Modeling of Non-Equilibrium Effects in the Gravity Driven Countercurrent Imbibition

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Abstract

One of the main mechanisms in the secondary oil migration from the source rock into oil traps is gravity driven countercurrent imbibition. Many mathematical models describe countercurrent imbibition considering local equilibrium. However, Barenblatt proposed a model to describe the effect of non-equilibrium in oil water displacement. Here, the proposed model was implemented in a gravity driven countercurrent imbibition process. Firstly Darcy's equation was written for vertical displacement of the oil phase and the water phase. In addition, using the mass conservation it is possible to formulate Barenblatt's model for two phase countercurrent gravity driven process. This model is possible to simulate countercurrent displacement in a core initially saturated with the oil phase and the water phase. The initial condition satisfies gravity - capillary equilibrium in a tube of 1 m length. Moreover, we assume no flow boundary in both ends. After establishing initial and boundary conditions, initial distribution of local effective saturation was calculated from the stationary model using COMSOL Multiphysics. This stationary solution was obtained as initial condition for the time dependent model. Simulations were carried out using the situation that tube was turned 180 degree vertically. The result shows the saturation profile as a function of time and again a stationary gravity - capillary equilibrium was obtained. However, the solution is not the exact mirror of the initial profile. This is attributed to this fact that a final equilibrium profile is only obtained after a very long time.

Reference

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Figures used in the abstract

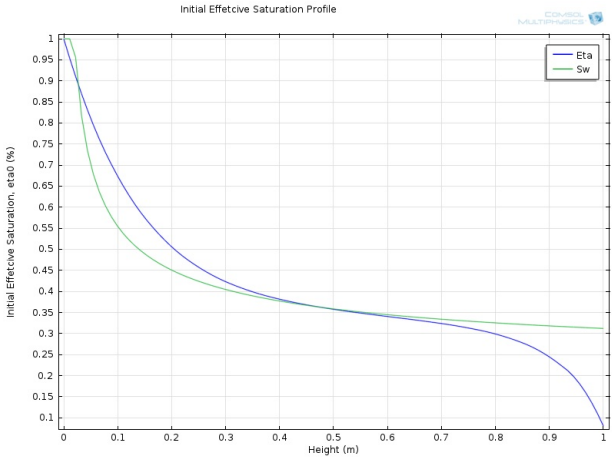

Figure 1: Initial distribution of local effective saturation (Eta) and water saturation (Sw).

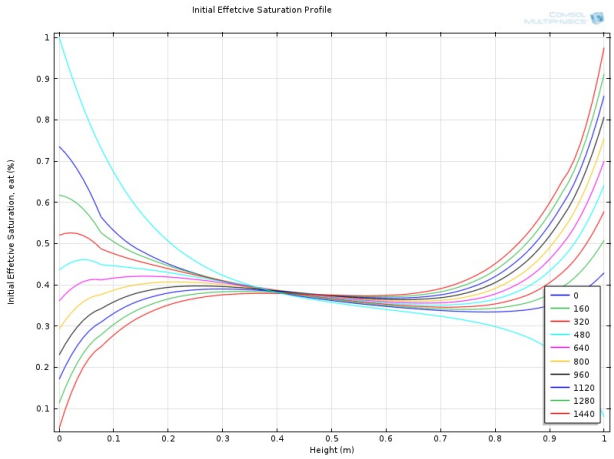

Figure 2: Final Distribution of local effective saturation (Eta).