Beitrag “Der Geothermiekongress DGK 2018” Essen, 27. – 29. November 2018

Thermal impact assessment of groundwater heat pumps (GWHPs)

Alessandro Casasso *, Co-Autoren: Bruno Piga, Rajandrea Sethi
Politecnico di Torino – DIATI ,corso Duca degli Abruzzi 24, 10129 Torino

Keywords: groundwater heat pump, thermal plume, advection, conduction, dispersion

Groundwater heat pumps (GWHPs) are becoming more and more widespread in European cities, due to their well-known energetic, environmental and economic benefits. However, their spatial distribution in urban areas should be properly managed to avoid the overexploitation of the heat exchange capacity of the aquifer, and possible geochemical alterations. In the case groundwater is reinjected after the heat exchange, part of the flow rate may return to the abstraction well (thermal recycling), thus impairing the system’s performance, and the remainder flows downstream, originating a thermally altered zone of the aquifer also known as thermal plume.
We present a review of tools and models for the thermal impact assessment of GWHPs, highlighting the main phenomena and parameters to be taken into account, and the main sources of uncertainty. Our analysis focuses on the long-term evolution of the thermal plume’s dimensions, expressed as the isotherm of 1 °C of groundwater temperature. The results demonstrate that, while the plume width is correlated to hydrodynamic variables (flow rate, transmissivity and Darcy velocity of the aquifer), the plume length can noticeably vary also depending on thermal parameters such as the thermal conductivity. The propagation of thermal plumes into an aquifer proves also a 3D process, due to heat exchange with underlying and overlying layers.
The correctness of some simplifying assumptions is also analyzed. While analytical formulae can acceptably approximate the plume width, this is not true for its length; on the other hand, using the yearly average thermal load as an input for numerical simulations can lead to an acceptable estimate of the plume length.
This work, carried out in the GRETA project, provides guidelines for the thermal impact assessment of GWHPs, which could be useful both for designers and public authorities in charge of the authorization process.

* corresponding author alessandro.casasso@polito.it mobile phone: +393204213886