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# Evaluating borehole heat exchanger long term potential including the influence of advection and dispersion

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Shallow geothermal energy (SGE) applications are gaining growing attention in the renewable energy sector because of high efficiency, worldwide availability and low environmental impact. Significant increase in the number of installations is envisaged as a result of energy policies and European Directives. Thus, the reliable evaluation of the available exchangeable energy, namely the geothermal potential, is of primary importance to support energy planning policies.

A variety of factors influences the geothermal potential of a specific area, including ground properties, installation features, the presence of groundwater flows and the site temperature. Different approaches to assess the geothermal potential have been proposed, both with reference to the regional scale and to the city or district scale [1]. These are based either on numerical simulations or on analytical closed form solutions. The latter are particularly suitable to be adopted in Geographical Information Systems (GIS) for geothermal potential mapping purposes and are being used in practice. Most available methods consider heat conduction only. This may lead to a conservative evaluation of the potential and to a non-optimised installation planning. This is particularly true in urban areas, where space scarcity is a key factor. Furthermore, these areas may present high density of geothermal installations [2], leading to overexploitation or conflicting use of the resource. Assessment of the geothermal potential at the natural state [3] in these cases is of limited use and can lead to wrong estimation of the actual working load of a new installation.

The need arises to develop methods able to capture real and actual geothermal potential which result from the cumulative effect of both natural and anthropogenic boundary conditions. This study was accomplished to implement advective and dispersive contribution and heterogeneous temperature boundary conditions in the existing analytical approach developed by [4]. This latter is considered very suitable for mapping borehole heat exchanger (BHE) potential both at regional and city scale. To consider the presence of groundwater flow and its influence on the heat exchange, a numerical parametric study was carried out. Conditions explored include temperature vertical heterogeneities and various groundwater flow velocities. It was found that, assuming depth-averaged mean parameters and a thermal conductivity equal to the first invariant of the thermal conductivities tensor, a multiplication factor $C_{gw}$, function of the ratio between advective and conductive contributions, should be added to the analytical formula [4] in order to provide improved evaluation of the BHE potential.

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