Corrosion and Failure Assessment for CO₂ EOR and Associated Storage in the Weyburn Field

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Abstract

Many depleted oil and gas reservoirs are targets for carbon dioxide (CO₂) enhanced oil recovery (EOR), resulting in CO₂ storage as part of the commercial EOR process. Oil and gas reservoirs are a primary target for CO₂ storage because of the CO₂’s ability to increase oil production, with an additional benefit being the long-term storage of CO₂. Hydrocarbon reservoirs have demonstrated storage capabilities by storing oil and/or gas resources for millions of years, thus providing a capable storage reservoir for CO₂. The numerous wells drilled to discover and extract hydrocarbons has provided a good understanding of the subsurface in oil- and gas-producing areas; however, the large number of legacy wellbores in these EOR fields has the potential to provide a leakage pathway for injected CO₂ if a wellbore’s integrity is affected by corrosion. Corrosion can occur anywhere along the wellbore through the cement, casing, tubing, or plugs and is an important issue facing the oil and gas industry, with large capital expenditures being directed at the problem.

For this paper, two case studies were conducted to evaluate legacy wells in the Weyburn oil field in southeastern Saskatchewan. The Weyburn Field has undergone CO₂ injection for EOR since 2000. The Petroleum Technology Research Centre (PTRC) has led a research program that has utilized the Weyburn Field for many EOR and CO₂ storage projects focused on monitoring, verification, and accounting; modeling; risk management; wellbore integrity; and public outreach. The large amount of data available for the Weyburn Field made it an ideal location to conduct a corrosion assessment study. This corrosion assessment relied heavily on the availability of well logs such as caliper logs, casing imaging logs, and cement bond logs. The challenge is to find wells that have a meaningful array of logs to evaluate the condition of the well’s casing and cement. In wells that are experiencing corrosion/integrity problems, logs may be targeted to a specific depth interval for evaluation. The selected case study wells had the best possible well log availability in the targeted location within the Weyburn oil field.
The two case study wells were selected to help understand the factors that contribute to casing corrosion in CO2-rich environments. The two wells are in relatively close proximity to each other, thus offering similar geologic characteristics. The first well has a history as a production well, water injector, and water alternating gas injector (injecting over 263 million cubic meters of CO2). The second well was exclusively a production well and is located just outside of the area that has been exposed to CO2.

Both wellbores exhibited signs of internal corrosion, most present in the lower sections, near existing production perforations. Corrosion ranged from small pits to complete penetration through the casing. In the first case study well exposed to CO2, corrosion appeared to accelerate after CO2 injection commenced. Both case study wells were eventually abandoned or suspended because of integrity problems. Contributing factors to corrosion in these wells range from exposure to CO2, packer placements, number of completions, formation fluid exposure, and stray current. In general, the well exposed to CO2 exhibited more severe corrosion when compared to the wellbore that had not been exposed to CO2; however, exposure to CO2 was not the only contributing factor identified.