Laboratory study on the addition of banana midrib and kwikseal as LCM to the physical properties of mud at high temperature

P Pauhesti*, A Hamid and C A Anggoro
Petroleum Engineering, Faculty of Earth Technology and Energy, Universitas Trisakti, Jl. Kyai Tapa No.1 Jakarta 11440 Indonesia

*paubesti@trisakti.ac.id

Abstract. Drilling mud is a very important role in drilling operations, start over drilling until reaches the depth of the intended. In the importance of drilling mud, therefore there should have an analysis of potential problems that might happen in the process of the drilling, one of them is about the lost circulation. One of the ways to overcome the loss of drilling mud is to use LCM (Lost Circulation Material). In this study used Kwiksickel and Banana Midrib as an ingredient LCM. Both of these materials into the fibrous material categories that have a little stiff texture so as inhibit the lost circulation in a way in the forced entry into the cracks and can clog the pores and close it to be able to cope with the onset of the lost circulation problem. In research was done three times experiment with the additional kwikseal and adding banana midrib. The results of the research are expected us to know how much composition kwikseal or banana midrib to be added to the mud and effective to overcome lost circulation. From the overall results obtained that the LCM Kwikseal has a better effect than the LCM Banana Midrib to reduce fluid loss at temperatures above 250°F.

1. Introduction
The purpose of drilling operations is how the drilling can reach the appropriate depth planned with no errors. An important factor that can support the optimum process of drilling is drilling mud. Drilling mud is vital for the successful drilling process to minimize the amount of time needed and increase efficiency in circulation. The more additives are used and the more varied type and usefulness [1].

In this study, two kinds of LCM are used, Kwikseal and Banana Midrib as material for the LCM. Both materials are categorized as typical materials that have a slight rigid texture that can inhibit the loss of circulation in a way forced into the cracks and the problem that can overcome the occurrence of loss circulation problem [2].

This study aims to analyze how much effectiveness of both materials, banana midrib and kwikseal, in overcoming lost circulation [3].

2. Method
The experiments conducted in a laboratory were studied how to prevent the loss of mud by using fresh water base mud with the properties of low solids mud. Fresh water base material will be mixed with bentonite. The additives used are banana midrib and kwikseal as LCM. The purpose of this observation is to be able to find out the influence of banana and kwikseal as LCM against mud rheology and physical
properties [4]. LCM here is the one additive that is inserted into the drilling mud that aims to overcome the lost circulation. There are three systems of mud that are analyzed, mud without LCM (water base mud), mud is added banana midrib (mud system A), and mud system with the added material of kwikseal (mud system B) [5]. The work procedures can be seen in figure 1.

![Research flow chart](image)

**Figure 1.** Research flow chart.

The specifications of drilling mud that must be met in temperatures above 250°F in order to prevent problems in a drilling process. The drilling specifications can be seen in table 1.

**Table 1.** Drilling fluid specification at 250°F (laboratory standard).

| Properties                  | 250°F                  | Specification       |
|-----------------------------|------------------------|---------------------|
| Density                     | 8.5 – 9.5              | ppg                 |
| Viscosity                   | 40 – 55                | second/quartz       |
| Plastic Viscosity           | 5 - 11                 | cp                  |
| Yield Point                 | 9 - 15                 | lbs/100 ft²         |
| Gel Strength 10 seconds     | 3 – 5                  | lbs/100 ft²         |
| Gel Strength 10 minutes     | 8 – 13                 | lbs/100 ft²         |
| Water Loss                  | < 11                   | cc                  |
| Mud Cake                    | < 1.5                  | mm                  |
| pH filtrate                 | 8.5 – 10.5             | dimensionless       |

In each mud concentration, researched the physical properties consisting of density, viscosity, gel strength, fluid loss and chemical properties such as pH. The addition of the two materials LCM, banana
midrib and kwikseal each as many as three systems (1 gram, 3 grams, 5 grams). This experiment was carried out from 80°F which is considered as room temperature and 250°F as the highest temperature considered as the formation temperature. The temperature changes are due to the heating with the thermo cup which aims to represent each depth. The mud composition can be seen in table 2.

| Materials       | Units | Composition | Mixing time (minutes) |
|-----------------|-------|-------------|-----------------------|
| Water           | ml    | 346.843     | -                     |
| Soda Ash        | gr    | 0.30        | 1                     |
| Bentonite       | gr    | 10.0        | 7                     |
| Caustic Soda    | gr    | 0.50        | 1                     |
| Ben-ex          | gr    | 0.10        | 5                     |
| CMC-HV          | gr    | 0.50        | 5                     |

Table 2. Water base mud composition (laboratory standard).

Mud system A the composition used is the same as water base composition, but added LCM banana midrib with three different magnitudes, namely 1 gram (A1), 3 grams (A2) and 5 grams (A3). The mud composition can be seen in table 3.

| Materials | Composition | Mixing time (minutes) |
|-----------|-------------|-----------------------|
| Water (cc)   | 346.64    | 344.69    | 343.23    | -          |
| Soda Ash (gr) | 0.30    | 0.30    | 0.30    | 1          |
| Bentonite (gr) | 10.0    | 10.0    | 1/0    | 7          |
| Caustic Soda (gr) | 0.50    | 0.50    | 0.50    | 1          |
| Ben-ex(gr) | 0.10        | 0.10        | 0.10        | 5          |
| CMC-HV (gr) | 0.50        | 0.50        | 0.50        | 5          |
| Banana Midrib (gr) | 1.00 | 3.00 | 5.00 | 5          |

Table 3. Mud system A composition.

For mud system B, the LCM used is kwikseal with three system same as the variation in the amount of mud used in system A. The objective is to be able to know and compare the effectiveness of each LCM with the same amount. The composition of mud system B can be seen in table 4.

| Materials | Composition | Mixing time (minutes) |
|-----------|-------------|-----------------------|
| Water (cc)   | 346.123    | 344.68    | 343.23    | -          |
| Soda Ash (gr) | 0.30    | 0.30    | 0.30    | 1          |
| Bentonite (gr) | 10.0    | 10.0    | 1/0    | 7          |
| Caustic Soda (gr) | 0.50    | 0.50    | 0.50    | 1          |
| Ben-ex(gr) | 0.10        | 0.10        | 0.10        | 5          |
| CMC-HV (gr) | 0.50        | 0.50        | 0.50        | 5          |
| Banana Midrib (gr) | 1.00 | 3.00 | 5.00 | 5          |

Table 4. Mud system B composition.

The next step is to measure the density of each mud system, determine the mud viscosity, measure the plastic viscosity, determine the gel strength, determine the fluid loss and determine the pH which are all carried out at two temperature conditions.
3. Results and discussion

Density of base mud system (lumpur dasar) is 8.70 ppg at 80 °F, the density decreases to 8.55 ppg after temperature is adjusted to 250 °F [6]. Mud is added with the LCM banana midrib and kwikseal, mud density is not much different from the basic mud system at 80 °F and decreased after heated to 250 °F. From the results that have been observed with the addition LCM, it can be concluded that the material LCM in the mud system A! B1 and B2 have good mud density because they are in the standard specifications, 8.5 – 9.5 ppg [7].

In figure 2 states that at temperature 80 °F, 137 °F, 194 °F and 250 °F the density included in the specification standard is mud system B with LCM Kwikseal [8].

In figure 3 the graph between temperature and viscosity is related to the ability of the mud to lift the cutting to the surface. In mud system A and B, the results included in the specification are mud system A1, A2 and mud system B1 and B2 because they can produce good viscosity [9].

Viscosity of the mud system A at 250 °F range from 38 – 42 second/quart is almost equal to the viscosity of the base mud, 43 second/quart. The viscosity which in the standard specifications ranging from 40 – 55 second/quart. The viscosity of the mud system A1 and A2 can meet standard specification is ranging from 42 and 40 second/quart, while the A3 system mud ranges from 38 second/quart [10]. On the B mud system with LCM material, viscosity of mud seal, mud system B at 250 °F ranging from 48-58
second/quart, the B mud system has a greater viscosity, compared to the base Mud 43 second/quart [11]. In mud system B, the viscosity that meets the standard specification is the mud system of B1 and B2 ranging from 48 – 53 second/quart, for the system mud B3 has a result of 58 second/quart [12].

In figure 4 shows the results of the fluid loss analysis, this is related to the fluid loss in the mud at the drilling process. At mud system A2 with LCM 5 grams banana midrib and mud system B are in the specification standard.

![Temperature vs API fluid loss](image1.png)

**Figure 4.** Temperature vs API fluid loss.

Fluid loss measurements are important to do because the results of the fluid loss can determine the effectiveness of the lost circulation material [13]. The addition of an LCM to the mud can affect the price of the fluid loss. The ideal fluid loss is less than 11 cc. The fluid loss of mud system A that can be seen on the figure 4 indicates the value above the ideal value that ranges from 11 cc. In mud system A that handles the rate of the fluid loss is the mud system A1 and A2 [14].

In figure 5 is the result of temperature vs mud cake analysis. Mud cake in accordance with the specifications can maintain in the stability of the borehole [15].

![Temperature vs mud cake](image2.png)

**Figure 5.** Temperature vs mud cake.

The results of the mud cake system A and B at 80 F and 250 F produce mud cake under the maximum mud cake limitation less than 1.5 mm. The value of the mud cake should be below 1.5 mm so that the mud cake can withstand water coming out from the mud drilling that could cause dehydration in the mud. So, it can be concluded that the mud system A with the material LCM banana midrib and mud system B with LCM material kwikseal is equally able to provide a mud cake in accordance with the standard specification can maintain in the stability of the borehole.
4. Conclusion
The results of this study can be summed up as follows, at measurements of density in both mud systems that have corresponding standard specifications of the price of density mud system A1 with banana midrib as the LCM as much as 1 gram, and the mud system B1 and B2 with kwikseal as LCM of 1 gram and 3 grams. In viscosity measurements, both mud systems after experiencing a temperature increase up to 250°F, which has the corresponding standard specifications of the viscosity price are the system mud A1 and A2 with banana midrib as LCM as much as 1 gram and 3 grams, and mud Systems B1 and B2 with kwikseal as LCM as much as 1 gram and 3 grams. In the mud cake measurement, both of these mud systems are both banana midrib and kwikseal can meet the standard of mud cake specification, which ranges below 1.5 mm. Based on the results of research, the fluid loss that occurs in the mud system B The material of the kwikseal can be addressed well, can be seen from the value of fluid loss for 30 minutes is 10 – 11.8 cc is at the ideal range of 11 cc. Whereas mud a system with banana midrib release material if more added material LCM can be able to cope with fluid loss, can be seen in the mud A system that can meet the specifications of the fluid loss is the mud system A2 and A3 as much as 3 grams and 5 grams ranging from 9.6 – 11.4. For mud system A1 is less capable in tackling well. 8. In pH measurements that meet the specification values ranging from 8.5 – 10.5. Thereby inferred from these two materials LCM is best to use is kwikseal because although the banana midrib can also reduce the fluid loss but there are many physical properties of mud that do not According to specification standards.

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