GEOHYDROLOGICAL INTEGRITY OF STORAGE CAVERNS IN SALT FORMATIONS

Kittitep fuenkajorn

Institute of Engineering, Suranaree University of Technology

Abstract

A concern for utilization of the underground space in rock salt has been the increase in its permeability due to the inelastic dilation near the opening wall. For the waste isolation, the permeability increase zone around salt excavations near the repository could provide a preferential flow path for the waste to bypass the seals or plugs. For oil, gas, brine or compressed-air storage caverns, the permeability increase zone induced by mining or by fluctuation of cavern pressures during operation may cause leakage to nearby caverns or to a high-permeability formation.

The objective of the present research paper is to predict the magnitude and extent of the permeability increase zone (PIX) as a function of time, cavern shape, confining pressure (depth), and storage (internal) pressure. Spherical, elliptical and cylindrical cavern models are simulated under a variety of confining and internal pressures. The results suggest that the characteristics of the PIZ are mainly governed by the initial in-situ stress (or cavern depth) and storage pressure. The in-situ stresses ranging from 20 to 30 MPa (about 900 to 1300 m depth) result in the largest PIZ of nearly twice the cavern radius. The permeabilities increase with time and reach their ultimate values within one year after excavation. These ultimate permeabilities are largest near the cavern boundary, and could be several orders of magnitude above the in-situ value. Raising the storage pressure can effectively reduce the magnitude and extent of the PIZ. Salt permeabilities around the cavern with a large diameter-to-height ratio may be several orders of magnitude greater than those around the spherical cavern. Care should be taken in applying these approaches and results to an actual group or array of storage caverns. Influence from the nearby caverns including their age, mining sequence, past and current storage pressures, size, shape and spacing must be considered for the determination of the PIZ.