

Coiled Tubing



Drilling Firms Extend, Simplify CTD

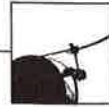
By Colter Cookson

For advocates of coiled tubing drilling, there have long been two key words: speed and safety. Because the crew never needs to make connections, coiled tubing can drill to total depth much faster than conventional jointed pipe, keeps rig hands off the floor during drilling, and provides constant well control with no intermittent interruptions to make up joints of drill pipe.

According to Buccaneer Energy Operations Manager Andy Rike, who played a key role in coiled tubing's development as founder of Technicoil Integrated Services and through work at what is now Tenaris Coiled Tubing, another key advantage of coiled tubing is the ability to flow the well while drilling underbalanced. Rike points out that this keeps the drilling mud from invading the formation, which can significantly reduce productivity.

"Coiled tubing started its journey into life as a live-well device," he notes. "It has no joints, no seams, and a nice, slick outside diameter that will slide in and out of the well bore under well control up to 10,000 psi. So it is a very, very effective live-well tool. And because it is an effective live-well tool, it is especially effective for underbalanced drilling and underbalanced well deepening."

To take advantage of the unique niche benefits of CT drilling, Rike asserts that operators need to plan as carefully as they would for a rotary drilling operation, if not more so. "Coiled tubing is a high-tech operation," he says. "There is a high degree of interrelated processes that take place all at once. The amount of fluid being pumped drives the downhole motor and cleans the well bore. It contributes to the overbalanced or underbalanced condition. And, of course, you cannot rotate the coiled tubing, so any subsequent operations have to take that into account."



But there is no doubt that the ability to drill in live wells makes coiled tubing a good fit for horizontal drilling in many applications, Rike says. "Typically, when you are drilling horizontally, you are drilling laterally in a long section of the reservoir or target zone. And that reservoir or target zone has that potential to flow," he explains.

Coiled tubing's small size makes it particularly useful for companies that want to drill a slim hole, Rike observes. In addition to saving money on casing and cement, smaller holes can target the formation more precisely and generate faster penetration rates to reduce rig costs, he reports. He says these qualities make slim holes an excellent tool for targeting bypassed reserves.

"Coiled tubing is probably best as a reservoir drilling tool," Rike declares. "There have been limitations in the past as far as the ability to directionally steer and control the coiled tubing itself, but most of those have been addressed."

Simplifying Operation

To help operators manage CT drilling's complexity, National Oilwell Varco is developing a computer-based system for controlling CT drilling rigs, reports Joel Park, a coiled tubing drilling specialist at NOV HydraRig.

The system helps operators in three ways, Park says. First, through three touch-screen monitors, it puts everything the operator needs within arms' reach. "He can run the fluid pumps,

nitrogen pumps, and the coiled tubing unit," Park details, adding that the cabin has space for a directional tool controller so the two can work together.

Second, the system automates routine tasks that are easy to overlook, but can lead to catastrophic consequences. "It takes care of the mundane stuff," Park says. "It does not take it out of your hands; you can still see what it is doing. But you do not have to reach over and turn that knob."

And third, he continues, the system allows users to limit such things as depth, weight and pumping pressure. "If you do not want to go any deeper than a specified depth or do not want to apply more than a certain amount of weight to the drill string, you can preset parameters that the system will stay within. Drilling will automatically stop if a parameter is exceeded," Park says.

To illustrate the system's benefits, Park uses chain traction. "As weight increases, traction pressure needs to increase. Normally, that is done by the operator. This system actually follows traction pressure and makes adjustments automatically. It almost eliminates pipe slippage from operator error," he says.

Because slippage can occur for other reasons, the system also has slip detection, Park says. "Before, the driller would have to detect a slip by feel. This system can detect and correct a slip before the driller even knows about it."

By preventing pipe slippage and other potentially damaging events, and by handling equipment smoothly, the control system reduces maintenance costs, Park claims, adding that it eases troubleshooting. "The system diagnoses itself. If you have an issue with a valve or a sensor, it will tell you," he explains.

"I am excited about the potential of this technology," Park enthuses. "As a matter of fact, I have volunteered to do the field testing. We want to see this technology on the market soon."

Remote Supervision

In addition to making coiled tubing rigs easier to run, NOV is helping companies use their resources efficiently and make better operational decisions by transmitting data from the well site in real time, reports Ed Smalley, the general manager of NOV CTES.

"Assuming the coiled tubing unit has Internet access, we can transmit the real-time job data anywhere it's needed and people that used to have to go to location to monitor drilling operations—especially during penetration of sensitive downhole zones—can remotely monitor the same information from the convenience of their desks," Smalley says, adding that data can even be sent to smart cell phones.

In addition to reducing travel expenses, remote monitoring reduces unproductive time, Smalley says, explaining that it allows key personnel to focus on other tasks when operations get delayed. "The remote system lets a company's sharpest hands cover more ground," Smalley adds. "Your best operator can monitor the data and basically look over the shoulder of the operator that is actually in the field."

Extending The Envelope

To Park, the key to bringing coiled tubing's benefits to deeper applications and a wider variety of formation types is reducing the equipment's footprint. Since splicing segments of coiled tubing is expensive and introduces pipe failure risk at the splicing point, the coiled tubing needs to be a continuous string on



By moving from hydraulic to electric controls, rig manufacturers have made operating coiled tubing rigs more precise and convenient.



one reel, he explains. In areas that limit vehicle weight, that means making it lighter.

As part of that effort, NOV has changed the gear box on its 100,000-pound pull injector head to reduce its weight by 30 percent, Park reports. "We are talking 12,000 versus 18,000 pounds," he says. "That means you can carry another couple thousand pounds of coiled tubing on the reel."

Meanwhile, Smalley says NOV CTES is looking for ways to address the key limit on lateral length: downhole friction. "With coiled tubing, you do not have the cross-sectional area that you do with drill pipe, so when you are going into a long horizontal lateral, you can only push the CT so far. Then it reaches a stage where you can no longer push it because of frictional forces," Smalley notes.

To reduce friction, NOV has developed a tool that generates vibration. "These devices go on the bottom of the coiled tubing, and as you are pumping fluid down through the tubing, they put a gentle pulsation into the bottom hole assembly and tubing. That pulsing reduces the friction that is normally present, so the CT can be pushed much farther without experiencing lockup," he details.

Enhancements to modeling software allow pre-job modeling simulations with this vibration device, enabling customers to determine how much farther they can push the CT before performing the field operation, Smalley says. "In most of the cases I have seen, the device can add somewhere between 500 and 2,000 feet," he reports.

Smalley adds that the company has developed an ultrasonic tool for monitoring coiled tubing thickness. "These monitoring devices provide a 3-D representation of the CT wall thickness," he says.

By identifying thin sections that may develop as abrasive fluids are pumped through the CT or confirming that none exist, the monitor can help prevent tubing failures and extend the life of a CT string, Smalley reports. "If you can extend the life of each of your strings by 10 percent, you can save quite a bit of money."

Electric Rigs

According to Mike Read, vice president of product development for Nabors Canada, electric rigs are ideal for CT drilling operations.

"Programmable A/C electric (PACE) technology is really noticeable with coiled tubing rigs because it offers a finesse of control that is not possible with hydraulic rigs," he says. "With an AC rig, for example, you can control the position of the blocks within inches. You can control the speed of drop or the pull using only a joystick, and it is very precise and fine."

That precision will have a big impact on weight-on-bit control, Read reports. "You can program the rig so you do not get even small spikes of higher weight, which can damage the bit. It is very, very precise and controlled. By maintaining a consistent weight on bit, I think it ends up improving bit life and ROP," he says.

"The pump rate can be controlled very accurately and in small increments, and typically set much slower than with mechanical pumps," Read adds. He says the broader range helps with well control and allows the operator to get the appropriate flow rate without changing liners.

"In our experience on bigger PACE rigs, there is also fuel

savings," Read notes. "Relative to a standard diesel electric D/C rig, PACE rigs use less fuel and generate fewer emissions, so there is an environmental benefit."

By eliminating hydraulic connections, he says PACE rigs offer a third advantage: quicker rig up and rig down. "You simply plug in connections. The generators have plugs, and the rig crew just plugs in the pumps or the draw works," Read remarks, adding that the electric connections are also more environmentally friendly in that they cannot leak like a hydraulic connector.

Read points out that Nabors' coiled tubing PACE rigs are hybrids, or units that can drill with coiled tubing or jointed pipe. "This lets you use different techniques to suit the type of drilling," he notes. "For example, on a typical shallow well, for surface hole, you would use jointed pipe because you are dealing with gravels and potential water flows. Once surface casing is set, you would get into the high ROP section and switch over to coil.

"Our coiled tubing hybrid rig fleet is predominantly fairly small rigs used in the shallower drilling," Read notes. "That is where CT drilling's small footprint, fast rig up, and super fast drilling really shine."

Reliability

Advanced Drilling Technologies has built its business around drilling shallow wells from spud to total depth with its coiled tubing rigs. Beyond shallow depths, operators need to ask whether CT drilling makes economic sense, contends ADT Vice President and Director of Operations Tom Roelfs. "If you have to make several trips, it is not good because additional cycles are very expensive. Operators need to target wells where they can drill with CT from surface to total depth in a single cycle. The rig starts drilling, drills to total depth, comes out of the hole to log the well, and then runs casing and moves on to the next well site."

According to Roelfs, greater depths also mean:

- Increasing hole quality problems;
- Deviation problems; and
- Reduced mobility.

Operators also need to watch out for areas with hard rock and where geology makes lost circulation an issue, Roelfs says. "Given a particular area where subsurface drilling conditions are good, there may be cases where CT could successfully drill deeper wells," Roelfs assesses. "In the Denver-Julesburg Basin of Colorado, for example, other CT rigs have been fairly successful drilling deeper wells in a particular area."

To Roelfs, acknowledging those limitations is key to increasing CT drilling's acceptance. "Over the years, coiled tubing has got a bad rap in the lower-48," he says. "We are very careful to analyze our capabilities and the areas in which we drill to make sure we never oversell ourselves. We are very conservative about what we can and cannot do with our CT rigs."

That caution has paid off, Roelfs avers. "We have drilled 1,700 wells since January 2005, and we have been successful on 99.5 percent of those wells," he reports.

Speed

To get its rigs on site as efficiently as possible, ADT uses trailers, Roelfs says. "We never need a rig-up truck or crane to set our rigs up," Roelfs explains. "We pull up with our trucks and our trailers, rig them down, raise the front of the trailer,



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To minimize downtime and optimize its CT rigs, ADT brings in a surface rig to drill and case the surface hole, and cement the surface pipe in place before moving the CT rig on site, according to Roelfs. “The wait time for cement is eight hours, so if we set surface with a CT rig, you would have a rig and crew sitting for eight hours, waiting for the cement to cure,” he offers.

“In a lot of places, we can actually drill a well to TD in one day with the surface preset. Without presetting, it would take two or maybe three days to drill those same wells,” Roelfs notes.

ADT also strives to maximize rig reliability, Roelfs goes on. “We use a wheel-type injector instead of a traditional injector,” he notes. “The maintenance on a wheel injector is very low. We hardly ever have any issues that impact reliability or productivity.”

To illustrate the efficiency gains attainable with ADT's process, Roelfs points to a 233-well project in South Texas. “The average rate of penetration was 220 feet an hour, reducing the operator's costs by 34 percent over jointed-pipe drilling,” he states. “That is pretty amazing.”

Roelfs sees directional drilling as the next growth opportunity in ADT's development. “We are pursuing that very hard,” he concludes. “The challenge has been developing directional drilling tools that are economic for shallow wells. That will become easier as demand increases.”

Going For Oil

Shallower natural gas zones have been the main targets of CT drilling in recent years, but Technicoil has modified its rigs so they can drill more efficiently for either oil or gas, according to Marvin D. Clifton, president and chief executive officer. “We think oil has longer legs than gas,” he comments.

To achieve that versatility, Technicoil has converted its rigs from 2½-inch to 3½-inch coiled tubing, Clifton notes. “This allows us to drill a larger hole,” he explains. “We're drilling 6¼-inch holes for gas, 7¼-inch holes for oil, and 8¼-inch holes for heavy oil.”

Technicoil operates five hybrid coiled tubing rigs in Western Canada. When designing its rigs, Clifton says the company emphasizes robustness, referencing mud tanks as an exam-



Wheel-based injectors offer less pull than traditional injectors, but need less maintenance, which makes them well-suited for drilling shallow wells. Many companies say that is where coiled tubing drilling shines.



ple. "Our mud tanks are larger than what is required for shallow gas, but they are ideal for larger and deeper wells."

Technicoil balances this flexibility with mobility, Clifton goes on. "The footprint is built in such a fashion that we can move as fast as the shallower rigs and faster than the deep rigs," he states. "We made our loads as large as we could, but maintained the small, efficient, fast-moving footprint."

To keep its fleet up and running, Clifton says Technicoil emphasizes comprehensive preventative maintenance of the units' injectors, which he dubs the "heart and soul of our rigs."

In addition to following daily, weekly, monthly, quarterly and yearly maintenance tasks, Technicoil tracks the history of every injector, Clifton reports. "When there is a failure, we analyze it to determine the root cause, and then readjust our standards to eliminate those failures," he details. "For example, we used to run injectors to 400,000-500,000 meters (1.3 million-1.6 million feet) of coiled tubing. We found that that was all right in some applications, but not in other applications. Consequently, we switched to 300,000 meters (984,000 feet) for those applications, and in some cases, change injectors as frequently as 150,000 meters (492,000 feet)."

Bits And Collars

Clifton contends that CT can drill deeper than many operators think. "There is a perception that coiled tubing is good to 1,000 or 1,200 meters. We think that you can easily drill to 1,800 meters (5,900 feet) in Western Canada," he reports.

But to reach that depth, Clifton says a lot depends on one of the most basic, yet critical, components in the entire drilling system: the bit. "Operators need to choose bits carefully. Bits are very area-specific, and if you choose the wrong bit, you will have problems," he cautions. "On the other hand, selecting the right bit will eliminate or minimize problems."

Unconsolidated formations are the ideal type of geology for CT drilling, according to Clifton. "If you are drilling unconsolidated formations and you drill the entire bore hole with one bit, coiled tubing is really going to shine because it is all about getting to TD and back out as fast as possible," he says. "But if you are drilling in unconsolidated zones, you have to be careful of back-reactive torque in your coiled tubing, which will snap or damage the CT string. If you get stuck, coiled tubing has a disadvantage in that it cannot be rotated. It is not as tough as drill pipe, so once you get stuck, you really have a problem."

Unconsolidated zones can be drilled with a bottom-hole assembly that is sufficient to keep the reactive torque from reaching the CT. "You have to make sure that you run the proper collar, weights, sizes and transitions, much like you would with a jointed pipe rig," Clifton offers.

"Some might say that takes away from the advantages of CT drilling, but I disagree," Clifton concludes. "As you go deeper with coiled tubing, the advantage comes not in the amount of drill collars you do or do not run. The advantage comes from the fact that after you make up the BHA, there are no more connections to make." □

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