Solution Mining Research Institute Fall 2010 Technical Conference
Leipzig, Germany, 3 - 6 October 2010

ADVANCED SYSTEMATIC DETERMINATION OF THE CAPACITIES OF SALT CAVERNS FOR UNDERGROUND GAS STORAGE

Ralph Dresen
ExxonMobil Production Deutschland GmbH, Hannover, Germany

Abstract

The reliable prediction of working and cushion gas volumes as well as of the withdrawal curve and the maximum withdrawal rate and the duration of the maximum rate plateau are key parameters of operating and planned underground gas storage caverns. These capacities and their availability are the basis for safe operations, marketable storage capacities and gas sales which leads overall to good economics.

The changing gas market with increasing competition and more active use of gas storage has prompted the need for more reliable predictions of the cavern capacities. Therefore, the evaluation of key parameters for an individual cavern must be based on a modeling approach using a complete numerical system which also refers to the salt rock formation around the cavern, the gas filled cavern itself and the well and surface facilities up to the storage connection point to the gas pipeline network.

By adjusting model parameters it is possible to calibrate models against reality by matching the model to historically observed data such as cavern well-head pressures and temperatures, gas injection and withdrawal rates and cavern geometrical volumes measured by sonar surveys in gas.
Subsequently a simulation run at maximum gas withdrawal rates provides a prediction over time of pressures, temperatures, withdrawal rates, salt convergence and the mentioned key parameters.
For these predictions the overall physical mechanisms with boundary conditions have to be modeled numerically. These include:
- pressures in the cavern, well and surface facilities as well as the pressure losses,
- temperatures and associated heat transfer in salt rock formations,
- geometrical volumes exposed to salt convergence and the salt mechanics limitations,
- gas injection and withdrawal rates,
- hydrate formation from the gas-water content to avoid blockages in the well tubing and surface facilities.

Based on a consistent history match and limiting conditions the key parameters resulting from predictions are illustrated by way of examples. Applications are shown which demonstrate the importance of an integrated modeling approach including dynamic temperature behavior and salt convergence for project decisions and storage optimization.
Calculations were performed by using a commercial simulation tool which had to be enhanced to describe the combined physical mechanisms along with the boundary conditions and moreover had to be adjusted to local requirements to end up with a reliable simulation model.

Key words: Caverns for Gas Storage, Computer Modeling, Computer Software, Instrumentation and Monitoring, Rock Mechanics