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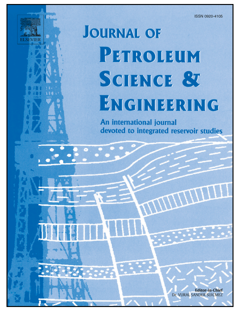

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An Enhanced Discrete Fracture Network Model for Multiphase Flow in Fractured Reservoirs

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Abstract

We present an **E**nhanced **D**iscrete **F**racture **N**etwork (**EDFN**) model for multiphase flow simulation in fractured reservoirs. EDFN can efficiently represent complex fractured porous media and accurately simulate fluid exchange between matrix and fracture. By using EDFN the fracture network is discretized with minimum number of grids based on the fracture intersecting points and fracture extremities. The matrix is also optimally decomposed into coarse blocks with different geometries using a rapid image processing algorithm. Each coarse matrix block is designed to be associated with one fracture grid and then discretized logarithmically to handle 1D flow between matrix and fracture. EDFN can greatly optimize the discretization for fractured porous media to conform interconnected fractures of arbitrary orientations. Via unstructured format, EDFN is successfully linked with an in-house unstructured compositional simulator. We validate the accuracy of EDFN through a number of multiphase flow simulations in fractured porous media with/without considering capillary pressure. Its efficiency is demonstrated to be superior by using a much less grid blocks comparing with other approaches. Ultimately EDFN is applied to predict hydrocarbon production in a shale oil reservoir and it enables to capture multi-scale fluid transfer in such complex system.

Keyword: Multiphase Flow; Fractured Reservoirs; Reservoir Modeling; EDFN

1. Introduction

Fractured reservoirs are commonly found all over the world, bearing essential natural resources such as groundwater and hydrocarbon (Gurpinar and Kossack, 2000; Saller et al., 2013). However, modeling and simulating multiphase flow through fractured porous media is of great challenges, such as how to efficiently model the detailed complex fracture networks and how to accurately simulate the multiphase matrix-fracture fluid exchange(Basquet et al., 2005; Sarda et al., 2001) . Fractures are often randomly distributed because of their geotectonic origins and could be disconnected or connected forming a global network or clusters of separated networks. Research in this area has been advanced significantly in the past several decades. The Dual-Porosity Model (DPM) was originally proposed by Barenblatt et al. (Barenblatt et al., 1960) and introduced to the petroleum industry for fractured hydrocarbon reservoir simulation by Warren and Root (Warren and Root, 1963). Since then, many variants of DPM have been developed to simulate the complex flow dynamics in fractured reservoirs, including Dual-Porosity Dual-Permeability (DPDP) model (Gilman, 1986; Gilman and Kazemi, 1988), Multiple Interacting Continua (MINC) model(Pruess and Narasimhan, 1985) , Subdomain model (Fung, 1991; Gilman, 1986), Triple Porosity Dual-Permeability (TPDP) model (Sun et al., 2015) and Multi-Porosity Model (Yan et al., 2016). The family of multi-continuum approaches are efficient and suitable when the fracture network is dense with global effect. Their main limitations include the facts that the simplified transfer function for fluid