Conquering clay

Randy Strickland looks at how drilling fluid additives can be used to improve cutting through clays

Wyoming sodium bentonite mixed with tap water (right) and mixed with controllable flocculant drilling additive (left)

Powdered bentonite

CLAY soils can be dealt with using a number of different products and techniques, but these need to be employed before drilling operations begin to maximise the benefits offered.

Many different types of clay exist and they tend to respond differently to varying drilling fluid additives. When planning a bore, discuss the options and contingencies available with your drilling fluid sales representative. They may have experience in the area in which you will be drilling, or might be able to recommend a more suitable product than the one you had in mind.

THE PROBLEM WITH CLAY

Clay has a high affinity with water and it is this quality that causes most problems during drilling. There is no getting around the fact that drilling fluids contain around 90% water, so the question is: do you add something to the drilling fluid that will keep the available water away from the clay, or do you add something that will negate the effects of water on the clay?

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We may do either or both depending on the nature of the clay. Let's take a common scenario to start with. Layers of clay often occur in sand or coarse soil formations which require controlled water loss when drilling.

Controlling water loss in coarser soils prevents loosening of material that can wash back into the borehole. After checking the pH of the water and adding soda ash (to bring the pH to 8.5-9.5) along with high-yield bentonite, it is important to add a water loss/filtrate controlling additive such as polyanionic cellulose (PAC).

PACs bind with the bentonite to create a tighter seal in the wall cake which prevents the free water in the drilling fluid from escaping the borehole out into the formation. This product addition can be particularly useful when drilling through sandier soils into clay, for example in alluvial environments, where the two materials are commonly found together. Even if drilling exclusively in clays, the addition of PACs will help by continuing to lower the amount of water coming into contact with the clay and lubricating the drill string.

Water loss can be cut to almost zero, but this can be extremely costly. It is often more effective to add something that will 'treat' the clay when the water gets to it. To treat the clay, there are several options (see box).

Above: a fluted reamer pack with clay

OPTIONS FOR TREATING THE CLAY

- Coat the clay so that it does not stick to the drill string;
- Inhibit the clay from swelling;
- Flocculate the clay so that it flows out of the hole;
- Thin the clay so that it does not stick together.

Remember that there are a wide variety of clay types and they react differently to additives. Some work well with one and better with another.

ADDITIVES

All drilling fluid additives should be used according to manufacturers' instructions. Most manufacturers print the usage instructions on the label and on the technical data sheets which can be found on their websites. There are four main types of additives:

1) Surfactants: these are often called drilling detergents and are a basic, low-cost additive for building a drilling fluid system that will help prevent clay from sticking. They work by coating the surface of the drill bit and the surface of the clay particles where they are cut by the bit. Coating the clay cuttings helps prevent them from sticking to each other and coating the drill bit helps prevent adhesion of the clay to the drill string.

2) Polymers: these are synthetic additives that have been used by the drilling industry for many years. Partially hydrolysed polyacrylimides, or PHPAs, are long chain 'polymers' that wrap themselves around the clay cuttings. Their molecular charges prevent the clay molecules from binding with the water molecules and swelling. This process is called inhibition. PHPAs may be used with PACs and drilling detergents. It is a combination that has served drillers well for many years and a number of advancements have been made recently in product development. A wide variety of new PHPA-type polymers are now available along with other chemical additives that can be very effective in clay.

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3) Flocculants: many contaminants can flocculate a clay-based fluid and most of the time this is looked upon as undesirable. However, intentionally flocculating drilling fluid with clay cuttings using a controllable chemical additive can be beneficial. Controllable chemical flocculants have the effect of partially binding the clay particles together into a liquid slurry. Getting the clay cuttings to flow solves the biggest issue usually encountered with clay soils – getting the clay out of the borehole without it re-agglomerating on the sides of the borehole, the drill stem or bit. Specific drilling fluid flocculants can work well for this application and most can be used with drilling detergents and PACs.

Wyoming sodium bentonite hydrating rapidly in tap water (left) and same product under control in high molecular weight polymer drilling additive (right)

4) Thinners: these are also called dispersants or de-flocculants. They perform a wide variety of functions in drilling fluids, including being used in the manufacture of some bentonite products. Most thinners are anionic polymers that have a very low molecular weight. They work by negating the electrical charge on the surface of the clay platelets. Platelets with strongly negative charges will repel other platelets with negative charges, therefore preventing them from building structures in the fluid. This will help to lower the viscosity of the fluid which can be really useful when dealing with clays or shales that do not respond to inhibitors or flocculants. Thinners can be used with PACs and drilling detergents. When used correctly, thinners can also be used to control wall cake and filtrate.

These products should all be readily available from good drilling fluid distributors. There is much to be said for having these types of additives on hand at job sites to add to the drill fluid mix before boring into formations that might contain clay.

BENEFITS OF BENTONITE

I am often asked about adding bentonite to mud when drilling through clay. "Why use clay to drill in clay?" This is a good question. There are a few reasons to keep at least some high-yield bentonite in the drilling fluid. The main one is that there is no clay-treating additive that has carrying capacity or 'gel strength'.

When the pump is turned off cuttings need to be kept in suspension and high-yield bentonite will do this – additives will not. Only a small amount of bentonite is needed to remove the cuttings, 4.5-6.8kg per 380 litres of water should be sufficient to carry the cuttings and the additives.

Another important fact to keep in mind when drilling in clay is the amount of fluid being pumped. The rule of thumb for drilling in clay is four to fives times the soil volume that is removed due to the small size of the cuttings.

Check with your drilling fluid provider for the types of additives they offer for dealing with clay. You may find that there are several you were not aware of which may come in handy on that next bore.

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