



TRS: a tool for the evaluation of thermal recycling in Ground Water Heat Pumps

Alessandro Casasso and Rajandrea Sethi

Politecnico di Torino, Dipartimento di Ingegneria per l'Ambiente il Territorio e le Infrastrutture (DIATI), Torino, Italy
(alessandro.casasso@polito.it)

Ground Water Heat Pumps (GWHP) are based on the thermal exchange with groundwater, which is usually reinjected into the same aquifer. This often leads to the return of thermally altered water to the extraction well, the so-called thermal recycling, thus impairing the long-term efficiency of a GWHP. Some simplified mathematical models have been already developed to simulate this phenomenon, but they require an imposed injection temperature (constant or variable), which should be known a priori. This simplification is a bit crude for GWHP modelling, for which it is more realistic to impose a temperature difference between the extraction and the injection well. We have therefore developed the freely available software TRS (Thermal Recycling Simulator), that overcomes this limitation by taking into account the variation of the injection temperature due to the thermal short-circuit. The software is based on the finite-difference approximation of the potential flow theory and it has been validated through the comparison with flow and heat transport simulations with FEFLOW. We have also developed an explicit formula for the calculation of the thermal alteration in a well doublet aligned with the groundwater flow direction, which is the ideal well arrangement. The parameters of the formula have been calibrated by fitting the results of a large series of simulations with TRS.

The mathematical tools we developed can be used for preliminary feasibility studies of GWHP, for fast sensitivity analyses and for the large-scale mapping of the thermal exchange capacity of an aquifer.