Dynamic Hydraulically Driven Fracture with XFEM

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ABSTRACT

Hydraulic fracturing involves the injection of large fluid volumes of at elevated pressures in oil and gas reservoirs with the aim of increasing the effective permeability of the reservoir. This is accomplished through the creation of fracture networks which hydraulically connect the reservoir to the well bore. In this presentation, an extended finite element method is presented to model the dynamics of the hydraulic fracturing process using a coupled fluid-soil model. The crack tip process zone is modelled using a cohesive law and fracture direction is determined using the maximum hoop stress ahead of the crack tip. The XFEM model presented builds upon recent developement by Pierce and co-workers, and Khoei and co-workers [1,2]. The presented methodology differs from previous methods, in way that the coupled fluid-solid interaction is modelled in the fracture process zone, leading to a more consistant treatment of the crack tip physics. The formulation used will be given and several example will be presented to illustrate the application of the model to fracture in heterogeneous rock masses and to compare the physics of hydraulic fracting in shallow and deep reservoirs.

References

[1] Gordeliy, E., & Peirce, A. (2013). Coupling schemes for modeling hydraulic fracture propagation using the XFEM. Computer Methods in Applied Mechanics and Engineering, 253, 305-322.
[2] Mohammadnejad, T., & Khoei, A. R. (2013). An extended finite element method for hydraulic fracture propagation in deformable porous media with the cohesive crack model. Finite Elements in Analysis and Design,73, 77-95.