Dilatancy of Rock Salt in Laboratory Tests

Leo L. Van Sambeek
RE/SPEC Inc.
Rapid City, SD

Introduction

Rock salt in its natural state is typically considered impermeable ($k=10^{-24}$ m^2). Creation of openings in salt, which is initially under lithostatic stress conditions, causes deviatoric stress states and creep begins to occur. There is no strong evidence to suggest that the permeability is increased by this creep under most situations. An increase in test specimen volume has, however, been observed to occur in some laboratory tests on salt core. Such a volume increase is called dilatancy and is attributed to microcracking occurring both during load application through plastic deformation and during creep tests while loads are held constant. The microcracking will cause an increase in permeability by increasing the connected porosity. In this paper the stress conditions applied in laboratory tests are separated into those that did and those that did not cause dilatancy. The types of tests considered are creep, constant strain-rate, and quasistatic true-triaxial. The laboratory test data are from published test results.

Until recently, little research was done in terms of relating stress states, creep rates, and accumulated strain to damage in rock salt. After reviewing the results of three different laboratory testing programs, a criterion is proposed that signifies the potential for dilatancy based on imposed stress states in laboratory tests. This same dilatancy criterion can be used to delineate dilatancy around openings in rock salt (such as shafts, boreholes, and storage caverns) based on calculated stress states. Dilatancy is in turn relatable to the risk of increased permeability in the rock salt. An evaluation of such damage is useful whenever tightness of the salt formation is a concern to prevent loss of stored products or the intrusion of brines. The criterion can also be used to evaluate the potential for healing of damaged regions if the stress state is modified.