EGU24-21884, updated on 03 Dec 2024
https://doi.org/10.5194/egusphere-egu24-21884
EGU General Assembly 2024

The Impact of Borehole Diameter on Loop Length and ThermalResistivity in Closed-Loop Ground Heat Exchanger System

Sriparna Roy, Tanusree Chakraborty, and Jagdish Telangrao Shahu
Department of Civil Engineering, Indian Institute of Technology, Delhi, Hauz Khas, New Delhi, 110016 - India

Introduction: Geothermal heat pump systems GSHPs use the Earth's subsurface as a heat source in winter and heat sink in summer. A GSHP system integrated with vertical HDPE U-loops for transferring the heat to and from the ground is called a closed-loop ground heat exchanger (CLGHE) system placed by drilling the boreholes. In this study, the relationship between borehole diameter, thermal resistance, and the optimum loop length of CLGHE
systems is investigated.
Methods: Utilizing the standard thermal line source equation, analysis of borehole thermal resistivity bR variations across a spectrum of borehole diameter d sizes (ranging from 80-180 mm) has been performed. The soil thermal properties like conductivity λ are considered as 1.5 W/mK , initial ground temperature is considered to be 25ºC. The analysis is extended to evaluate the influence of borehole diameter sizes on the optimal length of geothermal single U-loops using Ground Loop Design (GLD) software. This comprehensive assessment incorporated critical factors such as soil thermal properties, heat transfer fluid characteristics, and U-loop pipe attributes which has been replicated from the analytical study for a heat load of 10MWh.
Results: The outcomes of our simulations revealed notable correlations: larger boreholes consistently demonstrated increased thermal resistance analytically. It has also been observed through the GLD simulations that the loop length increases as the borehole diameter increases for example: when the diameter increases from 80mm to 100mm the loop length increases from 57.6 to 56.5m for a geothermal grid of 2x2 rectangular configuration for the same soil properties and thermal loading conditions. The observed relationship holds implications for optimizing system design and performance, particularly in diverse soil conditions. In conclusion, our study contributes valuable insights into the thermal efficiency of GSHP systems, emphasizing the importance of borehole diameter in influencing overall energy transfer capabilities. These findings provide a foundation for further research and practical applications for the CLGHE systems.