Solution Mining Research Institute Spring 2022 Technical Conference

Rapid City, South Dakota, USA 4-5 May 2022

SIMULATION AND ANALYSIS OF FLOW FIELD OF SALT CAVERN CONSTRUCTION FOR ENERGY STORAGE

Jinchao Wang, China University of Petroleum (Beijing), Beijing, China
Zhiming Wang, China University of Petroleum (Beijing), Beijing, China
Quanshu Zeng, China University of Petroleum (Beijing), Beijing, China

Abstract

The leaching of the salt cavern is a complicated process of fluid dynamics and chemical dynamics, including salt boundary dissolution, cavern development, brine flow, and species transport. The reaction processes occur simultaneously and interact with each other.

This study includes:

- establish a multiphysics coupled model for salt cavern construction to evaluate the real time 3D salt cavern shape development, the velocity field, and the brine concentration distribution simultaneously;
- the influence of turbulent flow on the leaching process was considered;
- the simulation results are compared with the field data of a Jintan Gas Storage Well in China;
- the reliability and correctness of the coupled model are verified.
- the coupled model considering the turbulent flow is compared with the one without considering the turbulent flow.
- the velocity field, brine concentration field, and cavern development are analyzed.

The multiphysics coupled model can predict the velocity field, concentration field, and cavern deformation in real time with reasonable accuracy. The prediction results of the coupled model are consistent with the field data. The average relative deviations with turbulent flow are 5.7 % for outlet brine concentration and 4.0 % for cavern volume.

After the leaching process considering the turbulent flow, the deviations are within 3.2% for the outlet concentration and 1.7 % for the cavern volume. However, without considering the turbulent flow, the deviations will be within 18.5 % for the outlet concentration and 7.5 % for the cavern volume. There will be a smaller deviation in the prediction results considering the turbulent flow.

The simulation results show that the process of cavern leaching is changeable and complicated. The cavern can be divided into four regions, including the shock region, plume region, reflow region, and suction region. The results also indicate that the turbulent flow will stimulate the formation of vortices, thus affecting the distribution of brine concentration. And, the brine concentration distribution primarily influences cavern leaching. The results suggest that adjusting the inject velocity and the position of the tube can change the rate of cavern construction and the cavern shape.

Overall, these results have guiding significance for the design and engineering practice of salt cavern construction for energy storage.

Keywords: Salt Cavern, Energy Storage, Multiphysics Coupled Model, Solution Mining, Flow Field, Cavern Shape