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Monitoring of a geothermal heat pump system with vertical borehole heat exchangers and standing column wells

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This study summarizes the monitored data of a ground source heat pump with two deep vertical borehole heat exchangers (BHEs) and two standing column wells. Due to the restricted available area for BHEs in the building, the deep BHEs and standing column wells were considered to cover the designed heating and cooling load. The conventional BHEs in Korea have been installed in the depth between 50 and 200 m because the cost is highly depends on ground condition and borehole stability. This system is installed in a crystalline granite bedrock with very low hydraulic conductivity of 1.2E-08 m/s. The ground temperature is distributed about 15 °C at 50 m and 25.4 °C at 464 m having the ground thermal gradient around 25°C/100 km. In the installation of the boreholes with 150 mm diameter, the single U-tube with 50A PE (outer diameter 50mm) was adapted and backfilled with gravel 2 $\sim$ 5 mm diameter in the closed system. Thermal response test (TRT)s were conducted at each borehole and obtained effective ground thermal conductivities 3.0 and 3.5 W/mK and borehole thermal resistance 1.04 and 1.20 mK/W respectively. The tests were performed by using typical TRT guidance with thermal injection 58 W/m during 48 hours. During the construction of the geothermal heat pump system the monitoring device was set up for collecting temperature and flow rates data. According to estimate the heat exchange rate, the detailed operation type and period was monitored at summer season from May to September, 2017. The average heat exchange rate of the system in vertical closed loop BHE is about 40 $\sim$ 50 W/m and that of the standing column wells represents 100 $\sim$ 150 W/m during peak time. Heat exchange rates of the both types are satisfied with the design values. For the evaluation of the correct performance, more monitoring data of several heating and cooling season are required. This monitoring study would help to design economic geothermal heat pump system.
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