Liner hanger system increases installation success

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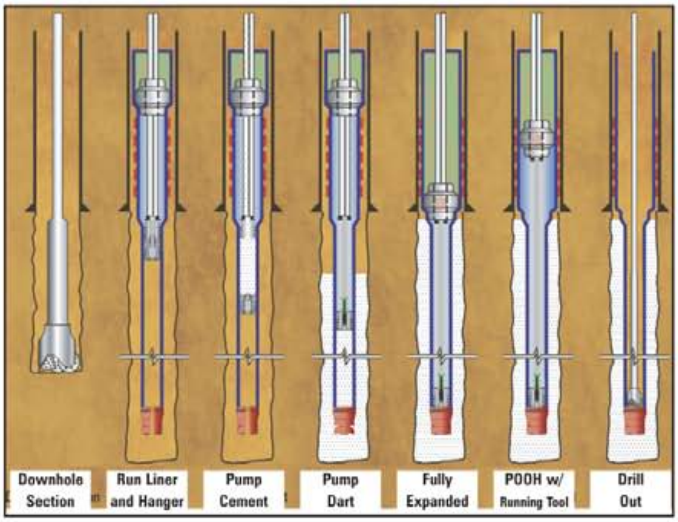
DRILLING OPERATIONS throughout the world occasionally require the use of casing liner strings. The installation of these strings presents a variety of challenges for both the installation tools and the cementing technologies.

Unfortunately, the failure of liner tops and/or liner installations is a common problem in today's oil and gas industry. The cost of fixing these failures can be significantly expensive, especially if the failure involves loss of the wellbore. The cost of a failed liner can be up to $30 million a deepwater well.



The VersaFlex liner system is run and expanded from the top down. After the interval is drilled, the mud is conditioned for cementing. The liner is then lowered into the hole and additional circulation is performed as required while reciprocating or rotating the liner string. Once the hole is prepared, the liner is cemented in place while working the liner as required. When displacement is complete, the setting ball is deployed in the drill pipe. Once the setting ball lands on the ball seat in the setting tool, pressure is applied to the drill pipe and the hanger/packer is expanded.

No other downhole tool has the potential damage-to-price ratio of liner hanger systems. Often these tools must operate in the most difficult sections of the hole with respect to temperature, pressure, solids and deviation.

With a failure rate approaching 30% in some cases, operators are actively seeking solutions to their liner top and liner installation problems.

There are numerous liner hanger technologies currently available in the marketplace, but all use running and setting equipment dependent upon multiple slips, exposed hydraulic ports, multiple potential leak paths and reduced radial clearance. Any of these features can increase the risk of failure.

WHY INSTALLATIONS FAIL

Liner tops and liner installations fail for a variety of reasons. Many of today's failures can be attributed to liner top cement integrity failure, inability to get the liner to depth and tool failures such as darts, plugs, running/setting tools, etc.

Additional problems include:

- Hangers with slips and cones provide a trap for cuttings and debris to pack off, increasing equivalent circulating density (ECD), causing lost circulation;
- Stuck setting tool caused by debris entering the setting tool/extension sleeve gap and incorrect tool assembly in the shop;
- Preset hanger or packer caused by debris catching the slips or packer elements and by surge effect running in the hole.

Current running and setting technology involves equipment with multiple slips, tortuous flow paths, exposed hydraulic ports, multiple potential leak paths and reduced radial clearance. Each of these factors can increase the risk of liner top and liner installation failure.

VERSAFLEX SYSTEM

Halliburton introduced a new expandable liner hanger (ELH) system called the VersaFlex™ liner system as a solution to liner hanger failure.

The system combines expandable liner hanger technology with Halliburton's complete range of cementing products and services to create a reliable, simple and versatile liner hanger system that overcomes most causes of liner top failure.

The system incorporates the liner hanger body with an integral packer, tieback polished bore receptacle, setting sleeve assembly and a crossover sub to connect the assembly to the liner. The liner hanger system body contains no setting mechanism or external components such as slips, hydraulic cylinders or pistons.

The hydraulic setting mechanism is contained in the setting tool assembly and is completely retrieved, eliminating a potential leak path in the flow stream.

The liner can be rotated and reciprocated in the hole or during cementing operations as required, and is the only liner hanger with this capability, according to the company.

Also, the hanger and setting tool stay in the unset (unexpanded) position during cementing and displacement, thereby preserving full cross-sectional bypass area, which maintains a constant ECD throughout the cementing process.

HOW IT WORKS

The heart of the system, the integral liner hanger/packer, is made up of an integral tieback receptacle above an expandable solid hanger body. Elastomeric elements are bonded on the body. As the body is expanded, the elastomeric elements are compressed in the annular space.

This virtually eliminates the liner hanger/casing annulus and provides liner top pressure integrity, as well as delivering high tensile and compressive load capacity.

The system is run and expanded from the top down. After the interval is drilled, the mud is conditioned for cementing. The liner is then lowered into the hole and additional circulation is performed as required while reciprocating or rotating the liner string.

Once the hole is prepared, the liner is cemented in place while working the liner as required. When displacement is complete, the setting ball is deployed in the drill pipe.

Once the setting ball lands on the ball seat in the setting tool, pressure is applied to the drill pipe and the hanger/packer is expanded. Expansion takes approximately 3-5 minutes with expansion pressures ranging from 3,500 psi to 7,000 psi at the surface (depending on the parent casing size and weight range).

When the tool is fully expanded, a bypass in the setting tool is operated, a pressure indication is observed at the surface and pumping is halted.

The setting tool is then disengaged from the liner and is pulled above the hanger. Any residual cement can be circulated out of the hole.

If reverse circulation techniques are employed, it is recommended that two workstring volumes be pumped, or that pumping should continue until there is no cement evident in the returns. At this point, the liner can be pressure-tested and the setting tool removed from the wellbore.

LINER SYSTEM ADVANTAGES

The system is very simple because no moving parts, slips or cages to suspend the liner in the support casing are necessary. Also, the stress distribution into the support casing is the most uniform possible and potential corrosion sites are eliminated, according to the company.

Multiple redundant elastomeric elements maintain pressure integrity while virtually eliminating gas migration paths in the liner top.

The absence of slips, radial geometry of the hanger body and the bonded elastomeric elements allow higher circulation rates during cementing to improve cement job integrity and minimize cement pack-off potential.

The system will be available in virtually all common liner/casing configurations for both standard and CRA service, and can be combined with existing (Halliburton) completion products to provide a superior liner top completion solution.

CASE HISTORIES

Anadarko Petroleum Corporation utilized the liner hanger system in a 13,549 ft well drilled to produce a limestone formation from a horizontal lateral in a Madison County, Texas, field. A drilling liner was needed to cover the 50° build section of the hole and to isolate the problematic shale section.

The liner was run in the hole without problems until getting stuck at 13,386 ft, some 149 ft short of the planned setting depth. Up to 260,000 lb of overpull was required to free the pipe. The hole packed off several times during pumping, creating a maximum pressure of 4,500 psi on the drill pipe.

Only when the pump rate was increased to 10.5 bpm and the liner rotated at 80 rpm with torque between 8,500 and 14,500 ft/lbs did the liner begin to move.

A total of 25 hours of continuous washing and reaming enabled the liner to ultimately reach the planned setting depth. After reaching the setting depth, circulation continued until the cementing equipment was rigged up. The well was then cemented using premium liner cement.

The job was displaced at 8 bbl/min and full circulation was observed throughout the cementing job. The setting ball was released from the cementing manifold and allowed to free fall to the ball seat in the setting tool.

When the ball landed on the seat, pressure was applied to the drill pipe and the expandable hanger/packer was expanded taking 2-3 minutes with expansion pressures initiated at 5,500 psi.

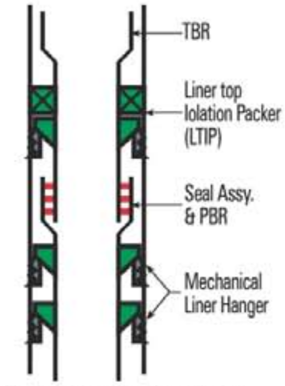
Once the expansion cone had full travel, it opened the bypass in the setting tool and the pressure fell, indicating the hanger set as designed. After setting the hanger, a 300,000 lb pull test and 4,200 psi positive pressure test with no pressure loss confirmed the hanger's performance.

Pinedale Anti-Cline. This well, which was drilled to a depth of 12,400 ft in Sublette County, Wyoming, showed minor lost circulation prior to running casing and cementing. These problems were seemingly healed using standard lost-circulation materials. The 9 ⅝-in., 47 lb/ft intermediate string shoe was at 10,640 ft.

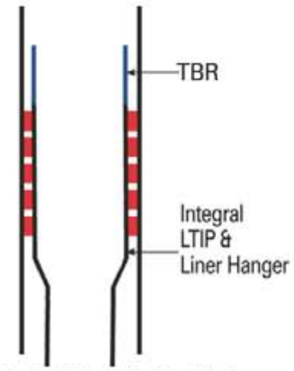
The liner casing was 7-in., 32-lb/ft, P-110 grade to be set from 10,540 ft-12,400 ft. When the liner shoe reached 6,000 ft, circulation was broken for 45 minutes to assist in breaking the mud gels and reduce initial circulating pressure at total depth.

The string was run into the borehole and no difficulty was encountered. The liner tagged up 10 ft short of the bottom of the hole.

When an attempt was made to circulate to bottom without success, a decision was made to start the cement job using 30 bbl of weighted spacer followed by 122 bbl of premium cement with additives mixed at 15.6 lb/gal.



Typical Liner Top Installation



Typical VersaFlex Installation

The integral liner hanger/packer, is made up of an integral tieback receptacle above an expandable solid hanger body. Elastomeric elements are bonded on the body. As the body is expanded, the elastomeric elements are compressed in the annular space. No moving parts, slips or cages to suspend the liner in the support casing are necessary. Multiple redundant elastomeric elements maintain pressure integrity while virtually eliminating gas migration paths in the liner top.

Nitrogen was added to the downstream side to create stable foam that weighed 13.2 lb/gal at downhole conditions. The total foamed cement volume was 152 bbl. No nitrogen was pumped for the final 10 bbl and the cement designed top was 10,400 ft.

The drillpipe dart was dropped and was displaced, deploying the liner wiper plug at 180 bbl pumped. The wiper plug was bumped at 240 bbl total displacement and pressured 1,500 psi over bump pressure. The float valves were checked to ensure they were holding. The setting ball was released from the cementing manifold and allowed to free fall to the ball seat in the setting tool.

When the ball was on seat the liner system was pressured to 4,350 psi and positive indication of the elastomers setting was seen. This process was completed using five distinct pressure cycles, with a final pressure of 5,500 psi.

Once the expansion cone had full travel, it opened the bypass in the setting tool and the pressure fell, indicating the hanger had set. After setting the hanger, a 315,000 lb pull test was performed to verify that the VersaFlex hanger was set. No movement was observed, indicating a good set. At this point, the setting tool was disengaged from the liner.

One stand and a pup joint were laid down and mud was circulated at 7 bbl/min to remove the residual cement above the liner top. The liner top and the liner casing were tested to 2,460 psi (17.5 lb/gal equivalent) with no leak off.

After a successful test, the hole was circulated again at 11 bbl/min by the rig's pumps and the setting tool was retrieved from the well bore.

*VersaFlex is a trademark of Enventure Global Technology.