Thermo-mechanical investigation of salt caverns for short-term hydrogen storage

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To investigate the temperature influence on the cavern capacity, a numerical model was developed in order to simulate the thermo-mechanical behaviour of salt caverns during cyclic hydrogen storage.

The model considers the thermodynamic characteristics of the storage medium as well as the heat transport and the temperature-dependent material properties of the host rock. Therefore, a well-known constitutive thermo-visco-elastic constitutive model was modified to describe temperature effects of rock salt and implemented into the freely available simulator OpenGeoSys. Thermal and mechanical processes are solved using a finite element approach, connected via a staggered coupling scheme. Numerical analyses were performed and evaluated using basic criteria for cavern safety and convergence. The results show that large temperature amplitudes in the working gas may lead to tensile stresses at the cavern boundary. Reducing the frequency of the cyclic loading is a way to reduce temperature variations and to avoid tensile failure. Furthermore, the influence of cavern shape was investigated. Narrow cylindrical caverns converge faster than spherical ones of the same volume and are subjected to a higher risk of structural failure.