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Laboratory study of additional use nano silica composite and bagasse ash to improve the strength of cement drilling

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Abstract. The effect of increasing cement prices and expensive additive will have an impact on the cost of cementing of oil and gas wells. So, the need for a strategy undertaken in order to minimize the cost of cementing other than that a good cement strength with additive alternative materials is necessary. Strategies are carried out by using materials that are economical and environmentally friendly in which the material is organic waste materials that have elements of silica and are pozzolanic. As for organic ingredients that are pozzolanic is bagasse ash. In addition, to reduce the level of cement pores, it is necessary to add additional additives by using nanosilica. Testing of the physical properties of cement conducted in laboratory research is by testing strength on cement with additives of bagasse ash added nanosilica into drilling cement suspension with temperature conditioning research 120°F pressure 14.7 psi and 24 hours in the water bath. The results of the research on several scenarios of the concentration of the addition of bagasse ash showed that the optimal compressive strength value obtained was 991.83 psi and the optimal shear bond strength obtained was 97,49 psi at the concentration of ash bagasse in 5% and nanosilica 0,019% in drilling cement.

1. Introduction

The drilling operation is an activity to see the characteristics of rock types in drilling wells. By looking at the characteristics of rock types, we can analyze the parts of rock types that contain oil and lift the oil to the surface. there are several aspects in drilling operations, one of which is [1]. Cementing is a way that is done to isolate zones in drilling wells to prevent the entry or expansion of undesirable formation fluids into drilling wells as well as an insulating material between the casing and formation [2].

Cementing is the process of pushing the cement slurry into the casing and going up to the annulus which is then allowed to stand until the cement hardens to have inherent properties, both to the casing and formation. The cementing process is carried out around the outer casing diameter that has been inserted into the wellbore. The diameter of the wellbore is greater than the diameter of the casing, therefore to strengthen the position of the casing, cementing is necessary [3].

The cement used in the petroleum industry is in the form of cement powder material without additives, namely Portland cement. The cement materials are limestone, clay and iron compounds (Fe_2O_3) plus a certain amount of gypsum to slow down the setting time and to increase cement hardness. Portland cement is cement commonly used in cementing operations in wells in the oil industry. This Portland cement will harden when it encounters water. This cement is made from calcareous base materials such as limestone, marl, coral and argillaceous like clay, shale, slate [2].

In general, cementing operations aim to attach the casing to the wall of the wellbore, protect the case from mechanical problems during drilling operations (such as vibration), protect the casing from the corrosion of formation cores that are corrosion and to separate one zone from another behind the casing [4].

2. Materials and Method

Tools and materials preparation is the initial process before the experiment starts, after that the test of basic cement slurry will start according to API standard (density, and free water test). A test will be next to determine the effect of Bagasse to both cement strength, CS and SBS. The main material which is prepared is nano silica and bagasse ash itself as an additive. The characteristics of the cement composition can be seen in Table 1.

Table 1. Cement Compositions

Composition	**Specific Gravity**
Cement type G	3,175
Water	0.98
Bentonite	2.65
Nano Silica	2,17
Bagasse Ash	1,3067
Calcium Chloride	2,15
Polypropylene Glycol	1,04

API G class cement from PT. Holcim is used in this experiment. This cement is the basic cement which is used at 8000 ft. (2440 m) depth. The cement slurry contains cement, water, bentonite, CaCl2, nano silica, bagasse ash, and polypropylene glycol. The cement slurry is made by mixing water and base cement into a cement mixer with low speed (about 200 rpm) and additives. After that continues the mixing with high speed (about 500 rpm) in 10 – 15 minutes.

After the slurry is done, the slurry will be put on the cubic and cylinder mold which are used in CS and SBS tests, with the following procedures:

1. The mixed cement suspension is incorporated into the cubic mold and the cylinder mold.
2. Closes the sample mold with aluminum foil and then with plastic until tightly and then immerses it in a water bath temperature controller that has been preheated according to the desired temperature, in this case, the temperature used is 140°F
3. Allow the mold for 24 hours, after 24 hours of sample lifted from water bath temperature controller then open sample from the cubic mold.
4. Measure pressure force cubic mold sample for compressive strength and cylindrical mold sample for shear bond strength with hydraulic pressure.
5. Record the test results for compressive strength and shear bond strength.

The procedure of determining compressive strength and shear bond strength was performed for all cement samples with the predetermined ash of rice husk composition.

For the rheology and density tests have been done with the following procedures:

1. Rheological properties of cement suspension are tested with VG meter Fann tools.

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2. Fill the VG meter fan vessel with a cement suspension that has been prepared to a specified limit.
3. Place the vessel in its place and adjust the position of the vessel in such a way that the rotor and bob are immersed into the cement suspension according to a predetermined limit.
4. Move the rotor at high speed by placing the rotor speed at 600 rpm. Screening continues to be carried out so that the scale (dial) reaches balance. Record the price shown on the scale as a reading of 600 rpm.
5. Lower the speed to 300 rpm and wait for the scale to reach balance then record the scale as a reading of 300 rpm.

The tools which are used in this experiment are:

1. Digital Scale
2. Cement Mixer with constant speed
3. Mud Balance
4. Measuring Cup
5. Fann VG meter
6. Filter press
7. Atmospheric consist of a meter
8. Water bath temperature controller
9. Sample molds
10. Hydraulic press
11. Stopwatch

3. Result and Discussion

The effect of additives on compressive strength can be seen in Figure 1.

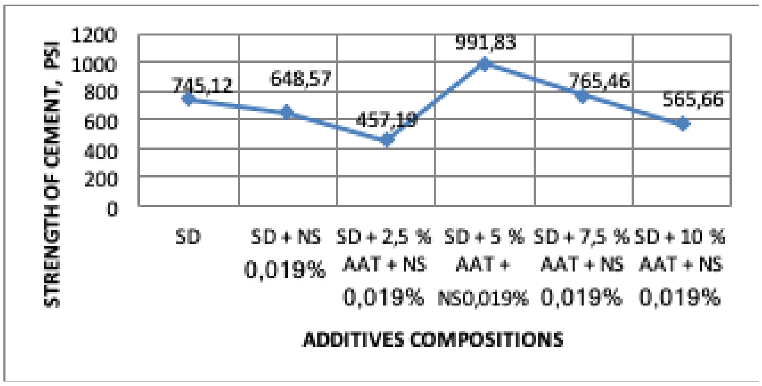

Figure 1. Compressive Strength vs Additives Compositions

Figure 1 Shows the value of compressive strength in basic cement and various compositions of cement added with bagasse ash concentration which began at concentrations of 2.5%, 5%, 7.5%, and 10%, in each 0.019% nanosilica addition at various concentrations. The basic cement sample obtained compressive strength value of 745.12 psi. then bagasse ash testing was carried out with the addition of 0.019% nanosilica into the cement drilling suspension.

At 0.019% nanosilica concentration and the addition of 2.5% bagasse ash decreased the compressive strength value of the base cement. Due to the amount of silica content in bagasse and nanosilica ash is still small compared to the content of lime (Ca (OH) 2) in cement. If lime, silica, and water cannot bind perfectly, it can cause cavities in cement which results in weakened strength prices [5].

At a concentration of 7.5% and 10% bagasse ash and nanosilica 0.019% seen from Figure 1 there was a decrease in strength value this was due to the amount of silica content on the amount of lime compound content (Ca (OH) 2) in cement so that the binding capacity was reduced which causes weakening of price strength [6]. Then in Figure 1 the optimum compressive strength value in the concentration of bagasse ash addition is at the concentration of 5% bagasse ash and nanosilica in a cement suspension with a compressive strength value of 940.92 and a shear bond strength value of 156.27 psi.

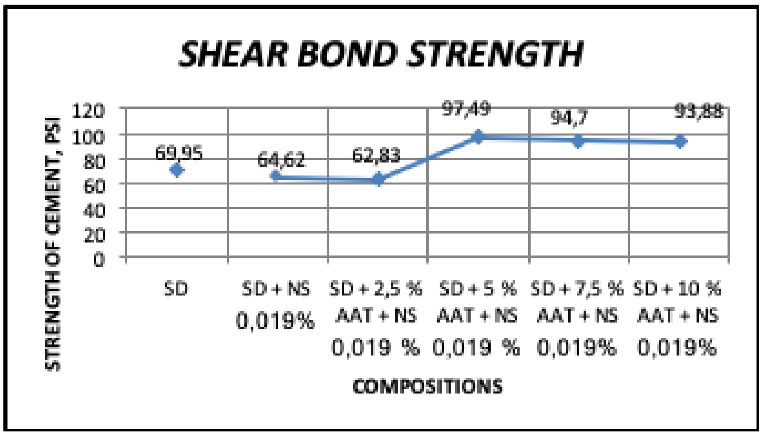

Figure 2. Shear Bond Strength vs Additives Compositions

Figure 2 shows the additives effect to shear bond strength in drilling cement. Same with compressive strength. Figure 2 shows the value of shear bond strength in basic cement and various compositions of cement added with bagasse ash concentration which began at concentrations of 2.5%, 5%, 7.5% and 10%, at each 0.019% nanosilica addition at various concentrations.

Results of the tests carried out, Figure 2 shows the addition of bagasse ash 5% and nanosilica 0.019% having a higher Share Bond Strength price of 97.49 psi. Whereas in addition to 0-2.5 bagasse ash, the price of Share Bond Strength is low. This is due to the greater percentage of addition of bagasse ash, the greater the amount of SiO2 content. The large amount of SiO2 in the cement suspension will provide a good cement bonding but when it exceeds the tolerance limit, it will cause a weak cement bond because the cement porosity that is formed is getting bigger [7].

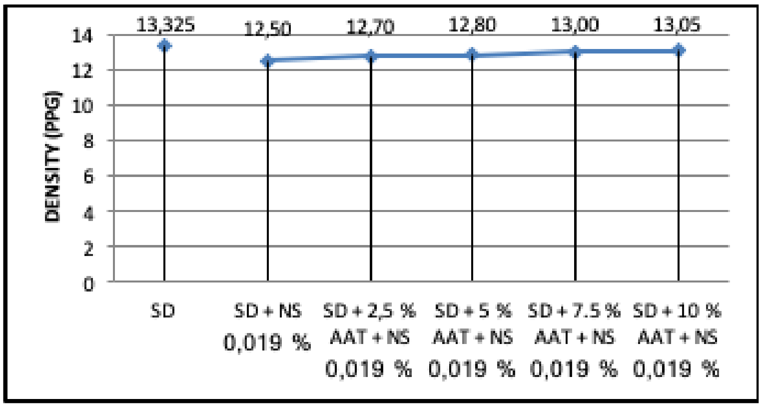

Figure 3. Shear Bond Strength vs Additives Compositions

Figure 3, measure the density using mud balance. Measurement results using mud balance where the Basic Cement is obtained is 13,325 ppg. While with bagasse ash addition, the density value decreases, this is caused because the density value of bagasse ash 1.3067 gr/ml is small so it can reduce the density price in drilling cement.

The density presented in Figure 3 explains that bagasse ash can be used as a lightweight additive (light additive) which can reduce the density of drilling cement. However, if there is an additional percentage of bagasse ash, there will be an increase in drilling cement density. The density of cement suspension greatly affects the pressure of the cement suspension into the wellbore. If the formation is unable to withstand the pressure of the cement suspension it will cause the formation to break, resulting in lost circulation. The low density of cement suspension is often used in primary cementing operations and remedial cementing, which is useful for avoiding fractures in weak formations [3].

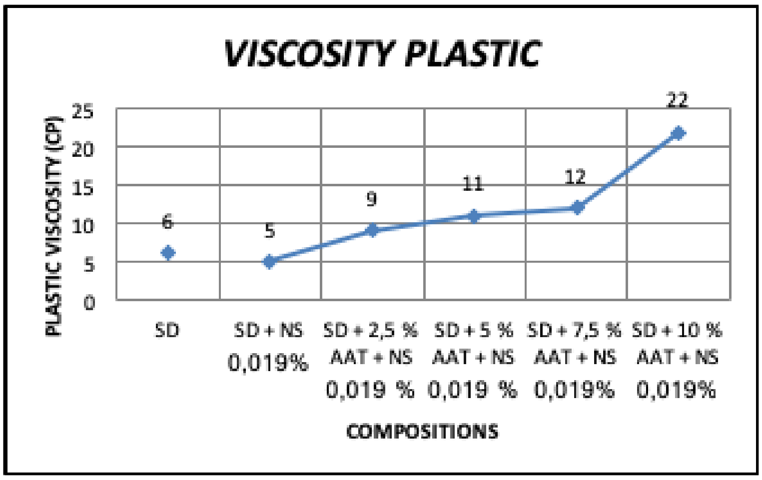

Figure 4. Plastic Viscosity vs Additives Compositions

The value of plastic viscosity (Figure 4) has increased due to the effect on the addition of bagasse ash and nanosilica. In addition, there is a similar relationship with density so that when the density is high it will affect the value of the plastic viscosity.

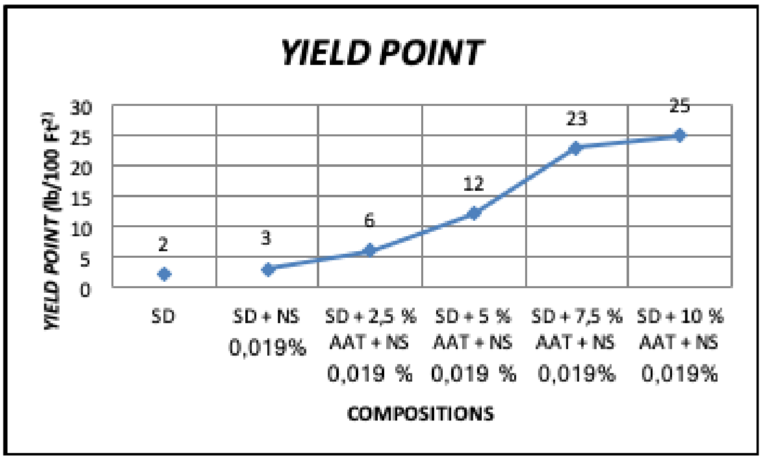

Figure 5. Yield Point vs Additives Compositions

The increasing of yield point occurs due to the binding of bagasse ash which is predominantly silica (SiO) with cement which is mostly composed of lime (CaO2) in drilling cement which is an attractive pull force between particles so that an increase in yield point can be seen in figure 5.

Rheology testing is carried out to estimate pressure loss due to friction and properties of cement suspension flow. By estimating pressure loss, it can regulate the pumping pressure of cement during cementing operations. Figure 6 shows the magnitude of free water that occurs in the cement suspension. The maximum limit of free water volume from the cement suspension is 3.5 ml which are allowed to stand for 2 hours at room temperature. If it exceeds the maximum limit, it causes the formation of pores so that the quality of cement is not good. From all the testing of free water samples that have been done, the data obtained shows that the values of all samples are not significantly

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different. From laboratory testing, the smallest free water value, which is the composition of basic cement, is added with 5% bagasse ash and 0.019% nanosilica at 1.5 ml.

By paying attention to the free water produced by the cement suspension we can do problem prevention, in order to regulate how much water is needed, because if it is not considered it will result in poor cement suspension. If too much water is added, this will cause incomplete cementing.

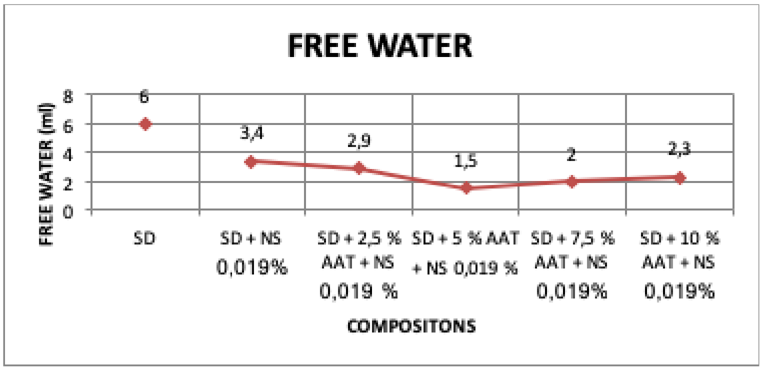

Figure 6. Free Water vs Additives Compositions

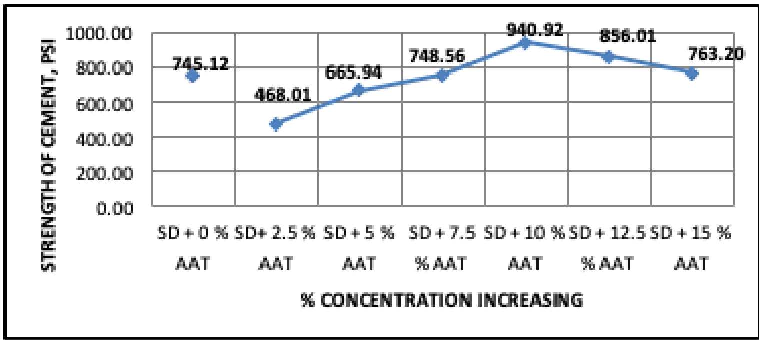

Figure 7. Compressive Strength vs Concentration Increasing

In previous studies, drilling was carried out by adding bagasse ash to increase the value of compressive strength. The value of compressive strength obtained can be seen in Figure 7.

The optimum value obtained from the addition of bagasse ash without nanosilica addition was 940.92 psi while the addition of nanosilica in the suspension of cement in bagasse ash was 991.83 psi (Figure 7). this proves that the addition of nanosilica has an impact on the increase in compressive strength because nanosilica has very fine particles and can close pores which cannot be covered by bagasse ash in the cement suspension so that the resulting cement will be good and have a low porosity value.

4. Conclusion

The effect of bagasse ash concentration variation of 0-5% with 0.019% nanosilica experienced an increase in the value of compressive strength and shear bond strength. Furthermore, bagasse ash concentration of 7.5% to 10% with 0.019% nanosilica experienced a decrease in compressive strength and shear bond strength. So the optimum concentration of bagasse ash obtained is 5%.

From several scenarios of bagasse ash composition and nanosilica composites that have been carried out, the optimum value obtained is 5% with compressive strength value 991.83 psi and shear bond strength 97.49 psi with a density value of 12.70 ppg and free water 1.5 ml.

Footnotes should be avoided whenever possible. If required they should be used only for brief notes that do not fit conveniently into the text.

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