Expandables in wellbore design

Expandables provide an economically feasible, logistically practical and technically proficient way to access hard-to-reach reserves or enhance marginal wells.

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The industry first used expandable technology as a contingency in unexpected drilling problems. As successful use of expandable pipe grew, its reputation as “enabling technology” also grew. Operators soon realized more value with solid expandables as an integral part of wellbore design, especially in complex wells, rather than just a last-minute fix. Planning expandable systems into wellbore design ensures a degree of flexibility that allows more options to be considered when confronted with drilling difficulties.

When planned high in the wellbore, more annular clearance exists between the expandable tubing outside diameter (OD) and the hole inside diameter (ID) than in smaller sizes. Running larger expandables reduces the need to use less common casing sizes to run through the expandable liner and additional systems can be used deeper in the wellbore if needed.

Factoring these advantages into the planning stage has led operators to view expandable tubulars as a significant design element. A proactive approach to well design has allowed operators to extend the shoe, case off trouble zones without compromising hole size and run larger logging tools that are more reliable and less expensive. These systems have also been used to secure wellbore stability, address narrow pore pressure/fracture gradient windows and facilitate slot recovery. Several operators have used the technology to slim the wellbore — start with a smaller casing size than usual and still maintain adequate hole size at total depth (TD). Successful results and the considerable benefits of intentional use have saved operators time, money and consumables.

Maximum size at TD
Burlington Resources capitalized on the advantages of expandable systems and applied the technology across a field development project as a means to slim the wellbore. By incorporating the solid expandable system at the beginning, they achieved a slimmer well profile while still maximizing hole size at TD. Incorporating a 6-in. by 7½-in. expandable openhole liner into the base well design enabled Burlington to drill a 14¾-in. surface hole instead of a 17½-in. hole, allowing drillout of surface pipe one day earlier. Below the surface pipe, the operator drilled a 9½-in. hole (drilled at 3.0 days/1,000 ft or 305 m) versus a 12½-in. hole (drilled at 4.8 days/1,000 ft). The expandable liner was run below this section, allowing for 4½-in. production casing at TD to facilitate planned production rates. The operator completed the primary target at TD and a secondary target behind the expandable liner.

Not only did Burlington maintain hole size but it increased rate of penetration (ROP), decreased mud volumes and cement volumes and increased flow rates. This drilling plan saved it more than US $1 million per well to date and continues to be part of Burlington’s ongoing Robertson County, Texas drilling program. Using solid expandable systems to achieve a larger well bore at TD resulted in a higher ROP in long intermediate casing section (36% enhancement), an overall drilling cost savings (15% to 20%) using slimmed well bore vs. big bore program and an improved drilling performance and lower equivalent circulation density below the expandable system. By planning multiwell use of expandable technology, the operator was able to significantly optimize the savings within the field development program.

Economic advantage
Solid expandables provide a viable solution for well re-entry in mature fields. A West African operator had previously used retrieving and milling operations to conduct an infilling campaign offshore in two fields. Milling was time consuming and increased the chance of accidental casing damage that could have jeopardized the project. The operator determined that solid expandable systems offered the most economic solution. Slot recovery methods were deemed too expensive and the associated technology proved undeliverable within the operator’s project schedule.

The first system used consisted of 2,025 ft (800 m) of 7½-in. by 9¾-in. openhole liner expanded through a 9½-in. window. Successful installation of the expandable liner maximized hole size after sidetracking and prompted the operator to apply the technology elsewhere. A 6-in. by 7½-in. expandable...
openhole liner, approximately 1,410 ft (430 m) long, was successfully installed after the second well was sidetracked through a 7¾-in. production liner.

Expandable technology saved time and maximized the use of existing assets. Total time to run and successfully expand the liner on the first well was 2.4 days compared to the planned 8 days necessary for trouble-free 9¾-in. milling operations. Expansion operations on the second well took 1.5 days. Incorporating expandable technology into the initial well design for the re-entry project enabled this operator to reduce drilling time without using risky casing milling operations and to reach the goal with the original target hole size. If expandables had not been available, the operator planned to plug and abandon the wells because other solutions were too risky, cost-prohibitive or impractical.

**Isolating a common problem**

An E&P company in China developed a program to revitalize existing production in a multiwell, multield casing repair project on land. The operator wanted to restore the integrity of the wellbore and extend the life of the well without compromising ID. A practical, reliable and economic solution was required to isolate watered-out upper perforations to produce exclusively from lower intervals with a higher oil cut.

Several strategies were considered to revitalize these marginal wells including cement squeezes, casing patches and solid expandable tubular systems. The operator selected a cased-hole expandable liner solution (Figure 2). The expandable system allowed for standard production casing to be used, provided attractive economics and implemented a technology with established reliability. The most prudent approach for this project called for installing bull-nosed 4¼-in. by 5¾-in. expandable cased-hole liner systems. Liner lengths for the 300+ well project range from 75 ft to 260 ft (23 m to 79 m) with setting depths ranging from 1,650 ft to 10,400 ft (503 m to 3,170 m).

By incorporating expandables, the operator increased production on the first well from 0.9 b/d to 9 b/d, an 8 b/d improvement. The incremental revenue provided by the enhanced productions paid for the expandable application in 61 days. The operator had a return on investment for completed wells in 3 to 6 months. To date, Enventure has installed over 20 of these systems for this operator. Results on subsequent wells are similar to the first well. By planning the installations with a field-enhancement approach, rather than a one-off solution, the operator is able to maximize on logistics costs for the multiwell project.

Conventional solutions provide little incentive to develop known but difficult-to-reach reserves. Enabling solutions exemplify how operators are capitalizing on technology to optimize overall drilling and completion efficiency through the use of solid expandable tubulars. The results are significant increases in production and reductions in cost and time. Because of their versatility and adaptability to many drilling conditions and situations, expandables are a practical element in wellbore design whether in open holes or cased-holes. With close to 100 miles (160 km) of pipe expanded, this technology is a proven and economically viable alternative to redrills and leaving production behind.