

# REVIEW OF THE STATE-OF-THE-ART OF NUMERICAL SIMULATION OF ENHANCED GEOTHERMAL SYSTEMS

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## ABSTRACT

Under the premise that the behavior of enhanced geothermal systems (EGS) will be dominated by fracture flow, this paper reviews the special features that would be required of any practical numerical simulator for EGS. These features, required in addition to the basic features of conventional geothermal simulators, namely, the ability to handle two-phase fluid flow, heat transfer and tracer transport in porous and fractured media, are: explicit representation of fractures, change in fracture aperture due to effective stress and shear, thermo-elastic effects, relation between fracture aperture and conductivity, and channeling of fluid flow within fractures. Chemical reaction between water and rock and coupling of the reservoir model with a wellbore model would also be desirable features. The paper reviews the well-known simulators that have been used or can be used to model EGS (TOUGH2, TETRAD, STAR, GEOCRACK, FEHM, FRACTure, GEOTH3D and FRACSIM-3D) with regard to the features listed above.

While each of the simulators has many of the capabilities listed above, none has all of them; and each simulator has its strengths and weaknesses. A single type of model may not be suitable for all EGS projects or at every stage of a given project. For example, in the early development stage of an EGS project, when available information is limited and the primary need is for reserves estimation and project planning, fracture network-type models may be more practical to use. In a more mature stage of the same project, when reliable information on fractures becomes available, discrete fracture-type models may be preferable for optimizing injection/production strategy. Water/rock interaction or two-phase flow may not be an important issue in some projects. Therefore, the need for developing a single, all-purpose simulator for EGS applications at this time is perhaps less urgent than taking advantage of the strengths of the various available simulators to solve the problem at hand.

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