Proceedings of the Canadian Society for Mechanical Engineering International Congress 2022
CSME Congress 2022
June 5-8, 2022, Edmonton, AB, Canada

Evaluate the application of ground-source heat pumps under freezing soil conditions in Alberta

Yaren Dincoglu[1], Ali Mirzazade Akbarpoor[1], Lexuan Zhong[1*]
[1]Department of Mechanical Engineering, University of Alberta, Edmonton, Canada
*e-mail address:
lexuan.zhong@ualberta.ca

ABSTRACT

To resolve some of the challenges instigated by the ongoing climate crisis, the implementation of sustainable heating and cooling processes is essential. This demands the design of new energy-efficient buildings and growth in renewable heating and cooling systems. Geothermal Heat Pumps (GHPs), also referred to as Ground Source Heat Pumps (GSHPs), are an appealing option for heating and cooling of commercial and residential buildings due to the fuel-efficient utilization of a stable underground temperature. The application of GSHPs is especially relevant in Western Canada, where freezing temperatures can be expected in winter months. In Alberta, where most buildings are heated solely through natural gas, the installation of GSHPs will aid in reducing the province's heavy reliance on fossil fuels. The cold ambient temperatures in these regions may cause soil to freeze and alter the average soil temperature. The heat removal executed by GSHPs will also cause a temperature decrease and induce soil freezing in the area around the borehole. In this study, a fully implicit one-dimensional finite-volume-based code will be developed to actualize the temperature profile of the ground in the vicinity of the ground heat exchangers (GHEs) and under freezing soil conditions. The numerical model will be validated with experimental data provided in the literature. The developed temperature profile of the ground will demonstrate the effects of frozen soil on the thermal behavior and performance of GSHPs. Moreover, the impacts of frozen soil and the borehole burial depth on the GHE's outlet temperature and coefficient of the performance (COP) of the GSHP will be evaluated. The analysis will convey GSHP design limitations and guidelines, which can be utilized in future installations of GSHPs in Western Canada.

Word count: 277