CTD Poised To Make An Impact On Segments Of Drilling Market

By Ken Newman

CONROE, TX.–As coiled tubing drilling (CTD) moves into its fifth year of commercial availability, it is interesting to review its rapid development process, and to try and extrapolate this process to see where the technology might be headed.

Figure 1 shows the growth rate of the CT drilling market through 1995. In 1991, when the first CTD experiments were being performed in the Paris Basin and the Austin Chalk, there were many questions about its future market. Would it be a new well drilling market for exploration and slim hole injector/production wells, or would it be a re-entry market for drilling drain holes in existing wells? Today, it is obvious that there is not going to be just one key market, but in fact, there will be many market segments where coiled tubing drilling technology will be applied.

As they appear today, CTD market segments involve several applications in both new well and re-entry drilling operations. New well applications include drilling shallow injection wells, shallow gas-vent wells, shallow natural gas wells, and exploratory wells.

To date, the largest number of wells drilled with coiled tubing drilling technology in a single area are shallow injector wells in Bakersfield, Ca. CTD was used because of the small footprint required for these wells.

Shallow gas pockets in Lake Maraciabo, Venezuela, have caused significant safety problems for drilling rigs in the past. CTD is being used to drill shallow (1,000-foot) holes to ensure that no shallow gas is present before rigs drill wells. CT drilling is much safer for drilling these holes because the barge containing the personnel and most of the equipment is moved away from the small drilling platforms during actual drilling operations. Hole sizes as large as 12.25 inches have been drilled, and plans are being made to drill an entire well with coiled tubing.

I am aware of only one shallow gas well, and one exploration well drilled with coiled tubing. The exploration well was drilled in the Paris Basin in 1992, and con-

tinues to hold the record as the deepest new well drilled with coiled tubing (5,200 feet). However, using CTD for exploration in remote areas is often discussed, and will probably become a reality in the future.

Re-Entry Applications

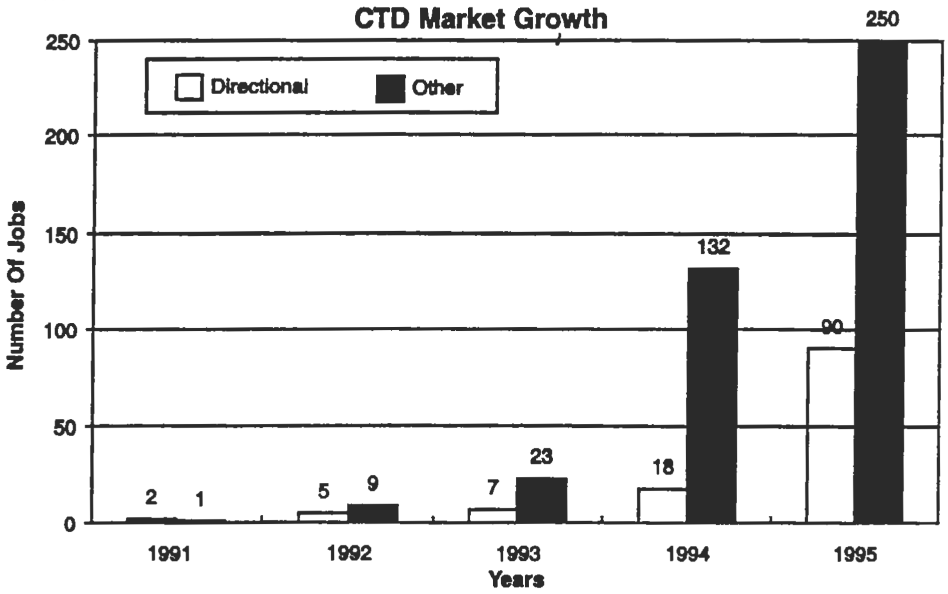
Re-entry applications for CTD technology include drilling both non-directional and directional wells, through-tubing operations, and under-balanced finishing. In the area of non-directional re-entry applications, a few CTD jobs have been performed to deepen existing wells to open new pay in an existing reservoir, or to enter a lower reservoir.

Most of the downhole technology developed for CTD has focused on milling a window and drilling a directional well bore from an existing well bore. Many successful operations have been performed, with the largest number of these being located in Alaska and Canada.

CT drilling technology has its greatest impact in through-tubing applications, where a directional or non-directional re-entry is performed through an existing completion. At present, this applies to large completions with 4.50-inch tubing, although smaller bottom-hole assemblies for working in smaller completions are being developed.

For under-balanced finishing, a conventional rig is used to drill, case and complete a well to the top of the reservoir, and CTD equipment is then introduced to drill under-balanced in the reservoir. A gas lift system in the completion installed by the rig may be used to lift the well to create the under-balanced conditions while drilling. This type of drilling has been performed offshore Denmark and on land in

FIGURE 1



Canada.

Under-balanced drilling is an area of significant discussion and study. Drilling with a mud pressure lower than the reservoir pressure reduces formation damage and increases penetration rates. CTD is ideal for this type of drilling because of the improved well control as compared to conventional drilling. However, the benefits of under-balanced drilling still need to be quantified over the long-term production of a well in many areas. Nonetheless, many believe that under-balanced drilling will prove the biggest market driver for drilling with coiled tubing.

CTD is a subset of slim hole drilling (SHD) because the coiled tubing sizes used for drilling (typically 2.0 and 2.375 inches) limit torque and mud flow. SHD has been around for many years, but has failed to become a common practice in the industry. The well-documented benefits of reduced drilling fluids, tubular costs, disposal volumes and other drilling expenses realized with SHD have not been able to offset the increased risks posed by less contingencies and faster kicks. CTD minimizes the risk associated with faster kicks with improved well control. I believe that CTD will be the catalyst which makes slim hole drilling more accepted by the industry.

Trying to look into the future with this multi-faceted market is difficult. It is clear that CTD will find several different market niches, although it is not clear which of these will be the largest. "Purpose-built" equipment will continue to change this market picture, and re-entry drilling will continue to dominate the technical developments in CTD for the near future.

Surface Equipment

For the first few years, CTD was performed using conventional CT surface equipment with some additional equipment to support the drilling process. Coiled tubing service companies tried to minimize the risk associated with testing a new technology. In fact, the very first experiment in the Paris Basin in 1991 was performed with 1.5-inch CT, because it was the size available at that time in France.

As the technology has developed, CT service companies have been willing to invest more in specialized "additional" equipment to aid in the drilling process. These additions include specialized mud systems, substructures, snubbing/casing jack systems and masts for handling jointed pipe. Only recently have complete, purpose-built CTD units been considered.

It is interesting to compare this development process to conventional rig systems. For many years, there were two basic types of conventional rigs: workover and drilling. Sometimes, a workover rig is used to do some drilling, and a drilling rig is occasionally used for workover-type of services. For the most part, however, the rigs are used for their respective primary purposes.

Workover rigs are designed for ease of mobilization and fast rig-up and rig-down, since most workovers are done in a relatively short time. Drilling rigs are designed for longer-duration drilling jobs with emphasis on a fast drilling process. In terms of coiled tubing service operations, the question is whether a CT unit designed for well servicing should be expected to perform as a CT drilling rig.

A CT unit for well servicing is designed for speedy mobilization to perform relatively short-duration service jobs, similar to a conventional workover rig. Usually it is the speed associated with performing services that gives CT units a competitive edge over a workover rig or snubbing unit.

Competitive Advantages

In most drilling operations, the speed of mobilization, rig-up and rig-down is much less important because the overall drilling operation is much longer. The competitive advantages of a CTD rig come from increased capabilities and improved safety and environmental conditions, rather than speed. If a CTD rig were to be purpose-built in the way a drilling rig is purpose-built, it should emphasize the advantages of SHD and CTD, and de-emphasize speed of mobilization.

"Hybrid" CT drilling units are being built to enable a drilling operation to handle both continuous and jointed pipe. These units combine a CT unit with either a mast or a snubbing system for handling jointed pipe. The units go part way in the development of a purpose-built CTD unit, in that the combined units add functionality often needed for drilling at the cost of more equipment to mobilize. However, these systems are not fully integrated. One portion of the system is used to move the continuous pipe (the CT injector head) and another portion is used to move the jointed pipe (draw works or snubbing or casing jack).

At present, there are several purpose-built CTD rigs under construction, some of which use a single device for moving both jointed and continuous pipe. These rigs are aimed at a variety of markets, including onshore Canada and offshore the North Sea. Some of these units look nothing like a conventional workover CT unit, and they are quite different from one another. Some of the units are being built by CT service companies, while others are being built by drilling contractors.

The future of this very active surface equipment picture is cloudy, although it is clear that there will be several purpose-built CTD units available for both on- and offshore operations by the end of the year. Determining which of these types of equipment will fit best in which market niche is not yet possible to predict.

Downhole Equipment

Progress in the development of bottom-hole assemblies for CTD has been very rapid. In 1991, BHAs were built from existing slim hole components. The first mechanically-operated orienting tool was developed to work in conjunction with an existing steering tool to perform directional drilling in the Austin Chalk. Today, several purpose-built CTD downhole systems have been developed and proven. The types of systems available for directional drilling are:

- Electric/mechanical systems (A cable in the coiled tubing is used to transmit the steering measurements to surface, and a mechanical tool using the up-and-down motion of the CT and/or mud flow is used to orient the BHA to point the bit in the desired direction).
- Electric/hydraulic systems (Again, a cable in the CT is used for steering measurements, and hydraulic fluid is pumped through a small hydraulic line(s) to orient the BHA).
- Electric systems (Fully electric systems transmit data to surface through a cable, and use electric power supplied by the cable from surface to orient the BHA. There may be a hydraulic pump in the BHA powered by an electric motor, which operates a hydraulic orienting tool).
- Mud Pulse/mechanical systems (The steering measurements are transmitted to the surface through pressure pulses in the mud, and a mechanical orienting tool is used to orient the BHA).

All of these systems have been used successfully. Continued improvements and refinements will be made to these systems for smaller diameters and improved reliability.

Likewise, the industry has witnessed very rapid development of window milling systems to exit an existing well bore. Conventional whipstocks and window mills were quickly adapted to CTD. The challenge in window milling has been in the through-tubing application. At present, there are three methods being used for through-tubing window milling.

The first is time drilling from a cement plug, whereby a cement plug is placed in the casing where the window is desired, and a hole is drilled in the cement along one side of the casing. A window is then milled by time drilling with a window mill against the casing. The second method uses a whipstock in a cement plug. Again, the cement plug is placed and a hole is drilled along the casing. The whipstock is placed in the hole, and the window is then milled off of the whipstock. The third method utilizes a through-tubing whipstock. Whipstocks small enough to fit through a tubing string and then set in the casing are now being tested.

Logging-while-drilling systems are the next major challenge for CTD downhole systems. The cable in the coiled tubing allows high-data rate telemetry. Some tools are already available that make gamma ray and pressure measurements while drilling. Development of other measurements to improve the well construction process and provide logging data while drilling will bring additional benefits to CTD. ❒

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Re-Entry On Ratana No. 3 Sets New Record For TVD

HOUSTON–Sperry-Sun Drilling Services reports that it participated in drilling a successfully-producing world record true vertical depth horizontal re-entry well, under contract for Occidental of Pakistan in the Ratana Concession in the Potwar Basin of northwestern Pakistan.

According to Sperry-Sun, the Ratana No. 3 natural gas well, located in an area known for its complex geology, was successfully re-entered and horizontally sidetracked to a TVD of 16,392 feet. Challenges encountered while drilling the well included:

- A bottom-hole static temperature (BHST) of 311 degrees, confirmed as measured at 16,240 feet;
- Concentrations of up to 3 percent carbon dioxide and 30 parts per million hydrogen sulfide;
- Maintaining critically high-quality standards in a remote location within a deep gas condensate reservoir located within naturally-fractured Paleocene carbonate formations under potentially hazardous circumstances; and
- Drilling a smooth curve and lateral section.

Pre-drilling modeling of the directional drilling assembly proved highly valuable, Sperry-Sun notes, pointing out that not only did the assemblies build as expected, but they held angle in the lateral section–over 90 percent of which was rotary speed. The company claims the low-speed, high-torque motors were a significant factor in overall success. ❒