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PROCEEDINGS

Solar Energy Storage in Deep Saline Aquifers: Three-Dimensional Hydro-Thermo Modeling and Feasibility Analyses

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ABSTRACT

The storage of solar energy in the subsurface in terms of heat is considered as a promising way for energy storage and conversion in future, which has a great potential to solve the temporal and spatial mismatch between energy demand and supply. Thermal energy storage in deep saline aquifers is capable to convert intermittent solar energy into high temperature stable geothermal energy. In this study, we propose a new solar energy storage and conversion system in which solar energy is firstly converted into heat using parabolic trough and then thermal energy storage in deep saline aquifer is conducted by high temperature hot water circulation. The feasibility and efficiency of solar energy storage in deep saline aquifer are quantified and evaluated by geostatistical modelling and hydro-thermo coupling simulations, and the influences of rock permeability heterogeneity (in terms of autocorrelation length and global permeability heterogeneity) on temporal and spatial evolution of temperature distribution and storage efficiency are comprehensive explored. The simulation results indicate that the increase of horizontal autocorrelation length and global heterogeneity may accelerate the breakthrough of hot water into production well, which will deteriorate the thermal energy storage efficiency. In addition, injection of hot water into saline aquifers with severe global heterogeneity may suffer a high injection pressure. Saline aquifers with small horizontal autocorrelation lengths and low global heterogeneity tend to have a high storage efficiency. The findings of this study can deepen the understanding of the mechanism of solar energy storage in saline aquifers, and provide important guidance to its field application.

KEYWORDS

Solar energy; geothermal energy; thermal energy storage; saline aquifer; hydro-thermo coupling

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