

Modification of DS-01 Drilling Fluid to Reduce Formation Damage

(Modifikasi Lumpur Pemboran DS-01 untuk Mengurangi Kerusakan Formasi)

Winarto^{1*}, Sugiarto Kasmungin²

¹Petroleum Engineering Department, Akamigas Balongan, Indramayu, Indonesia

²Master Program of Petroleum Engineering, Universitas Trisakti, Jakarta Indonesia

Abstract

In the process of drilling for oil and gas wells the use of appropriate drilling mud can reduce the negative impacts during ongoing drilling and post-drilling operations (production). In general, one of the drilling muds that are often used is conventional mud type with weighting agent barite, but the use of this type of mud often results in skin that is difficult to clean. Therefore in this laboratory research an experiment was carried out using a CaCO₃ weighting agent called Mud DS-01. CaCO₃ is widely used as a material for Lost Circulation Material so that it is expected that using CaCO₃ mud will have little effect on formation damage or at least easily cleaned by acidizing. The aim of this research is to obtain a formula of mud with CaCO₃ which at least gives formation damage. Laboratory experiments on this drilling mud using several mud samples adjusted to the property specifications of the mud program. Mud sample consists of 4, namely using super fine, fine, medium, and conventional CaCO₃. First measuring mud properties in each sample then testing the filter cake breaker, testing the initial flow rate using 200 ml of distilled water and a 20 micron filter disk inserted in a 500 ml HPHT cell then assembled in a PPA jacket and injecting a pressure of 100 psi. The acidification test was then performed using 15% HCL and then pressured 100 psi for 3 hours to let the acid work to remove the cake attached to the filter disk (acidizing). Laboratory studies are expected which of these samples will minimize the formation damage caused by drilling fluids.

Keywords: Drilling Fluid DS-01, CaCO₃, filter cake breaker, acidizing

Sari

Dalam proses pengeboran sumur migas penggunaan lumpur pemboran yang tepat dapat mengurangi dampak negatif saat berlangsungnya operasi pemboran dan pasca pemboran (produksi). Secara umum salah satu lumpur pemboran yang sering digunakan adalah berjenis lumpur konvensional dengan weighting agent barite, namun penggunaan lumpur jenis ini sering menghasilkan skin yang sulit dibersihkan. Oleh karena itu didalam penelitian laboratorium ini dilakukan percobaan penggunaan weighting agent CaCO₃ yang disebut Lumpur DS-01. CaCO₃ banyak dipakai sebagai bahan Lost Circulation Material sehingga diharapkan dengan memakai CaCO₃ lumpur akan sedikit memberikan efek terhadap kerusakan formasi atau paling tidak mudah dibersihkan dengan acidizing. Penelitian ini bertujuan mendapatkan formula lumpur dengan CaCO₃ yang paling minimal memberikan kerusakan formasi. Percobaan laboratorium pada lumpur bor ini menggunakan beberapa sample lumpur disesuaikan dengan spesifikasi properti dari mud program. Sample lumpur terdiri dari 4 yaitu lumpur menggunakan CaCO₃ super fine, fine, medium, dan konvensional. Pertama mengukur propertis lumpur pada masing-masing sampel kemudian yaitu pengujian filter cake breaker, pengujian laju alir awal menggunakan aquadest sebanyak 200 ml dan filter disk 20 micron yang dimasukkan didalam cell HPHT 500 ml kemudian dirangkai dalam PPA jacket dan diinjeksikan tekanan sebesar 100 psi. selanjutnya dilakukan pengujian pengasaman menggunakan HCL 15% lalu diberi tekanan 100 psi selama 3 jam untuk membiarkan asam bekerja merontokan cake yang menempel pada filter disk (acidizing). Penelitian laboratorium diharapkan ini sample mana yang akan meminimalisir formation damage yang ditimbulkan oleh fluida pemboran.

Kata-kata kunci: Lumpur DS-01, CaCO₃, filter cake breaker, pengasaman

*Corresponding author

E-mail: wintpetro465@gmail.com

Tel: +085378096266

I. INTRODUCTION

Formation damage should be avoided mainly in productive formation during drilling activity in order to keep its productivity. It can be compounded with weighting agent such as barite, since it participates to allow the mud filtrate to invade into the productive formation around the wellbore. Formation damage can led to pore and permeability reduction. Furthermore, if the formation contains clay minerals, the mud filtrate will react with the minerals to cause a clay

swelling, hydrated or dispersed clay [1].

Lost circulation material, such as calcium carbonate (CaCO₃) with a proper grain size may reduce the invasion mud filtrate into the formation as well as preventing base materials of the mud move into the formation [2]. Based on this consideration, a drilling mud which was named DS-01 was developed. The mud uses CaCO₃ in stead of barite. The main function of DS-01 mud is to develop filter cake or mud cake that is easy to clean by acidizing. However, the application of the

mud is limited to low pressure formations such as depleted reservoirs.

This research is focused on the observation of the properties of DS-01 mud. In addition, the effects of the mud were compared with those of the conventional mud.

II. METHODOLOGY

This research was conducted in the PPSDM Migas Cepu and Akamigas Balongan laboratories. The study was initiated by the making of a DS-01 mud sample which contained CaCO₃ mineral and conventional mud.

Laboratory tests were carried out to measure mud properties and mud rheology. Furthermore, other tests were performed such as flow pH measurement, rate testing using a cake breaker filter before and after the mud cake was formed and Permeability Plugging Apparatus test to measure the filtrate volume. In general, the research procedure is illustrated in Figure 1.

2.1 Mud Filtrate and Mud Cake Measurement

When there is contact between the drilling mud and porous rock, the rock will act as a "filter" that allows fluid and small particles to pass through it. Drilling fluid that is lost into the rock is called "filtrate", while larger solid particles were held on the surface of the rock to form a layer which is called "filter cake". The filtration process only occurs when there is a positive pressure difference towards the rock. Basically there are two types of filtration that occur during drilling operations namely static filtration and dynamic filtration. Static filtration occurs if the mud is at static condition and dynamic filtration occurs when the mud is being circulated.

If the filtration loss and the formation of mud cake are not controlled, it will cause various problems, both in drilling operation stage and in production stage. A thin mud cake will be a good cushion between the drilling pipe and the borehole surface. Thick mud cake will clamp the drilling pipe making it difficult to lift and rotate while the filtrate that enters the formation can cause damage to the formation.

The standard procedure used in measuring filtration loss volume and mud cake thickness for static filtration is the API RP 13B for LPLT (low pressure - low temperature) [3]. Mud is placed in a standard cylinder with a filter paper at the bottom and pressurized at 100 psi with a measurement time of 30 minutes. The volume of the filtrate is held in a measuring cup in cubic centimeter (cc).

2.2 Measurement of Drilling Mud at High Pressure and Temperature Properties

The efficiency of drilling operations is greatly influenced by the properties of the mud. Drilling

environmental conditions, in this case are pressure and temperature, can affect the properties of the mud. In general, high temperatures can reduce the function of the mud then additives should be added to the mud to maintain the properties of the mud. If under these conditions the properties of mud cannot be controlled, it can cause problems to drilling speed, bit and hole cleaning, stability of the drill hole and other serious problems.

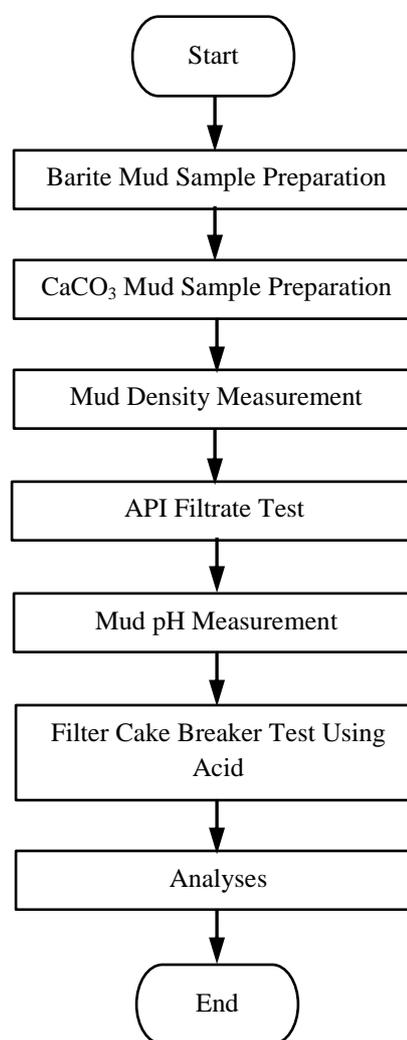


Figure 1. Flow Diagram of the Research

One of the properties of mud studied in this experiment was filtration / water loss at high pressure and temperature. The measurement of fluid loss uses High-Pressure and High-Temperature (HPHT) filter press which had the same principles as the standard filter press. In order to indicate the speed of filtration in permeable formations covered by mud cake formed after drilling, a standard filtrate paper was used.

2.3 Methylene Blue Test

When there is a lot of clay content in the mud system, it will affect the properties of the mud. The methylene blue test was used to determine the clay content in mud. In this research the value of methylene blue was less than 12.5 ppb.

2.4 Permeability Plugging Apparatus

Permeability Plugging Apparatus (PPA) is a tool used to find out the amount of filtrate produced by a drilling mud system after passing through a filter disc and how thick the mud cake is formed on the filter disc. The filter disc represents a formation layer. It has various pore sizes. The working principle of the tool is almost the same as the filter press, but this tool injects pressure both from above and below. The expected results in this method are the data of spurt loss and filtrate loss. Permeability Plugging Apparatus will also be used when the filter cake breaker testing is performed.

2.5 Filter Cake Breaker

Filter Cake Breaker is a method used to find out whether filter cake is formed on the filter disc and cover the pores on the filter disc can be easily broken down by acid or not by looking at the actual flow rate results recorded using aquadest. In other words, this method is carried out as an acidizing simulation of mud cake formed on the borehole wall. From The results obtained we can find out whether the mud will interfere with the acidizing process that will be done later or not, and whether the cake will tightly cover the pores of the rock or easily dissolved so that the acid is able to open larger rock pores to increase flowrate.

Hydrochloric Acid (HCl) is the most commonly chemical used to remove formed filter cake. However, EDTA solution can also be used as an alternative to HCl to remove the filter cake formed [4].

III. RESULTS AND DISCUSSION

The measurement results of mud properties and mud rheology are summarized in Table 1. The table shows that the measurement of plastic viscosity (PV) and yield point (YP) is two times. The properties of all mud types meet the required specification.

Table 2 shows the measurement results of initial and final rate of the four mud types. The table indicates that the mud with medium size of CaCO₃ is the best mud in this case since the mud needs a least time to flow. Other information obtained from the table is the difference between initial and final flow time of the mud with barite is much higher than those of other muds. This indicates that there was a plugging process during the test that restricting the flow of mud that resulted in permeability reduction.

Table 3 shows that the volume the spurt and the filtrate loss of the mud with barite is higher than other mud. This means that the mud produced more mud cake than other muds during the test.

Table 1. Mud Properties

Mud Properties	Spec.	DS-01 super fine CaCO ₃		DS-01 fine CaCO ₃		DS-01 medium CaCO ₃		Conventional Mud (Barite)	
Density (ppg)	1.25	1.25		1.25		1.25		1.25	
PV (cps)	ALAP	31	30	30	29	31	29	27	27
YP (lbs/100 ft ²)	15-25	17	18	19	21	17	20	23	22
LSR YP	5 – 10	6	6	7	7	9	9	5	5
Gel Strength 10' (lbs/100 ft ²)	5 – 15	10		10		10		9	
Gel Strength 10' (lbs/100 ft ²)	9 – 25	15		15		15		22	
Filtrate API (cc/30 min)	≤ 5	2.4		2.2		2.4		3.8	

Table 2. Initial and Final Rate Measurement

Mud Type	Time (Seconds)	
	Initial	Final
DS-01 CaCO ₃ Super fine	26	27
DS-01 CaCO ₃ fine	25	26
DS-01 CaCO ₃ medium	24	26
Conventional	27	48

Table 3. Spurt Loss and Filtrate Measurement

Mud Type	Spurt Loss (30 seconds)	Filtrate (30 minutes)	Total Filtrate (2xFiltrate + Spurt Loss)
DS-01 CaCO ₃ Super fine	0.40 ml	6.40 ml	13.20 ml
DS-01 CaCO ₃ fine	0.40 ml	6.00 ml	12.40 ml
DS-01 CaCO ₃ medium	0.20 ml	5.40 ml	11.00 ml
Conventional	0.5 ml	7.2 ml	14.9 ml

IV. CONCLUSIONS

The conclusions obtained from the results of the study are:

1. Testing results shows that the properties of the all mud meet the requirement.
2. The mud using medium size of CaCO₃ was the best mud since it had the smallest initial flow time compared with the three other muds.
3. The mud with barite as weighting agent experienced the biggest filtration loss that enlarged the difference between initial and final flow time.

REFERENCES

1. Van Zanten R., Horton D. W., Tanche-Larsen P. 2011. Engineering Drill-in Fluids to Improve Reservoir Producibility. SPE Journal, SPE-143845MS.
<https://doi.org/10.2118/143845-MS>
2. Hamid A. 2018. Penggunaan Fibroseal dan CaCO₃ untuk mengatasi Masalah Lost Circulation pada Sistem Lumpur KCl polimer. Petro, Vol. 7(2), 43-46.
3. API Recommended Practice 13b-2, 2009. Recommended Practice for Field Testing Water-based Drilling Fluids. Fourth Edition, American Petroleum Institute.
4. Wang X., Smith K. L, Cutler J. L, Beall B. B. 2012. Advancement in Acid-Precursor Chemistry for Removal of Drill-in Fluid Filter Cake. Society of Petroleum Engineers, SPE-147480-MS.
<https://doi.org/10.2118/147480-MS>.