AADE 01-NC-HO-32

Casing Drilling Technology Moves to More Challenging Applications

Tommy Warren, Bruce Houtchens, Garret Madell, Tesco Corp.

Abstract

The performance of Casing Drilling technology in simple wells is proving suitable for more challenging applications. This technology was recently used to successfully drill the surface hole sections of two offshore wells that required directional control, six onshore gas wells to depths as great as 9,576 ft, and surface holes for four Canadian horizontal wells. The equipment used to implement Casing Drilling activities is well into second generation designs.

Introduction

Tesco's Casing Drilling system, introduced for field trials in mid-1999, combines the drilling and casing processes into a single operation to achieve a more efficient well construction method.

The system has been applied in over 20 wells where the casing has been used as the drill-string. Approximately 87,000 ft have been drilled with casing in commercial wells since introducing the Casing Drilling process. These applications range from drilling only shallow surface holes to drilling as deep as 9,576 ft. Casing sizes of 4-1/2", 7", and 9-5/8" have been used in these Casing Drilling operations. Tools for 5-1/2", 8-5/8", and 13-3/8" casing have been constructed and are awaiting field runs.

This paper describes the Casing Drilling system, presents examples of where the system has been used, discusses what has been learned by drilling with the system, and suggests the type of applications that may be attempted in the future. The introduction of the Casing Drilling system has not been without its pitfalls, but the field trials suggest that the system can be successful in more challenging wells than have been attempted to date. It is the elimination of hole problems in some of these wells that offers the most potential benefit from Casing Drilling.

Casing Drilling System

Tesco's Casing Drilling system enables a well to be simultaneously drilled and cased by using standard oil field casing as the drill-string.[1, 2, 3] The casing provides hydraulic and mechanical energy to a retrievable drilling assembly suspended from a profile nipple located near the bottom of the casing. The profile nipple has the same drift diameter as the casing and can be used to land cementing equipment after the drilling assembly is removed.

The drilling BHA is connected to the casing with a "drill lock" (DLA) that provides a running/retrieval interface, mechanical attachment to the casing, and a hydraulic seal (**Fig. 1**). The drilling assembly (**Fig. 2**) suspended below the DLA terminates in a pilot bit, but may include other conventional drill-string components such as an underreamer, mud motor, core barrel, or directional assembly (non-mag collars, LWD, MWD, UBHO, motor, etc.). A pilot bit that will drift the drill casing is run with an underreamer to open the hole to the appropriate size for running the casing. For example, a 6-1/4" pilot bit is used with 23 lb/ft 7" casing, along with an underreamer to open the hole to a final diameter of 8-1/2". The hole may be opened to a larger diameter to reduce the ECD in critical applications.

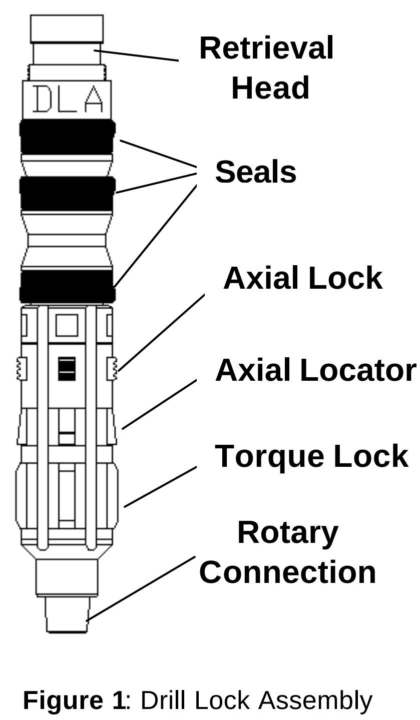

Figure 1: Drill Lock Assembly

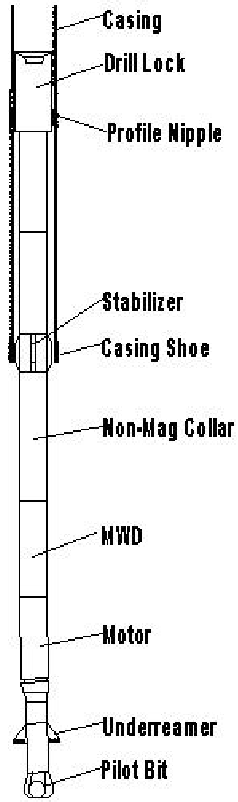

Figure 2: Casing Drilling system.

The BHA is usually run and retrieved with wireline, but for large diameter casing it may be run and retrieved with drill pipe. Using drill pipe is slightly more inconvenient because it requires the casing to be landed in the wellhead so that the BOP is available for well control while retrieving the BHA.

The casing used with the Casing Drilling 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.

Solid centralizers can be added to the casing for directional performance, wear management, key-seat control, and centralization for cementing. These centralizers (**Fig 3**) have rigid, hard faced blades and are attached to the casing with a friction fit so that they rotate with the casing. Non-rotating zinc alloy centralizers have also been used for torque reduction in directional applications.

Figure 3: Shrink fit rigid centralizer.

Once the BHA is landed in the profile nipple, drilling proceeds in a manner similar to conventional drilling. The Casing Drilling system utilizes a top drive to rotate the casing for rotary drilling, generally at a speed similar to conventional rotary drilling. The casing is slid without rotation when a directional motor assembly is used for oriented directional work. In some cases a mud motor may also be used for straight hole drilling to minimize casing wear and fatigue.

If a top drive with extend feature is available, single joints of casing are picked up off the pipe rack and set in the mouse hole. The top drive is connected to the joint, it is then picked up and stabbed into the top of the casing string in the rotary table and drilled down in a conventional manner.

If the top drive does not have the extend feature, the casing is picked up from the V-door with the elevators. A “drive sub” which is simply a crossover between the casing connection and rotary drill pipe connection is screwed into the casing in the V-door. The drive sub includes a drill pipe pup joint to facilitate handling with the top drive and elevators.

The casing drilling service may be provided from a rig specifically designed for Casing Drilling operations or may be provided from a conventional rig. In either case a top drive must be available to rotate the casing while drilling and to make the connections. Normally the top drive eliminates the need for powered casing tongs.

A split crown and split traveling blocks make wireline access to the top of the casing through a wireline BOP more convenient, but are not required. A large wireline unit with sufficient power to run and pull the BHA efficiently is needed.

Tesco has built rigs that are specifically designed for Casing Drilling.[2] Custom designed features on these rigs allow the entire Casing Drilling process to be implemented more effectively. The rigs are designed with hydraulic power units for the mud pump, drawworks, top drive, and wireline unit to reduce the equipment weight and to take advantage of Tesco's top drive technology. All this equipment is operated under computer control through PLC interfaces to minimize the potential for human operator error, optimize equipment performance, reduce manpower requirements, and facilitate data acquisition.

A newly developed Tesco casing drive head, shown in **Figure 4**, has recently become available to increase the ease and efficiency of drilling with casing. Prior to this, a drive sub was required below the top drive to screw into the top of each joint of casing. Using the drive sub causes the threads on each joint of casing to be made up and broken out before being made up for the final time. The drive head reduces the risk of damaging the casing threads by eliminating one make/break cycle.

The casing drive head handles casing sizes up to 9-5/8" and eliminates the need to make a threaded connection between the top of the casing and the top drive. It incorporates external slips to hold the casing axially and to transmit rotational torque. An internal spear and seal assembly provides a seal without using the casing threads.

The casing drive head is hydraulically operated with the top drive controls. After a joint of casing is placed in the mouse hole, a protective full open thread nubbin is screwed into the box, the top drive is extended over the mouse hole and the clamp is lowered over the top of the casing. The drive head is activated and the joint is picked up and stabbed into the stump in the rotary table. The connection is made-up to the thread manufacturer's specification with the top drive and Casing Drilling resumes.

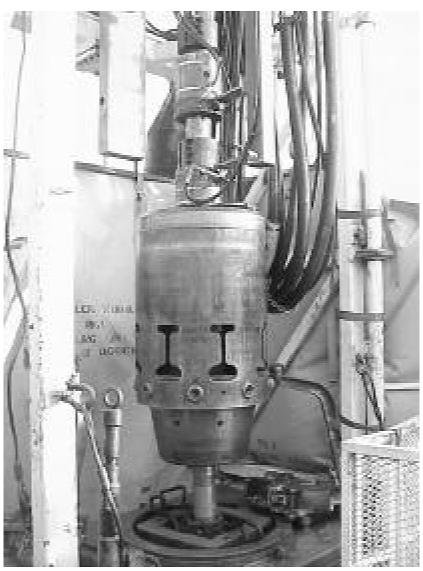

Figure 4: Casing Drive Head

Case Histories

The Casing Drilling system has been employed sufficiently to demonstrate its advantages and better understand its limitations. Three recent applications of the Casing Drilling system are described below to high light current experience with the system.

Onshore Gas Wells The Casing Drilling system was contracted to drill five wells in the Greater Green River Basin in south central Wyoming.[4] Based on the positive results of the first five wells, this drilling program was extended to include additional wells. The sixth well has been completed and the seventh is under way. Shepard, et al, provides more detail on the overall pilot program objectives and the results of the initial wells.[4]

The wells are being drilled in an area where the productive formation is a tight sand with native pressures of about 11 ppg encountered at depths ranging from 8,000 to 10,000 ft. The overlying Tertiary and Cretaceous formations are mostly sands and shales with interbedded coals and bentonite stringers. Wells in this area are drilled conventionally by setting 16" conductor, drilling 11" hole to set 8-5/8" surface casing at 1,150 ft, and then drilling 7-7/8" hole to TD where 3-1/2" tubing is set as the production string.

The upper several thousand feet of the production hole is drilled with fresh water as the drilling fluid at instantaneous penetration rates over 200 ft/hr. There are a number of problems that can be encountered in drilling the production hole above the pay zone. Water flows, lost circulation, and bit balling are common occurrences.

The drilling fluid is converted to a lightly treated Gel mud a few hundred feet above the pay zone, depending on drilling conditions, and is generally weighted up to about 10 ppg before drilling into the pay zone. Although the pay zone is usually tight, it gives up quite a bit of gas when drilled slightly underbalanced.

An active drilling program and intensive effort to reduce drilling costs over the last few years has seen mud motors and PDC bits significantly reduce drilling time. A single PDC bit is run on a motor from the surface casing depth to the top of the pay. A Type 2 insert bit is then used to rotary drill the pay interval.

The drilling program is being conducted with Tesco Rig 1, specifically designed as a Casing Drilling rig.[2] The rig utilizes PLC controlled hydraulically powered rotating, hoisting, and pumping systems. It was originally designed as a platform to assist in developing and testing the Casing Drilling system.

The rig was upgraded to provide additional pumping capability and to improve well control and gas handling equipment. These enhancements assure the rig can safely handle a large influx of gas if the well encounters virgin pressure from a natural fracture in the pay zone. This equipment also facilitates the normal handling of reservoir gas while drilling slightly underbalanced.

The surface hole in each well is drilled to approximately 1200 ft with 7" casing and the Casing Drilling system. A Tesco underreamer has been used in each well. A roller cone bit was used for the first two wells but was switched to a PDC bit for the subsequent wells. In each case the BHA is installed at the surface and retrieved with the wireline when the casing point is reached. The cement Service Company is called out before casing point is reached and begins rigging up for the cement job while the BHA is being retrieved.

Figure 5 shows the time from spud to completion of the cement job for the six Casing Drilled surface holes compared to the average offset well. A typical offset takes about 8-12 hours to drill the surface hole and a total of about 18.9 hours (based on the average of the last 19 wells in the field drilled between June and October of 2000) from spud to completion of the primary cement job.

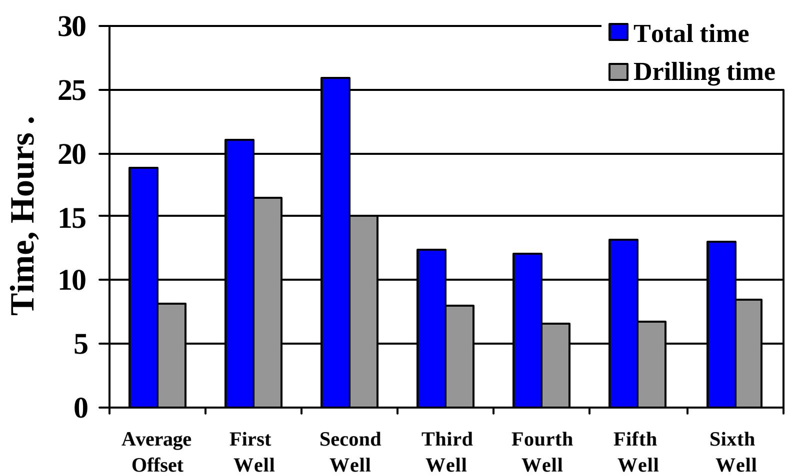

Figure 5: Times from spud to plug down for onshore gas well surface holes.

The first two Casing Drilled wells required longer than the average time from spud to completing the cement job, but the remaining wells were faster than the offsets. Even on the first well, the time between reaching TD and completing the cement job was significantly reduced, but the actual drilling time was greater than for the conventional wells. As additional wells were drilled, the penetration rate was improved by:

- switching from a roller cone pilot bit to a rental PDC bit,
- switching from spud mud to clear water as the drilling fluid,
- increasing the flow rate by using two mud pumps,
- drilling with more aggressive operation parameters,
- gaining more experience with the local environment.

Many of these practices were routine on the conventional wells but were not used on the first Casing Drilled wells in order to provide a conservative approach to introducing Casing Drilling to the field. Although there is still room to improve the ROP, these actions allow the advantages of the Casing Drilling system to be realized as an overall reduction in surface hole drilling time (from spud to plug down) of about 30 -35%.

The BHA was retrieved successfully on all six wells. BHA recovery typically requires about 45 minutes from the time the retrieval tool is ready to run until the BHA is back on the surface, including surveying time.

The underreamer performed extremely well for drilling the 8-1/2" surface holes. There were no difficulties in closing the arms to retrieve the tool. The same underreamer and cutters were used for all six wells. At the end of six wells the only indication of wear was slight chipping on the trimmers and minor erosion on the hardfacing around some of the cutters.

Casing Drilling with 4-1/2" casing in the 6-1/4" production hole was initially not nearly as effective as Casing Drilling the surface holes. In fact the first two wells were completed with a conventional drill-string after casing connection failures. Even though the third well was completely drilled with casing without a failure, at that point it was still not clear that Casing Drilling of these holes would be viable.

Shepard, et al discusses the initial difficulties, but by the fifth well the

Casing Drilling process had become competitive with conventional drilling. The primary difficulties that were encountered were an unacceptable ROP compared to the offsets and lateral drill-string vibrations that resulted in casing connection fatigue failures on the first two wells. As drilling continued, most of the initial problems were resolved and the process was tailored to the customers needs. The bottom joints of casing were changed to reduce the lateral vibrations. The casing connection was changed to one that was more fatigue resistant. The flow rate was increased and more of the hole was drilled with water to improve the penetration rates.

The last two wells were drilled with a conventional PDC bit (instead of pilot bit and drilling shoe) in order to further improve the ROP. At TD the casing was cemented in place without tripping out.

The completion of the fourth through sixth well with the Casing Drilling system represented a number of milestones for Casing Drilling. They were the deepest wells completed with the Casing Drilling system where all segments of the well were drilled with casing and the wells were completed without tripping the casing. Well number four represented the single longest run (242.5 hours and 4,035 ft) and successful retrieval of the DLA. They were the first wells to use the pump down cementing float and its use resulted in a successful cement job.

The casing drive head was used on these wells and facilitated the handling of the casing with minimal thread damage while drilling. It has become an essential piece of equipment for Casing Drilling applications.

The Casing Drilling process has encountered fewer incidents of lost circulation while drilling through depleted zones where lost circulation is common than was anticipated. This partially results from the ability to drill with a lower mud weight than may be used when the hole must be conditioned to trip the drill-string as required when drilling conventionally.

Underbalanced drilling of the pay interval has been quite successful with the Casing Drilling system. A lower density drilling fluid has routinely been used to drill the pay zone while circulating through the choke and flaring gas. Gas flares as large as 20 ft have been encountered. There have been no difficulties in retrieving the BHA and cementing the well once TD is reached. The lack of needing to condition the hole, trip the drill-string, and run casing saves about one day after the well reaches TD.

Offshore Wells. The 9-5/8" surface hole sections of two offshore Gulf of Mexico wells were simultaneously drilled and cased to depths of 3222 ft and 3728 ft with the Casing Drilling system.[5] These wells were drilled from a jack-up rig in about 58 ft of water. Experience gained in drilling these two wells indicates that the Casing Drilling process may be used to reduce the time required to drill, case, and cement the surface holes in similar wells by about 20%.

The directional work was done with conventional motors, MWD, and gyro surveying techniques. The well path for the surface hole of both wells included a slight build to about 4^{o} inclination while moving away from the platform and then a drop back to vertical.

The drilling assembly used on both wells consisted of an 8-1/2" milled tooth bit, 12-1/4" underreamer, 6-3/4" slow speed motor, float sub, 6-3/4" MWD, non-mag UBHO sub, non-mag drill collar, 8-3/8" stabilizer, two 6-1/2" pony drill collars, and Tesco Drill Lock. This assembly was run on 5" drill pipe, landed in the profile nipple, and the drill pipe stood back. Once landed, the drilling assembly extended about 100 ft below the casing shoe.

Drilling with the assembly proceeded very similar to drilling with a conventional directional assembly. Initial orientations were made with a gyro until magnetic interference cleared up so that the MWD could be used for orientations. The angle was built to 4^{o} as planned and then dropped back to vertical after sufficient displacement was achieved.

The Casing Drilling process was initiated on the first well by drilling with singles. Connections were made by placing a joint of casing in the V-door, installing the drive sub in the casing, and making it up hand tight. This was done while drilling with a second drive sub. The casing joint and drive sub were then picked up with the elevators and made up with the top drive. The final torque was applied with casing tongs, but additional make up was rarely observed.

A larger mouse-hole was installed at about 1800 ft and the remainder of the first well and the second well were drilled with "doubles". One joint of casing was picked up and placed in the mouse-hole while the drive sub was installed in a second joint of casing lying in the V-door. The joint in the V-door was picked up and made up to the joint in the mouse hole and then both joints made up to the casing in the rotary table.

In both wells the casing was drilled to casing point, the hole circulated clean, and the casing landed in the wellhead. The retrieving tool was run on drill pipe and the BHA was recovered. A composite cement retainer was run and the casing was successfully cemented.

Observations made while drilling these two offshore wells suggest that more aggressive directional wells can be drilled with the Casing Drilling system. Directional response was consistent, but with a slightly lower build rate than expected from similar directional tools run conventionally. Steering with the casing was easy because little twist was observed between the bottom hole and surface when the motor was oriented.

A conventional well had been drilled with the same rig and service providers immediately before drilling the Casing Drilled wells. The directional profile and surface casing depth of this well was almost identical to the second Casing Drilled well, thus providing a good baseline for comparison. The ROP was similar for the Casing Drilling and conventional drilling process. **Figure 6** shows the instantaneous penetration rates for the conventional well and Casing Drilled well. The Casing Drilled well averaged 187 ft/hr to a depth of 2400 ft while the conventional well averaged 159 ft/hr. This indicates that the Casing Drilling process is fundamentally able to drill as fast as the conventional method.

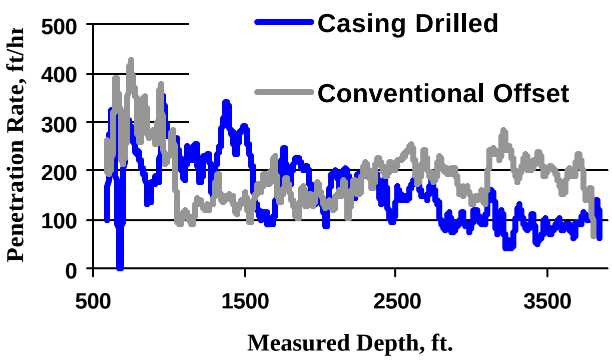

Figure 6: Instantaneous penetration rates.

Below 2400 ft, the ROP in the conventional well was higher than in the Casing Drilled wells. The WOB is normally increased to about 15,000 lb below 2400 ft to maintain the ROP as the formation firms up. But the WOB on the casing drilled wells was limited to 10,000 lb by the weight rating of the underreamer. The carbide underreamer cutters were also damaged while drilling a hard stringer at 3200 ft that caused a further reduction in the ROP. Changing the underreamer cutting structure from carbide elements to PDC cutters should completely eliminate both of these causes of reduced ROP.

Data from these two wells were evaluated to indicate the drilling performance that could be achieved on subsiquent Casing Drilled wells and to identify tasks that could be improved. A time analysis of the two wells indicates a reduction of 16 hours or 21% over the current conventional practice is possible (**Fig. 7**).[5]

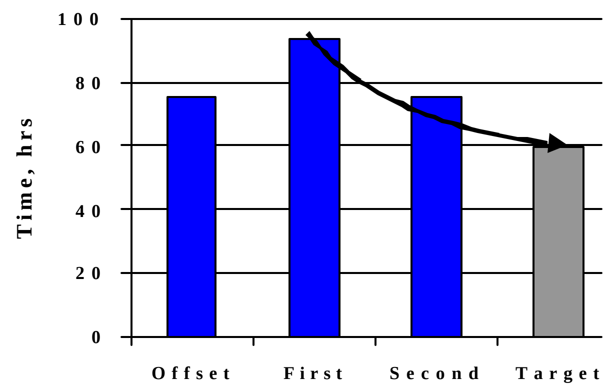

Figure 7: Potential improvement from Casing Drilling.

Canadian Wells. The Casing Drilling system is being used to drill 12-1/4"surface holes with 9-5/8" casing during the 2000-2001 winter drilling season in the Helmet area of northern British Columbia, Canada. These wells are being drilled with a purpose built single mast Casing Drilling rig equipped with a top drive, integrated wireline hoist and hydraulic pipe arm. The surface holes are drilled to two different depths, 825 ft and 1975 ft, depending on the directional target. Once the surface holes are drilled and cased with the Casing Drilling system, an 8-3/4" hole is conventionally drilled to horizontal with a directional motor.

These wells were drilled in an area where frequent surface hole problems exist. Lost circulation and sloughing are common, especially when the casing is set deep. Two of the last seven conventionally drilled deeper surface holes required laying down casing and re-conditioning the hole due to poor hole quality when the casing was initially run.

The fourth of the five planned wells was being drilled at the time this paper was written. The first two and fourth surface holes were rotary drilled to a planned depth of about 825 ft with an 8-1/2" roller cone pilot bit and Tesco underreamer. **Figure 8** shows the times required for this drilling compared to a typical conventionally drilled surface hole.

The third surface hole was drilled deeper, to a planned depth of 1965 ft. The upper 590 ft was drilled while rotating the casing and the deeper section was drilled with a positive displacement motor to improve the drilling rate. The penetration rates with the positive displacement motor were very consistent and significantly improved over that of the deeper conventional offsets.

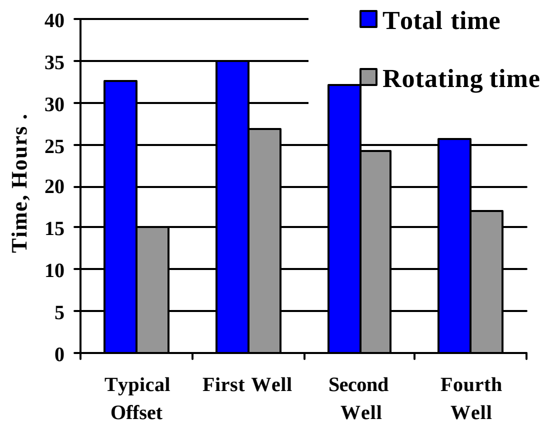

Figure 8: Drilling time comparison.

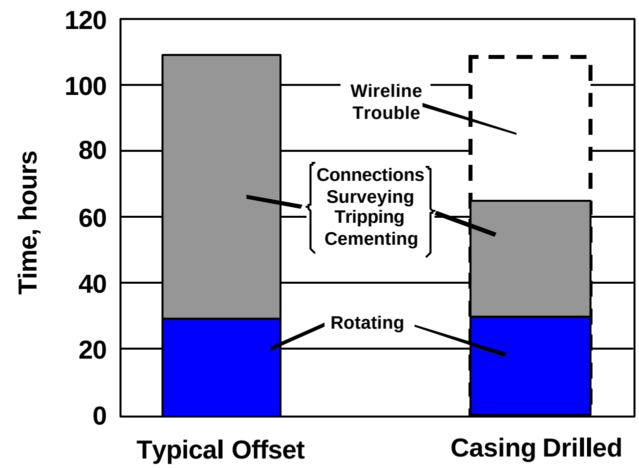

Figure 9: Comparison of conventional and Casing Drilled deep surface hole.

Figure 9 shows a comparison of the Casing Drilled well to a typical offset drilled to a similar depth. In this case both wells ended up taking about the same amount of time from spud to completion of the cement job, but this includes 43.5 hours of trouble time on the Casing Drilled well associated with an equipment problem caused by inexperience with the system. This problem should be easily eliminating and, if eliminated, the Casing Drilled section would have been 44 hours faster than the conventionally drilled section.

In all cases the drilling assemblies were successfully retrieved, deviation was minimal and overall rig operation times were competitive with recent conventional offsets. The performance of the drill-lock, PDC underreamer and non-rotating centralizers were all very encouraging. All the wells were considered equal to or better than the performance of conventional wells. There is potential to achieve additional optimization on future wells, in addition to reducing the risk of unscheduled events (especially difficulty in running the casing).

Observations from Field Trials

The Casing Drilling system has been used to drill over 20 wells ranging in size from 4-1/2" casing to 9-5/8" casing and in depth from 800 ft to 9,576 ft. Observations made while drilling these wells confirm the validity of the concept of Casing Drilling and provide information to refine the commercial focus.

The optimization of the conventional drilling process in many fields has reached an almost irreducible level. The crews drilling in the area have been drilling there for quite a long time. Bits have been optimized to the point where drilling rates are quite high and in many cases only one bit per section is required. Rig moves have been streamlined to the point where there is little time left to be extracted. As the drilling activity of the whole industry picks up, many of these extremely optimized operations may be disrupted by increased crew mobility, high rates of equipment utilization, and competition for contract services.

Such an environment is ideal for the introduction of a new technology such as Casing Drilling. As the technology is introduced, there will inevitably be some loss of efficiency as the new operating practices are learned and refined, glitches in the technology worked out, and new equipment proven. But ultimately the drilling process will be positioned on a path that has a greater potential efficiency than could be achieved by continuing to refine the conventional drilling process.

It has routinely taken three to five wells in a drilling program to achieve the savings potential offered by the Casing Drilling system. This learning curve is typical of drilling with any new technology or even drilling with conventional technology in a new area. Using conservative practices as the new technology is tried for the first time contributes to part of the learning curve. The Casing Drilling crew gaining familiarity with a new drilling area contributes to the learning. Making improvements and refinements to the technology as it is used in new applications also contributes to the learning curve. As the technology is used more frequently, the learning curve for new areas should become flatter, but even so, a realistic goal for the first application of the Casing Drilling technology in a new area is to simply match the conventional process.

Drilling larger diameter surface holes is the clearest and most straightforward application of the Casing Drilling technology to result in improved efficiency. In each of the field trials where 7" through 9-5/8" casing has been used to drill surface holes, a potential reduction in time of 25 – 35% has been apparent. In some cases this timesaving has not been achieved because only one or two wells were drilled, but specific improvements could be identified that would result in the savings on the next few wells. The advantages of the Casing Drilling system are easy to show on surface holes because the larger tools are robust and reliable, the hole is routinely drilled with one bit, and tripping, casing running, and cementing are a significant portion of the overall drilling time.

The greatest challenges in introducing the Casing Drilling system in new surface drilling applications are matching the conventional ROP, displacing conventional drilling practices, and handling logistics. There is a natural tendency to use conservative drilling practices when drilling with casing. For example the conventional practice may be to run 150 rpm with the drill-string, but the casing may be rotated at only 80-90 rpm. This hampers the ROP until confidence is gained that the casing really can be rotated faster without hurting it.

In some cases the concept of drilling to TD with retrievable tools has not proven to be the most effective way to implement Casing Drilling. For the deep Wyoming wells drilled with 4-1/2" casing, ineffective performance of the small underreamer and difficulty in cleaning the PDC drilling shoe and pilot bit has limited the overall effectiveness of the retrievable assembly. Under these conditions the use of a single, full hole PDC bit to reach TD was investigated and found to be effective. Cementing equipment was developed to effectively cement the well as soon as TD was reached.

Second generation Tools

After having drilled the surface holes in the offshore application it was clear that part of the advantages of the Casing Drilling system were offset by retrieving the BHA with drill pipe. This process was slower than using a wireline, but more importantly it risked sticking the casing off bottom and left the directional BHA exposed in the open hole without circulation while the drill pipe was being run. This experience resulted in the DLA being redesigned to provide a second-generation tool.

The new generation tools keep the packer cups for seals, the proven axial and torsional locking system, and the profile nipple, while expanding the versatility of the running and retrieval process. The increased versatility was added by simplifying the DLA that is left in the hole while making the running and retrieving tools slightly more complicated.

A dart (**Fig 10**) release feature was added so that once the casing was drilled to TD, a dart could be pumped down to release the tools so that the casing could be lowered to near bottom and landed normally before retrieving the BHA. In this way the directional tools would be protected inside the casing so that both wireline and drill pipe retrieval would be less risky.

Figure 10: Pump down dart.

One example of how the new system works is shown in **Fig. 11**. Step 1 shows the DLA positioned in the profile nipple at the time it is desired to retrieve the BHA. Step 2 shows the releasing dart (hydraulic releasing tool – HRT) being pumped down, and step three shows the dart landing on top of the DLA where an increase in pump pressure releases the axial locks. In step 4 the casing is lowered with the DLA and BHA being pushed up into the casing until the casing is on bottom and can be landed in the well head. Steps 5 and 6 show the mechanical retrieving tool being run on drill pipe and the BHA being recovered. A similar procedure is available when the BHA is being recovered with a wireline.

A hydraulic setting feature was added to make the tools more functional for use with wireline applications in deviated holes. This provides the ability to pump the tools in place while attached to the wireline, as well as to set and release the tools with pump pressure. This feature has been used successfully with the 4-1/2" and 7" tools and is now implemented in the new tools designed for use with 5-1/2" and 13-3/8" casing.

The capability to use wireline tools on conventional rigs is being improved concurrently with developing the second-generation downhole tools. A wireline tripping kit, including high capacity wireline unit will allow wireline retrieval of the BHA with minimal impact to the conventional rig operations. All the sheaves, wireline pack off, and wireline BOP's are installed in an unitized assembly that can be picked up with the elevators like a joint of casing. It includes the capability to circulating the well through the top drive while conducting wireline operations and will be powerful enough to pull directional

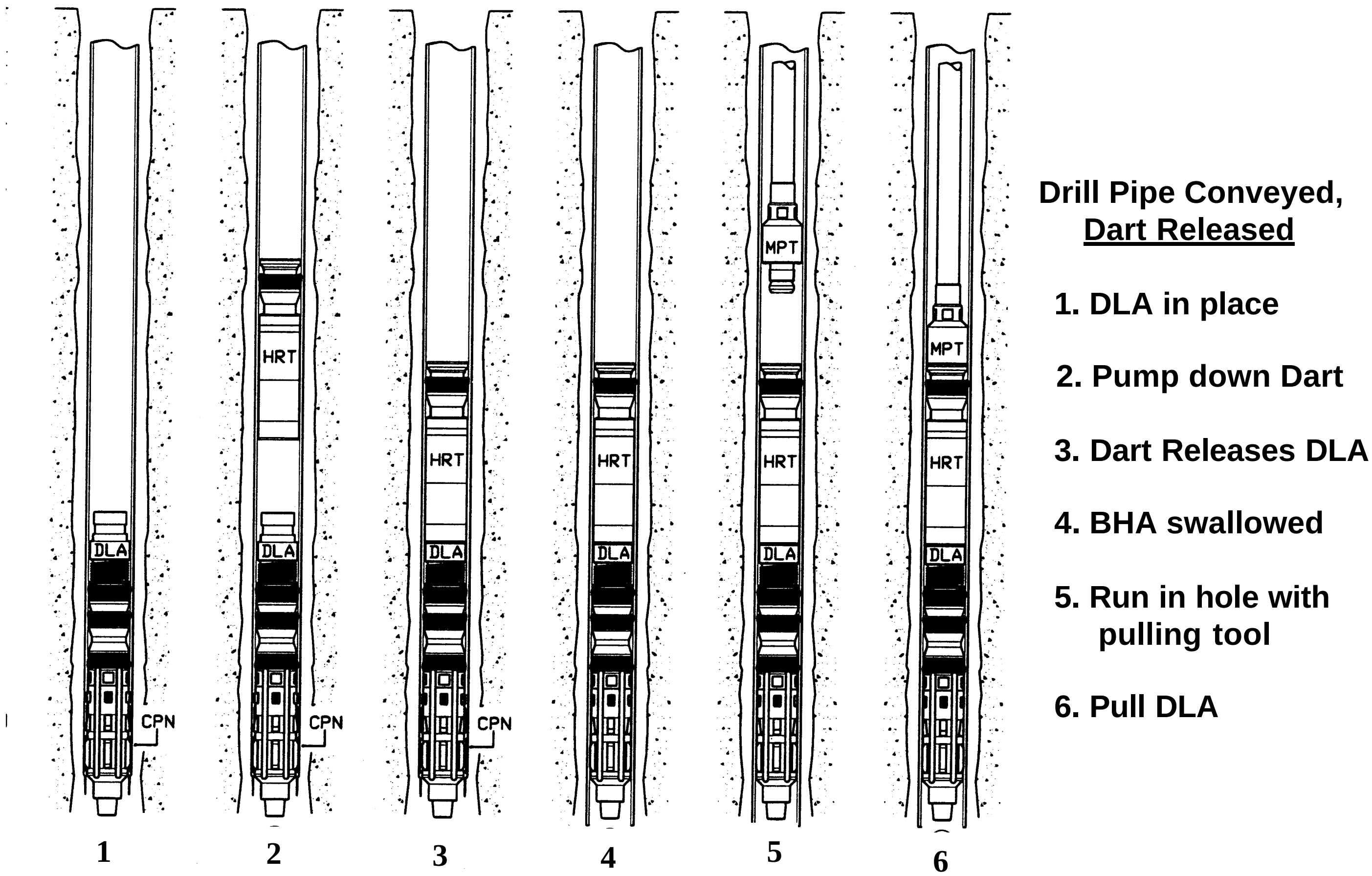

Figure 11: New generation dart released drill lock.

assemblies from 13-3/8" casing.

As utilization of the Casing Drilling system increases, experience and equipment refinements allow the technology to have broader applications and promises to impact a greater variety of wells. The value of the Casing Drilling process partially results from its potential to reduce the time required to install the casing, particularly in large hole sections where the formations are soft. But other benefits may have more value, such as in areas where it is difficult to run the casing after the hole is drilled. Simultaneous drilling and casing the well could eliminate these problems.

In other situations it may be desirable to set the casing deeper to achieve a higher shoe leak-off test, but the risk of drilling deeper and then running the casing limits the casing depths that can be expected. Casing Drilling may allow the casing to be set deeper and in some situations may even eliminate the need for one string of casing. As the need to provide additional surface access for new wells on existing platforms grows, Casing Drilling may facilitate the economic implementation of slot recovery techniques.

Summary

The Casing Drilling system has been used to drill a number of wells in both onshore and offshore situations. These wells demonstrate that the Casing Drilling system is practical and can reduce drilling time.

The system in its current state of development is well suited for drilling softer formations with larger casing sizes. In these situations the penetration rate can easily match conventional rates and the reduced tripping and drill-string handling can be used advantageously. This is particularly true in situations where excessive time is required to condition the hole before running casing or where difficulty is encountered running the casing after the hole is drilled. These time savings are significant for drilling situations with higher spread costs and the increasing reliability of the Casing Drilling system reduces the risk of using it in these high cost situations.

An active program of enhancing the Casing Drilling tools to allow a wider variety of applications to be drilled is ongoing. One of these areas showing promise is where the Casing Drilling system is used to drill the surface hole with the retrievable assembly and the production hole is drilled with casing and a single full hole bit. Other areas of active development are for applications requiring directional work at higher inclinations and enhancements to facilitate handling heavy retrievable BHAs on conventional rigs.

Acknowledgment

We would like to express our appreciation to the operating companies (BP, Chevron, and Anadarko) that have been willing to be first time users of the Casing Drilling technology, for supporting the technology during some of the teething pains, and for allowing us to disseminate information about the work.

References

1. Tessari, R. M., Madell, Garret, Warren, Tommy, “Drilling with Casing Promises Major Benefits”, Oil and Gas Journal, Vol. 97 No. 20, May 17, 1999, pp 58-62.
2. Laurent, M, Angman, P, and Oveson, D., “Hydraulic Rig Supports Casing Drilling”, World Oil, Sept. 1999, pp 61- 66.
3. Warren, Tommy M., Angman, Per, and Houtchens, Bruce, “Casing Drilling Application Design Considerations”, IADC/SPE 59179, presented at the 2000 IADC/SPE Drilling Conference, New Orleans, February 23-25, 2000.
4. Shepard, S. F., Reiley, R. H., and Warren, T. M., “Casing Drilling: An Emerging Technology”, IADC/SPE 67731, presented at the 2001 IADC/SPE Drilling Conference, Amsterdam, February 27-March 1, 2001.
5. Warren, Tommy M., Houtchens, Bruce, and Portas, W. R (Bill), Jr. “Casing Drilling with Directional Steering”, two part article published in the January and February 2001 issues of Offshore Magazine.