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Efficiency analysis of geothermal heating and cooling system using groundwater in S. Korea

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Increasing the interest in new renewable energies, geothermal energy is known as clean energy which can be used for heating and cooling. Geothermal energy was used in buildings in its early development, and has recently been applied to controlled horticulture in South Korea. It is mostly utilized in the vertical closed loop type in South Korea, but in areas of abundant groundwater, the open type is thought to be more effective [1, 2]. Thus, this study has analyzed efficiency in a geothermal heating and cooling system using groundwater for controlled horticulture in South Korea.

The location of this study is a reclaimed area where groundwater is flowing near the coast in South Korea. This area is expected to accommodate controlled horticulture facilities. Hydrogeological characteristics and underground temperature characteristics have been investigated. A pumping test shows that the research area has groundwater of 250 ㎥/day and that its hydraulic conductivity is 4.83×10^{-4} ㎝/sec. Two years of monitoring has resulted in the fact that an underground depth of over 10 m keeps temperatures constant throughout the year while an underground depth under 10 m has temperatures being affected by seasons. Thus, it can be judged that geothermal energies from an underground depth of over 20 m could be utilized. The thermal conductivity of underground areas has been analyzed through sample materials and compared with the results of the thermal response test (TRT), with its applicability examined.

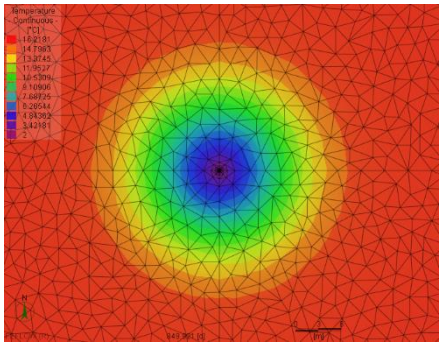

Figure 1: Simulated temperature distribution at 60 m depth of the SCW model (flow rate 100 ㎥/day)

By putting together these results, this study has simulated the optimal type of heat exchanger for the research area with abundant groundwater. To compare the vertical closed loop type with the open type, the first simulation experimented with the vertical closed loop type, standing column well (SCW), and doublet, revealing excellent efficiency of the open type. Accordingly, the second simulation experimented with the open type in three methods for heat transfer, distance, flow rate, and groundwater hydraulic gradient, seeking an optimal method of its utilization.

The results of this study are as follows. The area with abundant groundwater showed the highest efficiency for a geothermal heating and cooling system of the open type. Hence, this system is considered to be the optimal type of heat exchanger. But, when utilizing geothermal energy for a

controlled horticulture complex, it is necessary to examine its adequacy systematically based on the hydrogeological and thermal properties of the area concerned and also on the results of reviewing the COP (coefficient of performance) for a geothermal heating and cooling system.

References:

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