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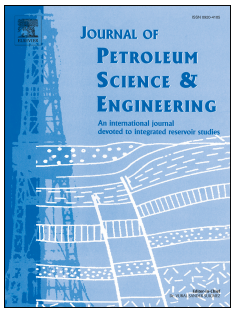

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An Innovative Approach to Relative Permeability Estimation of Naturally Fractured Carbonate Rocks

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Abstract

This paper presents an innovative numerical procedure for flow simulation and estimation of relative permeability of naturally fractured carbonate rocks by history matching laboratory derived multi-phase production data. The multi-phase flow simulator accounts for flow in discrete fractures with variable asperities. These discrete fractures are characterised by the fracture surface topography which is imaged with the use of surface laser scanning and micro computed tomography (μ-CT). Next, the production data for naturally fractured carbonate samples (matrix and fracture permeability), samples with no fracture (matrix permeability only) and samples with fracture only (near zero matrix permeability) for unsteady state conditions are obtained. Forward simulation performed by coupling both the matrix and fracture relative permeability to estimate production for a porous fractured system. This is validated by comparing to the laboratory obtained production data. This has allowed us to validate the proposed numerical procedure and subsequently history match the experimental production data for the porous fractured system to obtain overall porous fractured relative permeability curves. Results of this study show that there exists a strong discontinuity of phase saturation. It was also observed that Corey's parameters are best suited for history matching of the production data through porous matrix, and cubic parameters are best suited for fracture.

Keywords: Fracture roughness, Discrete fracture flow, Multiphase flow, Relative permeability, Capillary pressure

1. Introduction

The presence of fractures plays a significant role in the transport of fluids in petroleum and geothermal reservoirs as well as waste management due to the considerable amount of hydrocarbons and the possibility of leakage respectively. Central to flow simulation, relative permeability is an important parameter for estimating saturation profile of different phases and holds key to evaluating the production potential of a reservoir and its ultimate recovery. Relative permeability is yet considered one of the most uncertain parameters in multiphase fluid flow simulation, in particular in fractured reservoirs (Kazemi, 1969, Kazemi et al., 1976, Kazemi et al., 1992, Diomampo, 2001, Shad and Gates, 2010). Typically, most naturally fractured reservoirs have petrophysical properties varying between matrix and

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