Geophysical Research Abstracts
Vol. 20, EGU2018-12831, 2018
EGU General Assembly 2018

Hydraulic performance of a scientific Aquifer-Thermal-Energy-Storage (ATES) site in Berlin (Germany)

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The demand of heat for urban areas based on renewable energies has become increasingly important during the last decades. Aquifer thermal energy storage (ATES) is one technology to bridge the time gap between energy production and demand and is, therefore, a potential candidate for environmental friendly heat provision. The hydraulic properties of the ATES are the key parameter for its long term performance and sustainability. To analyse the potential of an ATES in the centre of Berlin, the ATES research drilling site Gt BCh 1/2015 on the campus of Technische Universität Berlin in Germany was established, geologically characterized and hydraulically tested. The Exter sandstone formation was chosen as the aquifer target formation. This aquifer formation has a temperature of 17°C at a depth between 220 und 230 m below ground surface.
Several hydraulic tests including slug-withdraw tests, a step-rate-test, production tests, and push-pull-tests were performed during 40 days' operation in 2017 to analyse the aquifer characteristics. These tests were accompanied by Distributed-Temperature-Sensing (DTS) which allows a continuous and spatial distributed temperature profiling in the well. These temperature measurements provide indications of injection areas based on the warm back period during a push-pull test with 90°C hot water. Each one slug-withdraw test was performed at the beginning and at the end of the test campaign to evaluate the changes of the hydraulic performance during testing and to compare the results to the conventional well-testing methods like production and step rate tests.
The results indicate, that the aquifer horizon although only 4 m in thickness is suitable for aquifer thermal energy storage. The aquifer transmissibility T = 3.2*10-5 m^2/s was calculated based on the shut-in and build up measurements after the step rate tests. During the well development and the subsequent hydraulic testing the productivity increases from initial 0.7 $m^3/h/bar$ to 1.8 $m^3/h/bar$ allowing maximum flowrates of about 10 m^3/h. We will present and evaluate the thermal-hydraulic responses of the aquifer formation during the testing campaign. Furthermore, we will compare the different testing methods applied and provide advantages and disadvantages of the individual hydraulic tests related the characterisation of ATES.