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Drilling Efficiency with Casing while Drilling Technique in South Rumaila (Iraqi Oil Field)

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Abstract: ***Current drilling operations are located in troublesome zones that may have severe lost circulation and wellbore instability which contribute to Non-Productive Time (NPT) while drilling. These challenges contribute to develop Casing while Drilling (CwD) technique. This paper presents case studies of the implementation of CwD technique in south Rumaila oil field in Iraq.CwDhad proven to be an effective technique to overcome Dammam formation problem by reducing cost and time of curing this problem. Also, the total time saving in both NPT and time spent in Dammam were ranging from 7****9% to 9****4% and from** 5**4% to** 70**% respectively.***

Keywords: Casing while Drilling (CwD) technique, NPT, Lost circulation.

I. Introduction

Drilling industry has undergone many developments and changes since the start of drilling and exploration of petroleum reservoirs, theseleft the drilling industry with a much more complex environment. The applications of drilling oil and gas wells are currently located in troublesome zones, depleted reservoirs, and wells with severe wellbore instability.These problematic wells encouraged to develop the CwDtechnique which is used in many challenging wells to drill through troublesome sections that would not have been possible with conventional drilling methods[i]. A successful using of CwD technique was done in FIQA shale in Oman. A reduction of 40-45% in the drilling phase was observed when using CwD technique [ii]. In this paper, we will introduce case studies of the implementation of CwD technique in south Rumaila oil field in Iraq. We will take the actual field data of six different wells (RU-358, RU-359, RU-361, RU-362, RU-366, and RU-371) which all experience lost circulation problem in Dammam formation.CwD technique was used for drilling through Dammam section in four wells to overcome lost circulation problem while in the other two wells, Dammam section was drilled conventionally. Through this study, a comprehensive economical and technical comparison between these wells were performed.

The economical issue includes performing cost calculations related to the cost of remedial actions that were used to treat lost circulation problem such as cement plugs; the cost of NPT that were spent in Dammam formation; and the cost of drilling fluids that were lost to the formation while drilling through Dammam formation.

The technical issue includes performing hydraulic analysis calculations by using Bingham plastic model.

II. Material and Methodology

The first implementation of CwD technique in Rumaila field was at the late of 2010. The main purpose of using this technique was reducing NPT and costs associated with curing operations of lost circulation while drilling through Dammam formation. Six wells were drilled in this area with the following summaries [iii]:

► In the first well (RU-358), the problem of lost circulation in Dammam needed four cement plugs to be cured which consumed a lot of time and cost.
► In the second well (RU-359), an alternative (non-conventional) casing design was used to eliminate the time spent to cure losses and minimize the drilling time.
► Inother wells (RU-361, RU-362, RU-366, RU-371), CwD technique was used to cure lost circulation problem.

The geological sequence of sub-surface formationsin Rumaila field indicates to the presence of unconsolidated formation (Ghar) notorious with wellbore instability problem (risk of wellbore collapse) located above Dammam formation (lost circulation zone). The main objective while drilling in this field is to isolate these two formations from each other to eliminate pipe sticking and plugged problems resulting from wellbore wall collapse while drilling through Ghar, thus; cuttings will be accumulated around the drillstring while drilling the next formations (including Dammam formation). So, the conventional casing design is achieved by [iii]:

1. Drilling the first hole section (26-in.) to cover Dibdibba formation with 20-in. casing.
2. Drilling the second hole section (17½-in.) including Lower Faris and Ghar formations to the top of Dammam (~ 421m), thus; isolating highly unconsolidatedformation (Ghar) from loss formation (Dammam) with 13⅜-in. casing.
3. Drilling the third hole section (12¼-in.) including Dammam formation and setting 9⅝-in. casing.

So, this design achieves full isolation between Ghar and Dammam formations. Moreover, drilling through Dammam formation is accompanied with the risk of pipe sticking and fluid flows due to disposal wells that historically required multiple cement plugs to be cured and caused delays in well delivery.

These problems must be treated very well to guarantee safely and easily drilling for the next high pressure zones (Tayarat).

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1 March. 2017

CwD Technique Strategy

CwD strategy was proposed to be used for certain wells as follows [iii]:

1. Drilling 17½-in. hole section with conventional Bottom Hole Assembly (BHA) to (100 – 110) m inside Dammam formation.
2. Pull out of hole (POOH)and Lay Down conventional BHA.
3. Rig up casing drive system.
4. Make up BHAwith 17½-in. drillable Polycrystalline Diamond Compact (PDC) bit and Run in hole (RIH).
5. Continue drilling with casing with normal parameters covering the losses formation and down until reaching the section Total Depth (TD) (4m inside Rus formation). The drilling is almost blind drilling.
6. POOH and changed the bit to a 12¼-in. PDC bit. Then, the PDC bit is RIH to drill the casing drilling bit.
7. The same PDC bit continues for drilling the next section.

III Results

From the field observations and the obtained calculations, the following results for many considerations can be listed below:

Job Execution

The implementation of CwD technique was executed with the following details[iii]:

1. The CwDtechnique was successful in three wells and failed in one (RU-366).
2. Ghar and Dammam formations were drilled in the same section (17½-in. section), this caused the casing to be stuck due to the collapse of Ghar formation on the casing string along with poor hole cleaning, so this was the reason of the failure in well RU-366.
3. In the three successful jobs:

a. The Overall time spent in Dammam section (13⅜-in. casing to TD), was shorter using the CwD technique, compared to drill with conventional BHA.
b. The Rate of Penetration (ROP) in CwD wells was lower (~ 4m/hr) compared with conventionally drilled wells (~ 9m/hr). But it saved significant time as it all went in one run only.
c. A relatively high torque was observed due to poor hole cleaning while drilling blind and no returns to surface.
d. Plastering effect did not occur as cutting most probably went inside Dammam formation instead of flowing up to the annulus.
e. In all jobs, the section TD was reached successfully, and the 13⅜-in. surface casing was cemented as per program.

4. In the well RU-362, there was a stuck pipe incident at 596m due to poor holecleaning.
5. An adequate water supply is the key of success in this specific application; in all jobs, it was necessary to wait on water due to the high water consumption.
6. In well RU-371, the 17½-in. casing drilling bit was plugged because of:

a. Non-continuous supply of water for blind drilling.
b. Only one float collar used: when it first came out, the bit nozzles were observed to be plugged.
c. Break circulation through casing string while waiting on water: the string was kept rotating and reciprocating half a meter up and down, continuously pumping to the annulus, but not through the casing, giving priority to fill the annulus and avoid holecollapse due to hydrostatic drop.
d. With the failed float collar and no backup (second float), the cuttings u-tubed back into the string plugging the nozzles of the bit.

Time Savings

The total time saving in both NPT and time spent in Dammam formation were ranging from 79% to 94%, and from 54% to 70% respectively. Figure 1 summaries the consumed time in Dammam section for each well.

Wells	NPT in The Dammam (Days)	Time Spent to Complete the Dammam Section (Days)	Section NPT %	Comments
Ru-358 (conventional)	11.9	14.1	84%	Four cement plugs
Ru-359 (Alternative)	3.7	9.1	41%	No cement plugs
Ru-361 (CwD)	0.92	6.1	15%	No cement plugs, No LCM
Ru-362 (CwD)	0.66	6.5	10%	No cement plugs, No LCM
Ru-366 (CwD failed)	6.15	11.7	54%	CwD stuck, Casing cemented in place. Conventional design with four cement plugs.
Ru-371 (CwD)	2.5	4.2	60%	Plugged CwD bit at 670m

Fig.1: Summary of time savings in the studied wells.

Cost Analysis

The reduction in the total cost were ranging from 73.7% to 94.6%.Figure 2 summaries the cost analysis in Dammam section for each well (all costs are in Iraqi Dinar (ID)).

Wells	The cost of NPT in Dammam (MM ID)	The cost of remedial actions required to cure lost circulation problem (MM ID)	The cost of mud losses (MM ID)	Total problem cost (MM ID)
Ru-358 (conventional)	595	92.6	111	799
Ru-359 (Alternative)	185	-	213.44	398.44
Ru-361 (CwD)	46	-	32	78
Ru-362 (CwD)	33	-	10.3	43.3
Ru-366 (CwD failed)	308	99.32	56	463.32
Ru-371 (CwD)	210	-	0.99	210.99

Fig.2:Summary of cost analysis in the studied wells.

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Hydraulic Analysis

The required Horse Power (HP) was reduced, this led to lower maintenance for mud pumps and improving bit hydraulics. The increasing of P_{bit} was ranging from 1.8 to 3.11 times.The reduction in System HP was ranging from 80.6% to 85.5%.Figure 3 summaries the hydraulic analysis for Dammam section in each well.

Wells	P_{bit} (Psi)	V_n (ft/sec)	A_n (in^2)	%psib	SysHHP	HHPb	IF
Ru-359 (Alternative)	16	46	4.8139	0.02	283	0.0081	142
Ru-361 (CwD)	65.8	93	1.8168	36.6	55	20	241
Ru-362 (CwD)	12.88	41	3.9571	9.2	41	3.8	92
Ru-371 (CwD)	45.2	77	2.1943	30.13	46	14	177

Fig.3: Summary of hydraulic analysis in the studied wells.

NPT Analysis

a. RU-358
► Four Cement Plugs to cure Dammam.

b. RU-359
► Pipe handling and circulating system.

c. RU-361
► Waiting on water

d. RU-362
► Pipe sticking incident.
► Waiting on water.

e. RU-366
► Sticking of the casing string and associated actions to get it free.
► Four cement plugs to cure Dammam.

f. RU- 371
► Plugged CwD bit.
► 13⅜-in. casing did not reach the bottom.

Advantages and Disadvantages

The Advantages and Disadvantages of the implementation of CwD technique in the studied wells can be described as the following:

Advantages:

1. Eliminates the necessity of setting cement plugs to cure total losses in Dammam formation before drilling into the high pressure formation (Tayarat).
2. Eliminates the cost and time for cement plugs.
3. No need to use Lost Circulation Materials (LCM) to cure mud losses.
4. Reduces flat times of tripping BHA/Casing.
5. Flexibility on the well design if there is any operational problem, such as casing sticking.

Disadvantage:

1. Risk of casing sticking.
2. High water consumption.
3. Limited ROP.
4. Requires additional trip (in RU- 362) to drill out the 17½-in. shoe bit.

IV Conclusion

Based on the field observations and calculations done on the studied wells in this study, it can be concluded that: with the current strategy, CwD technique is an inappropriate solution to the lost circulation problem in Dammam because of casing sticking, so the strategy must be changed.

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