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Analyzing the effect of gradation on specific gravity and viscosity of barite powder used in excavation mud

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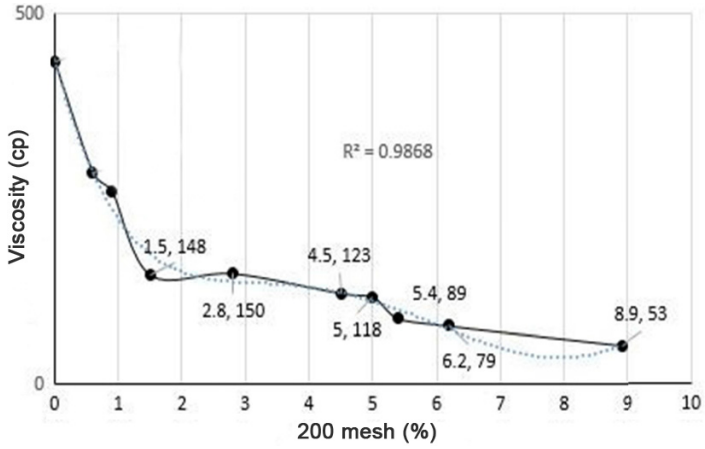
HIGHLIGHTS

- The excavating companies consume more barite powder when the specific gravity of excavation mud is diminished.
- It is very important to select the appropriate material to adjust the viscosity and density.
- The dimensions of the particles get finer; the specific gravity is changed and increased.

GRAPHICAL ABSTRACT



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ABSTRACT

Barite is an important additive material to increase the weight of excavation mud. It has been used extensively in the excavation mud industry. The barite particle sizes used in excavation mud is very important. There is a direct relationship between the amount on the sift of 200 and 325 mesh. By reducing particle sizes of the 200 and 325 mesh, the specific gravity of the barite power increased slightly. It could be concluded that increasing the size of the barite powder particle can reduce density, but this should be considered as a laboratorial error. Thus, granulation has a great influence on the viscosity of barite powder. According to previous studies dimensions below 325 mesh are very influential on viscosity. It can be said excavating companies consume more barite powder when the specific gravity of excavation mud is diminished because barite powder can enhance specific gravity but the viscosity goes up. There will be more problems in the excavation mud if viscosity increases.

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1. Introduction

The main task of drilling mud is to carry the drill bit to the head well [1]. In fact, the mud will pump from the reservoir into the well [2-3]. Barite is one of the most important additive materials to increase the weight of excavation mud. It has been used extensively in this industry. According to different statistics, approximately 6 million tons of barite is used in the excavating mud industry. When Barite powder was ground it demonstrated an inverse relationship between viscosity and gradation in the lab. In fact, increasing the size of barite powder particles can reduce viscosity of its mud. Barite is identified a strategic mineral existing in nature with several applications specially in excavating mud [2-4]. The specific gravity of excavating mud is 4.2 or more, its stiffness is 2.5 to 3.5 in Moss stiffness measurement, and the size of the particles is less than 74 micron. The mud can support and fill the well around the drilling area. Therefore, the concentration and viscosity of the drilling mud should be sufficient to control the pressure of the wall. It should be noted, water, air and oil fluids are used to make drilling mud. Air is the cheapest and most accessible fluid used up to now [6]. In some cases, in order to prevent the loss of drilling performance, ilmenite, manganese oxide, barite and silica particles are used on a Nano scale. So, it is important to select the appropriate material to adjust the viscosity and density. The specific gravity and viscosity of barite powder are very effective parameters in the type of drilling mud. Depending on the amount of powder, barite powder can have variable values [7-10].

In the current essay we investigate and optimize the parameters of specific gravity and viscosity for drilling mud. Therefore, by changing the amount of barite powder aggregation and analyzing the obtained data the ideal aggregate for proper operation of drilling mud can be determined.

2. Methodology

The feed is crushed to less than 6 mesh with a jaw crusher. After homogenization the powder was divided into 10 samples of 2 kg weight. Then it was thoroughly control ground by milling at different times (Figure 1). It should be noted, time was differed for grain control. In order to produce the desired grain, the crushed matter was controlled with 200 and 325 mesh screens.

The test parameters are: pH at normal temperature, pH at 82 ^{o}C, specific gravity, the remaining matter on the sift 200 mesh, the remaining matter on the sift 325 mesh, the solid particles dissolved in the water, the apparent viscosity before adding the plaster, after adding the real plaster and the alkaline amount of the soil metals dissolved as Ca^{2+}.

2.1. The instructions and evaluating methods of barite powder

Barite is a weight increasing substance with the specific gravity of 4.2 gr/cm^3. 75PCF is used as the specific gravity increasing substance in non-productive layers like Gachsaran. The barite powder used in the excavating mud should have the following global standards (API 13A).

2.1.1. Determining the pH of barite powder

35 gr of barite powder is mixed with 350 ml of water and its pH is measured by the pH paper or the pH meter. The mixture is heated to 82 ^{o}C and its pH is measured again.

2.1.2. The specific gravity of barite powder

The specific gravity is calculated by the Le Chatelier's method. About 200 gr of barite is dried in the oven and poured in the Le Chatelier container until the zero line. Then, it is placed in a bath at a stable 31.6 ^{o}C in order to register the maximum petroleum expansion, after half an hour (primary volume) the dried barite is poured into a metallic cylinder until it is completely filled. The

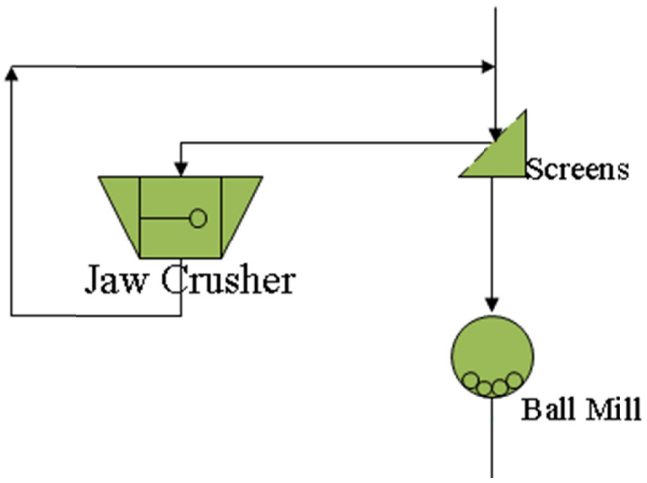


Fig. 1. Crushing and screening of feed.

cylinder and the barite are weighed and registered as the primary substance. After an hour, the maximum temperature of the petroleum is 31.6 °C. The Le Chatelier container is moved out of the bath and the dried barite is added to it. Thus, the height of the petroleum is 18 cm. The Le Chatelier container is again placed in the bath. The metallic cylinder with the remained barite is weighed again and registered as the secondary weight. After an hour the volume of Le Chatelier volume is read and registered as the secondary volume.

2.1.3. Determining the gradation by washing using sift

Sifts 200 and 325 meshes were used and then 100 gr of barite was added and washed by water at 15 psi pressure until clear water passed through the sift. The sifts should be dried in the oven. The barite content of each of them is weighed and registered based on the weight percentage.

25 gr of barite is added to 50 cm^3 of distilled water in an Erlenmeyer flask and then stirred for 5 min. Next, it remains still for 5 min and then is filtered by filter paper 42. Addition to 50 cm^3 of warm distilled water and the above mentioned steps are repeated. The third time, 50 cm^3 of cold distilled water is poured on the solid particle left in the Erlenmeyer flask. After three stages, about 150 cm^3 of water will be in the glass container. This container is put on the evaporating machine to evaporate the water content. Next, the glass container is next put into the oven to until completely dried. The solid sediments remaining in the glass container is weighed. Thus, the weight of the solid particles dissolved in the water is obtained by subtracting the weight of the empty glass container from the weight of the sediment inside. The calculated number is multiplied by 4 to achieve the percentage of the solid particles dissolved in water.

2.1.4. Determining the apparent viscosity

The amount of the required barite could be calculated by Eq. (1).

$$\text{Amount of the required barite} = \frac{D \times V(d_2 - d_1)}{D - d_2} \quad (1)$$

where D is the specific weight of the barite (4.2), V is the volume of distilled water for the test (250 cm^3), d_2 is the maximum weight of the specific weight by increasing the barite (2.5 gr/cm^3) and d_1 is the specific weight off the distilled water (1 gr/cm^3).

The amount of the intended barite is 927 gr which is poured into 250 cm^3 of distilled water. The weight is measured by the mud scale which should be 2.5 gr/cm^3. This mud is put in a closed glass container for 24 hrs. Then, the mud is mixed for 10 min and the θ_{600} is read and the apparent viscosity is calculated by a viscometer (Eq. (2)).

$$\text{Apparent viscosity} = \theta_{600}/2 \quad (2)$$

Then, 2.3 gr of plaster is added to the mud, it is stirred for 10 min and again the and the apparent viscosity are calculated.

2.1.5. Determining the amount of dissolved soil alkaline metals

100 gr of barite is added to 100 cm^3 of distilled water. Then, it is stirred on the shaker for 10 min three times and then let stand still for another 10 min. The liquid phase is filtered by filter paper 42 and the water is trapped in the glass container. 50 cm^3 distilled water, 5-6 drops of indicator EBT, and 10 cm^3 of clear water added into a Erlenmeyer flask. Then, it is put on a magnetic stirrer and titrated by the 400 ppm (EDTA) of Versonite solution to change the red color of the solution into blue one. The percentage of dissolved soil alkaline metals could be determined by using Eq. (3).

$$\text{Alkaline earth metal (\%)} = \frac{\text{Versonite consumption} \times 40}{10} \quad (3)$$

3. Result and discussion

Barite is one of the most strategic minerals in nature with many applications in drilling mud. Barite is a weight increasing substance which is used to a large extent in the base water.

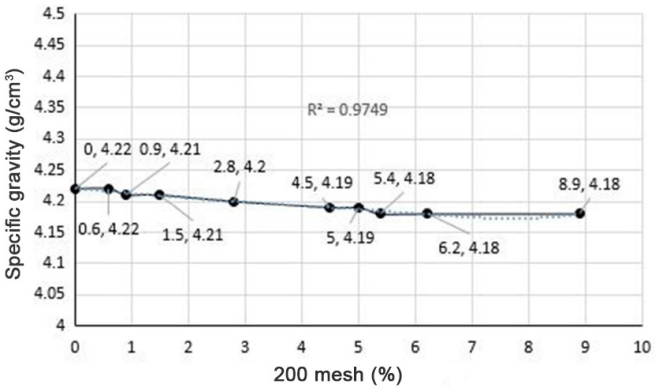
This article investigated and optimized the effective parameter such as barite aggregation, bpecific gravity and proper viscosity. It was planned to crush the barite in a gradation higher and lower than the standard used by excavation companies to scrutinize the complete trend of viscosity and specific gravity changes. Our results indicated that the coarser gradation corroded faster than other samples. The gradation changes of the

samples have been made by sifts of 200 and 325 mesh in order to be analyzed.

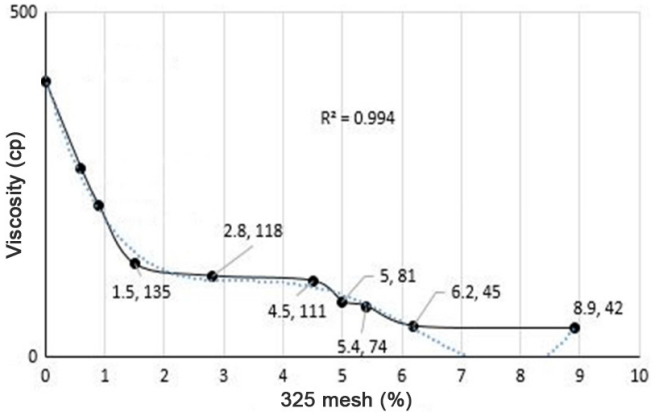
Therefore, Figure 2(a) shows the amount of barite gradient on 200 mesh grains per specific gravity. Also, the effect of aggregates on 325 mesh on specific gravity is measured as shown in Figure 2(b).

As can be seen in Figure 2(a), reducing the size of the grains increases the amount of the specific weight. The reason for these changes can be a loss of porosity between the particles. In other words, by increasing the crushing and the smaller the size of the particles, the hollow spaces between the particles will be eliminated. According to the specific gravity formula, the volume of particles decreases and ultimately increases the specific weight.

Figure 2(b) shows that reducing the size of the grains increases the amount of specific weight. The amount of 2% of the remaining material on the silicon can increase the density up to 4.22 gr/cm^3. By increasing the amount of material up to 8%, the density can be increased to 8 gr/cm^3.

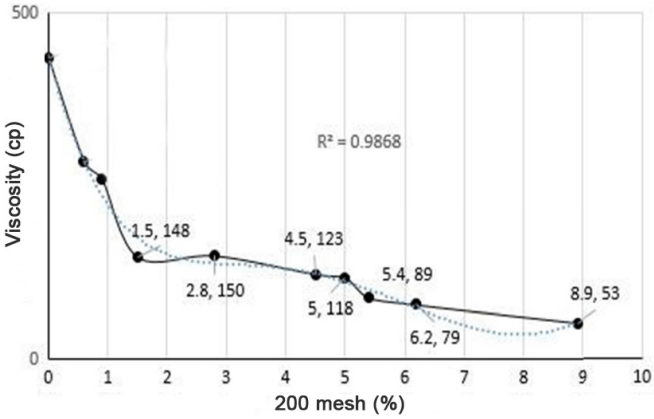


(a)

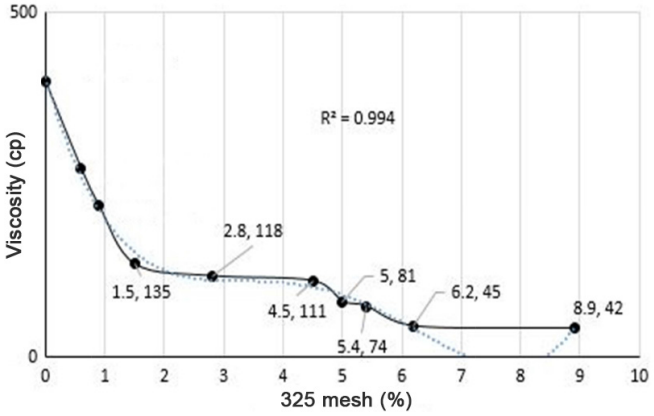


(b)

Fig. 2. The effect of graining on specific gravity (82 °C) of (a) 200 mesh and (b) 325 mesh.



(a)



(b)

Fig. 3. The effect of grains on specific gravity of (a) 200 mesh and (b) 325 mesh.

The effect of graining on the viscosity on 200 mesh is shown in Figure 3(a). The mesh size on the mesh 325 mesh is also measured in Figure 3(b).

Figure 3(a) shows that reducing the particle size or decreasing grain size can increase the viscosity. The results show that if 2.8% of the material remains on the 200 mesh, it can produce a viscosity of 118 cp. Increasing the material on the screens to 9% can decrease viscosity to 42 cp. Figure 3(b) shows increasing the size of the particle increases the viscosity. The results show that 5% of the material remaining on the 325 mesh screen can produce a viscosity of 118 cp. So, increasing the available materials on the surface of the screen to 9% can decrease the viscosity to 53 cp.

4. Conclusion

Barite is identified as one of the strategic mineral existing in nature and it has several applications specially in excavating mud. In some cases, in order to prevent the loss of drilling performance, ilmenite, manganese oxide, barite and silica particles are used on

a nano scale. Therefore, it is very important to select the appropriate material to adjust the viscosity and density. A drastic increase in the size of particles or the gradation reduction can lead to high viscosity. It is hard for excavating companies to transmit the excavating mud by pumps. In contrast, it is difficult to treat excavating mud after the cycle of excavating mud movement. Specific gravity variations with a percentage on 200 mesh screen can be estimated by increasing the particle size. On the other hand, changes in the particle size of 325 mesh have a greater effect on the specific weight than changes in the particle size of 200 mesh. More normal numbers and slopes are observed in the changes on 200 mesh than the percentage of the changes on 325. The dimensions of the particles get finer; the specific gravity is changed and increased.

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