TU Delft

SNF FLOERGER

The Polymer Research Platform

MSc Thesis Proposal

Microfluidics for polymer-assisted water alternating gas (CO_2) injection

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Motivation

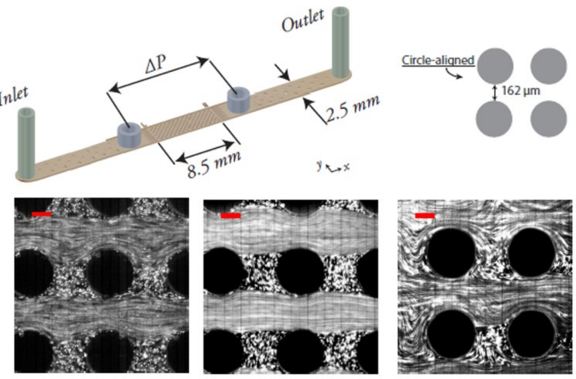
CO_2 flow in porous media is vital for both enhanced oil recovery and underground carbon storage. Often it has rather a low efficiency due to poor reservoir sweep efficiency as a result of viscous fingering, channelling through high permeability streaks and gravity override. Water Alternating Gas (WAG) has been applied successfully to counteract those side effects and thus improved reservoir sweet efficiency. The effectiveness of WAG diminishes however for thicker reservoirs and long inter-well distances and, therefore, requires further improvement for the water and CO_2 slugs.

Background

Polymer-assisted WAG (PA-WAG), where mobility control of the aqueous phase is achieved by dissolving a high molecular polymer (e.g. HPAM), has become an appealing alternative to WAG. However, much less attention has been devoted to PA-WAG in the literature and several questions remain about the feasibility of this complex process. Which flow regimes/patterns can we expect during the polymer solution and gas injection cycles in microfluidics? Will the corresponding displacement patterns result in delayed water or gas production, leading respectively to lower water cut and better gas utilization? In the case of gas with high water-solubility will the dissolved gas impact polymer slug behaviour, e.g. loss of viscosity, precipitation, etc.?

Proposed research

This thesis will investigate the feasibility of PA-WAG and the behaviour of the system in microfluidics. The polymers will be characterized by physical-chemical and rheological methods to quantify the parameters needed for describing polymer flow in microfluidics. Thus, the objective of this study is to investigate the processes that are responsible for the oil mobilization during PA-WAG injection at pore-scale. This will be done by conducting well controlled microfluidic experiments. Therefore, flow experiments in micro-fluidic device will investigate the displacement mechanisms of materials in narrow pores (10 to 100 micron) in support of CT-assisted core-flood experiment (i.e. medical CT-scanner resolution 200 micron).



Example of experiments performed in microfluidics

This study will be done in cooperation with Shell, DPI, and SNF. The tasks of the student in this research are as follows:

1. Literature review on WAG, polymers, and CO_2 hereof in the context of EOR
2. Characterize the polymer-based system in bulk phase by:
    a. Conduct rheological studies
    b. Microscopic analysis
3. Perform microfluidics experiment for selected systems with and without oil
4. Correlate microfluidic results with ongoing CT-assisted core-flood experiments

References

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