Casing drilling effective with retrievable assemblies

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CASING DRILLING™ (CD) combines the drilling and casing steps of well construction into a single process that improves drilling efficiency. **Tesco's** fully retrievable and re-runnable CD system has been used in more than 140 commercial wells to drill over 750,000 ft since it was introduced in 1999, including both vertical and directional wells with up to three strings of casing in sizes ranging from 4 ½-in. to 13 3/8-in.

Use of a retrievable system is the only practical choice for directional wells because of the need to recover the expensive directional drilling and guidance tools, the capability to replace failed equipment before reaching casing point, and quick and cost effective access to the formations below the casing shoe.

Over 300,000 ft have also been drilled with Tesco's non-retrievable tools, for a total of more than 300 strings of casing that have been drilled with both systems.

One of the most significant findings from using the CD system is that it can significantly improve drilling performance when drilling across pressure transitions. Wells drilled in areas that normally require a liner due to lost circulation have routinely been drilled with no difficulty from lost circulation.

In other areas, the reduction in fluid lost to low pressure production formations improves the production rate. These benefits can make the difference between a well being economical or not.

CASING DRILLING BENEFITS

Drilling with the casing eliminates at least one trip (at casing point), which may be sufficient incentive to consider CD for expensive rig operations.

More importantly, using the CD system significantly reduces downhole trouble time, while at the same time eliminating certain practices used for trouble avoidance when drilling conventionally.

Lost circulation and well control incidents have been nearly eliminated in the wells drilled with the CD system. This is particularly significant for wells where a weak zone is encountered before drilling into a higher-pressure zone. For these situations, balancing lost circulation and well control is difficult, particularly when tripping out in conventional wells to run casing.

Engineers often budget for preventing and recovering from drilling problems that routinely occur in their operations.

The portable casing drive system attaches to the top drive to facilitate Casing Drilling and casing running operations.

For example, making a short trip or a conditioning trip while drilling and/or before running casing has developed into a "prudent" practice, but is primarily a trouble avoidance measure. However, using the CD system can eliminate some of these operations.

CD may enable operations where the risk-weighted economics are unattractive for a well when drilled conventionally. For example, it may be known that drilling though a particular zone often requires a liner to be set. By using the CD system, the liner may not be required to successfully drill the zone.

This cost-savings may enable a well to be economical that would not be authorized when considering the risk of drilling and casing it conventionally. Similarly, an uneconomical conventional prospect may become viable by using CD to reduce the risk of losing excessive amounts of fluid to a low-pressure pay section and damaging production.

CASING DRILLING PROCESS

The Casing Drilling system is composed of downhole and surface components that provide the ability to use normal oil field casing as the drill string so that the well is simultaneously drilled and cased. The casing is rotated from the surface with a top drive for all operations except when there is a normal operational need to drill without drill string rotation. The drilling fluid is circulated down the casing ID and up the annulus between the casing and well bore.

The casing used with the CD system is generally the same size, weight and grade that would normally be used in the well. The casing connections may require a change from the conventional well design because they must provide adequate torsional strength, fatigue resistance and flow clearance. Both integral and coupled connections have been used successfully.

Each joint of casing is picked up with hydraulically activated single joint elevators attached to the Casing Drive System (CDS) located below the top drive. The CDS supports the full weight of the casing string, applies torque for both drilling and make-up and facilitates circulation without making a threaded connection to the top of the casing.

The CDS includes an internal spear assembly to provide a fluid seal to the pipe and a slip assembly to grip the interior of large casing or the exterior of small casing. This allows the casing to be placed into the drill string without screwing into the top casing coupling.

The use of the CDS speeds up the casing handling operation and prevents damage to the threads by eliminating one make/break cycle. Using the CDS and power slips allows casing connections to be made as fast as drill pipe connections, minimizes floor activity while making a connection and increases rig floor safety.

Vertical sections in soft formations can be drilled with casing using a variety of simple non-retrievable drilling tools. Vertical wells drilled with the casing in

somewhat harder rock may need the ability to replace the cutting structure before reaching casing point and/or require deviation control.

Using a retrievable BHA offers the flexibility to address these issues. The drilling assembly can be changed as often as required to match the cutting structure to the rock being drilled. Deviation control is managed by using a retrievable stabilized drilling assembly that extends below the casing shoe.

Stabilization in the pilot hole provides a smooth vertical hole that is opened (by an underreamer positioned above the stabilizers) to the required diameter for the casing to follow.

The directional drilling process with casing is similar to that with drillpipe in many ways. The same type of BHA is used. The main difference is that the components must be sized to pass through the casing being used as the drill string, rather than through the previous string of casing that has already been cemented. Both steerable motors and rotary steerable tools can be used with the Casing Drilling system.

The build rates that can be achieved while directionally drilling with casing depend on the size of casing being used, but cover a rather wide range. The upper limits of build rates that can be used with various sizes of casing are based on fatigue limitations of the casing. These build rates are routinely achieved with retrievable steerable motor assemblies.

The retrievable Casing Drilling BHA normally consists of a pilot bit with an underreamer located above it to open the hole to the final wellbore diameter. The pilot bit is sized to pass through the casing used as the drillstring and the underreamer opens the hole to the size that is normally drilled to run casing.

Other downhole tools in addition to the bit and underreamer are used as appropriate. For vertical drilling, stabilization would normally be included on the assembly and for directional drilling a steerable motor, MWD and non-magnetic collar would be included in the BHA.

The retrievable BHA is designed for tripping with a wireline. The wireline tripping procedures allow the BHA to be tripped under any normal well condition while maintaining the ability to circulate and reciprocate the casing. The fact that the BHA is tripped through the casing rather than through the open hole eliminates borehole damage due to tripping and provides a safer tripping process.

The ability to circulate the well even while tripping is particularly advantageous because it often allows the casing to be drilled with confidence to a deeper depth than could be achieved if the drillstring had to be tripped and the casing run as a separate process.

The retrievable drilling assembly is attached to the bottom of the casing in a profile nipple with the Drill-Lock Assembly (DLA). The DLA provides the ability to connect conventional drilling tools with rotary-shouldered connections to the casing and facilitates running these tools in and out of the casing.

The DLA axially and torsionally locks and un-locks to the profile nipple, seals in the casing to direct the drilling fluid through the bit, locates the DLA in the profile without relying on precise wireline measurements, and bypasses fluid

around the tools for running and retrieving.

The BHA can be run and retrieved in deviated wells with inclinations higher than 90° and the DLA can be released with a pump down dart before running the wireline.

The infrastructure to support drilling with drillpipe has been developed extensively over the past 100 years. Support services and accessories are available for almost any situation that may be encountered. This is not true for Casing Drilling and the lack of certain support items sometimes limits the operations that can be undertaken with casing.

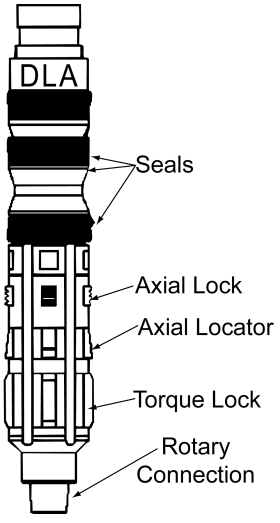
A new suite of auxiliary equipment is being developed for Casing Drilling, but in many instances, the size of the developing market inhibits the development of CD support accessories by conventional service providers.

Drillpipe tool joints have developed over time to provide high axial and torsional load carrying capacity, fatigue resistance and tolerance for making and breaking many times with crude equipment in a relatively dirty environment. Many casing connections have an adequate axial load rating, but few non-premium connections for smaller casing sizes have adequate torque carrying capacity.

This was initially addressed by developing a "multi-lobe torque ring" that could be inserted in a buttress box to provide a torque shoulder for increased torque capacity (typically doubling it). As the CD process attracted larger projects, companies began to develop lower cost premium connections specifically for use with it. One operator began ordering casing directly from the mill dressed for Casing Drilling application.

The casing must be in good condition when drilling is completed to satisfactorily function as the casing for completing the well. The condition of the casing after drilling with it was evaluated in early field trials and no wear or damage was seen on the pipe body, but it was not unusual for some of the couplings in the lower portion of the casing to be worn, often on only one side. An economical "wear band" was developed for field installation on the casing adjacent to the couplings to provide wear protection. These bands include about 1-in. of tungsten carbide hard facing material similar to that used for wear protection on drill pipe.

Centralizers may be needed for directional performance, wear management, key-seat control, and centralization for cementing. Most conventional cementing centralizers developed to be run on casing cannot take the abuse of drilling and still remain on the casing after more than a few hours of drilling. A CD centralizer with blades hydro-formed directly on a tubular body provides an effective means of centralizing the casing while drilling with it. These rigid stabilizers provide an economical, rugged centralizer that can be attached to the casing without altering performance.



The drill lock assembly is the critical component that allows conventional drilling tools to be run and retrieved through the casing.

Once the retrievable drilling assembly is removed from the casing at the casing point, there is no float equipment in place to prevent back flow of the cement. A drillable, pump down composite float that lands in the profile nipple has recently been run successfully in several commercial wells. This float can be pumped into the well at the same circulation rate that is used for drilling and may be pumped down while conditioning the mud before cementing.

The commercialization of CD technology has spawned the development of specialized equipment and procedures aimed at efficiently handling casing while it is being picked up and run as the drillstring. Since each CD job is a combination of drilling and casing running, the equipment and procedures used to handle the casing must be safe, relatively fast and compatible with operation by the rig crew in order to deliver a cost effective CD service.

Once these procedures and portable casing handling equipment were developed and proven, it was only natural that they be employed for running casing on wells drilled conventionally. Using the techniques developed for Casing Drilling provides a casing running process with improved safety, provides assurance that the casing can be run to the casing point on the first attempt, offers the potential to ream casing to bottom, and requires fewer additional people on the rig for casing running operations.

When required, specialized accessories, such as MLT rings and reaming shoes, are available to extended the performance of standard casing.

The new casing running service is based around the use of the portable CDS that hangs below the top drive. The CDS provides the ability to pick up joints of casing from the "V" door with single joint elevators, grip the top of the casing so that the top drive can be used to make up the connection and pick up the string to lower it, and to seal at the top of the casing for filling and circulating while the casing string is being lowered to pick up the next joint.

The combination of top drive, CDS and specialized casing accessories permits rotation of the casing to ream it to bottom for difficult wellbore situations as well as to improve cementing of the casing. The driller, rig crew and the CDS operator conduct this entire operation.

The new casing running system has been used on over 220 wells for twenty operators in six countries to run over 1,500,000 ft of casing ranging in size from 4 ½-in. to 13 ⅜-in. since being introduced in 2002.

These wells range from vertical holes to high angle extended reach wells and include both onshore and offshore applications. The equipment for running casing up to 20-in. with the new casing running system has recently been introduced.