

ABSTRACT

Investigation of the Subsurface Heat Transfer Effects of a Horizontal Geothermal Heat Exchanger for a Tropical Climate

Tennille A. Marajh

The depletion of fossil fuels and the on-going issue of climate change worldwide are key factors influencing the transition to renewable energy (RE) technologies. In Trinidad and Tobago (T&T), the most prominent RE technologies are solar and wind energy; natural deep geothermal energy is not believed to be a possibility in this area. As such, this research is focused on shallow geothermal energy in the form of Geothermal Heat Pump (GHP) applications. The main objective of this research is to examine the performance of a horizontal ground heat exchanger for space cooling in Trinidad and by extension, the other Caribbean islands. Although the main components of GHPs are the evaporator, compressor, condenser and expansion valve, a desuperheater was included since the aim was to provide air-conditioning for a small office, with water heating as a by-product. The COMSOL Multiphysics software was used to model, simulate and monitor the effects of heat transfer on the average fluid temperature leaving the loops in a horizontal GHP system by using in-situ ground data, as well as to determine the temperature influence on the surrounding soil. Weather data was also used to incorporate thermal effects on the ground since the location of the loops was considered to be shallow at a depth of 1.25 m. The total cooling load for the office was calculated and the cooling capacity of the GHP used was 2.3 kW. The minimum length of horizontal ground heat exchangers required was determined. Modelling of heat exchangers was performed for normal operating conditions and simulation was done for a 1 year-period. It is expected that the application of a GHP system for Trinidad and Tobago at the depth investigated will be technically feasible from July to December i.e. during the rainy season. In this study, the range of depths investigated was from 0 m to 10 m. These results may be improved by further investigating the applicability of GHPs at greater depths.

Keywords: Climate Change; Trinidad and Tobago; Renewable Energy; Geothermal Heat Pump; Air-Conditioning; Horizontal; Heat Exchanger; Caribbean; COMSOL Multiphysics; Cooling; Modelling.