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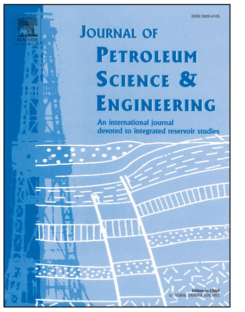

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Generalized Analytical Solution for Gravity Drainage Phenomena in Finite Matrix Block with Arbitrary Time Dependent Inlet Boundary Condition and Variable Matrix Block Size

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Abstract

Fractured carbonate reservoirs constitute a considerable proportion of hydrocarbon reservoirs in the world. In these reservoirs, gravity drainage is one of the dominating oil producing mechanisms that controls oil production depending on the interactions between the upper and lower blocks. Nonetheless, few theoretical studies have investigated the modelling of the reinfiltration process between the blocks.

In this study, first, the gravity drainage process is modelled for a 1-D single matrix block by considering gravity and capillary forces, then Laplace transformation is used to solve the governing partial differential equation related to a matrix block with appropriate initial and boundary conditions. Next, the obtained equations are extended to a stack of matrix blocks and the effect of the reinfiltration process is investigated afterward. The inlet oil flow rate from the upper boundary of the blocks is a function of time, and the lower boundary of the blocks is fully saturated with oil. At the initial condition, the matrix block is saturated with oil. Finally, based on the aforementioned saturation equations, oil production rate, cumulative production, gravity drainage mechanism and the effect of the reinfiltration process are studied. The presented analytical solution is compared with previous semi-analytical solutions (Firoozabadi and Ishimoto, 1994), finite difference and finite element numerical techniques.

Traditional gravity drainage models do not consider the effect of matrix block size distribution on oil recovery. In this study, a gravity drainage model is proposed to evaluate the oil recovery