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Smart Automation Boosts Economics

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A quiet revolution is happening in America's oil fields as next-generation automation works its way into every aspect of operations. Where once there was stiff opposition, now operators are scrambling to leverage the computing power and data accessibility provided by cloud technology. Edge computing also is becoming increasingly popular as a smart way to process key data in the field for near real-time problem solving.

These concepts offer great potential for operators to truly optimize production and reduce costs. New cyber-physical systems drive optimization with sophisticated algorithms, control systems and communication technology. Their providers say these systems are moving rapidly to identify problems through machine learning and the Internet of Things and recommend action or even solve problems with artificial intelligence, making near-autonomous wells a reality.

Downhole Optimizations

Automating surface equipment can have tremendous benefits, but to maximize production from each well, operators must also put the right tools and chemistries down hole, says Suzanne Stewart, Tendeka's vice president for North and South America. She says the company, which has a track record of using autonomous inflow control in conventional wells, is adapting its technology to meet the unique demands of unconventional plays.

"In both conventional and unconventional wells, we find that combining tools and chemistry optimizes production and results in improved recovery factors," Stewart relates.

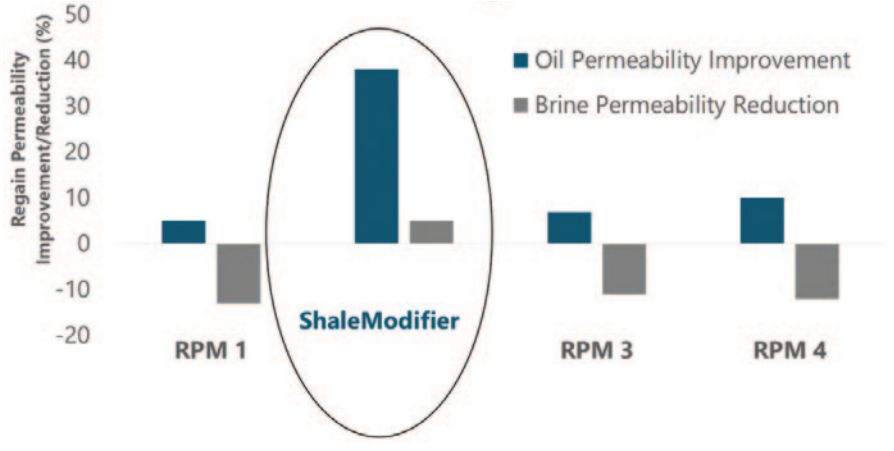
To illustrate the power of optimal tool use, Stewart cites huff-and puff projects, in which the operator injects natural gas or carbon dioxide to displace trapped oil through diffusion and push it to the wellbore. Using specialized valves to distribute injection along the length of the wellbore can ensure conformance in the lateral.

The injection valves can pair with autonomous inflow control devices designed to stop the well from producing gas too rapidly, Stewart describes. Keeping gas in the reservoir helps maintain pressure and extends soak times, she explains, ultimately increasing recovery.

In water injection wells that carry the risk of a thief zone, Stewart recommends deploying valves that sense when water is injecting at an excessive rate and respond by autonomously restricting flow to divert water into the rock matrix and enhance reservoir sweep.

To give operators greater control over downhole tools and access to feedback from them, Tendeka has pioneered a wireless method of two-way communication called fluid harmonics, Stewart relates. The tools communicate with the surface by changing how production fluids flow through adjustable ports to create brief pulses that convey information through their amplitudes, durations and intervals.

At surface, these pulses are detected and interpreted automatically. If a change is necessary, the operator can send commands to the tools with minimal choke adjustments that create pulses of their own, Stewart describes.



By using chemistry to modify rock surfaces so they repel water, operators can reduce fracture networks' capillary pressures and therefore resistance to hydrocarbon flow. Tendeka says permeability regain and other tests show this will increase oil production significantly.

Using fluid harmonics, Tendeka has created a downhole reservoir management system that Stewart introduces as the world's first redeployable wireless completion to come equipped with control, power, monitoring and communication capabilities.

"The system allows wireless communication from surface to down hole and vice versa, and it can be configured to operate in the cloud." Stewart says. "Unlike traditional intelligent completion systems, which must be installed during the initial completion, it can be deployed when it is needed, then pulled and redeployed elsewhere."

This allows producers to complete new wells that eventually will need intelligent completions at a lower cost or economically add intelligent completion capabilities to mature wells, Stewart mentions. For example, the system may be deployed in a mature well to shut off water-prone zones until the water encroachment has receded.

By eliminating the need for hydraulic or electric control lines, the pulse-based intelligent completion system reduces costs while improving reliability and safety, Stewart says. "In some scenarios, the valves may need to be pulled and replaced," she notes. "A vitality pulse communicates the system's condition, so operators will know when that is necessary."

Simplifying Fracturing

Chemistry can play the star role in improving returns from hydraulic fracturing treatments in unconventional wells, Stewart suggests. She cites an oil-based polymer that enhances flow by bonding with the rock's surface to change its wettability. The surface modifier's ability to penetrate pore networks as small as 100 nanometers with pressure differentials as low as 225 psi makes it ideal for tight reservoirs, she suggests. In laboratory tests, Stewart reports, it has increased the volume of oil recovered during flowback up to 250% and the average producing flowrate 194%.

The surface modifier can be injected during hydraulic fracturing or as part of a workover, she explains. When it is applied during a frac job, Stewart says the return on investment can be augmented by replacing corrosive spearhead acids with a noncorrosive alternative.

Operators pump spearhead acids down hole after perforating to reduce the formation breakdown pressure so the fracture can be initiated with less horsepower, Stewart notes. With traditional acids, the wireline and guns need to be pulled before the acid can be pumped to prevent corrosion. "By switching to a noncorrosive acid, we can eliminate this step and perforate in the acid. This saves time and 200-400 barrels of water for each stage," Stewart reports.

High-viscosity friction reducers (HVFRs) that work well even in produced water can help operators limit their freshwater consumption, she adds. In field trials, Stewart says combining the robust HVFRs with the surface modifiers and noncorrosive acids has cut total water consumption as much as 50,000 barrels while shortening pump times as much as 200 hours. ❐