EGU21-2838
https://doi.org/10.5194/egusphere-egu21-2838
EGU General Assembly 2021

Advanced investigations of hydro-geothermal ground properties using a geothermal experimental platform

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Although vertical Ground Heat Exchangers (GHE) is a booming technology for both cooling and heating buildings, several improvements could still be proposed in the dimensioning of such systems. Nowadays, most of the dimensioning methods consider only radial heat flux around GHE using a homogeneous ground thermal conductivity, averaged along the depth of the borehole and determined from thermal response tests (TRT) or tables. Impacts of layered ground and groundwater flows on the heat refurbishment around GHE are thus generally neglected.

Many numerical or analytical studies have investigated and quantified the positive impact of groundwater flows on the efficiency of GHE (Dehkordi & Schincariol, 2014; Funabiki et al., 2014). However, those results are rarely compared with in-situ temperature measurements around GHE. Indeed, such experimental data requires (i) the installation of temperature sensors in the heat ground reservoir around GHE and (ii) the characterization of groundwater flows (magnitude and direction) at great depths, which can be complex and expensive.

In this work, an experimental platform composed of 4 vertical GHE drilled at depths of 85 m has been exploited to provide in-situ temperature measurements characterizing heat transfers around GHE. The 4 vertical GHE are located at the 4 corners of a 4-m square and cross a succession of horizontal geological layers. The study focuses on the heat transfers in a 30-m thick sand unconfined aquifer layer, whose 17 m are saturated. A piezometer has been drilled in this unit and allows the characterization of groundwater flows with advanced hydrogeological tests (Brouyère et al., 2008). Each GHE is equipped with both PT100 (installed at the extremities of the unconfined aquifer and just below the groundwater table level) and optical fibres (OF) along the borehole. This experimental platform allows to perform innovative characterization of the geothermal properties of the site. In particular, performing a comparative analysis of the temperature measurement in the GHE between PT100 and OF and several Distributed Thermal Response Tests (D-TRT) under different conditions. In addition, it has been possible to follow the heat transfers around GHE during a long-term activation of a single GHE through heat plume temperature measurement in the non-activated GHE. Anisotropic temperature distribution highlights the impact of groundwater flows on heat reservoir refurbishment.

In this contribution, D-TRT results characterizing the ground geothermal properties, the pre-design of the long-term TRT using an existing analytical solution (Erol et al., 2015) and preliminary

experimental results of the long-term TRT will be presented and discussed.

References

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