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Controlling parameters of a mono-well high-temperature aquifer thermal energy storage in porous media, northern Oman

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Aquifer thermal energy storage (ATES) as a complement to fluctuating renewable energy systems is a promising technology to guarantee a continuous energy supply. A mono-well system, where the well screens are separated vertically within one aquifer, is investigated to realize an underground storage in northern Oman. In this study, we investigated the impact of conductive thermal inference and hydraulic short-circuiting between injection and extraction well screens on the heat recovery factor (HRF) of a planned high-temperature ($\sim$100°C) ATES system within the Seeb aquifer. The storage shall cover the energy demand of a planned thermally driven cooling system during night times. We analysed different controlling parameters: the vertical screen-to-screen distance, the impact of a no-flow barrier between the screens, aquifer thickness and vertical heterogeneities of the hydraulic conductivity. Simulation results indicate that using a mono-well ATES system could guarantee a continuous cooling process. The highest HRF (88 % after one year) is reached with a 10 m screen-to-screen distance within a 20 m thick aquifer, where no hydraulic breakthrough is observed but a conductive thermal interference between the screens. This indicates that to a certain degree thermal inference enhances the performance of the storage, when the temperature of the cold and warm well screen are both above the natural reservoir temperature. Aquifer heterogeneities reduce this thermal interference with a negative impact on the efficiency. Further, the fluid transfer is governed by the heterogeneous hydraulic conductivity distributions, which has a major impact on the heat distribution within the aquifer and leads additionally to lower HRF-values.