# Evaluation of Chemical EOR Performance: The Critical Role of Rock Properties and Fluid-Rock Interactions

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## Summary

Chemical enhanced oil recovery (EOR) is considered an effective technique to increase oil production in unconventional tight reservoirs. It increases the oil production by decreasing the oil-water interfacial tension (Tian et al. 2022) and by altering the reservoir wettability (Pan et al. 2022) towards water-wet. However, majority of the lab-based experimental work has focused on characterizing EOR chemicals and evaluating their performance using generic rocks (e.g. Berea sandstone). Very little attention has been given to investigate the impact of rock properties on surfactant performance.

In this study, performance of selected chemicals is evaluated with a focus on fluid-rock interactions and impact of rock properties on hydrocarbon recovery. An integrated suite of laboratory techniques are utilized to characterize the influence of critical rock properties along with the ability of chemicals to alter wettability during chemical EOR process. Cryo-SEM imaging and experimental results indicate that specific chemicals (Chem.1 and Chem.4) altered the rock wettability towards water wet, resulting in higher oil recovery compared to the other chemicals. The experimental results also suggest that critical rock properties such as rock fabric, mineralogy, permeability, pore sizes distribution and organic content play an important role in chemical EOR operations.

## Method / Workflow

Spontaneous imbibition tests were conducted in duplicate using core plugs from two depth intervals (Interval A and Interval B) of a well targeting low-permeability siltstone reservoir in the Western Canadian Sedimentary Basin (WCSB). The core plugs were drilled perpendicular to bedding and epoxy sealed from both ends, allowing only radial flow to mimic natural reservoir condition. A diverse experimental workflow was implemented to characterize the petrophysical, compositional, and petrographic properties of the samples. These core plugs were then saturated with reservoir oil, followed by chemical EOR. Lastly, selected core plugs, saturated with oil and surfactants, were examined using scanning electron microscopy (SEM) under cryogenic conditions to characterize fluid-rock interactions.

## Results, Conclusions

Four chemical solutions and a formation water sample were tested in duplication to recover the oil from oil-saturated core plugs. Spontaneous imbibition results show that the two chemicals (Chem.1 and Chem.4) outperformed the others with oil recovery of 22% and 16%, respectively. The oil recovery for the remaining chemicals and formation water (blank test) was below 5%. It is notable that the core plugs from interval A achieved up to three times higher oil recovery with the same chemical compared to the interval B. In the end, the pore-scale fluid distribution (oil vs. EOR chemicals) of the selected core plugs were characterized using cryo-SEM technique.

The experimental results from this study demonstrate the importance of selecting suitable chemical as well as the influence of compositional, petrophysical and rock fabric controls on the chemical EOR processes. The study also highlights the fluid-rock interactions leading to heterogenous mineral/pore-scale wettability and its impact on the flow properties of the reservoir rock.

## Novel

The novelty of this work is to analyze the impact of critical rock properties such as rock fabric, permeability heterogeneity, mineralogy, and organic content on chemical EOR processes.

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