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Laboratory assessment of carbon steel corrosion rate of grout-less ground heat exchangers

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The material used to make ground heat exchangers for shallow geothermal applications plays a key role in the overall performance of the system, especially if no grout is used to seal the borehole where the heat exchanger is installed. In this case, the coaxial steel probe is directly coupled with the ground, without any added layer providing thermal resistance between the heat exchanger and the ground. This kind of metallic heat exchanger provides a higher heat exchange efficiency and, in addition, the installation time and costs in unconsolidated deposits are reduced by innovative drilling technique, which has been developed on purpose, where the piling methodology has been combined with a vibrating head and high pressure water injection [1]. Among the materials proposed for the novel vertical ground heat exchangers within the European Horizon 2020 GEO4CIVHIC project, carbon steel is convenient for its low cost and high thermal conductivity [2]. As the main drawback, this material suffers from corrosion, and the physical characteristics of the subsoil directly affect the development of this phenomenon, which afflicts the buried metal bodies and which affects the aging of the ground heat exchange probes. In this study, the corrosion behavior of carbon steel used for an experimental shallow geothermal installation was investigated. The corrosion rates of steel samples were measured in the laboratory using the weight loss method [3] after exposure for certain periods of time in selected ground environments. Different soil conditions were tested, in turn varying the compactness and moisture content of the soil samples collected on site. Based on the results, the corrosion rate of carbon steel was evaluated as a function of both variable parameters. This information made it possible to advance in more precise quantitative forecasts on the expected life of the installed ground heat exchangers and their safety over time.

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