Geophysical Research Abstracts
Vol. 15, EGU2013-12053, 2013
EGU General Assembly 2013

Thermal dispersivity based calibration of a numerical borehole heat exchanger model

Valentin Wagner (1), Peter Bayer (2), Gerhard Bisch (3), Norbert Klaas (3), Jürgen Braun (3), and Philipp Blum (1)

(1) Karlsruhe Institute of Technology, KIT, Germany (valentin.wagner@kit.edu), (2) ETH Zurich, Department of Earth Sciences, Zurich, Switzerland , (3) University of Stuttgart, Institute for Modelling Hydraulic and Environmental Systems, Germany

Shallow geothermal energy is used worldwide as a heat and/or cooling source for buildings. The most often used technique to exploit energy from the subsurface is ground source heat pump systems in combination with a borehole heat exchanger (BHE). The BHE consists either of one U-pipe, two U-pipes or a coaxial pipe, which are inserted in a borehole. The remaining void space is filled with a grouting material to improve the thermal connection between the pipes and the subsurface and to protect the subsurface if there is a leakage in the pipes. In the pipes, a heat carrier fluid is circulated to establish a thermal gradient around the BHE and thus promote conductive heat transfer. This causes a temperature anomaly in the subsurface. Extension and magnitude of such temperature anomalies do not only depend on the amount of exchanged energy, but also on the characteristics of the ground and the installed ground source heat pump system itself. In this study, we developed a high-resolution finite element BHE model to simulate the heat propagation from a BHE to the subsurface or vice versa. First, the resulting heat propagation predicted by the numerical model is compared to the analogous analytical solutions. Then the numerical model is calibrated based on a large-scale geothermal tank experiment. The tank has a size of 9m $\times$ 6m $\times$ 4.5m (length $\times$ width $\times$ depth), and it hosts a layered artificial aquifer with four BHEs, which are surrounded by a dense temperature sensor network (> 150 PT-100 temperature sensors). In the tank, a hydraulic gradient can be established and thus groundwater flow can be imitated. By calibrating the numerical model, the sensitivity of longitudinal and transversal dispersivity values is evaluated. Our analysis cannot prove that the commonly assumed ratio of 1:10 between transversal and longitudinal dispersivity is correct. Rather, it is shown that there exists a wide range of possible parameter value combinations.