Simulation of a refracture treatment in tight formations

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Abstract

Reservoir access is improved through refracture treatments in unconventional hydrocarbon reservoirs. In a low gas price condition, re-fracturing can potentially offer a low cost replacement to drilling new wells. Hydraulic fracturing being rapidly developed has changed the energy industry throughout the world. However, a lack of control over the direction and number of propagating fractures is one of its disadvantages. In fact, some of the initial perforations remain inactive during the process of hydraulic fracturing. Applying high rate loadings in dynamic stimulation techniques such as the propellant method, results in multiple fracture patterns desired for enhancing permeability. This is a useful approach to connect a pre-exiting fracture network to a welbore but it is not effective for a zone far from the wellbore. A combination of these two approaches with a rest time will be a promising treatment to enhance the well productivity. By utilizing dynamic approach in the first step, several active branches connected to the wellbore are created and then after a rest time, the hydraulic fracturing method is applied. The main advantage of propellant fracturing is to create multiple cracks and consequently prepare the well for an effective hydraulic fracturing with potentially much lower cost as a re-fracturing solution.

A mesh adaptive discontinuous Galerkin method is used to model solution-dependent crack propagation in rocks. Two main components of the computational fracture model are a regularization of hydraulic pressure based on aperture and an interfacial damage model for transitioning between various contact separation models. The regularization model applies a fraction of hydraulic pressure based on the maximum aperture of all hydraulically connected fractures to a given crack segment; if the latter reaches a certain threshold hydraulic pressure is fully exerted on the crack surface and if smaller only a fraction of the pressure is applied. The interfacial damage model can accurately represent all contact modes (i.e., separation, contact-stick, and contact-slip) as well as smooth transition between them. Given the existence of several instances of contact mode transitions in refracturing simulations, the dynamic consistency of contact/separation solutions and the regularization of both pressure and fracture models are essential in their successful modeling.

KEY WORKS: hydraulic fracture, refracture treatment, contact-mode transition, contact regularization, damage model.