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Quantifying risks of salt contamination of freshwater aquifers during Aquifer Thermal Energy Storage

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Aquifer Thermal Energy Storage (ATES) has significant potential to decarbonise heating and cooling in regions with seasonal climate variations. These systems often target freshwater aquifers, which are also used to produce drinking water. Therefore, a major concern when developing ATES is to ensure that operation of the system will not create or redistribute pollutants in the targeted aquifer such that it compromises drinking water supply. A key potential pollutant is saline water, which often underlies the shallow freshwater zone. Groundwater abstraction can lead to up-coning of the saltwater interface, causing an increase in salt concentration in the aquifer. However, unlike simple abstraction, the saline water during ATES operation is recycled from the abstraction well into the injection well in each warm and cool cycle, creating potentially complex patterns of contamination.

Here, we report a methodology to model fluid flow, heat and salt transport in ATES systems with Dynamic Mesh Optimisation (DMO). DMO allows the mesh to refine in areas of high temperature and concentration gradients, whilst remaining coarse elsewhere. We validate the method against an analytical solution for up-coning of a freshwater –saltwater interface under a single abstraction well in a homogenous aquifer. The method is then applied to ATES operation using a well doublet. Simulated saltwater concentrations are monitored at the well heads and downstream from the ATES operation. Sensitivities to key parameters of an ATES installation are studied including the depth of the interface, injection flowrates, background flow of the aquifer, and aquifer heterogeneity, to understand their impact on contamination risk. Initial results suggest that the zone of contamination is limited to the hydraulic radius, which migrates downstream if there is background groundwater flow. However, aquifer heterogeneity can significantly increase the hydraulic radius compared to the homogenous case and must be accounted for when assessing risk.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

In person

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