Heat Recovery from Multiple-Fracture Enhanced Geothermal Systems: The Effect of Thermoelastic Fracture Interactions

This study investigates the effect of thermoelastic interactions between multiple parallel fractures on energy production from a multiple-fracture enhanced geothermal system. A coupled thermo-hydro-mechanical finite element model has been developed that accounts for non-isothermal fluid flow within the fractures, conductive heat transfer in the rock matrix, and the mechanical deformation of the matrix. The model results show that the matrix deformation significantly increases the interactions between the two adjacent fractures. Matrix contraction due to the cooling of the matrix increases the fracture aperture in the adjacent fracture, and facilitates the creation of favourable flow pathways between the injection and production wells. These flow paths reduce the energy production from the system. The effects of fracture spacing, reservoir temperature gradient and mechanical properties of the rock matrix on the production temperature and the net production energy are investigated. It is shown that the spacing calculated based on the assumption of rigid matrix (constant uniform aperture) are too small, and in order to account for the thermoelastic interactions, the spacing between fractures should be further increased to maximise the net energy production from the system. Otherwise, the multiple-fracture system fails to improve the energy recovery from the geothermal reservoir, as initially intended.
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