# WIRELESS COMMUNICATION TO A PLUNGER LIFT WELL

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Over the past several years, artificial lift technologies and processes have become increasingly popular as instruments for optimizing oil and gas production. Artificial lift is a process that allows oil and gas producers to optimize well production while minimizing overall maintenance and life cycle costs.

Plunger lift control is a form of artificial lift used by natural gas producers who experience heavy downhole fluid loads. When a gas well produces excessive fluid volumes, in many cases, the natural gas pressure of the well is unable to overcome the weight of the fluid trapped in the tubing, therefore unable to produce the natural gas. Traditionally, in order to produce a well that suffered from heavy fluid loads, an operator was required to manually shut in the well to create pressure downhole. The objective is to build enough downhole pressure to lift the fluid to the surface. To improve this process, producers also utilize a plunger, or a valve, to assist with lifting the fluid. The plunger is quite effective. However, it must be used correctly. Incorrect use, or excessive plunger travel speed, could damage the plunger equipment – which has a direct negative impact on maintenance cost.

In order to achieve optimal results, a plunger process must be managed by an experienced operator. By monitoring a few critical data points –which include pressure, time, production volume, and line pressure – an operator can achieve maximum results. The first two data points are tubing and casing pressure. Understanding these respective pressures and how they correlate with one another allows an operator to determine fluid load. Once fluid load is determined, it is time to produce the energy. However, producing the well too quickly can potentially damage equipment while also minimizing flow time – thereby reducing daily revenues. Again, traditionally, this process was managed manually. In some cases, operators would be required to physically sit on a well location, monitor plunger arrival times while also monitoring production volumes. This allowed the operator to understand the production characteristics of the well and develop a time-based program – using a mechanical timer – to shut in the well in order to accumulate enough downhole pressure to subsequently produce the energy. The operator then calculated the time for the valve to be open and for it to be shut thus setting the production for the well. The problem is that wells change with time and what was the right formula on a new well may not be adequate for a one-year old well.

Automation electronics manufacturers have been focusing a great deal of their development efforts on the plunger lift control application during recent years. The objective has been to automate this process and optimize the time-based shut in procedures. To improve these manual procedures, manufacturers have created a series of algorithms that allow their electronics to self-optimize the plunger lift process. In other words, the controller of Electronic Flow Meter (EFM) learns and adapts to the changes in the well. The algorithms utilize a collection of data points that include plunger arrival times (time), fluid load (tubing and casing pressure), after flow (volume and time) to make decisions. Based on these data points, along with high/low thresholds set by an operator, the Remote Terminal Unit (RTU) or the Programmable Logic Controller (PLC), or EFM can automatically self-adjust and determine when to produce (open the production valve); when to shut in (close the production valve); and, therefore, optimize the overall process for lifting heavy fluid loads while achieving each respective wells' maximum production efficiency.

This all contributes to the overall economics of a well during its life cycle. However, we must also consider the up-front costs associated with the acquisition of plunger lift control technology and the deployment of this technology. Cost factors that must be considered include:

1. Host software
2. RTU/PLC/EFM
3. Instruments
   a. Pressure Sensors
   b. Switch devices
   c. Automated valves
   d. Analyzers
4. Remote communications
   a. RTU/PLC level
   b. Local
   c. Backhaul
5. Remote power – solar applications
   a. Solar Panel
   b. Batteries
6. Installation
   a. Labor
   b. Equipment
   c. Time
   d. Cable
   e. Conduit
   f. Fittings
   g. Valves

** Does not include plunger equipment

The cost of a plunger lift control automation package (installed) can run from $3,500 to $12,000. There are many documented cases from differing wells in different geographic areas that suggest a 12 to 35 percent increase in production is attainable as a result of implementing automated plunger lift control systems on wells that produce high volumes of fluid. Therefore, in many cases, the system is relatively easy to justify by calculating the rapid return on investment (ROI).

Some smaller producers may not calculate the staff resources necessary to attempt to optimize production manually, but when you are producing hundreds or even thousands of wells, the cost can be prohibitive. Therefore, many operators are switching to new automated plunger systems, and incorporating Wireless I/O technology. .

What is Wireless IO, or wireless monitoring and control?

Wireless IO is a mechanism by which analog signals (1 to 5 Volt inputs or 4 to 20 milliamp inputs), discrete inputs, or other raw signals may be transmitted via radio to and/or from a central processing device (EFM, RTU, PLC).

Specifically the data transmitted includes level, flow, pressure, temperature, plunger arrival, alarms, and signals generated to final control devices, such as valves.

Why do this wirelessly? There are several compelling reasons, but the most compelling is substantial cost savings. The other factors are:

- Faster installations – wireless  can be up and running in 30 minutes versus several days with conventional wired methods.
- Less repair, -- a common source of irritation on well sites is the cut wire that was inadvertently severed when something was added later.
- No trenching – trenching is a slow, time-consuming and expensive process with cost of $20 per foot in many areas.
- No conduit – installing conduitis a slow process and it can take days to schedule a crew to do the install with costs running  in excess of $60 per foot.
- Redeployable, -- wireless is not a “sunk cost.” It is transportable. If the tank moves, the radio can be relocated.

These systems save time and money. Many operators in the past few years have switched to “pad” wells where multiple wells are located on one pad reducing the foot print of the wells and allowing operators to share production facilities between multiple wells, again reducing the cost per wellhead. These new techniques also lend themselves easily to automated plunger and wireless control systems.

On the wireless control systems, instead of installing a RTU, EFM  or PLC device at each wellhead, you can use one RTU, EFM or PLC  per pad. These RTU’s or EFM’s are capable of collecting custody transfer information from multiple wells as well as doing plunger lift applications on all of the wells. Some manufacturers can do as many as 20 wells per EFM. Obviously, this concept plays well with the same strategy as using one well pad and one set of production equipment.

At the wellhead, the operators use a radio to record the casing pressure, tubing pressure, determine the plunger status, and to control the valve (open or closed). This wireless IO radio is a fraction of the cost of a RTU or EFM and its only job is to act as the Pony Express and send the data back to the EFM where the mathematical algorithms are calculated to determine what needs to be done to optimize the production.

In many cases, the cost savings is $3,000 to $5,000 per wellhead to install a radio instead of an EFM. On a pad well, that savings could be $3,000 times 16 wellheads or $48,000.!

In the Rocky Mountain area, pad wells are rapidly becoming the norm. Major producers in Colorado, Montana and Wyoming are standardizing on wireless automation for the wellhead. Many operators are taking advantage of this technology and are also monitoring and controlling  tank levels, flow rates, pressures and temperatures, including water meter monitoring, sump or pit monitoring, flare monitorsand chemical injection monitoring. Essentially, all process variables can be  measured and controlled wirelessly.

Many of these ”new” Wireless I/O radios  utilize Modbus protocol. Whereas traditional wireless I/O is limited by the designed-in I/O count on the master radio, Modbus wireless I/O delivers data to a central control point via a serial port, exponentially increasing the I/O count and thus eliminating the need for hardwiring the I/O master the control system’s I/O. Thousands of devices can communicate with one Modbus master.

While no well pad has thousands of points to be monitored, the idea of limitless control has intrigued producers to constantly push the envelope, and in turn,  push radio manufacturers to constantly upgrade and expand their product offerings. Many of these manufacturers are now offering expandable “IO radios”. These products come with a base set of I/O and then the user can add modules for an expanded IO count where needed.

Several Texas operators are monitoring as many as five  analog inputs (casing pressure, tubing pressure, flow, etc.) and six digital inputs (plunger arrival, multiple chemical tanks, etc.) on each wellhead. Every producer seems to have found what they consider the “perfect” IO count, and no one ever has the same idea of perfection, so expandability and scalability are the keys to a successful product selection. If there is one universal consistent idea among producers, it is that they will find more ways to utilize the power of wireless communication from remote assets back to a central site and they do not want to be boxed into a fixed IO count. Many of these wireless IO radios are now capable of transmitting data 60+ miles with good line of site communication paths.

Another important criteria in selecting a wireless IO device is whether it has a “fail safe” configuration. Many wireless IO devices plan ahead for loss of signal. No device is immune to a loss of signal, and it is important that you be able to have the radio make the changes to the situation as you have preplanned for them. For example, if a wireless IO device that monitors tank levels looses its signal, you should be able to chose what the “fail safe” condition will be. You can choose to have the valve close on loss of signal, open on loss of signal or do nothing on loss of signal. In most cases, you will choose to have the valve close to insure you do not overflow the tank, but the important issue is that you have a fail safe and that it is user selectable.

When wireless IO was first introduced several years ago, many automation people were uncomfortable with allowing mission critical data to be handled in any way other than a hardwire connection. Today, with the advances in communications technology, the opinion has reversed and many industry automation executives feel safer with wireless connections than they do with wired connections that can corrode or be severed by mechanical devices.

By utilizing one EFM per pad and switching to wireless IO at the wellhead one major production company in Colorado’s Denver Julesburg Basin claims it saves $4,000 per well. This producer plans to automate 3,500 wells over the next four years in the area around Greeley, Colorado. That is the equivalent of saving $4 million for every 1,000 wells it automates, certainly a powerful argument for today’s high-powered flow computers that can handle 16 to 20 wells and the new radio technology of “wireless IO” at the wellhead.