The October edition of the Crisman Institute Newsletter contains summaries on the following projects:

1. **The Development of Unconventional Reservoirs Following the Masters’ Concept of Energy: Cases in the United States**
2. **Analyzing Pressure and Temperature Data from Smart Plungers to Optimize Lift Cycles**
3. **Design of a High-Pressure Research Flow Loop for the Experimental Investigation of Liquid Loading in Gas Wells**
4. **Investigation of Swirl Flows Applied to the Oil and Gas Industry**

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The Development of Unconventional Reservoirs Following the Masters’ Concept of Energy: Cases in the United States

Objectives
Worldwide, unconventional reservoirs (UCRs) are important sources of oil and gas when most conventional resources are declining and demand for hydrocarbons is growing.

The Masters’ (1979) concept of the energy resource triangle (RTT) suggests that the exploitation of UCRs is particularly sensitive to both technology and commodity price parameters. In this work, the effect of technology and different economic events for selected unconventional oil and gas plays in the U.S. was evaluated according to the RTT concept.

Approach
Studies conducted in the Austin Chalk (our textbook case) and seven unconventional plays in the U.S. have supported the RTT concept. Two approaches were employed to support RTT concept: correlation study and forecasting graphs.

The first approach, correlations of commodity prices with drilling activity, demonstrates that periods of high commodity prices coincide with an increase in unconventional wells.

The second approach shows that high prices and technological advances also translate into additional oil and gas production and reserves. This behavior was observed through the analysis of a series of decline production curves using a VBA program in Excel that compute oil and gas production volumes and their corresponding economic values (gross revenues) under specific conditions (Fig. 1).

Accomplishments
Periods of high commodity prices increase unconventional producing wells up to 75% from selected plays in this study, while a maximum value of approximately $50 billion oil plus gas would have been possible using conventional hydraulic fracturing technology only. However, later episodes of high commodity prices allow the introduction of new technologies that have boosted oil and gas production from the plays. Current production schemes suggest that the plays could produce an additional $320 billion when producing at rates higher than 5 BOE/day.

Significance
Our results confirm the RTT concept that natural gas and oil resources can be produced from low quality resources when either product prices increase or when better technology is available.

Great examples are the use of horizontal and multilateral wells which have opened up additional areas for development, such as the Barnett Shale and the Bakken Shale. Using horizontal wells has also revived older plays, such as the Austin Chalk. The combination of horizontal well technology and water fracturing technology has led to a dramatic increase in the development of both oil and gas from shale reservoirs.

Additional Estimated Ultimate Recovery and Gross Revenues for the Austin Chalk Foundation

![Additional Estimated Ultimate Recovery and Gross Revenues for the Austin Chalk Foundation](image)

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**Project Information**

1.1.1 The Effect of Technology and Product Prices on Oil and Gas Production Volumes in Unconventional Reservoir’s Development

**Related Publications**

Flores, C. 2008. Technology and Economics Affecting Unconventional Reservoir Development. MS Theses, Texas A&M U., College Station, Texas


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Cecilia Flores
Analyzing Pressure and Temperature Data from Smart Plungers to Optimize Lift Cycles

Objectives
Pressure and temperature data from smart plungers can be used not only for surveillance and troubleshooting of plunger-lifted wells, but also for modeling plunger lift cycles. Using smart plunger data, along with some measured data like bottomhole pressure and temperature, wellhead tubing and casing pressures, and wellhead flow rate, a simple model of plunger lift cycles can be developed which in turn can be used for optimizing the lift cycles. The model, implemented in a user-friendly VBA (Visual Basic Applications) code, could suggest the wellhead conditions that will provide optimized lift cycles for plunger lift operation in an onshore East Texas well.

Approach
We developed our model by focusing on the upward travel of a plunger along with liquid slug in a packerless completion. We divided the system into four different flow regions, shown in Fig. 1, coupled with common parameters. The model is developed by applying simple mass balance and pressure balance equations to these flow regions. The set of equations developed for the model is closed with the help of a dataset (including smart plunger data) available for an onshore East Texas well. The equations required to calculate plunger velocity, plunger position and annulus liquid level at different points of plunger upward travel are implemented in a user-friendly VBA code.

Significance
Though plunger lift has been used as an economic and successful solution to liquid loading in mature gas wells for over four decades, there is still a lack of thorough understanding of plunger lift cycles. Earlier plunger lift models tried to improve the understanding of lift cycles but were limited in their applicability because of the underlying restrictive assumptions used to develop them. We developed our model to overcome some of these restrictive assumptions by taking advantage of the additional data provided by new technology, like smart plungers which can log pressure and temperature data during plunger cycles. This model based on fundamental principles coupled with new data is simple and can be used for optimizing lift cycles without many restrictive assumptions.

Project Information
2.4.15 Analyzing Pressure and Temperature Data from Smart Plungers to Optimize Lift Cycles

Related Publications


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Gopi Krishna Chava
Design of a High-Pressure Research Flow Loop for the Experimental Investigation of Liquid Loading in Gas Wells

Objectives
Existing models used to predict and analyze liquid loading in gas wells are only applicable to steady-state flow. However, liquid loading corresponds to unsteady-state flow conditions, both in the well and in the near-wellbore region of the reservoir. A more reliable approach would be to use a transient multiphase flow wellbore model that accounts for the dynamics in the near-wellbore region via transient boundary conditions. Reproducing an integrated reservoir/wellbore system in a laboratory environment entails downsampling of the system's geometry and flow parameters, so we have developed a design to construct a facility that will significantly improve our ability to mimic the physics of multiple phase flow for models and lead to better optimization of existing fields and better design of new ones.

Approach
We performed a sensitivity analysis using a commercial wellbore/reservoir simulator along with response surface methodology (RMS) to minimize cost and investigate different design parameter settings to recreate liquid loading under laboratory conditions. Our results suggested using a compressed air system with a discharge pressure between 470 and 650 psi with gas rates of 400 to 650 scf/min along with water injected at a rate of 100 gpm. Our models show that three reciprocating compressors working in parallel provide the smallest, most economic, and most flexible configuration for the TowerLab. The pressure vessel design will require a cylindrical body with top- and bottom-welded flathead covers with multiple openings to minimize weight. The pipelines connecting the major equipment and injection manifold located at the pressure vessel must accommodate the superficial velocities for air and water. Those velocities also indicate that the system will need independent injection through two manifolds rather than commingled flow through a tee joint. Optimally, the system will use digital pressure gauges with coriolis or vortex technology to measure air flow and turbine meters for water flow.

Significance
This new facility will be the first to integrate pipe representing the wellbore with a porous medium that will mimic the formation surrounding that wellbore in a way that will allow us to study the full interaction of flow between the wellbore and the formation in the near-wellbore region, accounting not only for flow into the wellbore but any reverse flow into the medium that occurs as the fluids approach the pipe, thus providing a much more accurate analysis of this flow region. The system will be available not only for training students in our program but also for industry schools.

Project Information
Project 2.4.16 Design of a High-Pressure Research Flow Loop for the Experimental Investigation of Liquid Loading in Gas Wells

Related Publications

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Investigation of Swirl Flows Applied to the Oil and Gas Industry

Objectives
This research project aims at understanding how swirl flows can be applied to the processes in the oil and gas industry and solves potential problems which might hinder them. Two potential areas have been identified: liquid loading in high-gas fraction wells and reduction of erosion at pipe bends due to sand and slurry transport.

Approach
The method we adopted to use is Computational Fluid Dynamics (CFD) to simulate flow patterns encountered during the foresaid processes. We will then monitor how the introduction of swirl flows changes the dynamics of the process. Using CFD allows monitoring of the changes in critical parameters and the causes for these processes. Since CFD is a numerical simulation process, validation of the results is extremely important. In order to validate the simulations results from earlier work, ANUMET are being used. Once the results are within an acceptable margin, the actual processes can be simulated.

Significance
The figure below shows the erosion rates on a pipe wall with aluminum particles flowing in it. We can see that the erosion rate on the wall (7.63e6 kg/m²/s) is markedly reduced after the introduction of the swirler (1.34e6). These are preliminary results from simulations investigating possible applications of swirl flow in sand transport.

Project Information
2.4.17 Investigation of Swirl Flows Applied to the Oil and Gas Industry

Related Publications

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![Fig. 1–CFD analysis shows that swirling fluids in pipes would reduce damage from erosion.](image-url)