Numerical simulation of in-situ combustion in experimental tubes with homogeneous and fractured systems

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In-situ combustion is a thermal recovery method used mainly for heavy oil recovery in homogeneous reservoirs. In this process air is injected to the reservoir in order to achieve ignition and to maintain the combustion front while pushing the heated oil toward producing wells. Nowadays the application of in-situ combustion in fractured reservoirs is being studied. Then it is necessary develop experimental work and its numerical simulation in combustion tubes.

This work was conducted to study the development of in-situ combustion process in homogeneous and fractured systems (in-situ combustion tube) using the commercial reservoir simulator named Stars. A one dimensional, three phase simulation model, with six components (water, heavy and light oils, coke, O_2, and inert gas) involving a cracking reaction and three oxidation reactions, was performed.

In a first stage, a conventional homogeneous simulation model was performed based on the experimental work from Kumar (1987). The temperature and oil recovery predictions had a good fitting against experimental data. In a second stage, the last simulation was modified in order to incorporate fractures in the homogeneous system. Fractures were defined as areas of higher permeability and porosity than the matrix ones. The predictions presented good fitting with the simulation from Tabasinejad et al. (2006). In a third stage, the last simulation model was modified to reproduce the experimental work from Greaves et al. (1991), where a fracture (1 to 2 mm width) was formed by a heavy oil-water saturated core and the tube wall.

It was found that to simulate appropriately the in-situ combustion process in fractured media, is necessary use a fine block mesh due to the cracking reaction takes place in a narrow zone. The results showed that the combustion in the matrix seems to be possible mainly due to oxygen diffusion from the fracture. It was also found that the combustion front in fractured systems moves fast as air flow rate is larger, but it is necessary to restrict the air flow rate to avoid the oxygen breakthrough. On the other hand, the oil expulsion from the matrix to the fracture was affected mainly by the fluids thermal expansion than the rock one.

<u>The session where the abstract should be considered</u>: Mathematical and numerical modeling of enhanced oil recovery

<u>We prefer oral presentation</u>.