

Bigger coil sizes, hybrid rigs, rotary steerable advances push coiled tubing drilling to next level

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By Katie Mazerov, contributing editor

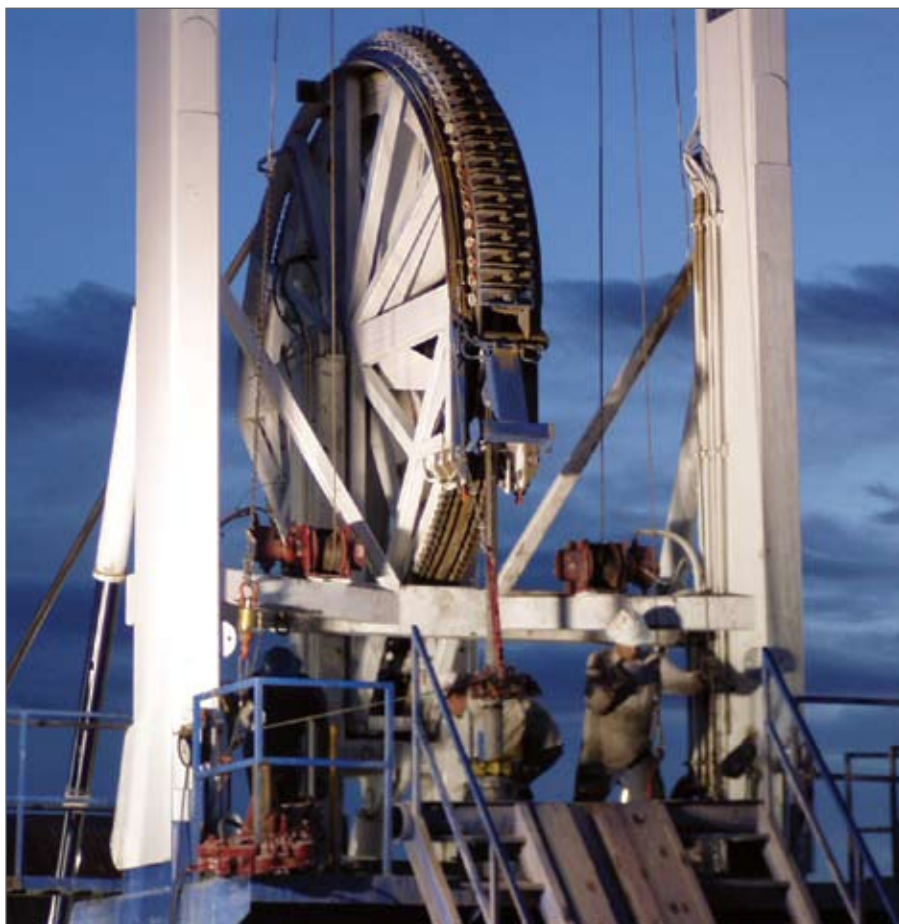
OLD WAYS MAY die hard, but in an era of declining, expensive and difficult-to-tap resources, new and unconventional methods of oil and gas exploration are challenging the status quo.

Among innovations rising to the top of the wave is coiled tubing drilling, which, while not new, is evolving through recent advances in technology and design as a viable alternative to conventional, jointed pipe drilling in shallow reserves – and beyond.

The method has been used successfully for the past decade in Canada, where up to an estimated 40% of wells are drilled with some form of coiled tubing (CT). Why CT drilling has been so slow to come to the continental United States, where it represents only 1-2% of all drilling, is a question “that has been asked many times, and there never seems to be a real good or clear answer,” said **Kent Perry**, managing director of unconventional research for the Gas Technology Institute (GTI).

The simple and often-stated answer is that Canada has more shallow reserves. But Mr Perry says it is more complicated than that.

“You will find that, in some cases in the lower 48 states, early on the technology was tried and did not work very well, and that kind of poisoned the water,” he explained. “I also think the geology in the US starts to separate into many, many basins that go from east to west and north to south,” he said, citing areas that range from the Appalachians, to the Niobrara Chalk, to the Illinois Basin,



Coiled tubing drilling is being used in the Niobrara Chalk in Kansas, where Advanced Drilling Technologies is drilling a well per day at savings of 35% to 40% per well.

Montana and West Texas. “Everything in Canada is mostly within the Western Canadian sedimentary basin, and while it’s a big basin, it’s a single area, and there seems to be a single industry more or less located in Calgary, and I think that helped overcome some of the start-up hurdles.”

Mr Perry believes the current potential for CT drilling is huge in the United States, a view he shares with the US Department of Energy’s National Energy Technology Laboratory (NETL). NETL has been a strong proponent of coiled tubing drilling, particularly when used in microhole drilling and for tapping



Advanced Drilling Technologies has two CT rigs, each with a 2 7/8-in. coil, that have drilled more than 1,000 vertical wells at no more than 3,900 ft since 2005.

what are thought to be vast reserves of shallow gas and oil resources and low-volume wells that often are not economically viable to produce with conventional, rotary drilling.

He cites a 2006 GTI analysis predicting that by 2024, coiled tubing drilling will represent 25% of the shallow well (5,000 ft or less) market in the United States at a savings of \$3.4 billion. The study also suggests the technology will expand into horizontal and directional drilling.

But Mr Perry thinks that projection is too conservative. "I believe that over the next 10 to 15 years, coiled tubing drilling, with improvements in the technology, will begin to replace most of the conventional wells drilled in the shallow depth range."

According to the Intervention & Coiled Tubing Association (IcoTA), a nonprofit

organization that facilitates communication and awareness of the coiled tubing industry, coiled tubing came onto the oil and gas exploration scene 40 years ago when it was used as an intervention and servicing tool for applications such as well cleaning and stimulating. Those functions still account for more than 75% of coiled tubing use.

As far back as the 1970s, operators, primarily in Canada and Alaska, took the technology up a notch by developing its use for more sophisticated applications, including drilling. Those applications began to blossom in the mid- to late 1990s.

"Most recently, CT fracturing and drilling applications have emerged as two of the fastest growth areas," said Ed Smalley, general manager, NOV CTES (National Oilwell Varco/Coiled Tubing

Engineering Services), which provides equipment to coiled tubing service companies. "Revenue from these two applications has grown from almost zero 10 years ago to approximately 15% or more of total (coiled tubing industry) revenue in more recent times."

Unlike conventional top drive or rotary drills, a CT drilling system utilizes a continuous line of steel coil that is released and recoiled on a reel and outfitted with a downhole mud motor for rotation. The coil, which can be pushed back and forth numerous times in the well, eliminates the need for connecting sections of jointed pipe.

"The technology is good for shallow wells or for re-entering existing wellbores horizontally," said John Purcell, technical support manager for IPS Advantage, an oilfield service company that provides CT equipment for service work on wells.

"Environmentally, there is the opportunity to do less surface prep so your footprint has the potential to be smaller," Mr Purcell said. "And from a safety standpoint, once the tool is in the well, nobody is around ... that is, people are not on the rig floor. By nature, it's got to be safer.

"You can also stick a wireline inside a coil and get real-time telemetry," he continued. "So it offers flexibility on where to drill and being able to react quickly."

Mr Purcell noted that the process can be cost effective and efficient if used within its limitations. "But when the coil wears out, you've got to throw the whole thing away," he said. "With conventional drilling, you just replace a section of pipe." He said the average lifespan of a coil is about three wells, but it can range from one to 10 wells.

Another limitation is that "a CT unit by itself doesn't do anything beyond drilling," Mr Purcell said. "Once I drill the hole, I have to run casing and cement the casing. "You can't rotate the coil, so you have to put a mud motor down the well. It is hydraulically limited. A rotary rig can continue to joint pipe together."

Those challenges, which have limited coil tubing's use in drilling to shallow wells in landscapes not defined by hard rock, such as coalbed methane, are now being confronted head-on with the latest generation of the CT drilling rig: the hybrid. The unit combines a coiled tubing drill with a conventional drill in one system, allowing operators to go back



Academy Services, a Nabors subsidiary, has built 13 hybrid rigs, including one with a 15,000-ft depth capacity that will be used in Alaska's Prudhoe Bay for oil re-entries and workovers. The company plans to add one more hybrid rig by mid-year. All but two of the rigs are in Canada — the other two are in Casper, Wyo., and Bakersfield, Calif. In the US, the rigs are rated to 5,000 ft and generally utilize a 2 7/8-in. coil. In Canada, the rigs are rated from 6,500 ft to 10,000 ft and use a 3 1/2-in. coil.



and forth between the two, and drill to greater depths.

Increased coil size – the standard 2 7/8-in. coil is being upped to 3 1/2 in. and even 4 in. – is further enhancing CT drilling capabilities by providing greater stability, better dynamics, less friction loss and the ability to drill deeper and larger wells in harder formations.

Many believe these developments will bring coiled tubing drilling technology to the Lower 48 States and beyond in a big way, and revolutionize the industry.

“There’s been a real change in the industry since 2002,” when the first hybrid rig was introduced, said **Marvin Clifton**, president and CEO of **Technicoil Corp.**, a Calgary company that provides primary well drilling and secondary well stimulation and fracturing for oil and gas production. Mr Clifton believes hybrids will render the original coiled tubing rigs “basically obsolete.”

While the initial cost for a hybrid rig is often higher, as much as 25%, than for a conventional rig, many believe the resulting efficiency and cost-savings make the investment worthwhile.

Coiled tubing drilling is already being used successfully in Kansas’ Niobrara Chalk, where **Advanced Drilling Technologies (ADT)** of Yuma, Colo., is drilling a well per day at an estimated savings of 35% to 40% per well. The rigs were built by **Tom Gipson**, a consultant and expert in coiled tubing drilling operations who has built several CT rigs over the past several years.

“We started with one coiled-tubing rig in January 2005 ... and we proved the technology,” said **Ovi Alfaro**, ADT’s executive manager. “It is truly state-of-the-art.” The company now has two CT rigs, each with a 2 7/8-in. coil, that have drilled more than 1,000 vertical wells at no more than 3,900 ft since 2005. In what amounts to a makeshift hybrid setup, the operation is supported by two conventional rigs that can drill up to 6,000 ft.

“What we do to optimize the coil tubing is we set our surface holes with a conventional rig ... then we take the coil rig and drill down to our targeted depth,” Mr Alfaro explained. “Then we have the logging company run logs, and we set casing.”

Mr Alfaro said the entire operation is completed in less than 24 hrs, with the drilling taking about six to seven hours, averaging 400 ft/hr to 600 ft/hr.

“From an operator perspective, the costs go way down,” Mr Alfaro continued. The set-up consists of three tractor-trailers and a four-man crew (driller, derrick operator and two floorhands), as opposed to a crew of 6 to 10 in conventional drilling. He said the operation is also quick and better for the environment as it involves less damage to the land and thus less time and money for remediation.

“We have good relations with the ranchers and farmers,” Mr Alfaro said. “If they have cattle, they are only disturbed for a day (as opposed to two to three days with conventional drilling), and we can work around (the farmers’) schedules.”

Safety is another issue. “This is inherently safe,” Mr Alfaro said, noting that no one is on the platform or making pipe connections. “Once we start drilling, it becomes what I call a joystick operation to manage the coil system. We have not had one lost-time accident, and we’ve had very little turnover.”

ADT plans to implement a hybrid rig with a 3 ½-in. coil this year. “The system will allow us the flexibility to drill larger holes and a more robust mud system that will allow us into a wider range of geology,” Mr Alfaro explained. “Of particular interest to us, it provides a pull-down capability that will allow us to build angle downhole at shallow depths, and increases our ability to extend the length of horizontal laterals in a relatively shallow environment.”

Nabors Industries, through its subsidiary **Academy Services**, has built 13 hybrid rigs, including one with a 15,000-ft depth capacity that will be used in Alaska’s Prudhoe Bay for oil re-entries and workovers, according to



Dennis Smith, director of corporate development.

“This will be our deepest application yet,” Mr Smith said, noting the company plans on adding another hybrid rig by mid-year.

All but two of the rigs are in Canada. In the US (Casper, Wyo., and Bakersfield, Calif.), the rigs are rated to 5,000 ft and generally utilize a 2 7/8-in. coil. In Canada, the rigs are rated from 6,500 ft to 10,000 ft and use a 3 ½-in. coil.

Katherine Holst, an engineer and project manager for Nabors, said that while the hybrid rigs represent a very small percentage of the company’s total, the technology has, “without a doubt, the potential, depending on the application, to increase efficiency significantly.”

“In a typical drilling scenario using the hybrid coil rigs, you drill your top section with jointed pipe, with your top drive,” she explained. “That might be to 500 ft. Then you’ll set casing and make up your new bottomhole assembly with your top drive. From there, you connect to the coiled tubing and drill to TD.”

Xtreme Coil Drilling said it sees the coiled tubing market going toward “the deeper S-curve wells,” said CEO and chairman **Tom Wood**. The company has nine hybrid rigs working in the United States.

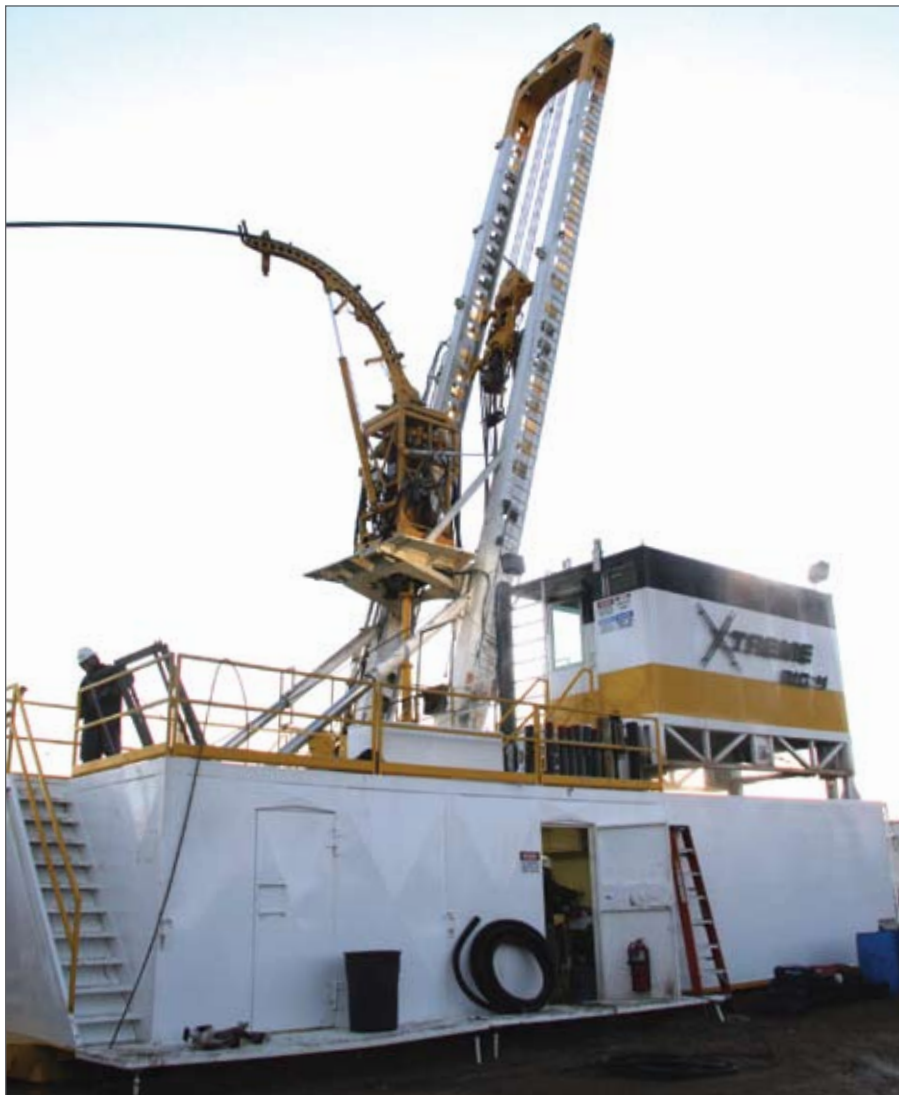
“You’re not having to make that connection every stand, you’re not drilling 30 or 40-ft joints and stopping to make a new connection,” Ms Holst emphasized.

And from a safety standpoint, “you’re removing the human interface,” she said. “You completely clear the drill floor of personnel when drilling.”

As the coiled tubing drilling technology advances into the next frontier, companies are seeing more opportunities for taking it beyond its shallow roots, into deeper territory and more complicated directional and horizontal re-entry situations.

“We are reliant on downhole tools to take this to the next level,” said Mr Clifton of Technicoil. “The problem with directional drilling is the high cost of the rotary steerable.” He does agree that the directional market will be “ideal for coiled tubing drilling” once it becomes economically feasible.

“Where we see the market going is the deeper S-curve wells,” said **Tom Wood**, CEO and chairman of Calgary-based **Xtreme Coil Drilling Corp.** The company introduced its first CT rig in 1998 and



The horizontal re-entry market has great potential for CT drilling, according to Xtreme Coil Drilling. It's an application that has been used with success in Alaska, where a combination of coiled tubing and specialized tracking tools can go as deep as 10,000 ft, then horizontally 2,500-3,000 ft for a total measured depth of nearly 13,000 ft.

since has developed six hybrid models of Coil Over Top Drive (COTD) drilling rigs for varying depths. It currently has nine hybrid rigs working in the United States.

"In Colorado right now, the bulk of what we're doing is all S-curve drilling," Mr Wood said. "CT offers better design, and it's environmentally friendly and sound-proof. We're working in a neighborhood in Colorado, and you can't even hear the rigs running.

"Once the marriage between coiled tubing and the various types of rotary steerable tools that go on the end of the coil gets perfected, you're going to be seeing the same gains on directional holes that you're seeing on straight holes," he continued. "This is what the energy companies are betting on: A process that can change the economics of shallow wells in

Canada can actually change the 8,000 to 9,000 S-curve wells in the United States."

Mr Wood said the horizontal re-entry market also has a lot of potential for CT drilling, an application that has already been used with success in Alaska, where a combination of coiled tubing and specialized tracking tools can go as deep as 10,000 ft, and then horizontally 2,500 ft to 3,000 ft for a total measured depth of nearly 13,000 ft.

"In the US, there are literally thousands of these wells that have been drilled and that are cased," Mr Wood said. "By utilizing coil, we can turn the corner very tight. If you can do that at a fraction of the cost, it can bring a whole group of wells that are throw-aways into the marketplace that can make a very economic producer."

Coil-X Drilling Systems Corp, a joint venture between Xtreme and **Shell Technology Ventures Fund** that is exporting Xtreme's COTD rigs into new markets, recently deployed a model in Permian Basin in West Texas.

"We're really pushing the envelope as to how far you can take coil," said **Rod Uchytel**, CEO of Coil-X. "Traditionally, we've been limited to about 7,000-7,500 ft with coil, and most of the rigs would have had a hook-load capability of less than 200,000 lbs," he said. "Our rigs start at a 200,000-lb hook-load, and go up to a 400,000-lb hook-load. Three of our designs can go to 10,000 ft with coil, which was a huge challenge in the past. The injectors we have can work with 4-in. coil and maybe larger than that."

Mr Uchytel said there is great potential for coiled tubing drilling in Mexico, where the offshore Cantarell Reservoir is in decline and where there are thousands of onshore vertical and directional wells at 7,500 ft to 8,000 ft. "It's perfect for what we're doing," he said.

Eugene Murphy is an investment principal at **Kenda Capital**, an independently owned manager of the Shell Technology Ventures Fund, which is focused on reducing the cost of energy by accelerating the development and deployment of new technologies. Mr Murphy sees a worldwide market for coiled tubing drilling.

"We are trying to export this globally," Mr Murphy said. "The industry is moving so fast now. What we do know is that the technology as it stands today is significantly more efficient than just jointed pipe.

"We want an adaptive drilling process," he continued. "We want to be able to adapt to drilling conditions as the hole and reservoir demand. To be able to switch back and forth between jointed pipe and coiled tubing ... run casing, move rigs quickly, keep the hole clean while drilling, minimize damage and work in uncertain conditions ... there is a whole list of things we can start to do with these rigs as a platform that we can't normally do.

"Multiple groups have seen the rigs working, and I'm not aware of anybody who has left unimpressed," he said. "It's not often you see such excitement around a new technology."

Video clips showcasing the coiled tubing technologies of Nabors, Xtreme Coiled Drilling and Advanced Drilling Technologies are available with the online version of this article at www.drillingcontractor.org.