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Reaming with Casing and Rotating While Cementing

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Abstract

The industry has long understood the advantages of reciprocating and rotating during cementing operations. The only barrier to implementing this technology as a part of standard drilling practices has been "the will to do it" (Smith, 1982) and tools that make it inherently simple to do so.

> Casing, once landed, which cannot be moved prior to cementing, is a positive indication that something is wrong. Often, not much can be done at this point other than to cement the casing in place; however, the chances of a successful cement job are diminished before even mixing the slurry. (Nelson, 1990)

The use of a single ball launcher and cement plug coupled with a modern casing running tool allows the casing string to be run, washed, reamed, and cemented as part of a seamless operation. This adds the benefit of getting casing to bottom despite difficult formations, and the ability to transition immediately to cementing operations while retaining the ability to reciprocate and rotate.

The conventional tools used to cement casing include long bails attached to the top drive, conventional casing elevators, and a standard cement head. These tools fail to allow rotation during cementation. The rigging up of this equipment is time consuming and leaves the pipe motionless on bottom at the time you would least want the pipe to be static.

Pipe movement during cementation has recently become a simple operation for any operator to include in a drilling program; there is minimal cost and planning required. A cement plug is attached to the bottom of the proprietary Casing Drive System™ (CDS™) and a side entry swivel sub is included between the CDS and the top drive. A ball launcher, also provided, is rigged up inline with the chicksan lines running from the cementing pump truck to the side entry swivel sub. This solution allows the operator to go directly to cementing after the casing has been run. It also enables the rotation and reciprocation of the pipe during cementation which prevents channeling of cement and leads to a notably superior cement job as proven by cement bond logs.

Using a hybrid cementing tool with a modern casing running system allows wells to be engineered more aggressively, thus ensure casing can be run to bottom in difficult formations and guarantee an improved cement job. In turn, this provides greater production and returns for the operator.

Introduction

With drilling costs increasing, operator's attention is now focused on eliminating NPT. Each year some operations that were considered productive and unavoidable in the past are being considered NPT. The modern view of the industry reflects drilling as a continuous process, with much effort spent to reduce the wasted time at operational interfaces such as the one between running casing and cementing.

The purpose of this novel approach is to reduce obvious and hidden NPT, as well as, increase cement job quality in a two phase process: 1) during casing running, washing and reaming can occur, as well as simply circulating and conditioning the wellbore, thus eliminating time wasted circulating and conditioning the wellbore between casing running and cementing; 2) during cementing it allows the casing to be rotated and reciprocated resulting in a superior cement bond with casing and formation face as demonstrated by cement bond logs. This process will reduce the possibility of gas migration, improve zonal isolation for Frac considerations, mitigate the probability of remedial cement work, and prevent freshwater contamination.

Washing and Reaming while Running Casing

Motivation

There are several reasons why wells are not drilled perfectly straight; tortuosity and hole spiraling are common even today. Moreover, after reaching TD and tripping out, wellbore stability and quality issues, such as tight hole, sloughing shales, mud cake thickening, break out, lost circulation, cuttings settlement, and mud gelation, might happen and deteriorate the condition of the wellbore. These hole problems necessitate washing and reaming casing to bottom in many cases.

Until recently, circulation and reciprocation were the only ways to clean the hole while casing running. If casing did not reach TD, it was often pulled out and drill pipe was then used to recondition the wellbore. A second attempt would then be made to run casing. With the introduction of reamer shoes and the CDS, it is possible to wash and ream to bottom while

* CDS is a trademark of TESCO Corporation.

continuously circulating and conditioning the wellbore. This approach enables the casing to pass through tight spots and work through ledges. In some cases when casing is run conventionally, the casing becomes stuck and must be cemented in place before reaching TD. This could prevent a significant amount of already drilled hole that would otherwise be productive from being cased and the associated production is permanently lost. The modern casing running process using the CDS secures potential production by getting casing to bottom.

Long laterals often require casing rotation to get to bottom. In the prolific shale plays in North America, most operators are drilling extended reach wells with lateral sections several thousands of feet long. These long laterals are drilled most commonly with bent housing mud motors and often require precise directional control to stay within the target pay zone. This constant correction of the wellbore trajectory results in micro-doglegs. Long laterals combined with the tortuous wellbore make it difficult, if not impossible, to conventionally run casing in many instances.

Tool Description

The Casing Running and Reaming Tool (CRRT), helps get the casing to TD, despite compromising hole conditions such as bridges, ledges, doglegs, sloughing formations and deviated holes. The CRRT combines hydraulic and mechanical energy to break through downhole obstructions and features a nosecone profile that cleans and circulates (Figure 1).

Fig. 1. Casing Running and Reaming Tool (CRRT)

Design features provide the ability to combine hydraulic and mechanical energy to break through downhole obstructions. The nosecone is durable, yet drillable (Figure 2) and designed to minimize the amount of material that must be drilled out at the beginning of the next hole section. Hole cleaning is achieved with three unique large scallops in the nosecone profile, providing powerful hole cleaning and circulation performance.

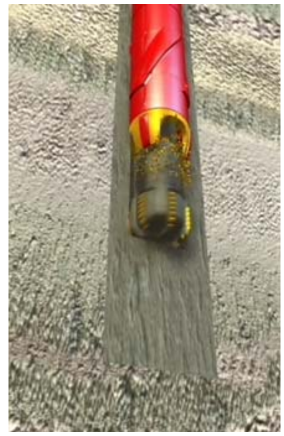

Fig. 2. Drilling out the CRRT

The CRRT is ideally suited for use with top drive and CDS, which allows a casing string to be simultaneously rotated, circulated and reciprocated (Figure 3).

Fig. 3. Top drive and CDS help rotate and circulate the string

The tapered nosecone provides an effective leading profile for navigating past ledges, obstacles and faults that can hang up casing (Figure 4). Three spiral helix external blades help condition the hole and provide centralization for cementing. The CRRT is available with or without an internal float.

Fig. 4. CRRT helps pass through wellbore obstacles.

Implementation

To implement this technology of running and reaming casing, the rig must have a top drive. The top drive can be of any make. Also, there must be enough clear working height in the mast to accommodate the length of the CDS, approximately 10 feet. A power unit is rigged up, and hydraulic lines are run through the service loop to power the CDS. Rig up typically takes less than an hour on most rigs. The rig up time can be as little at 30 minutes after rig crews are familiar with the tool. Figure 5 displays the CDS in further detail.

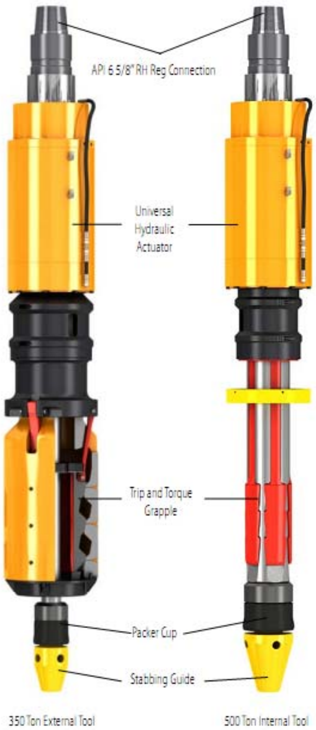

Fig. 5. Casing Drive System

Standard slips can be used, but air or hydraulic power slips can increase operational efficiency. The CDS is made up directly to the top drive, which allows for the rotation, reciprocation, and ability to circulate through the casing.

With the casing now rotating and experiencing torque, special attention must be paid to the casing connections. In extreme cases, torque can near drilling levels. Typically, it is not recommended to rotate long thread and coupling (LT&C) casing, because the fatigue induced by rotation can be greater than the connection can support. Often buttress connections will be sufficient, but if not, a premium connection can be used. Similarly, centralizers must also be able to withstand the rigors of rotation.

The CDS also reduces the amount of personnel required to run casing. Since casing is made up using the top drive, in most cases, no tongs are needed; thus eliminating the need for personnel on an elevated platform to operate power tongs. Typically the tool can be run with just two people. Also, since the tool has link tilts that operate hydraulically, no stabber is needed in the derrick. This greatly enhances safety by keeping people out of harm's way.

Rotating and Reciprocating the Casing while Cementing

Motivation

Poor bonding can cause failure at cement-casing or cement-formation interface that could afterwards lead to serious problems such as gas migration, cross-flow, and fresh water contamination. Rotating and reciprocating the casing while cementing has proven effective in improving the cement bond quality. As the casing is moved, it distributes the cement evenly covering the entire circumference of the wellbore. This is especially important in directional and horizontal wells since the casing rests on the bottom side of the well, and if not moved, may result in casing directly contacting the wellbore with no cement in between.

Mud partially dehydrates during the cement hydration; mud channels left in the annulus are preferential paths for gas migration (Bonett, et al., 1998). The bond between the cement and the formation is what typically determines whether there will be gas or fluid migration. Casing rotation helps the circumferential flow and plasters the cement on the wellbore wall to prevent channeling and the formation of micro-annuli.

It has also been scientifically proven that increasing the shear stress by pipe rotation in the annular gap greatly facilitates effective mud displacement (Moroni, et al., 2009). Reciprocating the casing will help clean the gelled mud and rotation helps the initiation of the spacer flow in the annulus.

Another issue is casing off-center in the annulus; this creates a narrow and wide passage for the cement. More cement tends to flow through the wide side and if the casing is not rotated and reciprocated the cement tops will be different between the narrow side and the wide side (Moroni, et al., 2009).

Operators in the North American shale plays are often completing their wells with multi-stage frac jobs. It is imperative to have a high quality cement job to facilitate zonal isolation. If cement does not completely encompass the casing and make a good bond with the wellbore, communication between zones can occur; this can result in a lower quality Frac job and well completion. A poor completion can result in lost production.

Tool Description

In order to rotate and reciprocate casing during cementing, the same aforementioned CDS is used. Prior to sending the CDS to location, a side entry swivel sub (Figure 6) is made up to the top of the CDS. This provides an entry port for the cement below the top drive, so no cement must pass through the top drive.

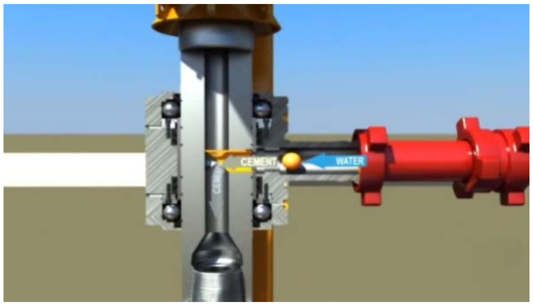

Fig. 6. Side Entry Swivel Sub

After casing reaches TD, the casing is set in slips in the rotary table and the nosecone of the CDS is removed. A cement plug with shear pins and threads matching that of the CDS is made up to the CDS in place of the nosecone. The middle of this cement plug is hollow to allow for the flow of fluid. It has an aluminum seat in the top to provide a place for the ball to land during displacement. A chicksan line is rigged up to the side entry swivel sub. This line is flexible to allow for the reciprocation of the casing as the cement is pumped. A single ball launcher is rigged up inline with the chicksan line (Figure 7) to allow for the injection of a phenolic ball into the fluid stream after cementing, prior to displacement, to release the cement plug from the CDS. Cementing lines are then run from the entry of the ball launcher to the cementing truck as per conventional cementing operations.

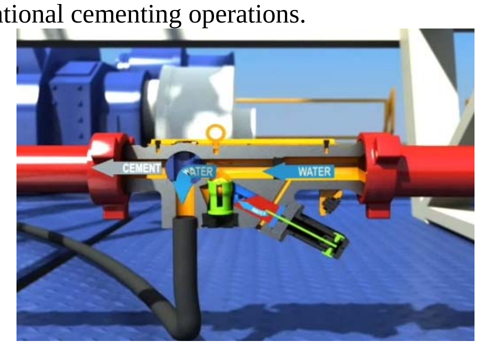

Fig. 7. Ball Launcher System

At this point, cementing operations can begin. If desired, a wiper plug with rupture disk can be launched manually in the casing. Next, the CDS is stabbed into the casing and engaged and the casing may be lifted from the rotary table so rotation and reciprocation is possible. Cement can now be pumped. Once the wiper plug lands in the float collar, pressure increases and the rupture disk will burst allowing for the flow of cement into the shoe track and then into the wellbore. Once all of the cement is pumped, a valve on the ball launcher can be closed to allow for water to be flushed through the cement lines and ball launcher to clear out any cement. This wash is routed through a hose coming from the bottom of the ball launcher and can be disposed of as necessary.

Next, the ball is injected into the fluid path by manually turning a knob which forces the ball out of a pocket where it had been placed prior to rigging up the ball launcher (Figure 8). Then, the displacement fluid can be pumped. The ball travels up the chicksan line, through the side entry swivel sub, and through the CDS where it will land in the throat of the cement plug. Pressure causes the ball to be permanently implanted in the aluminim seat of the cement plug.

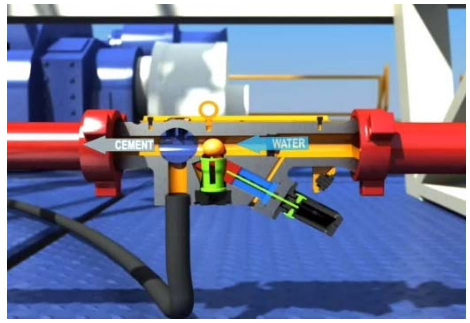

Fig. 8. The ball is placed into the fluid path.

After the pressure reaches a predertimined value, (dependent on the shear pins) typically around 1,500 psi, the shear pins will shear. This allows the cement plug to launch from the CDS and displacement fluid to flow through the casing. Displacement is then continued until the cement plug has landed ontop of the wiper plug (Figure 9) or in the float collar if no wiper plug was used.

Fig. 9. Cement plug is landed on top of the wiper plug.

At this point, the cement job is complete. The casing can be landed as usual, and the tools can be rigged down.

Implementation

There are a few important considerations for this type of operation. First, if centralization is needed, the centralizers must be capable of withstanding the rigors of rotating casing. A typical bow spring centralizer is not recommended as it can easily be torn apart. A much more substantial centralizer should be used, such as a crimped on design.

This cementing process can be performed in any size casing that a CDS can be used. The rig up of the ball launcher is quite simple, resulting in minimal downtime or NPT between casing reaching TD and cementing operations beginning. This time is on the order of 30 minutes or less, which is much faster transition time than when casing is run conventionally.

When using this process, standard cement equipment and slurries can be used. Adding the benefits of rotation and reciprocation does not require any modifications to the cement slurry design. Also, the same cement providers and trucks are utilized. This results in easy adoption of the technology both at the rig and engineering levels.

Cement Quality Evaluation

The industry has long since known that pipe movement results in a superior cement job. Attached are cement bond logs from an operator that has adopted this technology. There are logs of both vertical and horizontal wellbores. Offset wells were chosen such that the only variable was pipe movement as labeled accordingly. The cement bond was notably better on both vertical and horizontal hole sections in which the casing was reciprocated and rotated. Reciprocation improved the cement bond and rotation, combined with reciprocation, enhanced the results even further.

Conclusion

Using the CDS gets casing to TD with a significantly higher rate of success than conventional casing running tools in difficult well bores. When combined with the ball launcher and cement plug, NPT is further reduced by making the transition from casing running to cementing much more efficient. When the cementing tools are employed, casing can be rotated and reciprocated, resulting in a superior cement bond as demonstrated by the cement bond logs. Finally, safety is enhanced by reducing personnel on the rig and eliminating conventional casing running methods which are inherently dangerous.

Nomenclature

BHA: Bottom Hole Assembly
TD: Total Depth
NPT: Non-Productive Time

References

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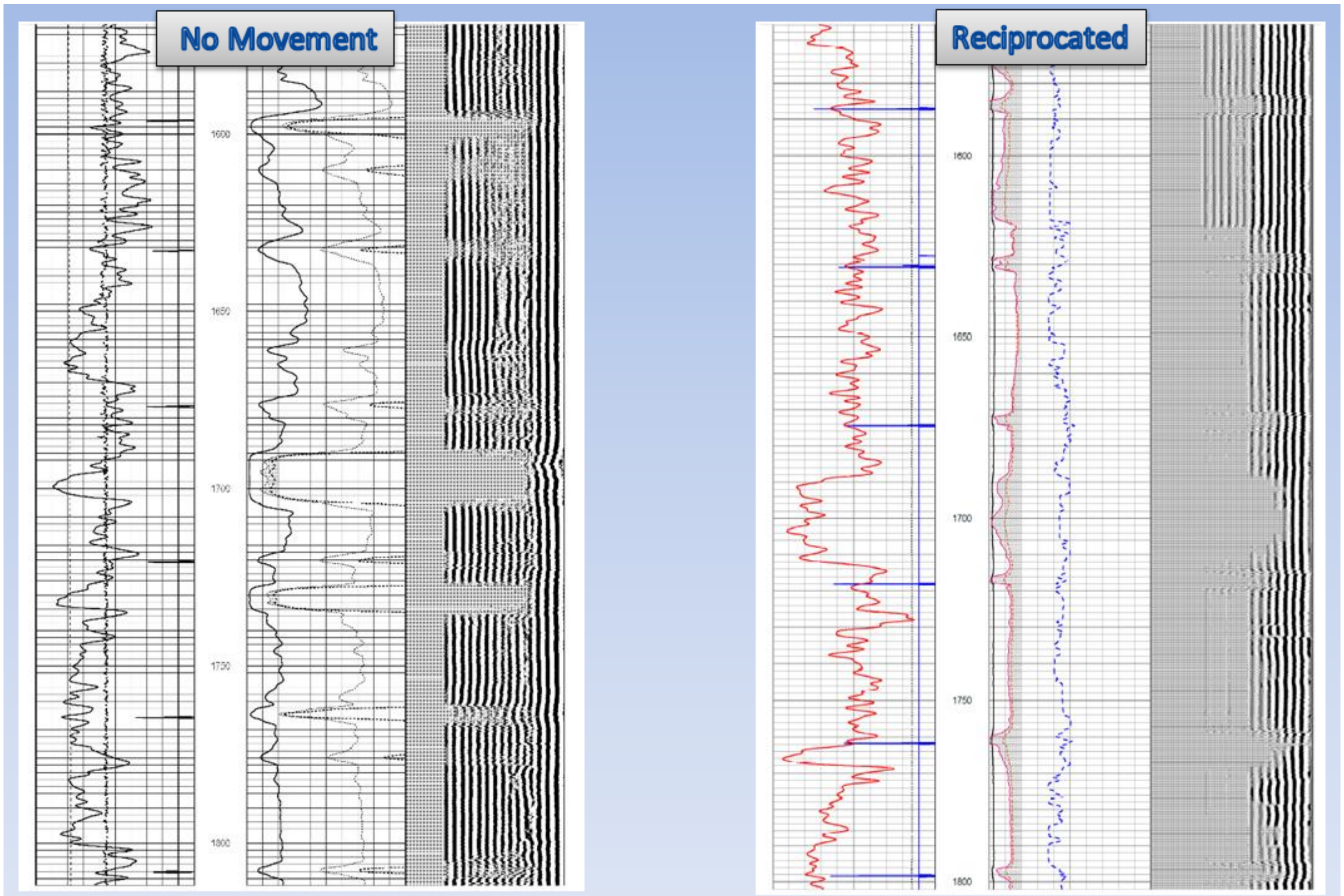
Cement Evaluation – Vertical (9-5/8")



Cement Evaluation – Horizontal (5-1/2")