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Memorandum

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To:

From:

Partners:

Subject: Lab No. 2: Introduction to Viscosity

Date:

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The main objective of this experiment was for students to obtain a better understanding of viscosity, and how it differs among fluids. This lab in particular focuses on bentonite and barite based drilling muds, and how these fluids compare on the basis of viscosity to water. This comparison was executed using a marsh funnel and timer to generate approximate funnel times for the two mud types and compare them to a water base time. Additionally, water, bentonite mud, and barite mud will be compared regarding their specific fluid densities in pounds per gallon using a mud balance.

“On my honor as an Aggie, I have neither given nor received unauthorized aid on this academic work.”

## Title: Introduction to Viscosity

### Executive Summary:

The main objectives of this experiment included measuring fluid density using a mud balance and comparing the funnel viscosity of water with the funnel viscosity of drilling fluids. This lab focuses on drilling fluids containing bentonite clay and barite. This comparison was executed using a marsh funnel and timer to generate approximate funnel times for the two mud types and compare them to a water base time. These times were used to approximate each fluids viscosity when compared to water. Additionally, water, bentonite mud, and barite mud will be compared regarding their specific fluid densities in pounds per gallon using a mud balance. The main conclusions of this experiment concerns how the addition of bentonite clay and barite can affect drilling fluids. The addition of barite increases fluid density without dramatically increasing viscosity, whereas the addition of bentonite clay increases fluid density as well as viscosity.

### Conclusions:

#### Viscosity analysis using a Marsh funnel

- Viscosity can be approximated by the amount of time it takes for one liter of the tested fluid to drain from a Marsh funnel.
- Water is the least viscous fluid tested, followed by drilling fluid 2 (barite and water), and lastly drilling fluid 1 (bentonite and water).

#### Measuring fluid density using a mud balance

- Water has the lowest weight (ppg) due to the fact it contains no dissolved solids.
- Bentonite mud and barite mud both have heavier weights (ppg) than water, and a small difference in weight (ppg) between each other.
- Weight (ppg) can be defined as fluid density in pounds per gallon. So reiterating, water is the least dense fluid tested, followed by bentonite mud, and lastly barite mud.

### Discussion and Results:

The laboratory group predicted that water would have the lowest viscosity, followed by barite mud, and lastly bentonite mud. These predictions were confirmed by the funnel times recorded in **Table 1**. Marsh funnels produce a rough approximation of how viscous a fluid is, the longer a fluid takes to drain from the funnel, the more viscous the fluid. Water is used in this experiment as the benchmark or “calibration” fluid for the funnel. Referring to the conclusions drawn from this experiment, Drilling Fluid 1 is defined as bentonite mud and Drilling Fluid 2 is defined as barite mud.

**Table 1 – Funnel Times and Fluid Weights**

<b>Fluid</b>	<b>Time (seconds)</b>	<b>Weight (ppg)</b>
Water	26.29	8.35
Drilling Fluid 1	33.56	8.60
Drilling Fluid 2	30.43	8.62

These times confirm the groups assumptions regarding water, barite mud, and bentonite mud. With the relative viscosities of the three fluids approximated, another comparison was performed regarding fluid density. Fluid density is expressed as weight measured in pounds per gallon (ppg). Fluid weight was measured using a mud balance and recorded in **Table 1**. Based upon the fluid weights recorded, our assumptions are proven to a degree. Water was in fact the least dense fluid out of the three, but the barite and bentonite mud were much closer in fluid weight than anticipated.

From the lab questions, the lab group initially concluded that barite could be added to mud to add weight without affecting viscosity, which was proven to be true even by the narrow .02 ppg margin. Bentonite was concluded from the questions to be a “thickening” agent for drilling mud which increases viscosity without dramatically affecting the fluid weight. Both of these conclusions were confirmed using the data collected and recorded in Table 1.

#### Questions:

1. Viscosity is a measure of a fluids internal resistance to flow. Informally it can be used to describe the “thickness” of a fluid, so a fluid with high viscosity is “thicker” when compared to a lower viscosity fluid like water. Viscosity is important to petroleum engineers because it generally describes how well a fluid can be pumped, a highly viscous fluid can not be pumped effectively through a drill string or drill bit, thus greatly decreasing the rigs overall efficiency. Drilling engineers want a drilling fluid with a higher viscosity than water so that cuttings from the bottom of the well can be carried to the surface and removed.
2. Effective apparent viscosity of a fluid is measured at a given shear rate specified by the American Petroleum Institute and fixed temperature.
3. Mud density is synonymous with mud weight, which can be measured in pounds per gallon (ppg). Mud density is used to control and modify hydrostatic pressure at the bottom of a well.
4. A mud balance is an instrument used to measure mud density in pounds per gallon (ppg). This is done by filling the sample cup on one end and moving a sliding weight down the beam until the bubble indicates its level.
5. A Marsh funnel is used to measure a fluids approximate viscosity. This is done by recording the time it takes for one liter of fluid to drain from the funnel and is an effective approximation for water and oil-based muds.
6. Barite is a mineral used in several industrial fields due to its high specific gravity, and in drilling it is used to add weight to drilling mud without dramatically increasing viscosity. Its main purpose is to suspend the rock cuttings produced by the drill bit and carry them to the surface. Bentonite clay is a “thickening” agent used to increase the viscosity of drilling mud as well as filtration control. A disadvantage of bentonite is that too much of this material present in drilling mud will render the rig incapable of pumping mud down the drill stem and back to the surface. This will halt the drilling process until the addition of water decreases the viscosity enough to where the rig can resume circulating mud.

#### Reference:

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6. "Oil Viscosity." *PetroWiki*. SPE, n.d. Web. 08 Feb. 2017.
7. "Mud Weight." *Oilfield Glossary*. Schlumberger, n.d. Web. 08 Feb. 2017.