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Comparison Study between Drilling with Casing and Conventional Drilling Techniques in the Western Desert

Mostafa Ibrahim[1], Mohamed S. Farhat[2] and Taher El Fakharany[3]

[1] Drilling and Workover Department, El Hamra oil Petroleum Company, Alexandria, Egypt
[2] Petroleum Engineering Departments, Faculty of Pet. and Min. Eng., Suez University, Egypt
[3] Mining and Petroleum Department, Faculty of Engineering, Al-Azhar University, Cairo, Egypt

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Abstract

The Field 'X', located onshore in KHALDA Co. in the Western desert of Egypt, encountered major challenges in both drilling and cased off problematic zone during running casing operation due to severe lost circulation conditions. Specifically, severe mud losses in the major loss zone recorded in MOGHRA formation. The operator has experienced massive loss problems while drilling the 12-1/4 inch section. Unsuccessful operations with conventional drilling technique have urged the operator to look for alternative drilling methods to the case of the massive thief zone.

The drilling with casing (DwC) system has been identified as one drilling technique that may repair the troublesome thief zone. This non-retrievable system, which utilizes casing as a drill string, allows the string to immediately be cemented in place once targeted depth is achieved, hence eliminating the risk of casing tripping failure through massive lose zone with conventional drilling method. (DwC) the technique is a Fast one-section casing design that uses casing with a special bit to drill the section of well as a drill string. systems integrate the drilling and casing process to provide a more efficient well construction system by eliminating the drill string's trips and allowing the well to be simultaneously drilled and cased.

This paper discusses the planning, implementation and finally, the results of 12-1/4 inch drilling with casing technique through the problematic MOGHRA lost circulation zone.

Keywords*: Comparison; Drilling with Casing (DwC); Conventional Drilling; KHALDA Field; Drilling Parameters; Total flow area (TFA); API; HAZID; Total depth (TD); POOH and RIH.*

1. Introduction

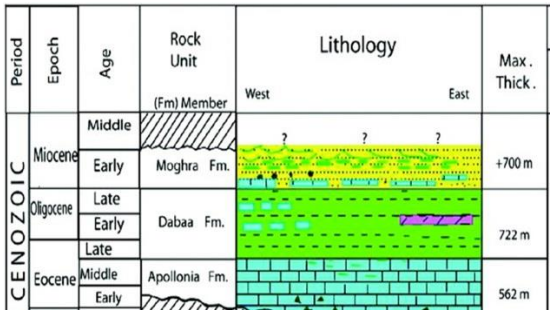

Fig. 1. Typical formation stratigraphy [2]

The X field, located onshore in KHALDA Co. in Western desert of Egypt. The area is known with its loss zone in surface hole section in MOGHRA formation, a sandstone formation type which found above DABAA active shale formation reaching into APOLONIA formation as shown in Fig. 1.

The well#2 was planned to 12" drill with casing in surface section and set at ± 3500 ft in 12 inch hole, 50 ft into APPOLONIA formation which drill out with conventional drilling with 8 ½" PDC bit to oil zone formation in the second section of vertical well design [1].

2. Conventional drilling sequences and problems

The first 300 ft in (Well#1), using conventional drilling techniques with 12 1\4" tri-cone bit drill by ROP slower than (well #2) due to avoidance of surface losses. Observing the torque increased in unconsolidated sand fractured formation from 200 ft to 1000 ft which reacted by an increase in WOB from 25 to 35 kb and in which the ROP is reduced to avoid formation loss. Observed that (Well #1) after enter to DABAA formation and with controlling the drilling parameters the drilling will take the normal operation with ROP like offset well. The drilling will continue to top 50 ft into APOLONIA formation, but some offset well before DABAA in wiper trip take complete loss, some can be successful controlled and other had packed off stuck with no success (ABANDON WELL) this can lead to optimize the conventional drilling by upgrade drilling with drilling with casing (DwC) [2].

3. Solution options

The non-retrievable drilling with casing system which uses casing as the drill string and allows the BHA to be cemented in place promptly after reaching TD, appeared to be the option with the most acceptable level of risk and cost. This technology has been proven to mitigate massive loss circulation problems in many previous successful applications. The system allows integration of the drilling and casing running completely in a single operation. The non-retrievable drilling with casing system as a drilling technique was implemented to overcome troublesome thief zone. The main objective was to drill, set, and cement the 9 5/8 inch casing to TD safely and successfully without any hazards to personnel, equipment and environment. Experience with reducing lost circulation and stuck pipe, coupled with the fact that well control is much safer when the well is circulated with the pipe on bottom, provides evidence that drilling with casing systems can mitigate difficult zones problems. Some key benefits of drilling with casing system include:

I. The lateral movement of the casing in the narrow annulus encountered during operations creates pulverized cuttings that adhere to the wellbore wall and seal pore spaces across thief zones. This is also known as the plastering effect, Fig (2).
II. Casing is always on bottom to ensure that the system drills to the location that can be cased. In other words, there is no concern that the casing is not reached on bottom with drilling with casing system.[3]

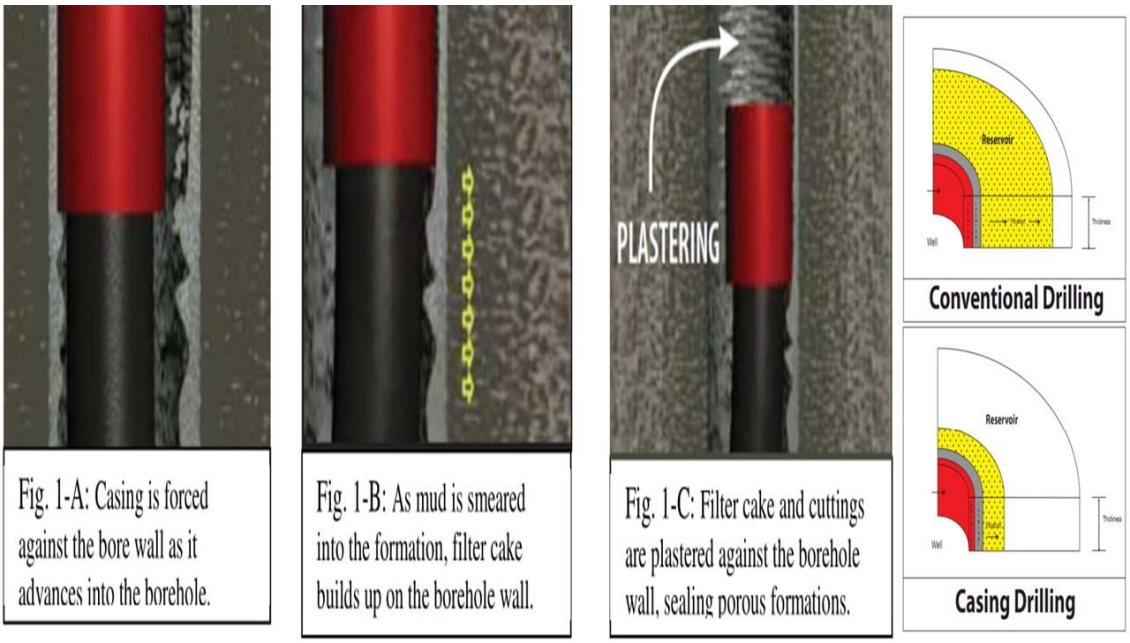

Fig. 2. Particle size distribution analysis, comparing cuttings from drilling with casing vs. conventional drilling.[3,6]

4. Equipment selection

All casing specification used during drilling with casing process is 9 5/8 inch, 26 ppf, L80, with BTC connection. Torque rings are also installed in Buttress type connection to increase casing connection torque capability during drilling process shown in Fig (3).

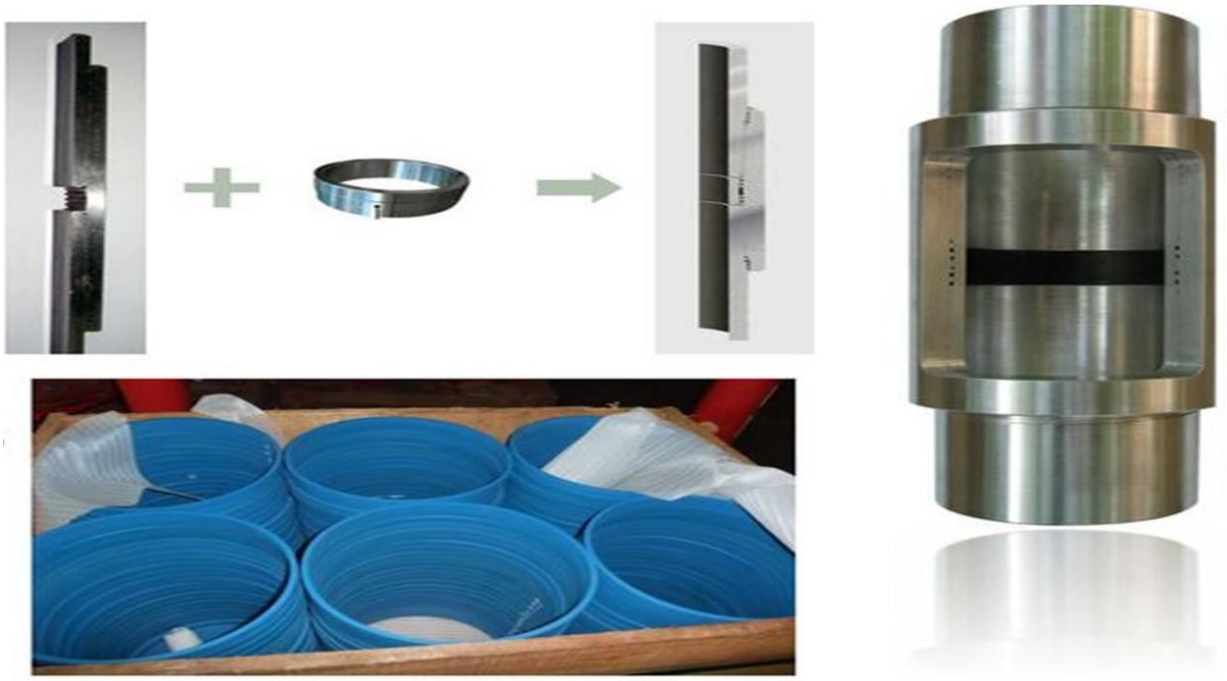

Fig. 3. Torque ring [8]

The drilling with casing system consists of a surface drive and drilling system that attached to the top drive shown in Fig. 4.

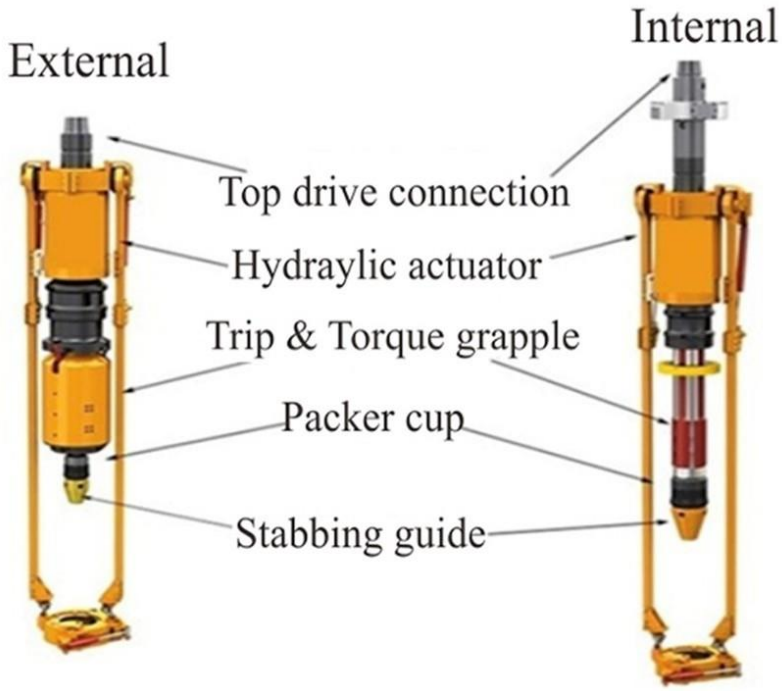

Fig. 4. Casing drive head

Standard float collar in place as required for cement job shown in Fig (5), and drillable casing drill bit. The Defyer 12 inch csg x 9-5/8 inch OD was selected as a casing bit to drill the formation to the TD planned in a single trip shown in Fig (6).

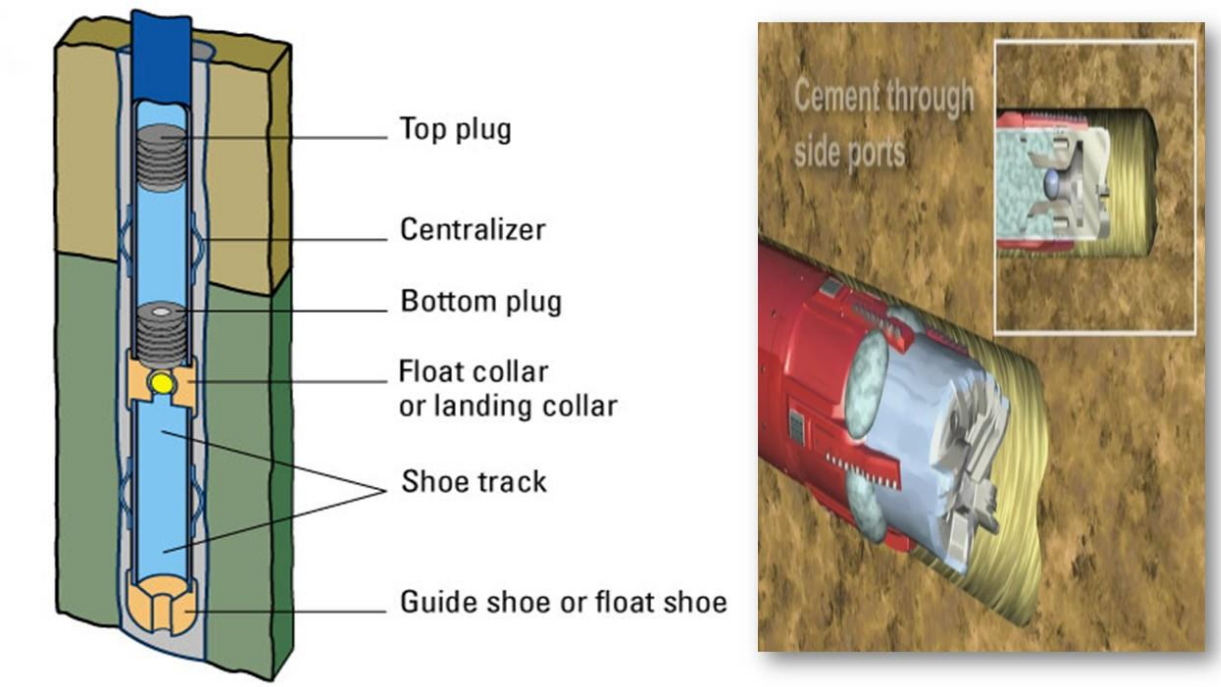

Fig. 5. Float shoe

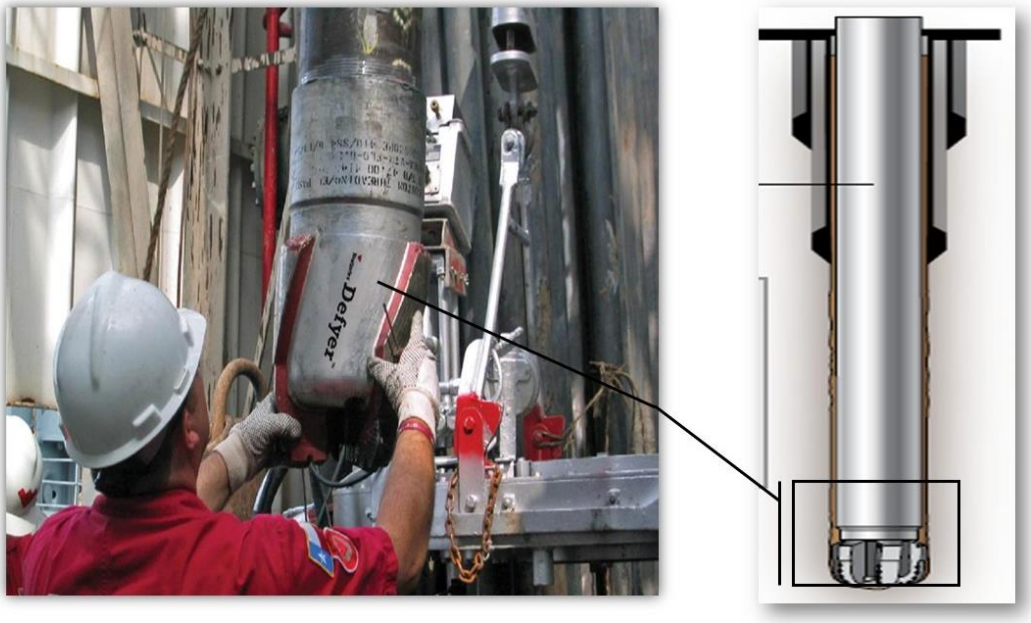

Fig. 6. Non- retrainable drilling casing bit

The Defyer series is designed for drilling with casing or liner applications in soft to medium formations having confined compressive strengths up to 7,000 psi. This tool incorporates PDC cutters on the shoulder with a proprietary diamond cutting structure mounted in drillable blades. A total of three copper nozzles of (8x14/32) -inch size (TFA = 4.518 in2) were installed onto the casing bit to optimize the hydraulic performance of the tool.

5. Conventional drilling operation

Operator decided to drill (Well#1) 12 ¼" with Conventional BHA and spud mud equal 8.8 ppg, drilling parameter flow rate 660 gpm, standpipe pressure 1100 psi, WOB 35 Klbs, RPM 140, and torque 2-3 Kftlbs. Continued drilling with these parameters from surface to 800 ft. Initial dynamic losses of 2 – 3 bph. Increasing drilling parameters gradually resulted in improved ROP from 78 to 95 ft/hr. Switched over to KCL polymer mud (9.2 ppg) at 1000' And continue with drilling parameter flow rate 560 gpm, standpipe pressure 1400 psi, wight on bit (WOB) 35 Klbs, Revolution per mint 140 RPM, and torque 4-6 Kftlbs. Continued drilling with these parameters from 1000 ft to 2220 ft. Initial dynamic losses changed from 35 to 25 BPH before ± 100 ft to DABAA formation. POOH to surface wiper trips and had a tight spots at 1839', 1776',1590', 1407' , RIH back to 2219' (BTM) has had complete Loss Of Circulation (No mud return to surface) spot 100 bbls (H.V.P) (120 ppb LCM) on depth. And POOH to surface.

Cont'd drilling 12 1/4" hole from 2219' to 2250'. Without any return of mud w/300 gpm pressure 700 psi, POOH with 12 1/4" drilling easy short trip to surface.

Operator decided to make cement plug and return to drilling to tag on cement plug to clean out, but meanwhile clean cement the drill string become stuck at 1580'.(No drilling progress), the drilling parameter used in these case is: (WOB = 0-5 KLB, RPM = 140, GPM = 400, pump pressure = 750 PSI, TQ = 2-3 Klb.ft). The action taken to free the stuck is as follow:

- Jarring down with max. string, total weight 100 klb.(30 klbs sack of wight (s.o.wt)), jar not working down.
- Jarring up w/total wt 300 klbs (over .pull 200 klbs)
- Circulation. W/400 gpm (spp: 700 psi), losses:6 bph.
- Performed blind back off by rotary, drill string wt. After back off 65 klbs
- Find in fishing (7 std x 4 1/2" d/p + 6 std x 4 1/2" hwdp + 7.5 std x 6 1/2" d/c), std back on drack, l/d 6 1/2" jar
- Left on hole (12 1/4" BIT + bit sub + 8 1/4"K- MONEL(drill collar) + 3*8 1/4"D/C'S + X.O + 6*6 1/2" D/C'S)
- Attempt to fishing left in hole (No progress) and perform cement plug to perform side track [1]

6. Drilling with casing challenge

Total length drilled with (DwC) for **(**Well# 2**)** was 3376 ft extending from 26 ft to 3400 ft. Total drilling with casing time was 97 hours with an average ROP of 120 ft/hr. At the end of the drilling process, a survey was taken to indicate the well with no inclination had dropped from the directional plan at TD. The casing was cemented in place immediately after reaching the TD without incident. It took subsequent drilling assembly nine hours to drill through the shoe track and only 0.5 hours through the The Defyer 12 inch csg x 9-5/8 inch OD casing bit[5], shown in Table 1.

Table 1. The average drilling parameters [1]

Parameter	Value	Parameter	Value
RPM	80-110	Flow Rate	400-700 GPM
WOB	8-14 Klb	Pump Pressure	900-1900 psi
Torque	3-5 Kft-lb	ROP	80-120 fph

6. Risk assessment

In order to identify the risk of drilling with casing in Field 'X' and recognize the weakest components of the chosen DwC system, a "Hazard Identification"(HAZID) workshop was held in conjunction with global reps of participating service companies. Both office and field drilling engineers where actively involved in the discussion where four major groups of uncertain events were identified: DwC the wellbore, casing handling, cementing, and post cementing. The team evaluated both the probability of occurrence and the consequences of each event, and highlighted their impact on drilling operation as well as the existing mitigation system to prevent the unexpected. The main potential risky events for which more than fifteen percent

likelihood of occurrence was recorded are: bit balling, excessive bit vibration, wellbore collapsing , reduced drilling performance, casing connection premature damage, conventional-float collar damage, deficient cement job, and problems encountered while drilling out drillable bit. A list of mitigation measures were put in place to minimize the risk and effect of each individual event on planned DwC trial. Before drilling operations, rig crew was knowledgeable on potential risks associated to DwC and the actions taken and to be set in rig-site to minimize such risks. The HAZID session must be considered as a driven teamwork achievement on the success of these first trials Khalda Petroleum Company (Apache) JV. in Egypt [4].

7. Conclusions

Drilling with casing technique is used to drill 12 inch, hole successfully to planned setting depth and the job was completed successfully. Drilling with casing application reduced the total mud losses into the thief zone, mitigate hole pack-off, reduce the stuck pipe due to the loss of circulation and cutting accumulations and finally reduce the associated non-productive time in this problematic wellbore. Massive losses were encountered in this well; however, the casing reached the TD and cased through the thief zone. During the drilling with casing the size of cuttings generated is smaller than with conventional drilling. This is due to the casing string grinding effect that pulverizes the cuttings as they travel up the annulus and the Plastering effect that smears them into the wellbore wall. In other words, cuttings substitute for the lost circulation material.

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Nomenclature

BHA	*Bottom Hole Assembly*	*LCM*	*loss of circulation mud*
BPH	*Barrel per Hour*	*POOH*	*Pull out off hole*
BTC	*Buttress type connection*	*PPF*	*Pound per Foot*
BTM	*Bottom*	*PSI*	*Pound per square inch*
CSG	*Casing*	*RIH*	*Run in hole*
DwC	*Drilling with Casing*	*ROP*	*Rate of Penetration*
FPH	*Feet per Hour*	*SPP*	*Stand Pipe Pressure*
GPM	*Gallons per Minute*	*TD*	*Total Depth*
H.V.P	*High viscous pill*	*WOB*	*Weight on Bit*
KCL	*potassium chloride salt*		

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To whom correspondence should be addressed: Mostafa Ibrahim, Drilling and Workover Department, El Hamra oil Petroleum Company, Alexandria, Egypt, E-mail Eng.mostafa.ibrahim2010@gmail.com