SPE 89880: **Streamline Simulation of Countercurrent Water-Oil and Gas-Oil Flow in Naturally Fractured Dual-Porosity Reservoirs.**

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Presented at the SPE Annual Technical Conference and Exhibition in Houston, TX, 26-29 September 2004.

**Abstract:** The flow of hydrocarbons in naturally fractured reservoirs is a very complex process involving the interaction of reservoir fluids with two distinct porous media. Accurate simulation of the physics of flow and fast execution of the resulting complex numerical code is fundamental in developing a viable tool for reservoir development and management. This paper addresses this issue by developing and evaluating a basic 3-D streamline reservoir simulator for counter-current water-oil flow in naturally fractured dual-porosity reservoirs. The concept is readily extended to counter-current gas-oil gravity drainage in such reservoirs.

In the water-oil case, the counter-current flow of water and oil between the fracture and matrix media is generally attributed to water imbibition process. However, in oil-wet or mixed-wet rocks, the water imbibition could be non-existent, small, or strongly saturation-dependent. In these cases, given the right conditions, gravity potential can enhance oil drainage. These physical concepts are included in the simulator.

In the gas-oil case, the capillary forces generally resist the gravity potential; thus, preventing counter-current flow of oil and gas. With proper placement of gas-oil contact in the fractures, the gravity potential can overcome the capillary resistance to invoke gas-oil gravity drainage. We will demonstrate how such a formulation can be included a dual-porosity streamline simulator.

In the simulator, we apply an incompressible flow assumption to the fracture network in order to solve the 3-D water-oil displacement problem using a set of 1-D streamlines. Simple, but realistic, transfer functions, handle the matrix-fracture counter-current flow. These transfer functions depend on fracture-matrix relative permeability and capillary pressure functions, as well as the local gravity potential. A simpler, but perhaps more realistic, form of the transfer function is determined experimentally as a scaleable fractional oil recovery curve versus an appropriate dimensionless time. The transfer functions include other conventional reservoir properties such as permeability, porosity, and shape factor.

The simulator was used to model several water-oil displacement test cases and the results were compared with Eclipse 100 dual-porosity model results. The comparisons were favorable and the differences in results were consistent with the difference in the simulation approach.

We believe the streamline simulation of dual-porosity reservoirs could become an important tool for evaluating and managing fractured dual-porosity reservoirs. Because of the efficiency of the formulation, larger, more realistic geologic models can be modeled as compared to conventional simulators. For instance, simulating the frontal advance of the gas-oil contact in fractures, to invoke gravity drainage without gas breakthrough, can be accurately and efficiently handled using the formulation described here. Similarly, the breakthrough of water in fracture channels can be accurately simulated for very complex geologic models.