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Pure water injection into porous rock with superheated steam and salt in a solid state

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Most of geothermal fields require injection of fluid into the hot rock to maintain pressure and productivity. The presence of solid salt in porous space may cause an unexpected change in the characteristics of the reservoir and produced fluids, and dramatically affect the profitability of the project.
We consider an injection problem of pure water into high temperature geothermal reservoir, saturated with superheated vapour and solid salt. Pure water moves away from injection point and dissolves solid salt. When salty water reaches the low-pressure hot domain, water evaporation occurs and, consequently, salt precipitates.
We develop a simplified analytical model of the process and derive the similarity solutions for a 1-D semi-infinite reservoir. These solutions are multi-valued and describe the reduction in permeability and porosity due to salt precipitation at the leading boiling front. If the parameters of the system exceed critical values, then similarity solution ceases to exist. We identify this mathematical behaviour with reservoir sealing in the physical system.
The TOUGH2-EWASG code has been used to verify this hypothesis and investigate the precipitate formation for an idealized bounded 1-D geothermal system of a length of 500 m with water injection at one extreme and fluid extraction at the other one. Both boundaries are kept at constant pressure and temperature.
The result for the semi-infinite numerical model show that the monotonic grow of the solid salt saturation to reach asymptotic similarity solution generally occurs over a very large length starting from the injection point. Reservoir sealing occurs if solid salt at the initial state occupies a considerable part of the porous space.
Numerical experiments for the bounded 500 m system demonstrate that a small amount of salt is enough to get reservoir sealing. Generally, salt tend to accumulate near the production well, and salt plug forms at the elements adjacent to the extraction point.
This type of simulation studies can be applied to Hot Dry Rock systems to investigate the effects of dissolution/precipitation of solid salt, if present in the system, on the feasibility of the project.