DIRECTIONAL CASING WHILE DRILLING ASSESSMENT

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ABSTRACT

Casing while drilling (CwD) is a drilling method that has been shown to lessen several drilling problems faced during drilling. This technique reduces NPT and increases drilling efficiency by performing drilling and casing wells simultaneously. The "plastering" effect has been proven to be helpful in reducing lost circulation, enhancing well stability, producing high-quality cement work, and enhancing rig floor safety. It reduces environmental carbon dioxide emissions by using smaller rigs and less fuel.

Keywords: *Dricetional Casing while drilling ,DCwD , Simulation, drilling, casing.*

1. BACKGROUND

In order to enhance drilling performance while reducing the dangers often connected with the top-hole section, the operator decided to utilize DCWD technology. Unretrievable bottom hole assembly (BHA) was the DCWD technology to be used; it was compatible with the simulator version used, and the objectives were:

- Casing drill in a single run from the 26in. conductor shoe to section TD.
- Reduce flat intervals for conditioning and cleaning directional top-hole sections that are soft, unconsolidated.
- Increase drilling efficiency in top hole formations by using 13 3/8in. casing rather as 5 in. drill pipe for improved hole cleaning
- Casing drive system (CDS) will increase the running and handling of casings in a safe and effective manner.
- Demonstrate the commercial and technical viability of batch casing drilling
- Casing drilling to be the default scenario for drilling top-hole section.
- Show that the 13 3/8in. casing drilling assembly has directional capabilities.

DCWD provided a mud loss benefit. able to continue drilling while switching the mud system to seawater without spending time mitigating the losses incurred. Another advantage is that the BHA can be retrieve while the casing remains in place.

There were two options for retrieving BHA: wire line or drill pipe. In order to run the drill pipe through the casing when using the drill pipe method, which was employed in these wells, a fake rotary is needed at the surface. When picked up, the grapple-type latching tool hooks into the drill lock assembly (DLA) and releases the dog locks, allowing a bypass port to open via the DLA's seal cups and preventing recovery swabbing. The BHA is brought to the surface by being dragged through the casing at nominal tripping rates.

1.1. Drilling Simulation System

System for Simulating Drilling This device offers fully portable well control simulation and complies with IADC and IWCF requirements.
The system uses many models, such as pressure, torque, drilling rate, etc., to simulate various operating situations, parameters, and interactions between them in petroleum engineering operations.

Figure 1- Drilling Simulation System

System Components

- Driller panel
- Top drive panel
- BOP panel
- Choke panel

2. Simulation Directional Casing While Drilling S-DCWD

Well S-DCWD

Used Drilling Simulator of AUC & Inter designed date required to run DCWD and run 13 3/8 in casing.
the 23-in conductor was set at 100 feet. A drill assembly with a 17.5 in. drill bit was driven into the hole and drilled 800 m.

The plan for the borehole provided for inclination to build to 45°. The dogleg severity (DLS) was 2.5°/100ft. and replaced the simulator drill pipe with a 13 3/8 inch CSG. Directional casing drilling BHA completed and drilled with Spud mud
Mud properties: from the offset wells mud properties will be as follow :
MW: 8.8-9.2 PPG, YP: > 25, MBT: 25, Visc. 60-80, PH 9.5-10.

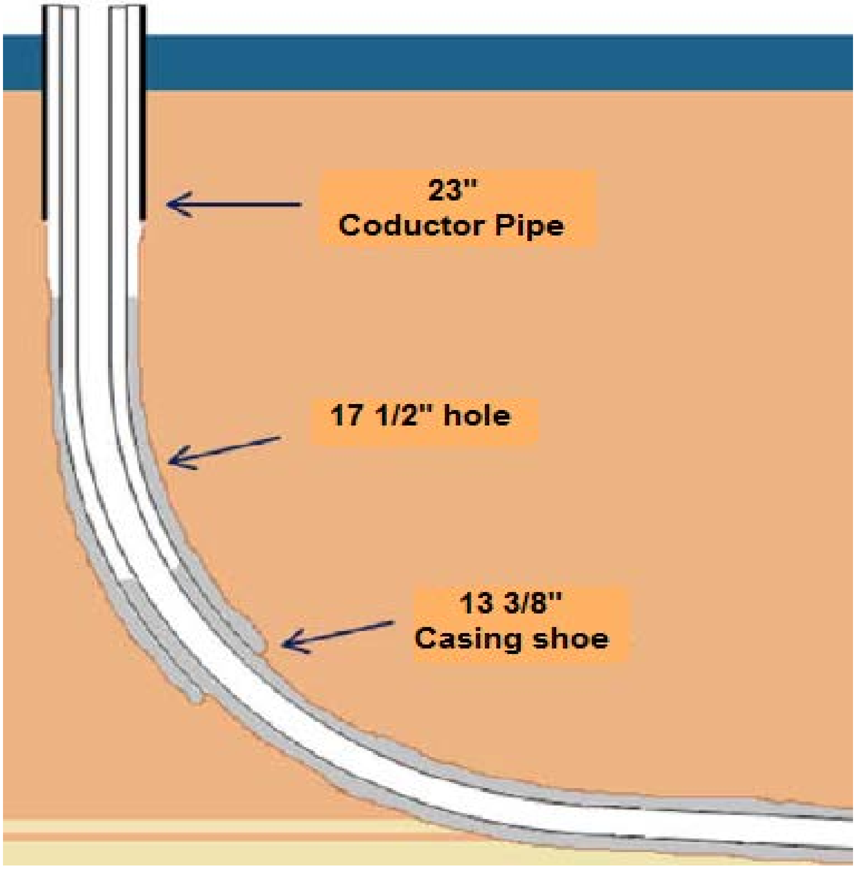

Figure 2- Well Bore Sketch

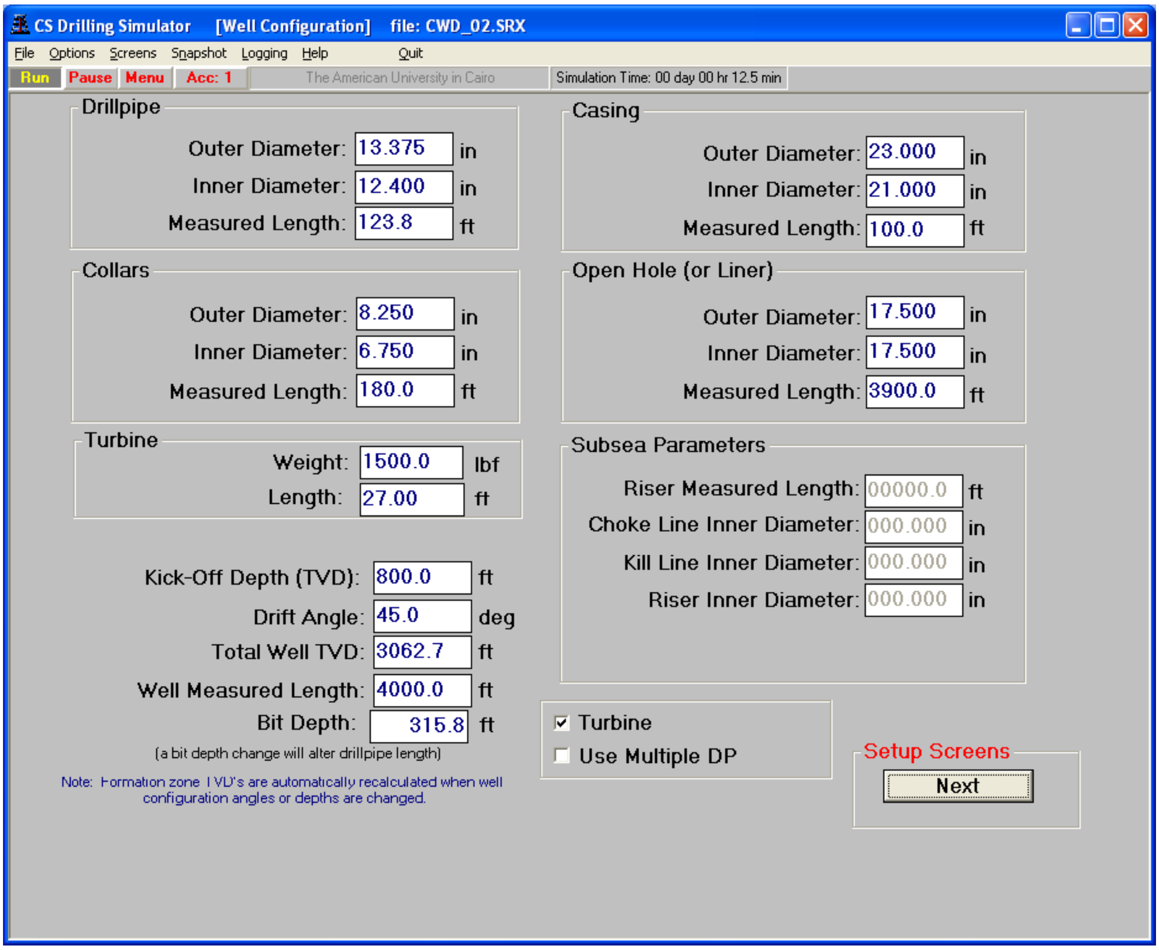

Figure 3- Drilling Simulator Data Input

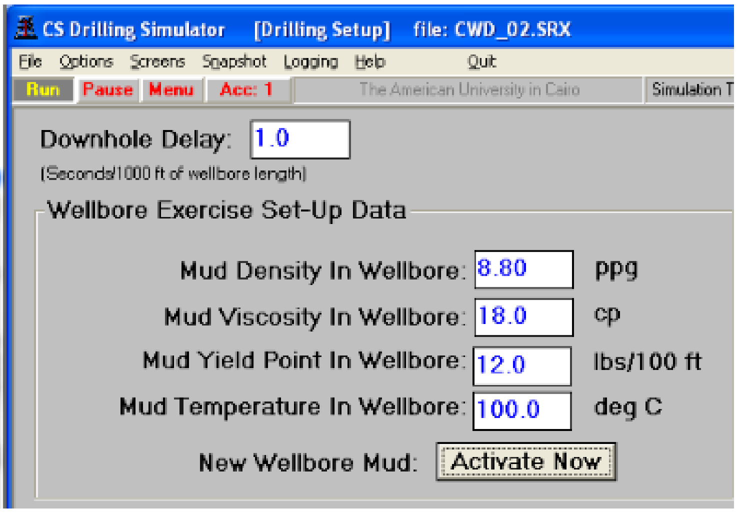

Figure 4- Drilling Simulator Data Input

Simulator casing drilling at 623 feet using 600-700 gpm drilling fluid at 50 rpm. Increase The flow rate to 700-1,050 gpm and continue drilling to depth 2043 feet, sliding as required. A 45° inclination was reached at 1666 feet, from which the tangent section being drilled. High drag was noted at 2043 feet.

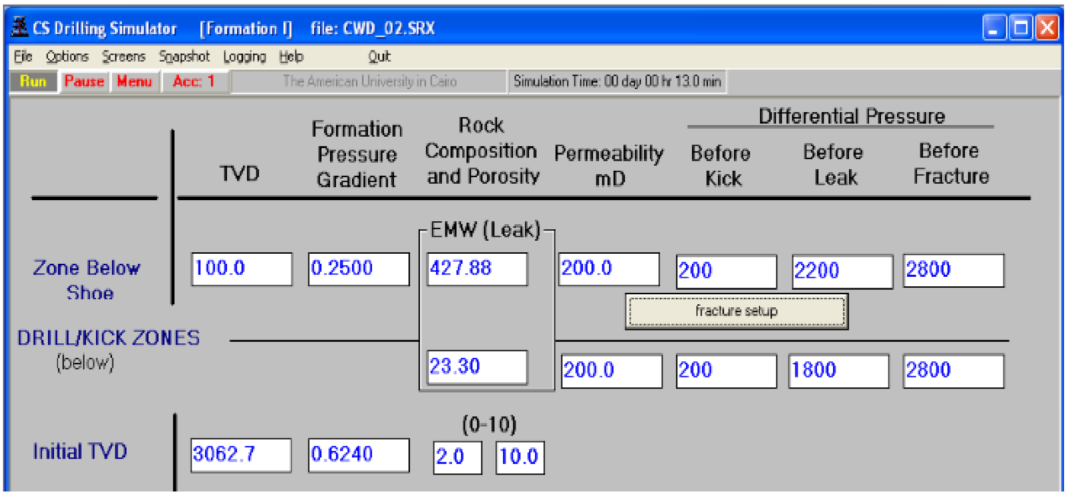

Figure 5- Drilling Simulator Data Input

Figure 6- Drilling Simulator Data Input

2.1. Directional performance:

The required 2.5°/100ft DLS was obtained at the beginning of the section in 100% Sliding mode. A build-up curve developed, and the sliding ratio decreasing of siding and a slight build-up was observed . The sliding continued while keeping the tool faces stable. After achieving the desired inclination, the assembly's rotation mode began to trend slightly downward. This well has a slide to rotate ratio of almost 50/50 to create a trajectory with the motor assembly.

2.2. The Drag:

The drag chart shows, the drag started to deviate from trend at 1708 ft, notes value reach to 20 kLB caused by cuttings build-up in the annulus with. At 2069 feet it was done circulate the hole till had clean return. Drilling continued until he reached 2463 feet. The drags values were higher than predicted, but appeared to trend toward predicted values.Total loss he occurred at 2463 feet and the well was completed with sea water.

2.3. The Torque:

At depth 1679 feet The Torque increased, the same depth where the drag increased more than the planed. A high overturning torque was observed after connection, suggesting some form of sticking differential pressure, possibly caused by a higher equivalent circulating density (ECD). Once start casing drilling by seawater, torque developed as planned and there was no significant overturning torque to restore rotation after connection**.**

2.4. Well bore stability

During DCwD operation, the rotation of the casing string and small annulus causes the drill bit to smear the borehole wall, thereby strengthening the borehole, as shown in Fig. 6. This process, called the plastering effect, restores wellbore stresses by wedging the created cracks and fracture pressure. This effect seals the pore spaces of the formation, reduces fluid loss, improves cementation, and protects wellbore integrity in drilling in loose or depleted formations. Centrifugal force is primarily responsible for the plastering effect. The main reason that helps overcome the loss circulation plastering effect.

(a) Plastering effect of casing string

(b) Repairing of imperfect mud cake by plastering effect

Figure 7- plastering effect

3. Performance

The performance of the approach was evaluated in three parameters including average ROP, bottom instantaneous ROP and overall time increase compared to conventional drilling, considering the expected advantages of D-CwD benefits in the simulator.

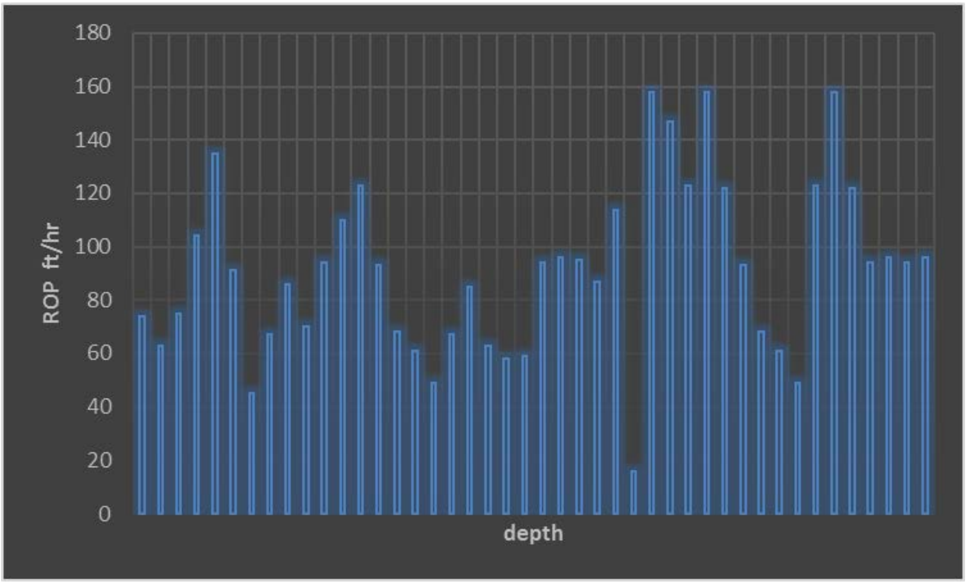

Figure 8—On-bottom instantaneous ROP per joint on S-DCWD

3.1. ROP performance:

This well drilled with 8.8 ppg spud mud. ROP was originally 75 ft/hr and increase to 158 ft/hr. Average slide ROP was 91 ft/hr.

3.2. The average Rate Of Penetration (ROP)

was compared to offset wells, where 13 3/8″ casing had been shallower and vertically. The average ROP on Eastren desert is the same as a fast case of conventional drilling ROP (ED-24 drilled in 2022).

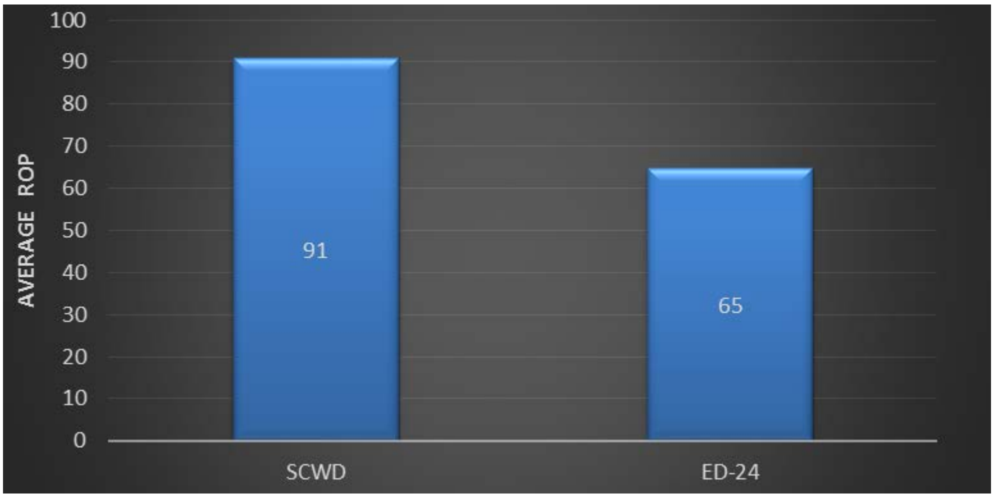

Figure 9—Comparison between different drilling techniques. Average Rate Of Penetration (ROP) in ft per hour, including connections

Looking at the detailed timing analysis of the entire sequence, the time gain in S-DCWD is 25% compared to conventional drilling. Benefits can reach 100% when the additional time required for conventional drilling to treat the problems (mainly losses) observed in some offset wells.

This comparison is based on actual timing achieved with ED-24, which takes over 6 days to avoid large losses.

As shown in Table 3, the time from to drilling and cased the hole (ready for cement work) was 65 hours for S-DCWD and took 168 hours based on 2022 experience. 60% reduction compared to conventional conventional case with losses.

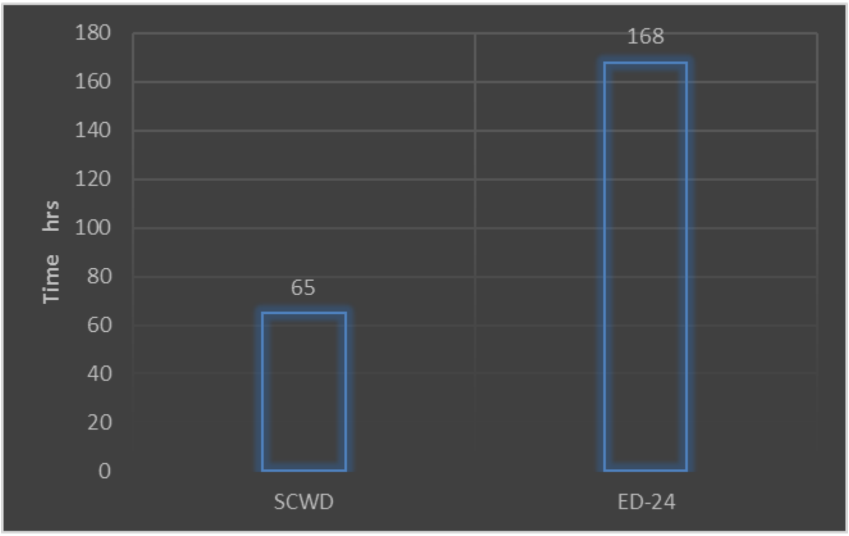

Figure 10—Normalized durations of Conventional Drilling versus D-CwD

3.3. Cost analysis

The objective of drilling wells in is drilling wells with minimum cost given quality and safety issues. To achieve this goal, the petroleum industry continually introduces new drilling methods. In practice, the decision to accept new drilling technology is based on economics. The benefits that new technology offers in terms of economy and efficiency that are better than existing technology with improved quality .and safety standards

Therefore, it is important to spend all the time of the rig drilling, lost time for secondary tasks such as handling pipes, retrieving stuck pipes, trip-in or out for for logging. Don't waste it. As mentioned above, drilling of the casing is done with a drill string consisting only of the casing, so no drill string is required. Thus, drillstring capital costs and drill string, transportation and maintenance costs are reduced. Less pipe handling on the rig location reduce NPT on the rig. Also, since a standard joint of casing is 40 feet long, a driller will make within range 25% less connections time compared of a standard drill pipe joint. 30 feet long. With casing drilling, the casing is already in place after drilling to the TD, saving time tripping the drill string and plugging it into the permanent casing. So, considering the above scenario, casing drilling will reduce his NPT by 45%.

Table 1
Drilling cost comparison between conventional drilling and CwD for vertical well.

Cost	Parameter	Conventional drilling cost[a]	CwD cost[a]
Intangible	Rig mobilization	$180,000	$95,000
	Rig dayrate	$462,500	$400,000–450,000
	Fuel	$112,500	$70,000-80000
	Solid control equipment	$34,375	$20,000–25,000
	Drilling mud	$210,000	$190,000-$200,000
	Cementation	$204,000	$170,000–175,000
Tangible	Bit cost	$40,000	$45,000–50,000
	Drill Pipe cost	$116,000	$0
	Conductor casing	$3200	$3600–4000
	Surface casing	$59,850	$69,825–74,100
	Intermediate casing	$212,000	$240,000–256,000
	Production Casing	$236,000	$262,800–275,940
	Total Cost	**$1,870,425**	**$1,566,225–1,685,040**

a Per day cost of drilling and total drilling cost is obtain from drilling time of conventional drilling and CwD system.

Table 2
Capital equipment cost required to convert conventional drilling rig into CwD rig.

Additional Equipment	Cost
Hydraulic Catwalk	$450,000
Top drive + cement swivel + casing drive	$4,000,000–5,000,000
Casing drilling wireline winch[1]	$500,000
Wireline BOPs[1]	$50,000
Total	**$5,000,000–6,000,000**

4. Challenges in CwD

The main challenges associated with CwD are:

1- **High torque and drag:**
Because the casing is heavier and larger in diameter than the drill pipe, the torque which applied to rotate the casing string is often higher.

2- **Hydraulic:**
As the clearance of annular in CwD is small compared to drill pipe clearance, requiring a hydraulic redesign. At deeper intervals he CwD hydraulics are difficult to design, even with low flow rates and optimal mud rheology.

3- **Casing Tripping:**
less trip time is a productive feature. CwD bits should be designed to complete drilling to the maximum casing depth in one pass. Otherwise, you will have to pull out the entire casing string to change the bit. Proper bit selection is therefore a prerequisite for short trip times.

4- **Gas influx:**
Due to small annular clearance in CwD, the influx of gas will expand and more Gas flow

(well control) due to the small clearance between casing and hole of CwD, the influx of gas will expand more in the height of the hydrostatic column. Therefore, it causes a sharp decline in bottom hole pressure and this situation leads to more influx

5- **Managing stick out:**
It become necessary managing stick out in BHA which retrievable, the benefit of CwD does not become apparent till the reaches the formation required. So if the directional/logging BHA extends 90 feet the casing shoe and the ROP is 30 ft/hr, it will have 3 hours of drilling before seeing any benefit from the plastering effect (reduced losses).

6- Fatigue failure:
In casing strings fatigue failure is most likely to occur in casing strings with high doglegs that cause high reverse stresses at the casing joints. To avoid this failure, a pre-job analysis should calculate a safe total number of revolutions.

7- **Cost:**
Although CwD has shown the cost of daily drilling savings in nearly every sector, major expenditures on CwD rigs remain high. Therefore, there is a need for cost-effective manufacturing of key CwD rig equipment such as CDS and hydraulic catwalk. To obtain good results with CwD, the above challenges must be addressed.

5. Benefits of Casing while Drilling

- **Save time and Cost**
  DCWD saves operational time by reducing NPT and reducing operational risk
- **Get Casing to Total Depth**
  Conventional wells typically cannot run casing to TD due to wellbore issues
- **Reduce Formation Exposure Time**
  the exposure time may be cause mud degradation, salt creep, and clay swelling
- **Overcome Drilling Zones Challenges.**
  Like salt zone, depleted and fractured formation. This is because casing is during drilling is isolate and cover the changed zone it has been drilled.
- **Improve Hole Cleaning**
  Small annular clearance between casing and wellbore. This is important as the drill is able easily to circulate drilling fluid and clear cutting.
- **Improve Hole Quality**
  plastering effect caused filter cake & cutting are crushed and pushed into the formation due to smooth casing rotation. This creates a wall cake with low permeability.
- **Reduce Mud Loss**
  filter cake which produced by rotation of a smooth pipe. This produce lower permeability and reduce mud loss.
- **Wellbore Strengthening**
  Improves the fracture of the formation resistance. filter cakes and cuttings are crushed into the formation, tiny cracks sealed off and adding extra integrity around the well while providing a wider mud weight window.
- **Reduce Operational Problems**

a- **Stuck Pipe**
- Differential stick is due to the action of the plaster a fine impermeable layer that perform as a barrier and save minimum differential pressure .
- Through hole cleaning, pack-off caused by cutting accumulation is greatly reduced. Additionally, the plaster effect provides additional structural support.

the CwD helps to reduce the stuck pipes problem

b- Well Control
CwD reduced tripping BHA and reduced the risk . retrievable BHA systems further reduce the risk of well, by the large by-pass between casing and BHA , reduce swabbing, and keep casing on the bottom.

6. Conclusion

The technology of directional casing while drilling allowed us to meet our goals, improve 6 performance and exceed offset drilling records. It has a deeper and higher inclination compared to all other offset . According to the orientation plan, a maximum slope of 45 degrees is achieved at 3 degrees/100 feet. There was no loss of time due to losses or well instability issues. The simulator shows another successful example of Directional CwD being proven in practice, but also highlights potential opportunities to improve limitations such as casing fatigue, torque and well control

Nomenclature

BHA - Bottom Hole Assembly
BOP - Blow out Preventers
BUR - Build Up Rate
CwD - Casing while Drilling
DCwD - Directional Casing while Drilling
DLS - Dog Leg Severity
ECD - Equivalent Circulating Density
NPT - Non Productive Time
RSS - Rotary Steerable System
ROP - Rate of Penetration
RPM - Revolutions per Minute
TD - Total Depth
TVD - True Vertical Depth
CDS - casing drive system
DLA - drill lock assembly

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