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DETERMINATION OF THERMAL CONDUCTIVITY IN HALITE FROM -75°C TO 300°C

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Abstract

Considerations of thermal, mechanical, and fluid transport properties of salt are important to the design, analysis and performance assessment of underground natural gas and air storage facilities, as well as potential repositories for high level heat-generating nuclear waste. Relative to most other rock-forming minerals, halite has high thermal conductivity, which is affected by the presence of porosity, fractures, microfractures, and impurities in the rock. Because halite is a good thermal conductor, thermal gradients in salt bodies may be lower than the gradients in the adjacent sediment.

Here we present thermal conductivity (K_T) measurements for single-crystal (-75°C to 300°C) and bedded salt (25°C to 200°C) with varying amounts of impurities and crack porosity.

Thermal property measurements were made at ambient pressure and moisture conditions using a transient method based on the theory of the transient plane source technique. The Hot Disk® sensors used for these measurements serve as a heat source to increase sample temperature and as resistance thermometers for recording temperature increase over time.

K_T for single-crystal salt was found to decrease by a factor of nearly 4 between -75°C and 300°C. Measurements at similar temperatures are close to those reported by Birch and Clark (1940a, b); this work extends measurements to lower temperatures.

K_T for fractured polycrystalline bedded salt decreased by a factor of about ~1.6 to 2 between 25°C to 200°C. These samples contained crack porosity as well as a variable, but small, proportion of impurities (primarily anhydrite). Absolute K_T measurement values are dependent upon impurity content and porosity/microfracture condition.

K_T dependence upon temperature is determined for single-crystal and polycrystalline salt. We recommend consideration of this dependence for thermal and thermo-mechanical analyses in which the salt experiences spatial or temporal temperature changes.

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