GUIDING MVA DEPLOYMENT USING NEAR-REAL-TIME HISTORY MATCHING AT THE AQUISTORE SITE

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Introduction

The Plains CO_2 Reduction (PCOR) Partnership, through the Energy & Environmental Research Center (EERC), is supporting the Petroleum Technology Research Centre (PTRC) Aquistore project. This involvement includes geologic characterization, participation in the Science and Engineering Research Committee, public outreach, geologic modeling, and performing predictive and history-matching simulations. The Aquistore project in southernmost Saskatchewan is part of the world's first commercial postcombustion carbon capture, utilization, and storage project from a coal-fired power-generating facility.

A simplified simulation model was developed, and simulation cases were run using Computer Modelling Group's (CMG's) GEM to history-match a field injection scenario at the Aquistore site. Injection began on April 16, 2015. Frequent updates regarding injection rates and pressure changes at the injection and observation wells were used to history-match the simulation model in near real time.

The history match and predictive results were used to evaluate predictions of CO_2 breakthrough time, pressure evolution at the observation well, and CO_2 plume extents and to update the model property characterizations. The technique will aid in the planning, development, and deployment of monitoring, verification, and accounting activities at the Aquistore site.

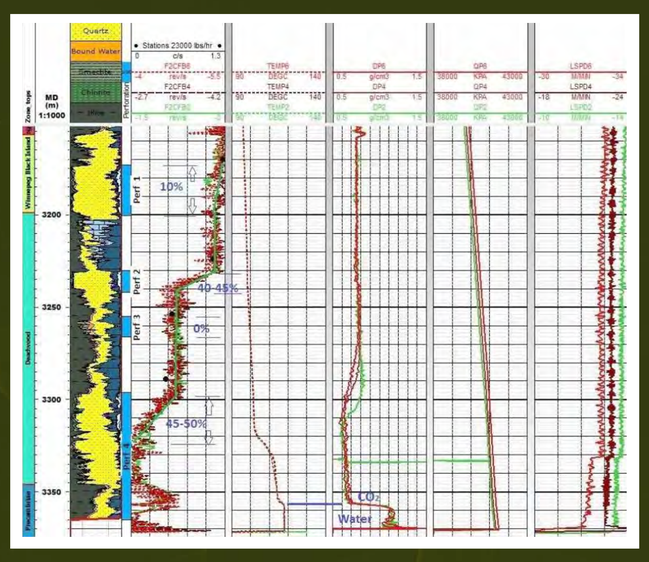
Aquistore site location, near SaskPower's Boundary Dam Power Station, just outside of Estevan, Saskatchewan. One injection well and one observation well were drilled (~340 ft apart from each other), and CO_2 captured at the Boundary Dam carbon capture and storage (CCS) facility was transported on-site. Injection started on April 16.

SaskPower Boundary Dam CCS facility.

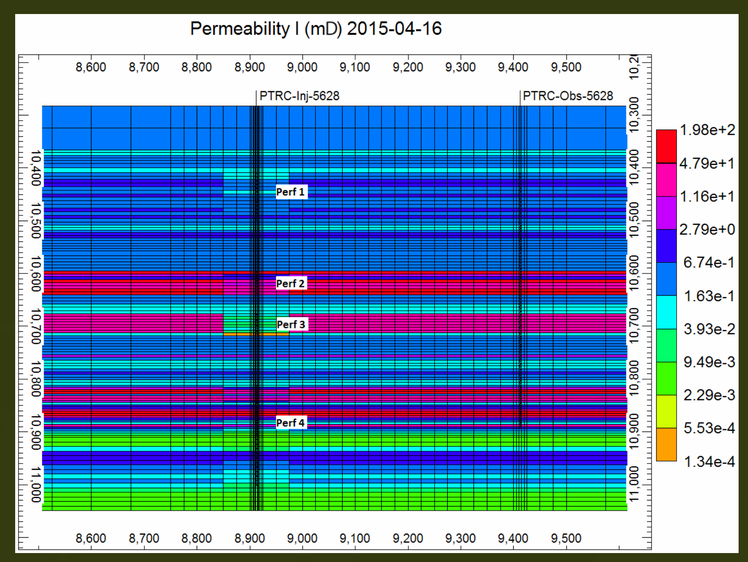
Simulation Model Permeability Update with Schlumberger log data for Injector

Near-Real-Time History-Matching Work Flow

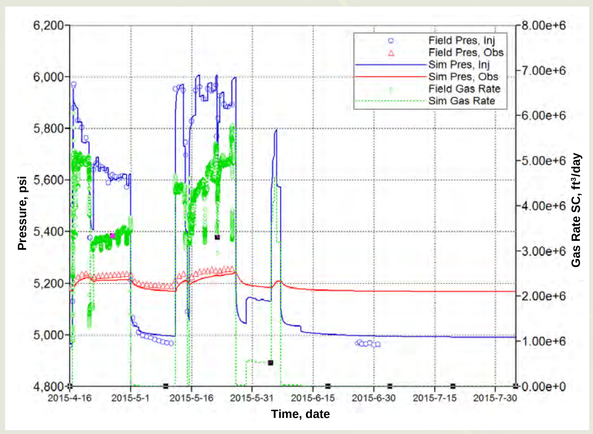
SaskPower Field Data
↓
EERC Data Management
↓
History Match
Simulation Model Update
↓
Uncertainty and Prediction
↓
PTRC
↓
MVA Implementation



Production log data with CO_2 injection rate of 23,000 lb/hr, provided by Schlumberger.

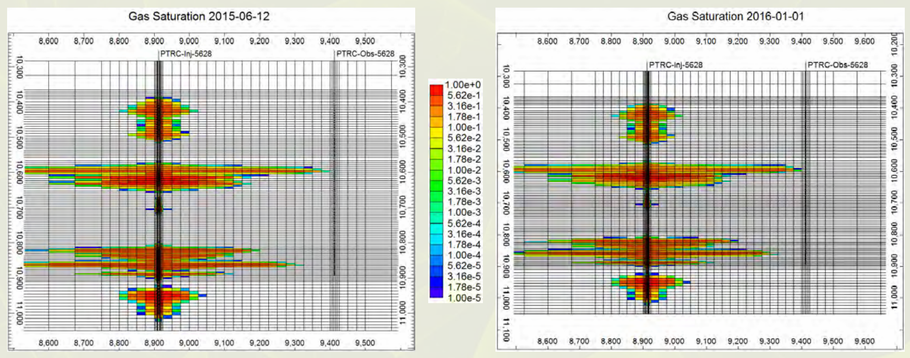


Horizontal permeability distribution view of history-matched model. Skin factor and reduced permeability are taken into consideration in perforation zones in order to match the pressure response. This matched model and CO_2 saturation distribution profiles match the production log data provided by Schlumberger. Increasing the near wellbore permeability by recompletion will eliminate the extra flow resistance and thus enhance flow performance.



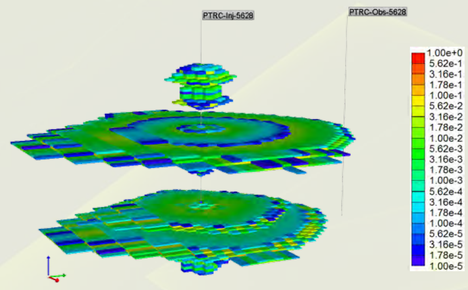
The history-matched pressure response with real-time injection rate. The wellbore damage brought an extra flow resistance near the wellbore, thus injectivity was lower than previously expected, and injection pressure was increased to 200 psi lower than the safe operation pressure. The history-match result suggests that well recompletion would improve CO_2 injectivity.

CO_2 Plume Evolution Change from June 12, 2015, to January 1, 2016, if Injection Not Resumed



CO_2 injection stopped June 12. The CO_2 plume extent is close to the blocks where the observation well is located, and the soaking process has a limited effect on plume evolution, so CO_2 would not break through even if CO_2 injection were not resumed.

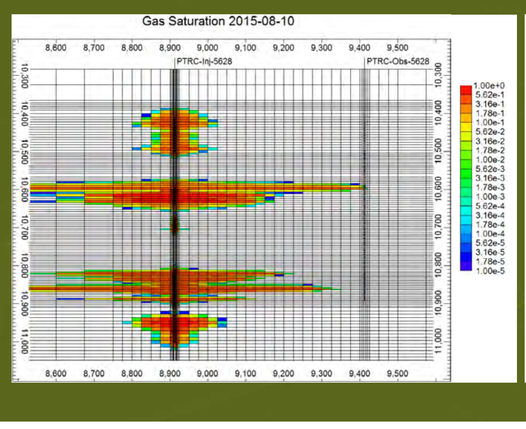
Gas Saturation 2015-07-31

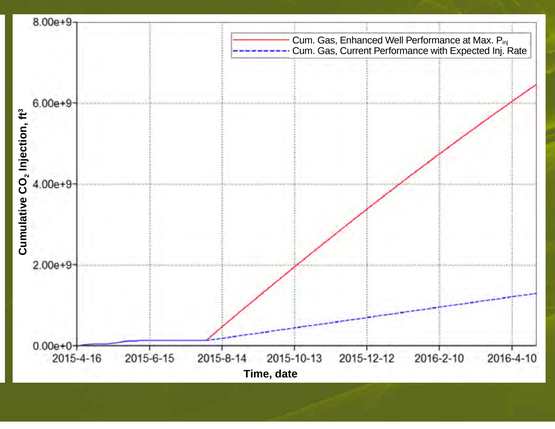


CO_2 Plume Distribution 3-D View on July 31, 2015.

Assumption Prediction

Based on the history-matched simulation model and assuming injection would be resumed August 1 at an expected rate of ~20,000 lb/hr and kept so, the CO_2 breakthrough would happen on August 10.





Summary

The near-real-time history matching was developed to evaluate and predict the CO_2 injection performance at the Aquistore site. The predictive results were used to evaluate predictions of CO_2 breakthrough time, pressure evolution at the observation well, and CO_2 plume extent and to update the simulation model properties. It was found that well performance can be improved with proper recompletion to achieve maximum cumulative CO_2 injection at the Aquistore site. This technique will guide MVA development and aid site planning, development, monitoring development, uncertainty evaluation, and verifications. It will ensure operational optimization and achieve the maximum value of the asset.

Acknowledgment

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