KU TORP Tertiary Oil Recovery Program

KU CPE
Chemical and Petroleum Engineering

Joint Industry Project: Sustainable Hydrocarbon Recovery in Unconventional Reservoirs

Thrust Area 3: Enhanced Oil Recovery in Shale Formations

KU's **Tertiary Oil Recovery Program** (TORP) and Chemical and Petroleum Engineering (CPE) Department have joined together to build a team of researchers dedicated to developing sustainable energy approaches to recovery of hydrocarbon in unconventional reservoirs.

Principal Investigator (PI):	**Dr. Jun-Syung Tsau (TORP) (tsau@ku.edu, 785-864-2913)**
Co-PI:	**Dr. Reza Barati (CPE) (rezab@ku.edu),**
Team:	**field liaison engineer (1), graduate research assistant (1), undergraduate research assistant (1)**

Project

The goal of the listed project is to develop a practical and economical method to enhance oil recovery from tight oil and shale oil formations.

CO_2/Gas huff-n-puff to improve oil recovery in shale formations

The application of CO_2 huff-n-puff in conventional reservoirs is feasible and economic. The performance and potential of this process in unconventional reservoirs, however, is not well investigated. As the interaction of CO_2 with shale oil and its recovery mechanism vary with the injection/production conditions, it is important to conduct the experiments with a preserved shale rock sample at reservoir conditions. Accordingly, we propose a systematic study to examine the effect of pressure, temperature, cycle of injection, shale oil composition and pressure gradient on a CO_2 huff-n-puff process to improve oil recovery in shale formations.

We will use preserved core samples from target shale formations for the test. Laboratory experimental work will be designed to simulate a typical huff-n-puff process to examine the role of key parameters on the effectiveness of the proposed method. A high-pressure / high temperature core holder with high-pressure CO_2 injection set up will be used to house the tested sample. Subjected to injection of CO_2, soaking, and production, the composition and amount of produced fluid will be analyzed. The fluid distribution in the core sample prior to CO_2 injection and postproduction is analyzed through CT imaging to assist material balance calculation. All the results will be examined to evaluate the effect of operating pressure, soaking period and number of cycles on the effectiveness of the CO_2 huff-n-puff process.

The experimental investigation will be extended to other type of gases to 1) formulate the gas composition to achieve optimum recovery conditions with shale oil, and 2) examine the effect of diffusion and pressure gradient on oil recovery performance. Computer modeling will be used to 1) improve understanding of the complexity of phase behavior and the dynamic behavior of flow in shale rock, and 2) design the process for optimization of oil recovery. The knowledge obtained from this proposed study will assist understanding of the recovery mechanism, the complexity of flow behavior and its impact on recovery performance and ultimately improve oil recovery efficiency in shale reservoirs with CO_2/gas cycling injection.

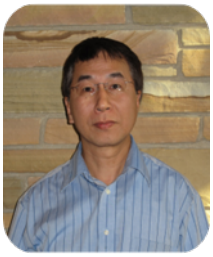
Benefits to industry

- Strong track record with industry-focused research.
- Access to faculty and researchers who are experts in their field.
- Opportunity to meet students actively engaged in research, trained from a solid community of faculty that have industry training and value industry sponsored projects.
- Extensive experience working with producers to perform field tests.
- Fully equipped laboratories.

Experience

By bringing together TORP researchers and CPE faculty members, KU has created a cross-disciplinary team that understands CO_2/gas injection techniques in both conventional and unconventional plays for the needs of the oil and gas industry. The project team includes TORP members with extensive experience in CO_2/gas injection for IOR, and CPE faculty members with extensive experience in research areas of hydraulic fracturing and nano technology for IOR.

Key Personnel



Dr. Jyun-Syung Tsau, the Principal Investigator, is an Associate Scientist and Director of CO_2 Flooding & Sequestration/Reservoir Management & Simulation for the Tertiary Oil Recovery Program at the University of Kansas (KU). He has twenty-plus years of experience in conducting research on oil recovery techniques and has worked on projects related to CO_2 miscible/near miscible injection, CO_2 foam for mobility control, and reservoir simulation. He has a record of successfully conducting research projects for the Department of Energy and other agencies. His research interests are in carbon dioxide application for IOR in conventional and unconventional plays, phase behavior, foam mobility control/stimulation and numerical simulation.

Dr. Reza Barati, the Co-Principal Investigator, is an Assistant professor in the Chemical and Petroleum Engineering Department at the University of Kansas (KU). Reza is experienced in managing successful research projects that have been conducted in conjunction with industry and the Society of Petroleum Engineers (SPE). He managed two industry projects in the area of core characterization and chemical flooding of the Minnelusa formation while working at the Enhanced Oil Recovery Institute (EORI) in Wyoming as a member of the Minnelusa Consortium. He has been the PI of two projects funded by SPE and Kansas Interdisciplinary Consortium (KICC) since he started his new position at KU.

Mr. Mark Ballard, the Co-Investigator, is currently the Field Liaison at the Tertiary Oil Recovery Program (TORP) at the University of Kansas. He acts to move the research performed at TORP out into the field to benefit the crude oil producers. He has 12 years of experience as a Petroleum Engineer with field experience in crude oil production, design & implementation of waterflood projects, and economic analysis of oil producing properties. Mr. Ballard also has over 25 years of business management experience. He has a B.S. in Petroleum Engineering and an MBA.

Facilities

TORP's research facilities occupy approximately 4,000 square feet with laboratories specifically dedicated to oil-recovery research. TORP possesses the equipment required to formulate chemical systems, to test their performance in flow tests through rock material, and to analyze fluids and materials. TORP is also well equipped with instruments to study phase behavior between various types of gas and hydrocarbons, determine physical properties of fluid at high pressure/high temperature (HPHT), and test gas/foam flooding performance through rock material. Special instrumentations include:

- Gas Chromatography (GC)-FID, GC-TCD, GC-MS-MS
- Total Organic Carbon/Total Nitrogen (TOC/TN) Analyzer
- FTIR, UV-Vis, Raman
- Particle size and zeta potential analyzer
- Slim-tube apparatus
- HTHP inline viscometer (Cambridge)
- HTHP inline densitometer (Anton Par)
- HTHP core flow test setup
- HTHP view cell for measurements of interfacial tension, gas solubility and oil swelling factor

CPE Barati (Co-PI)'s lab occupies 800 square feet and is also equipped to perform many aspects of oil recovery research, including equipment specific to oil and gas stimulation and improved oil recovery research:

- HPHT CO_2 flooding setup designated for temperature up to 100 °C and pressures up to 3000 psi
- Core-flooding setup for both steady state and unsteady state relative permeability measurements
- HPHT Rheometer (300 °C and 5800 psi) used for both fracturing fluids and CO_2 foam rheological measurements
- HPHT IFT and contact angle measurement setup
- A fully equipped Dynamic Fluid Loss setup including two shear loops
- Dean-Stark core cleaning setup
- Hydraulic fracture and acid fracture conductivity setup
- Hydraulic press and a core holder for stress-strain relation measurements

Both labs also have high performance computers equipped with 8 cores 512 GB RAM , 12 cores 48 GB of RAM and high performance graphics card for large scale reservoir simulations. Commercial softwares available in the lab include Ocean, PetroMod, PipeSim, Techlog, Eclipse and Petrel from Schlumberger, Winprop, IMEX, GEM, STAR, CMOST from Computer Modeling Group, Inc.