonation levels, respectively.

Keywords CCS, Corrosion, Cement-Metal Interface, Carbonation

Reference

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