

Numerical simulation of heat exchange process during thermal response test.

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Ground source heat pump systems (GSHP) use ground or groundwater as a heat source. They can achieve much higher coefficient of performance (COP) than conventional air source heat pump systems because the temperature of the ground is generally much more stable than that of the air. GSHP has been receiving great interests among countries in North America and Western Europe, as well as some developed countries in Asia because it can potentially reduce energy consumption and greenhouse gas emission. While GSHP can inject heat from the buildings to the ground for cooling during the summer, it can pump heat stored in the ground for heating during the winter.

A reliable simulation tool is needed to evaluate GSHP performance and to assess environment impact. In this study, we used FlexPDE software to simulate heat exchange and transfer processes during thermal response test (TRT) in the ground using a vertical-loop closed GSHP system. FlexPDE allows one to solve multi-physics partial differential equations in multi-dimensions based on finite element solutions. To simulate GSHP processes, 3D conduction and 1D convection of heat transport model was used as fluid flow inside U-tube of GSHP can be considered one dimensional.

This simulation study shows that, while initial heat exchange process is strongly affected by layering, the effect diminishes as time elapsed. This confirms the applicability of the infinite line source model to analyze TRT data.

Keywords: Thermal response test, Ground source heat pump, Numerical simulation