Recent achievements in computational modeling of hydraulic fracture propagation and proppant transport in fractured porous media

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Abstract

A numerical model is developed based on a combination of the extended finite element method and an equivalent continuum model to simulate the multi-phase fluid flow through fractured porous media containing fractures with multiple length scales. The governing equations involve the linear momentum balance equation and the flow continuity equation for each fluid phase. The extended finite element method allows for an explicit and accurate representation of cracks by enriching the standard finite element approximation of the field variables with appropriate enrichment functions, and captures the mass transfer between the fracture and the matrix. The pre-existing short fractures due to heterogeneity of domain, which are distributed randomly in the reservoir, contribute to the increase of the effective permeability tensor and are modeled with an equivalent continuum model. Moreover, the fluid inflow within the fracture is modeled using the one-dimensional mass conservation of the injected slurry and proppant along the fracture, in which the viscosity of the slurry is dependent on the proppant concentration. The transition from the Poiseuille to Darcy flow regime is incorporated into the computational model as the proppant concentration reaches its maximum pack value. The robustness of the proposed computational model is demonstrated through several numerical examples of typical hydraulic fracturing problems in order to investigate the behavior of the fracture propagation in the case of proppant transport.

References

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