Sec. 999 Small Producer Detailed Project Info

Research Area: Water Management

Project 1: **Cost-Effective Treatment of Produced Water Using Co-Produced Energy Sources for Small Producers**

Performer: *New Mexico Institute of Mining and Technology*

EXECUTIVE SUMMARY

The proposal "Cost-Effective Treatment of Produced Water Using Co-Produced Energy Sources for Small Producers," submitted by the Petroleum Research Recovery Center (PRRC) of New Mexico Tech, is for a demonstration project. The key objective of the proposed research is to test a low temperature distillation unit for produced water purification at the wellhead, yielding water clean enough for beneficial uses like drilling, stimulating, or waterflooding.

In this project, a low-temperature distillation process co-sited with the wellhead will be designed for meeting the requirements of energy efficiency and tolerance to variable water chemistry. Through the proposed process, water will evaporate at an elevated temperature (i.e., 80°C) in a flowing air stream, followed by cooling and capillary condensation resulting in the collection of highly purified clean water. The average treatment cost of produced water purification with this method is estimated to be $0.79/bbl (compared to the current cost in NM of $~2.50/bbl), through implementing the following tactics: (1) solar energy and co-produced energy sources will drive the desalination process, thereby reducing electricity consumption; (2) a specific design will be implemented to maximize internal heat transfer and latent heat recovery; and (3) the process will be fitted to deploy at the wellhead; drastic decline in the need for water storage and transportation is expected as a result of the implementation of this new design concept.

The proposed research includes two phases with research objectives targeting the development of a cost-effective produced water purification technology and its on-site demonstration for wellhead application. In Phase I, a low-temperature distillation unit with desalination capacity of 30 barrel/day will be constructed. In Phase II, produced water purification will be demonstrated at the wellhead of Fed 00#3 and Floyd #2 provided by our industry partners. Technical and economic feasibility will be evaluated.

Dr. Liangxiong Li will be the principal investigator and Dr. Randy Seright will be the Co-PI for this two-year project. Our industry partners are: (a) Harvard Petroleum Corporation, and (b) Robert L. Bayless, Producer LLC. The considerable efforts from the industry partners include site use, electricity, demonstration assistance, and water sampling. The New Mexico Oil Conservation Division also supports this project.

Research Area: Improved Recovery

Project 1: **Enhancing Oil Recovery from Mature Reservoirs Using Radial-Jetted Laterals and High-Volume Progressive Cavity Pumps**

Performer: *University of Kansas*

EXECUTIVE SUMMARY

High water-cut oil production in the U.S. is a severe problem that impacts many small oil producers limiting their ability to significantly increase oil production. Many of these strong-water drive fields typically do not achieve optimal recovery leaving considerable oil behind. New cost-effective, energy efficient technologies will be applied in Hillsboro Field, Marion County Kansas by the Kansas Geological Survey (KGS) and the American Energies Corporation (AEC) to address this significant problem. Radial-jetted laterals will be used to increase the drainage area and enhance oil production from a Viola production well pumped by an efficient high-volume progressive cavity pump, which will move higher fluid volumes at no incremental costs. Increased volumes of produced water will be economically disposed by a deepened Arbuckle injection well whose injectivity will be enhanced by targeted jetted laterals. Successful demonstration of this production-injection pair will be followed by application of this methodology to multiple producing wells in (nearby) Durham Center Field. This study will be the first publicly available scientific evaluation of the use of radial jetted laterals in both production and injection wells. An intense technology transfer effort focused on the small producer will convey project results.

Project 2: **Near Miscible CO2 Application to Improve Oil Recovery for Small Producers**

Performer: *University of Kansas*

EXECUTIVE SUMMARY

Carbon dioxide (CO2) injection for enhanced oil recovery is a proven technology. It is also considered as one of the most promising methods for carbon sequestration in geologic formations. CO2 injections are normally operated at a pressure above the minimum miscibility pressure (MMP), which is determined by crude oil composition and reservoir conditions. However, many reservoirs in the United States and around the world are at shallow depths or geologic conditions exist such that they operate at pressures below the MMP. The goal of this project is to demonstrate near miscible CO2 application can substantially increase oil productions with CO2 injection at pressures below MMP. The application of CO2 injection at near miscible conditions may lead to development of CO2 projects for small producers in reservoirs where the MMP is not attainable at current operating reservoir pressures.

When CO2 injection operates at a pressure below the MMP, displacement efficiency decreases as a result of the loss of miscibility. Near miscible displacement generally refers to the process occurring at displacement pressures below the MMP, but the actual pressure range has never been clearly defined. At displacement pressures near miscible, significant oil recovery has been observed in slim-tube experiments and to a lesser extent in core tests. This better recovery has been attributed to possible improvement of the mobility ratio in the displacement and an extraction process, both of which are closely related to operating pressure. To increase the resource base for CO2 flooding and substantially increase the production from reservoirs operated by small producers, it is proposed to investigate the feasibility of applying CO2 displacement at near miscible pressures by conducting appropriate experimental work and reservoir simulation.

The proposed project will include both experimental and computational studies. In the experimental study, proposed work will 1) systematically characterize the near miscible condition and study recovery of waterflood residual oil using CO2 displacement at near miscible pressures, and 2) identify key parameters in phase behavior and flow tests for simulation modeling. In the computational study, the proposed work will 1) develop a representative model to simulate near miscible displacement physics and 2) assess the potential of recovery processes at near miscible pressures.

This project is a joint effort by the Tertiary Oil Recovery Project (TORP) at the University of Kansas and Carmen Schmitt, Inc. (Kansas independent producer). The successful completion of this feasibility study will lead to future field demonstration pilots in producing areas operated by our project partner in the Arbuckle formation. The potential benefits will be significant with an increase in the resource base for CO2 flooding and an expanded opportunity for small producers to apply CO2 flooding.

Project 3: **Preformed Particle Gels for Conformance Control**
Performer: *University of Missouri, Rolla*

EXECUTIVE SUMMARY

Excess water production is a major issue that leads to early well abandonment and unrecoverable hydrocarbon for mature wells. Gel treatments at injection wells to plug off preferentially the water thief zones are a proven cost-effective method to improve sweep efficiency in reservoirs and reduce excess water production during hydrocarbon production. A newer trend in gel, treatments uses preformed particle gels (PPG) to overcome some distinct drawbacks inherent in in-situ gelation systems. This proposal will study gel particle transport through fractures and fracture-like channels. The ultimate purpose of the project is to establish methods to optimize particle get treatments to increase oil recovery plus reduce water production, by improving waterflood sweep efficiency. This has direct economic benefits by increasing income and saving routine operating costs, plus a reduction in the water production rate serves to decrease the associated environmental risks and impact of any spills.

The proposed project has four main tasks. The objective of the first task is to indentify where particle gels can be effective and how to best use them. This task will be done via analysis of previous data using our developed theories and modern soft computing technologies. The second task will quantify particle gel propagation for different PPG products during extrusion through open fractures and fracture-like channels; results will thereby guide the best particle gels for different widths fracture and channels. This task will be fulfilled through experiments using screens and cores with fractures and channels. New theoretical models will be developed based on the experimental data and will be used to update the models of the first task for better design of particle gel treatments and prediction of well performance. The third task will be laboratory flow tests to evaluate novel processes (e.g. modified PPG chemistry, including surfactant, and using gravity effects to improve particle placement) that have significant potential to enhance gel particle treatment efficiency. The fourth task is to develop well size-distributed commercial preformed gel particles.

The project will be led by the research group at the University of Missouri, Rolla. The fourth task is the procurement and synthesis of commercial and newly developed PPG chemistries, which will be provided by ChemEOR, a chemical product provider in the USA. Another key activity is the interactive consultation from BJ Services who would take the results from this study and provide the actual field deployment of PPG technology to small producer end users. BJ Services will provide expert guidance so that the field data analysis and laboratory program tasks will generate information that will be key towards faster deployment of PPG technology to domestic small producers.

Project 4: **Fracture Detection and Characterization within Oil and Gas Reservoirs Using Fracture Stoneley Waves**

Performer: *Lawrence Berkeley National Laboratory*

EXECUTIVE SUMMARY

The proposed research aims to develop a technology that can substantially increase, in an environmentally sound manner, commercial productions and ultimate recovery of oil and gas. Recent developments suggest that anomalously strong waves can exist within fluid in fractures (fracture Stoneley waves), which can be used as a new tool for underground reservoir mapping and fracture imaging, and potentially, also for fluid mobilization and enhanced hydrocarbon recovery. Development of this new effective technology based on the fracture Stoneley waves requires laboratory study, numerical modeling, and field scale experiments to ensure that (1) the physics of fracture Stoneley waves is well understood and (2) technical problems for developing practical methodology for oil and gas stimulation are addressed.

Lawrence Berkeley National Laboratory will lead the proposed research project entitled "*Fracture Detection and Characterization within Oil and Gas Reservoirs Using Fracture Stoneley Waves.*" This project will be conducted in collaboration with PetroTrace Global, LLC, which will implement the developed technologies for improved fractured reservoir detection in the field. The principal Investigator of the project is Dr. Valeri Korneev who has an extensive experience in innovative geophysical technology development in collaboration with oil and gas industry partners. The proposed research project will verify the existence and examine the properties of fracture Stoneley waves within real fractures at seismic to near-seismic frequency ranges. Fluid mobilization caused by these waves within a fracture will also be examined. Concurrently, the laboratory results will be simulated using numerical models. Finally, the obtained results will be verified using specially designed field experiments. The potential impact of the technology developed in this project will be an economical, more accurate detection and imaging of fractures within a reservoir, which can lead to an improved exploration and production of oil and gas. It is expected that this technology is environmentally safe (unlike conventional formation treatment via chemicals and acids) and also reduces the amount of fluids commonly injected into under-performing reservoirs to improve production.

Research Area: Operation Cost Reduction

Project 1: **Field Site Testing of Low Impact Oil Field Access Roads: Reducing the Footprint in Desert Ecosystems**

Performer: *Texas A&M University*

EXECUTIVE SUMMARY

Texas A&M University is proposing to build a series of minimal impact O&G lease roads and then test their effectiveness in reducing the environmental footprint of field development in sensitive desert ecosystems. The goal of our program is to reduce the environmental impact of mature field O&G operations and reduce the costs and regulatory delays associated with additional resource development. The overall objective of this program is to identify technology that will reduce the field operating costs and minimize the environmental impact of future development.

This project will identify and test new techniques to reduce the environmental impact of oil field lease roads in desert-like ecosystems. The goal is to identify cost effective technology usable by small operators in existing fields. Independents and small producers operate more than 90% of the onshore U.S. oil and gas fields. Most of these fields are mature reservoirs. It is generally thought that existing access roads, surface production facilities and production wells represent infrastructure that can be leveraged. In fact to maintain production facilities or in the case of enhanced recovery, most of this infrastructure will have to be upgraded to support increased field activity and production.

The test site will be located at the Texas A&M University Desert Test Center near Pecos, Texas on the edge of the Chihuahua desert. This research program is classified (NETLF451.1-1/3) as field test research thus not requiring arduous regulatory approval for testing. The experimental test sections at the site will be instrumented for remote measurement, with the goal of finding the material with the ability to withstand both normal and heavy truck traffic over intermittent periods through a complete calendar year. One type of low impact road (a "disappearing road") will be incorporated into the test site as part of a nationwide engineering scholastic competition currently being conducted by the Global Petroleum Institute (GPRI) (http://www.gpri.org/disapperaingroad).

The impact of the project will be realized by providing the means to reduce the impact of increased field activity in all areas of the Western U.S. A 1% addition to natural gas reserves represents more than $4 billion dollars. The business community, the public sector, and the small O&G producers all benefit. Sponsors of the project include road material vendors, oil field service companies and the Texas General Land Office (representing more than 400 lease operators on Texas public lands).

Project 2: **Reducing Impacts of New Pit Rules on Small Producers**
Performer: *New Mexico Institute of Mining and Technology*

EXECUTIVE SUMMARY

The project "Reducing Impacts of New Pit Rules on Small Producers" will be conducted by the Petroleum Recovery Research Center of the New Mexico Institute of Mining and Technology. The Principal Investigator will be Dr. Robert S. Balch. Key partners are the Independent Petroleum Association of New Mexico, representing 250 producers, and the New Mexico Oil Conservation Division.

The objective of this project is to minimize the impact of new "pit rules" on New Mexico's small producers. The added cost of compliance and increased difficulty of permitting could price these producers, who as a whole produce the majority of New Mexico's marginal and mature fields, out of future drilling and production—thus reducing future reserves. New compliance will be required for a number of surface and subsurface features such as depth to groundwater, distance to surface water and variety cultural and environmental features. Compliance will require expensive site surveys and significant permitting delays and costs will be acquired by small producers, ill equipped to deal with these expenses.

In partnership with industry and the regulatory agency, this project proposes to make available a wide selection of data needed for compliance, in acceptable automated formats, that will allow faster applications without the necessity of expensive surveys in most areas. In addition, maps of leaching potential and site risk will be generated to allow a quick review of compliance issues and potential remediation expenses for all potential drill sites in New Mexico's producing regions.

Eight major tasks are to be performed in order to accomplish the project goals: Data Assessment will occur during the first 6 months of the project and will categorize and locate all necessary data and determine acquisition issues such as digitization that may need to be addressed. Data Acquisition will be completed by the end of the first project year and be deemed successful when all data required for the project has been collected and organized. Data Cleaning will be ongoing from the middle of the first year to the end of the second year overlapping with data being cleaned as it is acquired. Database Construction will also begin in the middle of the first year. Database construction is an iterative process and development will proceed through a series of temporary databases as data is acquired and then cleaned. Data Presentation and Feedback represents a key milestone in the project. Toward the end of the first project year a preliminary database and list of acquirable data will be presented to industry and government for review and feedback and immediate use in reducing compliance costs. The Build Data Access task will involve generation of web pages, GIS layers, downloadable data tables, and maintainable (upgradeable) database software to allow fast and simple use of project results. Software to generate and fill required application forms will also be created during this task. The Industry/OCD Feedback task will involve a final review and active testing of the results by industry and government partners. Based on this feedback, Final

Delivery will make final adjustments and then public posting of data, software, and risk analyses online, in a maintainable online format.