Solution Mining Research Institute Fall 2019 Conference
Berlin, Germany, 23-24 September 2019

Thermodynamic Simulation of Salt Cavern Behavior for Gas Inventory Verification

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Abstract

Performance of a gas storage cavern is a function of the transient thermal and thermodynamic properties of a cavern and the stored gas. The Salt Cavern Thermal Simulator (SCTS) software provides a means for gas storage operators to utilize the measured thermal and thermodynamic data to evaluate cavern integrity, metering devices, cavern creep, and to verify gas inventory. Calibration modelling can be performed to adjust cavern parameters through history matching. Further, SCTS may also be used for predictive modeling of gas movements to accurately determine future cavern performance.

SCTS models were created to simulate the thermodynamics, heat transfer, and fluid flow associated with the transport of water, brine, and natural gas into and out of two solution-mined storage caverns connected to a common surface manifold. The simulation accounted for the heating and cooling effects associated with gas compression and expansion, the mass transfer during injection and withdrawal, and the heat transfer between the gas and the surroundings-both in the wellbore and cavern.

This paper describes the development and implementation of the cavern-specific SCTS model of two gas storage caverns, Caverns 1 and 2. The use of SCTS to calibrate model parameters including cavern closure rate, cavern volume to area ratio, and cavern volume is discussed. Predictions of cavern pressure, temperature, and gas inventory are provided and compared to measured data. Additionally, discussion of future use of the SCTS model including its application in cavern integrity monitoring is addressed.

Key words: Salt Cavern Thermal Simulator, History Match, Gas Storage Caverns, Cavern Integrity Monitoring, Inventory Verification, Thermodynamic Simulation.