

# CHARACTERISTICS OF VERTICAL AND HORIZONTAL GROUND HEAT EXCHANGERS FOR GROUND SOURCE HEAT PUMP/AIR CONDITIONING SYSTEM

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**Keywords:** Ground heat exchanger, Vertical, Horizontal, U-tube, Double-tube, Multi-tube, Slinky-tube

## ABSTRACT

Utilization of shallow ground heat energy for a heat source of heat pump and air conditioning system give the reduction of energy consumption. Temperature of the shallow ground which is in the depth of 200 m from the ground surface is kept a constant value through the year. Because the temperature is nearly equal to annual average temperature, we can use the heat source with higher temperature than the atmospheric in the winter. And, in the summer, the ground can be used as a heat sink of which temperature is lower than atmospheric temperature. From these reasons, in general the coefficient of performance of the systems using the ground heat is higher than the systems using the air heat. Use of the ground source heat has been mainly developed for heat pump in cold area. Recently, the use in warm area is also attracting attention and some investigation results have been reported in which utilizations of ground give the higher performance to the systems. Expanding the ground source heat pump/air conditioning systems in the warm area are expected for decelerating the global warming and preserving the environment of human life.

However, the initial cost to install the ground heat exchanger is impeding popularization of the ground heat source. Cost reduction of the installation is indispensable for popularization. Understanding the characteristics and improving the performance of ground heat exchangers lead the cost reduction.

In our study, five kinds of vertical-type ground heat exchangers, such as U-tube, double-tube, small diameter double tube, multi-tube, spiral-tube, and two kinds of horizontal-type ground heat exchangers, such as standing Slinky and reclined Slinky, were experimentally and/or numerically investigated in order to clarify their heat transfer characteristics. Because of the low thermal conductivity of the soil which depends on the soil material and water content, the heat transfer rate of ground heat exchanger becomes a strong function of utilization time. Effects of heat extraction mode which is continuous mode and intermittent mode were also studied.