

Development of a through tubing (microhole) artificial lift system

FINAL TECHNICAL REPORT

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GAS PRODUCTION SPECIALISTS

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DISCLAIMER

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ABSTRACT

The goal of this project was to develop a small diameter pump system capable of being deployed through existing production tubing strings in oil/gas wells. The pump system would then pump water up an inner tubing string (likely coil tubing) and allow gas to flow in the annulus between the coil tubing and production tubing. Accomplishing this would allow wells that are currently loaded up (unable to flow at high enough rates to lift the fluid out of the wellbore) to continue to produce additional gas/oil reserves.

The project was unable to complete a working test system due to unforeseen complexities in coupling the system components together in part due to the small diameter. Although several of the individual components were sourced and secured, coupling them together and getting electricity to the motor proved technically more difficult than expected. Thus, the project is no longer active due primarily to the complications realized in coupling the components and the difficulties in getting electricity to the submersible motor in a slimhole system. The other problem in finishing this project was the lack of financial resources. When the grant was first applied for it was expected that it would be awarded in early 2004. Since

the grant was not actually awarded until the end of August 2004, GPS had basically run out of \$\$\$ and the principle developer (Steve Bodden) had to find a full time job which began in late July 2004. When the grant was finally awarded in late August, it was still hoped that the project could proceed as a part time development but with less financial exposure to the partners in GPS. This became very problematic as it still had many technical obstacles to overcome to get it to the stage of prototype testing.

REPORT DETAILS

The final results of GPS efforts to build a small electrical submersible pump system to dewater loaded up gas wells were unsuccessful. The two primary reasons the project was unsuccessful was the lack of financial resources and the complexities in building a complete system capable of operating in downhole conditions. The problems with financing of the project developed primarily due to the later than expected timing of the awarding of the grant. GPS was expecting the grant to be awarded in early 2004 when in fact it was not awarded until late August 2004. Because GPS was running very low of funds by this time, the principle developer, Steve Bodden, began consulting and looking for permanent employment to reduce the funding that the GPS investors had to come up with. In fact, Steve Bodden began permanent employment with Stone Energy approximately one month before the grant was actually awarded. Even so, work continued to attempt to complete the development. The other main reason for not successfully completing the project was in the unforeseen technical problems. In attempting to complete the project, GPS obtained three of the 5 components that were thought to be the main components of the complete

system. GPS obtained a progressive cavity pump, a slimhole electrical submersible motor, and a slimhole 10 to 1 gear reducer to allow the high speed motor to operate the progressive cavity pump. The main obstacles to complete the testing were the problems in coupling these devices together and deploying them inside an actual well. The plan called for running coil tubing and either running the electrical cable inside or outside the coil tubing and allowing the gas to flow up the coil tubing / production tubing annulus. As per the original application, the project was broken down into a total of 14 tasks that had to be completed for a successful prototype test to occur. Below is a summary of the results of each task of the project.

Task 1.0 - Progressive Cavity pump manufacturing and delivery

GPS was successful in obtaining two progressive cavity pumps from KUDU Industries, Inc. These pumps modified slightly from the "off the shelf" pump to allow for the electrical cable to pass along side the pump and down to the motor.

Task 2.0 - Motor modifications

This task was included because at the time the DOE application was

being prepared, a hole was discovered in one of the two motors. The plan was to have Woodgroup ESP make the repair but since the other motor seemed fine, this was not seen as critical to get the project to the prototype testing stage. It was decided to proceed with the one good motor and repair the second motor only if it was needed.

Task 3.0 - Gear manufacturing and delivery

The gear section was required because a progressive cavity pump is not designed to be turned at as high of rates as the electrical motor would rotate. GPS took delivery of two slimhole 10 to 1 gears from ITW Spiroid in December 2004 for a cost of \$10,000.

Task 4.0 - Thrust bearing/flex shaft section

Task 5.0 - Electrical throughput section

Task 6.0 - Bench test of all downhole components

GPS was not successful in engineering/manufacturing thrust bearing and electrical throughput sections. These were two of the components that were more technically complex than what had been expected. Because of the small diameters, both of these components became very difficult for a

machinist to actually build and yet have enough strength to stand up to downhole conditions. Obviously, without a complete system, the bench testing of all downhole components could not be accomplished.

Task 7.0 - Identification of candidate wells for prototype testing

Although the system was not complete, GPS did advance this particular item. A specific trip to Houston working in Devon's office revealed several candidate wells that would likely benefit from this type of system. The wells were relatively shallow and had large diameter tubing to allow planned system to be deployed in a "rigless" manner.

Task 8.0 thru Task 14.0 - Steps to accomplish prototype testing

Without completion of the steps above, it is obvious that the project did not make it to these stages. Tasks 8.0 thru 14.0 were the steps needed to prototype test a system in an actual well.

Lessons Learned/Path Forward

Although the system could not be developed by GPS using the same basic technology that already exists within the oil & gas industry, it is still believed that the idea/concept to pump small volumes of liquids from wells to eliminate well loading problems is a good idea. When this idea was first developed by GPS, oil & gas prices were much lower than today's prices. The higher prices make this an even more attractive idea than the original business plan had planned.

The major hurdles encountered centered around the electrical system and how to get power down to the motor in such a slimhole environment. Because of this, perhaps a better approach would be to use either gas or hydraulic power to supply a downhole pump that could then pump fluids to the surface. Like the electrical submersible system that GPS tried to develop, these exist although not in a slimhole type of application. A gas power pump for example, would still need three separate flow paths from the bottom of the well. A downward flow of gas to power the pump, an upward flow path for the pumped liquids, and an upward flow path for the produced natural gas. This could possibly be accomplished by running two

strings of small diameter coil (example Dyna-Coil) and allowing the gas to flow up the annular space between the two strings of coil and the production tubing. This type of system now seems less complicated when compared to the electrically powered system that GPS attempted to develop.

Another lesson learned would be to try developing a system on a larger scale in terms of financial terms. GPS tried to develop this system as cheaply as possible rather than attempt to hire a lot of outside consultants and the time spent taking this path ended up being a major obstacle in the success of the project.