Multi-zone, expandable completions

New technologies provide more options for sand-prone, open-hole reservoirs

INNOVATING WHILE DRILLING
Case studies on monobore expandable liner extension, directional casing while drilling

REGIONAL FOCUS: EUROPE & THE NORTH SEA
As prospects get smaller, contractors must deliver efficiency
Open-hole applications testing multi-zone completions, expandable tools to new limits

By Katie Watson, contributing editor

---

Completions have NEVER

delivered game-changing technologies to develop game-changing technologies to operate in exceedingly complex environments. Multizone completion technologies, along with expandable gravel pack technology, are increasingly being deployed worldwide in land and offshore applications.  Multi-zone completions, expandable tools are really starting to thrive.

Halliburton’s Alternate Path gravel pack systems have been on efficiency, using packers and frac sleeves. For multi-zone stacked completions, for example, which are possible only in a single-trip, multi-zone completion service. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ multizone completion service, which uses single-trip technology to set packers, gravel packing across an entire interval. It is used in conjunction with the MZ mul...
ing depths and long reservoir intervals that require sand control treatments, was the primary development driver for Halliburton’s Enhanced Single-Trip Multizone (ESTMZ) completion system. It is being deployed to address the challenges of completing longer intervals that cannot be cost-effectively completed with existing multi-zone stack packing technology. Mr Grigsby explained, “The ultra-deep well depths of 28,000-plus feet required to reach the Lower Tertiary, along with intervals with gross lengths up to 1,400 feet, provide both economic and time challenges.”

Among the specific challenges that the ESTMZ system addresses are well depths that require multiple workstring trips to deploy the sand face completion kit. “Maximizing the number of reservoir intervals that can be isolated and stimulated with an optimized treatment design only adds to the number of workstring trips required when existing stacked pack completion technology is used,” Mr Grigsby pointed out.

“The Lower Tertiary also requires a frac tool assembly to deliver large proppant volumes at high enough rates to create the optimized fracture geometry to maximize well productivity,” he continued. “The potential long interval lengths require segmentation to optimize fracture treatments. This poses challenges with integrating the uphole production assembly with the sand face assembly to provide access and potential selectivity of the multiple completion intervals.”

Halliburton’s suite of sand control tools, including screens, sand control pumping and sand consolidation products, are used on all types of completions requiring the abatement of sand production, Mr Grigsby noted. The primary sand control completions techniques include stand-alone screen completions (SAS), conventional cased hole gravel pack completions (CHGP), open-hole horizontal gravel completion (OHHGP) and FracPac (FP) completions.

Halliburton uses its expandable liner hanger technology, the VersaFlex liner hanger system, primarily in the well-construction process when running drilling liners and production liners, Mr Grigsby said. “While currently not used in multizone completions requiring a pumped sand control solution, the system is used as the hanger assembly in multiple interval land completions that require stage fracturing and other specialized screen-only completion systems.”

When expandable technology was introduced in the mid-1990s, it was viewed as an aggressive idea by an industry that historically was slow to adapt. But not only did expandables survive those early days of skepticism, they are increasingly being used as wells have become more complex and designed with multiple zones that require sophisticated techniques for maximizing production and cost-effectively controlling sand.

The early promise of expandables was casing that could be expanded in place to create wells with a single borehole with a diameter that could be expanded in place, thus eliminating loss of hole diameter due to multiple conventional liners to handle over pressured zones, said Vikram Rao, executive director, Research Triangle Energy Consortium, a nonprofit research facility that studies ways to solve the world’s technical, economic, societal and public policy problems related to the use of energy.

“The concept was that you could go to unlimited depths with casing and end up...
with a production tubing size that was pretty big,” Mr Rao explained. “This way, not only did you definitely get to bottom, but, by the time you got there, you could have essentially any production tubing you wanted.”

As the technology developed, expandables increasingly were used in zonal isolation applications. “It became apparent that expandable technology was ultimately meant for zonal isolation and that hanger applications and zonal isolation relative to sand control were probably going to be more prolific sooner than multi-diameter casing of wells because the value proposition was relatively easy to understand,” Mr Rao explained.

Once the industry became comfortable that expansion could create a sound-enough joint, expandables began being used, first in liner hangers, then in multi-zone completions, where they have become an important tool for sand control, particularly in deepwater and ultra-deep well environments.

“One step in reducing the cost of deepwater completions is multi-zone completions, particularly with fewer trips.”

Now, tools such as expandable sand-screen systems are serving as an alternative to the conventional gravel pack method of sand control, in an increasing number of wells. In some cases, expandable technology has been deployed with conventional gravel pack tools to solve particularly challenging completion issues.

Expandable Sand Screens, or ESS, is the primary expandable completion technique in Weatherford International’s suite of slotted expandable tubulars that was developed from a concept originally identified in 1993. The system, primarily a compliant sand-control technique, has been applied in over 600 applications worldwide, including oil and gas production wells, water-injection wells, gas storage and multilateral wells, ranging from shallow land-based operations to deepwater arenas. ESS is best applied as an open-hole solution, whether via long horizontal wells or to target multi-layered deviated pays.

“In shallow, deviated or long horizontal wells, Weatherford’s expandable sand screens can be an alternative to open-hole gravel pack.”

“From a sand control perspective, ESS brings improved performance and reliability, particularly important with the trend towards reservoir completions in more aggressive environments,” said Martin Geddes, Weatherford global product manager – ESS. “It is an alternative to gravel pack and frac pack technologies that, when applied appropriately, is extremely valuable in providing productive, cost-efficient completions in a multi-zone environment where we use casing between the isolation devices and can deploy the system in a single trip. In some multi-zone deepwater wells, operators have seen a $10-million savings in installation costs per well with the system over other techniques.”

Wells typically are evaluated on a case-by-case basis to see which technology – ESS, gravel packs, frac packs, standalone screens – is best for a particular well, Mr Geddes said. In producing wells, for example, ESS might be used when a weak rock is expected to fail and elements from the wellbore would start to mix. “ESS supports the formation in place so that it is more productive, preventing sand movement and reducing skin development,” he said.

For shallow, deviated or long horizontal wells, ESS is an alternative to an open-hole gravel pack. “With ESS, we get an efficient sweep of the reservoir because the screen is placed in direct contact with the wellbore so we can maintain a larger completion ID,” Mr Geddes explained. “With a gravel pack, early water/gas breakthrough might be encountered due to the higher friction loss along the smaller completion ID. ESS provides a more even flow, meaning the reservoir will be drained more efficiently.”

In water-injection wells, performance over time is the chief goal. “We want to maintain the injection rates required over the life of the well while controlling the sand during injection shutdowns,” Mr Geddes said. “Because ESS is contacting the formation directly, a large open area is presented, enabling effective filter cake clean-up, resulting in good injection performance.”

Similarly, in gas production wells, because the ESS is in contact with the wellbore, annular flow is minimized, thus mitigating against hot spotting and potential screen erosion. Weatherford has used this technology to complete a number of deepwater gas wells with rates up to 360 million standard cu ft/day.

For the gas storage market, ESS has the ability to maintain performance of the well over many withdrawal and injection cycles over many years. “These fields, because they are generally old oilfields, tend to be highly depleted and therefore are very difficult to gravel pack,” Mr Geddes explained. ESS also has been used successfully in multilateral wells to maintain a larger ID in a smaller hole size.
In a long, horizontal, multilateral leg, the reduced hole size presents a challenge both in terms of performance and reservoir sweep. ESS can be used to address this,” he added.

Looking ahead, Mr. Geddes sees continued advances in expandable sand screens, such as the integration of new-technology zonal isolation devices to complement Weatherford’s existing expandable zonal isolation offering and the provision of reservoir isolation integrated within the same single installation trip. Also, with the increase in challenging deepwater field developments, there will be continued optimization of expansion systems for use from semi-submersibles.

Baker Hughes has a suite of expandable technologies that are used worldwide, including land, shelf and deepwater environments, and has continued to adapt the technology for increasingly challenging scenarios. “We’ve taken lessons learned early on to develop a system that can be run flawlessly and executed with a high degree of technical efficiency,” said Eddie Bowen, product line manager, screen-equalizer technology for the company’s sand control marketing division.

“The company’s current expandable metal sand control technology is the EXPress expandable screen system, Mr. Bowen said. “It is especially effective in high-rate gas production and gas storage wells where cyclic injection and production occurs. EXPress is a stand-alone screen solution in applications where pumping a gravel slurry is not feasible or not preferred.”

The screen, designed with perforated base pipe and hydraulic expansion technology, can be expanded outward to reduce or eliminate space between the wellbore and the screen, thus reducing the potential for sand coming into the hole. In 2008, the system was deployed and expanded in a single trip in an open-hole, horizontal, single lateral workover well of more than 1,900 feet of reservoir contact, the longest application to date.

In another application, Baker Hughes combined a conventional horizontal gravel pack system with expandable technology to accomplish sand control in a gas storage-producer injector well in northern Italy. “The operator wanted to isolate the shale sections and perform a gravel pack without pumping fluids across the shale sections,” Mr. Bowen explained.

“So, to isolate those swellable clays in the shale, we ran expandable blank pipe with annular isolation provided by expandable elastomers isolating the shales from the sands, and expandable perforated pipe across the sand bodies, and then ended with a gravel pack. So they used unconventional technology to isolate the problem, and then completed the process with a conventional sand control technique.”

Baker Hughes is the process of launching a non-metal expandable sand control technology that utilizes a shaped memory material that can be manufactured at a desired diameter. That diameter can be reduced to a run-in-hole diameter and will return to its original diameter in situ across the sand face. In field trials now, the product is expected to be commercially available in December 2010.

An animation of the Weatherford expandable sand screens is available online at www.DrillingContractor.org.

Alternate Path is a mark of ExxonMobil Corporation; technology licensed exclusively to Schlumberger.

STMZ and ESTMZ are trademarks of Halliburton. VersaFlex is a registered trademark of Halliburton.

ESS is a registered trademark of Weatherford International. EXPress is a trademark of Weatherford International.