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High Temperature Aquifer Storage

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Combined heat and power generation (CHP) is highly efficient because excess heat is used for heating and/or process energy. However, the demand of heat energy varies considerably throughout the year while the demand for electrical energy is rather constant. It seems economically and ecologically highly beneficial for municipalities and large power consumers such as manufacturing plants to store excess heat in groundwater aquifers and to recuperate this energy at times of higher demand. Apart from the hydrogeological conditions, high transmissivity and favorable pressure gradients, the hydrochemical conditions are crucial for long-term operation.

Within the project High Temperature Aquifer Storage, scientists investigate storage and recuperation of excess heat energy into the bavarian Malm aquifer. After one year of planning, construction, and the successful drilling of a research well to 495 m b.s.l. the first large scale heat storage test in the Malm aquifer was finished just before Christmas 2014. An enormous technical challenge was the disruption of the carbonate equilibrium - modeling results indicated a carbonate precipitation of 10-50 kg/d in the heat exchangers.

The test included five injection pulses of hot water (60 °C up to 110 °C) and four tracer pulses, each consisting of a reactive and a conservative fluorescent dye. Injection and production rates were 15 L/s. About 4 TJ of heat energy were necessary to achieve the desired water temperatures.

Electrical conductivity, pH and temperature were recorded at a bypass where also samples were taken. A laboratory container at the drilling site was equipped for the analysis of the concentration of the tracers and the cation concentrations at sampling intervals of down to 15 minutes. Additional water samples were taken and analyzed for major ions and trace elements in the laboratory.

The disassembled heat exchanger proved that precipitation was successfully prevented by adding CO_2 to the water before heating. Energy recovery during the first pulses was above 35 % and rising. As a side effect of the extremely good hydraulic conditions, the research well was flowing freely with 20 L/s which resulted in a significant mixing of the injected water with formation waters during production. The recovery rates for the tracers were above 60 % depending on the type of tracer.