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EXPERIMENTAL DEFORMATION OF SALT IN CYCLIC LOADING

INSIGHTS FROM ACOUSTIC EMISSION MEASUREMENTS

Stephen Bauer, Scott Broome, David Bronowski, Alex Rinehart[1] and Mathew Ingraham[2]

Sandia National Laboratories*, Albuquerque, New Mexico, USA

[1]New Mexico Tech, Socorro, New Mexico, USA
[2]Clarkson University, Potsdam, New York, USA

Abstract

Compressed air energy storage (CAES) in geologic media has been proposed to help ensure reliability of renewable energy sources, for example wind and solar, by providing a means to store energy when excess energy was available, and to provide an energy source during non productive renewable energy time periods. Such a storage media may experience hourly (perhaps small) pressure swings within a geologic storage media. This implies that the storage "container", for example, a salt cavern, may experience small irregular pressure cycling.

An ongoing study is underway wherein confined rock salt specimens (a Gulf Coast domal salt 98% halite) have been cyclically stressed. The rock salt was first characterized by developing a dilatancy criterion. Then, specimens confined at 3000 psi were cycled (in triaxial compression) between 25-30% and 50-60% of the dilatant strength. Specimens were cycled up to the 50-60% load, held at constant stress for ~ 3 hours, then cycled down to the 25-30% load, and again held for 3 hours. Specimens experienced about four load cycles per day; tests ran from 12 days to about 60 days, resulting in about 40 to 240 load cycles on different specimens. Acoustic emission (AE) detection during these cyclic creep tests provides insight into when microcrack damage occurs during the complicated deformation history. AEs were detected during the constant stress portions of the test at both the upper and lower test load level.

Also during these tests, axial and radial displacements were recorded as well. It was found that Young's Modulus determined from unloading cycles decreased with increasing axial strain, load cycle, and time after an initial period of limited change. Using a dilatancy criterion of the volume strain changing from compaction to dilation, the specimens are also observed to dilate at these low stress levels. These strain measurements, together with AE measurements indicate that the specimens are cracking at these low cyclically-applied differential stresses well below the short-term testing dilation criterion curve.

The cyclic testing has been augmented by constant mean stress and constant strain rate testing in which AE measurements were recorded. These additional tests provide insight into the semi-brittle deformation of salt during application and hold of confining pressure, monotonic loading, and decreases in confining pressure after deformation.

Key words: Cyclic loading, Rock salt, Semi-brittle Deformation, Renewable Energy**,** Rock Mechanics