International Journal of Engineering and Management Research
e-ISSN: 2250-0758 | p-ISSN: 2394-6962
https://ijemr.vandanapublications.com
Peer Reviewed & Refereed Journal
Volume-13, Issue-4 (August 2023)
https://doi.org/10.31033/ijemr.13.4.8

Casing While Drilling - Revolutionizing Drilling Operations for Enhanced Efficiency and Safety

Mohit Kumar
Location Account Manager, SLB, Anchorage, Alaska, USA

Corresponding Author: mohit.jadon@gmail.com

Received: 05-07-2023 Revised: 21-07-2023 Accepted: 04-08-2023

ABSTRACT

Efficiency and safety are at the core of any field operations in the Oil and Gas industry. During drilling a well, the biggest risk is a stuck pipe incident owing to the wellbore issues. If these issues are not treated timely, they can have devastating effects on the whole drilling operations. Also, running drilling and casing in and out of the borehole poses a huge operational risk on the drilling crew. It is the objective of any well design to minimize safety risks. This paper discusses about a new drilling technology commonly known as Casing While Drilling (CwD) along with factors to design the CwD operations to achieve the desired success.

Keywords— Casing While Drilling, Plastering Effect, Wellbore Instability, Performance Enhancement

I. INTRODUCTION

The oil and gas industry has always been at the forefront of technological enhancements to revolutionize processes and workflows while enhancing efficiency and safety. If you have ever worked as a well engineer, you know one of the worst nightmares for any well engineer is wellbore stability and stuck pipe while drilling operation. Although the objective of well design is to reduce all operation-related challenges as much as possible, sometimes it is not possible with the traditional drilling technology to mitigate the risks completely and effectively.

One such innovation is Casing while drilling which seems to provide a great alternative to traditional drilling techniques to completely mitigate the drilling-related challenges specifically the stuck pipe and wellbore stability risks. This cutting-edge technology holds the potential to reshape the way wells are currently being drilled and offers multiple benefits.

II. WHAT IS CASING WHILE DRILLING (CwD)

Traditionally well drilling, on a macro level, comprises two phases: the drilling phase, in which the borehole is drilled with the help of drill bit, drilling bottom hole assembly (BHA), drill pipe and drilling mud, and the casing phase where steel pipes, commonly known as casings, are run into the wellbore and cemented in place to provide the structural well integrity for years to come. In traditional drilling techniques, one of the biggest risk factors is borehole exposure to drilling mud. Since the casing is run post-drilling the wellbore, the drilling mud plays an extremely important role in keeping the borehole intact till the casing is run. The wellbore collapse due to mud incompatibility with the downhole formation becomes very common.

In the CwD technique, as the drill bit penetrates deeper and drill the formation, the casings simultaneously run into the wellbore. This process eliminates the need for a separate casing run completely, thus reducing the borehole exposure time to drilling mud significantly. That in turn reduces the chances of wellbore instability issues. This technique involves advanced drilling tools such as casing drive system (CDS), a real-time monitoring system, and a competent crew to enable drilling contractors and operators to execute both drilling and casing installation simultaneously.

III. BENEFITS OF CASING WHILE DRILLING

Although the main benefit of CwD is to eliminate classic run and isolate the formation while drilling, there are many more benefits of this new technology. Few advantages are listed below:

1. Reduced Drilling Time

It is well known that the more drilling time, the greater the chances of wellbore instability. CwD completely reduces the total amount of time for drilling the wellbore by completely eliminating additional casing run

Peer Reviewed & Refereed Journal
Volume-13, Issue-4 (August 2023)
https://doi.org/10.31033/ijemr.13.4.8

and reducing the Non-Productive Time (NPT) related to drilling problems.

2. Effective Wellbore Cleaning

The annulus area (the cross-sectional area between borehole and pipe) with CwD reduces significantly due to the outside diameter of the casing. This increases the annular velocity of the cuttings at the same flow rate. This increase in annular velocity greatly improves wellbore cleaning and reduces the requirement for a very high flow rate.

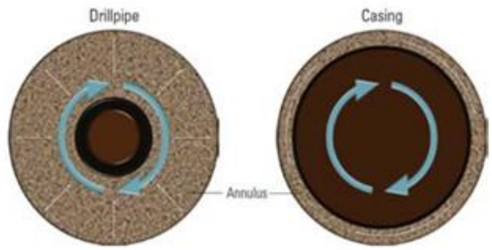

Figure 1: The annulus area comparison between CwD and Traditional Drilling. [7]

3. Plastering Effect

The biggest benefit of CwD is the plastering effect. This effect is caused by the continuous interaction of the wellbore wall with the large diameter casing. Due to the smaller annular space between the casing and the wellbore wall, the cuttings get finely ground and these finely grounded cuttings get plastered on the wellbore wall thereby strengthening the well bore. This action is termed the plastering effect restores the wellbore's hoop stress by wedging the created fractures. This process provides additional benefits of improved well control and stability. This effect seals pore spaces in the formation to reduce fluid losses and improves cementing to protect wellbore integrity in loose formations or drilling in depleted formations. This effect results in lesser cuttings being returned to the surface whereby there is a great reduction in solid handling problems.[5][7]

The plastering effect reduces NPT resulting from borehole-related problems, such as

- Sloughing shales
- Tight holes
- Borehole bridges
- Lost circulation
- Large-diameter surface hole resulting in hard-to-remove cuttings from the annulus
- Damaged producing zones
- Stuck pipe

4. Wellbore Integrity

By installing casing during drilling itself, CwD minimizes the exposure of the wellbore to subsurface pressures, reducing the risk of wellbore instability and fluid influx. This technique enhances wellbore integrity from the very beginning, contributing to a more robust well architecture that is better equipped to handle the challenges of deep and complex formations.

5. Reduced Formation Damage

During conventional drilling methods, drilling fluids and cuttings can damage the formation by invading pores and fractures. CwD mitigates this issue by immediately casing the well as it is being drilled. This prevents the uncontrolled invasion of drilling fluids and cuttings into the formation, preserving reservoir productivity and minimizing formation damage.

6. Operational Efficiency and Reduced Drilling Time

CwD reduces the overall drilling time by eliminating the need for a separate casing run. Traditional drilling methods require pulling the drill string out of the well to run casing, a time-consuming process. CwD streamlines the operations, leading to quicker well construction and a faster path to production. Reduced drilling time translates to substantial cost savings, making projects more economically viable. Time is of the essence in the oil and gas industry, and CwD caters to this need for speed. By integrating drilling and casing installation, the technique significantly reduces the overall drilling time. Traditional methods necessitate halting drilling to retrieve the drill string and commence casing installation—a process that can be time-intensive. CwD's ability to circumvent this downtime results in quicker well construction, earlier access to reservoir resources, and ultimately, enhanced project economics.

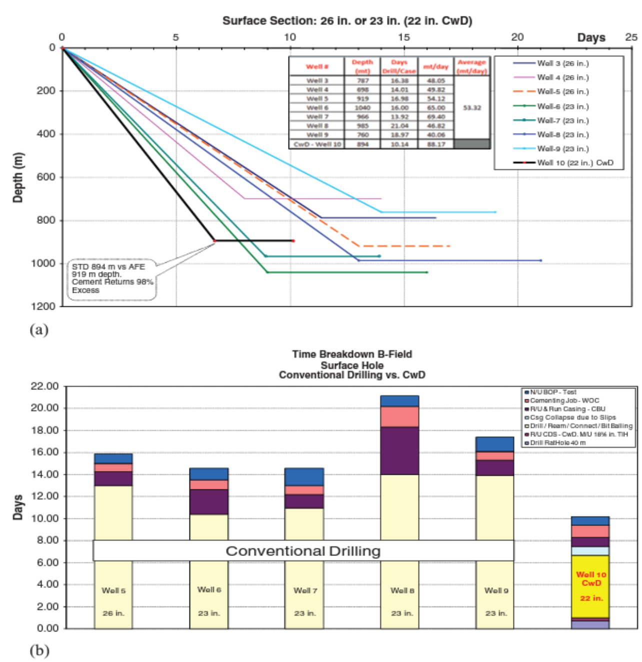

Figure 2: A comparison between conventional drilling and casing while drilling in one field in Oman (SPE 136107-PA, SPE Journal Paper – 2012).

7. HSE (Health, Safety, and Environment Benefits)

CwD reduces the number of tripping operations (pulling the drill string out of the hole and then reinserting it) required in traditional drilling, which inherently reduces exposure to potential safety hazards. Fewer tripping operations mean a decreased likelihood of accidents, leading to a safer work environment for drilling personnel. The oil and gas industry places a premium on health, safety, and environmental (HSE) considerations. CwD inherently enhances safety by reducing the frequency of tripping operations—removing and reinserting the drill string—which can pose safety hazards. Fewer tripping operations translate to a safer work environment and reduced exposure to potential accidents. Furthermore, by minimizing formation damage, CwD contributes to more responsible environmental practices.

IV. TYPES OF CwD

From drilling the first well to drilling the longest lateral with the CwD, the technology has advanced a lot. There are different versions of CwD technology available in the market. However, those are mainly classified into two types.

Non-Retrievable BHA CwD System: This is the most basic type of CwD. This system is made up of a drillable bit, a casing string, and a casing drive system. The BHA is non-retrievable and non-directional. This is used mostly in vertical or tangent sections of the well.

Retrievable BHA CwD System: An advanced version of CwD in which BHA is specially designed to be retrieved without pulling the casing out of hole. The main advantage of this system is that it can be steered directionally and used with both conventional measured while drilling (MWD) and logging while drilling (LWD) tools.

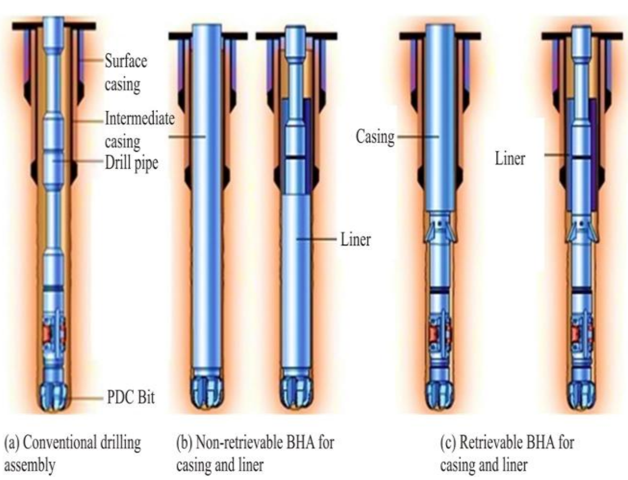

Figure 3: Different types of CwD Systems

Lately, the industry has developed Liner while drilling technology as well which is capable of replacing conventional drilling in liner section. With the latest advancements, the BHA can be configured to accommodate different types of Logging While Drilling and directional tools. This has increased the application envelope for this technology.

V. COMPONENTS OF CwD

1. Casing Drive System

The Casing Drive System (CDS), also known as Casing Running Tool (CRT), is a piece of equipment used in the oil and gas industry to run the Casing into the well and is powered by the hydraulic system. This tool is connected to rig top drive. This holds the full weight of casing string and applies torque for drilling and making & breaking connections. The Casing string is connected to the drilling rig’s top drive system through CDS. There are two types of CDS depending on the casing-catching mechanism - external catching and internal catching.

2. Drilling Rig

The Drilling rig is an extremely important part of CwD as it provides the hydraulic power to drill. Also to use CDS, the rig needs to have a top drive system. The Kelly drive rigs cannot use CDS and therefore can not be used for CwD.

3. Casing String

The casings used in CwD are similar to the casings which are used in conventional drilling. The only difference is the amount of loads casing encountered during CwD in comparison to conventional drilling. Depending on the load analysis, a suitable casing string can be chosen to withstand these drilling loads such as buckling, fatigue and wear etc.

4. Drill Lock Assembly

Drill Lock Assembly (DLA) is an essential part of the retrievable CwD system. With the use of DLA, the drilling BHA components such as MWD/LWD & DD tools can be pulled out of the hole while keeping the casing at the bottom for the next operations such as cementing. [6]

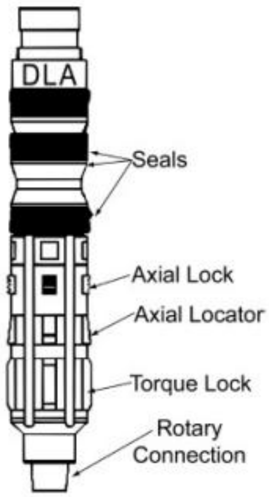

Figure 4: Drill Lock Assembly (Warren et al. 2001)

5. Other Accessories

There are certain other accessories that are also essential part of the CwD operations such as

- Casing Centralizers
- Pilot Bit
- Underreamers
- Float Collars
- Stabilizers
- Pump down displacement plugs
- Multi-lobe torque rings
- Wear resistant couplings.

In case of a retrievable CwD system, the other downhole tools such as Positive Displacement Motor (PDM), Rotary Steerable System (RSS), Measurement While Drilling (MWD), and Logging While Drilling (LWD) tools can be part of the BHA to achieve the desired well objectives.

VI. FACTORS TO CONSIDER WHEN SELECTING FOR CwD

Although CwD is having multiple benefits, it does not mean that it is a suitable technology for all scenarios. There are a few factors that need to be considered while planning for a successful CwD operation.

Torque and Drag Analysis: Torque and drag analysis is a critical aspect of the drilling process in the oil and gas industry. It involves evaluating the forces that act on the drillstring as it is being rotated and advanced into the wellbore. These forces include torque, which is the rotational force applied to the drillstring, and drag, which is the axial resistance encountered as the drillstring moves through the wellbore. In case of CwD, this torque and drag analysis becomes more important due to the weight of string. The casing is larger in both size and weight in comparison to the drill pipe. This means the greater air weight of the string. Due to the larger surface area of the casing string, the friction loads also become large which increases the drag during the drilling operation. The tortuosity of the hole and stiffness of the casing can further aggravate the toque and drag loads during this process. [10]

Currently, in the market, several software are available that can simulate the torque and drag load cases with both soft string and stiff string model using finite element analysis. It is extremely important to perform this analysis while planning any CwD job to make sure rig specifications meets the minimum torque and drag loads with some safety factors.

Hydraulics: Hydraulics plays an important role for hole for proper hole cleaning during the CwD operations. Since the clearance between Casing OD and Wellbore is small in case of CwD, the annular pressure loss are higher. It can create a high ECD. That needs to be examined during the CwD job design. Also, the careful hydraulics calculations can help to identify the gaps in the drilling rig’s mud circulating system. Based on the Torque and drag analysis and hydraulics calculations, the rig can be selected.

Rig Capability: Since the casing is larger in diameter and heavier than a conventional drill pipe, the torque required to rotate the casing string is often higher. The rig must be capable to handle that kind of torque and drag. Rig needs to be equipped with a Top Drive system, the Kelly drive system can not run CwD system. Also, the mud circulating system should be efficient to handle the pumping rates.

Bit Design: One of the biggest benefits of CwD comes by saving tripping time. The drilling bit for CwD system needs to be engineered such that it can last till section depth. Otherwise, the POOH of BHA to change the bit will erode all benefits of CwD and increase the risk of failure in operation.

Casing Fatigue: Fatigue failures are caused by cyclical loading at stress level well below the elastic strength[1]. Fatigue failure occurs even when the stress levels applied to the material are well below its ultimate strength. This is because materials can tolerate significantly higher static loads compared to cyclic loads. The repeated stress cycles can lead to the initiation and propagation of small cracks within the material, which gradually grow until the material can no longer support the applied load, resulting in failure.

Casing Connection Types: Since during the drilling with CwD, the casing needs to be rotated continuously, the casing connections should be strong enough to withstand the loads for drilling period. There are premium connections available in market which are specially designed for CwD.

Premature Casing Wear: This applies when using the casing as your drill string. Therefore, hard-band centralized need to be used to mitigate the risk.

Crew Competency: The rig crew needs to be trained in performing CwD operations. Without a competent crew, the benefits of CwD cannot be achieved.

Well Control: As the annular space is reduced, a kick will travel faster in the annulus. Therefore, preventative well control measures should be in place, and frequent kick-drills should be performed to mitigate the impact of a kick in case it occurs.

Mud Losses: Due to the higher Equivalent Circulating Density (ECD) in the annulus, accidentally fracking the formation becomes more likely to happen.

Cost: Although the CwD shows a reduction in drilling time and an increase in drilling efficiency. But the capital investment required for CwD rig is higher in comparison to conventional drilling rig. Also, the cost of CwD equipment, the premium casing connections, and the training of crew need to be considered for the planning purpose to realize the actual benefits of CwD.

VII. THE FUTURE OF CASING WHILE DRILLING

Casing While Drilling stands as a testament to the oil and gas industry's commitment to innovation and progress. As technology continues to evolve, CwD is likely to undergo further refinements, offering even more nuanced benefits to drilling operations. The integration of automation, advanced sensors, and data analytics could further optimize CwD processes, resulting in improved decision-making, reduced operational risks, and enhanced drilling efficiency.

In a world where the demand for energy remains insatiable, the efficiency and safety gains brought about by Casing While Drilling are invaluable. This technique not only accelerates the pace at which hydrocarbons are accessed but also introduces an elevated level of environmental stewardship by minimizing formation damage and reducing the industry's ecological footprint. The balance between efficiency, safety, and environmental responsibility that CwD strikes is indicative of the oil and gas sector's determination to meet global energy demands while embracing sustainable practices.

In conclusion, Casing While Drilling (CwD) is poised to reshape the landscape of oil and gas drilling. Through its integration of drilling and casing installation, CwD offers a range of benefits including operational efficiency, wellbore integrity, formation protection, safety enhancements, optimized zonal isolation, and improved well control. As technology continues to advance, the oil and gas industry can anticipate even more refined iterations of CwD that elevate drilling practices to new heights of efficiency, safety, and environmental consciousness.

REFERENCES

[1] Naveen, Velmurugan & Vinay Babu. (2014). Experimental study of plastering effect during casing while drilling. *Abu Dhabi International Petroleum Exhibition and Conference, Abu Dhabi, UAE*. DOI: 10.2118/171997-MS.

[2] Mitchell, R.F., Miska, S.Z. & Aadnoy, B.S. (2012). *Fundamentals of drilling engineering*. Richardson, TX: Society of Petroleum Engineers.

[3] Sánchez, F. J., Said, H., Turki, M. & Cruz, M. (2012, June 1). Casing while Drilling (CwD): A new approach to drilling fiqa formation in the Sultanate of Oman–A success story. *Society of Petroleum Engineers*. DOI: 10.2118/136107-PA.

[4] Australian Drilling Industry Training Co (ed.) (2013) *The drilling manual: The manual of methods, applications, and management*. (2nd ed.). Boca Raton, FL: CRC Press.

[5] Dipal Patel, Vivek Thakar, Sivakumar Pandian, Manan Shah & Anirbid Sircar. (2019). A review on casing while drilling technology for oil and gas production with well control model and economical analysis. Petroleum, 5(1), 1-12. DOI: 10.1016/j.petlm.2018.12.003.

[6] B. Pavkovic, & R. Bizjak, B. (2016). *Petrovic review of casing while drilling technology*. DOI: 10.5937/podrad1629011P.

[7] AADE-11-NTCE-64. *How casing drilling improves wellbore stability eric moellendick*. Moji Karimi, TESCO Corporation.

[8] Warren, T. M., Angman, P. & Houtchens, B. (2000). Casing drilling: Application design considerations. In: *Proceedings at the SPE/IADC Drilling Conference, New Orleans, Louisiana*. SPE.

[9] Warren, T. M., Houtchens, B. & Madell, G. (2001). Casing drilling technology moves to more challenging applications. In: *AADE 2001 National Drilling Conference, held in Omni in Houston, Texas*. AADE.

[10] Warren, T. M. & Lesso, B. (2005) Casing directional drilling. In: *AADE 2005 National Technical Conference and Exhibition, held at the Wyndam Greenspoint in Houston, Texas*. AADE.