CASE STUDY

HALLIBURTON

North America

Corrosion-Resistant Cement and Tailored Casing Equipment Solution Enable Class VI Permit Application

ThermaLock™ cement and Fidelis™ stage cementer achieve zonal isolation in low-fracture-gradient injection zone of CCUS well

CHALLENGES

- Design and place a corrosion-resistant cement solution in low-fracture-gradient injection zone.

SOLUTION

- Implement three-string design using CorrosaCem™ cement system, ThermaLock™ cement, and SwiftCem™ cement
- Deploy Type P ES II™ cementer and Fidelis™ stage cementer designed with corrosion-resistant seals.

RESULTS

- Successfully cemented three casing strings to cap rock without losses using ThermaLock cement solution.

Overview

Wells used for permanent CO_2 storage are classified as Class VI carbon capture, utilization, and storage (CCUS) and involve a rigorous and lengthy permit process. One of the key requirements to obtain a Class VI permit is full annular isolation of the production casing from total depth (TD) to the surface using a corrosion-resistant solution.

Challenges

An operator in North America required a corrosion-resistant solution to obtain Class VI injection well status to sequester carbon dioxide. The cap rock was in an unfamiliar region of the basin characterized by a low fracture gradient. This challenge required a corrosion-resistant solution that could minimize hydrostatic and ECD impact during system placement to meet annular isolation requirements.

Solution

To combat the corrosive environment, Halliburton proposed a three-string cement design using the CorrosaCem™ cement system and ThermaLock™ cement placed in multiple stages using ES II™ and Fidelis™ stage cementers.

Two of the three casing strings were cemented in multiple stages with the intermediate casing using the CorrosaCem system and a Type P ES II™ cementer. The CorrosaCem cement system, a reduced Portland-based cement, is tailored with low permeability to help minimize corrosion alteration. This system provides the cement sheath with increased ductility compared to conventional cement systems to better withstand cyclic pressure during operations.

The Type P ES II cementer offers a reliable and cost-effective solution and was deployed during the second stage of the operation. These cementers are equipped with a plug-operated opening sleeve that mechanically provides full access to circulation ports and external closing sleeves mechanically driven by a closing plug with pressure bearing capabilities to help prevent annular fluid ingress.

A Fidelis stage cementer was deployed in the injection string in tandem with an openhole inflatable packer and a 13-lbm/gal ThermaLock cement solution. With two sets of CO_2-resistant, high-pressure seals on either side of the cementer circulation ports, the Fidelis stage cementer is designed to better withstand cumulative stresses and future well events, such as injection, throughout the life of the well.

The ThermaLock system is optimal in CO_2-laden and high-temperature environments. A non-Portland system, ThermaLock cement removes components that react with corrosive environments and reduces potential pathways for gas or fluid to enter the cement sheath over time. The ThermaLock cement slurry provided corrosion resistance up to the cap rock. The CorrosaCem cement system tail and SwiftCem™ cement lead were deployed during the second stage to help ensure a full column of cement to the surface for isolation.

Results

Post-job analysis of the injection string indicated that 21 bbl of ThermaLock cement circulated to surface during the first stage. The inflatable packer operated as planned and 20 bbl of SwiftCem cement circulated to surface during the second stage, allowed by the flawless operational sequence of the Fidelis stage cementer. For each casing string, cement returns to surface confirmed full isolation of the annulus, one of the key objectives to obtain Class VI well status. A CBL was run to further evaluate the cement job and it confirmed full coverage from TD to the surface.

ThermaLock™ and CorrosaCem™ cement systems placed in multiple stages using ES II™ and Fidelis™ stage cementers delivered isolation requirements for CCUS permit application.

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