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# Influence of pre-existing fracture and viscosity of injected fluid on effective hydraulic fracturing

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Hydraulic fracturing has been applied for enhanced recovery of hydrocarbon reservoirs and enhanced geothermal systems. In this technique, rock mass is fractured by applying fluid pressure on borehole wall. For the estimation of the propagation of hydraulically induced fractures, the strike of pre-existing fractures and the viscosity of injected fluid should be taken into consideration. Although theoretical solution shows that hydraulically induced fracture propagates in the direction of maximum principle stress in a homogeneous medium, the propagation direction in real field does not always correspond to the expected direction from the regional stress due to pre-existing fractures. The viscosity of injected fluid also influences the behavior of hydraulic fractures. The injection of high viscous fluid could improve the permeability of rock and enhance the effectiveness of the hydraulic fracturing. In order to examine the influence of pre-existing fractures and of injected fluid viscosity on the propagation of hydraulic fractures, we performed a series of numerical simulations for hydraulic fracturing in naturally fractured rock by using a 2D flow-coupled discrete element method. In our simulations, fluid pressure is applied to a borehole wall, and hydraulically induced fracture would intersect with an inclined pre-existing fracture adjacent to the borehole. We perform simulations with three different strike angles of the pre-existing fracture, using two different viscosity of fluid. As a result, hydraulic fracture propagates beyond the pre-existing fracture when high viscous fluid is injected, while it is trapped by the pre-existing fracture in the low viscous fluid injection. This is caused by the strong fluid pressure on the borehole wall and the surface of the pre-existing fracture in the high viscosity case. The results also show that the higher the intersection angle of hydraulic fracture and pre-existing fracture is, the more hydraulic fracture propagation is retarded. We conclude that high viscous fluid could be recommended for effective hydraulic fracturing when the hydraulic fracture has high intersection angle to pre-existing fracture.

Keywords: Hydraulic Fracturing, Discrete Element Method, Viscosity, Pre-existing Fracture