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Abstract

Ground source heat pumps are attractive alternatives for both conventional heating and cooling systems because of their higher energy efficiencies. A ground source heat pump system consists of a conventional heat pump coupled with a ground heat exchanger where water or a water-antifreeze mixture exchanges heat with the ground. Several major design options are available for ground heat exchangers, which are classified by layout to open and closed loops. Closed loop tubing can be installed horizontally as a loop field in trenches or vertically as a series of long U-shapes in wells. Slinky-coil horizontal ground heat exchangers are a compromise between vertical ground heat exchangers and conventional horizontal ground heat exchangers. They combine the relatively small installation cost of conventional horizontal ground heat exchangers and the high heat exchange capacity of vertical ground heat exchangers. These traits make a slinky-coil horizontal ground heat exchanger a suitable alternative for space heating in areas with limitations on land space usage. However, caused by a lack of appropriate dimensioning tools, these systems are often undersized or overdesigned. In this research, the feasibility of modeling and simulation of slinky-coil geothermal heat exchangers in the modeling language Modelica has been demonstrated. A model of a slinky-coil horizontal ground heat exchanger has been developed to simulate the performance of such systems. The model includes a ground heat exchanger and a soil cell. The ground heat exchanger has been modelled in two levels of detail, one with coil-like pipes and one with thin plates instead of pipes. In order to be able to assess the validity of the model, it has been developed based on a field test in Japan, and simulated under the same conditions. Reasonably good agreement has been obtained between the numerical predictions and published experimental measurements, which demonstrates the reliability and accuracy of the model.

Keywords: *Dymola; Dynamic modelling and simulation; Ground source heat pump systems; Horizontal ground heat exchanger; Modelica; Slinky-coil*