Hydraulically driven fractures in deformable porous media- Impact of non-linear flow patterns in vicinity of fractured zone

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Abstract

Predicting mutual fluid-solid interactions in subsurface reservoirs is essential to address critical geoscientific challenges related to geoenergy such as geothermal energy, hydrocarbon exploration, underground storage sites. In this work, a mathematical setting is presented on the basis of the variational principle for the minimisation of fracturing system energy in the context of finite strain elasticity. The nonlinear system of equations is solved by employing an iterative Newton method on the finite element mesh to emulate nonlinear hydro-mechanical processes of the subsurface porous materials. The application and robustness of this numerical method is tested by simulating a benchmark example, and particular focus is on investigating the impact of the non-linear flow fields within the fractured zone on propagating fracture pathway and evolution of reservoir transmissivity. The results imply the significant changes of the fluid regime and the pressure drop inside the crack as well as around the crack-tip caused by the development of fracture subjected to fluid injection.