IJCPE
Iraqi Journal of Chemical and Petroleum Engineering

Iraqi Journal of Chemical and Petroleum Engineering
Vol.17 No.2 (June 2016) 47- 52
ISSN: 1997-4884

University of Baghdad
College of Engineering

Study the Efficiency of Drilling With Casing Operation in an Iraqi Oil Field

Ayad A. Alhaleem
University of Baghdad / College of Engineering Petroleum Department

Abstract

Drilling with casing (DWC) can be considered as a modern drilling technique in which both of drilling and casing operations done in the same time by using the casing to transfer the hydraulic and mechanical power to the bit instead of traditional drilling string. To overcome oil well control, minimizing the total cost through enhancing drilling efficiency, drilling with casing was proposed as an enabling technology.

Two surface sections (17 1/2 - and 12 1/4- inch) were drilled successfully in Rumaila oil field with casing strings which reached 655m and 1524m measured depths respectively.

By using DWC technique, the total drill/case phase time was reduced up to 20% comparing to conventional drilling in the same field .

Drilling both sections with DWC system eliminating the number of trips and nonproductive time (NPT) related to wellbore instability.

Key Words: casing drilling, BHA, drill string, tripping, CDS.

Introduction

Casing drilling technology can be considered as one of the most important developments in drilling operations. It is an effective method to reduce the over drilling costs by reducing drilling time and drill string problems associated with conventional drilling process [1].

There are two basic method of drilling with casing [2]:

1- A latched retrievable bottom hole assembly (BHA) inside the casing that incorporates a motor to drive a conventional bit and under-reamer.
2- A rotate the casing at surface system incorporating an internal casing drive system and a drillable “cement in place” drilling BHA.

In general, designing a well to be drilled with casing drilling technique is similar to designing a conventional well. The most important significant difference is that the casing in the well is subjected to additional stresses while casing drilling, so buckling, fatigue, and hydraulics deserve special attention [3].

Drilling with casing has proven many advantages for certain classes of wells, i.e., wells which have low deviations. Actually, with providing good directional control, casing drilling would be beneficial for limited step-out, shallow extended reach drilling (ERD) wells [4].

The new method of drilling the time-development Figa formation using DWC allows well engineers to suggest perspective top/intermediate well bore sections differently by enhancing the overall drilling performance. The risk of setting casing strings at unplanned depth is reduced through this plan besides the reduction in getting pipe stuck [5].

Many results in a more stable well bore can be achieved with casing drilling since casing stays in the hole at all times. Every inch of hole drilled can be kept, even if well control problems or well stability force the casing to be set and cemented prior to the full interval being drilled [6].

Site Observations

In the selected well, the top section (17 1/2 inch hole) which include Dibdibu, Lower Fiars, Ghar formations are drilled with the known bottom hole assembly (BHA), while Dammam formation is drilled by casing with the availability of casing drive system (CDS) tool. This tool is connected from the top with top drive and from the bottom it will be inside the casing (as the first component) to drill with casing. The mentioned tool is not regular for the local companies and it was used by schlumberger companyin south Rumaila. Here in this section , the drilling was done with drillable bit which considered as one usage tool since the next drilling will be finished with PDC bit (from 520m to 655m).

The implementation of DWC technique in Dammam can be attributed to the main reason named complete losses. The treatment of this problem with several usages of cement blocks which may be reached in certain conditions to more than twenty blocks can cause an increasing in whole drilling time. The increasing in loosing time, cost and materials consumption (as mud or cementing) leads to consider a DWC as a better option to prevent many drilling problems.

Consequently, DWC technique was used in Hartha and Tayarat formations (12 1/4 inch hole).

Table (1) represents the lithology and mechanical state of the selected well in which two sections were planned and practiced with DWC process [7].

Table 1, Lithology and mechanical state of the selected well [7]

Formation	Potential Risk
Didbba	Caving
L.Fars	Caving, heavy oil in shely limestone
Dammam	Partial to complete mud losses may
Rus	
Umm-Radhuma	Sulphurous Water may flow
Tayarat	Sulphurous Water may flow Tight hole
Shiranish	Tight hole
Hartha	Mud loss may occur, tight hole
sadi	Tight hole
Tanuma	Caving
Khasib	
Mishrif	
Rumaila	
Ahmadi	
Maudud	
Nahrumr	Caving
Shuaiba	Mud loss may occur
Zubair	Medium oil impregnation in sandstone
Ratawi	

Hartha formation have the losses problem and Tayarat formation have a potential risk of sulphurous water flow which results a changing in drilling mud properties due to presence of H_2S and the failure in cement blocks. So the DWC was considered a best option to deal with such problems.

Well Planning

Surface hole sections in Rumaila oil field are almost drilled with large diameter bits (17 1/2 – 26 inch; PDC) using fresh water bentonite (FWB) and a standard rotary BHA. The two holes are cased with 133/8-in and 20 in respectively. The next sections in both wells are commonly drilled with 121/4 and 81/2 PDC bits and cased with 9 5/8 and 7 inch casing respectively. The major components of the casing while drilling system are [9]:

17 1/2″ bit +1 Float collar +1×13 3/8″Casing +1 Float collar +13 3/8″Casing. In comparison with traditional drilling for the same hole, the components of BHA and drill string are:

17-1/2″ bit +bit sub with float +2×9-1/2″ DC +Roller Reamer 17-1/2″ + Cross over+ 6×8″ Drill collar + Hydroulic Jar +2×8″ Drill collar + Cross over + 6×6-3/4″ Collar + 15×5″ HWDP + 5″ 19.50 G-Drill Pipe.

It can be seen from the above BHA and drilling design, the DWC need less components which consequently means no more trips were needed to improve drilling conditions.

The same note can be observed while examining the BHA and drill string components of 121/4″ section which can be summarized as: 121/4″ insert bit + Near bit stab. With Fv. + 1 ×8″ Drill collar + string stabilizer + 2 ×8″ Drill collar + string stabilizer + 11 ×8″ Drill collar + Jar +2 ×8″ Drill collar + X/O + 3 ×63/4″ Drill collar + 15 × HWDP + 5″ 19.50 G Drill Pipe.

Similarly, the major components of casing while drilling for 12-1/4″ hole are:

12-1/4″ bit + Float collar + stabilizer + 1 × 9- 5/8″ casing joint +1 Float collar + 9-5/8″ casing joint.

Absolutely the optimization in no need to drilling pipes and collar pipes with DWC technique can be considered advantage for both of the whole drilling operation and drilling contractors.

Figure (1) and (2) show a schematic diagram of BHA and drill string for casing drilling for 17-1/2″ hole section and 12-1/4″ hole section respectively.

It can be seen from the given figures that fit for purpose stabilizer in 12-1/4″ hole section to reduce the chance of buckling, while no stabilization is needed in 17-1/2″ hole section.

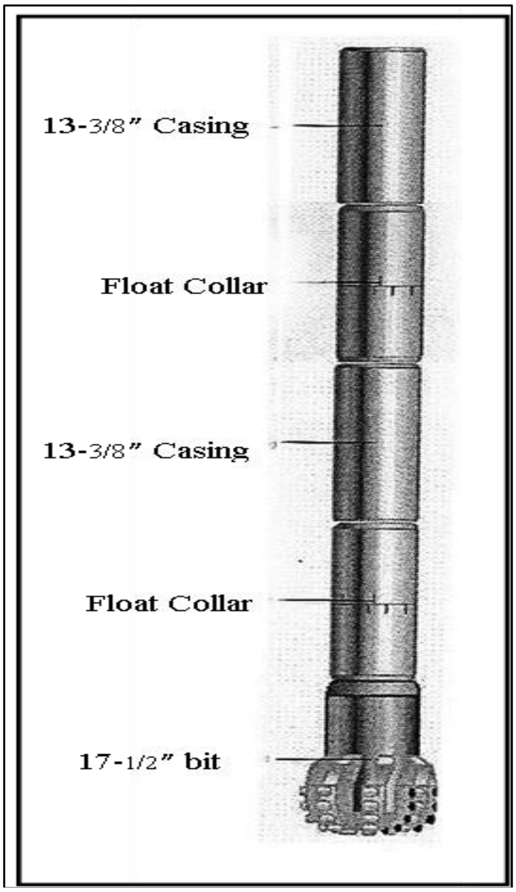

Fig 1, Schematic diagram of BHA and drill string design of 171/2 inch hole

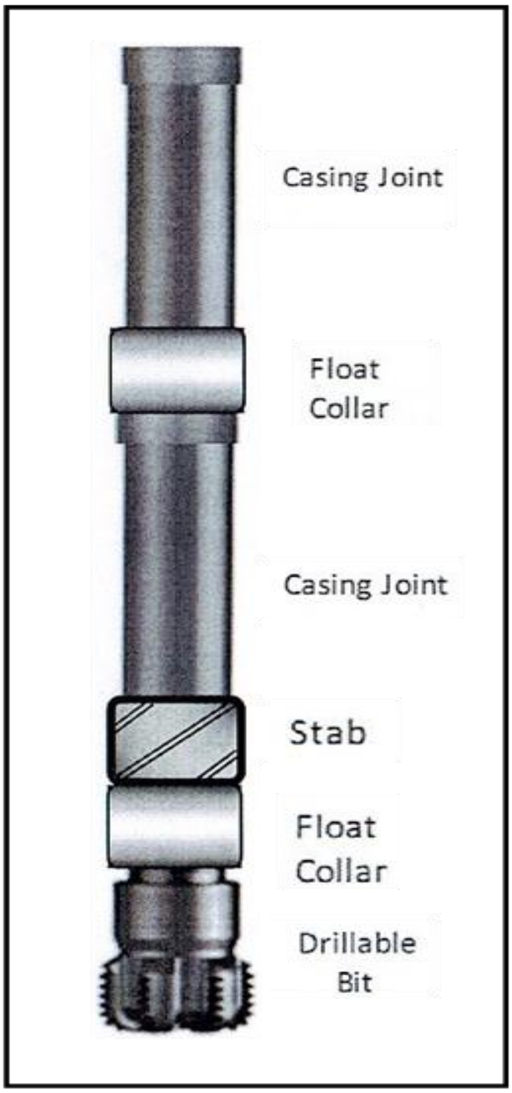

Fig 2, Schematic diagram of BHA and drill string design of 12 1/4 inch hole

Results and Discussion

Generally, in any drilling operation, the hydraulic energy besides the mechanical energy represents the major power components to optimize drilling efficiency.

Table (2) shows the hydraulic parameters for both rotary drilling and casing drilling through 171/2″ hole section.

Table 2, Hydraulic parameters for rotary drilling and casing drilling [7]

Parameters	Rotary drilling	Casing drilling
WOB (MT)	5-12	2-14
RPM	120-130	40-60
Expected ROP (m/hr)	10-15	4-7
HIS (hp/in^2)	2.21 @ 3780 l/min	0.14 @ 2250 l/min
Pump Pressure (Psi)	2415@ 3780 l/min	181 @ 2250 l/min
Flow rate (l/min)	2270 l/min (first 30m) 3780 l/min	2250 l/min

As shown from table (2), there is an important parameter used in drilling hydraulics to show a better understanding about the magnitude of the hydraulic horsepower. This term is called the H.S.I (hydraulic horsepower per square inch of bit face area) and is basically obtained by dividing the hydraulic horsepower by a hole size [8].

Although that the rate of penetration with DWC is less than rotary drilling, but the whole drilling time is optimized. Using normal drilling at tight formations can cause borehole instability and many other problems which can be prevented by using DWC technique. Providing enough hydraulic energy is required to prevent bit balling, to avoid cuttings accumulation inside annulus and flow line and finally to reduce overall energy consumption.

The proper analysis of mechanical factors can give the following issues:

- Collapse and burst rating of drill pipe is many times larger than that of large-diameter casing which can be attributed to unrestricted and large internal diameter casing which reduces maximum stand pipe pressure.

- High torque up to 80KLBS can be achieved when drilled 171/2″hole section starting with 5-6 KFT.LB. These values are many times larger than in APIDP (American Petroleum Institute Drill Pipe) to allow them to repel greater axial and torsional loads than traditional joints. So, fatigue-related washouts in the pipe body and risks of twist-off during DWC operations are negligible.

Implementation of DWC showed the following advantages:

1- Reducing the nonproductive time (NPT) through overcome the following concepts the kick during drill string pulling, sloughing formations within swab and surge, pipe sticking, and key seat.

2- The cementing operations was successfully implemented and proved by cement-bond log (CBL) which revealed good cement bonding.

3- Reduction on total drilling cost through the following concepts:

a. Reduction on whole drilling problems.

b. Having perfect cementing operation.

c. Less environmental impacts compared with traditional methods due to less drilling time, less pumps pressure which result in less fuel consumption.

Drilling with casing results in less casing rotating and which restrike or prevent fluid loss to the production formation and reduce flushing of mud filtrates to the permeable zone where the accumulation of drill cuttings inside the sections of high permeability and porosity at the top of annulus which finally help in well stability.

The application of drilling with casing technique for two sections in the selected well save the operator 14 rig days which representing a significant cost reduction, fig (3).

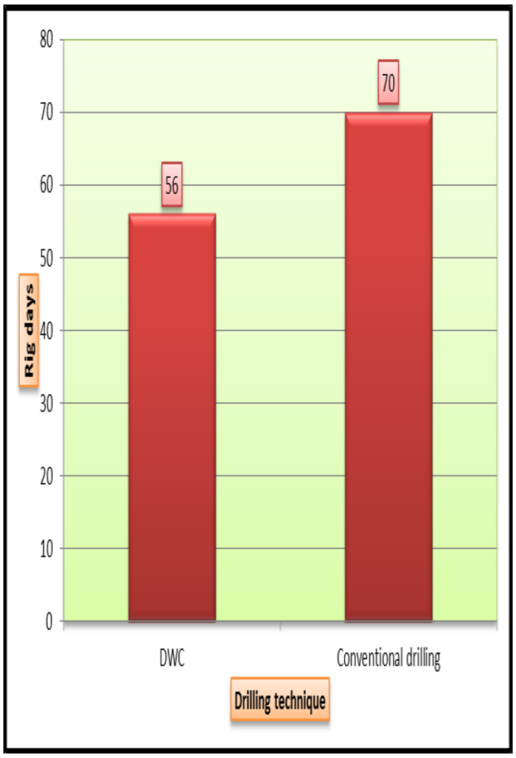

Fig 3, Comparison between conventional drilling and DWC days

Certainly, reducing the rig time by 20% saved millions of dollars to the operator.

One concern about drilling with casing is the likely need to modify the rig to undertake drilling with casing. One of the best important modifications on rig is casing drive system (CDS) which offers safe and non-threaded connection between casing string and top drive.

In spite of lack of local experience in DWC technique, the potential problems which likelihood of occurrence during drilling the selected sections were prevented or limited.

Conclusions

The results of the present study indicate that:

1- Problems attributed to pipe tripping can be reduced with CDS in addition to reduce surge and swab pressure punctuations.
2- It is important to know that evaluation of lithological characteristics of the formations and hole conditions is very important prior to apply certain design criteria of the casing to improve drilling performance.
3- Casing drilling has proven benefits for the application southern Iraqi oil field (especially for vertical well) where low torques and loads are commonly created during DWC process.
4- DWC process provided efficient hole cleaning through presence of mono diameter annular geometry which gave higher annular velocities.
5- Eliminating swab/surge effect resulting in higher reducing of risks of well control incidents.
6- The additional stresses which casing is subjected to (in DWC) need the operator to deserve special attention to bucking, fatigue and hydraulics.

Abbreviations

API	American Petroleum Institute
BHA	Bottom Hole Assembly
CBL	Cement Bond Log
CDS	Casing Drive System
DC	Drill Collar
DWC	Drilling With Casing
ERD	Extended Reach Drilling
FWB	Fresh Water Bentonite
HSI	Hydraulic Horsepower Square Inch of Bit
HWDP	High Weight Drill Pipe
MT	Metric Ton
NPT	Non Productive Time
PDC	Poly Crystalline Diamond Bit
ROP	Rate of Penetration
RPM	Revolution Per Minute
WOB	Weight on Bit

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