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Potential estimation for geothermal heat exchanger system in Saitama prefecture

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Ground heat exchanger system is economical and environmentally friendly technology and widely used in Europe and North America, while it is rarely used in Japan. One of the causes is relatively complex topography and geological structure in Japan in comparison with those in Europe and North America. Complex structures produce regional differences in subsurface thermal properties and temperature structure, leading to regional variation in efficiency of heat exchanger system. It is thus important to evaluate available subsurface heat energy through thermal response tests and/or numerical simulation and to design appropriate systems (depth and number of boreholes for heat exchange). Information on subsurface environment in target areas is necessary for evaluation of potential subsurface heat energy, but little information has been published.

Center for Environmental Science in Saitama is a research institute established by a local government, Saitama prefecture, which is located on the north of Tokyo and has a population of over seven million. We have been collecting various subsurface environmental data in Saitama (e.g., lithological column data on over 10,000 boreholes). We have compiled the accumulated data and obtained new data (geological information, subsurface temperature distribution, and hydrogeological properties) to construct a database for application of ground heat exchanger systems in Saitama.

It is important to estimate demand for heat energy in the target areas as well as available subsurface heat energy. We therefore compile meteorological data (air temperature and solar radiation) necessary for estimation for the demand and investigate regional variation in meteorological condition.

We intend to disclose the database and research products using web GIS (geographic information system) in the future. It will assist spread of ground heat exchanger systems in the target areas. Investigation methods of subsurface environment survey and database construction can be applied to other areas.

We present results of numerical simulation of ground heat exchanger system operation based on the database. The amount of available heat energy and influence on subsurface thermal environment vary by up to about 20 % within the study area depending on geological, subsurface thermal condition,and ground water flow.

Keywords: geothermal heat exchanger, subsurface temperature, ground water, heat pump