INTRODUCTION

In mud rotary drilling, drilling fluids (or "mud") are engineered liquids (usually water mixed with bentonite clay and additives) circulated down the drill pipe to clean the hole, cool the bit, stabilize walls, and carry rock cuttings to the surface, functioning as the workhorse that makes drilling possible, especially in unstable formations.

A good drilling fluid will assist the driller by performing functions in five main areas:

1. Hole making
2. Hole clearing
3. Hole stabilizing and control
4. Sample transport and logging
5. Self care, that is, should be stable, easy to treat and testable.

The ability of the drilling mud to carry out all these functions depends on specific parameters of the fluid namely:

a. Viscosity
b. Density
c. Sand content

VISCOSITY

Viscosity of the drilling fluid is crucial for efficient drilling. Viscosity is the resistance offered by a fluid to flow, in this case, to be pumped. Viscosity and uphole velocity are the primary factors determining the ability of a drilling fluid to remove cuttings from around the bit and move them up the borehole. The viscosity of the fluid is increased to the point where it will suspend the cuttings while moving up the hole but kept low enough to allow the cuttings to settle.

Viscosity can be measured at the drill site with a Marsh funnel, where one quart of drilling fluid is allowed to drain through the funnel into the measuring cup and the flow time is recorded. Muds having viscosity or buoyancy are used to slow settling when drilling is stopped so that cuttings do not settle back into the hole.

A too high viscosity causes pressure surges and formation damage. On the other hand, low viscosity leads to inability of the fluid to suspend cuttings which fall back into the hole as well as inability to hold cuttings when circulation stops.

Material	Marsh Funnel (Seconds)
Fine sand	30-45
Medium sand	40-55
Coarse sand	50-65
Gravel	60-75
Coarse gravel	75-85
Lost circulation	85-120

Fig 3: Recommended Marsh funnel viscosities required for drilling fluid. (Source: Fletcher G. Driscoll, 1986, Groundwater and wells 2nd Ed.)

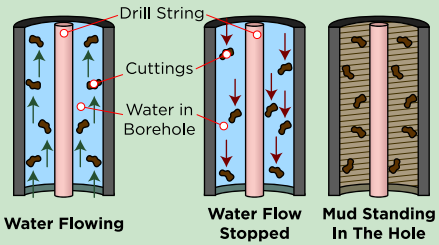

Fig 1: Demonstration of ability of drilling fluid to suspend cuttings in borehole vs water

Fig 2: Marsh funnel, measuring cup and a stopwatch for viscosity test

MIXING THE BENTONITE

For a good quality drilling fluid, It is critical to ensure good quality water is used to mix the bentonite and make up the drilling fluid.

- **pH** should be between 8.0 and 9.5.
- **Hardness** is recommended to be less than 180 ppm.
- **Chlorides** (salt) are recommended to be less than 500ppm. If higher, a different water source should be used as salt cannot be removed.

For pH and hardness, soda ash can be added to the water to raise pH and reduce hardness.

Mixing ratio: High-yield bentonite 15 to 30 lbs/100 gal of water

SAND CONTENT

Sand and silt in the drilling fluid will cause wear in the mud pump, pipes, valves, swivels and drilling tools and interferes with the efficient operation of the bit. Suspended solids have very serious effects on the drilling performance:

1. Suspended solids can be carried into permeable formations and thus destroying permeability.
2. Suspensions flowing through the rods at high speeds are centrifuged and deposited on the inside of the rods.

It is therefore critical to maintain sand content within the recommended range of 2% - 4%.

Sand content can be tested using a simple kit (200-mesh (74-micron) sieve, funnel, graduated glass tube, wash bottle). Sand content can be reduced by using hydrocyclones to separate suspended solids and restore drilling fluid to its original density.

Fig 5: Sand Content test kit

Fig 6: Hydrocyclones for removing sand from drilling fluid

DENSITY

Density is the weight per unit volume of fluid. Control of drilling fluid density is a fundamental factor in successful water well drilling. The actual pressure exerted at any point in the borehole by a static drilling fluid depends on the density and height of the fluid above that point.

Selection and maintenance of proper drilling fluid density prevents collapse of the hole and flow of water into the borehole. To maintain an open hole, the pressure exerted by the drilling fluid column must exceed the pore pressure in the aquifer.

Dense muds slow down chip clearing because of the high bottom hole pressure. Suspended material (silt, sand and very fine cuttings) increase the density of the drilling fluid.

The recommended density range for drilling fluid is 8.5 – 9.2 lb/gal
A simple mud balance can be used to test the density of the drilling fluid at the drill site.

Fig 4: Mud balance for density test

CONCLUSIONS

Proper drilling fluid parameters can be achieved by:

1. Ensuring use of good quality water that has been tested.
2. Closely monitoring of the drilling fluid through viscosity, density and sand content tests.
3. Managing the viscosity and density of drilling fluids through the use of polymers.
4. Managing sand content through desanders or shakers.
5. Allowing the bentonite to well hydrate before its use as a drilling fluid.

The use of drilling fluids with the proper viscosity, mud weight and sand content has several benefits:

a. Reduced equipment maintenance,
b. Improved drilling efficiency,
c. Increased hole yields and,
d. Reduced cost in the time to develop wells.