ADDING STRING ROTATION TO CASING RUNNING OPERATION, MITIGATING RISK AND ENABLING IMPROVED WELL CONSTRUCTION.

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Abstract
This paper discusses casing installation methods with a new generation top drive casing running system versus conventional and mechanized casing running methods. The enabling technology provides opportunities for change in conventional well construction methods by using the option to rotate casing strings at high speed, instantly circulate and reciprocate when required, and even push down the rotating casing into the well. The paper highlights how this technology, when combined with drilling with casing tools and expertise, can significantly reduce well construction costs, thereby providing earlier production at less risk.

Applications include: drilling with casing from rigs with top drives; casing installation in predrilled wells; risk mitigation for casing installation in extended reach, deviated, and troublesome wells; removing flat spots in the well construction curve through methods such as “hole cleaning with casing,” drilling and reaming with casing, and more.

Results, Observations, and Conclusions:
The top drive casing running system enables improved safety through simpler and less personnel intensive operations, by combining several conventional casing tools into one system: Power tong, main hoisting elevator, single joint elevator, fill-up and circulation tool, weight compensator and, casing stabbing.

Lab and field test results have proven that the new technology provides greater casing running efficiency, increased safety through personnel reduction and remote operation, and drilling with casing capabilities.

Significance of Subject Matter:
Step change in technology allowing oil & gas operators to increase drilling performance, improve safety, and reduce well construction costs.

Introduction

Conventional casing running methods include power tongs for making up threaded joints of casing to build the casing string. The methods also include casing elevators connected to bails suspended from the traveling blocks, gripping around the casing string in order to hoist and lower the casing string into the well. Over the last 15 – 20 years, drilling operations have evolved substantially through the use of top drive technology, pipe racking systems, and rig mechanization in general, while the method for lowering the casing string into the well has remained basically the same. When considering the safety aspect of manual casing running operations, we have seen how rig mechanization has helped move personnel out of harms way. In some cases this evolution has significantly improved rig efficiency, but with a consequence of the

drilling rig becoming more crowded with automated machinery.
Since the mid-1980's, fill-up and circulation tools improved casing running operations through the ability to start circulation at any time during the casing run without requiring the makeup of a circulating swedge on top of the casing string. Connected to the top drive above the casing elevator, these tools enabled a quick transition from casing fill-up mode to casing circulation mode with no manual intervention in the derrick.

Circulating casing string to bottom
Borehole conditioning is of significant importance prior to conventional casing installation. The drilled formations are seldom forgiving, and in many cases the cleaning processes (reaming and wiper trips) cause added damage to the borehole profile. Minimizing the exposure time from when the well section is drilled (and cleaned) until the casing is actually installed in the well is also critical for reasons such as unstable formations (e.g. swelling shale) can hinder getting the casing to bottom. By the time the casing is run into the well, the wellbore can be full of cavings or fill, or the borehole diameter has reduced in some places due to swelling shales. In a vertical or near-vertical well, the drilling of a rathole beyond planned casing setting depth accommodates space for loose rocks and cuttings that settles on bottom, but in long horizontal well profiles, gravity will not bring such sediments to the end of the well profile.
For many years, circulation was the only means for removing formation settlement in front of the casing string when hole cleaning was insufficient or when unstable formations and/or extended exposure time caused problems for the casing string. With the addition of a reamer shoe [Figure 1] installed on the end of the casing, the driller could also reciprocate the casing string up and down to "rasp" the borehole wall with the cutting structure on the reamer shoe's outer gauge. This approach reopened the well to proper hole diameter and enabled the casing to pass through tight spots. Although this method often saved casing strings from having to be pulled back out of hole, the method has limited efficiency when compared to what is possible with drill shoes when the string can be rotated.

Early adoption of drill shoes and drilling with liner
Drilling with liners was quickly adopted by the drilling industry for the following *simplified* reasons: the casing liners were run on drill pipe and could, therefore, be rotated and drilled to TD with conventional drilling equipment on the rig; [1] liners are normally set where there are well problems such as lost circulation zones, high/low pressure zones, etc.; liner setting depth is forgiving as the rotating liner hanger can be set virtually anywhere inside the previous casing.
By drilling with liners through problem zones,[1,2] these zones could be effectively isolated behind casing before the liner was cemented in place. Well construction could then continue with the next size drilling assembly and drill through the previous drill shoe at the bottom of the liner.

Rotating, reaming and drilling with casing
The benefits seen in drilling with liner applications also apply for drilling with casing strings; however, other methods must be used for rotating casing. One such method is the internal casing drive (spear) seen in [Figure 2], which provides the ability for string rotation by suspending the casing string from the top drive and transferring torque from the top drive to the casing string. This spear device depends on a minimum string

weight (a few joints) before it can transfer drilling torque to the string; thus power tongs are necessary for the connection makeup process.
The drilling or reaming with casing system [Figure 3] utilizes a special drill bit, called a DrillShoe [Figure 4], which is attached directly to the first joint of casing (replacing the conventional guide or float shoe).[3,4] With the 'Rotate the Casing' drilling system, the casing is simply rotated during the drilling process the same way as drill pipe is rotated in a conventional drilling operation.
The unique feature of the Rotate the Casing drilling system is that the DrillShoe's aluminum center is fully drillable. This means that once the interval drilling is completed there is no drill bit to trip out. The drilling fluid density can be reduced, since the casing will not be tripped. The Rotate the Casing drilling system uses a conventional casing float collar in the casing string, thus allowing cementing to begin immediately. The small annular space enables effective hole cleaning at a lower flow rate than conventional drill pipe; therefore, extensive circulation is not required prior to cementing. Then, the next bit can be run to drill out the shoe track in exactly the same way as a conventional operation. This system requires no modifications to the rig, but requires a top drive on the drilling unit.

Applying casing drill shoes for casing reaming operations when the casing string can be rotated

Although the casing drill shoes were originally developed for drilling with liner and drilling with casing operations, these drill shoes have proven to be extremely efficient for hole cleaning operations with casing in predrilled wells once the rig is equipped with the added tools to rotate, reciprocate and circulate the casing string inside the well. This situation can be explained by the cutting structures of the drill shoes agitating loose formation and cuttings in front of the casing string, while also having cutting structures on the gauge to better ream through swelling formations, ledges, and other well obstructions. A casing string is very stiff compared to a drill string, so it provides support for the drill shoe from the predrilled formation. The casing string is, therefore, less likely to sidetrack even when the predrilled borehole is filled with cuttings.
An example of successful utilization of the system in predrilled holes is where the system assisted an operator in the Asia Pacific region where conventional drilling and casing running methods were simply unable to set casing strings at desired setting depths. Running 9-5/8" casing through an unstable volcanic section proved to be problematic and required multiple trips to ream and condition the hole. In many cases costly re-drills were required before the well could be successfully cased off. In early 2004, the drillable DrillShoe and internal casing drive tool [Figures 3 and 4] were introduced as a solution to ream with casing through the troublesome zones, mitigating the extensive cost of getting casing across the problematic zone. Since its adoption, the Rotate the Casing system with a drillable drillshoe has achieved 100% success in getting casing to accepted setting depth on the first attempt. A broad estimate of 1 to 40 days savings per casing section in over 22 sections has been achieved.
Conventional drilling methods are still used for pre-drilling the formations, and casing strings are still made up with power tongs, but the internal casing drive and drill shoes solved the problems of getting the strings to bottom. Obviously, the problematic formation justified the additional expense and tools required.

Non-productive time (NPT) reduction for casing running operations

Another example where casing rotation and circulation were of extreme benefit was demonstrated by a North Sea operator who monitored NPT contributors to running

casing or liners. This operator experienced a loss of more than 50 days NPT over a period of two years due to tight hole conditions and/or stuck casing strings, accounting for approximately 50% of their total casing running NPT [Figure 5]. The operator now estimates that the majority of this lost time could have been avoided through preventive rotation and circulation (reaming) of the casing string and friction reduction tools. This example has not taken into account the cost of loss of casing size, re-drills, sidetracks, section milling, whipstocks, etc. that resulted from stuck casing. These additional costs put even more emphasis on the potential benefits of the previously discussed technological advances in drilling with casing and drilling with liners, as well as the emergence of top drive casing makeup (TDCM) technology.

TDCM Technology Improving Safety for Mechanized Casing Running Operations while Enabling Drilling and Reaming with Casing and Liners

The next generation top drive casing running and drilling tools are designed to effectively address also the casing makeup process, eliminating the use of power tongs and other casing running equipment on the rig floor.

The TDCM systems illustrated [Figure 6 and Figure 7] are specially designed to handle premium threads as well as non-premium threads through sensitive thread compensation and high torque capabilities, thereby addressing the concerns some operators have had on the makeup process. A unique torque sub included in the systems measures the true torque applied to the connection without erroneous torque readings from mechanical losses and friction in the top drive and hydraulic swivels. Further components of this system comprise internal fill-up and circulating tools, hydraulic swivel and independent service loop, link tilt and bail arms with automated single joint elevators, integrated safety interlocks, and a control system for safe remote controlled casing running operations.

When compared to conventional casing running operations, the TDCM system replaces such tools as the main casing elevator, power tongs, tong positioning systems, fill-up and circulation tools, stabbing tools, and/or manual stabbing operations. As a result, the rig floor operation becomes less crowded because of a reduction in equipment and personnel normally associated with casing running operations. Further, with the additional drilling and reaming with casing capabilities, a number of well construction processes are eliminated, including the handling of bottom hole assemblies and the associated personnel safety risks.

Well Construction Optimization

As the industry adopts TDCM technology for general casing running operations it becomes an enabler for improved well construction with the ability to simultaneously rotate, reciprocate, and circulate the casing string at any given time. When planning to drill with or rotate the casing string inside a well, torque and drag modeling, cyclic fatigue calculations and method of centralization must be considered.[3,4]

By implementing TDCM technology as the standard for regular casing running operations, the drilling engineer can eliminate substantial flat time from the well construction process. Benefits include reduction in circulation time, elimination of wiper and reamer trips, and the use of the casing string for the hole cleaning process as the casing is run. Additionally, TDCM technology prepares the operator to quickly respond to unforeseen hole problems, and/or to use drilling with casing techniques as part of the well construction plan.

Conclusion

These new systems and technologies enables acceleration of the well construction process, lowering drilling costs, and reducing the risks associated with unplanned events. The advantage of the TDCM technology over conventional casing make-up tools is that it enables the operator to combine drilling technology with casing running, providing means for improved well construction and substantial cost reduction.

Although our industry is historically very conservative, the potential and proven benefits of TDCM technology will drive its rapid adoption.

The combination of the TDCM and casing drilling technologies is quickly being recognized as a means of:

- reducing flat time, by drilling or reaming in conductors and surface strings
- problem resolution, whereby drilling or reaming casing or liners into the well can isolate problematic zones
- running and reaming with casing in pre-drilled holes:
    - where casing cannot get to bottom
    - where re-drills are having to be performed
    - where dedicated reaming runs and wiper trips are having to be performed

In summary, the TDCM system offers substantial savings and benefits to operators, reduces non-productive time, reduces personnel safety risks, and greatly increases the probability that operators will reach planned setting depths with their casing strings.

Figure 1
Reamer Shoe

Figure 2
Internal Casing Drive System

Figure 3
Drilling With Casing System

Figure 4
Drill Shoe

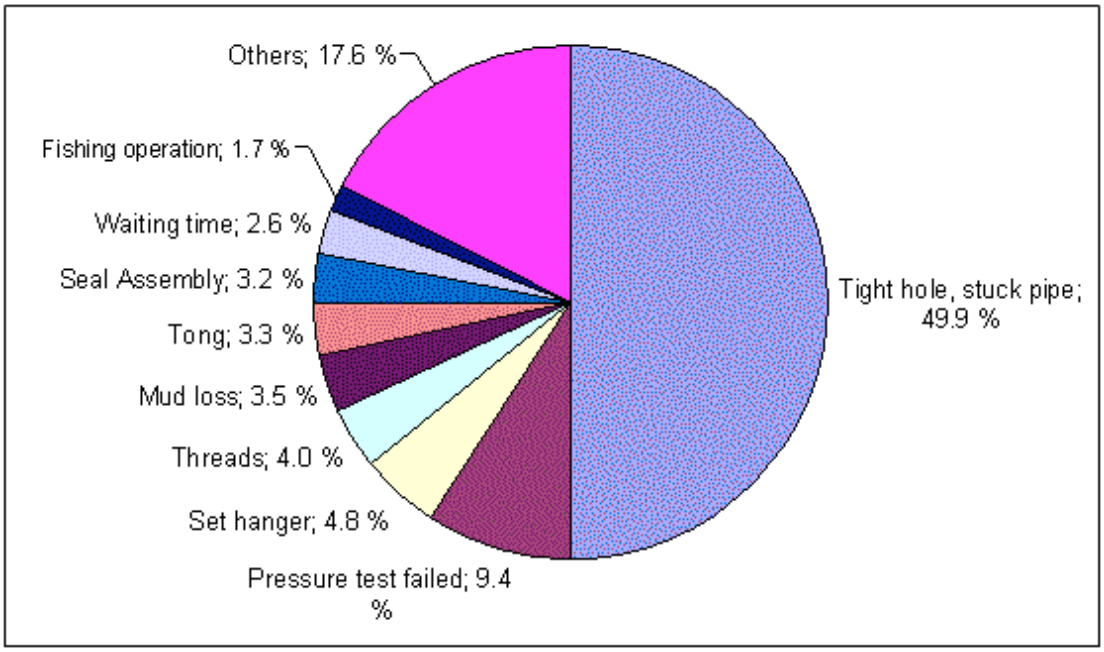

Figure 5
Casing Running NPT

Figure 6
Next Generation Top Drive Casing Makeup System, Externally Gripping

Figure 7
Next Generation Top Drive Casing Makeup System, Internally Gripping

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