Pore scale visualization of Improved Sweep Efficiency During Fines Assisted Low-salinity Waterflooding Using Micro-CT Imaging

Yamin Wang*, Muhan* Yu*, Furqan* Hussain

Abstract.

Objective:

A number of studies suggest improved sweep efficiency as an enhanced oil recovery mechanism during low-salinity waterflooding (LSW). Fines migration during LSW can lead to partial blockage of pore space which diverts the injected water into unswept pores resulting in a better sweep of oil. However, there is no direct evidence of improved sweep efficiency due to fines migration. In this study, we use micro-CT imaging to visualize the changes in residual oil saturation before and after tertiary LSW.

Methodology:

Experiments were conducted on a Berea sandstone core sample. X-Ray Powder Diffraction (XRD) and X-Ray Fluorescence (XRF) were run to characterize Berea sandstone before the experiment. Scanning Electron Microscopy and Energy Dispersive X-ray Spectroscopy (SEM-EDS) analysis were run to observe changes of minerals before and after the experiment. The core sample received injection first of systematic oil, then of brine (40g/L NaCl), and finally of low-salinity water. Micro-CT images of the core sample were taken at 5 stages: (1) dry core before the experiment, (2) after synthetic oil injection, (3) after brine injection, (4) after distilled water injection and (5) dry core after the experiment. The pressure difference between the core's injection face and production face was recorded during the injection. Samples of produced water were used for ionic chromatography to measure the concentration of produced fines.

Results:

The experimental results show an extra 5% oil recovery and an order of magnitude drop in permeability after distilled waterflooding. Micro-CT images show additional swept pores after LSW.

Novelty:

The images of Micro-CT provide direct evidence of how fines assisted low salinity water flooding improves the sweep efficiency.