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Starting from both ends: expandable casing design

From the top down and the bottom up: there are always two ways to find a solution when designing challenging wells.

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These two methods are exactly how two operators added considerable value to their well designs. At either end of the well bore, these applications illustrate how innovative operators are using expandable casing as planned components in well designs and reaping the benefits.

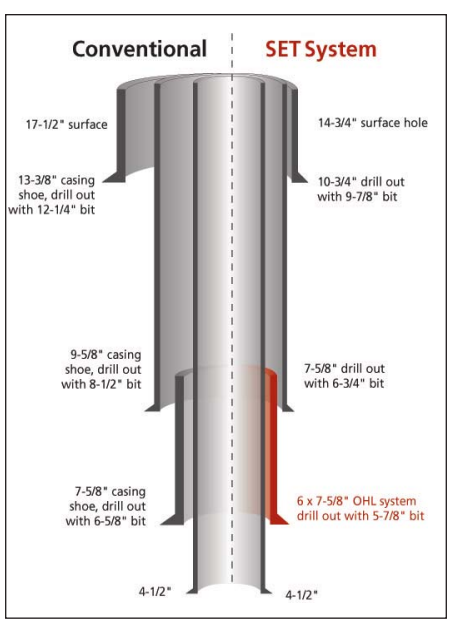
Drilling deep Miocene wells in the shallow-water coastal region of the Gulf of Mexico presented frequent fracture gradient problems that challenged well economics for one operator. Non-productive time (NPT) was also a costly burden and reaching bottom with sufficient hole size was a constant concern.

This operator's solution started at the top. Although the top section of the well was successful, extra casing strings were needed to get past problem zones and achieve the designed completion. Expandable casing provided the means to conserve hole size while mitigating known wellbore stability issues.

On land, another operator was seeking ways to cut costs on its multiwell program drilling hard rock in the lower Bossier play northwest of Houston, Texas. One approach was to improve economics by reducing consumables — such as cement, casing, mud, bits, etc. However, the reduction was not sufficient. The operator's next target was to increase penetration rates.

In this operation, the focus started on the bottom. The operator started with the optimal completion size and worked up the well bore to reduce hole diameter in each section, thus slimming the well profile. With a smaller hole size, drilling time was significantly faster in addition to using less pipe (steel tonnage) and mud, and producing fewer cuttings.

In both cases, operators confronted costs in field development programs with innovative changes in well design. Though they created different solutions, both operators approached the problem from a planning perspective using expandable pipe as in integral part of their casing plans.



By incorporating solid expandable technology into the wellbore design, the operator reduced overall drilling time by 21 days. Additional savings were realized when swellable elastomer technology was used with the expandable system to provide zonal isolation – eliminating the need to cement. (Images courtesy of Enventure Global Technology)

Reducing NPT

Just offshore Louisiana in about 20 ft (6.1 m) of water, deep Miocene reserves at 15,000 to 25,000 ft (4,575 to 7,625 m) hold potential production rates that can exceed 100 MMcf/d. But on the way down the hole, low fracture gradients and highly compartmentalized geology caused lost circulation and hole stability problems — resulting in unacceptably high NPT. Additional casing strings required to deal with the trouble zones would constrain hole size and compromise the completion design.

Following their 2007 discovery well in the South Marsh Island area, the operator has drilled five additional successful wells in the field. Four wells are currently producing at a gross rate of about 200 MMcf/d. The current drilling program uses expandable liners as a standard component in the casing plan. The operator installs two SET Openhole expandable systems to mitigate pressure differentials — a 9⅝ by 11⅞-in. liner and a 7⅝ by 9⅜-in. liner.

Drilling out under 11⅞-in. casing, the plan calls for installation and expansion of the first liner into the 11⅞-in. casing. A 9⅜-in. conventional casing that runs to surface followed the expandable system. Set below the 9⅜-in. casing, the second 7⅝-in. liner expandable system is run and expanded. Conserving hole size with the two expandable systems facilitates a 7-in. completion to accommodate the high rates of production.

In contrast, the conventional design mitigates the lost circulations zones with a much more dramatic decrease in hole size. It sets 9⅝-in. casing and follows it with a 7-in. string, resulting in just a 4½-in. completion.

The new design using expandable liners has resulted in a substantial reduc-

tion of NPT. Time to drill a well has decreased from about 200 days per well to 60 to 90 days per well. Compared to earlier wells where operators used expandables in a contingency role, the planned-in design saved the operator US $24 million on the first well.

In addition to time saved by not having to fight lost circulation, differential sticking and hole stability problems, South Marsh Island well economics also benefit from less rig time, and lower consumption of mud and other consumables. Greater efficiencies gained through the multiwell program also contribute.

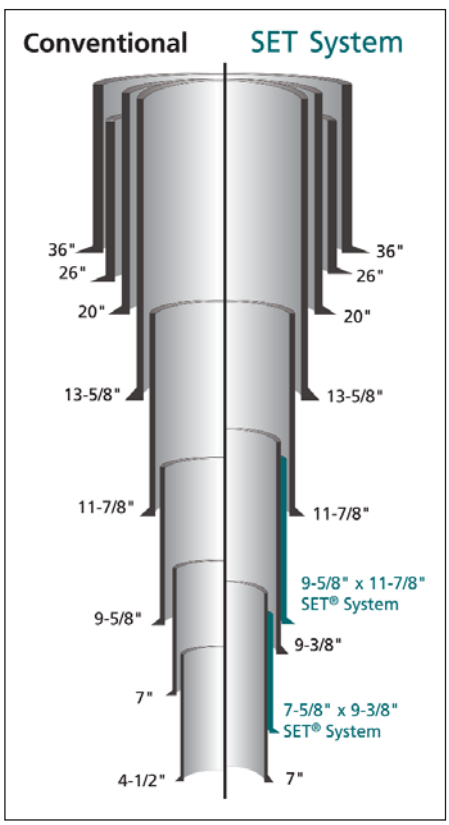
The greatest benefit of the expandables is the increased production rates and accelerated reserve development by completing with an optimal 7-in. casing versus a 4½-in. string. Considering the costs of completion hardware and workovers, the operator will realize additional benefits in its long-term return on investment.

For this operator, planning expandables into the well design was a step arrived at through considerable experience. Five years ago, they first began using it as a contingency of last resort. However, experience brought a growing comfort level. At the same time, expandable technology was building an industry-wide track record for reliability. The decision to use expandables as a design component reflected a strong overall confidence level.

Drilling efficiency

Once considered a low-pressure nuisance on the way to the Cotton Valley group, the Lower Bossier section is now an eagerly sought objective for many drillers in the United States. However, reaching the goal can be a slow process because thick sandstones and distal shales make the Travis Peak one of the hardest and most abrasive formations in the US. Compressive strengths can exceed 40,000 psi.

Grinding away toward the lower Bossier at about 18,000 ft (5,490 m) gave the operator the time and incentive to look for ways to speed up the drilling process. One answer was to slim the well bore.



In the Gulf of Mexico shelf, an operator used two expandable systems to reduce drilling time from 200 days per well to 60 to 90 days per well.

General drilling physics dictate that a medium size bit in the 7½-in. to 9⅞-in. range, applied across many formations and drilling depths, is more efficient than larger or smaller bits. The operator proposed to stay in this optimal range by decreasing hole size in the upper, larger sections without reducing the completion size.

To do this, the drilling team began a multi-well program using expandable openhole liners that is yielding compelling results. The company has achieved a rate of penetration (ROP) boost of about 37%. Increased penetration rates reduced drilling time for each well by approximately four weeks to save more than $1 million per well.

In addition to reducing bit size, the well slimming program also resulted in the use of smaller casing strings, less mud and cement, and smaller wellhead equipment. Fewer cuttings from a smaller hole also meant less disposal requirements.

Because of increased savings, this program essentially drills every sixth well at no cost. Planning approximately 18 solid expandable tubular installations each year in this field conserves enough economic resources to drill three more wells per year.

On the surface, the well slimming program yields a 14¾-in. surface hole instead of a 17½-in. hole, which allows drill-out of surface pipe one day earlier. Below the surface pipe, a 9⅞-in. hole is drilled at a rate of about three days per 1,000 ft (305 m) versus a 12¼-in. hole drilled at nearly five days/1,000 ft (305 m).

A 1,000-ft (305-m) 6-in. by 7⅝-in. expandable openhole liner is run below this section, allowing for planned 4½-in. production casing required at total depth (TD). The process yielded a 21% reduction in drilling time to TD — from 94 to 74 days.

Recent use of swellable elastomers is further improving the economics of the deep Bossier field. Incorporating a specialized expandable swellable shoe to provide zonal isolation eliminated the need for underreaming and cementing the expandable section.

The innovation — the first openhole expandable liner installations ever achieved without the usual cement and under reaming requirements — eliminated another four to six days of rig time, equating to an additional savings of about $300,000.

The planned application of expandable tubulars is providing considerable advantages in improving the economics of land and offshore wells. Highly versatile, expandables enable innovative approaches to meet unique circumstances and objectives.

For well designers familiar with the technology, expandables are proving the means to increase return on investment, and even turn undrillable wells into attractive prospects. E&P