A 3-Dimensional Borehole Numerical Modeling For Single And Double U-tube Ground-Coupled Heat Pump

A. Tarrad[1]

[1]Université de Lorraine, CNRS, LEMTA, Nancy, France

Abstract

The heat transfer rate and borehole design represent great challenges to thermal equipment designer of the ground-coupled heat pump. The present model represents a mathematical numerical technique implemented to tackle such problem. A thermal assessment was established to estimate the total energy dissipated to the ground zone for a heat pump utilized for cooling purposes at summer season. COMSOL Multiphysics® was used to build a 3-dimensional model to assess the thermal performance of single and double U-tube boreholes that circulate water as a thermal transfer medium. The (Heat Transfer) module has been implemented for the purpose of this investigation under the (Stationary) study option. The model couples both of the heat conduction in solids including tube metal, grout and soil regions and that of thermal medium fluid flow inside the U-tubes. The numerical solutions were compared for both heat exchangers at fixed borehole geometry, diameter and depth, and constant operating conditions at a steady state mode. The double U-tube heat exchanger was tested in parallel circuiting orientation of the U-tubes. The total mean resistance of the single U-tube borehole was higher than that of half loading double U-tube heat exchangers by (14.6) %. The results also revealed that the heat transfer rate enhancement for the double U-tube was in the range of (10-14) % when operates at the same fluid mass flow rate and inlet temperature for a given borehole design.

Figures used in the abstract

Figure 1 : Temperature distribution at the bottom portion of a double U-tube ground-coupled heat pump

Figure 2 : Temperature distribution at the bottom portion of a single U-tube ground-coupled heat pump