CASE STUDY

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Permanent downhole monitoring strengthens confidence in responsible CO_2 injection and storage

Integrated pressure, temperature, and fiber-optic surveillance supports compliant CCUS operations from first injection

CHALLENGE

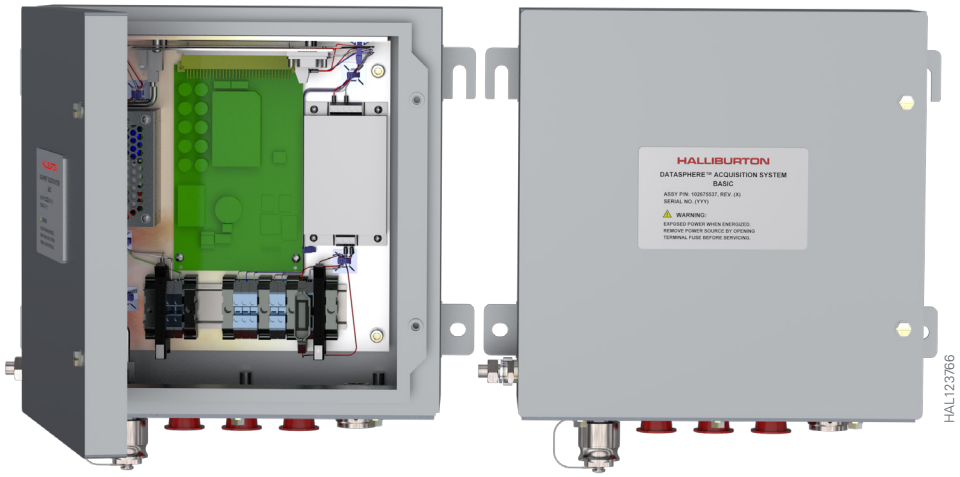
- Support containment verification activities
- Meet AER measurement, monitoring, and verification requirements
- Monitor injection performance continuously
- Support earlier visibility into potential integrity anomalies

SOLUTION

- Install permanent pressure and temperature gauges
- Deploy fiber-optic DTS and DAS diagnostics
- Integrate packer and tubing gauge on injection string
- Cement monitoring system in place for lifecycle use

RESULT

- Provided real-time data to support injection management
- Supported alignment with regulatory requirements
- Improved confidence in containment performance
- Potentially reduced future intervention



DataSphere® permanent monitoring suite data acquisition system

Overview

An operator advanced its carbon capture, utilization, and storage (CCS) strategy with the construction of their first CO_2 injection well. The project required a solution that could deliver continuous monitoring designed to support monitoring throughout the life of the well. From initial injection through long-term storage, the operator required clear visibility into reservoir behavior, injection performance, and well integrity to support responsible sequestration practices and alignment with regulatory requirements.

To meet these objectives, the operator collaborated with Halliburton to deploy a permanent downhole monitoring solution designed for CCUS environments. The system integrates pressure and temperature sensing with fiber-optic diagnostics to deliver real-time data from the reservoir to surface. Installed and cemented in place during well construction, the monitoring infrastructure is designed to provide continuous surveillance that may help reduce the need for repeated well intervention and has supported the operator's operational and regulatory requirements from day one.

CASE STUDY

Challenge

This operator required a monitoring approach that could support efforts toward verification of CO_2 containment and help address the Alberta Energy Regulator (AER) measurement, monitoring, and verification (MMV) requirements. Unlike conventional injection operations, CCUS projects demand approaches that build confidence over time in well integrity and formation containment, supported by continuous data rather than periodic measurements.

The challenge was to implement a system designed to operate reliably in CO_2 environments while capturing high-resolution pressure, temperature, and acoustic information from multiple well sections. The solution also needed to support early indicators of potential anomalies and provide actionable insight to help execute injection parameters in real time, all while being permanently installed as part of the well construction program.

Solution

Halliburton designed and installed an integrated permanent monitoring system tailored to the specific needs of the well. The team installed two DataSphere® Array permanent monitoring suite pressure and temperature gauges on the intermediate casing and cemented them into place to provide continuous formation level measurements. Alongside the gauges, the team also deployed a fiber-optic cable to deliver distributed temperature sensing (DTS) and distributed acoustic sensing (DAS) along the full length of the wellbore.

The fiber-optic system and gauges are engineered to withstand the thermal and chemical conditions associated with CO_2 injection to help ensure long-term data reliability. Halliburton also deployed an MHR permanent injection packer on the injection string paired with an Opsis® permanent downhole gauge. This configuration is designed to support CO_2 isolation in the target formation while delivering continuous bottomhole pressure and temperature measurements during injection operations.

Together, these components form a multilayered, permanently installed monitoring system that transmits real-time data from the reservoir to surface. The integrated design provides a detailed view of well and reservoir performance to help support injection management, containment verification, and long-term CCUS monitoring without reliance on temporary tools or repeated interventions.

Result

Although the project remains in the early stages of CO_2 injection, the operator has realized immediate operational and assurance value from the permanently installed monitoring system. Continuous real-time pressure and temperature data provide visibility into injection conditions and support timely adjustments to injection rates and temperature in alignment with internal standards and applicable AER guidance.

The combination of permanent gauges and fiber-optic diagnostics supports ongoing monitoring to support assessment of zone conformance and wellbore integrity. The system offers early indicators of deviation to help strengthen the operator's MMV strategy and increase confidence in long-term containment. While no anomalies have been detected to date, the operator views the monitoring system as a important early-stage monitoring mechanism to help identify potential integrity or containment issues.

Beyond immediate operational control, the operator expects long-term lifecycle value from the permanently installed system. Continuous data collection helps reduce the potential for future intervention, supports improved reservoir understanding, and contributes to more informed CCUS project design and optimization over time. For this operator, permanent monitoring is an important element of responsible CCUS operations and key to its broader low-carbon objectives.

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