Paper Number 56477
Title A New Three-Phase Relative Permeability Model For Various Wettability Conditions
Authors J-C. Moulu, O. Vizika, P. Egermann and F. Kalaydjian , Institut Français du Pétrole

Source SPE Annual Technical Conference and Exhibition, 3-6 October, Houston, Texas

Abstract

A mathematical model for three- phase flow has been previously developed and validated in water- wet and spreading conditions. The model was based on a description of the porous medium considered as a set of fractal pores. The fluids are allowed to flow together in a same pore, gas in the center, and, for water- wet conditions, water in the vicinity of the walls and oil as an intermediate phase.

The objective of the present study is to confirm that the above model is able, when properly applied, to describe more general wetting conditions. Three- phase relative permeabilities are obtained by history matching gas injection experiments performed in water- wet and oil- wet porous media. Two fluid systems characterized by spreading and non- spreading of oil on water in presence of gas were used. The model is properly modified to take into account different wetting conditions through a wettability index.

It is shown that the model is able to correctly predict oil recovery and breakthrough time for a series of gas injection tests performed under secondary and tertiary conditions.

In water- wet condition, the presence of water next to the solid wall determines the shape of the pore space available for the oil and gas flow. It is observed that the fractal linear dimension decreases, with increasing water saturation, from the dimension of the roughness (DL = 1.72) to the one of a cylindrical pore (DL"1). In oil- wet condition, water looses its ability to model the wall of the medium since oil is preferentially in contact with the solid surface. This leads to a constant DL, the value of which corresponds to the surface roughness. In this last case the presence of water in the center of the pores decreases the gas mobility.