

Suitability maps for Ground-coupled heat pump system using groundwater flow/heat transport modeling

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Ground-coupled heat pump (GCHP) systems are considered to be one of the most energy conservation systems. In Japan, however, use of the GCHPs is still limited because of a lack of information on the advantages offered by these systems and because of their high initial costs. The accurate estimation of heat exchange rates, which can minimize the initial cost of the GCHP systems, is therefore of crucial importance to enhance the distribution of the system. The geological condition and groundwater flow strongly affect the heat exchange rates of ground heat exchangers (GHEs). In this study, the suitability maps for GCHP system and the heat exchange rate maps for the Fukui Plain, Hokuriku District, based on field-wide groundwater and heat transport analysis were developed.

First, a field-wide groundwater and heat transport model was constructed for the area and the results were matched against measured groundwater levels and vertical temperature profiles. Then the suitability maps for GCHP system were constructed by four kind of thematic maps, which were produced by using the results of the numerical modeling and hydrogeological information. After that, in order to make the heat exchange rate maps, the single heat exchanger models were constructed. The setting of the boundary and initial conditions of the models were reflected the results of the field-wide groundwater flow modeling. Finally, the heat exchange rate maps were compared with the suitability maps and the hydrogeological information. The results indicated that the ratio of sand gravel layer thickness was strongly effect on the both maps. A further study of the quantification of the effect of hydrogeological information on heat exchange rate should be conducted.

Keywords: Ground-coupled heat pump, heat exchange rate, groundwater flow modeling, GIS