Geophysical Research Abstracts
Vol. 21, EGU2019-7392, 2019
EGU General Assembly 2019

Development and application of an underground storage steering module

Jens-Olaf Delfs, Martin Rehders, and Sebastian Bauer
CAU Kiel, Kiel, Germany (jens.delfs@ifg.uni-kiel.de)

Subsurface heat storage might be an option for increasing the fraction of renewable energy sources in the heat market. Heat is stored by circulating a heat carrier fluid either through boreholes (ATES) or within borehole heat exchangers (BTES), with the heat transferred to the geological subsurface. Heat transport is thus governed by a combination of temperature difference and fluid velocity. Pumping costs in underground thermal energy storages are an important factor for operating costs, so that minimum pumping rates for a given heat flow are sought. Due to this reason, a software tool has been developed that calculates the flow rate of a heat carrier fluid such that the heat loading and extraction rates as well as temperature constraints either at the heat exchanger (above-ground installation) or within the storage site (subsurface) are automatically met. This is important for two reasons. First, the storage and extraction rates define the size of a storage for a specific purpose (e.g. the number of ground-coupled heat exchangers in a BTES). Second, it is necessary in a storage design that the storage is examined in combination with the above-ground installation to guarantee that a suitable total system is developed. The software tool is implemented as an open-source library that can be run with any storage model. It has been successfully tested with an ATES scenario where all the major thermo-hydrological processes at the wells are simulated in a sufficiently high resolution to include even temperature-driven free-convection, which can considerably affect storage and extraction rates. To achieve this, the setup makes use of radial symmetry. This new approach is very efficient and compared with full 3D-simulations, where impacts of natural groundwater flow can be considered as well. One target of the resulting model is that it is a component in a coupled underground heat storage-power plant-electricity network model, where the steering module provides consistent boundary conditions at the heat exchanger between the heat storage and a heating network with power plants. The scenario is a design study for technology assessment, where waste heat from a computing centre is stored in summer and released during the heating period in winter into a university building. Both options ATES and BTES have been considered and are assessed against each other and the alternatives (e.g. a chiller, heat dumping). The results reveal that both underground storage options are suitable, e.g. 150 heat pipes of a length of 45 meters are required for a BTES in the glacially developed soils. The existing aquifer layers are relatively small, but despite of this are able to meet the storage requirements, e.g. injection and extraction rates, as well.