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CWD saves significant time in challenging exploratory well

The first global 30-in. CWD job using a customized PDC bit delivered time and cost savings in Mexico.

The first 34-in. PDC drillbit from the Schlumberger Direct XCD drillable alloy casing bit portfolio was specially designed for drilling two challenging shallow-water exploration wells in the Gulf of Mexico. (Source: Schlumberger)

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The combined challenges of uncertain market conditions and greater well complexity compel operators to seek solutions that push the limits of technology far beyond conventional capabilities. The ability to reach total depth (TD) in a single run, for example, is a critical factor in overall field economics, reducing well construction costs and risk.

Casing while drilling (CWD), the technique that simultaneously drills and cases a well section, has proved to be an effective alternative to the conventional practice of using drillpipe to drill a section, pulling out the bottomhole assembly (BHA) and going back in to case the section. The casing string conveys torque, rpm and hydraulics to the bit. Drilling and casing at the same time eliminates tripping as the drillstring is always near or at the bottom.

CWD technology is not new, but it has gained broader acceptance in recent years as operators have recognized its benefits in reducing drilling time and cost, especially in cases of mud losses through the plastering effect, wellbore stability issues and difficulties tripping BHAs and running casing. Reactive shales that are time-dependent also can be managed by CWD.

CWD is typically deployed in 7-in., 9 ⅝-in. and 13 ⅜-in. sizes, depending on the region. However, more sophisticated designs and applications are expanding the operating envelope farther to meet the needs of production companies in reducing well construction costs while increasing drilling efficiency.

In a first-ever application, Pemex collaborated with Schlumberger to design a 30-in. CWD operation using a custom-made polycrystalline diamond compact (PDC) bit and a unique modification of a casing running tool to reach planned TD in a single run in two challenging shallow-water exploration wells. The successful implementation of this approach resulted in significant time and cost savings for Pemex.

The 2016 CWD project involved the conductor sections of both wells, located in Campeche Bay, characterized by interbedded sections of sands, shales and abrasive sandstones; low-pressure zones; sloughing shales; borehole instability; and gas influxes. These issues, combined with the uncertainty inherent in exploratory wells, prompted engineers to formulate a plan that would optimize the well construction process—without compromising the well design—while reducing the associated risk of not being able to drill and set surface casing to planned depth.

Failure to achieve that objective would have likely increased nonproductive time resulting from the need for extra wiper trips, multiple trips to run casing and set cement plugs, removing stuck pipe and running contingency casing or liners to cover low-gradient zones and sometimes unstable formations of the field.

Implementing CWD design

In this case, Pemex wanted to apply lessons learned from previous successful 20-in. CWD conductor sections to 30-in. CWD conductor sections to optimize drilling efficiency based on the well design and reservoir objectives. To that end, both companies embarked on a technical feasibility study to analyze the viability of implementing an innovative CWD design incorporating the first 34-in. PDC drillbit from the Schlumberger Direct XCD drillable alloy casing bit portfolio.

The study involved the integration of the Schlumberger drillbit and BHA expertise using the company's casing drilling proprietary software to model multiple considerations, including torque and drag, centralizer placement, hydraulics and accumulated fatigue cycles. Calculations using varying parameters—weight on bit, rpm and flow rate—were made to predict operational performance.

The engineers also conducted analysis to determine an appropriate cutting structure regarding blade count and cutter size along with offset data, rock compressive strength and bit records. Rock strength analyses showed low unconfined compressive strength values ranging from 500 psi to 2,000 psi.

The end result was the design and manufacture of a 30-in.-by-34-in. diameter bit that could drill the conductor sections and provide enough annular space for cementing 30-in. casing. The candidate wells had experienced mud losses, lost-in-hole incidents and wellbore instability, issues that could have withstood conventional drilling but would have presented difficulties when running casing.

The final design was a four-bladed bit with a sub of durable oilfield-grade steel, a copper bronze alloy body and 19-mm PDC cutters. The bit included a large junk slot area for efficient cuttings removal and a spiral gauge pad for maximizing bit stability and reducing vibration. The 30-in. casing, conveyed by the modified casing running tool (CRT), would be used as the drillstring. The CRT was modified to facilitate the handle, rotation, circulation and reciprocation of the 30-in. casing, from 264 lb/ft to 310 lb/ft. Internal tests of the CRT, which featured the damage of the CRT's packer cups by casing internal weld seams at pressures of 400 psi and 800 psi, confirmed that with the modifications the CRT could carry out the intended load capacity and withstand high pressure.

First-ever CWD design

On the first well the first 30-in. CWD job was successfully completed using the 34-in. PDC drillbit and 30-in. CRT—a size and diameter never before achieved. The entire operation, including rigup, run-in and jetting, CWD drilling, connection, circulation, and realignment of casing, took 30 hours. The 30-in.-by-34-in. conductor section was drilled and cased at a depth of 256 m (840 ft), with the PDC bit drilling 178 m (584 ft) in nine hours and 52 minutes, a reduction of 26.3% (1.31 days) compared with conventional drilling. Average ROP was 18.04 m/hr (59 ft/hr). The conductor casing was run and secured at the planned TD with no stuck-pipe issues or need for wiper trips to calibrate the hole. The 30-in. casing was then prepared for cementing.

Drillout was achieved with a BHA pendulum and 26-in. PDC bit with eight blades and 16-mm PDC cutters along with MWD and LWD tools. Total drill-out time was 130 minutes. The crew then circulated for hole-cleaning. The PDC bit was drilled out at 256 m (840 ft) and then drilled ahead to 688 m (2,257 ft), drilling 432 m (1,417 ft) in 19 hours and 18 minutes at an ROP of 22.38 m/hr (73 ft/hr).

Experience gained in the first CWD operation proved valuable in enhancing drilling parameters for the second operation. Flow adjustments resulted in more effective hole-cleaning and optimized ROP, viscous pills were pumped to improve circulation and casing manipulation, and a pump-off test monitored pump pressure and checked string weights to reduce cuttings in the string and the risk of packing off and high drilling torque. Connection makeup was enhanced by using the CRT's hydraulic pipehandlers and a hydraulic single-joint elevator to improve connection times.

In the second conductor section the 34-in. PDC bit drilled 120 m (394 ft) in two hours and 42 minutes, a 76% improvement over the first job. The CRT's pipehandlers and single-joint elevator reduced connection

Activity	First Job Hours	Second Job Hours	Improvement Percentage
Rig up CRT	3	2.50	17%
Safety meeting	1	0.50	50%
Run in hole 30-in. touch seabed and jetting	5	0.38	92%
Drilling with 30-in. casing	9.86	2.40	76%
Connection and casing lifting	9.14	2.50	73%
Circulation	0.50	1	-100%
Change casing for lack of self-alignment	1.50	1	33%
Total time	30	10.28	66%

FIGURE 1. The table compares the activity time between the first and second 30-in. CWD jobs. (Source: Schlumberger)

time from nine hours and 14 minutes to 2.5 hours, a 73% improvement. Total operational time was 10 hours and 28 minutes, an improvement of 66% over the first well. Furthermore, safety was enhanced by minimizing the crew's need to make casing adjustments during connections (Figure 1).

The unique operation has expanded the operating envelope for CWD in reaching TD in unstable formations. CWD is increasingly being applied globally, including basins in Indonesia, Malaysia, Myanmar, Colombia, Argentina, Mexico and the Middle East. In 2016 Schlumberger completed 25,281 global CWD runs for a total footage of 14 million m (46.4 million ft). E&P

Editor's note: *For further reading, see SPE 185613-MS paper, "Successful introduction of the first worldwide 30-in. casing-while-drilling job saves 1.31 days in an exploratory well in shallow waters, Mexico."*