EGU22-9128
https://doi.org/10.5194/egusphere-egu22-9128
EGU General Assembly 2022

Thermal and hydraulic effects due to interaction between aquifer thermal energy storage systems

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Aquifer thermal energy storage (ATES) is a technology to provide energy-efficient heating and cooling to buildings by storage of warm and cold water in aquifers. In regions with large demand for ATES, ATES adoption has led to congestion problems in aquifers. The aquifer utilisation and the recovery of thermal energy stored in aquifers can be increased by reducing the distance between wells of the same temperature. Hence, this approach is implemented in practice, but the understanding of how this affects both the recovery efficiency and the needed pumping energy is missing.

In this research, the effect of well placement on the performance of individual systems is quantified using numerical modelling. Results show an increase in performance of individual systems when the thermal zones of wells of the same temperature are combined. The relative increase of the thermal recovery efficiency is 12% for average-sized systems with a storage volume of 250,000 m^3/year, and 25% for small systems (50,000 m^3/year). Performance of the combined system improves because the surface area of the thermal zone of the combined system, over which thermal losses occur, is smaller than the sum of the surface areas of the individual systems. Performance improvement is larger for systems with small storage volumes and long well screens. The optimal distance between wells of the same temperature is 0.5 times the thermal radius, following the trade-off between an increase of the thermal recovery efficiency and an increase in pumping energy. The distance between wells of opposite

temperature must be larger than 3 times the thermal radius to avoid negative interaction.

How to cite: Bloemendal, M., Duijff, R., and Bakker, M.: Thermal and hydraulic effects due to interaction between aquifer thermal energy storage systems, EGU General Assembly 2022, Vienna, Austria, 23–27 May 2022, EGU22-9128, https://doi.org/10.5194/egusphere-egu22-9128, 2022.