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Pore-scale modeling of hydraulic fracture

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Hydraulic fracturing is one of primary engineering techniques to improve well productivity especially for unconventional reservoirs. Generally, there are two kinds of numerical models for hydraulic fracture simulation, continuum-based models and discontinuum-based models. In continuum-based models governing equations based on continuum theory are solved with single planar fracture assumption. However, in unconventional reservoirs this assumption breaks down, which results in the predictions by continuum-based models are not consistent with experiments [Al-Busaidi et al., 2005]. Firstly, complex rather than single hydraulic fracture is often observed in laboratory or field experiments [Wang et al., 2014]. Secondly, continuum-based models generally assume that hydraulic fracture is caused by tensile force at fracture tip, but shear-type seismic events are often recorded in experiments and even in some cases shear failure dominates the fracture behavior [Falls et al., 1992; Ishida et al., 2004].

In this work we develop a more accurate pore-scale hydro-mechanical coupled model, where the solid deformation and fracture behavior are simulated by discrete element method (DEM) and the fluid flow is solved directly by lattice Boltzmann method (LBM) at pore scale. To validate current hydro-mechanical coupled model, sphere sedimentation in Newtonian fluid is simulated, and the results agree well with that reported in literature. Then hydro-fracturing is simulated, attempting to answer the inconsistency between continuum-based model predictions and experiment observation. Simulation results show that strength heterogeneity of rock has a significant influence on hydraulic fracture geometry and the involved failure mechanism. In unconventional reservoir, rock strength heterogeneity is high, which leads to the complex fracture geometry and abundant shear failure events, but it is often ignored in continuum-based models. The origin of this strength heterogeneity arises from ubiquitous natural fractures in unconventional reservoir, which are sealed with different minerals. Thus, hydraulic fracture interaction with cemented natural fracture is simulated, which shows that strength contrast between cemented natural fracture and host rock plays an important role in hydraulic fracture propagation.

References

Al-Busaidi, A., J. Hazzard, and R. Young (2005), Distinct element modeling of hydraulically fractured Lac du Bonnet granite, Journal of Geophysical Research: Solid Earth, 110(B6), B06302.
Falls, S., R. Young, S. Carlson, and T. Chow (1992), Ultrasonic tomography and acoustic emission in hydraulically fractured Lac du Bonnet grey granite, Journal of Geophysical Research: Solid Earth, 97(B5), 6867-6884.
Ishida, T., Q. Chen, Y. Mizuta, and J.-C. Roegiers (2004), Influence of fluid viscosity on the hydraulic fracturing mechanism, Journal of energy resources technology, 126(3), 190-200.
Wang, T., W. Zhou, J. Chen, X. Xia, Y. Li, and X. Zhao (2014), Simulation of hydraulic fracturing using particle flow method and application in a coal mine, International Journal of Coal Geology, 121, 1-13.

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