Coupled H-M fracture interaction using FEM with zero-thickness interface elements.

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ABSTRACT

Massive treatments of hydraulic fracturing is a procedure employed for low permeability reservoirs stimulation. This technique consists in generating a series of parallel spaced fractures parallel (multi-stage fracturing). The generation of a fracture involves the modification of the local stress state, so in the case of a multi-stage treatment, the fracture propagation can be modified by the injection sequence, as it is observed with microseismicity monitoring [1].

This work proposes the study of this technique by means of the finite element method with zero-thickness interface elements for the geo-mechanical modelling of discontinuities [2]. The technique consists in inserting interface elements in between standard elements to allow jumps in the displacement solution fields. For the mechanical problem, their kinematic constitutive variables are relative displacements, and the corresponding static variables are stress tractions. The relationship between variables is controlled via a fracture-based constitutive law with elasto-plastic structure [3]. Concerning the hydraulic problem, the interface formulation includes both the longitudinal flow (with a longitudinal conductivity parameter strongly dependent on the fracture aperture), as well as and the transversal flow across the element (seepage)[4].

Previous works by the authors focused on the validation of the method, the analysis a single fracture plane problem [5,6]. In this case the method is extended to allow free propagation of fractures in any direction, by means of inserting interface elements between all continuum elements. The results presented in this paper analyse the effect of material properties, in particular fracture characterization, in the propagation and the effect of fracture job sequence.

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