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A New Approach of Micromodels Construction based on X-ray micro-computed tomography (µCT) from Core Plug

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Abstract

The application of micromodels in oil and gas industry has been increased in the past ten years particularly in investigation and visualization of EOR flooding processes. Alongside with its advanced technology and advantages, the comparison of displacement processes during flooding experiments between micromodel and conventional porous media such as core plugs and sandpacks is challenging. In this work, we have developed an applicable workflow to construct the structure of micromodels that resemble major properties of the core plug based on X-ray micro-computed tomography (µCT). The main goal of this work is to transfer the rock properties and morphological features such as porosity, permeability, pore and grain size distribution from a core plug into a 2D micromodel chip.

The construction of micromodels started with optimization of µCT images, establishing flow connections and the application of flooding flow approach. The optimization of µCT images was performed by using Matlab® image processing tools to convert the µCT images stack from the core plug to a 2D image. Subsequently, we established a pore network (flow path connections) based on grain density distribution to connect all the pores in a 2D image structure, which is termed as “Rock on the Chip”. During these processes, we performed a pore-scale simulation to calculate the porosity, permeability, pore and grain size distribution of the micromodel. The results of these calculations were used as matching parameters between core plug and micromodel. As a final step, we introduced a flow flooding approach into a micromodel including the design of inlet/outlet and artificial channels. In order to facilitate the experiments at high pressure and high temperature condition, we are using a Quartz Capillary as connections system. Additionally, to produce a linear shock front of injected fluid when entering the micromodel system we design artificial channels around the inlet and outlet of micromodel.

The results of this work show that the micromodels can be constructed based on X-ray micro-computed tomography (µCT) from core plug while considering the rock properties and morphological features. The proposed approach can be useful for improving the fundamental understanding of the displacement process during EOR flooding process particularly visualization of the microscale process or interaction of multi-phase environments (i.e. rock, oil, aqueous solution).