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Numerical implementation and detailing of the Standard Black-Oil model used by IMEX

Victor Antonio Paludetto Magri*, Mauricio Pereira Tada†, Leonardo Karpinski+
Clovis Raimundo Maliska

*SINMEC-EMC/UFSC
Florianopolis – SC, Brazil
victorapm@sinmec.ufsc.br

+SINMEC-EMC/UFSC
Florianopolis – SC, Brazil
leonardo@sinmec.ufsc.br

†SINMEC-EMC/UFSC
Florianopolis – SC, Brazil
mauriciotada@sinmec.ufsc.br

SINMEC-EMC/UFSC
Florianopolis – SC, Brazil
maliska@sinmec.ufsc.br

ABSTRACT

Petroleum Reservoir simulation is a CFD application highly explored in the oil and gas industry, aiming to solve the governing equations and then estimate parameters such as the economic value, the production volume of each phase and the lifetime of a particular oil reserve. There are many commercials software developed for this purpose. Among then, it can be mentioned Eclipse, a Schulumberger's company product, and IMEX, a simulator built by CMG – Computer Modelling Group Ltd.

This study presents in detail the procedure for obtaining the numerical solution in IMEX for a specific problem of reservoir simulation. Thus, it is proposed a real reservoir problem containing an oil layer with dissolved gas and a free gas layer, both with connate water. Difference in pressure between phases water/oil and gas/oil are taken into account through the concept of capillary pressure. In this problem, the medium is considered homogeneous and anisotropic.

The Standard Black-Oil is the mathematical model employed to represent the fluid flow of phases water, oil and gas. The governing equations are presented in the differential form according to the mass fraction formulation and also in the discrete form by the traditional finite control volume method [5]. In this model is considered that the gas component can be dissolved in the oil phase and/or being present as a free gas phase, while water and oil components are only present in their respective liquid phases.

It is presented with a greater level of detail the numerical method employed to solve the mentioned equations and, based on what is contained in the IMEX simulator manual [3], the model of relative permeability, capillary pressure and solubility as well. The injector and producer wells are modeled by Peaceman's model [1] with pressure prescribed conditions. The equations and models discussed are implemented and solved computationally using a C++ code. The same problem is then solved in IMEX simulator for comparisons. In this process it is compared the initialization of the reservoir with the presence of transition zones between the fluids, the water cut and production rate curves for each producer well.

The solutions show that the equations which have been implemented in the "in-house" simulator lead to similar results compared to those obtained by the commercial software IMEX. One of the results is illustrated in Figure 1, showing the water cut curve for a producer well. Therefore, this work can satisfactorily address the models used by IMEX for the solution of this particular simulation case.

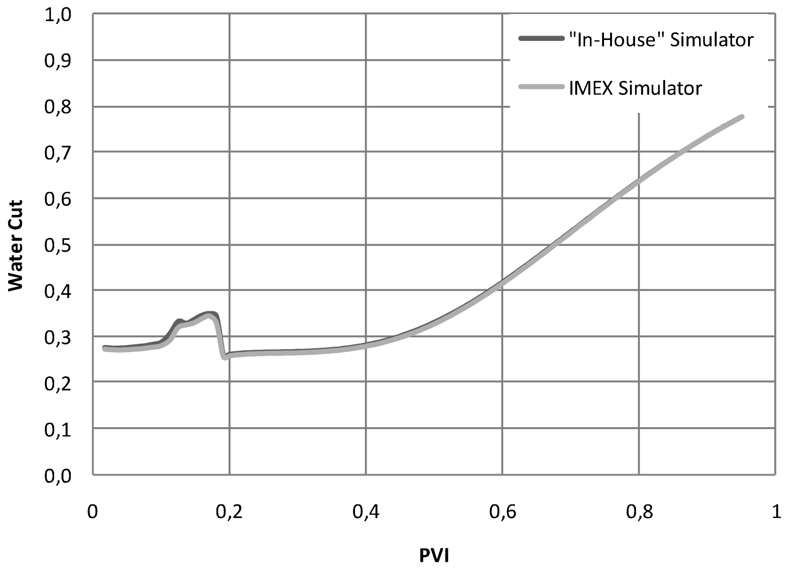

Figure 1. Water cut: comparison between "in-house" and IMEX simulator.

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