Oil and Gas TECH FOCUS – Cost-Effective Artificial Lift for Wells with Low GLR

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Multi-Stage Plunger Lifts Offer Economical Alternative to Pumping Units

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INTRODUCTION

Plunger lifts are effectively used primarily in natural gas drilling, and particularly appropriate for wells in which natural depletion has fallen below critical flow rate, or for wells with high accumulations of solids such as sand, salt, coal fines, paraffin and scale. Because it is easy to install and economical, a plunger lift is a popular method of deliquification for wells with high gas and low liquids.

But what about particularly deep wells, or wells with low gas and high liquids, or low gas-to-liquid ratio such as gassy oil wells? As the ratio of liquids increases, more artificial lift is needed to get liquids out of a well. Typically, a pump jack or soaping would be used in these situations. However, another alternative exists that is more economical and has produced solid results.

In wells with low gas to liquid ratio (GLR), or wells that are seeing only marginal results from a conventional plunger lift system, a multi-stage tool can be used to increase production. Intended to create multiple plunger lift systems in one well, this design enables the liquid load to be lifted in stages. As such, it allows the well to utilize its own energy to efficiently remove even large accumulations of liquids, even the heavy kind.

HOW A MULTI-STAGE TOOL INCREASES PLUNGER LIFT EFFECTIVENESS

The multi-stage tool is placed by wireline roughly 40-70% of the way down the tubing above a plunger lift system installation, which is typically comprised of a bottom home bumper spring and a plunger above it. Then a second plunger is set on top of the tool.

The system is operated like a conventional plunger lift. During the first sales cycle, the lower plunger carries fluids up the tubing and delivers them to the tool. The fluids flow through the tool and are held above it by gas flow. Upon shut-in, the ball check in the tool engages, retaining the fluids until the upper plunger falls from the surface, settles through the liquids and lands at the tool. Simultaneously, the lower plunger falls back to the bottom.

During the next sales cycle, the upper plunger delivers its fluids to the surface, while the lower plunger delivers more fluids to the tool. Both plungers work in tandem in subsequent cycles. This way, the multi-stage tool acts like an intermediary standing valve. This process lifts smaller and more frequent liquid loads in stages, allowing the well to more efficiently utilize its own energy to remove liquids and increase productivity.

MULTI-STAGE PLUNGER LIFT: AN EASY AND ECONOMICAL ALTERNATIVE TO PUMP JACKS

The 'nodding donkeys' visible at countless well sites demonstrate the popularity of pump jacks as an artificial lift method. Pump jacks (also known as sucker rod pumps, beam pumping units and other names) are typically powered by a fossil fuel or an electric motor. They require a large up-front investment in equipment and installation, and maintenance costs can be high.

A multi-stage lift system typically costs roughly one-tenth that of a pump jack. There is no large, expensive equipment required to operate a plunger lift system. Unlike a pump jack, it requires no power or fuel source because it is an entirely mechanical system that utilizes the well's own energy to operate.

Overall, a multi-stage plunger lift system is much less expensive to install, operate and maintain over the life of a well.

A TALE OF TWO WELLS

Multi-stage plunger lift is being used successfully in wells in the DJ Basin and central Alberta, as well as other regions of North America. Here are two examples of wells that went from being pump jack candidates to multi-stage plunger lift success stories.

Well A - This well site was frequently loading up and no longer able to lift fluids on its own. Initially, a plunger lift system was installed, with the bottom hole bumper spring set at 8,169 feet. The plunger cycled, but because of the large amount of liquid, long shut-in times were required. By the time the plunger was able to run, the tubing pressure was more than 800 psi, which knocked down the separator. When able to cycle, the well produced roughly 17 mcf/day of gas and 12.6 bbl/day. A pump jack installation was considered, but the cost was prohibitive given the marginal production.

The multi-stage tool was installed at a cost of approximately $4,000, which included the existing equipment, the tool and a second plunger. The tool was set at 4,872 feet, with a dual-pad flow-thru (by-pass) plunger below it and a padded plunger above it. The tubing pressure was 1,460 psi, and the casing pressure was 1,510 psi.

After a couple cycles, the pressures lowered to the point where the separator was able to function and constant production was achieved. The cycle times were fine tuned, and the well was able to produce 106 mcf/day of gas and 37.7 bbl/day of oil. After one month, production leveled out and remained at 124 mcf/day of gas and 12.6 bbl/day of oil.

Well A Statistics

	Gas Production (mcf/day)	Oil Production (bbl/day)
Before Stage Tool	17	12.6
After Stage Tool	124	12.6

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Well B had similar initial production issues. In addition, it was producing significant frac'ing sand and wax. The bumper spring was set at approximately 8,136 feet. The starting tubing pressure was 200 psi, and the casing pressure was 1,000 psi. Because of the amount of fluid, wax and sand the well was producing, the plunger would not cycle consistently, and the well was shut-in the majority of the time. Pump jack installation and chemical injections were being explored as potential methods to both stabilize and maximize production.

Instead, a multi-stage tool was installed at approximately 5,085 feet, with a solid flow-thru (by-pass) plunger below it and a solid ring sand plunger above. By this time, the well's tubing pressure had increased to 250 psi, and the casing pressure to 1,200 psi. During the first few cycles, the sand production was challenging. As the casing pressure came down, the well produced more and more sand, causing the bottom plunger to stop cycling and the top plunger to wax off.

After simply pulling the tool by wireline and cleaning the tubing, the sand production decreased. The plungers were able to cycle regularly, keeping the tubing clean and prohibiting wax build-up. The initial production was extremely high for a typical plunger lift system at 70 mcf/day and 37.7 bbl/day of oil. The well's production then slowed to its current rate of 42 mcf/day and 8.8 bbl/day.

Well B Statistics

	Tubing Pressure (psi)	Casing Pressure (psi)	Gas Production (mcf/day)	Oil Production (bbl/day)
Before Stage Tool	250	1200	0	0
After Stage Tool	800	1450	42	8.8

CONCLUSION

A multi-stage plunger lift system is a reliable form of artificial lift that can produce significant production increases, while also being easy to operate and much less expensive to install and maintain compared to a pump jack and other common artificial lift methods. With recent design enhancements and proven successes, the multi-stage plunger lift system is providing producers a cost-effective and easy-to-implement alternative to maximize production in marginal wells and wells with low GLR.

A plunger lift isn't expected to be successful in wells with a 1:1 gas to fluid ratio. However, with the addition of a multi-stage tool, plunger lift designs are successfully being utilized in wells with these characteristics to produce significant production increases.

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