

Contract No. G-041-081

“Functional Nanoparticle-Augmented Surfactant Fluid for Enhanced Oil Recovery in Williston Basin”

Submitted by: University of North Dakota - Department of Petroleum Engineering, Department of Chemistry, and Institute of Energy Studies

Principal Investigators: Hui Pu & Julia Xiaojun Zhao

PARTICIPANTS

Sponsor	Cost Share
Hess Corporation	\$ 0*
InPetro Technologies, Inc.	\$ 236,250 (in-kind)
University of North Dakota	\$ 524,628 (in-kind)
North Dakota Industrial Commission/OGRC Funding	\$ 678,932 (cash)
Total Project Cost	\$1,439,810

*Hess will be providing crude oil samples - value undetermined

Project Schedule – 3 years
Contract Date – March 4, 2017
Start Date – May 1, 2017
Final Report: April 30, 2020

Project Deliverables:
Status Report: August 1, 2017 ✓
Status Report: November 1, 2017 ✓
Status Report: February 1, 2018
Status Report: May 1, 2018
Status Report: August 1, 2018
Status Report: November 1, 2018
Status Report: February 1, 2019
Status Report: May 1, 2019
Status Report: August 1, 2019
Status Report: November 1, 2019
Status Report: February 1, 2020
Final Report: April 30, 2020

OBJECTIVE/STATEMENT OF WORK:

The objective of this project is to develop a novel nanoparticle enriched surfactant fluid for enhanced oil recovery (EOR) in Williston Basin. In this fluid, the nanoparticles will carry surfactant to deeply penetrate rock matrix, then effectively displace oil locked in micro- and nano-pores of tight rocks, and finally carry the oil out of the rocks. The features of the designed nanoparticles will be: 1) controllable delivery of surfactant and alter the wettability of interfaces of oil with the fluid; 2) high mobility, water solubility, stability, and uniform dispersion in the reservoir fluids; 3) tunable chemical composition, shape, size, porosity and functionality; 4) environmentally friendly; and 5) low cost. The commercialization of this technology will lead to higher oil recovery, prolonged reservoir life, reduced operation cost and further minimizing the environmental complications.

The results will provide conceptual validation of nanoparticle loaded surfactant fluid for EOR in Bakken tight formation. Vital data will be collected based on the fluid performance regarding their wettability, mobility and the effects of EOR in the Bakken play from macro-to nanoscale levels. Positive recovery rates are expected. Accumulated data, mechanisms and optimization outcomes will lay a solid foundation to the technology’s commercialization in the near future.

STATUS

The Contract has been executed by the Commission and the University of North Dakota.

Quarterly Report for the period of May 1 - July 31, 2017 received. It has been posted on the Oil and Gas Research Program website. The report notes the following:

NDIC project is a three-year project with the goal of developing a novel nanoparticle enriched surfactant fluid for enhanced oil recovery (EOR) in Williston Field. In order to fulfil this project, we are supposed to have good knowledge of the reservoir conditions of the Williston Basin, to design different types of nanoparticle enriched surfactant fluids, and to find the optimum types of fluids that is cost-effective and environmental-friendly under the Williston Basin reservoir conditions.

During the first quarter of this project, our primary goals are to screen nanomaterials and Bakken core samples. We mainly focused on the following five tasks:

- 1) Systematically reviewed literature for deep understanding of Bakken reservoir conditions in Williston Basin;
- 2) Obtained various Bakken core samples from North Dakota Geological Survey Wilson M. Laird Core and Sample Library and conducted preliminary screening of these samples;
- 3) Conducted preliminary IFT experiments in order to prepare future IFT measurements;
- 4) Selected targeting nanomaterials and studied their properties;
- 5) Prepared experimental plan for next quarter.

Detailed results of these tasks are included in the quarterly report.

Quarterly Report for the period of August 1 - November 1, 2017 received. It has been posted on the Oil and Gas Research Program website. The report notes the following:

During the past quarter our primary goals are to start synthesizing and testing of different types of nanoparticles. Our focus is the characterization of nanoparticles and the stability test for those nanoparticles. We mainly focused on the following tasks:

- 1) Preparation and Characterization of PEG-coated Silica Nanoparticles for Oil Recovery;
- 2) Evaluation and Optimization of the nanoparticles and Nanoparticle-surfactant Hybrid for EOR;
 - a) Stability test of graphene oxide nanosheet (GON);
 - b) Stability test of partially reduced graphene oxide nanosheet (PrGON)
 - c) Stability test of Silica-Triton X-100 system
 - d) Stability test of Silica Nanoparticles

Detailed information this work is included in the quarterly report. It was stated that Future Work will include:

1. Prepare polymer nanoparticles, carbon nanoparticles, and porous silica nanoparticles as outlined in the proposal for investigation.
2. Reduce the size of the silica nanoparticles to less than 20 nm for fitting the requirement in the Bakken formation.
3. Modify silica nanoparticles with different types of surfactants to test the stability and oil recovery efficiency.
4. More stability test will be done based on nanoparticles, since the changes in type, size, wettability and electrical property will all have effects on the final results.
5. Measure the interfacial tension and conduct the adsorption test.