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Three Years Of Safe Operations At The Quest CCS Facility, Fort Saskatchewan, Alberta, Canada

A. Halladay[1], S. O'Brien[1]*, O. Tucker[2], J. Duer[1]
[1]Shell Canada, [2]Shell

Summary

Operatonal update on the storage facility operations at Quest CCS.

Introduction

The Quest carbon capture and storage (CCS) project is a fully integrated CCS project developed as part of the Athabasca Oil Sands Project (AOSP), a joint venture between Canadian Natural Upgrading Limited, Chevron Canada Limited, and 1745844 Alberta Limited, and operated by Shell Canada Energy. CO_2 is captured from the Scotford oil sands upgrader, located northeast of Edmonton, Canada, and transported by pipeline to the storage site. Over 1 million tonnes of CO_2 per year is injected into the Basal Cambrian Sandstone (BCS), a saline aquifer located at a depth of about 2 km below ground surface.

First injection of CO_2 into injection wells 7-11 and 8-19 occurred on August 23, 2015 and commercial operation was achieved on September 28, 2015 (Tucker *et al*. 2015). In 2017, Quest surpassed 2 million tonnes of injected CO_2 and was recognized by the Global Carbon Capture and Storage Institute (GCCSI) as setting a record for the most CO_2 sequestered in a calendar year (Halladay *et al*. 2017).

Operations through 2018 have been sustained, safe and reliable. Reservoir performance and injectivity assessments thus far indicate that the project can sustain adequate injectivity for the duration of the project life; therefore, no further well development should be required. MMV activities are focused on operational monitoring and optimization.

Capture and Transport Operations

Quest captures CO_2 from three hydrogen manufacturing units (HMUs) at the Scotford Upgrader, where the hydrogen is used to upgrade the bitumen mined from the oil sands into a synthetic crude oil. Quest has seen strong reliability performance since inception. The capture unit utilizes a CO_2 capture technology called ADIP-X, which is a common amine-based gas processing technology, and has experienced low levels of chemical loss from the process.

The CO_2 capture rates were 82.6% in 2017. The CO_2 stripper operation has been stable, and the CO_2 product sent to the compression unit has been on target for purity at approximately 99.46% CO_2 (volume %). The dehydration unit performance continued to exceed expectations, and carryover of TEG into the CO_2 stream also appears to be significantly less than design, with the estimated losses in 2017 being <6ppmw of the total CO_2 injection stream, compared to the 27 ppmw expected in design.

CO_2 emissions for the capture process are primarily those linked to low pressure steam use in the CO_2 stripper reboilers (~67% of total capture emissions), and from electricity for equipment in the capture system (~24% of capture emissions).

Storage Operations

The Quest storage site consists of three vertical injection wells that can be used to inject CO_2 into a deep saline aquifer, the Basal Cambrian Sands (BCS) two kilometres beneath the surface. The BCS Storage Complex consists of the BCS saline aquifer, as well as several geologic seals and baffles (Winkler *et al* 2010).

Injection of CO_2 into the 8-19 and 7-11 wells began on August 2015, and as of June 2018, 3.0 Mt CO_2 have been injected into the two wells as illustrated in Figure 1. Injection volumes at the two operating injection wells are shown in Figure 1. The variations in injection rates are generally related to fluctuation in the capture rates associated with hydrogen demand, maintenance and turnaround activities and performance of the capture facility and amine unit.

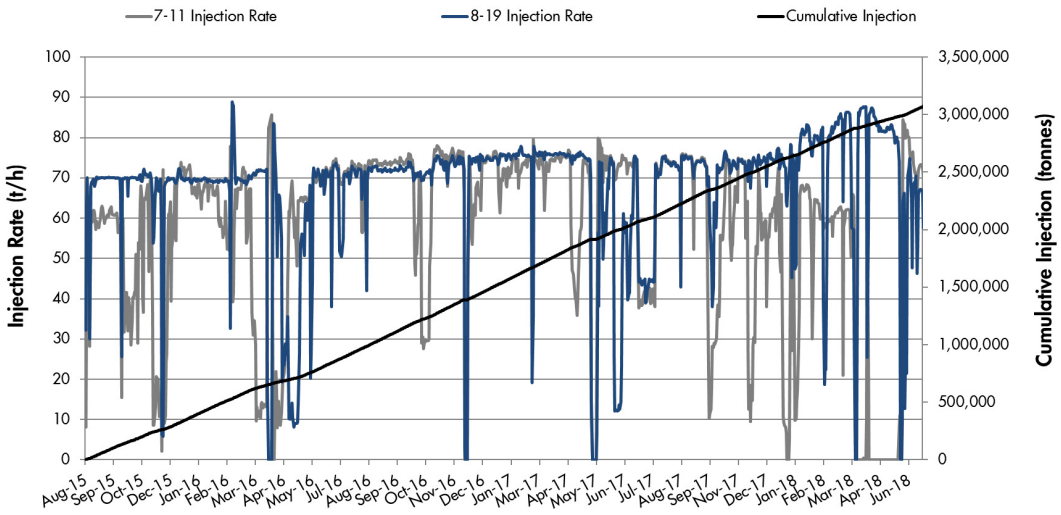

Figure 1 *Quest Injection Totals: Cumulative* CO_2 *injected into the wells from start-up through to the middle of 2018 (right axis). The blue and grey lines show the average hourly flow rates into the two individual injection wells.*

MMV Operations and Performance

A Measurement, Monitoring and Verification Plan (MMV) is a regulatory requirement and a key component of demonstrating the safety and performance of the Quest CO_2 storage site. The two distinctive components of the Quest MMV Plan are to ensure containment and conformance of the CO_2 within the storage site. This is achieved via the deployment of a variety of monitoring technologies that address specific risks defined in the geosphere, hydrosphere and atmosphere (Bourne *et al*. 2014). After two years of operation, a new MMV Plan was submitted and approved in 2017. This update reflects initial learnings gained from injection operations and focuses the Plan on operational (as opposed to baseline) MMV activities.

In terms of containment monitoring results, no trigger events have been identified through to mid-2018 to suggest a loss of containment. This is important in demonstrating that no CO_2 has migrated outside of the Basal Cambrian Sands (BCS) injection reservoir in that period. MMV activities to date have also demonstrated CO_2 injection within the BCS is conforming to model predictions, an indication of conformance (Duer 2017). For example, the ongoing assessment of pressure and temperature data continue to indicate that the reservoir has more than enough capacity for the extent of the project (Figure 2). In addition, the time-lapse seismic monitoring results indicate that the size of the CO2 plumes, as measured by two monitor VSPs, is much smaller than the maximum plume lengths predicted from pre-injection modelling (Oropeza Bacci *et al*, 2017).

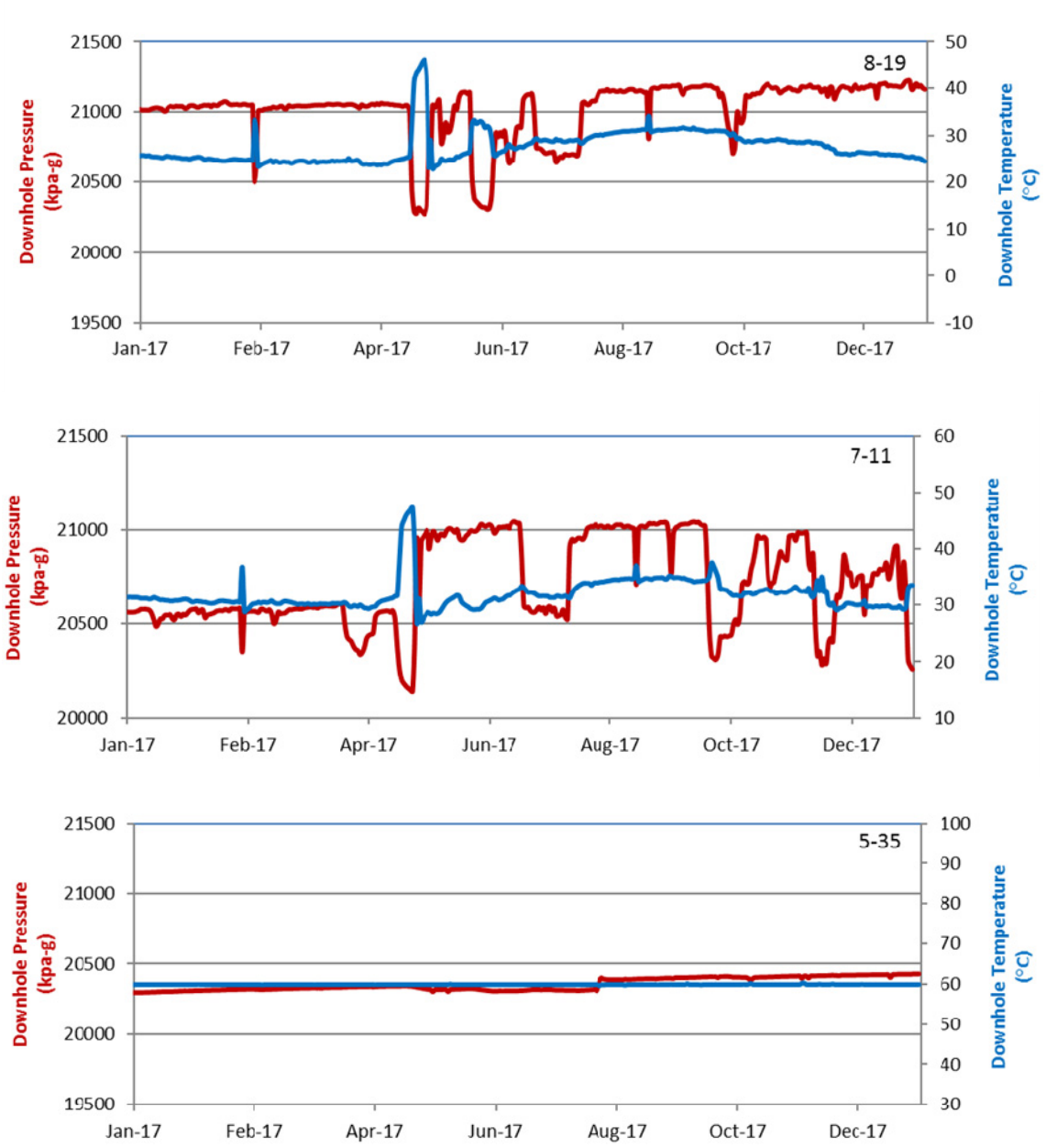

Figure 2 *Quest injection wells downhole pressure and temperature trends from 2017.*

Conclusions

In operation since August 2015, the Quest CCS facility continues to demonstrate the safe storage of CO_2 on a commercial scale. The performance of the capture facility has been very reliable, resulting in a higher rate of capture than expected. The storage facility, the BCS saline aquifer, has also shown better than expected injectivity, as demonstrated by the use of only two of the three injection wells. The MMV operations have also been reliable, and the technologies utilized continue to demonstrate safe operations at the injection site.

Quest has thus far been able to successfully demonstrate that the implementation of CCS at the Scotford oil sand upgrading facilities is technically achievable. As part of a knowledge-sharing commitment, the Quest Project has made available the technical documentation and learnings to enable the continued deployment of CCS in the oil sands industry, and in other applications. Additional information on the Quest Project, the design, implementation and operations, can be found at the Alberta Government knowledge sharing site for CCS (Alberta Energy, 2018).

Acknowledgements

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