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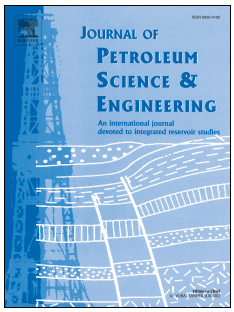

Semi-analytical simulation of transient flow behavior for complex fracture network with stress-sensitive conductivity

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Semi-analytical simulation of transient flow behavior for complex fracture network with stress-sensitive conductivity

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Abstract: The main object of this paper is to establish a benchmark model to investigate the transient flow behavior for complex fracture network with stress-sensitive conductivity. An associated semi-analytical solution is proposed by coupling reservoir-fracture flow model and incorporating stress sensitivity of fracture conductivity into coupled model, with sufficient flexibility to account for complex fracture geometry and stress sensitivity. A dimension transformation with multiple source terms is fully developed and extended to the case of complex fracture network, which renders the resulting nonlinear equations fully amenable to the linear treatment. An accurate, closed form iterative algorithm is subsequently provided and verified against numerical reservoir simulator. A set of synthetic simulations is utilized to investigate the physics of transient flow behavior and capture the interaction between fracture-production interference and conductivity decay by performing pressure transient analysis. The results show that the pressure response transitions from the initial condition (constant initial-conductivity) to the limited condition (constant minimum-conductivity) because of the loss of stress-sensitive conductivity, displaying a gradual increasing in the pressure drop. The magnitude of extra pressure drop is dependent on the complexity nature and conductivity decay of fracture network. In the condition of high flow resistance (i.e. low initial conductivity, small area connected to the reservoir), it is of great significance to take the effect of stress sensitivity into account to obtain correct simulation of transient pressure response. The findings in this paper could improve the understanding of flow mechanisms and facilitate the analysis of transient pressure/rate data for complex fracture network with stress-sensitive conductivity.

Key words: Fracture-fracture intersection, stress-sensitive conductivity, dimension transformation, transient pressure response

1. Introduction

The key of achieving effective horizontal well stimulation and economic production of unconventional resources is maximizing the reservoir area by creating large made-fracture network with sufficient conductivity (Warpinski et al., 2008; Warpinski, 2009). The transient behavior of complex fracture network is essentially different from that of traditional planar fractures due to the complexity of fracture geometry and geomechanics effect. The geomechanics of hydraulically fracture filled by proppants is more pronounced during fluid withdrawal due to proppant embedment and crushing (Rosen et al., 2014; Busetti et al., 2017). The productivity would be generally degraded, which makes data analyzed by using conventional analysis method (uncorrected for geomechanics) subject to the characterization of boundary-dominated flow. Although many attempts were made to eliminate the considerable error of conventional analysis method in terms of identifying flow regimes, it is still challenging to achieve the exact information by facilitating transient response analysis from such complex fracture geometry.

Because of the complexity and cost of coupled flow-geomechanics model (Wilson, 2015, 2017),