Joint Industry Project

SUSTAINABLE HYDROCARBON RECOVERY IN UNCONVENTIONAL RESERVOIRS

The University of Kansas

The University of Kansas (KU) is launching a new Joint Industry Project (JIP) in Sustainable Hydrocarbon Recovery in Unconventional Reservoirs. Researchers from the **Chemical & Petroleum Engineering Department** (CPE), **Tertiary Oil Recovery Program** (TORP), **Civil, Environmental, & Architectural Engineering Department** (CEAE), the **Department of Geology** (GEOL), and the **Kansas Geological Survey** (KGS) are working together to develop novel technologies to address issues of critical importance for sustainable unconventional reservoir exploitation.

Thrust Area 1: Produced Water Treatment

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Team: post-doctoral associate (1), field liaison engineer (1)

- **Removal of naturally occurring radioactive materials (NORMs) and scale-causing minerals using nanotechnology –** using polyelectrolyte complexes as nanosized entrapment agents to target metals such as barium, strontium, and radium directly in produced water. Once formed, these nanoparticles can be separated from the produced water through filtration or gravity separation, and may be regenerated for additional use.
- **Application of fluidized bed biological reactors for organics removal –** increasing contact between organic chemical contaminants and reactor components (microbes) using fluidized beds to increase the reaction rate, enabling the processing of large volumes in minimal space.

Thrust Area 2: Hydraulic Fracturing of Shale Reservoirs

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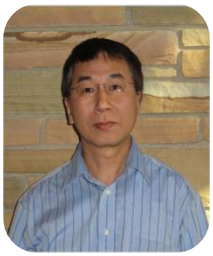
- **Nano-proppants for hydraulic fracturing of hydrocarbon-bearing shale reservoirs**– using nano-proppants capable of packing micro-fractures to prevent fluid loss and improve both effective fracture length and productivity of the fractured wells.
- **Nanoparticle-stabilized CO_2-foam as fracturing fluids –** fluid loss and fracture cleanup properties of CO_2-foam as fracturing fluid will be studied for different nanoparticles and chemicals to be used in optimization of fluid properties.
- **Effects of produced water composition on fracturing fluid efficacy** – identifying the levels below which chemical contaminants need to be reduced in order for reuse to be attractive to the producer. This work will be performed in conjunction with our produced water treatment activities and will initially focus on fracturing fluids.
- **Fracture propagation in ultra-tight unconventional reservoirs–** developing robust models capable of modeling fracture propagation in a variety of litho-facies, including in brittle or semi-brittle formations with natural fractures.
- **Hydraulic fracture cleanup improvement- modeling and experimental-** Cleanup of fracturing fluids from hydraulic fractures has been improved using polyelectrolyte complex nanoparticle systems with dual applications of fluid loss prevention and delay release of enzyme breakers. Simulation studies have been applied and effects of fracture cleanup, water blockage, and fracture properties on productivity were studied.

Thrust Area 3: Enhanced Oil Recovery in Shale Formations



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- **Gas injection to enhance oil recovery from shale formations –** studying the feasibility of using different gases with huff-n-puff process to improve oil recovery in tight shale formations. Preserved core samples from target shale formation will be used to examine key parameters to the effectiveness of the process. Experimental investigation and computer modeling will be used to improve understanding of the complexity of phase behavior and the flow behavior in shale rock for optimization of the oil recovery. Initial focus will be on CO_2 due to its favorable solvation property. Other gases will be evaluated later.

Thrust Area 4: Reservoir Characterization and Simulation under Uncertainty

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- **Improved reservoir characterization –** using improved correlations between seismic data and fracture properties, develop a more representative fracture network/property model for shale reservoirs capable of adjusting the fracture spacing based on the fracture characteristics of the reservoir
- **Reservoir modeling –** developing a small scale model for production from a naturally fissured shale block that captures the full physics behind the shale gas or oil production. This model will then be extended to gas injection application and reservoir scale models
- **Production optimization under uncertainty- shale oil/shale gas reservoirs -** investigating various drilling, fracturing and injection scenarios to improve production from ultra-tight, organic rich unconventional reservoirs
- **Seismic methods for production optimization –** develop seismic technology for optimizing production of unconventional reservoirs. Assess surface seismic methods, multi-component, time-lapse and borehole micro seismic monitoring. Conduct pilot characterization study of the Chattanooga shale in South-Central Kansas.

To ensure the JIP is successful from the start, KU is investing **$642,861 in initial research funding** as well as providing research, staff support, and access to **more than 7,500 sq. ft. of research lab space** with:

- Fracture conductivity set-up for proppant and acid fracture conductivity measurements
- High pressure—high temperature CO_2 and CO_2 foam flood set-up
- State-of-the-art reservoir characterization and simulation capabilities and software
- High pressure—high temperature interfacial and contact angle measurement setup
- Shear loop and dynamic fluid loss setup
- High pressure—high temperature rheometer with CO_2 foam rheological measurement capabilities
- Matrix acidizing coreflooding apparatus
- Sandpack and core testing capabilities, including high pressure rated core holders
- Slim tube set-up
- Extensive analytical instrumentation for the characterization of produced water and fracturing fluids
- Anaerobic chambers and a biological safety hood for the growth of bacterial cultures
- Access to key facilities on and off campus, including the KU Center for Metagenomic Microbial Community Analysis.