Geophysical Research Abstracts
Vol. 17, EGU2015-13107, 2015
EGU General Assembly 2015

Simulation of Mechanical Processes in Gas Storage Caverns for Short-Term Energy Storage

Norbert Böttcher (1), Thomas Nagel (1), Olaf Kolditz (1,2)

(1) Department of Environmental Informatics, Helmholtz-Centre for Environmental Research - UFZ, Leipzig, Germany, (2) Environmental Systems Analysis, Technische Universität Dresden, Germany

In recent years, Germany's energy management has started to be transferred from fossil fuels to renewable and sustainable energy carriers. Renewable energy sources such as solar and wind power are subjected by fluctuations, thus the development and extension of energy storage capacities is a priority in German R&D programs.
This work is a part of the ANGUS+ Project, funded by the federal ministry of education and research, which investigates the influence of subsurface energy storage on the underground.
The utilization of subsurface salt caverns as a long-term storage reservoir for fossil fuels is a common method, since the construction of caverns in salt rock is inexpensive in comparison to solid rock formations due to solution mining. Another advantage of evaporate as host material is the self-healing behaviour of salt rock, thus the cavity can be assumed to be impermeable.
In the framework of short-term energy storage (hours to days), caverns can be used as gas storage reservoirs for natural or artificial fuel gases, such as hydrogen, methane, or compressed air, where the operation pressures inside the caverns will fluctuate more frequently.
This work investigates the influence of changing operation pressures at high frequencies on the stability of the host rock of gas storage caverns utilizing numerical models. Therefore, we developed a coupled Thermo-Hydro-Mechanical (THM) model based on the finite element method utilizing the open-source software platform OpenGeoSys. The salt behaviour is described by well-known constitutive material models which are capable of predicting creep, self-healing, and dilatancy processes. Our simulations include the thermodynamic behaviour of gas storage process, temperature development and distribution on the cavern boundary, the deformation of the cavern geometry, and the prediction of the dilatancy zone.
Based on the numerical results, optimal operation modes can be found for individual caverns, so the risk of host rock damage can be minimized. Furthermore, the model can be used to design efficient monitoring programs to detect possible variations of the host rock due construction and operation of the storage facility. The developed model will be used by public authorities for land use planning issues.