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Estimation of yield capacity of fractured rock aquifer for multi-well groundwater heat pump system

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<Abstract>

Geothermal heat pump system is classified as closed loop and open loop. Closed loop uses a refrigerant as a heat source. For the reason, when using it for a long time, there is a possibility that the refrigerant pipe is corroded. Accordingly, soil and groundwater can be contaminated. Whereas the open loop system uses a eco-friendly groundwater as a heat source. Thermal circulation of standing column well (SCW) occurs in one well. In contrast, thermal circulation of multi-well groundwater heat pump system (MGHP) occurs through fractured rock aquifer between extraction and injection wells. Therefore, temperature efficiency of MGHP appears to be better than that of SCW. However, the MGHP has problems such as the overflowing in the injection well and the clogging, which restricts the wide use of MGHP. This study aims at how to to array the extraction and injection wells for stable circulating of groundwater and at evaluating the sustainable yield capacity of groundwater circulation between the two wells. The study site is located in Chuncheon, Republic of Korea. Pumping tests were conducted to estimate transmissivity of the two wells (W3, W4). In addition, the step-circulation tests were conducted to estimate the sustainable yield capacity. Transmissivity of W3 and W4 was estimated to be 5.81 x 10-5 m2/s and 2.57 x 10-5 m2/s, respectively. Preliminary groundwater circulation tests were conducted to figure out the array of the extraction and injection wells. Circulation tests were performed for two cases: first, extraction well was set at the well with higher transmissivity and injection well set at the well with lower transmissivity, and the opposite array was set for the second case. In the first case, when flow rate was set at 70.47 m3/day, the water level of W3 fell 0.61m and that of W4 rose 1.89m. In the second case, when flow rate was set at 67.70 m3/day, the water level of W4 fell 2.17m and that of W3 rose 0.5m. Preliminary groundwater circulation tests indicated that the well with relatively higher transmissivity is favorable to the extraction and that with lower transmissivity is favorable to the injection. The step-circulation test was performed in all four step increments between the extraction well (W4) and the injection well (W3), which helps evaluate the sustainable yield capacity of groundwater circulation between the two wells. After the four increments, the yield capacity of sustainable groundwater circulation was estimated to be 270 m3/day without the overflowing at injection well and sustainable drawdown at the extraction well.