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Drilling in with expandable liner hangers

Using an expandable liner hanger as a drill-in tool offers numerous advantages and eliminates or reduces many of the risks associated with using a conventional liner system.

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Expandable liner hangers have been shown to provide multiple advantages over conventional liner hangers, but work at Shell's Brutus platform demonstrated a new benefit — the ability to drill in with the liner hanger in place.

This approach provides particular advantages in problem well situations, including tortuous well paths or hole sections drilled through depleted well formations such as the **Green Canyon Block 158** in the Gulf of Mexico, where the Brutus tension-leg platform (TLP) is located.

Liner hangers provide two key functions: they sustain the weight of the liner below, and they isolate pressure differentials above and below the liner.

Conventional liner running methods require drilling through the reservoir, often inducing losses in the depleted interval, then pulling out of the hole at a controlled rate and finally running the liner — again potentially experiencing losses. Conventional liner hanger systems often do not permit rotating the liner. In some instances, conventional liner hanger systems are used to rotate or drill-in, but often at the expense of not running slips or the packer element.

An expandable liner hanger allows for hanging the liner and setting the element in one step, eliminating a potential cement squeeze job or an additional trip for a liner top packer. Experience at Brutus showed that it also can be drilled in, minimizing the time the formation is exposed and reducing losses. Furthermore, it allows rotation through depleted sand. Needless to say, this approach uses the liner as part of the drill string, eliminating the need for a mud motor, which in turn allows the liner to be drilled at lower flow rates with low associated equivalent circulating densities (ECD).

Expandable vs. conventional

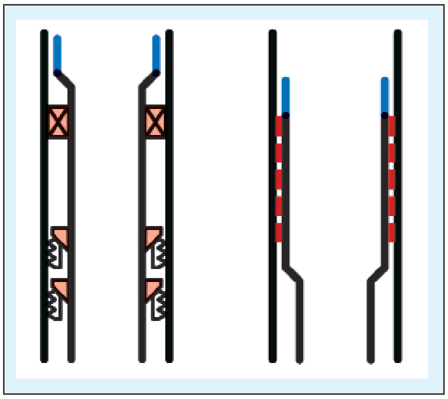
While a conventional liner hanger works with a series of complex moving parts, an expandable liner hanger is a pleasingly simple design that has dual functionality as a hanger and packer. The expandable liner hanger used here was initially developed by Enventure, a joint venture between Shell and Halliburton. Elastomeric elements bonded to the outer diameter of the hanger body make a gas-tight seal against the parent casing and take the load of the liner weight. The seal is achieved by using applied pressure to hydraulically push a cone down a mandrel, expanding the body outwards to the casing.

The expandable system is run similarly to conventional liner systems with a few key differences, most notably that the liner is cemented prior to setting the hanger, as the hanger will provide hydraulic isolation when it is set.

The system has a tieback receptacle on top and a lower setting sleeve below the elastomer section, containing slots into which the collets on the setting tool fit. This allows the system to be rotated in order to ream in the hole, improve the cement job, or drill through trouble formations.

The expandable system eliminates or reduces many of the risks associated with using a conventional liner system as a "drill-in" tool:

- The smooth outer diameter allows faster circulation and better hole cleaning with less back pressure;
- The lack of external components eliminates traps for cuttings and debris, reducing ECD and preventing damage to the hanger/packer prior to getting to total depth;
- The packing system is hydraulically set, eliminating the need to apply set-down weight;
- The setting tool annulus is completely sealed off against debris/fines ingress; and
- The hanger is unaffected by pressure surges while reaming or drilling. The setting tool is unaffected by drilling pressure.



Compared with a conventional liner hanger (left), the simple design of an expandable liner hanger (right) uses elastomeric elements to create the seal and carry the load of the liner weight. (All images courtesy of Halliburton Energy Services)

Brutus case history

Production at the Brutus TLP began in 2001, and like many such fields, production from the original wells has declined. A series of sidetracks have been planned for many of the original producers. Based on field experience, significant drilling problems were expected using traditional techniques in these highly depleted zones. The plan developed was to drill conventionally 45 ft (13.7 m) below the pay zone, pull out of the hole and drill an additional 200 ft (61 m) with a rotary liner drilling system, cement the open hole interval back to the shoe and set the expandable liner hanger.

A careful analysis was made using both software modeling and field data to predict and minimize torque values during rotary drilling with the liner. A decision was also made to change flow rate to keep ECD constant, even at the expense of proper hole cleaning.

The sidetrack well being drilled used a 7⅝-in., 47.1 ppf casing, using 15 ppg synthetic based mud. The planned top of the liner was at 14,500 ft (4,420 m), with a 5½-in., 20 ppf liner shoe at 17,170 ft (5,235 m). We planned a 3.5°/100 ft (30.5 m) drop angle from a 25° hole angle to near vertical.

A first unsuccessful rotary liner drilling trial was made, from which it was decided to modify three key elements of the test. First, a short trip back to the shoe after drilling the hole conventionally would be used to verify favorable hole conditions. Second, molded-on centralizers were added to the liner to minimize borehole contact and thus reduce the risk of getting differentially stuck. Third, frequent drill pipe fill-ups were needed to reduce the hydrostatic imbalance at the tool emergency release mechanism.

Once these conditions were addressed, the second liner drilling trial was successful. The conventionally drilled section was drilled off a whipstock at 14,595 ft (4,449.6 m) to a depth of 16,925 ft (5,160 m) and then pulled out of the hole. The liner and expandable liner hanger was run, and 600 ft (183 m) from bottom tagged and set weight. The rotary was engaged and the liner was reamed the last 600 ft of open hole. At total depth, 97 ft (29.5 m)of new hole was rotary drilled in 8.5 hours using various combinations of flow rate, rpm and weight on bit (WOB), up to 120 gpm, 80 rpm, and 15,000 lb WOB. The liner was rotated 45,600 revolutions during the drilling test.

The liner was drilled in and cemented successfully with full returns. The liner hanger was successfully expanded. The setting tool released without incident and the liner overlap tested successfully positive and negative.

What was learned

Several key lessons were learned. The most significant was that the expandable liner hanger system is robust enough to use for rotary liner-drilling applications. In addition, such an application provides the benefit of a one-trip process for rotary liner drilling, hanging the liner and setting the top packer, saving work and time. The importance of torque analysis in achieving a successful rotary liner drilling application was also noted. Combining software models with the actual drilling torque measured while drilling with the conventional assembly enabled accurate calibration of friction factors to predict torque values for the rotary drilling liner.

The successful application at Brutus demonstrated that the expandable liner hanger can be drilled in to address difficult borehole conditions where there is a requirement to rotate or ream to the bottom. The drill-in expandable liner is another tool in the portfolio of options for problem well scenarios. E&P