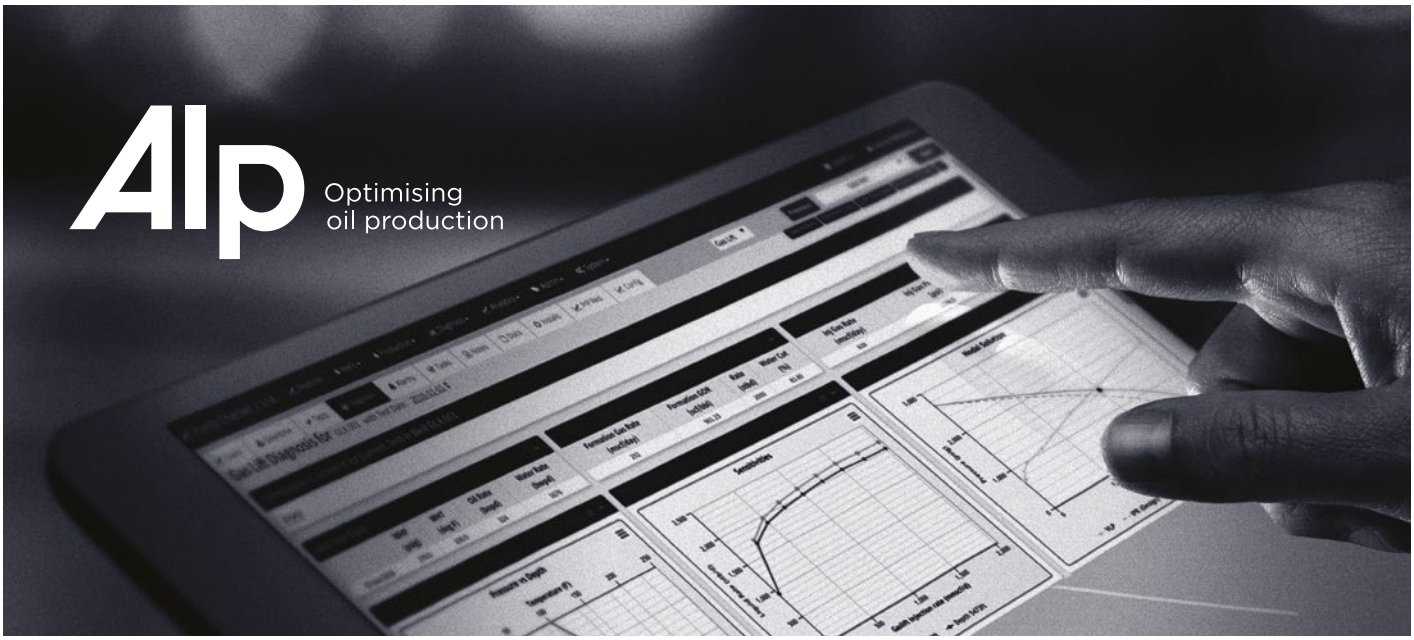


Artificial Lift, Machine Learning and Analytics – Are we for real?

Pump Checker™

Most industries talk about analytics and machine learning - it's fashionable. Analytics has a very obvious attraction for our industry - how can more wells be managed effectively, with fewer experienced engineers?

If analytics can help understand and improve performance in sports such as stock car racing and football, or even diagnose when an elevator needs maintenance, all based on realtime data, how can analytics be used to improve our ability to produce oil wells using artificial lift (AL)?

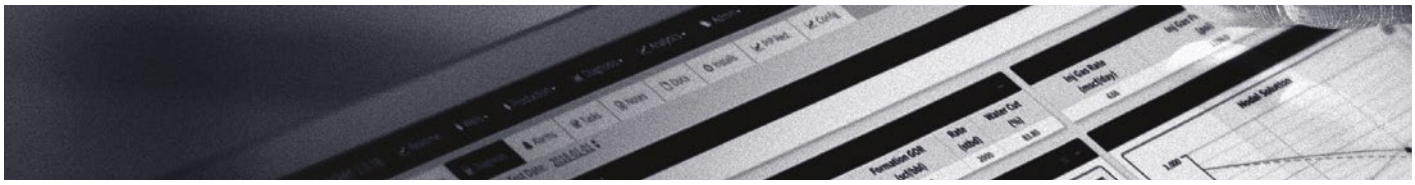
An article[1] published by Bain and company states that 'analytic advantages could help oil and gas companies improve production by 6% to 8%'. which is what operators typically gain when they implement our artificial lift optimization software.

When using AL, oil companies pay money to achieve a certain drawdown and get additional production. If the AL method sub-performs, production Is lost. Using analytics, it is possible to analyze and diagnose the AL performance for every production test - automatically and identify when the AL system has a problem, resulting in lower production.

AT A GLANCE

- Analytic advantages could help oil and gas companies improve production by 6% to 8% - we have seen this
- The technology exists to manage 100s of wells automatically using management by exception and high level dashboards
- Diagnosis engines exist to analyze every well test, optimize AL production and identify sub performing wells
- Spotlight which wells can give you more production
- Enable engineers to manage more wells in less time
- If the correct data is collected in a synchronous manner (generally it's not), the tools exist to perform production optimization using analytic tools

Operators can spend circa $10 million fracking and completing an unconventional well. The goal is to then to produce the well at an appropriate rate to ensure rapid pay-out. When a well is planned to produce 2000 bopd and then only produces 1500 bopd, a wedge of production is lost. AL analytics can tell



whether this is a due to a well inflow problem or an issue with the artificial lift. The ability to identify poorly performing AL systems is critical to optimizing production. This article will look at the latest analytic techniques for gaslift and ESP produced wells.

GASLIFT ANALYTICS

Stephen Rassenfoss in his JPT article[2] states

"When a gas lift system starts performing poorly, there is a good chance no one will notice. It is not an event that demands attention like a broken pump. A gas lift system will continue injecting gas into wells and oil will continue to come out. Just not as much oil as there could be....."

This is so true. When people use gaslift, complacency sets in, as long as the well is producing, no real optimization is done.

Ideally a downhole pressure and temperature sensor should be installed on all gaslift wells. Then every production test can be analyzed to verify the injection point and answer two simple questions: how much more production can be achieved by injecting more; and how much more production can be achieved by injecting deeper.

On existing wells, that do not have a downhole sensor, a good practice is to perform a gradient survey monthly to verify the injection depth and ensure that the well is being produced optimally.

Because of the uncertainty around IPR performance on unconventional wells, traditional nodal analysis cannot predict well performance. Instead, it's important to have a top down process to verify injection depth and predict well performance.

Unconventional wells can often have 10-15 mandrels in the wellbore, to account for inflow uncertainty and to be able to produce the depleted well late in life. Having so many mandrels in the wellbore means that the design information has to be extremely accurate, which inevitably results in valves staying open when they should be closed and injection at multiple valves (known as multi pointing).

Figure 1 shows a gaslift well with a production test and data from a gradient survey. The software determines that the deepest possible injection point, is at mandrel 4 and that all the mandrels above that point are open. The software also predicts if additional production can be obtained by injecting more gas in the upper 4 valves, versus injection at the orifice and compares the results.

Performing these calculations automatically every time there is a production test on the well allows for constant screening and flagging of wells where: injection is very shallow, flowline differential pressure is excessive, back pressure is high, injection rate is low and may result in slugging, injection rate is high; or the injection flowline is plugged/closed (hydrates). Having this knowledge all the time across all wells is the holy grail of production optimization and is the true value of analytics with respect to production optimization

ESP ANALYTICS

In the earlier referenced article by Rassenfoss, it was indicated that gaslift production losses can go undiagnosed. However, there is a similar phenomenon with ESPs. If an ESP is worn, has a blocked intake, is running in reverse or has deposition in the ESP it can be running, but not producing what it should. Most operators never identify these scenarios, which results in lost production. How can such opportunities be identified?

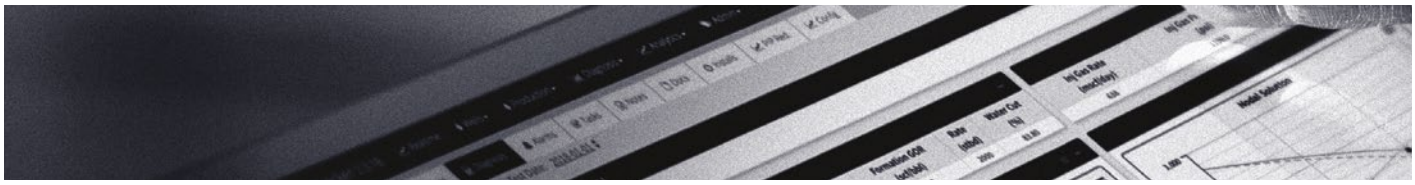
An ESP, like any other AL method should reduce bottom hole flowing pressure. Any time the ESP has a problem such as deposition in the pump or pump wear the ESP creates less drawdown and well production is reduced. Using analytic tools, it is possible to analyze the pump performance every production test, quantify pump degradation, identify poorly performing pumps and provide recommendations related to recuperating a lost wedge of production.

Figure 2 shows a well that has declined rapidly in production over 3 months, the operator thought it was an IPR issue. Implementation of the ESP analytic tool proved categorically that the production decline was due to a pump problem. A proactive workover was performed which confirmed the pump issue (scale and wear inside the pump as shown in figure 3). The new pump resulted in an additional 610 bopd.

Figure 1 - Automated analysis of a production test with gradient survey on a gaslift well

Figure 2 - Production loss over time due a to pump issue and subsequent production gain after a proactive replacement

Figure 3 - Scaled damaged pump stages



The ability to diagnose and rectify missing wedges of production highlights the benefit of being able to use analytics to analyze and diagnose ESP produced wells. When dealing with large quantities of wells, automated analysis really is the only way to be able to validate ESP performance.

ANALYTICS – REAL OR A PIPE (PUN INTENDED) DREAM

When it comes to using analytics for optimizing production of oil wells, the tools exist, the computing power exists and realtime data from SCADA systems has existed for decades. However, the challenge our industry faces is that we don't always have the correct data that is required to optimize our wells, or that we're not using automation appropriately to do what it is good at. From experience of working with many operators on 1000s of wells some examples of where operators can improve are:

Field staff still record downtime on a well by well basis manually and enter it in the production reporting system manually each day. Automation can do this much better and achieve much better granularity, so that all downtime is captured.

Wells on artificial lift often have realtime downhole information but no wellhead and casing pressure transducers to bring in flowing pressure and temperature or casing pressure. Any well analysis software requires flowing pressure and temperature to perform analysis. Why not spend the extra $2000 to bring these parameters in realtime?

When production tests on wells are recorded, the artificial lift operating parameters are seldom recorded with the tests. Oil, water and gas rates are recorded along with wellhead pressure and that is it. For an ESP the operating frequency, pump intake pressure and pump intake temperature should be recorded simultaneously so that ESP performance can be analyzed.

Downhole completion information is entered by drilling and completion people that don't understand what information a production engineer or analytic software tool need so that a well can be analyzed e.g. gas lift valve depths and settings or ESP pump type and stages. The format for input of the AL system details needs to be standardized, so that it meets the needs of the software tools and automatic population of software tools can be performed.

The technology exists to be able to identify gaslift and ESP produced wells that are 'losing' production due to an undiagnosed AL problem. The ability to diagnose and rectify such issues can add a missing wedge of 'lost' production.

Many times, money is spent on a very expensive 'realtime' system, that doesn't enable full analytics as the parameter set is incomplete.

The biggest challenge that our industry faces, in terms of using analytics appropriately, is a failure to collect all of the data we need in a synchronous manner. It's an easy fix, if and when automation, production and IT combine to ensure that a complete data set exists for true production optimization using analytic tools.

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