Comparison between different geothermal grouts: from composition to numerical analysis

COMPARATIVE METHODS FOR DIFFERENT MIXTURES AND 3D NUMERICAL SIMULATIONS

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Abstract

Aiming to provide an excellent heat exchange between pipes and ground in vertical closed-loop systems, the use of a proper grout is essential. Being the thermal conductivity one of the fundamental rock-forming minerals properties with a clear thermo-physical meaning, it reveals a crucial factor in this respect. For this reason, it is the main objective of this work in order to find the most suitable material to be used as geothermal grout. To this regard, six different kind of mixtures have been tested analysing both thermal, mechanical and mineralogical properties after twenty-eight days of hardening. In particular, two commercial geothermal grouts with different percentages of water and two other mixtures made of Portland cement and quartz sand in different volumetric amounts were investigated. Since alumina is an highly conductive element, two further mixtures consisting of Portland cement, quartz sand and alumina shavings in various proportions were also tested. In order to obtain reliable data, three devices working on different principles (steady state and transient conditions) were employed to measure thermal conductivity. Furthermore, strength and homogeneity of the studied materials through Ultrasonic Pulse Velocity (UPV) and mineralogical determinations thanks to X-Ray Diffraction (XRD) were determined. Results reveal that commercial geothermal grouts present lower values of thermal conductivity compared to that clamed, approaching those measured on the cement and sand mixtures. Promising results comes from the use of alumina shavings in small amount, instead the other analysed mixtures. 3D numerical simulations of borehole heat exchangers filled with the different grout mixtures analysed, were carried out in different geological and hydrogeological conditions as well. Results confirm the knowledge of grout's thermal

conductivity to be as important as that of the underground to increase the efficiency of closed-loop geothermal systems.

Keywords: geothermal grout, thermal conductivity, mechanical and chemical properties, numerical simulation