Hot Dry Rock Geothermal Energy Development Project at Ogachi, Japan

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Abstract

Some of geothermal energy has been exploited and used for power generation and for direct use by conventional development methods in many countries so far. In these methods, geothermal energy only contained in water was extracted, but most of geothermal energy is stored in underground rock. In Hot Dry Rock (HDR) geothermal energy development method, geothermal energy stored in rock is extracted by circulating water between the ground surface and the underground rock through wells.

Since 1989, the Central Research Institute of the Electric Power Industry (CRIEPI) has conducted HDR experiments at Ogachi in northern Japan. In these experiments, two vertical separated HDR reservoirs were artificially created by hydraulic fracturing at around 720 m and 1,000 m depths in a 1,000 m injection well (OGC-1). Totals of 10,140 m^3 and 5,440 m^3 of water were injected into OGC-1 at average flow rates of 500 liters and 400 liters per minute with average well-head pressures of 18 MPa and 22 MPa in the deeper and shallower reservoir creation operations, respectively. The location and size of the reservoirs were estimated by induced microearthquakes or acoustic emissions (AE) measurement and electrical measurements. The sizes of the deeper and shallower reservoirs were estimated to have long axes of 1,000 m and 800 m, respectively.

A production well (OGC-2) was drilled to penetrate the reservoirs. The drilling target of OGC-2 was determined based on the AE hypocenter distribution. Some water circulation tests were conducted between OGC-1 and OGC-2 through the reservoirs from 1993 to 1997. In these circulation tests, surface water at temperature of 15 degree C was injected and recovered as hot water with steam at a temperature of 165 degree C. Water flow during these circulation tests were numerically simulated.

Through these experiments, it was shown that basic technologies for creating artificial geothermal reservoirs, estimating the reservoir location and size and extracting heat by circulating water between two wells through the reservoirs has been developed in practical use. These technologies are applicable not only to HDR but also to conventional geothermal development.