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Analytical and numerical study of the thermal feedback in Groundwater Heat Pumps (GWHP)

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Ground Water Heat Pumps (GWHP) are a promising renewable heating and cooling technology, which can noticeably reduce primary energy consumption of air conditioning in buildings. To ensure their efficiency and sustainability over time, hydrogeological modelling is of pivotal importance, since thermal feedback between injection and extraction well can heavily impair their performances. On the other hand, an accurate numerical flow and heat transport simulation is not usually performed and is not affordable on small installations.
The aim of this study is to solve the hydraulic and thermal transport problem of an injection and an extraction well, in presence of a subsurface flow, by means of a finite-difference approximation of the potential flow theory. The results of this approach have been firstly validated against FEM numerical simulation showing a good agreement in a wide a range of operating conditions, then used in order to develop an approximated analytical relationship which describes the evolution of the thermal feedback over time. The relationship is dependent on the most relevant parameters of the aquifer system and of the GWHP and it can be effectively used for a fast dimensioning of full scale installations.

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