GEORGE DUGAN

Clay: Getting Out of a Sticky Situation

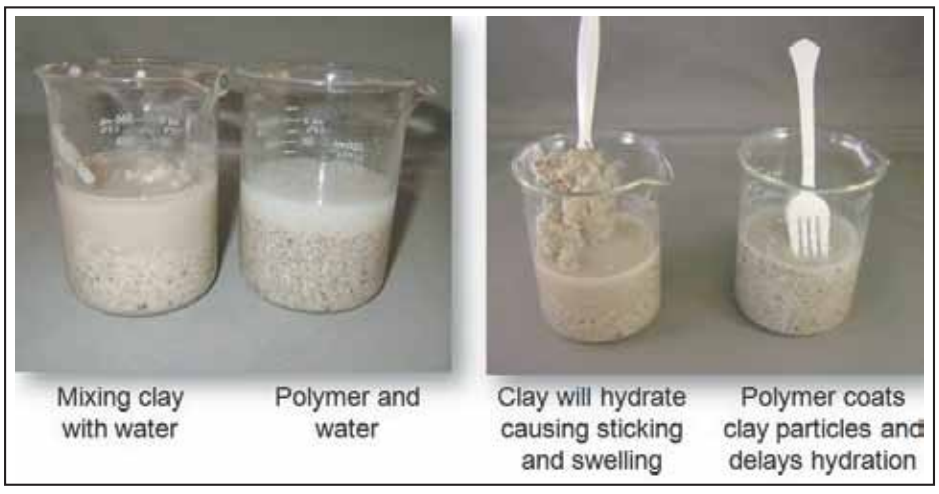
In the drilling industry, clay is commonly referred to as reactive because, when hydrated, clay will swell, get sticky, ball up around drill bits, and cause headaches for drilling contractors. The term "clay" is used to refer to any mineral particle that is below two microns in size, compared to human hair, which can range from around 80 microns to 120 microns in diameter. In order to deal effectively with reactive clays, a drilling contractor must be able to identify reactive soil conditions, understand how and why clay reacts the way it does, and know how to modify the behavior of reactive soils.

Determining whether soil is reactive or non-reactive can be as simple as dropping some of the soil into a clear cup or container of water and stirring it up. Coarse soils (non-reactive) will quickly settle to the bottom, and remain loose when stirred. If the material sticks to whatever it is being stirred with, swells up, or thickens the water, it is a pretty good bet that it is reactive soils/clay, and it is going to cause problems during the drilling process.

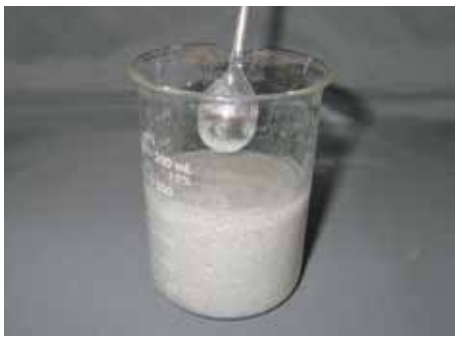
Clay becomes a problem when it comes in contact with water or freshwater drilling fluid because of clay's small particle size as well as its composition. The smaller the particle size, the more surface area per given volume that particle will have for water to contact, and cause the material to expand. There also is a chemical reaction that occurs when clay particles, such as sodium Wyoming bentonite, come in contact with water, causing the clay to attract water and expand. Sodium Wyoming bentonite clay can expand up to 20 times its size when hydrated, while other types of clay, such as illite, do not swell. The most common methods of dealing with reactive clays are dilution, clay inhibitors, dispersants, surfactants and clay flocculants.

Dilution, which involves continuously adding water to thin down the drilling fluid and constantly dumping clay-thickened drilling fluid, does not modify the behavior of reactive clays, and does not address the problems downhole. Without modifying the behavior of reactive soils, the formation constantly is closing in around the drilled hole, creating problems during the drilling process, and making it difficult or even impossible to install casing, product line or geothermal loops.

Inhibiting clays involves the use of polymers, such as high-molecular-weight (will increase viscosity), partially-hydrolyzed polyacrylamide (PHPA) polymer, which creates a polymer film that coats and delays the hydration of clays, therefore delaying reactivity (modifying the behavior of reactive clays). PHPA polymers do not create any significant gel strength, and do not provide adequate fluid-loss control; therefore it is important to add the PHPA polymers to an existing bentonite drilling fluid (after the bentonite has thoroughly yielded). Keep in mind when using a drilling fluids recycling system that high-molecular-weight PHPA polymers will blind shaker and mud-cleaner screens; therefore, one should use either a low-molecular-weight PHPA polymer, or polyanionic cellulose (PAC) polymer that can inhibit clays, and yet will work well with mud-cleaning equipment. Some natural polymers, such as guar gum, also are good clay inhibitors. When clay is properly inhibited, the returns tend to look like runny oatmeal, and the coated clay can be removed from the drilling fluid through settling or solids-removal equipment.



Determining whether soil is reactive or non-reactive.



Clay, flocculated.

Dispersants (a.k.a. thinners) usually are anionic (negatively charged) low-molecular-weight polymers – they will not add to the viscosity of a drilling fluid – that can be used to thin drilling fluids, and break down clays to reduce problems associated with swelling and sticky clays. Dispersants work by enhancing the surface charge of clays, which cause charge repulsion, similar to taking two magnets and holding them negative pole to negative pole. One benefit to using dispersants or thinners in moderation is that some types actually can thin a drilling fluid while increasing filtration control. The downside to over-using clay dispersants is that eventually drilling fluid properties (such as plastic viscosity, gel strength and fluid loss) can get out of whack, because of the thinning of bentonite drilling and the large amount colloidal (clay-sized) native soil particles that have become incorporated into the drilling fluid.

Non-foaming drilling fluids detergents – surfactants – also are used to reduce the stickiness of reactive clays by reducing the interfacial tension between clay and water or drilling fluid, and surfactants can help reduce torque, bit-balling, and prevent clay from sticking to shaker and mud-cleaner screens on drilling fluids recycling systems. While drilling fluid detergents do not inhibit or stop clay from swelling, they do work well with clay inhibitors to increase drilling productivity in reactive soils. Remember the order of addition for drilling fluids – first, soda ash, followed by bentonite, then polymer, and last, drilling detergent.

Clay flocculants utilize particle-to-particle attraction to break down clay into masses of smaller particles called flocs, which readily separate from drilling fluid. My experience with clay flocculants has shown that flocculants can be tricky (easy to overdose and or under dose), and the best success that I have had with clay flocculants has been in drilling applications, such as horizontal directional drilling projects, where the drilling fluid returns are not re-used.

As previously mentioned, the trick to dealing with reactive soil conditions is to modify the behavior of these soil conditions (stop the sticking, swelling, torque and bit-balling), and this is where polymers and additives come into play. Polymers and additives are designed to enhance desired qualities of bentonite drilling fluids, adjust drilling fluids to soil conditions, increase efficiency in drilling operations, and increase overall profits for drilling contractors. If you have any questions on the use of these products, do not hesitate to contact your drilling fluid manufacturer representative. ND

Shoveling clay.

George Dugan is a regional manager for CETCO.