Wireless intelligent completion technology

Tendeka, a leading provider of completion systems and production optimisation technologies, discusses the benefits of its PulseEight intelligent well technology for the digital oilfield.

INTELLIGENT WELLS USE valves or chokes in the reservoir section that can be operated from the surface. For more than 15 years, they have been used in fields across the world for the more effective exploitation of resources through shut-off of unwanted production, improved water injection placement, and modification to hydrocarbon inflow profiles to increase recovery factors.

Currently available intelligent completion technology is controlled from the surface using multiple hydraulic and/or electric control lines which must pass through the wellhead into the completion annulus, along the length of the completion, through any packers and into the reservoir section where the monitoring and control devices are located. While this technology has been successfully implemented in low complexity wells, there are some limitations associated with the use of control lines. Such examples include the compatibility with complex well architectures, potential well integrity issues due to feedthrough connections, and the significant amount of hardware required which can make it uneconomical for marginal fields.

Wireless completions equipment is becoming more common, from DST testing to multi-node intelligent completions. The move from conventional equipment with no communication mechanism, and more modern control line based systems, to a wireless system is ongoing and presents several key advantages in efficiency, performance and safety.

While control line systems typically require increased CAPEX, the alternative of a conventional completion system can often see the savings on equipment nullified due to increases in OPEX and deferred production through increased intervention and poor reservoir performance.

Wireless intelligent well technology will extend the operating envelope for the advanced completion to allow interval control where currently this cannot be achieved. Independent valve assemblies without control lines can be rotated in the well during deployment and function without physical connection to the surface. Single critical point failure modes are eliminated and inflow control can be achieved in the laterals of multilateral wells or at the furthest extent of a long openhole lateral. Well construction costs are reduced as cost savings in control lines, downhole connection and completion times are made, and basic top hole workovers can be performed more simply and cheaply without affecting the advanced completion functionality.

Wireless systems can help to provide a hybrid of the key features, whereby the control line for downhole communication and actuation. Even single control line strings can add significant cost to the project, while triple or more bundles for hydraulic control can add over US$1 million to the project cost once the additional hardware, man power and rig time are included.

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PulseEight technology
Tendeka’s PulseEight intelligent well technology provides cable-free control and monitoring solutions for a wide range of applications. Each independently acting device provides an infinitely variable choke and seal with pressure and temperature measurements for optimum control.

The all-electric system is microprocessor driven and can be programmed to function based on wirelessly transmitted instructions from surface or to respond autonomously to the well environment, for example detecting well shut-ins, changes in well pressure or metering mass flow rates.

The wireless communication uses a unique semi-duplex pressure pulse telemetry suitable for multi-phase fluid environments that utilises the existing wellhead equipment to interface with the downhole valve.

Once in the well, the PulseEight device can be actuated from surface using pressure pulse commands. These commands are typically generated using the surface choke, and the size of pressure change required can be establish prior to deployment using well modelling.

Flow from the reservoir enters ports in the tool and flows to surface. The device creates a downhole pressure response by briefly choking the flow, with the response being viewed at surface.

Six pressure pulses are identified on the surface recorder. The time between the pulses is analysed to give a unique binary code that is decoded to provide pressure and temperature readings as well as tool status information.

To communicate from surface down the well to a PulseEight device, a number of pulses are created at the wellhead. Each device responds to a unique pulse sequence and takes action to open, close or choke or to amend any variable.

In addition to this direct surface controlled operating mechanism, PulseEight can be configured to work autonomously based on changes in downhole conditions. Computer models can be used to build the optimal inflow profile, and the PulseEight device can be programmed to target a fixed dP through the valve. This computer model can be kept updated with the downhole pressure data sent from the valve, and the valve’s programmed parameters can be adjusted while in hole to suit the update output from the model. This offers an additional benefit over hydraulic control line valves as autonomy leads to faster decision making and implementation of optimisation techniques.

Example application areas
PulseEight can be used for various applications, such as pressure/temperature profiling for improved reservoir understanding; variable interval control for reduced water cut and improved recovery factors; multilateral control for efficient well construction and performance; water and gas shut-off for rapid control of high WC/GOR zones; remote barrier for management of Frac hits; autonomous gas lift for optimal well performance; downhole regulator for optimal gas hydrate prevention; and autonomous crossflow prevention during well shut-ins.

Delivering a robust and reliable solution to market
The uptake of new technology in the oilfield tends to be slow due to the significant perceived risks with new technology and the financial cost of equipment failing downhole.

To minimise the risks and deliver a reliable system to market, PulseEight has gone through a robust and staged qualification program including component testing, system testing, and field testing.

Reliability of the design was ensured by using internal components common to previous system offerings, while testing sequences were designed in accordance with appropriate industry standard and regular input from operating companies along the way. The ability to test the system in live well scenarios has been invaluable in proving the communication mechanism over long distances, and under flow regimes that would have been impossible to recreate in a lab environment.

While the immediate future for this technology will be to extend the operating envelope for intelligent completion technology and address some of the applications mentioned in this article, the long-term aim for the technology is to form part of a fully digital oilfield. This would involve a set of “goal-seeking” devices being installed in a well and communicate with each other, as well as with surface, to provide a fully autonomous, optimal production environment.