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THERMAL EFFECTS IN SALT CAVERNS

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ABSTRACT

The temperature of rock increases with depth. However, caverns most often are leached out using soft water pumped from rivers, lakes or shallow aquifers with colder temperature, and the temperature of cavern brine is significantly lower than rock temperature. The difference slowly resorbs with time, due to heat conduction in the rock mass and heat convection in the cavern. This effect has important consequences, especially when the cavern is closed, as brine warming results in pressure build-up in the cavern. Several papers presented during various SMRI Meetings have addressed this problem.

This paper focuses on the following points.

- Influence of cavern shape on temperature increase rate — The increase rate is the slowest in a spherical cavern. Various shapes and sizes are considered, and the brine-warming rate is discussed as a function of cavern shape.
- Convection in the cavern — Due to the geothermal gradient, warmer brine at the bottom of a cavern is slightly less dense than colder brine at the top of a cavern, and a brine cavern is the seat of perennial convective flow. One or several convective cells develop, stirring cavern brine and making the brine-temperature gradient smaller than the geothermal gradient. The influence of cavern size and shape on the convective flow rate is discussed.
- Rock thermal expansion — The brine temperature increase causes heat transfer from the surrounding rock, rock cooling and rock contraction. However, it is proven that rock contraction generates a small, or no, cavern volume change when the cavern shape is cylindrical or spherical.

Keywords: Convection, Thermal Expansion, Brine Warming