

## Advanced Noncement Options for Isolating Wellbores

For today's long horizontal wellbores and multilateral completions, competent zonal isolation is especially critical. But cementing and perforating multiple zones is costly and time consuming, requires specialized equipment and personnel, can cause near-wellbore formation damage, and poses safety and environmental risks. Alternative isolation technologies now can reduce costs and improve well productivity through more effective fracture treatment and better inflow management. Among these new options, reactive-element (RE) technology and other fit-for-purpose packer systems are field-proven solutions for a variety of zonal isolation challenges.

Much more of the world's oil and gas can now be recovered economically by exposing to the wellbore long stretches of reservoir that typically contain several pay zones. Without cost-effective zonal isolation, however, the full potential of advanced drilling and completion technology to increase production, ultimate recovery, and profitability cannot be realized. Efficient, practical zonal isolation is also important in solving fluid-loss problems while drilling and in reviving mature wells.

With new, noncement isolation methods, it is possible to achieve uniform flow in highly productive wells, perform multiple fracture treatments in carbonate and shale reservoirs, and employ inflow control devices (ICDs) to manage flow without well intervention. All of these capabilities extend a well's productive life and profitability.



**Fig. 1—RE packers and frac sleeves used in a cementless multistage completion design.**

### Two Key Drivers

Isolating well intervals without cement is not a new concept, but recent growth in commercial use has been driven by such challenges as the need to fracture tight gas formations and to regulate flow in high-rate wells.

Two means of achieving cement-less isolation are the use of

- RE packers with swelling-elastomer elements that self-energize in reaction to water and/or hydrocarbons
- Hydrostatic/mechanical packers, set hydraulically

The latter type of packer often is used with an ICD.

### RE Systems

For a fast-growing number of diverse zonal isolation challenges, an RE packer is an efficient, cost-effective alternative to cementing and perforating. RE-packer completions are simple to deploy and require fewer trips, no running tools, and no specially trained personnel on site. RE devices are usable in both oil and gas producers.

Elastomeric-polymer sealing elements in the packer react with oil or water to swell and seal off the annulus between liner or casing, and open hole. The water-reactive element consists of particles contained in a nitrile-based polymer that swell by absorbing water. The rubber expands without the particles being physically absorbed in the rubber matrix. Oleophilic polymers in the oil-reactive element absorb hydrocarbons into the matrix.

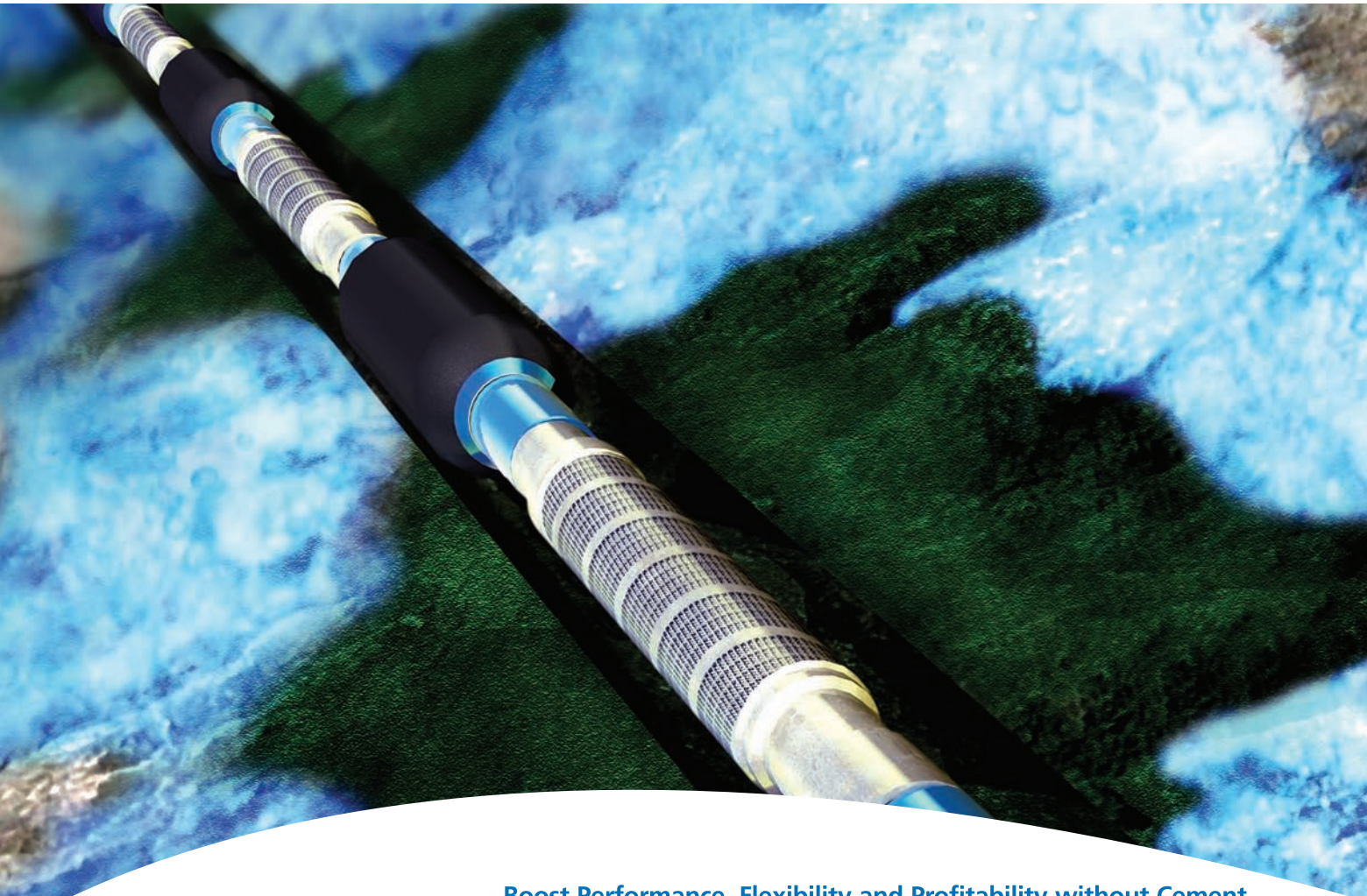
The swelling mechanisms are not reversible, so the element will not shrink if fluids are changed after swelling. Tests show negligible contraction in the elastomer when exposed to natural gas. RE packers are rated for temperatures to 300°F and pressures to 10,000 psi.

RE-packer applications include water shutoff and the isolation of cement shoes, lateral junctions, and fractures. A special type of RE packer can be field-installed onto existing tools for added flexibility in deployment. Another RE tool can be used as a debris barrier.

On a well in the Middle Bakken formation of the Williston basin in North Dakota, the use of RE packers with frac sleeves significantly reduced completion cost while achieving a new extended-reach record of 7,740 ft (**Fig. 1**). The entire interval was fracture treated in 12 hours. Using conventional perforating guns and composite plugs, the job could have taken more than 4 days. Total vertical depth was 10,176 ft, openhole (OH) inner diameter was 6.125 in., and bottomhole temperature was 210°F.

The job originally was planned to be run in brine, but that had to be replaced with an oil-based mud (OBM).

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**Fig. 2—Hydro/mechanical, composite packers deployed with IWS technology.**

Testing indicated that the OBM would swell the RE packer, but to deploy the system successfully, a new retardant had to be tested. Used successfully to deploy the packers and frac sleeves, the retardant is now available for similar contingencies.

In Mexico, on a multilateral completion where cementing was unsuccessful, the RE-packer system isolated a relatively unconsolidated zone above the pay zone. Two 5-in. RE packers with water-reactive elements were set at 9,215 ft and 9,176 ft in a 6-in. open hole to regain gas production that had been lost when water invaded a low-pressure productive zone. Additionally, the packer deployments isolated a thief zone.

The result was a 500% increase in gas production, a 150% increase in oil production, and no increase in water production. The well was returned to production with 2,670 psi (3.022 MMcf/D), compared with 730 psi (0.480 MMcf/D) before the packer installations. The solution was engineered by Baker Oil Tools and required only 10 days, including the delivery of equipment to the rigsite. The multilateral completion was successfully installed and the trouble zone isolated, eliminating 2 days of rig time and the need for squeeze cement jobs.

### Pinpoint Multizone OH Fracturing

The growth of shale formations as a source of natural gas is an important opportunity for pinpoint multizone OH fracture treatments that employ noncement isolation techniques. Treatments of this type improve initial well productivity and accelerate reservoir drainage. The system for performing these pinpoint treatments includes a liner-top packer, OH packers, frac sleeves, and pressure-actuated sleeves. Pinpoint fracturing applications developed by Baker Oil Tools are capable of treating up to eight intervals or stages in one trip.

Among their advantages, pinpoint OH fracture treatments

- Eliminate perforating and liner-cementing operations
- Allow one-trip installation and pumping treatments for each section on the same day
  - Improve fracture-extension control, compared with non-selective hydraulic fracturing
  - Reduce fracturing costs by means of smaller, selective treatments

### Flow Management

A uniform production profile is a key to optimizing production and ultimate recovery, as well as minimizing field development costs. Zonal isolation is critical to establishing a uniform flow profile. Effective inflow control can reduce gas cusping, water coning, and costs related to cementing and perforating. The result is longer well life, improved depletion, maximum reservoir sweep, effective sand control, and fewer well interventions.

In horizontal wellbores, for example, single-trip packers with composite structures and hydro/mechanical elements, set hydraulically, can be used to isolate sections of varying permeability. This saves the expense and risk of cementing and perforating. Packers can be run on blank casing to isolate unwanted zones, in slotted casing or standalone screens to separate producing zones, or between screens in a gravel pack for zone isolation. Because the composite element in the mechanical packer developed by Baker Oil Tools is actuated by means of wellbore hydrostatic pressure, the tool is able to conform to irregular wellbore geometries, the industry's only noninflatable mechanical packer that can do so.

Wellscreens equipped with ICDs, which employ radial-flow resistance to equalize inflow to the well, can be installed in each section to mitigate coning along the interval. If used in sandstones, the screens can be designed as premium sand-control devices. If used in carbonates, that feature in the screen design can be eliminated.

The combination, spacing, and geometry of packers and ICDs for flow management are determined in advance. In long horizontal wells, this type of completion provides balanced flow along the entire length of a horizontal section, improving productivity, drainage, and ultimate recovery.

In one field study, the combination of hydro/mechanical, hydraulically set packers and screen/ICD assemblies increased overall recovery by up to 60%, compared with existing completions. More than 2,000 packers of this type, combined with screen/ICD assemblies, have been installed in Saudi Arabia—in sandstones and carbonates—for OH, casing-shoe, and gas-/water-zone isolation.



**Fig. 3—Hydro/mechanical, composite packers deployed with ICDs.**

### Optimized Control of Water or Gas Breakthrough

With the ability to provide competent isolation using OH packer technology, long horizontal wellbores can now be divided into numerous short intervals in which water or gas breakthrough can be controlled. Without this control, excess water or gas produced from a short section with high permeability could lead to the loss of the entire wellbore.

Flow control can be accomplished with mechanical sliding-sleeve technology or an intelligent-well system (IWS). Mechanical sliding sleeves can be manipulated to shut off

unwanted production by means of coiled tubing and conventional shifting-tool technology. An IWS allows flow control without well intervention, through the use of surface-operated valves.

In June 2007, a Middle East operator used composite, hydraulically set OH packers and IWS technology, both from Baker Oil Tools, integrated into an OH reservoir-optimized completion (**Fig. 2**). The solution made it possible to isolate and control water production, plus enhance oil production by means of artificial lift—using the upper gas zone—without the need for well intervention.

In another OH installation, a horizontal lateral was drilled close to the oil/water contact. Composite, feedthrough OH packers, set hydraulically, divided the wellbore into four intervals. Within each interval, pressure and temperature gauges, along with remotely operated choking valves, were installed to provide independent monitoring—while actively controlling the drawdown of each interval to optimize commingled production (**Fig. 3**). This type of system accelerated production and enabled real-time water management.

Whether flow control is achieved mechanically or with an IWS, the use of OH completion technology has proven that ultimate recovery can be increased. **JPT**

*Information provided by Ed Wood, Sean Yakeley, Jesse Constantine, and Jody Augustine, Baker Hughes.*

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