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Assessing grouting mix thermo-physical properties for shallow geothermal systems

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The main goal of the EU funded GEO4CIVHIC project is the development of more efficient and low-cost geothermal systems for conditioning retrofitting civil and historical buildings. In this framework, the identification of the most appropriate grout for different heat exchangers is a key factor for improving the overall efficiency of shallow geothermal systems. Therefore, a dedicated investigation was focused on the selection and optimization of the thermo-physical properties of grouting products to be used for:

- the sealing of the coaxial geothermal probes' head characterized by different installation depths
- the sealing of the coaxial geothermal heat exchangers by filling the annular gap between the outer casing and the geological formations exposed to the wellbore

In both cases, the thermo-physical behavior of conventional and thermal enhanced grouts has been determined in laboratory for the purpose of manufacturing satisfactory cement based grouts with a real in-situ application. On the one hand, it is important to identify the grout mixtures having a suitable in situ workability, that is those satisfying specific conditions in terms of injection pressure, grout flowability, open working time and costs. On the other, it is essential to determine those providing optimal heat transfer between the probe and the surrounding ground.

Several lab experiments were performed on commercially available and enhanced selected mixtures to define (i) the workability and the flowability of the grouts; (ii) fundamental properties

like mechanical strength, thermal conductivity and permeability of the hardened materials; (iii) leakage and calorimetric behavior, useful to identify sealing properties and grout setting times; (iv) viscosity and (v) density of the cement based mixture able to give information about the grout rate of descent and thus its pumpability under pressure.

Lastly, according to the lab results, few grout mixtures were selected as the best choice to be applied in situ for sealing the head of the geothermal probes' and the annular space between the outer casing and the geological formations exposed to the wellbore. Therefore, this work attempts to address a knowledge gap of the thermo-physical properties, behavior and characterization of grouts for borehole heat exchangers (BHE), that are little studied and known.