Simulation of a geothermal aquifer storage in Brussels showing the need for a better balanced system with regards to the local hydrogeological conditions

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Abstract

An Aquifer Thermal Energy Storage (ATES) system was started in 2014 in the center of Brussels using the Landenian confined aquifer for heat and cold needs of an administrative building. Unfortunately, imbalance between the injection of warm and cold water combined to the local hydrogeological conditions, have led rapidly to thermal interferences between the heat plume and the cold wells. A second ATES system located nearby started to operate around August 2017 for the heat and cold needs of another large administrative building. In the scope of the MUSE project (GeoERA/ERA-NET program), a numerical model was built using FEFLOW® to simulate groundwater flow and heat transport in the confined aquifer. After calibration on the available piezometric and temperature data, realistic scenarios were simulated to determine possible interferences and to image the year after year persisting and growing heat plume in the aquifer. Results show that even if the heat plumes of the two systems had come into contact, the influence of the second system on the first one was negligible during the first two years of joint operation. Indeed, for a longer period, simulated results pointed out that due to the thermal imbalance and the limited advection in the aquifer, the groundwater temperature would rise inexorably in the warm and cold wells of both

systems. A business as usual scenario will lead to a decrease in efficiency for both systems. This case-study is showing how it could be difficult to find an optimum with regards to the local hydrogeological conditions. If advection is very important, thermal energy cannot actually be stored locally as heat and cold plumes are transported far away from the wells. On the contrary, if advection is limited, a global thermal balance is required for hot and cold injections. If advection is moderate (as in this case study), a detailed simulation of the groundwater flow and heat transport in the aquifer is required to find out if the annual imbalance can be managed in relation with the specific local hydrogeological conditions.

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