Seminole Services announced the commercialization of its first product, the Powerscrew Liner System, a new expandable liner hanger that is set with torsional energy from the top drive (Fig. 1). The Louisiana-based company began development on the tool and associated equipment in the fall of 2012. Rooted in solid mechanics and material science, the company provides engineered wellbore solutions to exploration and production companies actively engaged in drilling oil and gas wells.

In the evolution of liner hangers, mechanically set systems were developed first. While many operators believe mechanical systems are more robust and provide superior sealing integrity when compared with hydraulically set hangers, older mechanical systems typically lack reliability, especially in applications requiring longer liners in deviated wellbores. In large part, this is because of the risks associated with reaming a mechanical hanger to setting depth. Reliability rates were increased with the introduction of hydraulically set hangers, which allowed a greater range of applications. However, the newer setting method suffers from its own limitations, such as flow-area restrictions, compatibility with drilling-fluid additives, and a multitude of potential leak paths.

With the advent of expandable liner hangers, further increases in setting reliability were achieved along with even greater applications. The increase in reliability, at least in part, stemmed from greater success reaming the liner to setting depth. The higher reliability of expandables is perhaps a consequence of greater flow area at the liner top and the lack of external setting devices. This has led to many new developments in drilling with liners (DWL).

Nevertheless, expandable liner hangers continue to suffer from potential leak paths associated with high hydraulic pressure sourced at the mud pumps. The hydraulic pressure provides energy to the running tool necessary in setting the liner top. In most expandable systems, pressure pushes the roller/expansion cones/sleeve through a metal-formed tubular by use of a multitude of pressurized connections and fluid ports. By contrast, the torsionally set system combines the latest in metal-forming technology along with the best features of mechanically set systems. The result is a setting process that does not require high hydraulic pressures and eliminates the risks associated with reaming the liner to setting depth and DWL.

Novel Features. In addition to torque as the primary method of energy transfer, other novel features of the tool include a patent-pending helical stretch method of metal forming using a multilead rifling (MLR) mandrel (Fig. 2). The MLR mandrel provides microupsets, increasing the post-formed collapse resistance of the set liner top. Also, helical stretch forming has less friction and therefore requires less force to forge a metallic tubular downhole. The tool incorporates a high-strength (drop) ball-activated single-use clutch that disengages the running tool from the liner upon reaching setting depth and initiates the metal-forming process with the application of torque.

The torsionally set tool does not suffer from pressure losses associated with setting hydraulically in extremely deep wells. The tool has been qualified with optional hardened slips, a difficult incorporation given the ductility needed for metal forming. The integral slips were qualified by use of a hardening process proprietary to Lone Star Heat Treating of Houston. Along with the slips, two types of packer elements are used. Both the top and the bottom of the set liner top contain profiled, pressure-energized packer elements that are mirrored to provide maximum differential-pressure containment. The second type of packer elements are fully energized upon setting and used to prevent gas migration. Hanging capacity and pressure containment are paramount to any premium hanger system and the ability to do both at high temperature will continue to be an engineering challenge.

Proven Design. After several component level and subassembly tests over the years, the first wellbore installation on a full-scale prototype was field tested.

Fig. 1—Graphic of Powerscrew.
on 22 October 2014 at the Catoosa facility, Well Lucy 6G, in Hallett, Oklahoma (Fig. 3). A 7⅝-in. liner was reamed to setting depth, cemented in place, disengaged, and set with torsional energy from the top drive. A drop in torque indicated full integration of the liner top into the 9⅝-in. intermediate casing and the running tool was retrieved from the well (Fig. 4). With success on the first run came the realization that the setting torque needed to be lowered. This issue was resolved by working with our planetary gear vendor, Creative Motion Control (CMC). CMC was able to customize a solution specific for our unique downhole application and was able to reduce the setting torque by 50%. In addition to the success with the running tool, a torsionally set 7⅝-in. liner top was qualified under extreme well conditions at Oiltool Engineering Services (OES) in Willis, Texas (Fig. 5). The set liner top was able to withstand the maximum load capacity of OES’s Hydraulic Ram at 500,000 lbf, simulating liner weight. Also, 4,000-psi differential hydraulic pressure and 3,000-psi differential gas pressure was maintained continuously from below the set system without the benefit of cement. Finally, under combined load, the set liner top withstood 300,000-lbf load and 3,000-psi hydraulic pressure at 300°F, reaching a project milestone.

Wide Appeal. While Seminole’s target market is the Gulf of Mexico (GOM), the technology can be used in any land or overseas application where reliability is of paramount importance. Failure rates can be as high as 40% for conventional hanger systems, so reliability is an industry goal. The increase in expandable liner systems used in the GOM is an indication that metal-forming technology is being adapted for the most challenging wells and will only continue to increase in market share given increased competition and lower prices. Finally, of particular interest is the lesson that running a production liner with a reliable hanger system, rather than employing a long tapered string, could be the difference between a successful completion and a problem. The benefits associated with running a liner with a hanger system include the following:

- A rotating liner hanger improves the chances of a good cement bond.
- The presence of a liner top packer adds a barrier to annular flow near the bottom of the well.
- The arrangement allows for the omission of the differential fill tube, a potential failure mechanism for the float collar.
- The negative test is potentially simpler to conduct and interpret.
- The well is better configured to control and repair a leak in the liner.
by leaving the well filled with drilling mud to a greater depth and by placing the drill pipe at a greater depth in the well during the test.

In summary, the Powerscrew eliminates potential leak paths while setting with torsional energy from the top drive or rotary. This new liner hanger uses a patent-pending MLR mandrel that helically stretch forms the liner top with greater post-formed collapse resistance than that of a typical expandable tubular. These unique characteristics are complemented by other exceptional features, such as a high-strength running tool, high hanging capacity, and impressive pressure containment and zonal isolation with packers and cementing accessories. The tool has been rigorously tested both in the field and in the laboratory and has shown respectable results. Finally, though somewhat underused, expandable liner hangers have proven themselves in the most demanding applications.