Convert 15 wells to BORS Pumping Units and Test/Compare to Conventional Units

Final Technical Report

Reporting Period Start Date: September 1, 1999

Reporting Period End Date: March 31, 2000

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February 4, 2003

DOE Award Number DE-PS26-99BC15251

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Forward

The attached Final Technical Report is being provided by the National Energy Technology Laboratory and RMC Consultants, Inc. on behalf of the original project Principal Investigator, Truluck Enterprises, L.L.C., and their subsequent joint venture partner, Croesus Capital Group, L.L.C.

The material contained in this Final Technical Report was compiled primarily from information obtained through communication and correspondence with personnel from Truluck Enterprises, Croesus Capital Group, and the BORS Lift inventors, as well as information from various reference materials.

Abstract

A new type of fluid lifting equipment called Balanced Oil Recovery System (trade named BORS Lift™) was installed on several idle oil wells to demonstrate the operating efficiency of this innovative equipment technology. The BORS Lift system is designed to bring oil to the surface without the accompanying formation water. The BORS Lift system uses an innovative strap mechanism that takes oil from the top of the downhole oil-water column and lifts it to the surface, eliminating production of the formation water. Eliminating salt water production could potentially increase oil production, reduce operational costs, benefit the environment, and cut salt water disposal costs. Although the BORS Lift units did not function as intended, lessons learned during the course of the field demonstration project resulted in improvements in the technology and redesign of subsequent generation BORS Lift units which are reported to have significantly improved their performance characteristics.

BORS Lift units were installed on 15 temporarily abandoned wells which had been shut down due to low oil production, high water production, and uneconomic operating conditions. The wells had been producing with artificial lift at a high watercut from a shallow (850-900 feet), pressure depleted oil sand reservoir prior to being shut down. The electrical motor driven BORS Lift units provided a possible approach for economically returning the shallow, low-volume oil wells to production. The BORS Lift units used in this field demonstration were designed to recover up to roughly 22 barrels of fluid per day from depths ranging to 1,700 feet, ideal for many marginal stripper well operations. The BORS units were first-production-model test units, operated under oil field conditions for the first time, and were naturally expected to experience some design problems. From the onset, the operator experienced mechanical, design, and operational problems with the BORS Lift units and was unable to maintain un-interrupted production operations. The inventor provided considerable on-site technical support in an ongoing effort to correct the problems with the units and the inventor worked extensively with the operator to make design and manufacturing changes to the units to try to improve their reliability and performance.

The operational problems were mostly related to the durability of the various components under oil field operating conditions such as inadequate mechanical, electrical, and electronic design for rough service, extended operation, and severe weather conditions. During the course of the demonstration project, it further appeared that the producing formation lacked sufficient reservoir energy and/or favorable oil properties to mobilize and displace oil from the formation into the well bore in order to recharge the oil column in the well. The BORS Lift units were then moved to a second lease which appeared to have more favorable WTI quality oil properties. Eight of these units were reported to have been installed and placed in operation on the second lease, however, operational difficulties continued. It was determined that the units were inadequately designed and would need to be replaced by improved second generation units. Due to the lack of success with the first generation units and the extra cost to replace them with the redesigned units, the operators decided not to continue with the project and the project was terminated at that point.

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Introduction

The field demonstration project proposed to test a new type of artificial-lift pumping unit in order to lower the operating cost of stripper wells on the T. J. Smart Lease in Jefferson County, Oklahoma. High water cut and frequent repairs due to salt water corrosion were very common operating problems. High electrical costs associated with moving large volumes of salt water, combined with extensive labor and equipment costs associated with constant repairs to conventional surface and subsurface equipment were making low oil cut wells uneconomic to operate. The 15 active wells on the lease, equipped with conventional beam pumping units and rod pumps, were producing 15 barrels of oil per day and 180 barrels of water per day. There were 15 other wells on the lease that had been temporarily abandoned. Lease production was from the pressure depleted Hoxbar sand formation at 850-900 feet.

The new lifting equipment, trade named BORS Lift™ for Balanced Oil Recovery System, is designed to extract oil from the well at the same rate it flows into the well bore from the surrounding formation without extracting the salt water below the oil. The BORS Lift system uses an innovative strap system to lower a flexible, hollow cylindrical tube down through the well casing to the balance point at the top of the oil column in the well bore where the tube fills with oil. The oil filled tube is then lifted to the surface, drawn into a shroud, and the oil is drained into a small holding tank. The oil is periodically transferred from the holding tank to a larger storage tank. While the oil-filled tube is lifted to the surface, oil driven by reservoir energy migrates from the formation into the well bore to recharge the fluid column. The tube is then lowered back into the well and the process is repeated.

A custom evaluation and a proprietary mathematical formula are used to calculate the balance point and to determine the rate that oil flows into the well from the formation. A computer control system, which controls the mechanical lifting system, manages oil extraction at the same rate as it enters the well. Careful calibration of the depth-settings and withdrawal rates ensures that the oil is extracted with a minimum of water production. Powered by a small electric motor, the BORS Lift units used in this field demonstration project were designed to recover up to roughly 22 barrels of fluid per day from depths ranging to 1,700 feet.

Lower electrical power costs, low or no salt water production, and lower equipment maintenance costs would significantly reduce operating costs and reduce environmental risks associated with saltwater handling and disposal at the surface. The proposed technology, if successfully demonstrated, could allow many economically marginal stripper wells to remain in production for a much longer period of time, recovering a significant amount of additional reserves.

Experimental

The field demonstration project involved the application of a newly developed, innovative artificial-lift fluid production technology intended to increase oil production at a lower cost while eliminating salt water production in oil recovery operations. The Balanced Oil Recovery System (BORS) technology, trade name BORS Lift™, is a system designed as a complete unit to extract fluids, specifically crude oil, from the static fluid column in an oil well. The BORS Lift technology was developed to produce oil from shallow, low-volume, non-flowing wells in a weak solution gas or gas cap drive reservoir. The BORS Lift units used in the field demonstration project were designed to recover up to approximately 22 barrels of fluid per day from depths ranging to 1,700 feet.

The BORS Lift system consists primarily of a small skid mounted surface unit on which are mounted a fluid holding tank with an fluid transfer pump, an electric motor driven mechanical lifting device connected to a revolving wheel, and a computer control system; an inclined shroud connecting the holding tank to the well head; and a nylon strap system connected to a flexible, hollow cylindrical tube which are lowered through the shroud into the wellbore by the mechanical lifting device and revolving wheel.

In operation, the strap system is used to lower the weighted flexible tube down through the well casing to the top of the static fluid column in the well bore where the oil on top of the oil-water column fills the tube. Using the strap system and mechanical lifting device, the oil filled tube is then lifted to the surface, drawn into the shroud, and the oil drains from the tube into the holding tank. The oil is periodically transferred from the holding tank to a larger storage tank. While the oil-filled tube is lifted to the surface, oil driven by reservoir energy migrates from the formation into the well bore to recharge the fluid column. The tube is then lowered back into the well and the process is repeated.

Lift timing is matched to oil inflow by performing a custom evaluation using input such as porosity, water saturation, permeability, depth to perforations, oil/water/gas production drive, and oil and water gravities. A proprietary mathematical formula is used to calculate the "balance point" in the oil column and the rate that oil flows into the well bore from the formation. An integrated computer logic control system, which operates the mechanical lifting system, times the cycling sequence and manages oil extraction at the same rate as it enters the well bore. Calibration of the depth-settings and withdrawal rates ensures that only the oil is extracted with a minimum of water production.

Results and Discussion

The objective of the field demonstration project was to install newly developed BORS Lift units on 15 temporarily abandoned wells, and evaluate production efficiency compared with currently used beam pump jacks and rod pumps. Plans were to install two BORS Lift units per month, with production monitoring during the entire time frame. The operator expected to find that the BORS Lift technology increases oil production, reduces operational costs, benefits the environment and cuts disposal costs by eliminating salt water production.

New, first generation BORS Lift units were installed on the 15 temporarily abandoned wells on the lease. The BORS units were first production model test units, tried for the first time in a full scale field demonstration under oil field operating conditions, and were naturally expected to have some design problems. Overall, for numerous unanticipated reasons, the opportunity to test the BORS units properly did not fully materialize.

All of the BORS Lift units experienced considerable mechanical and manufacturing related operating difficulties. The units would operate only about one day out of a week at most, before breaking down. Each unit had to be attended continuously to be repaired in order to keep them working for any amount of time. Most of the operational problems were associated with inadequate manufacturing and design problems such as the use of 3/4-inch flowlines, PVC fittings, single phase motors, and improperly grounded and protected computer and electrical components. Lightning strikes during frequent local thunderstorms caused damage to the control system computer and electrical components. There were problems with the nylon strap system tangling in the lifting mechanism, the stuffing box had to be redesign, and there were malfunctions of the magnetic stop mechanism.

In addition to the mechanical and manufacturing related problems, several other unanticipated problems were encountered such as the high viscosity of the oil on the T. J. Smart Lease, lack of proper driving mechanism (reservoir energy) for the wells, lack of sufficient pre-installation due diligence, and insufficient attention to well-setting recommendations by the manufacturer.

The inventor provided considerable on-site technical support in an ongoing effort to correct the operational problems with the units. The inventor worked extensively with the operator to make ongoing design and manufacturing changes to the units to try to improve their reliability and performance. The inventor switched to a new manufacturer to improve quality control and began incorporating the experience being gained from the demonstration efforts into a new generation of units. The inventor redesigned some of the components, using stainless-steel and made modifications and up-grades to bearings, and other components. The new units had reinforced wheels and rollers for the straps to prevent strap tangling, newer magnetic units and computers, better motors, faster cycle times, as well as other retrofitted items.

After considerable concerted effort, it became apparent that the BORS Lift technology

was not suited for this particular lease due to the oil's viscosity and low reservoir energy. A joint venture was formed between the operator and an investment group with the initial purpose of funding the movement and installation of the BORS Lift units from the T. J. Smart Lease to a different lease which would be better suited for the technology. The new group, working with the inventor and new manufacturer, located a potential candidate lease identified as the Baptist Foundation/MacGregor Lease in Shackelford County, Texas. Historical and current data on a number of aspects of the field were collected for review and analysis in order to insure that the lease was a worthy prospect for the BORS technology. Past information, including well logs, production figures, oil sale report documents, etc, were assembled in order to build a substantive database with reference to historical production. Several of the BORS Lift units were moved to the Baptist Foundation/MacGregor Lease, installed, calibrated, and placed in operation for monitoring, however, operational difficulties continued.

After some anecdotal evidence, coupled with hard input from the new manufacturer of the machines, it was determined that the first generation units, manufactured by a company with little or no experience in oil field application, did not have the rigorous quality control measures or production specifications necessary to produce machines that were durable, reliable, and would function as intended in the field. The cost to retrofit and upgrade the original units to improve reliability was cost prohibitive. As a result of this realization, it was decided that the only way possible to properly test the technology would be to purchase and install new generation units. Due to the cost to purchase the new generation units, the older units were removed from service, placed in storage, and the project was terminated.

Conclusions

The first generation BORS Lift units as delivered from the manufacturer and used in this field demonstration project were not sufficiently durable enough for oil field production application. Although the technology was invented and developed by inventors who had some oil field experience, the units were manufactured by a manufacturer with no background or experience in oil field operations. The units did not have the rigorous quality control measures or production specifications necessary to produce machines that were durable, reliable, and would function as intended in the field.

These first generation units had not been previously operated under oil field conditions and thus suffered from numerous unanticipated operational problems. The various operational problems were analyzed as encountered and the units were retrofitted in the field with replacement parts on an ongoing basis during the course of the project. Additional testing of prototype units under realistic oil field operating conditions during the manufacturing phase would probably have identified many of the design and operational problems, allowing those problems to be addressed and corrected before the units were installed in the field.

Although the demonstration project produced little tangible results in and of itself, the lessons learned and the operational experience gained provided invaluable information to the inventors and to the succeeding manufacturer. Using the feedback and experiences from the field, following generations of BORS Lift units incorporated design changes and renovations which appear to have significantly improved their performance.

Success of subsequent generation BORS Lift units in field operations has been reported by Regent Energy Corporation (Reference 1 , December 2001; reference 2, October 2001; and reference 3, September 2001), Rocky Mountain Energy Corporation (Reference 4, October 2002), and Renco Energy (Reference 5, April 2000; and reference 6, May 2000).

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