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PETher – Physical Properties of Thermal Water under In-situ-Conditions

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The objective of PETher, a research project funded by the German Federal Ministry for Economic Affairs and Energy (BMWi), is to experimentally determine thermo-physical properties (specific isobaric heat capacity, kinematic viscosity, density and thermal conductivity) of geothermal water in-situ-conditions (pressure, temperature, chemical composition including gas content of the brine) present in geothermal applications. Knowing these thermo-physical properties reduces the uncertainties with respect to estimating the thermal output and therefore the economic viability of the power plant. Up to now, only a limited number of measurements of selected physical properties have been made, usually under laboratory conditions and for individual geothermal plants. In-situ measured parameters, especially in the temperature range of 120°C and higher, at pressures of 20 bar and higher, as well as with a salinity of up to 250 g/l, are sparse to non-existing. Therefore, pure water properties are often used as reference data and for designing the power plant and its components.
Currently available numerical models describing the thermo-physical properties are typically not valid for the conditions in geothermal applications and do not consider the substantial influence of the chemical composition of the thermal water. Also, actual geothermal waters have not been subject of detailed measurements systematically performed under operational conditions on a large-scale basis. Owing to the lack of reliable data, a validation of numerical models for investigating geothermal systems is not possible.
In order to determine the dependency of the thermo-physical properties of geothermal water on temperature, pressure and salinity in-situ measurements are conducted. The measurements are taking place directly at several geothermal applications located in Germany's hydrogeothermal key regions. In order to do this, a mobile testing unit was developed and refined with instruments specifically designed in-house to meet any geothermal reservoir conditions present in Germany. The obtained results will be compared with standard analytical methods as well as used to calibrate laboratory measurements that simulate the encountered in-situ conditions. A series of measurements will be performed to create a data base.
In addition, these data can be used as reference data for developing and validating numerical models. In-situ measurements – in contrast to laboratory measurements – record the data online and instantaneously during normal operation of the plant and without changing the properties of the investigated fluid (pressure, temperature, etc.). Due to this, the uncertainties in the thermo-physical properties caused by degassing and precipitation are studiously avoided.
As a result, the thermo-physical properties density, specific isobaric heat capacity, kinematic viscosity and thermal conductivity have been measured as functions of the geothermal water temperature, pressure and salinity at five sites, up to now.
The measurements show that the thermo-physical properties correlate strongly with the salinity and therefore differ considerably from pure water values when a significant salt content is present.