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Obtaining a History Match with the Salt Cavern Thermal Simulator when Caverns Have Undergone Multiple Solution Mining Under Gas or Refill Operations

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Abstract

The Salt Cavern Thermal Simulator (SCTS) software allows modelling of the complete thermal and thermodynamic history of a cavern or caverns. The SCTS software is an excellent tool for inventory verification and the evaluation of annual cavern creep. There are, however, limitations. Many cavern operators utilize Solution Mining under Gas (SMUG) operations in the further development of cavern size. The model does not simulate the thermal response for SMUG operations. Moreover, the gas metering at caverns often does not adhere to AGA metering standards (AGA Reports No. 3 and No. 9) or may be completely absent, creating input issues to the model for daily injections and withdrawals.

This paper presents a methodology for obtaining history matches after the completion of SMUG operations or refill scenarios. Once the cavern is fully in gas operations a “dummy” leaching scenario is used to initialize the model. Additionally, other inputs to the model can be improved for purposes of history matching. Measured cavern volumes at each well are trued up using an allocation technique back to the custody transfer meter numbers at pipeline interconnect points. Plant balances are examined. Where the mileage of pipeline header systems is small (200 miles or less) daily line pack changes can be ignored. Actual gas injection temperatures at the wellhead enhance model accuracy. Finally, the inclusion of pressure temperature surveys at high and low inventory levels is also discussed as a means to estimate cavern volume and provide other downhole information.

Models were constructed for three caverns in gas operations. The length of the simulations varied from 711 to 1012 days in length. Parameters matched and examined were the flowing and shut-in wellhead pressures, plus flowing wellhead temperatures during withdrawal operations. Cavern pressures and temperatures from survey data are compared to modelled results. An average deviation as low as 10 psig was obtained in one model for observed versus modelled daily wellhead pressures.

New Pipeline Hazardous Materials and Safety Administration (PHMSA) rules in the United States place an increased focus on needs for inventory verification and cavern integrity monitoring methods. Successful SCTS simulations enhance holistic and comprehensive approaches to monitoring cavern integrity as described in API Recommended Practice 1170.

Key words: Computer Simulation of Gas Cavern, Thermodynamic Simulation, Instrumentation and Monitoring, Inventory Verification, Caverns for Gas Storage, Salt Cavern Thermal Simulator, History Match