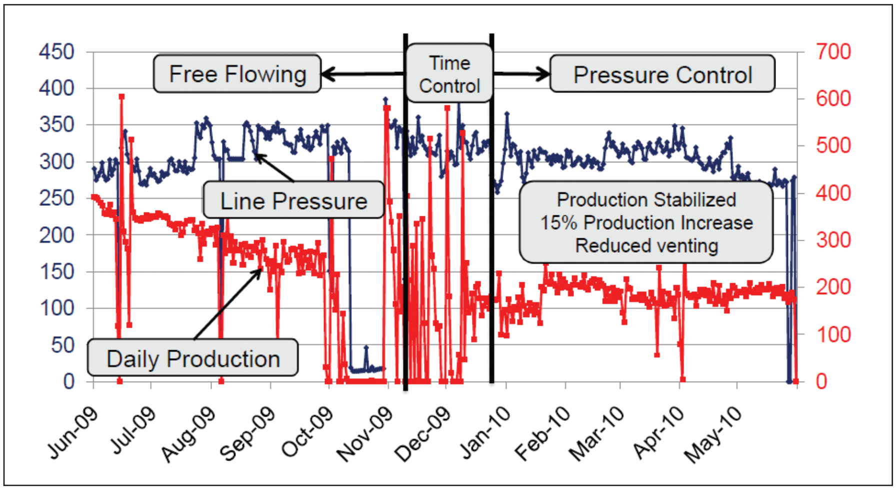
As seen in the July 2010 issue of E&P

Plunger lift technology improves shale gas production

A new automatic, self-actuating technique that operates as it is needed is taking the guess work out of dewatering in shale gas wells.

AUTHORS
David Cosby P.E., Harbison-Fischer Manufacturing Co. and ***Jason Churchill P.E.***, XTO Energy Inc.



An examination of traditional vs. advanced controllers shows the HF OPTI-MISER well control system helped XTO stabilize and improve production on all of the plunger lift capable wells tested. (Images courtesy of Harbison-Fischer Manufacturing Co.)

Shale gas is dramatically impacting reserves numbers in North America. The plays are extensive, and reserves are enormous. This is good news. The bad news is that with shale gas wells, production can decline 70% or more during the first year of operation.

As production falls, liquid collects in the well bore, which further impedes gas flow. Operators have turned to artificial lift technologies in an effort to extract more gas from these wells.

Looking for the solution

In the interest of evaluating some of the methods used to increase production, the Fort Worth, Texas, division of XTO Energy Inc. recently completed a study evaluating artificial lift methods. The company's findings show that a proactive approach executed early in the decline cycle maximizes profitability and reduces the need for future, costly intervention.

Three main forms of artificial lift were examined in this program: foaming agents, gas lift, and plunger lift. The advantage of foaming agents is that they are inexpensive, but they often are ineffective when injected through the casing into the slipstream. Gas lift is effective, but installation requires a large capital investment. The plunger lift solution, on the other hand, is effective and economical.

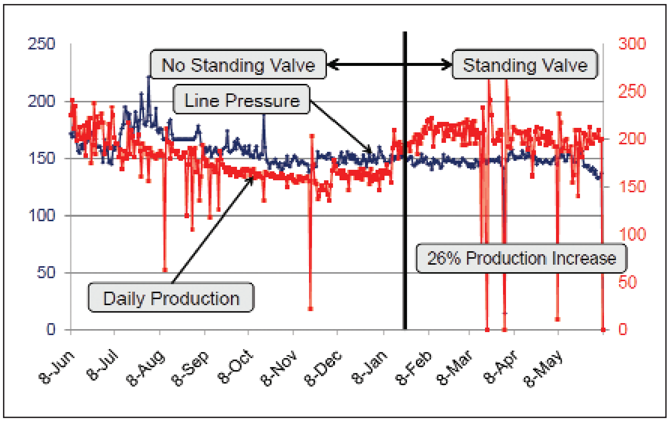
Plunger lift

A plunger lift system uses a plunger that freefalls to a bottomhole buffer spring location when the well is closed. As gas is produced, liquids accumulate in the well bore above the plunger creating a gradual increase in backpressure. At the appropriate time, a controller signals the motor valve at the surface to open, and the well's own energy pushes the plunger and any accumulated fluid above it to the surface. An arrival sensor notifies the controller when the plunger reaches the surface, and the plunger is captured in the lubricator. To optimize a well's production, the arrival sensor must work 100% of the time without any false signals. Algorithms within the controller instruct the motor valve when to open and close. The most efficient algorithms close the well just long enough to build the required pressure to move the liquid in the tubing to the surface. Once gas flow is stabilized, the automatic controller releases the plunger and it drops back to bottom, whereupon the cycle repeats.

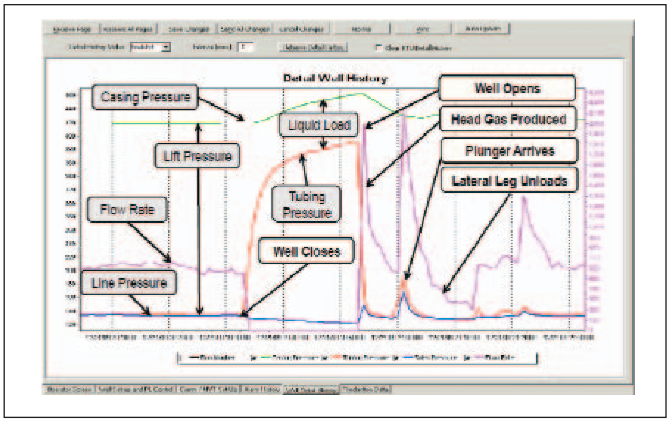
XTO identified a variety of manufacturers during its investigation. Each offered various forms of equipment, control algorithms, and surveillance. Options ranged from controllers with and without telemetry to gas flowmeters with integrated plunger lift algorithms. XTO selected four systems for trial, installing them on 95 wells over a 12-month period. Of these systems, 50% were traditional standalone controllers using time to cycle the plunger, and 50% had controllers with telemetry capabilities using pressure and flow rate settings. XTO included one of the newer systems on the market, Harbison-Fischer's HF OPTI-MISER well control system, in the latter category.

The study identified a number of factors that impact results, including plunger selection, control settings, surveillance, ease of use, operator knowledge, and equipment durability. Even the vendor-supplier relationship determined whether or not a long-term reduction in the decline rate was achieved. Open and frequent communication between XTO and Harbison-Fischer resulted in significant production improvements on many underperforming wells.

Early in the well's life, when gas-to-



After being fitted with standing valves, some wells showed production increases of 20% to 100%.



Data provided by the HF OPTI-MISER well control system allowed engineers to determine the root cause of problems specific to horizontal wells and optimize production.

liquid ratios are typically higher, the control method had little impact on cycling the plunger. As gas production declined, increased surveillance and control methods have significant advantages.

During the course of the evaluation, XTO discovered standalone controllers come with hidden costs. Improper plunger application and control settings resulted in unplanned downtime, lengthy onsite troubleshooting, and inconsistent plunger runs. Root cause analysis was impossible without detailed pressure and flow data.

Wells with telemetry proved more productive over the long term. The systems that consistently enhanced profitability were those that provided remote access to detailed data on each plunger cycle, real time e-mail alerts, automatic shut-in on high or low line pressure, and automatic adjustments for missed arrivals. In particular, the HF OPTI-MISER system helped XTO stabilize and improve production on all of the plunger lift capable wells tested. When using real-time surveillance with e-mail alerts, XTO could dynamically adjust well settings as needed, not just when the lease operator was on site. Using these methods, the frequency of plunger replacement and swabbing declined significantly. Though systems like the HF OPTI-MISER were initially more expensive, XTO found that the savings, plus increased production (typically 15% to 30%), quickly made up the cost difference.

The study also emphasized the importance of access to minute-interval pressure and flow-rate data. Flow observed when the well is closed indicates that either the electronic flowmeter needs calibration or the motor valve is leaking. Line pressure declining when the well is closed suggests either the separator liquid level controller or dump valve is malfunctioning. With access to real-time well data, response time from the actual event to detection and correction was reduced by days.

Observing minute-interval data, XTO identified tubing and casing pressure equalizing on some wells near the end of the shut-in period. Liquid in the tubing was being pushed back into the well bore. This issue could be corrected by shortening the close time (using fast-falling plungers) or installing a standing valve. A standing valve consists of a ball and seat positioned in the bottomhole spring assembly to prevent liquid in the tubing from re-entering the well bore. After being fitted with standing valves, some XTO wells had production increases of 20% to 100%.

Working with real-time data led to the unexpected discovery that the traditional theory on limiting after-flow for vertical wells does not necessarily apply to horizontal wells.

When a well is opened, flow rate spikes as the gas above the plunger is produced. As the plunger rises, flow rate declines. When the plunger surfaces, gas production spikes then declines. Conventional thinking suggests closing the well as the flow rate approaches the critical rate, but XTO discovered horizontal wells need to be flowed until the lateral leg unloads. If the horizontal wells are closed before the lateral leg unloads, a large amount of fluid accumulates in the tubing for the next run.

The measure of success

Gas well optimization is determined solely on the amount of gas safely produced. Optimizing a single cycle is no guarantee of future production. Often, simply eliminating unplanned downtime is more effective. Production optimization centers on operating the well at the lowest flowing bottomhole pressure and minimizing the time the plunger is stationary at the bottom of the well. An optimal cycle balances the amount of fluid entering the tubing during after-flow with the amount of lift pressure (casing over line) available when the plunger reaches the bottom. Wells that cycle at low casing pressures that are sufficient to surface the plunger generally produce the most.

Early in the decline curve, casing pressure on typical shale wells builds quickly when the well is closed. To minimize shut-in time, fast-falling plungers are preferred. Under the right conditions, fast-falling plungers significantly boost production by making 20 or more trips a day. XTO realized production improvements of 40% on some wells when using Harbison-Fischer's long-lasting By Pass plunger. E&P