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Recent Advances In Numerical Simulation Of Interacting Discontinuities In Naturally Fractured Porous Media

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Abstract

An extended finite element method is presented for simulation of interaction between hydraulic fracturing and natural fractures in saturated porous media. The well-known $u-p$ formulation is employed in order to obtain the fully coupled set of governing equations. Natural faults are modeled for both opening and closure modes where the fluid inflow and contact conditions are considered at the interface, respectively. The Darcy law is employed in conjunction with an aperture dependent permeability for the fracture channel to describe the interfacial inflow. The contact constraints of both the solid and fluid phases are imposed using the Penalty method. The Heaviside and modified ramp enrichment functions are introduced to model the required strong and weak discontinuities in the displacement and pressure fields, respectively. Furthermore, new enrichment functions are introduced to model the junction and/or intersection of the discontinuities. The system of nonlinear equations is solved using the Newton-Raphson iterative algorithm with an implicit time stepping scheme. Finally, several numerical examples are chosen to illustrate the robustness of the proposed formulation as well as to study the interaction of hydraulic fracturing with natural faults.