

# Optimal zwitterionic surfactant slug for an improved oil recovery in oil-wet carbonate rocks

Madison Barth<sup>1</sup>, Japan Trivedi<sup>1</sup>, Benedicta Nwani<sup>1</sup>, Yosamin Esanullah<sup>1</sup>

<sup>1</sup>Department of Civil and Environmental Engineering, University of Alberta

## Abstract

Of recent, there has been research and development in the technologies/techniques required to meet the ever-growing energy demand in the world. Oil is a major source of energy which is contained in over 50% of carbonate reservoirs. The oil/mixed wettability of carbonate rocks makes it technically challenging to recover the needed oil. The process of crude oil recovery has three different stages primary, secondary and tertiary recovery. Tertiary recovery is also known as enhanced oil recovery or EOR. EOR includes the use of surfactants to reduce the interfacial tension between a hydrocarbon and brine, thus suspending them both in a microemulsion. Surfactant performance can be affected by multiple variables, including brine salinity, surfactant concentration, and type of hydrocarbon. A petroleum engineer must take all variables into consideration when selecting a surfactant to make sure that its efficiency is as high as possible, especially because the use of surfactants is costly.

In this work, a chembetaine zwitter ionic surfactant of two different concentrations are evaluated at various synthetic formation brine salinities for their favourable wettability alteration and interfacial tension reduction in oil-wet carbonate- Silurian Dolomite. For the evaluation, fluid-fluid and rock-fluid analysis are carried out to select the optimal surfactant concentration and brine salinity with the greatest improved oil recovery potential.

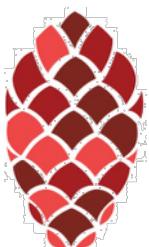
Results are indicative that the surfactant at the two concentrations studied is compatible at the ranges of salinities evaluated. However, from the fluid-fluid analysis, there was no ultra-low interfacial tension that is needed for oil mobilization. More so, the rock-fluid analysis shows that the surfactant is not able to alter the wettability of oil-wet rocks favourably. The optimal surfactant slug for the greatest oil recovery, in this case, would be expected at 0.5% surfactant concentration in 10,000 ppm synthetic formation brine salinity. This study, therefore, serves as a guide for the design of optimal surfactant slug in oil-wet carbonate cores requires to reduce non-productive time, prevent reservoir damage and therefore improve recovery.

## Key words:

surfactant, zwitterionic, enhanced oil recovery, oil -wet, silurian dolomite

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**Cite as:** Barth M., Trived J., Nwani B., Esanullah Y. 2019. Optimal zwitterionic surfactant slug for an improved oil recovery in oil-wet carbonate rocks. Alberta Academic Review, Vol 2 (2) 7-8, WISEST Special Issue (not peer-reviewed), DOI: 10.29173/aar45.



# Optimal Zwitterionic Surfactant Slug for an Improved Oil Recovery in Oil Wet Carbonate Rocks

Madison Barth, Yosamin Esanullah, Benedicta Nwani (MSc), and Japan Trivedi (PhD)

Department of Civil and Environmental Engineering, University of Alberta



UNIVERSITY OF ALBERTA  
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## 1. Introduction

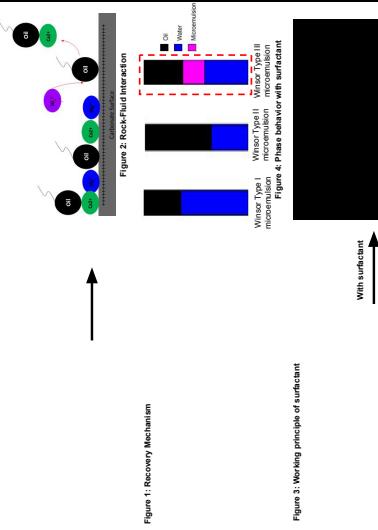


Figure 1: Recovery Mechanism

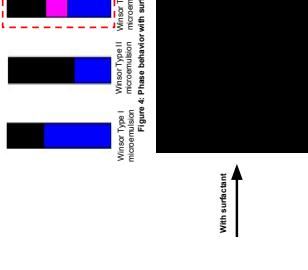


Figure 4: Schematic of water and surfactant slug required for an improved oil recovery in Silurian Dolomite?

## 2. Materials and Methods

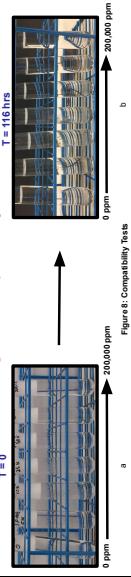
### Research Question:

- What is the optimum zwitterionic surfactant slug required for an improved oil recovery in Silurian Dolomite?

## 3. Results and Discussion

### Fluid - Fluid Analysis

#### Stage 1: Compatibility Test



#### Stage 2: Phase Behavior Test

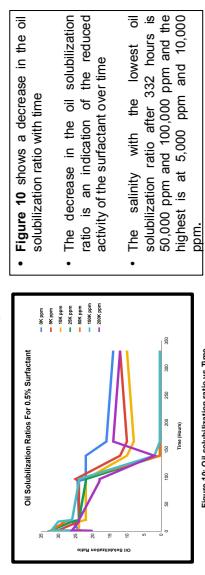


Figure 10: Oil solubilization ratio vs Time

### Stage 3: Interfacial Tension Measurements

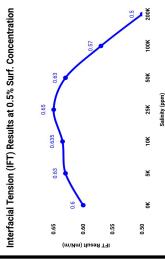


Figure 11: Interfacial Tension (IFT) Results at 0.5% Surf. Concentration

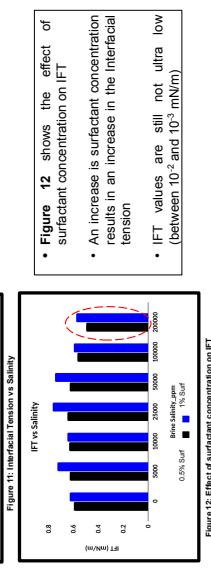


Figure 12: Effect of surfactant concentration on IFT

Surfactant	Concentration	IFT (mN/m)
0.5% Surfactant	0.5%	~10
0.5% Surfactant	1.0%	~10
0.5% Surfactant	2.0%	~10
0.5% Surfactant	4.0%	~10
0.5% Surfactant	8.0%	~10
0.5% Surfactant	16.0%	~10
0.5% Surfactant	32.0%	~10
0.5% Surfactant	64.0%	~10
0.5% Surfactant	128.0%	~10
0.5% Surfactant	256.0%	~10
0.5% Surfactant	512.0%	~10
0.5% Surfactant	1024.0%	~10
0.5% Surfactant	2048.0%	~10
0.5% Surfactant	4096.0%	~10
0.5% Surfactant	8192.0%	~10
0.5% Surfactant	16384.0%	~10
0.5% Surfactant	32768.0%	~10
0.5% Surfactant	65536.0%	~10
0.5% Surfactant	131072.0%	~10
0.5% Surfactant	262144.0%	~10
0.5% Surfactant	524288.0%	~10
0.5% Surfactant	1048576.0%	~10
0.5% Surfactant	2097152.0%	~10
0.5% Surfactant	4194304.0%	~10
0.5% Surfactant	8388608.0%	~10
0.5% Surfactant	16777216.0%	~10
0.5% Surfactant	33554432.0%	~10
0.5% Surfactant	67108864.0%	~10
0.5% Surfactant	134217728.0%	~10
0.5% Surfactant	268435456.0%	~10
0.5% Surfactant	536870912.0%	~10
0.5% Surfactant	1073741824.0%	~10
0.5% Surfactant	2147483648.0%	~10
0.5% Surfactant	4294967296.0%	~10
0.5% Surfactant	8589934592.0%	~10
0.5% Surfactant	17179869184.0%	~10
0.5% Surfactant	34359738368.0%	~10
0.5% Surfactant	68719476736.0%	~10
0.5% Surfactant	137438953472.0%	~10
0.5% Surfactant	274877906944.0%	~10
0.5% Surfactant	549755813888.0%	~10
0.5% Surfactant	1099511627776.0%	~10
0.5% Surfactant	2199023255552.0%	~10
0.5% Surfactant	4398046511104.0%	~10
0.5% Surfactant	8796093022208.0%	~10
0.5% Surfactant	17592186044416.0%	~10
0.5% Surfactant	35184372088832.0%	~10
0.5% Surfactant	70368744177664.0%	~10
0.5% Surfactant	140737488355328.0%	~10
0.5% Surfactant	281474976710656.0%	~10
0.5% Surfactant	562949953421312.0%	~10
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0.5% Surfactant	9007199254740992.0%	~10
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