

Case study: Decatur, Illinois

Plume growth monitoring for CCS maintained Class VI certification

Permanent storage of carbon dioxide (CO₂) in deep underground geologic formations is an important pathway to reduce the release of CO₂ into the atmosphere. When stored underground, CO₂ exists in a fluid state (supercritical) and possesses a lower density relative to water and higher mobility. These physical properties enhance the risk for CO₂ migration out of the intended storage reservoir and into important underground sources of drinking water (USDW).

In the United States, the Environmental Protection Agency (EPA) developed the Class VI well permit certification, a regulatory framework to address the challenges of CO₂ injection and USDW protection. To obtain a Class VI well permit, a comprehensive monitoring plan is required to address all aspects of well integrity, CO₂ injection and storage, and ground water quality during injection and post-injection site care periods.

In 2014, the EPA approved the first Class VI permit for the Midwest Regional Carbon Sequestration project in the Illinois Basin. This permit detailed requirements for direct formation samples and reservoir pressure measurements to be collected from an offset monitoring well to validate the reservoir model and confirm the caprock integrity. Failure to perform this monitoring would incur serious consequences and could result in the loss of the injection permit.

When the project's operator performed the first test injection of the Carbon Storage Assurance Facility Enterprise

(CarbonSAFE) Phase III into the basal sands of the Mount Simon sandstone, the completion equipment failed to achieve objectives of monitoring and isolation, leaving the operator with no method to monitor the reservoir.

To avoid having the Class VI permit revoked, the operator faced a difficult choice: either (1) abandon the existing monitoring plan and drill new wells or (2) replace the existing completions equipment. Based on the application, it was clear that the new completions system would need long-term reliability and the ability to run surface controlled hydraulic sleeves in addition to multiple pressure/temperature gauges on a single tubing encapsulated conductor (TEC) line. Based on a reputation as the industry's leading completions expertise, the customer approached Baker Hughes with the challenge, and we recommended a customized solution for the operator's specific objectives.

The **SureSENS™ gauge for permanent downhole installations** includes the ELITE electronics package, built upon an industry leading superior temperature accuracy reliability (STAR) hybrid electronic package design. The ELITE electronics package incorporates an application-specific integrated circuit (ASIC), providing superior reliability in demanding high-pressure/high-temperature (HP/HT) temperatures and qualifying the gauge for operation at pressures up to 35,000 psi (2414 bar) and temperatures up to 437°F (225°C).

Challenges

- Enable formation fluid sampling in multiple injection zones as well as the reservoir above the caprock
- Monitor pressure front associated with multiple injection and caprock intervals
- Seal annular space and prevent any cross contamination of reservoirs
- Retain Class VI monitoring requirements

Results

- Replaced competitor's failed completions equipment with proprietary solution
- Monitored plume growth for six years without interruption
- Maintained requirements for Class VI permit
- Experienced no health, safety and environmental (HSE) issues or nonproductive time (NPT)

The self-energized **REPacker™ reactive element packer** works with annular fluid (oil or water) to set the packer, eliminating annular flow and enabling for feedthrough without reducing tubing inside diameter (ID).

InFORCE™ slide sleeves enable remote, reliable isolation of specific wellbore intervals without costly or intrusive intervention. Simple surface actuation supports cost-effective, remote operation to collect fluid samples in selective zones and does not require intervention of the well to acquire the samples.

Baker Hughes efficiently installed this customized solution into the existing offset monitor well, replacing the failed completions equipment. Baker Hughes enabled successful monitoring of the plume growth for five years without interruption. The SureSENS technology transmitted pressure and temperature data in real time via the surface electronics, providing measurements to an accuracy of 1.5 psi (0.1 bar) and <1°F (1.8°C). All isolation components remain intact and there has been no contamination of fluids between the zones. Finally, the InFORCE sleeves facilitated regularly scheduled fluid sampling as intended, streamlining the process for field personnel without complicated procedures.

With Baker Hughes expertise and technology, the operator was able to maintain the Class VI permit by cost effectively monitoring the pressure and fluid front with direct measurements that had low upfront and operating costs using an interventionless completions system.