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Rotary Vacuum Dryer Technology

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Abstract

The drilling industry has met the challenge of lowering retention on cuttings associated with synthetic base mud to below EPA (Environmental Protection Agency) mandated limits through the use of HI-G Dryers. Now new technology has evolved which uses vacuum. This paper explores the physics of drying cuttings, compares the HI-G dryers to vacuum dryers, compares the two drying systems and points out the advantage of the Patented (Patent No. US 6,681,874 B2) Hydro-Carbon® RVD-12 Vacuum Cuttings Dryer System.

Introduction

Operators have many options when it comes to meeting EPA mandated retention of synthetic base fluid on cuttings. The overall goal is to keep the offshore waters clean while spending the least amount of money. Jobs must be planned with consideration given to safety, specific rig configurations, equipment needs for conveying cuttings, drying wet cuttings, overboard disposal of dry cuttings, box and ship equipment, and personal requirements. Once the job is started it is important to monitor the interval reports, project daily well R.O.C. (retention on cuttings) averages, and manage the operation to meet EPA limits while minimizing cost. In small hole sections and conditions of sands and lost circulation material a combination of drying intervals and zero discharging intervals may be necessary. End of well pit cleanouts must also be a projected and weigh heavily when the total number of intervals is low. Another consideration is low gravity solids build up. Will this be managed by dilution, or the use of a decanting centrifuge?

New technology has been developed using vacuum to dry the synthetic base cuttings. Vacuum dryers have been developed especially for use on drilling rigs and have many advantages over conventional HI-G dryers.

Before comparing the HI-G dryer and the vacuum dryer we should briefly look at the fundamentals.

1. The physics of drying cuttings
2. The types of HI-G dryers
3. Components of the Rotary Vacuum Dryer System.

The Physics of Drying Cuttings

The description of cuttings dryers would lead one to believe that all of the wet cuttings going into the dryer are individually dried and exit the dryers as they come in only drier. A more accurate description of the process would be cuttings separators. "Cutting sizes greatly influence the quantity of drilling fluid that tends to adhere to the solids. As in extreme example, consider a golf-ball size drilled solid coated with drilling fluid. Even with a viscous fluid, the volume of fluid would be very small compared with the volume of the solid. If the solids are sand-sized, the fluid-film volume increases as the solids surface area increases. For silt-size or ultra-fine solids, the volume of liquid coating the solids may even be larger than the solids volume (1. *Shale Shaker*, AADE, Pg. 92)." This may be an over simplification because some of the synthetic based mud on the surface of the cuttings held on by surface tension is removed by the friction of cuttings rubbing against each other and the dryer screen all the while under a separation force pulling the mud and wet fines through a screen. The separation force for HI-G dryers is centrifugal force. The separation force for vacuum dryers is differential pressure. Unfortunately, the same force that breaks the surface tension can also damage the cuttings and make many small cuttings out of one large cutting and increase the surface area making drying more difficult. Also the generated fines end up in the recovered mud and increase the percentage of low gravity solids. The dust, which sometimes is seen at the outfall of some HI-G dryers, is more a function of the grinding of the cuttings then the dryness of the cuttings.

Types of HI-G Dryers

The HI-G Dryers in use today borrow technology from the mining industry and are divided into two main types, the vertical shaft dryers and the horizontal shaft dryers.

The vertical shaft dryers **(Fig. 1)**, commonly called the Verti G or the Typhoon, is made by CSI and modified for improved performance drying cuttings. Cuttings enter the top of the dryer through an 8" opening and are immediately accelerated to machine speed by the cone cap while flights continuously direct cuttings to the screen surface. Fluid solid separation occurs instantly as cuttings makes contact with the centrifugal screen. Solids are discharged at the screen bottom and fall by gravity into a screw conveyor or agitator tank.

The horizontal shaft dryers can be divided into two types, which are differentiated by the shapes of their baskets and the mechanism of moving the cuttings across the screen **(Fig. 2, Fig. 3)**. The horizontal HI-G cuttings dryers that use conical baskets are the M-10, the M-8 (smaller version of the M-10), and the D-Hydrator. The Hutchinson-Hayes Duster Dryer **(Fig. 4)** uses a cylinder shaped screen requiring an internal scroll to transfer the dry cuttings across the screen. The M-10, M-8, and D-Hydrator use a suspended vibrating mechanism that provides axial vibration of the shaft to move dried solids from the screen basket.

The G-Force in the CSI centrifuge is 98 G's at the top of the screen and increases to 352 G's at the bottom. The G-Force in the Hutchinson-Hayes is constant along the screen, and like the other horizontals shaft dryers is adjustable because of the variable speed.

Components of the Rotary Vacuum Dryer

The Rotary Vacuum Dryer has five components **(Fig. 5)**:

1. The hydraulic variable speed dryers. One for each shaker.
2. The High-Pressure Pressure Blower, which is connected to the system on the fan suction side as the source of vacuum. One Blower has the capacity to serve up to three dryers.
3. The Mud/Air Separator, which goes between the vacuum source and the dryers. The recovered mud is pumped from the mud/air separator back to the mud system and the clean air goes on to the High-Pressure Pressure Blower. Each fan has one mud/air separator.
4. The lightweight pipe hoses, which connect the dryers to the separators and fans **(Fig. 6)**.
5. The Hydraulic Power Pack provides the hydraulic power for the variable speed vacuum dryers. Each Hydraulic power pack can run up to five dryers.

Vacuum Cuttings Dryer vs. HI-G Dryers

There are 10 areas we can look at to compare the vacuum cuttings dryer to the HI-G cuttings dryers.

1. Location
2. Size of Dryer
3. Numbers of Dryers
4. Conveying Wet Cuttings
5. Capacity
6. Mud Quality
7. Redundancy
8. Screen Blinding
9. Speed Control Systems
10. Rig Up Time

<u>1. Location</u>

<u>Rotary Vacuum Dryer</u>

The vacuum dryer system brings the dryer to the cuttings and conveys only recovered mud from the shakers.

<u>HI-G</u>

100% of the shaker discharge is conveyed to the dryers.

<u>2. Size of Dryers</u>

<u>Rotary Vacuum Dryers</u>

Since differential pressure is the force to dry the cuttings, there is no need for large diameter screens and high speed to produce HI-G's. The small horizontal screen drum of the vacuum dryer fits directly in front of the shaker above the overboard trough.

<u>HI-G</u>

Larger size must be located outside of shaker house.

<u>3. Number of Dryers</u>

<u>Rotary Vacuum Dryers</u>

The number of dryers on a drilling rig is the same as the number of shakers. Each shaker has its own dryer system.

<u>HI-G</u>

Most jobs use one HI-G dryer to dry all of the wet cuttings. Some jobs may require two, but both must be located away from the shakers.

<u>4. Conveying Wet Cuttings</u>

<u>Rotary Vacuum Dryers</u>

Since the vacuum dryers receive wet cuttings directly from the shaker screen there is no conveyor between the shaker and the dryers.

<u>HI-G</u>

Wet cuttings must be conveyed from the shaker to the dryers either by a chute, an auger, or a vacuum system or a combination of the above.

<u>5. Capacity</u>

<u>Rotary Vacuum Dryers</u>

Each dryer is designed to process the cuttings from a single shaker. The drilling is not limited by the capacity of the vacuum cuttings dryer.

HI-G

HI-G dryers claim high capacities, but must use conveyors, either screw or vacuum, to move the wet cuttings to the HI-G dryers (this proves to be most problematic part of the cuttings dryer system!). Many times the limiting factor involves the conveyance of the wet cuttings from the shaker to the dryers.

6. Mud Quality

Rotary Vacuum Dryers

Since vacuum dryers use screen types and openings very similar to HI-G dryers, the quality of the mud is similar and equally affected by the particle size distribution. Since conveyors are not used the deterioration of the cuttings due to conveying is eliminated.

HI-G

Mud quality depends on particle size distribution and screen slot size. Conveying wet cuttings from the shakers to the dryers results in the generation of more fines adversely affecting mud quality.

7. Redundancy

Rotary Vacuum Dryers

Since each shaker has its own dryer, the loss of a single dryer will have little or no effect on the drilling.

HI-G

If a HI-G dryer goes down, the drying stops.

8. Screen Blinding

Rotary Vacuum Dryers

Vacuum dryers incorporate an axial scraper, which rides on the screened drum moving the cuttings while under vacuum. A full-length variable screen brush constantly cleans the screen even in conditions of same size fines and lost circulation material.

HI-G

Screen blinding is a problem in high sand content and lost circulation material. This causes out of balance condition requiring machine shut down for cleaning.

9. Speed Control Systems

Rotary Vacuum Dryers

Vacuum dryers are hydraulically driven. Each dryer uses three hydraulic variable speed motors. One for the screened drum, one for the axial scraper, and one for the full-length brush. A flow control for each motor is located on each unit along with an emergency shut off **(Fig. 7)**. The simple hydraulic system has two hoses 3/8" diameter going to each dryer. A hydraulic power pack supplies the hydraulic power for up to five dryers. All hydraulic components are common off of the shelf parts. There are no complicated electronics.

HI-G

Most HI-G dryers use variable frequency electronic drives. Electronic variable speed drives can be a source of downtime.

10. Rig Up Time

Rotary Vacuum Dryers

It usually takes less time to rig up a vacuum drying system than a HI-G system because no auger is needed to feed the dryer and dried cuttings fall directly to the existing overboard trough. This eliminates the need for an addition overboard trough with salt water flushing or an auger.

The High-Pressure Pressure blowers, which provide the vacuum source and the hydraulic power pack, are pre-wired with 150' of cable. The blowers and Mud/Air Separators can be located below, near, or above the shakers. Lightweight, clamp together pipes and hose connect the system components.

HI-G

HI-G dryers systems usually require longer rig-up time because they use augers to move the wet cuttings from the shakers. The inlet of the HI-G dryers are 6-1/2' to 7-1/2' high, augers must run straight requiring several augers if the dryer inlet is not in the line of sight. Each auger requires its own drive. Vacuum systems can also be used to vacuum the wet cuttings for conveying to the HI-G dryer. If the wet cuttings can be made wet enough they can be pumped to the HI-G dryer inlet. A screw conveyor may be required to collect the cuttings coming off of the shakers to make vacuuming easier.

Both the HI-G cuttings dryer system and the vacuum cuttings dryer system must be able to switch to zero-discharge if the mud becomes contaminated or the well R.O.C. (Retention on Cuttings) exceeds EPA (Environmental Protection Agency) guidelines. The preferred method would be to seal off the overboard trough, turn off the salt water flushing, and vacuum from the overboard trough to cutting boxes. In cases where the overboard trough does not have enough slope for the cuttings to slide to the vacuum hose suction point, vibrating slides or augers must be installed in the overboard trough.

Conclusion

The Hydro-Carbon Flow Specialist, Inc.® patented Rotary Vacuum Cuttings Dryer system (Patent No. US 6,681,874 B2) saves rig time in three ways. The system eliminated the need to move cuttings from the shakers to the HI-G dryers (the most problematic part of drying cuttings with HI-G systems). The rate of penetration is not limited by the vacuum dryer system. The loss of one vacuum dryer has little effect on drilling. Other advantages are safety, faster rig up, and better use of rig space.

References

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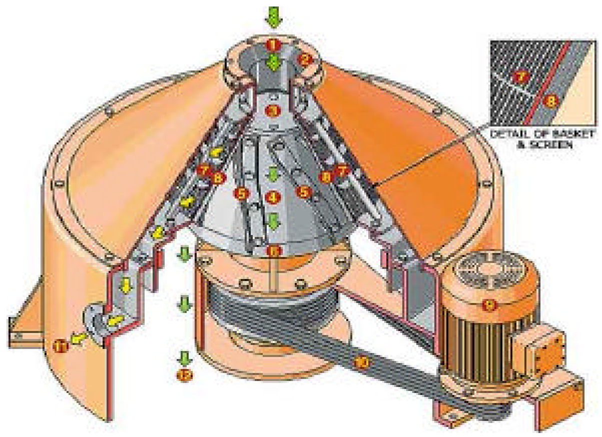

Figure 1

Figure 2

Figure 3

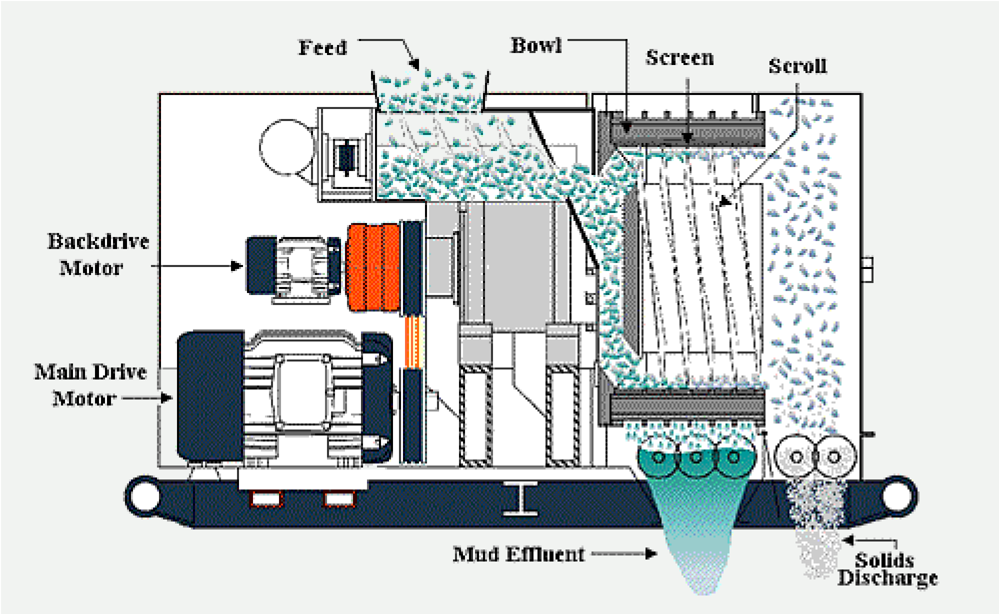

Figure 4

Figure 5

Figure 6

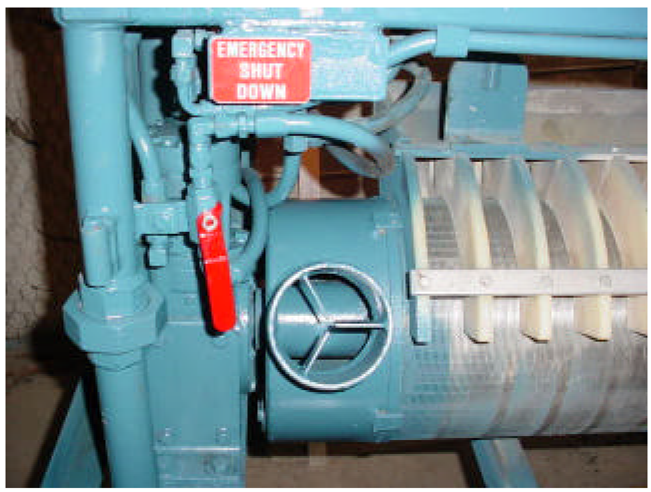

Figure 7