IMPROVE DRILLING OPERATIONS CONTROL DRILL SOLIDS IN MUD MECHANICALLY

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INTRODUCTION

Through the drilling industry's efforts to drill faster and deeper has come the application of three types of mechanical separators for processing drilling muds—the fine-screen shaker, hydrocyclone separator and the decanting centrifuge. These mechanical separators are necessary in today's drilling to maintain both low and high-weight drilling muds economically. With proper application, installation and operation, these machines can help reduce overall drilling costs by improving penetration rate and reducing mud treating costs.

FINE-SCREEN SHAKER

The fine-screen shaker is the newest addition to the three types of separators. There is a variety of different shakers on the market that qualify as fine-screen shakers (single, double and triple-deck) all available on rental basis. The important thing to consider when choosing a fine-screen shaker is its maximum fluid capacity and whether the total flow of mud can be processed through the finest mesh screen being used. Normally, a "multi-deck" fine-screen shaker will process total circulating mud volume through each screen due to its horizontal position, while other fine-screen shakers are constructed with a slanting single deck, equipped with two or more screen sections. This type "multi-screen" shaker is often equipped with different mesh size screens; and mud not processed by the first screen section flows to the second or third section before total flow of mud is processed. Each screen section processes only a portion of the total mud volume. None of the mud is processed through two or more screens as it is on a "multi-deck" shaker. Other important things to consider when selecting a fine-screen shaker are amplitude and vibrating motion at which the screens operate. The amplitude and vibrating motion have a direct effect on capacity and screen mesh size that can be used. Each make of shaker has its own characteristic motion varying in degrees from a flat-elliptical motion to the more effective motion of a perfect circle. If the amplitude is great enough, the motion of a shaker is easily checked by putting a small pencil dot on the side of it when it is off and then observing what form the dot makes when the shaker is in motion. As an auxiliary piece of equipment, the fine-screen shaker may be installed on a rig in one of three ways: (1) the rig shaker is removed and the fine-screen shaker is installed in its place; this is the most common method of installation, (2) the fine screen shaker is installed alongside the rig shaker by tapping into the existing flowline. This method keeps the rig shaker available for emergency use, and (3) the rig shaker is left in place and the fine-screen shaker is placed downstream and used as a secondary separator. After the mud has passed through the rig shaker, it is pumped to the fine-screen shaker for further cleaning before being recirculated.

Fine-screen shakers have application in drilling wells from surface to total depth. When controlling solids is an objective on a well, the program should be started as soon after drilling as practical. The important thing about any solids control program is to remove as many drill solids as possible during their first circulation out of the hole to prevent them from recirculating and becoming finer. The smaller the particle becomes, the more difficult it is to effect separation and these ultra-fine particles can ultimately cause severe mud problems.

Common screen sizes used on fine screen shakers range from 30 mesh to 100 mesh as compared to conventional shakers that normally use 12 to 20 mesh.

The mesh size of the screen governs the size particles removed from the mud as shown in the following:

Mesh Size	Particle Size
12	particles down to 1680 micron
20	particles down to 840 micron
30	particles down to 590 micron
50	particles down to 297 micron
80	particles down to 177 micron
100	particles down to 149 micron

A shaker plays an important role in any solids control program. It is the primary solids separator, the workhorse; and the more efficient it operates, the better the secondary equipment (cyclones and centrifuge) will perform.

HYDROCYCLONE SEPARATORS

The term "hydrocyclone" applies to both desanders and desilters. The principal difference in the two is the size of the cone. A desander cone is usually 8 in. or 12 in. in diameter at the larger end, while desilter cones vary in size from 2 in. to 4 in. in diameter at the larger end, the 4 in. being the most common size desilter cone used for processing drilling mud.

All hydrocyclone separators operate on the same principle, with mud entering the cone tangentially and establishing a spiralling flow pattern that moves down the wall of the cone increasing in velocity as cone size decreases, thus creating a second spiral flow in the center of the cone moving in an upward direction, passing through the vortex finder into the overflow header.

The hydrocyclone separator is a very useful tool in maintaining low solids, unweighted drilling muds. However, it is more critical to install and operate properly than are the shaker and decanting centrifuges. Some of the important things to consider when using a desilter or desander are:

1. Know the maximum amount of mud that will be circulated by rig pumps and then select a cyclone unit with capacity slightly greater than rig volume. For best results it is advisable to process slightly more than total volume being circulated.
2. Installation should be made properly by a competent person. For maximum performance from the cyclones, never discharge the processed mud back into the same pit that it was taken from. Always have the suction upstream from the discharge. Never desand and desilt in parallel; always in series. To help prevent cones from plugging, use a screen on the suction, avoid putting suction in sand trap and maintain proper flow to the cones. Too much flow to the cones will cause "roping." A cone is said to be roping when the underflow is a solid stream. The correct underflow from a cone is in a spray pattern which is obtained by adjusting the orifice size or other mechanical adjustment at the base of the cone.
3. After proper installation it is necessary to check the cones regularly for proper performance. Plugging is a common failure and can easily be recognized. When a cone plugs up there is no underflow; when the feed end plugs up there will be a backflow through the cone from the discharger header and there is a forceful discharge out the bottom of the cone. A great deal of mud can be lost if this is not corrected.
4. Cyclones are normally run continuously while drilling, mud volume permitting. With good efficient cyclone equipment, mud treating costs can be reduced and less dilution required. Of course, some dilution is required to keep sufficient mud volume since some whole mud is lost in the underflow. It is also necessary at times to add mud materials to maintain desired mud properties.
5. The last but far from least important factor in the operation of a hydrocyclone is differential pressure. It is most important that recommended pressures be maintained for effective solid separation. Optimum operating range, generally speaking, is from 30-50 psig. The higher the pressure, the more efficient the cut, so long as turbulent flow conditions are not created.

DECANTING CENTRIFUGE

The decanting centrifuge is the most efficient of these mechanical separators due to the centrifugal force it creates. A decanting centrifuge consists primarily of a helical screw conveyor located inside a conical bowl. In operation the bowl rotates at high speed while the conveyor turns in the same direction at a slower speed. As the bowl rotates, it creates centrifugal force, increasing with bowl speed. Drilling mud to be processed is pumped through a feed pipe extended into the center of the rotating mechanism. Due to centrifugal force, the mud is instantly thrown outward, forming a pool on the inside of the bowl. The large particles and particles of high specific gravity (e.g. barite) are forced against the wall of the bowl momentarily and then conveyed out of the pool toward the solids discharge ports located in the small end of the conical bowl and discharged as damp sludge. Having separated the solids from the liquid, the liquid, or effluent as it is called, is discharged through weir ports located in the large end of the conical bowl.

The centrifuge was originally introduced on the drilling rig to salvage barite from weighted mud systems and is still predominately used for that purpose. However, in the last few years, the centrifuge has found new application in processing low solids/low weight oil muds and polymer muds. This application is steadily increasing as the low solids muds increase in popularity.

The decanting centrifuge, if installed to salvage barite, may be placed on the suction pit in such a way that as barite is removed from the mud, it falls back into the active mud system. The centrifuge is supplied mud for processing by a small hydraulic mud pump that can be placed to draw mud from the active system upstream from the suction pit or it may be used to pump salvage mud from storage so that barite might be reclaimed. On an unweighted mud system, the centrifuge is located in such a way that removed solids fall into a shale pit or into a container for disposal. It is the liquid phase of an unweighted mud that is returned to the active system.

A complete rental centrifuge consists of a decanting centrifuge machine, power unit and controls. The power unit is usually a diesel, gas or electric motor driving a hydraulic pump that in turn drives hydraulic motors on the centrifuge, mud pump and effluent pump. The control system is used to control bowl speed at desired rpm, mud feed rate in GPM and water additions in GPM. With the centrifuge being used on both weighted and unweighted systems, a good control system is most important. When processing weighted mud, the bowl speed may be set between 1200 and 1500 rpm for salvaging barite, while on an unweighted system, the expensive liquid phase of oil muds and polymer muds is salvaged and the bowl speed is controlled at around 1800 to 2000 rpm. A mud feed control is also a necessity since the quantity of mud a centrifuge can efficiently process varies with mud weight. A barrel per minute of light mud can be processed while only ten gallons per minute of 18 ppg mud can be processed. Accurate control of the centrifuge improves its efficiency in separating solids.

CONCLUSION

The economical justification of mechanically separating drilled solids is easy to make when you consider dilution as the only alternative. Not only are the direct mud costs created by dilution expensive, the associated cost of disposing of large volumes of mud after the well is drilled can also be very expensive.

A well-planned solids control program from surface to total depth reduces overall drilling costs. An unweighted mud system with minimum solids provides a fluid for maximum penetration rates. A weighted system with minimum low gravity solids will also provide good hole-making fluid. Fewer solids in the mud mean less abrasion and longer life for bits, pump parts, drill pipe and other metal parts that are exposed to the mud under pressure. Drastic reduction in dilution requirements translates into reduced treating costs to the mud and less excess mud for final disposal.