

Evaluation of Soil Thermophysical Properties for a Ground Source Heat Pump System with Pile Heat Exchangers

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During the remaining 100 years or so, there are concerns regarding the drain on the current major primary energy sources of oil, coal, natural gas and uranium. Therefore, utilization of renewable energy in order to reduce the use of limited resources has attracted attention. We have focused on geothermal energy, which a renewable energy source. For the design of a Ground Source Heat Pump (GSHP) system, it is important to understand the thermophysical properties of the soil. GSHP commonly uses the heat energy of soil approximately 100 m underground, however expensive drilling costs (about 10,000 Yen/m) prohibit the progress of the GSHP system in Japan. Furthermore, geology in Japan makes it difficult to design a suitable GSHP system. In this study, we have focused on the development of a ground source heat pump system with pile heat exchangers for a residence (GSHP with PHEs). A pile heat exchangers has 20 or shorter. Heat flow in the ground is 2 dimensional because pile heat exchangers are short. So, Thermal Response Test method is not applicable to know the thermal properties of the soil. In order to develop such a GSHP system, understanding of the thermophysical properties of the soil must be incorporated into the measurement system. Therefore, we measured the thermophysical properties of the shallow soil, approximately 10 m underground. A pile serving as a heater and a temperature sensor was set up in the soil; the pile was heated and the subsequent temperature rise was measured. The thermophysical properties such as thermal conductivity, specific heat and density were then estimated by fitting experimental data with numerical analysis based upon the principles of unsteady heat conduction.