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Lattice Numerical Simulations of Hydraulic Fracture and Natural Interface Interaction

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Extended Abstract: Hydraulic fracturing is the main technology for enhancing production from unconventional oil and gas reservoirs. One of the challenges that has been the subject of many previous studies is the interaction of hydraulic fracturing when intersects with a natural interfaces. Crossing, arresting and opening are the known interaction mechanisms. Formation properties, state of in-situ stresses, stress anisotropy, strength properties of the interface, angle of approach and injecting fluid properties are some factors influence interaction mechanism. In this study, lattice modelling was used for lab scale numerical simulation of hydraulic fracturing. The scaling laws were also used to increase the sample size, rate of fluid injection and reducing its viscosity, in order to reduce the simulation time. The simulations were performed in the viscosity dominated propagation regime as occurred in the lab and the interaction mechanism for the natural interfaces with different angle of approaches (90°, 60° and 30°) and different filling materials (very weak to strong glues) were investigated respectively. In general, the results of lattice simulations were in good agreement with the lab results and showed that the larger angle of approaches and stronger glues would promote the probability of crossing mode.

Keywords: Hydraulic Fracturing, Interaction, Natural Interfaces, Numerical Simulation, Lattice.

Summary: lattice modelling was used to simulate the interaction mechanism of lab experiments which carried out on mortar samples with different angle of approaches and filled with different type of glues.

Introduction: Hydraulic fracturing is the main enhanced oil recovery (EOR) technique used in unconventional reservoirs, including shale gas and shale oil. Due to the low permeability of such formations, application of hydraulic fracturing to generate networks of induced fractures within the hydrocarbon bearing rock is necessary. In this paper we employ the lattice approach, which is a computationally efficient version of the particle-based model, to study the fracture interaction mechanism.

Methodology and Approaches: Lattice, a newly introduced method by Itasca was used in this study. The scaling law was applied to simulate the lab scale experiments in a viscosity dominated fracture propagation regime and the results was compared to lab results.

Results and Conclusions: The results demonstrated the advantages of lattice simulation to study the impact of each parameter on the interaction model. Larger angle of approaches and stronger glues showed to promote the crossing mode.

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