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Report Title Plunger Lift Process Optimization Using a Surface System for Plunger Generated Acoustic Noise Detection and Digital Signal Processing for Wellbore Plunger Location Monitoring

Type of Report: Final Report

Project Report Period: Start Date – August 01, 2004

End Date- March 11, 2005

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Date Report was issued: March 11, 2005

Subcontractor No. 2773-TTI-DOE- 2098

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Disclaimer

Abstract

The hydrocarbon producers today are faced with significant challenges to maintain wells operational and production cost effectiveness due to large changes in electricity rates in different parts of the US, volatility of oil and gas prices and unexpected requirements for intervention in the wells. Optimization of the processes required to produce hydrocarbons constitutes an on going concern in the oil and gas industry. The goal of this project was to develop a low cost surface system to monitor the plunger travel in a well and when it hits the springs in the lower section of the well. The purpose of monitoring the plunger location is to assure that the maximum amount of liquids will be lift every time the plunger is brought to the surface. The surface system will be based on an existing commercial low end system used to process data from a downhole wireless gauge system developed by Tubel Technologies in conjunction with the Stripper Well Consortium for low end wells. This new system will be able to optimize plunger lifting operation and to lower lifting costs and increase the pump reliability. The project will acquire and map the noise generated by the plunger in the well as it travels in and out of the well in an attempt to determine when the plunger hits the springs in the well. This project will research, develop and test a low cost, high reliability, real time system to determine when the plunger hits the springs inside the wellbore to optimize the lifting process. The surface system will be divided into 2 sections: A wellhead acoustic to electrical converter module and a low cost portable system with advanced real time digital signal processor and interface to a pump controller using 4 -20 milliamps output to command the

pump controller to start the unloading process. Analog inputs will also allow for surface parameters to be acquired and processed in real time by the surface system.

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Fig. 2 Noise generated by the flow of fluids from the wellbore during production

Introduction

The ability to optimize the production of hydrocarbons when using an artificial lift system is essential to reduce the amount of energy required to lift the hydrocarbon. Today, this task is performed by automatically timing (either time or pressure) at the surface when the artificial lift system should be turned on and off, and in some cases echometers are used at the surface to determine fluid level. This open loop approach is often quite inefficient and in most cases is a guessing game at best increasing considerably the cost of lifting hydrocarbons.

Plunger lift operations are difficult to optimize due to extreme conditions such as well depths, tubing obstructions, multiple plunger type characteristics and fluid characteristics as well as the lack of information related to tubing and annulus pressures, liquid accumulation on the tubing and location of the plunger. The plunger uses the reservoir gas energy to lift the liquids to the surface without any additional power required making the lifting process quite inexpensive. The location of the plunger in the well is essential for the optimization of the process since the closer to the bottom of the well the plunger is located when the unloading process starts the higher the fluid column it can lift to the surface. With traditional plungers, when optimized , the well should only be shut long enough for the plunger to reach bottom.

The plunger lift process is divided in 3 stages: Unloading which performs the lifting of the fluids to the surface, after-flow which allows the unobstructed production of gas after the liquids are lifted and shut-in which stops production and allows the plunger to fall to

the bottom of the well. The optimum shut-in process time is not known and the travel time of the plunger into the well is also unknown to the operators causing the lifting process to be quite inefficient. An excessive shut in period is equated to downtime and a loss of production.

This project addressed these inefficiencies and eliminated them.

Executive Summary

The hydrocarbon producers today are faced with significant challenges to maintain wells operational and production cost effectiveness due to large changes in electricity rates in different parts of the US, volatility of oil and gas prices and unexpected requirements for intervention in the wells. Optimization of the processes required to produce hydrocarbons constitutes an on going concern in the oil and gas industry. The goal of this project was to develop a low cost surface system to monitor the plunger travel in a well and when it hits the springs in the lower section of the well. The purpose of monitoring the plunger location is to assure that the maximum amount of liquids will be lift every time the plunger is brought to the surface. The surface system was based on an existing commercial low end system used to process data from a downhole wireless gauge system developed by Tubel Technologies in conjunction with the Stripper Well Consortium for low end wells. This new system optimized plunger lifting operation and to lower lifting costs and increase the pump reliability. The project acquires and maps the noise generated by the plunger in the well as it travels in and out of the well in an attempt to determine when the plunger hits the springs in the well. This project researched, developed and tested a low cost, high reliability, real time system to determine when the plunger hits the springs inside the wellbore to optimize the lifting process by reducing shut in time, and ensuring adequate fluid removal from the well bore. The surface system is divided into 2 sections: A wellhead acoustic to electrical converter module and a low cost portable system with advanced real time digital signal processor and interface to

a pump controller will command the pump controller to start the unloading process.

Experimental

Experimental Apparatus –

The tests performed required the following equipment:

1. Surface system with cables for interfacing to PC and acoustic converter.
2. Personal Computer
3. Acoustic to electrical converter
4. Acoustic holder on the production tubing.

Experimental and Operating Data –

The test encompassed interfacing the decoder to the well production pipe and monitoring through the PC the lifting process using the plunger going in and out of the wellbore. The system monitored multiple cycles of the plunger lift process utilizing different gain levels to tune in the system for the noise generated by the plunger movement throughout the wellbore. The tests were very successful.

The pictures below provide some information about the acoustic signature of the plunger noise as it hits the bottom of the well and also as it is lifting the fluid to the surface.

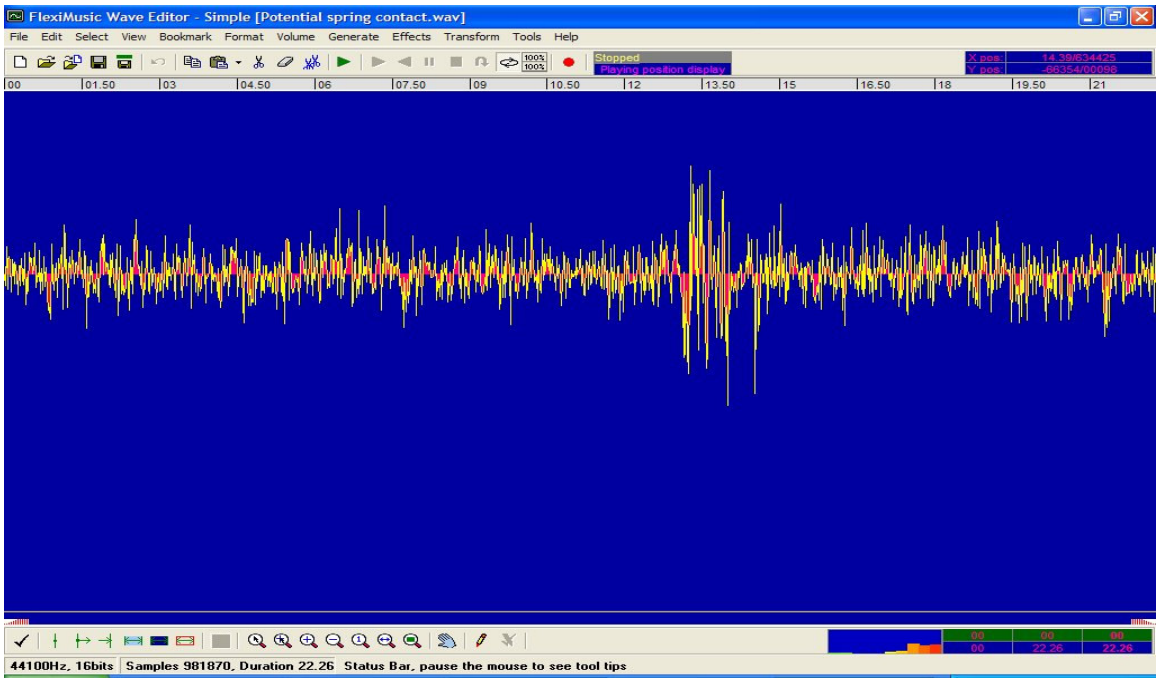

Figure 1. Signal generated when plunger hits springs on the bottom of the well.

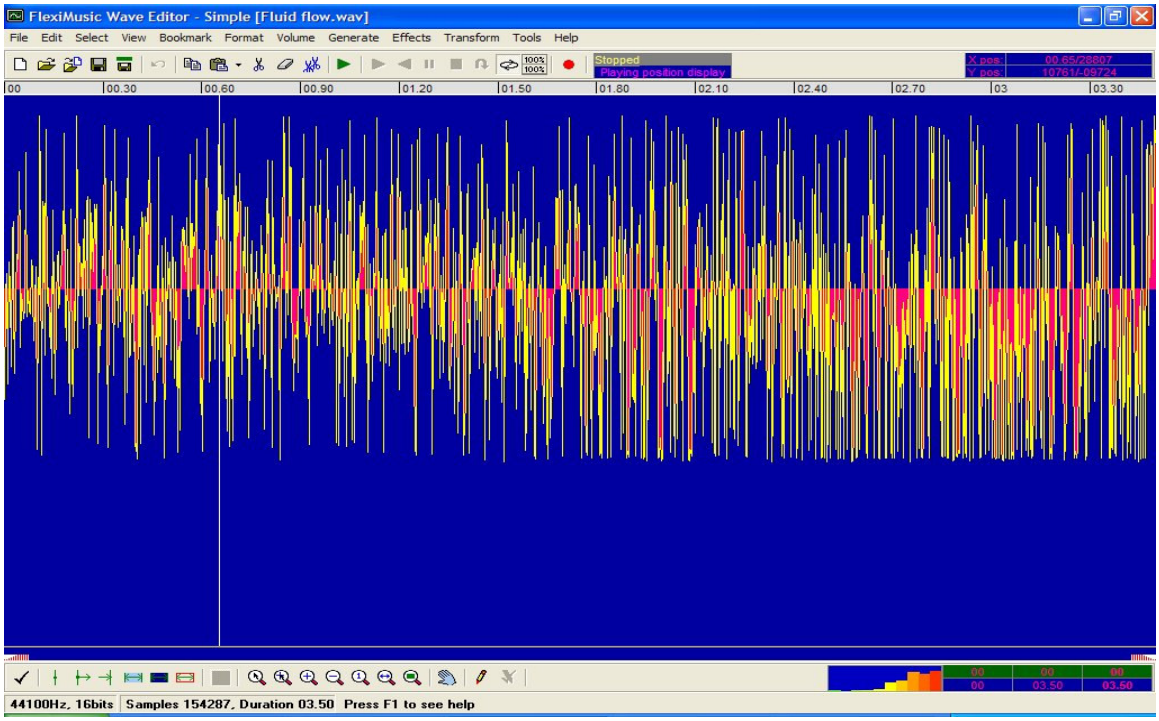

Fig. 2 Noise generated by the flow of fluids from the wellbore during production

Test Results:

1. The test results showed that the system concept and performance were successful. The system was able to pick up the acoustic signals and translate them into signals that could be used to track the plunger in the field
2. The tests showed that the system is capable of picking up signals from deep wells such as the 2 wells at BP with depths of over 8,000 ft.
3. The tests also indicated that the system can pick up production noise that will provide an indication that the well is producing.

Results and Discussion

The plunger lift production optimization surface system development has been completed and the results have surpassed all performance expectations at Tubel Tech. The system was tested successfully in 2 British Petroleum plunger lift wells that were 8,000 ft deep. The surface system was capable of detection the plunger as it passed the tubing collars, detected when the plunger hit the well fluid and also the contact between the plunger and the springs at the bottom of the well.

The new system is low cost and easy to deploy. The plunger lift optimization system features include the following:

1. It is non intrusive, so it does not require anything to go inside the wellbore for the system to detect the plunger information.

2. The system is passive so that it does not require any signals to go inside the wellbore to obtain the plunger information.

3. The system can be used as a portable device to go from well to well for production optimization or it can be deployed at the well permanently.

There are 2 areas of development that will enhance the surface system for plunger lift optimization. The first is the ability to provide the plunger data into a remote location. The other would be to develop a smart plunger system.

The new system would provide the information obtained inside the wellbore 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 system will help reduce well down time, increase natural gas production lifted using plunger systems and reduced OPEX.

The other project would be to develop technology necessary to create a smart plungers with the following features:

1. Embedded pressure sensor to provide fluid column levels in the wellbore.
2. Accelerometers to measure if the plunger is moving or not in the well.
3. Acoustic communications to provide downhole parameters in real time while the plunger is on the bottom of the well or plunger is stuck in the well.

Conclusion

Tubel Technologies has developed a surface system for optimization of the plunger lift process. The system acquires the noise generated by the plunger as it travels in and out of a wellbore. The noise provides information related to the following:

1. When the plunger goes through a collar.
2. Plunger hits the wellbore fluid.
3. Plunger hits the downhole springs.
4. Plunger is at the surface.
5. When hydrocarbons are being produced at the surface.

The information above can optimize the plunger process providing the following information:

1. If the plunger is stuck in the well.
2. Provides the proper time to turn on the surface valve to start the lifting process.
3. Determine when to shut down the production to start the process to get the plunger back to the bottom of the well.
4. Allows the lifting process to be optimized by lifting only after the plunger hits the downhole springs.
5. Monitors production.

Tubel Tech system is composed of a surface noise detector, a signal processor, a controller electronics board and a power supply for AC or solar interface. The system can provide a 4-20 milli Amperes output that can be interfaced to a plunger controller at the wellsite to provide information such as if the plunger has reached the bottom of the well. The system uses an advanced software package

to detect the events occurring in the well. The software is based on the wireless gauge data acquisition system.

References

There are no references related to this project and work.

Bibliography

There is no bibliography related to the work being performed.

List of Acronyms and Abbreviations

There are no acronyms or abbreviations in this report.

Appendices