Special Newsletter - RPSEA Grants Awarded 2009

This edition of the Crisman Newsletter highlights four newly funded research programs involving the Harold Vance Department of Petroleum Engineering. Grants from RPSEA in the un-conventional gas program will fund three of the grants while one was selected in the Small Producers program.

The unconventional gas research projects are focusing on the formation characteristics of fractured shales. The first project, a collaborative effort between Texas A&M Petroleum Engineering and TerraTek-Schlumberger has a photograph of the Upper Devonian Marcellus Shale outcrop – the Web URL has several telling photographs of this massive petroleum containing formation.

Gulf Coast Green Energy was the recipient of the Small Producers grant. This project plans to demonstrate the use of a waste heat energy extracted from hot produced water to provide power to small oil field operations.

1. Sustaining Fracture Area and Conductivity of Gas Shale Reservoirs for Enhancing Long-Term Production and Recovery
2. Coupled Flow-Geomechanical-Geophysical-Geochemical (F3G) Analysis of Tight Gas Production
3. Electrical Power Generation from Produced Water: Field Demonstration of Ways to Reduce Operating Costs of Small Producers
4. The Environmentally Friendly Drilling Systems Program
Sustaining Fracture Area and Conductivity of Gas Shale Reservoirs for Enhancing Long-term Production and Recovery

Objectives
One of our four RPSEA funded research programs is a collaborative effort between Texas A&M Petroleum Engineering and TerraTek-Schlumberger. This project aims to better understand the multiple causes of loss of fracture area and fracture conductivity in gas shales. The objective is to define types of fracture networks more prone to loosing fracture area, and to define critical parameters (e.g., fluid interaction and relative shear displacement, etc) for each reservoir type, to maintain adequate fracture conductivity. The effort consists in evaluating (theoretically and experimentally) the dominant causes of loss of fracture surface area and fracture conductivity, in complex fracture networks, created or interconnected by hydraulic fracturing. The goal is to define technical and operational solutions for predicting and maintaining higher long-term gas production and recovery.

Approach
The project tasks include an evaluation of reservoir geology, mechanical properties, in-situ stress, and rock-fluid interactions. This is required to predict how sparsely propped or self-propped fractures can have and maintain conductivity and to understand the rock fluid sensitivity which could adversely affect the movement of gas from the matrix into the fracture and the conductivity of the fracture. Understanding the nature of these characteristics will help the engineer to understand and be better able to predict the fracture connectivity—fracture conductivity alone is not enough; fractures must be connected.

The participants bring critical, essential technology, unique laboratory and field experience, access to reservoir core, logs, completions information (including micro-seismic measurements), and production history, as well as cash and in-kind financial contributions.

The project is expected to include measurements on characteristic reservoir mudstones from the Marcellus, Barnett and Haynesville gas shale plays, including 1) long-time, creep effects, 2) un-propped and propped fracture conductivities considering critical proppant concentration required for conductivity, 3) an evaluation of connectivity in generic situations, and 4) a methodology for reservoir typing and selection of fracture stimulations for preventing loss of productive fracture area and loss of fracture conductivity.

Significance
Many factors contribute to the loss of productive fracture area and reduction of fracture conductivity, both immediate and over time. Current operational experience in gas shale reservoirs indicates that retention of productive fracture area and conductivity are major economic issues in these plays, literally “a billion dollar problem that needs resolution for deep plays to be economically viable.”

Marcellus Shale (Route 54 south of Washingtonville, PA)
In this outcrop the Marcellus is not heavily fractured. In viewing this outcrop is it easy to understand why many vertical wells penetrated the entire 30m + thickness of Marcellus without encountering a single joint. Yet, even with joints spaced in excess of 5 meters, a 500 meter horizontal well could expect to penetrate upwards of 100 joints. The geologist in this picture is Prof. Richard Nickelsen of Bucknell University. More images are located here.

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A team from Lawrence Berkeley National Laboratory, Texas A&M University and Stanford University has received one of nine RPSEA research projects aimed at increasing US supplies of natural gas from unconventional resources.

**Objectives**
The team has been funded to develop a new integrated geomechanical model of tight gas systems that will allow more accurate estimation of early phase production to long term production. The project methodology is based on a novel way for characterizing fractured rock and for modeling fluid movement through it. Based on earlier studies of geothermal energy sites, the team has developed models to detect and map fractured rock and create better site models that predict subterranean fluid flow.

**Approach**
The research group will develop and implement an integrated program consisting of:

- A methodology for constructing geomechanical models of tight gas systems (shale),
- A means of theoretical analysis, numerical simulation, laboratory studies and field experiments of the interrelation between the geomechanical and geophysical behavior of such systems in the course of well completion and stimulation and
- A derivation of models of the coupled flow, geomechanical, geophysical, and geochemical behavior of fractured tight gas systems from the earliest stages of well stimulation to long-term production.

The program team expects to develop new knowledge with respect to (a) establishing the relationship between changes in the pressure regime and the geomechanical status of the system, (b) determining the long-term behavior of the fracture system and its effect on production, and (c) possible geophysical markers that can track the evolution of the flow properties and fracture characteristics of the reservoir under production and allow system monitoring and prediction of long-term behavior.

- Improved pressure/production curves for the description of long-term production.
- A minimum of three publications and a final project report.

**Significance**
This study will provide new knowledge for application by the oil and gas industry, including a) how to design optimized production systems, b) the underlying relationship between changes in the pressure regime and the geomechanical status of a tight gas system, c) the long-term behavior of the induced and natural fracture systems and the effect on production, d) possible geophysical markers that can track the evolution of the flow properties and fracture characteristics of the reservoir under production and allow system monitoring and prediction of long-term behavior, e) a quantitative methodology and numerical model of radon and helium transport for evaluating enhanced extraction techniques, f) improved well and well stimulation designs, g) improved pressure/production curves, and h) publications in high-visibility journals of interest to the oil and gas industry.

As recovery technologies have advanced and petroleum prices have risen, unconventional resources have become more economically viable. Looking forward, unconventional gas is projected to continue to grow in importance to global energy supply.

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Electrical Power Generation from Produced Water:
Field Demonstration of Ways to Reduce Operating Costs of Small Producers

Objectives
Gulf Coast Green Energy and its partners have won an award from the RPSEA Small Producers Program to demonstrate a modified waste heat generator using hot produced water to create "green" electricity usable on site or for transmission off site.

The goal of this project is to reduce the small operators exposure to rising electric rates, increase their productivity, reduce environmental impacts, and to create more favorable public perception. The overall objective is to identify and demonstrate technology that will reduce the field operating cost of electricity and minimize the environmental impact by creating green electricity using produced water and no additional fossil fuel.

Approach
The electrical generation technology operates on heat from produced water, preferably at temperatures above 190°F. The technology is based on an organic Rankine cycle (ORC) system. The condensing side of the ORC will utilize fan coolers eliminating the extensive amount of fresh water usage and maintenance expenses of operating a cooling tower. The prototype power plant aims to provide the lowest cost for alternative power generation of less than 4 cents per kilowatt hour and deliver that power to the O&G operator for field operations or to sell back to the electrical grid.

Significance
The demonstration will include two phases with research objectives targeting the development of cost-effective produce water distributed electrical generation. Phase I includes the well selection, while Phase II the installation, startup, and operation of the waste heat generator.

This field demonstration will require efforts by Gulf Coast Green Energy and Denbury Resources, Inc. to identify the optimum well. Gulf Coast Green Energy will install, operate, and maintain the equipment and assistance or the data management and third party verification by our university industry partners.

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The Environmentally Friendly Drilling Systems Program

Objectives
The Houston Advanced Research Center (HARC) and Texas A&M’s Department of Petroleum Engineering have been funded by RPSEA for an additional three years to continue efforts to reduce the impact of O&G operations in environmentally sensitive ecosystems. The Environmentally Friendly Drilling (EFD) program combines new low-impact technologies that reduce the footprint of drilling activities, integrates light weight drilling rigs with reduced emission engine packages, addresses on-site waste management, optimizes the systems to fit the needs of a specific development sites, and provides stewardship of the environment.

Approach
The RPSEA EFD effort is based on a previously co-funded U.S. DOE/industry JIP program led by Texas A&M University and HARC that created a government, industry, and public partnership to reduce the environmental footprint of drilling systems in sensitive ecosystems. The 2005-2008 EFD program identified critical technologies appropriate for low impact systems, created industry-led research projects, and developed techniques for selecting low impact systems for a given project site. The first EFD program showed that the industry could achieve more than 90% reduction in the impact on the environment if low impact technology was combined into a complete system.

The RPSEA EFD program will leverage on-going research in order to move technologies closer to field application and subsequent commercialization. The program will include (a) commercialization of technology to treat and reuse produced water, (b) development of Alternate Rig Power to reduce operating costs and emissions, and (c) identification and testing of improved technologies and equipment that will reduce the footprint of access roads and well pads, to optimize EFD technologies in E&P activities. Various applications supported in the U.S. DOE NETL “Microhole Technology” will also be brought within the RPSEA EFD collaboration.

Significance
The outcome of the RPSEA EFD program is expected to result in greater access, reasonable regulatory controls, lower development cost and reduction of the environmental footprint associated with operations for unconventional natural gas. The RPSEA EFD program will increase the public’s and regulatory agencies’ acceptance to operate in environmentally sensitive areas, and add significant reserves to the U.S. unconventional natural gas inventory.

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