What’s new in artificial lift

Recent developments are introduced in beam/rod pumping, electrical submersible pumping, gas lift, gas well dewatering and artificial lift monitoring.

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Presented here are 18 recent technology developments in artificial lift equipment and software associated with artificial lift.

New offerings related to beam and rod pumping include an improved downhole separator for placement in the near-vertical section of a horizontal well producing gas and some liquids. An improvement in materials is discussed for a device to prevent pump sanding, as well as a pump designed for sandy wells, and an adjustable threaded polished rod is presented that allows for safer and simpler spacing of the downhole sucker rod pump.

Among ESP-related advances, a dual ESP system provides either a backup in the case of primary pump failure or an improved solution for multizone production. Enhanced modeling software is presented that assists in the design of ESP and gas lift systems. A number of improvements in one supplier’s pump stage portfolio are discussed, as well as an elevated-temperature ESP for SAGD applications and an ESP deployment system that allows pulling and replacement without a workover rig.

Gas lift-related advances discussed are a valve plug that dissolves in saltwater, to eliminate the need to remove dummy valves in new gas lift systems, and two new check systems for 1½-in.-OD gas lift valves and for use on a recently introduced mandrel.

Within the topic of gas well dewatering, a new instrumented plunger determines location by sensing the collar locations in the tubing along with pressure and temperature. Also, a three-in-one plunger combines increased efficiency, pressure actuation for sandy conditions, and improved lubrication. Also presented is a high-pressure, cold-weather lubricator developed to comply with the same standards and requirements as other wellhead components.

To monitor artificial lift system performance, a proprietary interpretation technique provides real-time flowrate without the need to retrofit additional hardware in the field, with the exception of downhole ESP gauges and SCADA. Also discussed is a flexible ESP monitoring, surveillance and production optimization tool. Another company has combined computerized analysis of dynamometer records with powerful portable computers, advanced modeling software and wireless data acquisition to allow visualization of rod pump operation in real time.

Finally, a novel pumping system is presented that combines the advantages of beam pumping and ESP systems.

ELECTRICAL SUBMERSIBLE PUMPING

The push by E&P companies into increasingly challenging production environments worldwide has created an expanding market for electrical submersible pumps that provide additional functionality, as well as tools to increase the functionality of existing ESPs.

Dual ESP system. Schlumberger’s dual ESP system features a variable configuration that provides additional functionality, specifically for ESP backup and multizone production requirements. The company has installed more than 100 dual ESP systems in a wide variety of applications, including on- and offshore, for both backup and multizone ESP applications, Fig. 4.

The backup functionality allows operators to minimize time-consuming and costly workovers in the event of a primary ESP failure, while also extending the ESP system run life. Additionally, having the backup option helps to minimize deferred production and also allows for improved workover scheduling.

Many countries impose regulations requiring independent production of fluids from different producing zones. The dual ESP system provides a means to comply with such regulations by producing multiple zones either independently or simultaneously. This is achieved by running either one or both of the ESPs in the dual ESP system. For multizone production applications, the system uses two ESPs, one of which is housed in a pod that includes a tailpipe string and seal assembly and is located in a seal bore packer situated between perforated zones. The pod-and-packer configuration isolates the producing zones. An upper ESP, which is installed above the pod, includes a bypass and produces the upper zone. Fluids from each zone are produced independently to the surface through the use of two tubing strings installed concentrically.

Both pumps are fully instrumented, and they also measure operational and production parameters for each pump and zone. The arrangement allows each ESP to be sized and operated optimally for its zone. A dual concentric tree prevents the commingling of production at surface. Additionally, it is possible to shut down one zone without affecting production from another.

Modeling software update. In 2010, Schlumberger updated its Avocet Well and Surface Modeler software with the release of its WSM 2010.1 software package, which provides a comprehensive design solution for ESP and gas lift systems. The 2010 release includes an intuitive workflow that allows users to navigate through the application design in a logical and concise manner.

Enhanced reporting features allow for the reformatting and improvement of all reports, as well as improved report loading times and customization options.
also includes additions for surface power source calculations and added support for user-specified inflow performance relationship curves.

The ESP design module provides a comprehensive well performance analysis solution for a complete ESP system design. The software uses fluids, well and reservoir data to predict the inflow and outflow performance of an ESP design. It sizes and analyzes an entire ESP system, with the goal to optimize pump design and greatly increase run life for increased production. The software package also provides a comprehensive selection of fluid models and correlations to match measured well data. An extended set of empirical and mechanistic flow correlations is also available, allowing users to match field performance.

Installation and reliability improvements. Recently, Schlumberger revamped its ESP volume stage portfolio and released a number of new stages that increase hydraulic efficiency and lift capability in its REDA line of ESPs. The company’s new stage development process uses computational fluid dynamics modeling and prototype performance verification to optimize internal stage geometry and flow profiles in order to produce maximum possible efficiency and lift.

Higher hydraulic efficiency directly results in reduced motor horsepower requirements and total power consumption for an application, allowing for significant savings to the total cost of ownership of an ESP system.

Among the latest ESP stage developments is the D1050N stage, which is now the smallest and most efficient mixed-flow geometry stage in the REDA line for wells with approximately 1,000 bpd production rates, Fig. 5. Wider vane openings and smoother flow patterns allow the mixed-flow geometry to provide improved hydraulic efficiency, as well as gas- and abrasives-handling capacities, unlike radial flow stages that are normally used for similar production rates.

All REDA pumps with new stages are assembled in compression factory-shimmed design. This feature ensures that the pump shafts are precisely matched at the factory to enable the axial thrust transfer directly to the high-load protector bearing, eliminating time-consuming and error-prone field shimming procedures. Combined with Maximus motors and factory-shimmed Maximus protectors, factory shimming of pumps reduces ESP installation time requirements by at least 60%, while also protecting the quality and integrity of the system by eliminating human and weather-related factors.

GAS LIFT

New components and modeling software continue to increase both the effectiveness of the gas lift method and its applicability to a widening variety of artificial lift applications.

Modeling software update. Already discussed in the context of its ESP design module, Schlumberger’s updated Avocet Well and Surface Modeler software (WSM 2010.1) also has new features specifically for gas lift systems. These include improved calculations for test rack opening pressure, deepest injection point (DIP) and minimum valve spacing. The default design module has been changed from the injection-pressure-operated (IPO) surface close to the IPO minimum/maximum design. Additionally, the new software package includes improved DIP plot interactivity, with data modification and additional variables added for sensitivity analysis and case comparisons.

The gas lift design module is intended to help operators optimize gas injection depth, minimize downtime through continuous gas lift operation, and maximize production through best-suited gas lift equipment selection. The software defines the wellbore schematic and accurately sizes all downhole components. A comprehensive database of components includes the most recent gas lift equipment.

MONITORING PERFORMANCE

Operators are increasingly demanding real-time data and analysis to help them optimize their use of pumping systems, driving suppliers to offer more advanced
diagnostic tools for artificial lift.

**Real-time flowrates.** In 2010, Schlumberger introduced a proprietary interpretation technique to provide real-time flowrate data without the need to retrofit additional hardware in the field, with the exception of downhole ESP gauges and a SCADA system, which in many cases is already available. Through the use of this real-time flowrate data, back allocation can be improved.

Real-time flowrate data represents a step-change in measurement over the once-a-month testing with manual data entry that is typical in wells that are not equipped with dedicated multiphase meters. The granularity provided is particularly important in wells where production fluctuates rapidly. Furthermore, many reservoirs produce at flowrates below the threshold required to achieve reasonable accuracy with test separators, making another means of flowrate determination necessary.

When downhole measurements are used, it is possible to plot flowrate, flow pressures and reservoir pressure accurately, which allows engineers to see production changes as small as about 10 bpd. Enhanced superposition analysis can be used to monitor real-time reservoir pressure based on flowing pressure, reducing the need for frequent buildups.

To accommodate the advances provided by this new real-time flowrate technique, the company’s LiftWatcher real-time surveillance service now hosts data from rod pumps, progressive cavity pumps and vortex flowmeters, as well as the previously supported ESPs and hydraulic production systems. This overhaul allows operators to have a better insight into the entire infrastructure rather than just portions of it.