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Disclaimer

ABSTRACT

The Pennsylvania State University, under contract to the U.S. Department of Energy, National Energy Technology Laboratory will establish, promote, and manage a national industry-driven Stripper Well Consortium (SWC) that will be focused on improving the production performance of domestic petroleum and/or natural gas stripper wells. The consortium creates a partnership with the U.S. petroleum and natural gas industries and trade associations, state funding agencies, academia, and the National Energy Technology Laboratory.

This report serves as the third quarterly technical progress report for the SWC. Key activities for this reporting period include: 1) organizing and hosting the 2005 Spring Meeting in San Antonio, Texas to review and select projects for SWC co-funding, and 2) preliminary planning of the fall technology transfer meetings.

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1.0 INTRODUCTION

The Pennsylvania State University, under contract to the U.S. Department of Energy (DOE), National Energy Technology Laboratory (NETL), is in the process of establishing an industry-driven stripper well consortium that will be focused on improving the production performance of domestic petroleum and/or natural gas stripper wells. Industry-driven consortia provide a cost-efficient vehicle for developing, transferring, and deploying new technologies into the private sector. The Stripper Well Consortium (SWC) will create a partnership with the U.S. petroleum and natural gas industries and trade associations, state funding agencies, academia, the National Energy Technology Laboratory, and the National Petroleum Technology Office.

Consortium technology development research will be conducted in the areas of reservoir remediation, wellbore clean up, and surface system optimization. Consortium members elected an Executive Council that will be charged with reviewing projects for consortium co-funding. Proposals must address improving the production performance of stripper wells and must provide significant cost share. The process of having industry develop, review, and select projects for funding will ensure that the consortium conducts research that is relevant and timely to industry. Co-funding of projects using external sources of funding will be sought to ensure that consortium funds are highly leveraged.

2.0 EXPERIMENTAL

A description of experimental methods is required by the DOE for all quarterly technical progress reports. In this program, Penn State is responsible for establishing and managing an industry-driven stripper well consortium. Technology development research awards are made on a competitive basis. Therefore, this section is not applicable to the Penn State contracted activities. Technical reports from the individual researchers will be required to contain an experimental discussion section and will be submitted to consortium members and DOE for their review.

3.0 RESULTS AND DISCUSSION

Key activities for this reporting period include: 1) organizing and hosting the San Antonio, Texas Spring Proposal Meeting, and 2) planning the fall technology transfer meetings.

3.1 Spring Proposal Meeting

The SWC organized and hosted its spring proposal meeting on March 8-9, 2005 in San Antonio, Texas. The agenda for this meeting is provided in Appendix A. The meeting was dedicated to reviewing the proposals that were submitted to the SWC for co-funding. The Principal Investigators of the proposed projects provided the SWC membership with a 20-minute presentation of their proposed research. Of the 17 proposals submitted, the Executive Council recommended 13 proposals for SWC co-funding. A total of $1,546,521 was committed to co-fund the 13 research projects. Table 1 summarizes these projects. Appendix B contains a one page Executive Summary for these projects. The program breakdown for the approved projects is as follows:

Total Project Value: $3,141,289
Amount Approved for DOE Co-Funding: $1,546,521

TABLE 1: PROJECT SUMMARY

Title	Project Cost Summary			Committed Funding
	Total	SWC	Applicant	
Demonstration of Hydroslotter Technology on New York Stripper Wells	$375,748	$239,804	$135,944	$215,000
Control of Water Production Using Disproportionate Permeability Reduction in Gelled Polymer Systems	$207,468	$145,227	$62,241	$200,000
Field Application of Accurate, Low Cost Portable Production Well Testers	$324,510	$199,510	$125,000	$199,510
Evaluating Casing Plunger Cup Design	$338,208	$231,708	$106,500	$150,000
Uncovering Bypassed Pay in Central Oklahoma Using Statistical Analysis and Field Tests	$255,200	$150,000	$105,200	$125,000
Desalination of Brackish Water and Disposal into Waterflood Injection Wells	$180,103	$105,103	$75,000	$105,103
Real Time Remote Field Monitoring of Plunger Lift Wells to Reduce Production Down Time and Increase Natural Gas Production	$187,900	$97,900	$90,000	$97,900
A Study to Evaluate the Effect of Completion and Production Procedures on the Ultimate Recoverable Reserves from Knox Formation Wells: Rose Run Sandstone and Beekmantown Dolomite	$120,850	$83,974	$36,876	$83,974
New Technology for Unloading Gas Wells	$146,512	$97,755	$48,757	$75,000
Extended Application of a Proven Low Cost Water Mitigation Treatment	$307,195	$192,195	$115,000	$75,000
Building and Testing a New Type of Vacuum Pump for Casinghead Pressure Reduction in Stripper Wells	$266,500	$186,550	$79,950	$75,000
Re-fit Two Stripper Wells with Existing Large Diameter or Open Hole Completions with Spoolable Non-metalic Tubing, Transition Connections, Variable Diameter Seal Cups and Modified G.O.A.L. Casing Swab to Automatically Lift Fluids and Enhance Performance	$330,605	$208,943	$121,662	$75,000
Interaction of Nitrogen/CO2 Mixtures with Crude Oil	$100,490	$70,034	$30,456	$70,034
Grand Total	$3,141,289	$2,008,703	$1,132,586	$1,546,521

3.2 Upcoming Meetings

The SWC will host two technology transfer meetings in 2005.

Warren, Pennsylvania. The first technology transfer event will be held in Warren, PA at the Conewango Club on October 18, 2005. The meeting is still in the planning stage and will be organized to showcase selected SWC research projects.

Midland, Texas. The second technology transfer event will be held in Midland, TX at the Hilton Midland Plaza on October 27, 2005. The meeting is still in the planning stage and will be organized to showcase selected SWC research projects.

4.0 CONCLUSIONS

During this reporting period, the SWC provided $1,546,521 to co-fund 13 projects. These projects build upon 49 other projects that the Consortium has co-funded in previous funding cycles. Since the inception of the SWC, the Consortium has now provided $5.6M to co-fund a total of 62 projects. The SWC is in the process of developing a technical bulletin, in conjunction with Hart Energy Services, to showcase selected SWC projects.

The SWC is preparing for it's upcoming fall technology transfer meetings that are planned for the October time-frame. Two regional technology transfer meetings will be held: one in the southwest (e.g., Texas/ Oklahoma region) and one in the northeast (e.g., Pennsylvania/ New York region). The SWC has laid a solid foundation for continued membership growth and industrial-relevant technology transfer.

5.0 REFERENCES

A listing of referenced materials is required by the DOE for each quarterly technical progress report. This technical progress report for the SWC did not utilize any reference material.

6.0 APPENDICES

APPENDIX A: MEETING AGENDA

MEETING AGENDA

St. Anthony Hotel * San Antonio, Texas

March 7, 2005	
6:00–7:30PM	**Welcome Reception (St. Anthony Hotel – Jefferson Manor)**
March 8, 2005	
9:00 – 10:00	**Buffet Breakfast (Jefferson Manor) and Meeting Registration (Peraux)**
10:00 – 11:00	**Welcome/ Roundtable Introductions**
11:00 – 11:30	**Field Application of Accurate, Low Cost Portable Production Well Testers** *Presenter: Ken Oglesby, Oak Resources, Inc.*
11:30 – 12:00	**Interaction of Nitrogen/CO_2 Mixtures with Crude Oil** *Presenter: David Johnson, The Pennsylvania State University*
12:00 – 1:00	**Lunch (Jefferson Manor)**
1:00 – 1:20	**Further Development of MEOWS Mentoring Systems: Surveillance and Pump-Off Controllers** *Presenter: Mason Medizade, Petrolects*
1:20 – 1:40	**Systematic Modeling for Improved Performance from Low-productivity Oil and Gas Wells** *Presenter: Anne Oudinot, Advanced Resources International, Inc.*
1:40 – 2:00	**Uncovering Bypassed Pay in Central Oklahoma Using Statistical Analysis and Field Tests** *Presenter: Larry Moore, Schlumberger Consulting Services*
2:00 – 2:30	**Re-fit Two Stripper Wells with Existing Large Diameter or Open Hole Completions with Spoolable Non-metallic Tubing, Transition Connections, Variable Diameter Seal Cups and Modified G.O.A.L. Casing Swab to Automatically Lift Fluids and Enhance Performance** *Presenter: Paul Yaniga, Brandywine Energy and Development Company*
2:30 – 3:00	**Desalination of Brackish Water and Disposal into Waterflood Injection Wells** *Presenter: David Burnett, Texas A&M University*
3:00 - 3:20	**Break (Peraux)**

3:20 – 3:50	**New Technology for Unloading Gas Wells** *Presenter: Richard Christiansen, Colorado School of Mines*
3:50 – 4:20	**Building and Testing a New Type of Vacuum Pump for Casinghead Pressure Reduction in Stripper Wells** *Presenter: Paul Weatherbee, W&W Vacuum & Compressors, Inc.*
4:20 – 4:40	**A Study to Evaluate the Effect of Completion and Production Procedures on the Ultimate Recoverable Reserves from Knox Formation Wells: Rose Run Sandstone and Beekmantown Dolomite** *Presenter: Tim Knobloch, James Engineering, Inc.*

March 9, 2005	
7:30 - 8:30	**Buffet Breakfast (Jefferson Manor) and Meeting (Peraux)**
8:30 - 9:00	**Real Time Remote Field Monitoring of Plunger Lift Wells to Reduce Production Down Time and Increase Natural Gas Production** *Presenter: Paul Tubel, Tubel Technologies, Inc.*
9:00 – 9:20	**Demonstration of Hydroslotter Technology on New York Stripper Wells** *Presenter: Lewis Taylor, Hydroslotter Corporation*
9:20 – 9:40	**Control of Water Production Using Disproportionate Permeability Reduction in Gelled Polymer Systems** *Presenter: G. Paul Willhite, University of Kansas*
9:40 – 10:00	**Extended Application of a Proven Low Cost Water Mitigation Treatment** *Presenter: Ken Oglesby, IMPACT Technologies, LLC*
10:00 - 10:20	**Break (Peraux)**
10:20 – 10:40	**Evaluating Casing Plunger Cup Design** *Presenter: Windel Mayfield, PAAL, LLC*
10:40 – 11:00	**Mud Gas Isotope Logging (MGIL) – A Leveraging New Technology for Gas Stripper Well Exploration and Production** *Presenter: Leroy Ellis, Isotope Logging, Inc.*
11:00 – 11:20	**Reverse Water Injection Pump for Gas Wells** *Presenter: Daniel Roberts, Airlift Services International*
11:20 - 11:30	**Closing Comments / Meeting Adjourned**

***SWC Executive Council Meeting will immediately follow the Proposal Meeting on March 9, taking place in Bowie.**

APPENDIX B: EXECUTIVE SUMMARIES

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Field Application of Accurate, Low-Cost, Portable Production Well Testers

Secondary Recovery methods, primarily waterflooding, provide approximately 50% of the oil production in Oklahoma. Much of this secondary production is in the northeast and the southern areas of Oklahoma. Secondary and Tertiary Recovery methods also provide a significant amount of production in other states. These type operations typically handle large volumes of water, small volumes of oil and natural gas. In addition, the Hunton, Bartlesville and Arbuckle formations also produce large amounts of water with smaller amounts of oil and gas under primary production. Accurate testing of such wells is important to determine reserves, the economics of continued operations and to evaluate projects (recompletion, gel polymers, horizontal laterals, other actions) to improve oil and gas production and/or reduce water production, i.e., methods to increase well profitability and reserves. There is no substitute for good accurate data on which to base these decisions and actions. A single incorrect decision to treat (acid stimulate, frac, workover) a given well based on bad data can cost tens of thousands of dollars, which could be used more efficiently on other wells.

Such production well testing is currently done by a centralized separation and metering stations (utilizing standard oilfield equipment or expensive electronic testing equipment) or by portable testers (standard oilfield equipment or expensive electronic testing equipment). Centralized systems require extra lines to be installed and maintained over their entire lives. This results in increased cost and risks. Portable systems allow testing at the individual well and do not require additional lines to be installed and maintained. Current low cost portable testers ($10,000) are not accurate enough, due to sampling frequency and gas interference. First generation portable electronic test units were about $125,000 (after prototyping and proving). Second generation electronic testing units, such as designed /constructed in the current 2004-2005 SWC Project, are about $80,000 but are designed to cover the full range of well conditions. That project was initiated to achieve next generation testers in the $20,000 price range.

This proposed project will take the earlier designed and constructed tester into the field for additional testing of wells/fields so that ten (10) field/area specific testers can be designed and constructed at these lower costs. This proposed project includes target identification, field testing, specific unit designs and construction, monitoring of units in the field, evaluation of obtained data and reporting of results. The knowledge of these lower cost units being used in the field will have a ‘snowball’ effect on the market- with operators, vendors and manufacturers increasing demand and lowering cost further.

The anticipated results from this work are: driving the cost of well /field specific testers down to the $25,000 price range, getting these highly portable and accurate testers to stripper well operators, driving the market price of next generation testers down to the $15,000 price range. However, the most important and lasting result will be more accurate testing results and better decisions made on the stripper wells. This will hopefully result in increased production and more reserves for the nation and consumers.

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Interaction of Nitrogen/CO_2 Mixtures with Crude Oil

A nitrogen huff and puff process has been utilized to stimulate oil production in the Big Andy field located in eastern Kentucky. This nitrogen stimulation project has been ongoing for over 6 years, in which a four fold increase in oil production has been achieved. Nitrogen is generated on site, utilizing membrane separation technology, at an approximate unit cost $1 per MCF. It requires 2.5 MCF of nitrogen per barrel of oil produced. The nitrogen obtained through membrane separation technology contains up to 5 percent oxygen by volume. Also, given the fact that a significant increase in oil production has been realized, the question becomes what is the long term effect of nitrogen injection on the crude oil.

The objective of an existing funded stripper well project has been to develop an understanding of the phase behavior of N2/O2 gases in the presence of hydrocarbons. In order to meet this objective, a PVT system was fabricated in order to measure the impact on the physical properties of the crude oil. System validation tests have been completed with propane, methane/propane and propane/ethane mixtures at different temperatures. Pressure versus specific volume data has been generated and compares well with published charts in the literature. A phase behavior computer package has been developed and is being tuned using data obtained from the field and laboratory.

Field experience has indicated that periodic injection of CO2 mixed with nitrogen has improved the volumetric flow rate of the wells. It is postulated that the CO2 tends to remove skin damage in the near well bore area. Also, it is understood that CO2 is miscible in oil.

The objective of this proposal is to evaluate the behavior of N2/CO2 injection and its impact on the recovery process. Moreover, it is likely that future legislation will mandate a reduction in CO2 levels that are generated through hydrocarbon combustion. A means of sequestering this CO2 is to inject it into oil and gas horizons. It is likely that the injection of CO2 can result in improved recovery from these horizons.

The Crude oil to be evaluated will be obtained from the Big Andy Field in Kentucky and the Chipmunk sandstone in Cattaraugus County, New York. It is anticipated that the results of these studies will be used as the underpinnings to subsequent field tests.

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Uncovering Bypassed Pay in Central Oklahoma Using Statistical Analysis and Field Tests

In a five county area of central Oklahoma there are over 12,000 stripper oil and gas wells. Many of these wells are operated by small, resource-constrained producers who lack the ability to properly evaluate behind pipe potential and/or may be unaware that such potential exists. Uncovering this hidden potential could ultimately result in the recovery of millions of barrels of oil and oil equivalent.

A team composed of Schlumberger Consulting Services, the University of Oklahoma, and Sand Resources proposes to develop, test, and calibrate a methodology to uncover behind pipe potential in mature oil fields greater than 30 years old (Brownfields). Sand Resources is the operator of twelve stripper oil wells in the NW Noble field just south of the O.U. campus in Cleveland County. A class of senior petroleum engineering students under the direction of two senior faculty members has taken on the task of evaluating these twelve wells for undeveloped, behind-pipe reserves. Schlumberger Consulting Services, through the use of its Moving Domain software, proposes to aid in the evaluation of the field and, at the same time, develop a methodology that would be made available to other operators in the state. In addition, to the development of an evaluation methodology, Schlumberger, using Moving Domain analytical techniques, would also identify areas within the five county region that includes Cleveland, McClain, Oklahoma, Garvin, and Logan Counties that appear likely to contain undeveloped potential. These operators could then be given the option of joining the Stripper Well Consortium to gain immediate access to this information.

It is estimated that this methodology could result in the recovery of an additional two to ten million barrels of oil.

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Re-fit Two Stripper Wells with Existing Large Diameter or Open Hole Completions with Spoolable Non-metallic Tubing, Transition Connections, Variable Diameter Seal Cups and Modified G.O.A.L. Casing Swab to Automatically Lift Fluids and Enhance Performance

Energy usage of oil in the United States is expected to increase by 30% by the year 2020. Natural gas demand is on course to double with in the next two decades. Current striper well domestic production of oil meets ~ 28% [~ 324,000,000 barrels/ yr in 2002] of the nations needs. Natural gas production from domestic stripper gas wells produces ~ 8% [1 TCF equivalent/yr. = 8%] of current US consumption needs.

Over the past two decades within the Appalachian basin, several tens of thousands of shallow oil and gas wells [1000' – 3500'] have been completed using open hole techniques with multiple zones notched, fractured and produced. The foci for these open hole wells is Pennsylvania, West Virginia and New York. These wells are often configured with 7.0" to 8 5/8" steel surface casing cemented through the water table aquifers, then open rock hole well bore [6.25" to 7 7/8"] to the total depth of well. These wells follow a similar production performance history as their predecessor-cased wells. Several months of flush production are followed by decreasing well pressure and yield of oil/ gas. These wells like many others with in a relative short period fall into the category of stripper well production. Down hole pressure in these wells declines to a point where the well is no longer able to lift the fluid in an unassisted manner to the surface. Often time in these multi-zone completion wells an up hole zone [s] will act as a thief for down hole higher pressure producing zones further complicating their operation and production. In on going stripper well production from these wells 'Beam Pumps', tubing velocity strings, small diameter tubing and plungers and other conventional techniques are often employed with some finite success. Most of these techniques do not allow the well to produce itself down to with in several tens to a hundred psi of the Fm. pressure. The result is non-captured reserves and higher operation cost for hydrocarbon produced.

This project will select and refit two- [2] existing 6.25"or larger gas or oil and gas, open hole stripper wells with a re-fit well system comprised of a slip lined 3.0" or 4.0" ID spooled non –metallic tubing, metal to non metal connectors, open hole packer assembly, casing stand /stop, and modified G.O.A.L. PetroPump with unique variable diameter seal cups to automatically lift fluids. The operating system will be designed and constructed to allow shallow up well, low pressure, gas to produce off the back side of the casing above the packer. The non-metallic spoolable tubing coupled with modified 'GOAL Tool' with new flex diameter cups [allows passage, without fluid/ pressure loss, across necessary non-metallic to metallic well head connections]will afford automatic and regularly lift of fluids to the surface and foster improved gas and fluids production. Comparison of pre system and post system use production and cost will be developed to project applicability and upside impacts on the stripper well industry.

Historic testing of GOAL PetroPump alone under SWC subcontract #2052-BEDC-DOE-1025, jointly sponsored by NYSERDA and SWC of the Tool in standard J-55 steel cased-perforated stripper wells has demonstrated 1.5 fold to 3 fold improved production at a fraction of the service necessary to operate other stripper well operating systems. Similar improvement is expected in re-fit wells. [Figures 1,2 & 3]

This unique new system of modified GOAL PetroPump, new variable diameter cups, packer assembly, metallic to non- metallic connection of spoolable tubing is unique for maximizing yield through re-completion of large diameter and or open hole stripper wells. Coupling non metallic spoolable tubing with a new flex wall cup accommodates passage with out pressure and or fluid loss across diameter changing transitions in tubing and packers. This coupled with the simple elegant design of the GOAL tools on board valve control allows it to free travel with in the re-fitted well bore. The new system will allow the re-fitted wells to "pump themselves" despite natural declining down hole pressures. The system is "smart" in both directions, dropping down hole when pressure at the well head is low/ reduced by down hole fluid accumulation. The system is "smart" up hole using below tool formation pressure to lift tool and fluid [oil/brine] to the surface, subsequently free floating in the well head lubricator allowing down hole pressure/ gas to flow to the process unit. At such time as pressure has declined below system control pressure, the system will once again repeating the automatic pumping cycle.

Successful application of the outlined system will have positive economic impact on the 10,000+ existing potential candidate wells. Open hole well re-fit cost at $30,000- $49,000/ well could be offset in a 1 to 1.5 year period at achievable 1.5 X to 3 X increase yield on target wells.

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Desalination of Brackish Water and Disposal into Waterflood Injection Wells

A joint venture has been created to design and operate a pilot project for inland brackish ground water desalination with disposal of byproducts into an operating oil field waterflood. The city of Andrews, Texas, in cooperation with the Texas Water Resources Institute is planning this two year, $425,000 pilot demonstration to show the feasibility and the cost effectiveness of brackish ground water (BGW) desalination as a potential source of fresh water for the community. The U.S. Bureau of Reclamation is being asked to fund $270,000 of the cost.

The SWC is being asked for an additional $105,103 for the project to fund operations relating to the oil field brine disposal operation. The Andrews pilot demonstration will use the mobile Texas A&M desalination unit which will be modified to desalinate the BGW. We will utilize oil field disposal of the concentrate from the reverse osmosis (RO) process as a cost savings option.

ExxonMobil has agreed to incorporate the concentrate into its makeup water in the Means Field Water flood operation. SWC funds will allow our A&M team to coordinate the desalination activity with the operator and to monitor the mixing characteristics of the RO concentrate with waterflood brine and to ensure safe and proper operation. ExxonMobil will realize a cost savings because of lowered make-up water requirements. Finally, the Texas Commission on Environmental Quality has given approval to the project and will issue an authorization for this type of disposal operation. This is the very first authorization of this type in the nation.

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New Technology for Unloading Gas Wells

Objective. Evaluate the performance of a variety of devices for lifting liquids from stripper gas wells.

Motivation. Removal of water and hydrocarbon liquids from gas wells is increasingly recognized as an important topic for mature gas reservoirs.

Specific Directions. The four tasks proposed below describe briefly the specific directions for this study.

1. Baffle Assembly for Boosting Liquid Production. Use the flow loop in the High Bay Lab at CSM to experimentally study performance of baffle assemblies for boosting liquid production rate of stripper gas wells.

2. Vortex Performance. Resolve the discrepancy between lab performance and field performance of vortex tools, focusing on their effect on liquid transport through the tubing-casing junction. Explore a variety of flow rates and pressures up to 60 psia.

3. Transient Design Simulation of Gas Well Loading and Unloading. Use commercial flow line simulating software to investigate the effect of condensation, transient fluid flow, and transient heat transfer on performance of stripper gas wells.

4. Gas-Flow Powered Pump. Test a prototype unit that uses a small amount of the available energy in the flowing gas stream to drive a pump that will lift liquid to the surface.

5. Liquid-Lifting Short Course. Continue one-day short courses on lifting liquids from gas wells using the CSM Flow Loop for hands-on demonstrations.

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Building and Testing a New type of Vacuum Pump for Casinghead Pressure Reduction in Stripper Wells

Recently W&W Vacuum & Compressors, Inc. has developed the Weatherbee Wedge Pump, a new, patented technology, for introduction into the oil and gas industry. It is anticipated that this new technology will potentially eliminate the problems which have, for the most part, made it economically unreasonable for the small, independent operator to attempt to increase production in stripper wells.

Cashinghead gas has always restricted the oil and gas production in stripper wells due to the pressure the "wet" or "rich" gas exerts on the formation. Existing technology used for this purpose cannot pull the volume of vacuum (throughput) necessary to alleviate the pressures exerted on the formation. Furthermore, currently used devices cannot economically handle the high BTU gas that is typical of casinghead gas. In these devices the condensate from the high BTU gas contaminates must be separated thus requiring an expensive multi-component system.
The concept behind casinghead pressure reduction is rather simplistic. Casinghead gas is relatively wet (16 - 18 GPM) as it is basically flashgas from the formation. The weight of this column of wet gas sitting on the formation has an incremental effect on bottom hole pressure. This pressure is obviously dictated by oil specific gravity and the well depth. When wellhead pressure is added (i.e., flowline or surface separation), the pressure on the formation is significantly impacted. The well pressure seen at the formation level is further complicated by fluctuating wellhead pressure from the gas line. The concept is easily understood - by relieving the pressure in the casinghead, the weight (pressure) on the formation is reduced thus allowing oil or gas to more easily flow from the formation into the wellbore. Furthermore, by reducing the pressure on the formation, down hole pump gas locking problems are dramatically reduced. Although each formation responds differently, but many mature basins have shown phenomenal increases in production.

It is believed that the Weatherbee Wedge Pump would be ideally suited to increase production in stripper wells without having to purchase the costly pumps and multi-stage components currently in use. The Weatherbee Pump will be relatively inexpensive, easy to operate and cost effective. In addition to the operators who have the financial and technical resources available to them and can justify the expense necessary to purchase and operate the expensive and complex systems on the market now, it is believed that an entire new market can be targeted (the small, independent operator) who, to date, has been priced out of the market for this technology.
The objectives of this Proposal and research project are: (1) to build three prototype models to determine the feasibility of using the Weatherbee Wedge Pump as a pressure reducing pump on stripper wells in order to increase oil and gas production;(2) design and build a test stand to simulate various wellhead conditions most common in stripper wells, and; (3) bench testing of prototypes which will allow automated real-time measurement of pressures and flow rates during operation of prototype pumps.

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A Study to Evaluate the Effect of Completion and Production Procedures on the Ultimate Recoverable Reserves from Knox formation Wells: Rose Run Sandstone and Beekmantown Dolomite

Over the years various drilling, completion, and production methodologies have been applied to the Knox Formation, specifically the Rose Run Sandstone and the Beekmantown Dolomite, resulting in various levels of production. The varying levels of success are due not only to the technology used to identify the prospects and the quality of reservoirs encountered, but also to the petroleum engineering principles applied to the completion and the production methodologies employed.

The completion and production technical issues include: cased-hole versus open-hole completions, matrix acidizing versus fracture stimulation, perforation concentration and interval selection, fluid removal methods, paraffin treatments, operating wellhead pressures, gas sales line pressures, as well as general operating procedures. As in all plays, the combined influence of these factors and the reservoir quality ultimately determine the recoverable oil and natural gas reserves.

The Knox/Beekmantown (or equivalent) has been drilled though or tested in approximately 9,500 wells in the Appalachian Basin including the states of Kentucky, New York, Ohio, Pennsylvania, and Tennessee. Some of the earliest Knox well production was in Ohio in 1919, in Kentucky in 1941, and in New York in 1949. Knox drilling represents an increasing percentage of the wells drilled in Ohio.

In Ohio alone, over 257,000 wells have been drilled from 1888 through 2004 with 215,000 being classified as productive and 42,000 as dry. The wells drilled through the Knox are identified as 5,400 Cambrian and 2,700 Knox Formation. Only 550 Knox wells were drilled from 1963 through 1989, while over 2,100 wells were drilled from 1990 through 2004 at an average success rate of 56%. A Ohio's Mineral Management's database query identified 1,480 Rose Run wells statewide accounting for greater than 11,000,000 barrels of oil and 186,300,000 mcf. In Holmes County, Ohio alone 188 Rose Run wells have cumulative average production of greater than 9,000 barrels of oil and 282,000 mcf of gas. Assuming that modifications in completion or production practices could affect 10-20% of the 1,500 Ohio Knox producing wells, and assuming that a 10-20% increase in ultimate reserves would result for each well with a estimate of 300,000 mcfeq ultimate reserves per well. The potential overall increases range from 4.5 to 18 bcf of recoverable reserves.

It is well known that many Knox/Beekmantown wells are initially very prolific. However, all these wells eventually become stripper wells and could potentially benefit from the production practices portion of this study. The most significant value of the study may be the potential of stimulation of the poorer quality reservoirs encountered in a large percentage of the wells drilled, especially to the Beekmantown.

Experience indicates that past and current completion and production practices employed have negatively impacted the ultimate recoveries of some Knox wells. The proposed study will evaluate the critical factors associated with completion and production practices and the effect on the ultimate reserves predicted. The ultimate reserves will be estimated through volumetric analysis based on open-hole log analysis, material balance, P/Z, traditional decline curve analysis, and Reciprocal Productivity Index analyses performed by BJ Services. The comparison of these reserve estimates to the critical completion and production factors should result in a methodology and application guide to delineate areas of opportunity to increase production and ultimate recoverable reserves. The study will include Knox/Beekmantown wells (or equivalent) from the Appalachian Basin and will assist operators to optimize both production and ultimate reserves. The same methodology utilized for Appalachian Basin Knox wells is anticipated to be applicable to operators of similar reservoirs in other basins.

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Real Time Remote Field Monitoring of Plunger Lift Wells to Reduce Production Down Time and Increase Natural Gas Production

Optimization of the processes required to produce hydrocarbons constitutes an on going strategic concern and a major goal in the oil and gas industry. The goal of this project is to develop a low cost surface system to achieve the following: monitor the plunger lift process in wells, transmit well production streaming audio signals to remote locations, monitor in real time the performance of the entire field and determine if and when the wells stop producing. The purpose of monitoring the plunger lift process is to optimize the production and to minimize the amount of down time and lost production from wells. This new system will acquire the information generated by the plunger as it travels in and out of the wellbore and monitors the fluids and gas being lifted by the plunger. The information will be transmitted to a central control area where the operator can listen in real time to each well performance to determine if the well is producing. A person can be dispatched to the well site for evaluation if the well is not producing. A computer system will also be developed to automatically listen and inform the operator if a well is not producing properly. This project will research, develop and test a low cost, high reliability, real time system to monitor the plunger lift well production process and provide the operator with production information to determine if the well is producing. This system will help reduce well down time, increase natural gas production lifted using plunger systems and reduced OPEX.

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Demonstration of Hydroslotter Technology on New York Stripper Wells

This project is submitted by Hydroslotter Corporation ("HSC"), which owns an innovative, patented technology named abrasive hydrojet perforation or "hydroslotting". Hydroslotting is a two-step completion process that exponentially increases permeability around a wellbore by transferring near-wellbore compressive stresses away from the wellbore and out into the formation. The first step is to cut two 180^{o}-phased slots through the casing, cement, and deep into the formation, to gain access to the targeted undepleted pay zone. The second step is to cycle proprietary remedial chemical reagents throughout the near-wellbore zone via the newly created slots. It should be noted that only hydroslotting (and no other technology) transfers near-wellbore damage to the distant tips of slots as a method of maximizing productivity and extending a well's life.

It needs to be emphasized that HSC's slot-cutting process has been documented as excavating deeper into formations (reaching out 10 feet deep and over 1 inch wide, compared with 3 feet deep and 1/2 inch wide) and using different petro-chemistries than previous or conventional technologies, which may or may not have been used in the past or are currently available. It should be clarified in advance that hydroslotting is either far more advanced than or not related to "notching". Hydroslotting is the opposite of hydraulic fracturing.

This project will demonstrate the precision, efficacy, and performance of hydroslotting on five different well environments in three New York geological zones: Onondaga, Medina, and Theresa. At least one demonstration will be so close to a gas-water contact that completion using hydraulic fracturing would be perilous or bound to failure. The project will cover field orientation, program configuration, and evaluation and monitoring. The project will produce a good understanding of the performance capability of hydroslotting as a method of enhanced recovery in various types of wells and formations for future deployment.

The successful demonstration of hydroslotting will solve one of the perennial problems that inhibits oil and gas productivity, namely, the impact of unnatural compressive stresses (usually caused by drilling and completion damage) on well productivity. When widely applied, hydroslotting will provide independent operators with a cost-effective and environmentally benign alternative to conventional completion technologies and help achieve the inflow improvement and breakthrough economics needed to maximize production from and extend the life of their wells. This will eventually add significant reserves to the nation's energy resources.

The proposed technical approach consists of carefully planned analysis and field-tests in three different formations and five well environments, which achieves the research objectives of reservoir remediation and satisfies the overall program goals set forth by the Stripper Well Consortium (SWC). Bulletins and details of the project will be transferred to interested parties through regular progress reports, publications, and informal contacts, as well as SWC meetings. Letters of in-kind support from New York Gas and Oil Company and Quest Energy Inc., both of Buffalo, New York, are attached for reference.

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Control of Water Production Using Disproportionate Permeability Reduction In Gelled Polymer Systems

A two-well field test is proposed to determine if the water production rate following treatment of a well using a gelled polymer system can be reduced by a process in which the gel that has formed in situ is dehydrated following placement by slow injection of oil. Oil flow channels formed by the dehydration process exhibit preferential permeability to oil over water because of the large permeability reduction when water displaces the oil from these channels leaving a residual oil saturation with low permeability to water. This mechanism, termed disproportionate permeability reduction, reduces water permeability by at least an order of magnitude in laboratory tests. It is believed that reducing the permeability of these flow channels to water will enhance displacement of oil from other regions of the reservoir containing mobile oil as water flows from the aquifer to the wellbore under the prevailing pressure gradient. Three results are anticipated: 1) substantial reduction of water production rates after treatment, 2) increased incremental oil production caused by creation of new displacement paths for the water moving to the wellbore and 3) longer interval between gel treatments because the dehydrated gel is stronger than the original gel because the polymer concentration increases in the gel that is dehydrated. The field test is a cooperative field demonstration program between the Kansas University Energy Research Center and the Vess Oil Corporation, an independent oil company located in Wichita, Kansas.

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Extended Application of a Proven Low Cost Water Mitigation Treatment

Secondary and tertiary recovery methods, primarily waterflooding, provide approximately 50% of the oil production in Oklahoma. Much of this secondary production is in the northeast, central and the southern areas of Oklahoma. Secondary and Tertiary Recovery methods also provide a significant amount of production in other mid-continent states, including Texas, Kansas, Arkansas, and Louisiana. These type operations typically handle large volumes of water, but small volumes of oil and gas. Water production also impacts gas well production in many areas. In addition, the Hunton, Bartlesville and Arbuckle/ Ellenberger formations also produce large amounts of water with smaller amounts of oil and gas under primary production.

One of the biggest cost and headaches of operators on many, many wells is the problem to lift, treat, process and re-inject or haul off and dispose of excess produced water. The bottom line problem is that water production is expensive to pump, lift, separate, treat, pump and reinject. Its cost is between $0.12 to $1.50 per barrel of produced water. Reducing the watercut in a field and on a well basis, under primary, waterflood or tertiary recovery methods, is important for efficient and economic operations. As the watercut increases, the profit margin on that well decreases reaching a point where the well is no longer economic and the well must be shut-in and plugged. Extending the life of the well or field by mitigating/reducing costly water production, will improve profitability and extend the productive life of these wells/ properties and increase ultimate oil recovery.

A non- polymer water shut off treatment was developed and field tested in Kansas by a major oil company in the 1970s. Continued field testing was performed by a Kansas independent through the 1990s, who improved the treatment process. A total of 12 injection wells and 1 production well have been treated in 10 properties in central Kansas. Average field improved recovery was 17,855 bbls of oil per treatment over 25 months.

The primary benefits of this process are that it is very low cost (about 50% of current gel polymers) for larger treatments, non-toxic, easy to handle/ mix and pump in the field, inorganic thus no problems with microbes, aqueous salt solutions that seek the path of the injected water, stable for a long life with a sufficient shear strength to remain in place for long term water shut-off with no back flow, non-corrosive, inert to most oilfield chemicals, works in either carbonates or sands, can be mixed and buffered with many high- saline / brackish reservoir waters, and will not set up in oil saturated zones.

This project will treat at least 23 wells with this treatment and will report the results. This proposal tests the applicability of extending this very low cost, non-polymer process in other mid-continent injection wells. It also tests the possibility of an improved single stage treatment process. These treatments can then be extended to other geographical areas and into production (oil and gas) wells. Once this water mitigation treatment is further proven to be low cost and reliable in an extended geographical area, the process can be made commercially available to the industry.

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Evaluating Casing Plunger Cup Design

After decades of casing plungers using "pear-shaped" tapered elastomer sealing cups, PAAL, LLC has introduced a patented casing plunger known as the PAL. Older methods employed an elastomer cup with the major outside diameter larger than the casing inside diameter. This design provided the necessary sealing contact surface with the casing wall, but it also increased the premature wear of the cups and often created a condition in which the casing plunger could become wedged against the casing wall and fail to fall to bottom for correct operation.

After five years of intensive research, design, and field testing, the PAL has been granted one patent with others pending. PAL improves reservoir operations by reducing operating pressures in many stripper gas wells. This reduction extends the length of the productive life, increasing total reserves recovered. In other stripper gas wells, rod pump units have been replaced with PAL casing plungers, successfully removing the accumulations of fluid in the well bore that seriously restrict gas production.

Since the novel cup design of the PAL, incorporated into a totally revolutionary mechanical design, is smaller than the casing inside diameter, the cups do not experience unnecessary wear during descent. The cups are mechanically and pneumatically expanded and sealed at the bottom of the well. This has enabled the effective production of wells with tapered casing strings, as well as those previously excluded due to squeeze cement casing leak repairs.

In spite of these significant accomplishments, much remains to be determined to further advance optimal reservoir operations. This request for funding seeks to determine actual well bore testing and diagnostic evaluations of various aspects of the elastomer sealing cups. Still to be determined are the specific responses of any number of elastomer choices for sealing cups. This proposal offers to modify an existing PAL casing plunger to provide test chambers in which to suspend various samples of elastomers to be exposed to bottom hole and well bore conditions to determine the best choice of cup materials. This will eliminate many costly and unsuccessful "trial and error" attempts to guess the best choice. After exposure to actual well conditions, which vary greatly from well to well and reservoir to reservoir, cups can be manufactured for specific well conditions. Skilled professionals will supervise and obtain the field data, providing useful data for the industry.

This proposal permits the inclusion of BHP/BHT (bottom hole pressure and bottom hole temperature) data collection, both above and below the sealing cups simultaneously. This data will be acquired in the well bore under actual conditions and can be correlated to depth to determine the actual hydrostatic differentials across the sealing contact surfaces. Empirical data has been observed that indicates substantially different wear rates exist between the upper and lower cups. This data will provide the industry with the information necessary to best design casing plunger cups. This proposal, if approved, will contribute significantly to the state of the art in casing plunger cup design.