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**A NEW DRILLING METHOD WITH OPEN CIRCUIT SYSTEM (CYCLE C) IN
TOP HOLES OF MARUN FIELD IN IRAN**

**НОВЫЙ МЕТОД БУРЕНИЯ В НЕЗАМКНУТОЙ СИСТЕМЕ (ЦИКЛ С) В
ВЕРХНЕЙ ЧАСТИ СКВАЖИНЫ
(НА ПРИМЕРЕ МЕСТОРОЖДЕНИЯ МАРУН, ИРАН)**

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Abstract. In last the years, before beginning of drilling operation in 17.5 inch holes in Marun field, great amount of water is saved in earthen reserve pit to increase rate of drilling after running 18 5/8 casing to the depth of 100 meters and cementation, using a packed hole assembly, saved water in earthen reserve pits is directly pumped to hole with high velocity as a drilling fluid. Also by applying high weight on bit (WOB) and revolutions per minute (RPM), rate of penetration will be increased considerably. In these conditions, circulating system cannot refine drilling fluid because of large amount of cutting. Thus drilling mud is conducted to the earthen reserve pit to allow solid materials to settle there, and then free water is pumped to well again. High drilling rate observed by this method (1000 m/day).

In this paper, evaluation of drilling problems from the beginning to the end of 17.5 inch hole is considered. These problems are: leaning situation, crushing, stock pipe, hole deviation and cementation.

Аннотация. В последние годы перед началом бурения в 17,5-дюймовых скважинах на месторождении Марун, при увеличении скорости бурения (после спуска обсадных колонн 18 5/8 на глубину 100 метров и цементирования с использованием бурильной компоновки) в земляном резервуаре накапливается огромное количество воды. Накопленная в земляном резервуаре вода в качестве буровой жидкости на высокой скорости перекачивается прямо в скважину. Также с применением высокой нагрузки на долото скорость вращения и скорость проникновения будут значительно увеличиваться. При таких условиях система циркуляции не может очищать буровой раствор из-за большого количества естественной аэрации. Таким образом, буровой раствор направляется в земляной резервуар, чтобы позволить твердым материалам осесть там, а затем свободная

вода перекачивается обратно в скважину. С помощью такого метода наблюдается высокая скорость бурения (1000 м/день).

В данной работе, дается оценка проблем бурения от начала до конца 17,5-дюймовой скважины. Затрагиваются следующие проблемы: положение наклона, раздавливание, искривление скважины и цементирование.

Keywords: earthen reserve bit, drilling fluid, WOB, RPM, drilling rate.

Ключевые слова: резервное земляное долото, буровой раствор, высокая нагрузка на долото, частота вращения, скорость бурения

INTRODUCTION

One of the primary functions of a drilling fluid is to transport the particles generated in the drilling process (drill cutting) efficiently to the surface through the well bore annulus [1]. The ability of a fluid to transport cuttings is called “carrying capacity” of drilling mud [2]. During the last years, especially in recent years, many studies have been conducted to obtain a better understanding of factors to control and increase the rate of drilling.

One of the best criteria for reducing costs of drilling is to increase rate of penetration during drilling operation [3]. Cycle C method (or open system method) is one of these criteria which used to increase ROP by using only water (density is 62.4 pcf) as a drilling fluid. Advantage of this method is that we do not need to use shale shaker, desander or desilter, because in this method, the mud is directly pumped to the earthen reserve pit [4]. Despite the increasing of ROP in cycle C method, this method has some disadvantage such as: stuck pipe during round trip, washout, using reamers to crush and clean the wellbore during the trip in and out and other problems that can be happen during the drilling [5].

For obtaining the best information about the cycle C method and its condition, we evaluate 10 wells in Marun oil field, that five of them have been drilled by cycle C (open system) and others by close system method. By comparing open system and close system method in these wells, we can get more information condition of about Marun field.

This work aims to give an introduction to the principles and some recommended procedures practiced in drilling engineering also.

METHODOLOGY

We can see that different parameters can be compare in below figures in different graphs in each other.

Comparison of rate of penetration (ROP):

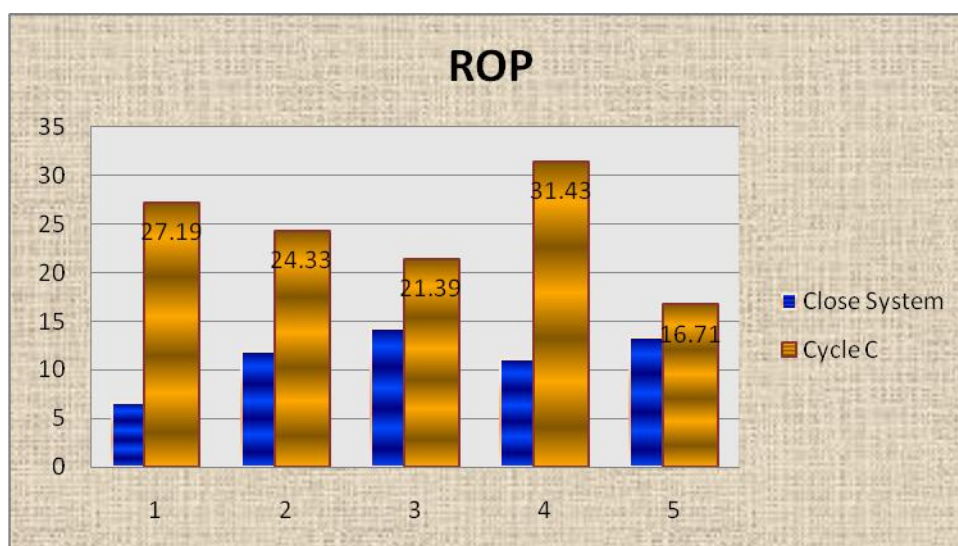


Figure 1. ROP consideration

As we see in the figure (1), all the wells that are drilled by open system method have higher ROP than the wells that are drilled by close system method; therefore one of the advantages of the open system method is high ROP which cause to reach target faster than close system method. Despite low ROP of case 5 for open system, we see that in this case also we have higher ROP in comparison with close system in this case.

Comparison of round trip time:

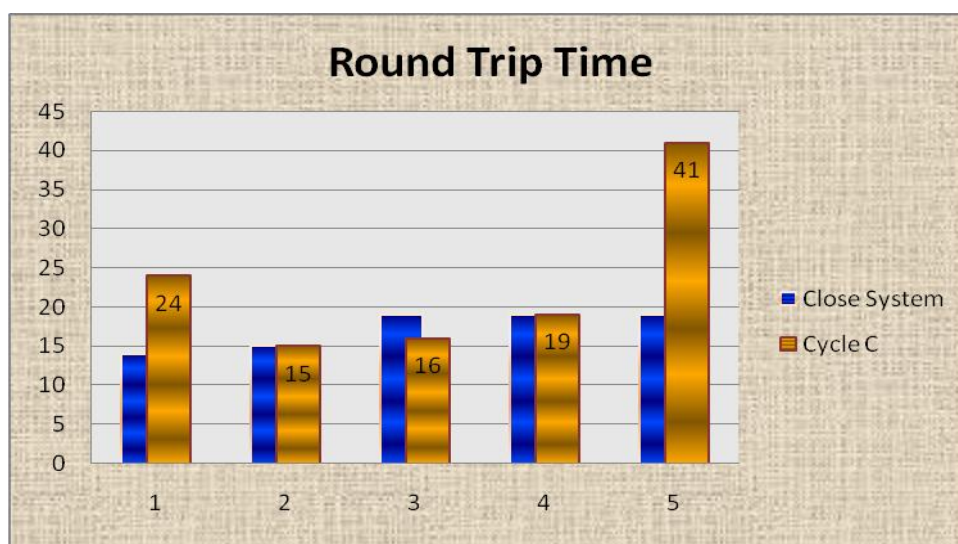


Figure 2. Round trip time consideration

According to the figure (2), round trip time for all wells is approximately same except for the well number 5 that in this well we have stuck pipe during round trip and reason for this stuck pipe was the formation that is drilled in that time.

Comparison of bit pressure drop (ΔP_{Bit}):

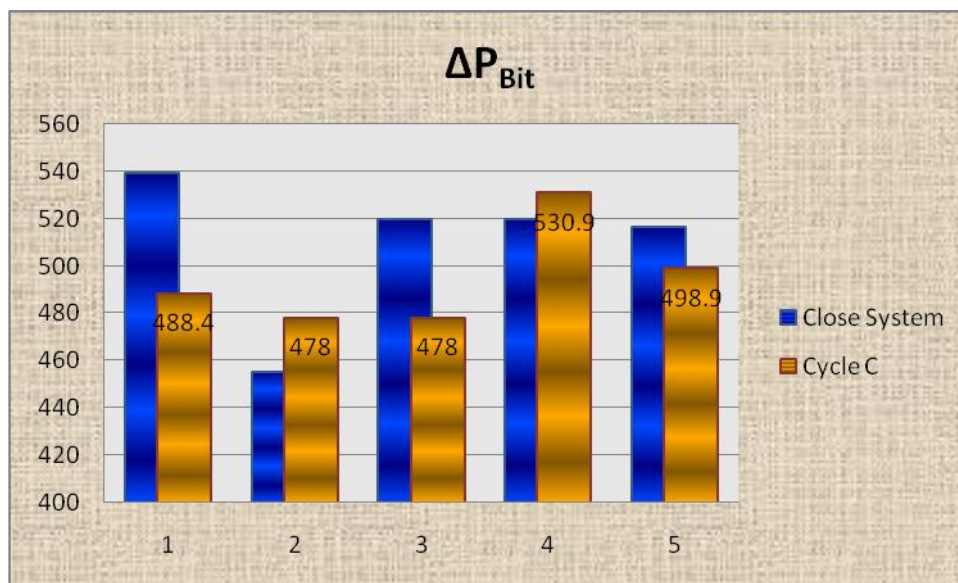


Figure 3. ΔP_{Bit} consideration

As we see in the figure (3), the pressure drop in the bit in most cases for cycle C is less than close system method. This low pressure drop leads to increase impact force and finally leads to increase rate of penetration.

Comparison of hydraulic horsepower (HHP):

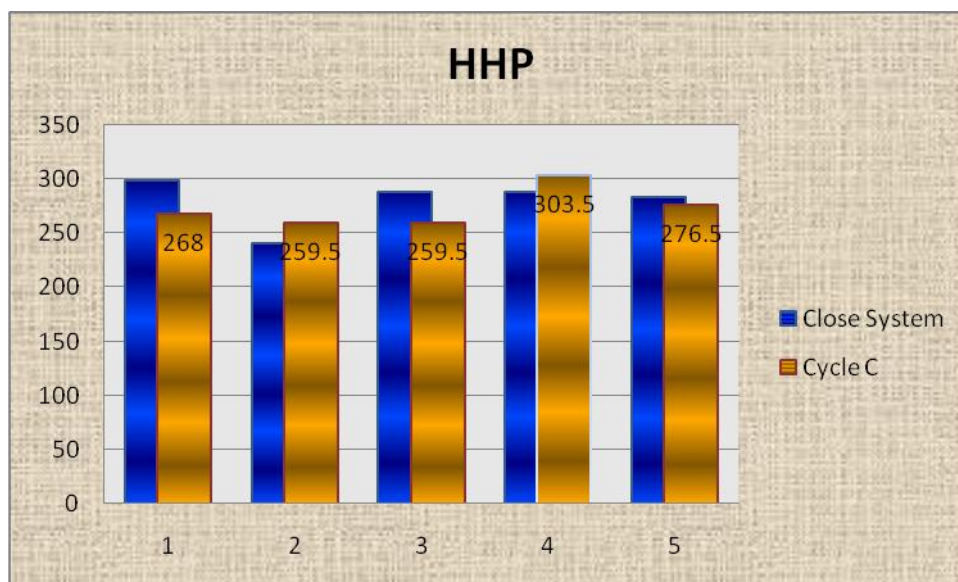


Figure 4. Hydraulic horsepower (HHP) consideration

As noticed in the figure (4), hydraulic horse power for all cases both for cycle C method and for close system method are in the same range; therefore, on the basis of the hydraulic horse power both methods are good enough but as we noticed in earlier graph

cycle C method has higher ROP; so we can have higher ROP with the same horse power with using cycle C method.

DISCUSSION AND ANALYSIS

Most important parameter for considering is the total cost per foot. From definition, we have the below relationship for total cost per foot:

$$C\left(\frac{\$}{ft}\right) = \frac{C_{bit} + C_{rig} \times (t + T)}{d} \quad (1)$$

Where C_{bit} is the bit cost in dollar, C_{rig} is the hourly rig cost in dollar per hour, t is the trip time in hour, T is the rotating time in hour and d is the drilled depth in ft.

It is possible to write the equation (1) in the form of equation (2):

$$C\left(\frac{\$}{ft}\right) = \frac{C_{bit}}{d} + \frac{C_{rig} \times (t + T)}{d} \quad (2)$$

In the equation (2), $\frac{C_{bit}}{d}$ is called fixed cost and $\frac{C_{rig} \times (t + T)}{d}$ is called variable cost.

In equation (2) we have same cost for all bits, therefore just variable cost changes in two states of drilling (cycle C and close system method).



Figure 5. Total Cost

We know that the most important factor in drilling is cost. All condition must be set to get the minimum and optimum cost during the drilling. According the figure (5), we can understand that the cost in most cases in open system method (cycle C drilling

method) is less than close system method. Also we can see that in first four cases the total cost is about twice for close system, therefore, using open system method for drilling is better than close system since in all cases except case 5, the cost of drilling with open system is less than close system. If we compare the total cost in case 5 for open system with other close system, we will understand that the total cost in case 5 for open system is approximately equal to the other close system. The cause of above phenomenon for case 5 in open system is round trip time. In this case round trip time is 41 hours and this time is about twice for other open system's round trip time. The reason for this delay in round trip as we see in daily report is stuck pipe during round trip.

Finally according to total cost, we can understand that in most cases, the total cost in open system (cycle C) method is less than the close system method, therefore, using the open system method for the drilling in top holes of wells in north of Marun oilfield is very useful and also the cost will be reduce by using this method of the drilling. For this reason in the most case of drilling in the north part on Marun oilfield this method is used to decrease the cost and get higher ROP in the drilling to finally reach the target at the minimum possible time.

As we noticed, in the figures, in most cases that holes have been drilled with open system method, we reached high ROP and this high ROP led to the low cost of drilling. Therefore, after evaluation of all factors and parameters, we recommend this method of drilling to be used for shortening the drilling time and in the same time to hasten the beginning of the recovery operation.

SUMMARY AND CONCLUSION

With evaluation of data, the most important factor in drilling to get early to target and finally reduce the cost is increasing ROP. By considering the ROP in figure 1, we can see that all of the wells which are drilled by cycle C method have higher ROP than the wells that are drilled by close system method, therefore for ROP parameter cycle C method are better than close system method. Another parameter for the evaluation is round trip Time. The working time is the time frame between changing until we reach to the depth of 1000 meter (it varies from 814 to 1345 meters depth). By considering round trip time in both cycle C and close system method we understand that this time is approximately equal in both state and only for one well this time is high. If we see the daily report for this well during the round trip we understand that this well had stuck pipe and for this reason the time got so much in comparison with the other wells that drilled to open form.

RECOMMENDATIONS

As a notice, we should mention that in the open system method we need large amount of water onsite and powerful pumps for pumping drilling fluid with high gallon

per minute (GPM). Also recommend using expert and professional crew for this method who are familiar with what they are doing to reach an optimum condition in drilling.

As our last recommendation, to reach high ROP and minimum cost per foot in drilling, use of open system method instead of close system method is preferred and recommended.

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