Undergraduate Research Day
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October 12, 2017

Anionic Surfactant Adsorption/Partitioning in Iron-Rich Environment

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Purpose

- Analyzing the adsorption rate of an anionic internal olefin sulfonate surfactant [O-332] in an iron-rich environment, will help provide valuable economic insight in the field of enhanced oil recovery.
- Being able to accurately model the adsorption and partitioning behavior of a surfactant aids in the reduction of the chemical costs associated with tertiary recovery processes.

Figure 1: Sample of Siderite

Figure 2: Internal Olefin Sulfonate

Economics

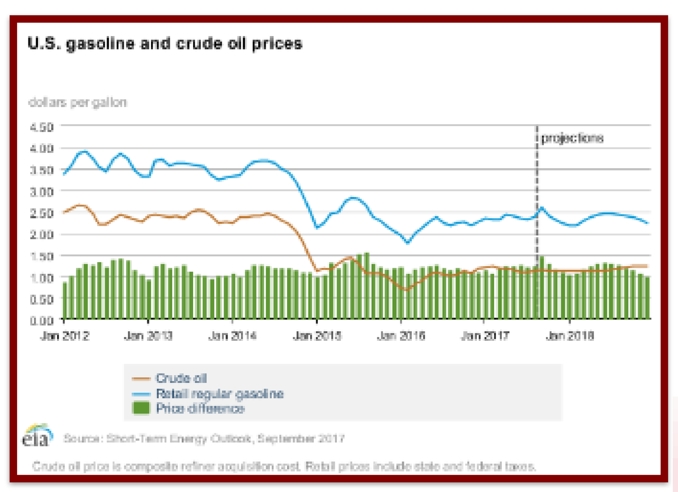

Figure 3: EIA.gov

Cost per barrel has dropped significantly, which has led to an increased interest in tertiary recovery processes.

This renewed interest in tertiary recovery processes, has led to an increase in the efficiency and a decrease in the cost per bbl of surfactant.

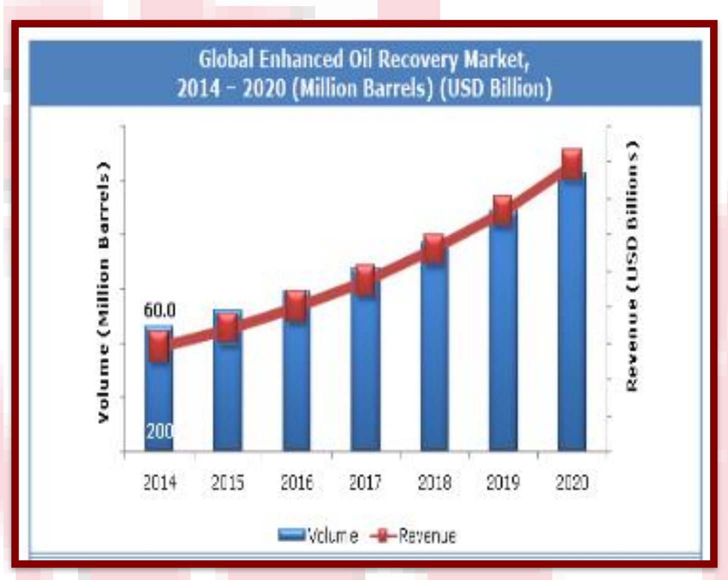

Figure 4: "EOR Projections" from Market Research

Table 1: "Historical Surfactant Cost" from The Center For Petroleum & Geosystems Engineering University of Texas-Austin

Year	Surfactant Concentration (wt%):	Surfactant Cost ($/bbl of Oil Produced):
1993	1.78%	18.21
2008	0.88%	9.11
2015	0.36%	3.64

Approach

- Design and fabricate a synthetic silica core that includes 7 (wt%) siderite ($FeCO_3$).
- Test and quantify O-332 Surfactant's adsorption and partitioning rates within the iron-rich environment.

Concepts / Definition

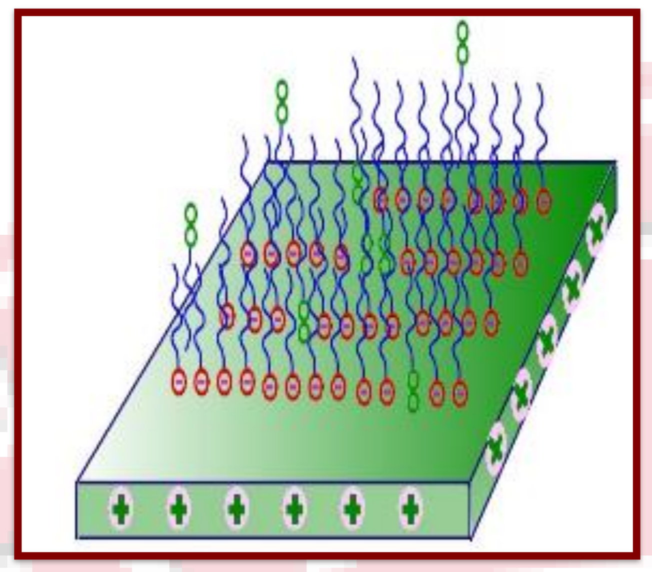

Figure 5: Adsorption of Anionic Surfactant from SurfSorb Inc.

Adsorption:

Arises due to the presence of unbalanced residual forces at the surface of liquid and solid interfaces. The negative hydrophilic head group of the surfactant is attracted to the positive charge of the reduced iron located within the core.

Partitioning/Distribution Law:

"When a solute is taken up with two immiscible liquids, in both of which the solute is soluble, the solute distributes itself between the two liquids in such away that the ratio of its concentration in the two liquid phases is constant." [Nernst]

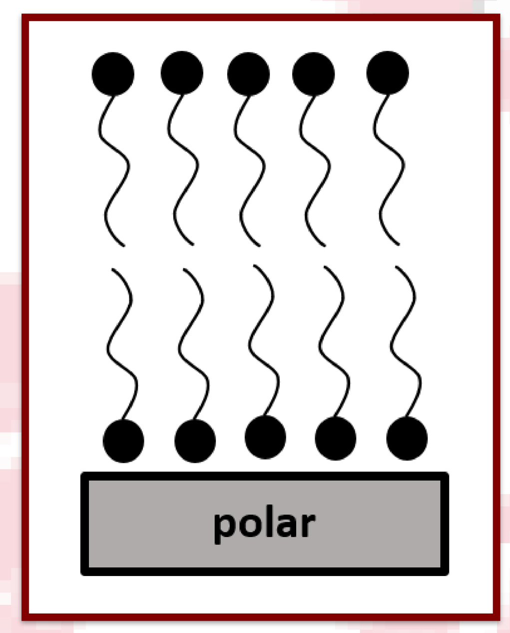

Figure 6: Partitioning of Surfactant Molecules from Holmberg et al

Procedure

1. Fabrication of synthetic core

Figure 7: Core Distribution Setup

Figure 8: Liquid Nitrogen Application

Figure 9: Fabricated Synthetic Core

2. Core flood procedure

Figure 10: Injection and Vacuum Core Flood Mechanism

3. Titrando-888 Titration Analysis

Figure 11: Surfactant Concentration Analysis

Results and Conclusion

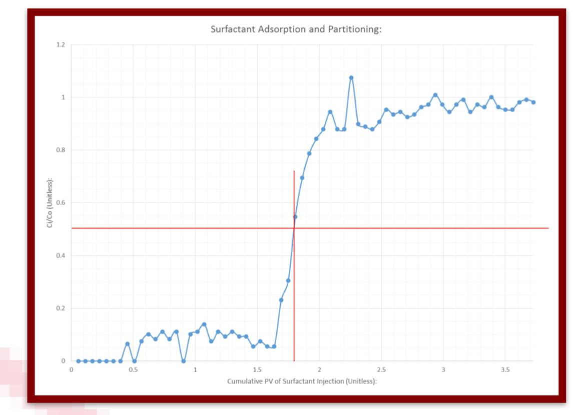

Figure 12: Illustration of Internal Olefin Sulfonate Surfactant Adsorption and Partitioning Phenomena

Using the material balance approach, we were able to determine the internal olefin sulfonate surfactant adsorption rate due to the siderite: 5.28 mg-surfactant/g-$FeCO_3$

Table 2: Material Balance Data

Internal Olefin Sulfonate Surfactant Adsorption:	
Mass of Surfactant Injected (g):	2.85
Mass of Surfactant Produced (g):	2.63
Adsorption Due to Silica (g):	0.02
Adsorption Due to $FeCO_3$ (g):	0.21

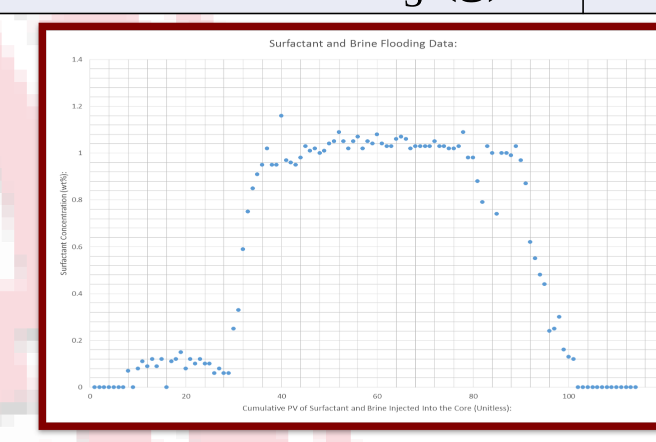

Figure 13: Concentration Profile of Surfactant

Figure 11 depicts the adsorption and partitioning phenomena experienced throughout the core flood procedure. We determined the retardation factor to be: 1.80. The retardation factor may be due to adsorption or partitioning, but is most likely caused by partitioning due to the delay in the surfactant production.

Follow up

Future work: Replicate this experiment with the following weight percentages of siderite ($FeCO_3$):

- 6.00%
- 8.00%

Acknowledgements

We appreciate the guidance and support from our faculty mentor:

Dr. Konstantinos Kostarelos

We appreciate the generous help of University of Houston Graduate Students:

Pushpesh Sharma
JaeHo Lee

We would like to thank Shell Chemical, U.S. Silica, and Sidco, Inc. for allowing us to use their products.

We would like to acknowledge Travis Comer for his Master Thesis work at the University of Houston.