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Numerical Modelling of Immiscible Fluids Flow in Oil Reservoir Rocks during Enhanced Oil Recovery Processes

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Abstract : Ensuring the maximum recovery rate of oil from reservoir rocks is a challenging task that requires preliminary numerical analysis of different techniques used to enhance the recovery process. After conventional oil recovery processes and in order to retrieve oil left behind after the primary recovery phase, water flooding in one of several techniques used for enhanced oil recovery (EOR). In this research work, EOR via water flooding is numerically modeled, and hydrodynamic instabilities resulted from immiscible oil-water flow in reservoir rocks are investigated. An oil reservoir is a porous medium consisted of many fractures of tiny dimensions. For modeling purposes, the oil reservoir is considered as a collection of capillary tubes which provides useful insights into how fluids behave in the reservoir pore spaces. Equations governing oil-water flow in oil reservoir rocks are developed and numerically solved following a finite element scheme. Numerical results are obtained using Comsol Multiphysics software. The two phase Darcy module of COMSOL Multiphysics allows modelling the imbibition process by the injection of water (as wetting phase) into an oil reservoir. Van Genuchten, Brooks Corey and Levrett models were considered as retention models and obtained flow configurations are compared, and the governing parameters are discussed. For the considered retention models it was found that onset of instabilities viz. fingering phenomenon is highly dependent on the capillary pressure as well as the boundary conditions, i.e., the inlet pressure and the injection velocity.

Keywords : capillary pressure, EOR process, immiscible flow, numerical modelling
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