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A thermal-coupled model of hydraulic fracture propagation in deep reservoir

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Abstract: With the increasing demand of oil and gas resource in the world, the development of deep reservoir has become an inevitable trend. In order to investigate the coupled effects of rock elasto-plastic deformation, fluid flow and heat transfer in the process of hydraulic fracturing of deep reservoir, the mathematical model of hydraulic fracture propagation is established based on cohesive zone model (CZM) and embedded discrete fracture model (EDFM). The constitutive equation incorporating thermal stress is derived by using Drucker-Prager yield condition and the associated flow law. Fluid flow in the fracture is modeled with lubrication theory. The thermal non-equilibrium theory is employed to describe the heat exchange between rock matrix and fluid in the fracture based on EDFM. The CZM is used as fracture propagation criterion. Finite element method is used to solve the rock deformation equation. The thermal field and fluid flow in the fracture are modeled with finite volume method. Due to the non-linearity of flow equation, an iterative method is adopted to solve the coupled problem of stress, pressure and thermal fields. A Triangular-PEBI (Perpendicular Bisector) dual mesh system is presented for numerical implementation. The numerical model is validated against with analytical solution and other methods in the literature. The results show the significance of accounting for elasto-plastic deformation and heat transfer when simulating hydraulic fracture propagation in deep reservoir.
Keywords: deep reservoir; hydraulic fracturing; elasto-plasticity; heat transfer; cohesive zone model; embedded discrete fracture model

References

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