The Uses & Limits of Decanter Centrifuges

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When centrifuges are properly deployed, they can dramatically affect drilling performance. In fact, without them, many of the advances made in drilling would not have been possible. Centrifuges can:

• Reduce the content of drilled fines, specifically colloidal solids and
• Perform barite recovery to reduce drilling fluid additive costs

Individually, each goal is a valid initiative. But when combined, they present complications that are overlooked by most modern solids-control service providers.

The ultimate goal of a solids-control centrifuge is to reduce the plastic viscosity of the drilling fluid. This improves the drilling rates of penetration and reduces the damaging effects of accelerated wear on bits, mud pumps and related equipment. Further, by controlling the colloidal solids, significantly less mud make-up dilution is required. Centrifuges should enhance the drilling fluid properties, which will improve rig performance (increased rates of penetration, improved cake wall stability, reduced bit torque and reduced pipe drag). Centrifuges can also lower waste disposal costs by reducing the volume of waste drilling fluid and reduce raw material additive costs by maintaining the target properties of the drilling fluid.

Despite these goals, the evolution of the drilling industry has resulted in the rapid deployment of centrifuges that are unable to achieve the targeted results. Though the centrifuges available in the market have improved, modern drilling practices have evolved greatly in the last decade. Many industry professionals are expressing concerns as to whether the application of centrifuges has evolved at an equal pace. Concern was initially raised by Eugene E. Bouse in his May 4, 2013 EdP article titled "The Use and Misuse of Centrifuges." Bouse says,

"Unfortunately, misuse has become more common, and many of the costly present-day practices are so ill-conceived that they are actually detrimental to both mud quality and waste minimization efforts."

Centrifuges are deployed to "cut" solids from the liquid stream, essentially creating two separate streams from the incoming influx. The cut is typically considered the underflow (also called solids discharge, cake or heavy phase effluent) and the cleaned liquid stream (also called centrate or light phase effluent) is considered the overflow. The centrate contains most of the liquid and the finer solids. The cut contains less liquid and the coarser solids. The goal is to have the cake as dry as possible with the lowest volume of surface wetting liquid achievable.

The ability to reach this goal is affected by several factors other than drilling fluid inhibition. For example, formation solids reactivity is the combined measure of the potential for a material to cause a negative impact to the drilling activities by material hydration or dispersion. Centrifuge design and operating parameters also play a role. However, the goal of achieving a dry solids discharge should not be prioritized over the goal of achieving the proper colloidal solids cut.

The application of traditional centrifuging techniques removes both the ultraline and colloidal solids regardless of their classification as formation solids (drilled solids, low gravity solids or LCS) or drilling fluid solids (weighting agents, mostly carbonate barite). The goal would be to remove all suspended solids above a targeted particle-size distribution. Then new drilling fluid solids would be added to the system. In barite recovery, the traditional intent is to maintain the larger solids, specifically barite
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Defining Traditional Barite Recovery

For barite recovery operations, service providers pair two centrifuges together, in which the first centrifuge targets solids between 10 and 100 micrometers (μm) and the second purportedly removes those solids less than 10 μm. This 10 to 100 μm range is the sweet spot within the particle size distribution curve for barite. The lower end of this range (10 μm) is set by the centrifuge's applied G-force, but the upper end (100 μm) is set by the practical suspended solids cut achieved by the flow line -shakers, which are primary solids control system.

The influent to the barite recovery centrifuge comes as a slip-stream from the active mud system. This means that the full circulating volume of the active mud system is not sent through the centrifuge system. The first centrifuge's solids cake is returned to the active mud system with the goal of recycling barite, while the centrate is plumbed to the second centrifuge.

The second centrifuge is configured as a high-speed centrifuge to remove low gravity solids. The target range rests between the maximum capability of the centrifuge, relative to the maximum achievable G-force that can be applied (typically 2 to 5 G), and the lower range defined by the barite recovery centrifuge.

The solids cake is considered waste and is disposed of. The cleaned centrate is returned to the active mud system.

Figure 1 shows the typical barite recovery process.

Colloidal Solids' Effect on Plastic Viscosity

Many centrifuge operators do not understand that drilling fluids' performance and the associated plastic viscosity are driven by the colloidal solids content, not low-gravity solids. Even fewer operators understand the difference between low-gravity solids and colloidal solids.

Barite has a particle size distribution that ranges from 1 to 100 microns (predominantly ultra-fine and fine solids). API specifications that barite should achieve a size distribution where the percentage of material greater than 75 μm is minimized, while ensuring that the percentage of material less than 6 μm is less than 30 percent by weight.

Bentonite particle size distribution can range from less than 1 to 10 μm (colloidal and smaller ultrafine solids).

Bentonite solids have a much smaller particle size distribution than barite. This is the reason that bentonite is typically considered a thickening agent to increase viscosity, while barite is simply considered a weighting agent.

Barite has only a modest impact on viscosity, because the aggregate surface area of the solids is lower than the surface area exhibited by the solids found in bentonite. This is because the negative effects of elevated plastic viscosity are predominantly driven by the available surface area exposed by colloidal solids, which are more prevalent in bentonite than barite.

Despite the fact that the particle size distribution bands are fairly well defined, measuring solids within these ranges is complicated. Many centrifuge operators mistakenly rely on a retort analysis. Though the retort is a practical tool to measure the total aggregate mud weight, it is not helpful for defining the change in plastic viscosity (since an increase in total surface solids surface area as it directly relates to an increase in the colloidal solids content) associated by the continued and natural degradation of drilling fluid and formation solids into colloidal solids. To pinpoint the changing conditions (thickening) of the drilling fluids through the well cycle, details relative to the particle size distribution must be captured.

A particle size distribution analysis can shed light on the total surface area exhibited by the drilling fluid suspended solids. Because this test is not considered practical or cost-effective to complete on the rig site on a daily basis, most operators choose retort analysis instead.

Unfortunately, by relying exclusively on the retort analysis, centrifuge operators and mud engineers are unable to ascertain the characteristic life cycle of the colloidal solids.

Many mud engineers assume that when the mud weight increases, as defined by the retort analysis, the only logical option is to increase the treatment capacity of the centrifuge or increase the applied G-force. However, since the centrifuges treat a small percentage of the total circulating volume and centrifuges are unable to manage colloidal solids, operators are left fighting a losing battle.
A properly designed blender has a mixing tub/pump designed to mix widely varying sand concentrations at different flow rates without sanding off. The two main types of mixers are the tub type, which is typically characterized by an open top, and the mix pump design, which combines sand and water at the vane of the pump. Tub type blender designs should also have a level sensor that can read accurately in the presence of foam.

The advantage of the tub type is that it can generally handle larger volumes of sand and water. However, the tub can be overfilled if the tub level system is not properly calibrated. The main advantage of the mix pump is that it has no fluid level system, and it also acts as the discharge pump. But this design usually cannot handle the higher rates and sand concentrations commonly seen in slickwater fracture treatments very well.

Before making a selection, users should understand what the typical job for the blender will be. Will they be pumping high-rate slickwater jobs, or is this blender going to be used for more low rate, low pressure, linear gel fluids? Favor tubs in cases where flow rates and sand concentrations are higher.

Lastly, a properly designed blender has a modern control system that can be controlled locally, remotely and in an automated fashion from a predetermined job schedule coming from the data van or remote site. Today’s sophisticated electronics have intelligence built into the local controller for critical safety concerns but maintain robust communication systems that can quickly manage the operation of the unit. The hardware and networking infrastructure of older technology systems cannot handle the demands of the more complex controls architecture and the data-intensive communication requirements.

Modern blenders can handle more than 250 different data points from the blender. Many blenders have Ethernet communication rather than serial, Modbus, CAN Bus or similar communication architecture. This equipment should also have modularity and scalability built in to the control system to grow with the blender and the application.

Traditional programmable logic controller (PLC) technology often falls some of the more feature-rich embedded PC-based automation systems. Demand for enhanced automation, tons of data and remote access to that information in real time can quickly exceed the limits of older legacy systems.

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