DRYCAKE: DECANTER CENTRIFUGES

The market for decanter centrifuges is very competitive. With the use of an innovative design DRYCAKE's centrifuges has created their own advantage in the market. The intent of this document is to outline those advantages, while at the same also providing an explanation of how centrifuges operate and their advantages.

CENTRIFUGE OPERATIONAL PRINCIPLES:

A decanter centrifuge behaves like a gravity settling tank, the difference is the centrifugal force: it improves the settling time and efficiency!!

GRAVITY SETTLING TANK

In a gravity settling tank, the solids settle by the force of gravity, which are then discharged out one end and the clarified liquid are skimmed off and come out the other end.

Also the settling area is increased by virtue of the G-force working in 360 degrees towards the outside of the bowl.
“G-force” is defined as the ratio between the centrifugal acceleration created inside the bowl and the earth gravity acceleration $g=9.81 \text{ m/s}^2$.

A centrifuge works like a gravity settling tank, except instead of operating at 1G, the centrifuge operates at several thousand G thus reducing the settling time. The Bowl rotates at ~3000RPM*, and the Scroll/Screw rotates at ~3010RPM, creating a differential speed of 10RPM(3010-3000). The solids are moved out of the centrifuge at this speed of 10RPM. The clarified liquid comes out the rear end of the centrifuge, like in a gravity settling tank.

The Bowl and Screw RPMs will vary depending on the size of the centrifuge. The differential speed can be set according the application, and the desired retention time.(the time the sludge stays inside the centrifuge before discharge)

The liquid outlet level is set by a liquid level weir plate.
Equivalent Area ($A_e$)

R = bowl radius  
L = distance between feed point and liquid outlet  

Area = $2\pi R \cdot L$

The settling ability indicates the decanter settling capacity, and is calculated as the surface area needed for a settling tank to achieve the same task.

**Centrifugal acceleration**

$A_c = \text{centrifugal acceleration}$  
$\omega = \text{angular velocity (radians / sec)}$  
$n = \text{rotation speed (rpm)}$  
$r = \text{radius}$

- The angular velocity is relative to the Rotation Speed  
- The centrifugal acceleration is relative to the angular velocity and the diameter of the bowl. (Angular velocity is usually expressed in G-force)
Solids discharge: This is where the dewatered solids drop. Normally, a screw conveyor with a valve or a diverter gate is positioned below the discharge. This is because for the first few seconds after start-up, liquid will come out of the solids discharge of a centrifuge.

Solids deposited: These are the settled solids. They form an annular, 360 degree, shape around the bowl, and being conveyed forward by the scroll/screw of the centrifuge at a rate relative to the differential speed.

Liquids discharge: This is the liquids discharge end of the centrifuge, this liquid is still dirty, and is sent back to the head of plant. The water looks clear or slightly trouble, with a usual capture rate of 95-98%.
**Feed Pipe:** This is where the sludge is fed, one some machine, the feed pipe is on the other end of the machine. The sludge is fed upon halfway through this feed pipe, at which time the sludge is released and by the centrifugal force, the solids settle along the outside of the bowl. This is adjustable for optimization.

**Clarified liquid pond:** This is the separated liquid part of the centrifuge, once the liquid reaches the outlet level, the liquid begins to discharge.

**Cylindrical Section:** 90% of the dewatering occurs in this section.

**Beach(Conical section):** This section is designed to exert additional force on the solids, squeezing out the last drops of liquid as we are not only applying the centrifugal G-force but also pushing the solids uphill. It is designed to elevate the solids above the waterline into the discharge chamber.

The angle of inclination can vary from 8 to 15 degree depending on the sludge characteristics.

**Gearbox:** The centrifuge is equipped with a drive system composed of an electric motor, a hydraulic motor, hydraulic pump and a cyclo gearbox. The electric motor provides the power required to turn the complete rotating assembly driving the drum directly and the scroll through the hydraulics. Controlling the differential speed between the drum and the scroll is PLC controlled. The PLC controls the working cycle as well as the protection in case of torque overload.
Polymer Injection: The polymer is usually injected inline right before the sludge feed pump before going into the feed pipe.

Feed Zone: This is the point at which the solids are released into the centrifuge.

Baffle Disc: This plate serves two functions.

1. Without a baffle disc, the liquid level cannot be set higher than the sludge discharge level. Since, the liquid level is one of the factors in determining the capacity of a centrifuge. The baffle therefore allows a smaller machine to dewater a larger volume.
2. The G-force is lowest at the very center of the centrifuge. The baffle disc allows the centrifuge to exert more pressure on the sludge. This is done by forming a plug; the centrifuge is completely filled with sludge in the beach section beyond the baffle disc. Without the baffle disc, this would not be possible as the sludge would go to the center and there would be no baffle disc to protect. This especially helps with performance with viscous sludge that has a tendency to splash back like yoghurt.

With a baffle disc, if you choose to set the liquid level higher than the solids discharge level, then upon start up liquid will come out of the solids discharge until a plug is formed. Also, if the plug is lost during operation, the same will happen again. This is why quality controls, especially torque control, are of utmost importance and why we recommend a hydraulic back drive.
Decanter with variable differential speed (Hydraulic back drive)

LEGEND:
1. Main motor
2. Gearbox
3. Scroll Belt
4. Bowl belts
5. Hydraulic pump
6. Hydraulic motor
7. Heat exchanger
8. Touch screen
9. DPC (Decanter Process Controller)

Decanter with Electric Back Drive

LEGEND:
1. Main motor
2. Gearbox
3. Scroll belt
4. Bowl belt
5. Scroll motor
6. Touch screen
7. DPC (Decanter Process Controller)
As mentioned before torque control is essential to optimal performance. Hydraulic back drives have a flat performance curve; electric back drives on the other hand have performance peaks, and don’t perform as well outside certain parameters. Hydraulic are therefore always preferable to electric back drives.
DECANTER REGULATION AND OPTIMIZATION

START

Select Feed rate

Cake & Centrate monitor

Acceptable cake and clear centrate

Adjust polimer rate

Adjust differential speed
To optimize the performance set the following parameters:

- Q = feed rate
- d = flocculation
- η = viscosity
- n = RPM
- Δn = differential speed
- (R-r) = Pond depth

Performance Optimizing

Influence of flocculation, rotational speed and feed rate on separation efficiency
With Solid Steel bars if there is wear on the scroll, it can be fixed with a weld. The hollow steel bars that some other manufacturers use cannot be fixed if damaged, and require the complete replacement of the scroll.

SCRAPER
Solids build up in the sediment room is one of the major reasons that a centrifuge stalls. The DRYCAKE centrifuges are equipped with a separate scraper room and continuous full geared, independently driven low-speed (5RPM) solids scraper to prevent this from happening.

The discharge of a centrifuge is thrown against the walls of the sediment room with a force over 1000G. Normally, the sediment falls down because of gravity, but with alum sludge and other sticky sludges, the sediment build up and clog the discharge.

If the discharge is clogged, no solids can leave the centrifuge, and the bowl of the centrifuge will fill up completely, causing the centrifuge to come to a stop. It will then be necessary to remove the scroll and clean out the bowl. In certain applications, this might require a 30 ton pulley.
Some other manufacturers also have a scraper but it runs with the bowl/scroll assembly which results in excessive wear in the scraper blades and can cause increase in loss of balance. Others may use a chain driven scraper motor resulting in sealing problems in the discharge chamber.

Our Scraper is fully geared, uses ball bearings, and operates independently from the bowl and the scroll. This feature sets the scraper of the DRYCAKE centrifuge apart from every other major manufacturer.

ADJUSTING THE WEIR PLATE

Most Other Manufacturers

Our System, using a single weir plate
All other major manufacturers make use of several different bothersome weir plates to change liquid levels. These are usually half-crest moons that are difficult to change and are often lost in storage.

DRYCAKE only makes use of one plate. So, when the liquid levels do need changing the plate is exactly where you need it, on the machine.

Changing the liquid levels is also easier on the DRYCAKE because of the three section hinged cover, which provided quick and easy access to the weir plate.

**Integrated Hydraulic Reservoir**

One of the biggest concerns we get from operators in regards to hydraulic back drives is the location and connection of the hydraulic tank. Typically a hydraulic unit is placed next to the centrifuges with the hydraulic lines running on the ground to the centrifuge.

DRYCAKE has addressed this issue by simply using the legs of the centrifuge as hydraulic tank. This reduces the footprint of the
complete supply, and removes any, potentially unsafe, connection lines lying around.

In effect DRYCAKE offers a zero-footprint hydraulic back drive.

**DISCHARGE BUSHING REPLACEMENT**
The discharge bushings are very easy to replace due to our three section hinged cover and the use of standard tools.

We can also rotate our discharge bushings to get more life out of them. The wear on the bushings is always on the same side, so simply rotate the bushing in place 1/4 turn to gain up to 4 times more wear life.