**Drilling Mud Exercise**

Objectives:

1. Learn how to calculate the mud density.
2. Learn how to measure the mud density.
3. Learn how to measure viscosity using the rheometer,
4. Learn how to measure relative viscosity using a Marsh funnel.

Example Mud Description:

The mud used in this lab is in the large white mud bucket. It is made with 10 pounds of bentonite clay per barrel of fresh water. Bentonite is the most commonly used commercial clay in drilling muds because of its ability to build viscosity in fresh water using relatively small amounts of clay. Sodium montmorillonite, the main compound in bentonite, has a sheet-like structure. When dry the sheet like particles of this clay simply stack against one another. However, each sheet has unequal surface charges. When placed in fresh water the water molecules penetrate the bentonite structure and allow the electric charges on the clay platelet structures to repel each other. Thus, the clay platelets float apart or swell and this increases the viscosity of the water.

The viscosity of a mud is important in determining the friction pressure that must be overcome by the pumps in order to cause the mud to flow as well as the rock chip carrying capacity of the mud. Fresh water alone does not carry rock chips effectively except at high velocity. By increasing the water viscosity, the rock chips do not fall back as readily but move along with the flow. Also, the clay platelets form a kind of plaster or seal over permeable zones which reduces fluid loss into those reservoirs.

Mud density is also a very important property. The mud density creates a hydrostatic pressure in the well bore. The hydrostatic pressure at any point in a well that is created by the density of the mud can be calculated using the following pressure gradient equation.

If the hydrostatic mud pressure at a given depth is greater than the pore pressure in a permeable rock at the same depth, the reservoir fluids cannot flow into the well bore. This is a desirable result because the well will not be attempting to flow uncontrolled or “blow out” while the well is being drilled.

On the other hand if the hydrostatic mud pressure is too large and exceeds the fracture strength of the rock, a fracture will be created in the rock and mud will be lost into this fracture. This is an undesirable result because mud will be escaping the well bore (known as “lost circulation”). This results in an expensive loss of mud and could lead to other problems such as stuck pipe or shallow blow outs.

Additionally, hydrostatic mud pressure that is much larger than needed to create a stable bore hole will slow down the drilling rate, in effect holding down the rock at the bottom of the well where the bit is attempting to break away chips.

Mud density depends on what is in the mud. The mud is made up of perhaps water, clay, drilled rock cuttings, and heavy material designed to increase the density. The mud density can be calculated as follows:



In this lab the solids added to the water are only bentonite clay.

Question (1) What should the mud density of the lab sample be if 10 pounds of bentonite (equivalent to 10 g) was added to one barrel (equivalent to 350 g) of fresh water?

Answer: \_\_\_\_\_\_ ppg.

Question (2) What is the measured density for the lab mud using the mud balance shown below?

Answer: \_\_\_\_\_\_ ppg.



Rheological Properties

A bentonite clay mud exhibits the properties of a Bingham plastic fluid. As such the viscosity of this mud is called the plastic viscosity. It is called a plastic because, unlike fresh water, it takes some amount of pressure or stress to force the mud to flow once it has become motionless.

Mud like this makes a straight line graph of rotating speed (shear rate) versus shear stress, both of which can be measured using a Fann 35 viscometer.

The slope of the straight line is a direct measurement of viscosity and can be calculated in oil field units as follows.



The dial readings are representative of the shear stress, with some units conversions, required to keep the mud moving at a given rotating speed.



600 rpm

300 rpm

Note that the viscosity of fresh water is 1 centipoise (cp).

Use the Fann 35 viscometer to determine the shear rate of the moving mud at 600 rpm and then 300 rpm.

The 600 rpm speed is obtained when the speed set in high gear and the red knob is all the way down. Let the dial stabilize before taking the reading.

The 300 rpm reading is made by simply switching to the low speed. Again, allow the dial to stabilize before taking a reading.



High / Low speed switch



Red Knob.

Dial Reading.

Question (3) Record the dial readings at:

600 rpm \_\_\_\_\_\_

300 rpm \_\_\_\_\_\_

Calculate the plastic viscosity as the difference between the two.

Plastic viscosity \_\_\_\_\_\_ cp.

A common field measurement that is an indicator of viscosity is the time necessary to fill one quart of mud through a Marsh funnel.

The more viscous the mud, the longer the time needed to drip out of the funnel.

Fresh water should take about 26 seconds to fill one quart.

While this is only a relative measure it is easy for the rig crew to make and will be correct when it matches the results obtained by the mud engineer.





Question (4) What is the Marsh funnel viscosity for fresh water using your funnel?

What is the Marsh funnel viscosity for the sample mud.

Fresh Water \_\_\_\_\_\_ sec.

Mud \_\_\_\_\_\_\_ sec.

Please return all mud volumes back to the mud bucket and rinse out all equipment.

