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Scalings at geothermal facilities exploring the Malm Aquifer (Bavarian Molasse Baisin)

Bernhard Köhl, Moritz Herbrich, and Thomas Baumann
Germany (bernhard.koehl@tum.de)

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(Herbrich, M., Köhl, B., Baumann, T.)

Scalings are a widespread problem among geothermal plants which exploit the Malm Aquifer in the Bavarian Molasse Zone. They effect the technical and economic efficiency of geothermal plants and cause costly revisions of the geothermal cycle. Scalings observed at geothermal facilities exploring the Malm Aquifer mainly consist of different $CaCO_3$ polymorphs and are found at the motor, in the pumps and pipes and throughout the groundlevel facilities including the heat exchangers. There are two main processes leading to a disruption of the carbonate equilibrium and causing these $CaCO_3$ scalings: local temperature peaks and degassing of less soluble gases due to local pressure drops. While the increase of the temperature leads to a local supersaturation at the hot surface of e.g. the motor, the formation of gas bubbles strips all soluble gases from the solution according to the Henry equilibrum constants, thus shifting the carbonate-equilibrium towards less soluble $CaCO_3$. In order to prevent the formation of scalings, these processes have to be quantified. Therefore, we investigated the scalings in all sections of the geothermal cycle at geothermal plants in the Malm Aquifer.
So far, we have sampled scalings from the pumps and the production pipes after three exchanges of the pump, scalings collected in the particle filters, scalings from the ground level geothermal facilities, and scalings from the injection pipes. The samples were characterized by REM-EDX, XRD, and image processing to assess the mineralogical features and the elemental composition. The porosity and bulk density were measured to assess the mass of the deposits and to calculate the kinetics of the formation. All together, this generated a unique quantitative dataset with a spatial resolution of 9 m along the production tubes.
The thickness of the scalings first decreases from the outlet of the pump to about 600-400 m b.s.l. From here, the thickness of the scaling increases again towards the well head. While the scalings at the well head show a crystalline structure with little porosity, the scalings at the pump reveal a rather sponge-like structure. The thickness of the scalings above the pump shows a dependency on the pump type. The overall thickness correlated to the produced volume of thermal water is on the order of 500-1500 μm/10ˆ6 mˆ3. As the geothermal water is produced, the gas bubbles, which are formed at the pump, slowly dissolve under more steady flow conditions and less new scalings build, since the precipitation of some material reduced the saturation. Closer to the well head, scalings are formed as the pressure in the production pipe decreases. The processes leading to scalings are controlled by the hydrochemical conditions and the gas loading, both largely differing at the different exploration sites. Therefore, we will focus on the acquisition of additional data from other sites to quantify and predict the formation of the scalings and to develop countermeasures.