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Taylor dispersion and the optimization of residential geothermal heating systems JESSICA TOWNSEND, Olin College of Engineering, ALEXANDRA ORTAN, VINCENT QUENNEVILLE-BELAIR, McGill University, B.S. TILLEY, Olin College of Engineering — Residential geothermal heating systems have been developed over the past few decades as an alternative to fossil-fuel based heating. These systems consist of tubing (2 cm radius, 1 km in length) buried below the ground surface through which a coolant flows. Tube length has a direct correlation to installation cost. The temperature of this fluid rises as it flows through the tubing, and the energy from this temperature difference is utilized to heat the residence. As a first model, we consider a single tube of fluid encased in an infinite medium of soil, with the goal to find the minimum length over which temperature variations occur. Through lubrication theory, we derive an evolution equation for the local soil temperature near the tubing. We find that Taylor dispersion of heat in the fluid and thermostat frequency dictate the minimum tubing length needed for successful operation in an insulated subsystem. Next, matched asymptotics is used to incorporate far-field temperature variations. Comparison of our model with experiment is presented.

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