Artificial lift goes digital

Schlumberger’s new production life cycle management service, which provides real-time data collection, monitoring, analysis and interpretation to optimise the performance of artificial lift systems, has helped Agiba Petroleum Company to increase production and reduce costs.

As the industry pushes to extend the economic life of once-productive brownfields, artificial lift is keeping pace, with improved equipment functionality and digital enhancements that are setting new standards for well performance. Far beyond the implementation of sensors and measurements, this shift marks an important step-change by expanding the technological envelope to quickly and accurately analyse and interpret data. For operators, the ability to pair advanced equipment with surveillance, data collection and precise, real-time interpretation is critical to maximising production while reducing costs and risks in increasingly challenging wells.

Once reserved for high-value offshore wells, monitoring and surveillance is now being recognised for its value in declining, remote and widely dispersed wells by boosting the performance of artificial lift systems, including that long-proven oilfield workhorse, the electric submersible pump (ESP). Historically, operating data of ESPs have been collected at the wellsite and sent to a remote surveillance and monitoring site where they are analysed by multiple systems to determine a course of action.

That time-consuming and cumbersome process has been replaced with a new, integrated web-based approach that provides monitoring, secure data collection and transmission and data evaluation and interpretation to optimise the performance of artificial lift systems in real time, helping operators avoid shutdowns and prevent failures. This step-change in artificial lift capability extends equipment run life, maximises production and reduces operating costs and downtime by providing access to all critical wellsite data in a single cohesive, solutions-based software platform, merging data for quick and seamless management of well and field performance indicators, alarm and event management and diagnostics and optimisation.

The single platform enables operators to proactively monitor and improve pump performance, from monitoring hardware in a single well to optimising equipment across an entire field. The service has been implemented in more than 30 countries worldwide, including a declining field in Egypt, where it was integral to the success of an ESP water injection project.

Officially launched in March 2017, the Lift IQ* production life cycle management service was uniquely designed with embedded analytic tools that give engineers the ability to conduct real-time well system diagnostics and, importantly, optimise data to understand the causes of every event in order to take the appropriate corrective action. The new service monitors the important commissioning phase of an artificial lift system and also provides long-term monitoring and analysis while managing pump operations for the life of the well. (Figure 1)

Figure 1: The Lift IQ service provides access to critical data, detects events, and offers quick and easy monitoring and troubleshooting. (Courtesy of Schlumberger)

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New, integrated, web-based approach

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Hundreds of data signatures that trigger alarms are monitored and analysed by experts to identify gas locking, production declines, solids production and other issues that impair pump performance. Engineers can immediately adjust parameters to avoid shutdowns and return pumps to normal operating conditions. Well data are gathered via satellite or cellular connections and stored onsite, in-country or globally. Data are then transmitted to one of six strategically located artificial lift surveillance centers (ALSC): The Middle East, North America, South America, Europe, Russia and Asia.

ALSC engineers review alarms for all measurements at the wellsite, and analyse summaries and poll data to identify likely causes of the events and quickly recommend remediation options via text message or email to the onsite crew for implementation. Critical events requiring immediate action can be communicated directly by phone.

In a move to provide both flexibility and fit-for-purpose solutions to meet operators’ unique requirements, the service encompasses four tiers -- visualisation, real-time surveillance and diagnostics, well optimisation and field optimisation.

**Novel solution for depleted field**

Agiba Petroleum implemented the production life cycle management service in conjunction with a unique artificial lift system in the Emry Deep field in the Egyptian Western Desert. Production in the field began in June 2012 with a startup rate of 4,300 bpd. Nine wells were then drilled, producing a total of 24,000 bpd from a sandstone reservoir primarily located in the Alam El Bueib formation.

During the development phase, average reservoir pressure began declining, from 4,070 psi to 2,450 psi. In an attempt to maintain reservoir pressure to improve recovery, Agiba Petroleum drilled a new water injection well, ED-16 ST, using two water source wells in the northern sector of the field. However, because the 16,500 bpd (2,623 m³/day) capacity of the available water source wells was insufficient to feed the new injector well, the operator needed to find an additional source of compatible water.

Two possible solutions were considered. The first was to simply drill another water source well, but the costs of drilling, completion and installation of flow lines encouraged the operator to seek a second alternative. This option involved use of a natural dump flood, giving the injector well access to both the injection and the higher-pressure, water-producing zones of the field. By perforating both zones, a natural crossflow would occur, providing additional pressure.

Even in this scenario, however, the pressure difference between the two zones was not adequate to provide the necessary flow rate. Furthermore, an intelligent completion would need to be incorporated to control the flow rate between the two zones. Frequent production logging runs also would be required to determine the flow rate unless an expensive downhole flowmeter was installed.

To address these limitations, Agiba Petroleum collaborated with Schlumberger to engineer a new artificial lift system that would solve both the water supply and pressure issues. The end result involved installation of an ESP to produce the water from the higher-pressure upper zone and divert water back to the lower, injection zone through a bypass system, or reversed Y-tool. (Figure 2)

A packer between the upper and lower zones served as a pressure barrier, allowing the ESP to pressurise the flow to achieve the required flow rate. After the ESP boosted the pressure, the high-pressure water flowed through the reversed Y-tool and bypass tubing to the target injection zone. The pressure management system was implemented for the new injection well and two target wells, ED-9 and ED-12, which were closest to ED-16 ST. (Figure 3)

To evaluate the effectiveness of the configuration, the operator implemented real-time monitoring and surveillance. The Phoenix xt150 high-temperature downhole ESP monitoring system, which utilises high-temperature microelectronics and reliable digital telemetry, provided comprehensive pressure, temperature, current leakage and vibration data to protect the ESP system’s integrity and optimise well performance.

Additionally, the Lift IQ service, which had previously been used to monitor performance of offset wells in the region, was implemented to optimise pump performance and enhance observation of changes in downhole pressure across the field.

After installing the ESP, the operator saw an immediate increase in reservoir pressure, with downhole pressure readings of the offset wells confirming that injection was occurring. The two target wells also demonstrated an immediate effect of the ESP dump flood.

**Figure 2: Water flows from the low-pressure water-producing zone to the pump intake; after the ESP boosts the pressure, the high-pressure water flows through the reversed Y-Tool and bypass system tubing to the target injection zone. (Courtesy of Schlumberger)**

**Figure 3: Downhole pressure increases in the ED-12 offset well after starting the ESP in the ED-16 well. (Courtesy of Schlumberger)**
In well ED-12, the ESP had initially operated at a speed of 49 Hz, but was increased to 55 Hz to compensate for a production decline. After the injection, downhole pressure increased by more than 500 psi, resulting in an increase in daily production of more than 400 bpd. The well also maintained a consistent water cut before and after the injection. Pressure did decline after well ED-9 was put back on production. (Figure 3)

Severe depletion and reduction in production in ED-9 resulted in the ESP experiencing low-flow events, a sign the pump was operating at a very low flow rate. Poor cooling conditions, caused by less fluid passing by the housing, and excessive starts and stops required a workover, including acid stimulation. The ESP was replaced and set at a deeper setting depth to enhance the flow rate. The injector well was then able to enhance performance of E-9, increasing and maintaining production at 4,900 bpd.

Other wells in the field also were impacted by pressure maintenance provided by the injector well, showing a combined production increase of 350 bpd.

All monitoring, analysis and diagnostics regarding the ESPs were managed in real time from the 24/7 Schlumberger ALSCL located in Cairo.

The combination of a unique artificial lift design and a production life cycle management service that provided real-time data collection, monitoring, analysis and interpretation resulted in a successful outcome for Agiba Petroleum. Overall production from the target wells improved by nearly 5,650 bpd (898 m³/d), saving the operator US$3.6mn compared to the cost of drilling a new source well.

*Mark of Schlumberger