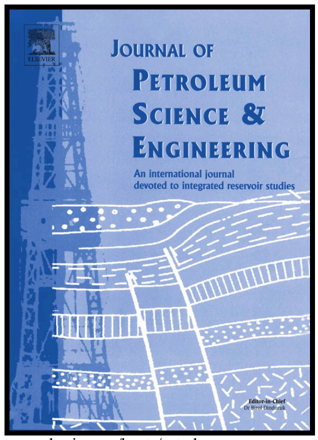

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Dynamic Conductivity of Proppant-Filled Fractures

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Abstract

A common challenge in matching the production from hydraulically fractured wells is related to changes in conductivity of propped fractures due to changes in the stress configuration. In this paper, we investigate the dynamic nature of fracture conductivity, by evaluating the permeability and width of a propped fracture segment at variable differential stress conditions. We combine the Discrete Element Method (DEM) and the Lattice Boltzmann Model (LBM) to simulate the evolution of a fracture segment filled with proppant and to evaluate the related fracture conductivity at various stress states. An ensemble of spherical proppant particles is generated and compacted under a specified confining stress via DEM to generate an initial propped fracture segment. A representative elementary volume (REV) of the proppant pack is then extracted from the DEM representation and used for fluid flow simulations. LBM is used to calculate the detailed single-phase flow field, at the pore-scale, and allows for calculation of permeability. In-situ conditions are then simulated by applying confining and differential stress on the REV via DEM. The differential stress is gradually increased on the REV, to simulate a reduction in the pore pressure due to production, until the formation of shear band(s) is observed and fracture failure begins. Permeability of the proppant pack, from LBM simulations, combined with the fracture aperture, from DEM simulations at different differential stress levels, allow us to determine the dynamic conductivity of the propped fracture segment. From a range of proppant-size distributions, we demonstrate that a well-graded proppant pack outperforms a poorly graded pack in maintaining the fracture conductivity over a broader range of differential stress conditions. Furthermore, we demonstrate that a well-graded proppant pack keeps the fracture segment open over a larger range of differential stress states.

Keywords: hydraulic fractures, conductivity, proppant, differential stress, Lattice Boltzmann Model, Discrete Element Method.

Nomenclature

k_f Reservoir rock permeability, D