

# PCS-Canada White Paper:

## Multi-Stage Plunger Lift an Economical Alternative to Pumping Units

Plunger lift is recognized as one of the simplest, most effective and most economical artificial lift systems for wells that primarily produce natural gas. Plunger lift is ideal 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 low cost, 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 (low GLR), such as gassy oil wells? Typically, a pump jack or soaping would be used in these situations. However, another alternative exists that is more economical and has produced impressive results.

In low GLR wells, or wells that are seeing only marginal results from a conventional plunger lift system, a multi-stage tool can be used to increase production. A multi-stage tool is utilized to create multiple plunger lift systems in one well. The tool allows 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 or heavy liquids.

### 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, 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 system. During the first sales cycle, the lower plunger carries fluids up the tubing and delivers them to the tool. They 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. In 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 many well sites demonstrate the popularity of pump jacks as an artificial lift method. Pump jacks (also known as sucker rod pumps, beam pumping units, et al.) are typically powered by fossil fuels or an electric motor. They require a large up-front investment in equipment and installation, and maintenance costs can be high.

Typically, a multi-stage lift system costs about 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; it's 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.

### Two former pump jack candidates now successful plunger lift 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

Well A 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 2,490 mKB. 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 >800 psi, which knocked down the separator. When it would cycle, the well was able to produce roughly 0.5 e3m3/day of gas and 2 m3/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, including the existing equipment, the tool and a second plunger. The tool was set at 1,485 mKB, 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 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 3 e3m3/day of gas and 6 m3/day of oil. After one month, production leveled out and remained at 3.5 e3m3/day of gas and 2 m3/day of oil.

#### Well A Statistics

	Gas Production (e3m3/day)	Oil Production (m3/day)
Before Stage Tool	0.5	2
After Stage Tool	3.5	2

#### Well B

In Well B, the initial production issues were similar. Additionally, the well was producing significant frac sand and wax. The bumper spring was set at approximately 2,480 mKB. 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 stabilize and maximize production.


Instead, a multi-stage tool was installed. The tool was placed at approximately 1,550 mKB, with a solid flow-thru (by-pass) plunger below it and a solid ring sand plunger above it. 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 2 e3m3/day and 6 m3/day of oil. The well's production then slowed to its current rate of 1.2 e3m3/day and 1.4 m3/day.

#### Well B Statistics

	Tubing Pressure (psi)	Casing Pressure (psi)	Gas Production (e3m3/day)	Oil Production (m3/day)
Before Stage Tool	250	1200	0	0
After Stage Tool	800	1450	1.2	1.4

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 than 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.

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 is being used in wells with these characteristics to produce significant production increases. 

For information, call our Calgary office at 403-477-5515 or visit [www.pcslift.com](http://www.pcslift.com).