GEOMECHANICAL EVALUATION OF TWO GULF COAST NATURAL GAS STORAGE CAVERNS

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ABSTRACT

This paper provides the results of a geomechanical evaluation of two natural gas storage caverns located in a Gulf Coast salt dome. Both caverns are relatively deep with casing seat depths of about 4,100 feet. One of the caverns is about 750 feet tall while the other cavern is about 1,200 feet tall. The objectives of the evaluation were to determine: (1) minimum gas pressures, (2) maximum gas withdrawal rates and quantities, and (3) historical cavern closure rates. The study included laboratory testing of local salt core followed by thermal/thermodynamic and thermomechanical finite element modeling of the caverns. The simulations covered the entire history of the caverns.

Thermal/thermodynamic simulations were completed first to estimate the temperature in the caverns as a function of time and also to estimate creep closure rates of the caverns during historical gas storage operations. The historical data used in the simulations included gas injection/withdrawal records, measured wellhead pressures, and water injection/brine removal records during partial refills of one of the caverns with fresh water. Cavern closure was adjusted in the models to best fit the recorded wellhead pressure history of the caverns. A good fit was obtained between measured and predicted wellhead pressure data. Temperature swings of over 100°F were estimated during storage operations.

The thermomechanical finite element modeling of the caverns used the pressure history of the caverns along with the temperature history to evaluate cavern stability during historical gas storage. The finite element models were also used to determine minimum gas pressures based on cavern stability and maximum gas withdrawal rates and quantities. The minimum gas pressure gradients determined for the two caverns were 0.28 psi/foot of depth at the casing seat for the shorter cavern and 0.33 psi/foot for the taller cavern. Historical closure rates were estimated to be 1.8 and 2.6 percent per year for the shorter and taller cavern, respectively.