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Quasi-static crack propagation in porous media due to hydraulic pressure within the crack

A. Juan-Lien Ramirez[1]*, S. Löhnert[2] and I. Neuweiler[1]
[1] Institute of Fluid Mechanics and Environmental Physics in Civil Engineering,
Appelstraße 9A, 30167 Hannover,
alina.juanlien@mario.uni-hannover.de, neuweiler@hydromech.uni-hannover.de
[2] Institute for Continuum Mechanics,
Appelstraße 11, 30167 Hannover,
loehnert@ikm.uni-hannover.de

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ABSTRACT

The creation/enlargement of fractures in rock through the injection of fluid at high pressure, the so-called hydraulic fracturing, has been gaining importance in the last couple of decades. It is a technique used in the oil recovery and geothermal industries as a method to enhance production. Fracturing a rock increases its permeability, thus increasing fluid flow and also creates larger contact areas between the rock and the fluid.

Fracturing rock with fluid poses a combination of various physical processes that strongly influence one another; e.g., the deformation of the rock, the fluid flow within the rock and within the fracture and the fluid exchange between the fracture and the rock, above others. When it comes to their numerical simulation, accounting for these processes and their coupling becomes rather challenging.

We have developed a two-dimensional, homogeneous, poroelastic model [1] to simulate the propagation of a single embedded crack using the Extended Finite Element Method. The rock is modeled as a fully saturated porous medium, meaning that both the displacements and pore pressure fields are discontinuous along the crack [2]. The behavior of the solid component is assumed to be linear elastic and the fluid flow is described by Darcy’s law. The fracture propagates following the criteria of the energy release rate and the stress intensity factors. The open flow within the fracture is coupled with the porous medium by enforcing continuity of fluxes and pressure along the interface via Lagrange Multipliers.

The model is able to simulate the propagation of the fracture with different initial geometries.

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