Meeting the growing global demand for energy is requiring oil and gas operators to increasingly extract hydrocarbons from unconventional resources such as shale reservoirs. While North America has led the charge in shale resource development over the past decade, the U.S. Energy Information Administration (EIA) estimates that there are 287 Bbbl of technically recoverable crude oil and 187.9 Tcm (6,634 Tcf) of natural gas in shale plays in more than 41 other countries globally.

As they work to develop their own resources, shale developers in these countries are closely watching the lessons learned and technology developments advanced by U.S. shale operators. Considerable improvements to horizontal drilling technology and multistage stimulation have already been made in North America and will likely occur at a more measured pace. However, efficiency improvements are likely to continue at a faster pace for other technologies, including surface coiled-tubing (CT) equipment.

CT units have played a larger role in post-fracturing cleanup in recent years in U.S. shale developments, particularly in milling out frack plugs after plug-and-perf completions in extended-reach horizontal wells (Figure 1). But as lateral lengths get longer—up to 3,050 m (10,000 ft) or greater—and the number of frack stages increases to 30 or more, service providers are challenged with developing CT technologies that increase the speed, efficiency and safety of post-frack cleanup operations such that the well can be brought onto production as quickly as possible.

New CT packages deployed in various shale fields in the U.S. in 2013 demonstrated an average 50% reduction in rigup times. (Source: Boots & Coots, a Halliburton company)

Unconventional rigs for unconventional wells

Compared to conventional workover rigs, CT units have demonstrated reduced operational times, lower environmental impact and an ability to operate under live well conditions. However, performing intervention work on deep or long wells with conventional CT units is generally limited either by the dimensions (length or outer diameter) of the CT strings or by reel capacity. This is in direct conflict with the industry requirement to use larger CT diameters to help prevent helical buckling and tubing lockup where high wall-contact forces prevent the CT string from being advanced any deeper into the wellbore.

Boots & Coots has developed a new CT system to address these challenges and improve efficiency and safety during frack plug mill-outs in shale wells. The system is designed with the well-control package preassembled on a mast, thus improving operational efficiency, reducing rigup time and creating an overall safer rigsite environment compared to conventional CT applications.

The system’s design upgrades reside in three primary components. The first, an auxiliary mast unit, consolidates all well-control and power systems for the package on a single trailer, reducing wellest site footprint and emissions. The unit’s trailer base comprises front and rear outriggers and also carries the CT hydraulic power pack, a 110-VAC generator, mast unit with pressure-control equipment, a fuel tank and hydraulic-hose packages. By incorporating the preassembled well-control stack and mast trolley system, the unit reduces rigup time by as much as 50% compared to conventional CT systems and reduces the need for working
under suspended loads while also reducing potential for dropped objects.

The second component, a quad-axle reel trailer, carries the reel with tubing, the operator house and tubing guide. This trailer contains several size and equipment upgrades to meet the operational requirements for plug mill-outs in longer extended-reach laterals. These include:

- Capacity for 6,098-m (20,000-ft), 2-in. CT, a significant increase over traditional reel capacities of about 4,573 m (15,000 ft) of 2-in. pipe;
- A maximum width of 2.6 m (8.5 ft) and height of 4.27 m (14 ft);
- A standard hydraulic start tractor (no wet kit);
- A maximum design loading of 25,000 pounds-mass (lbm) per axle;
- Sufficient accumulator capacity to operate 5½-in., 15,000-psi well-control equipment (WCE);
- Circuit capacity to operate up to three CT strippers;
- The ability to accommodate both current and in-design CT injectors on tilt system; and
- Enhanced display and control functions in the operator house.

**New boom crane trucks**

The third main component of the new CT system is a dedicated boom crane capable of meeting the greater lift requirements of larger sizes of WCE and riser sections for extended-reach lateral applications. Different cranes have been purposely sized to suit the requirements of various pressure-control equipment stacks. An 80-ton climate-controlled crane is capable of lifting 40,000 lbm 5½-in. well-control packages over a radius of 7.6 m (25 ft) with a boom extension of 26.7 m (87.5 ft). A smaller-capacity 60-ton crane is capable of lifting 35,000 lbm for 4½-in. well control packages over the same radius and boom extension lengths (Figure 2).

The relatively simple design of both cranes makes them suitable for operation by trained and certified CT personnel. Standardized controls of both cranes would enable personnel to operate either of the crane options.

Because the new boom crane trucks would typically be at maximum axle loading and could not support additional equipment, the upgraded CT system also includes an auxiliary equipment trailer that would carry, at a minimum, the CT unit’s power pack and all the WCE. The trailer features a base design that enables the entire well control stack to be carried preassembled on the trailer, which saves a considerable amount of rigup time.

Further rigup time savings are realized by mounting the equipment on a hydraulic mast that lifts the entire well control stack into the vertical position. The addition of a docking trolley system, which could be latched in position while making up bottomhole assemblies (BHAs), extends the mast concept further.

The use of a preassembled WCE, mast, and trolley system presents several benefits, including:

- Faster rigup/rigdown of CT equipment as the number of flange connection makeups onsite is drastically reduced. This also lowers the risks of finger injuries and dropped objects when making up the flanges;
- Reduced number of crane lifts as the preassembled well-control stack removes eight lifts from the rigup operation;
- Reduction of working under suspended loads. With the trolley docked and locked into the mast, preparing tubing end connectors and making up the BHAs can now be performed without the loads suspended below a crane; and
- Reduction of pinch and crush points, which is a natural extension of the reduced number of lifting operations.

**Delivering tangible results**

During 2013, more than 20 of the new CT packages were deployed in various shale fields in the U.S., where these demonstrated an average 50% reduction in rigup times while also improving safety metrics. In many cases, the units were rigged up on the wellhead with BHA ready for pressure-testing and running in hole in under three hours, with no recordable incidents to date.

Additional units, custom-designed for local requirements, are being deployed in the Middle East and Australia during 2014. As best practices continue to be shared across the world and local variations of these new equipment designs are developed to meet individual country requirements, the efficiency and safety benefits of the new CT system will be realized by the E&P community.
Faster and safer rig-ups equate to efficient well interventions. Halliburton’s Boots & Coots service line—the coiled tubing experts—introduce their next-generation Enhanced QuikRig® (EQR) system. Suitable for work in new and mature fields and ideal for unconventional markets, this system can be rigged up in half the time of a conventional unit. Plus, the QuikRig system’s unique design featuring pre-assembled well control equipment—capable of deploying extended bottom hole assemblies, and coupled with a latching mast design—helps provide safer operations by significantly reducing the risk of working under suspended loads.

Faster rig-up. Safer operations with fully supported loads.

What’s your well intervention challenge? Boots & Coots is ready to go.

To learn more, visit Halliburton.com/boots-coots