Understanding Important Characteristics of Grit Handling & Washing

Wastewater treatment plants around the world are becoming more mechanized, and as a result, the grit removal process is now often implemented as an important treatment step to protect downstream process equipment. When designing a grit removal system and/or selecting equipment, there are important considerations beyond just selecting the grit chamber. Although the grit chamber is the centerpiece unit and key selection in any grit removal scheme, other important aspects include the selection of grit handling equipment, arranging the grit piping, and selecting components for the second-stage grit washing and dewatering phase.

Grit washing and dewatering are particularly important processes because of the volume of grit that today's flat-bottomed vortex grit chambers remove from large wastewater streams. In particular, there are three important reasons to wash and dewater grit: odor reduction, improved grit removal efficiency and ease of grit disposal Tremendous odor can be produced from disposed grit when removed from raw sewage because of organic material still attached to the grit slurry.

Generally, the organic separation from the grit starts at the grit chamber using a flat bottom design and special propeller blades. However, a small percentage of organics will remain with the grit, necessitating a "second-stage" grit washing and dewatering phase. Making intelligent decisions about how to handle removed grit not only can further enhance system efficiency, but also can significantly reduce odors and maintenance costs.

Grit Handling and Piping

After grit has been separated from the flow in the vortex/circular grit chamber, the collected grit slurry, usually stored in a "hopper" below the chamber basin, must go through grit washing and dewatering process to remove excess organics and water. These steps essentially separate the collected grit slurry into basic components of water, organics and grit. Organics and water are returned to the wastewater stream while the grit is dewatered for hauling and disposal.

There are only two automatic ways to physically remove the grit slurry from the grit chamber's storage hopper. In the initial development of circular grit chambers in the 1970s and 1980s, it was by airlift. Although airlifts are still available, the preferable and more efficient method of transfer is now by the use of a grit pump. Improvements in pumping technology have brought forth the availability of pumps designed exclusively for pumping grit.

Grit pumps have generally replaced airlifts for several reasons. Airlifts, which release air into a vertical pipe and raise grit out of the storage hopper and through a horizontal pipe to the dewatering equipment, have the greater tendency to plug. Plugging is due to the low pressure exerted by the airlift, which doesn't convey the grit slurry as powerfully as the grit pump. As a result, settling grit accumulates more rapidly in the horizontal pipeline and as time passes, plugging occurs.

The result from a carefully considered grit handling, washing and dewater scheme is odor-free, dry grit for easy disposal.

Additionally, the limited pressure from airlifts also eliminates the selection of grit washing equipment and requires larger dewatering mechanisms. Of most significance, grit cyclones, the mechanism used for washing grit, cannot be utilized with airlifts, which require a higher head that can only be provided by grit pumps. Thus, grit systems that utilize airlifts discharge to the dewatering classifier grit slurries containing organics and the resulting odor problems.

The airlift design also requires more routine maintenance because of its extra moving parts. For example, blower lubrication can be a daily task compared to grit pump lubrication, which is usually just twice a year. Blowers have belts and shieves, which require periodic replacement, while superior grit pumps only need an annual inspection for a possible seal replacement.

Performance costs are also greatly reduced with grit pumps because an airlift's blowers typically have to run consistently to move the flow to the classifier while the grit pump may only need to run 30 minutes every four hours (depending on the grit load). As a result, the long-term operating and manpower costs associated with airlifts generally outweigh the smaller differences in initial equipment cost.

As such, grit pumps have emerged as the premier grit handling device. Grit pumps employed in these applications are centrifugal, and the superior ones feature a Ni-hard construction, easier maintenance considerations and minimal wearing parts. They can be remote-mounted, using gravity flow (flooded-suction) or be top-mounted on the grit chamber using vacuum priming.

Top-mounted grit pump designs are the latest trend and are successfully employed globally. They offer unique advantages including self-

After grit is removed from this flat-bottomed vortex **PISTA®** *Grit Chamber, a top mounted turbo grit pump (pictured at right) pumps the collected grit slurry from nearly 114,000 m^3/d of raw sewage to a* **PISTA®** *Grit Concentrator (cyclone) and screw classifer for washing and dewatering (pictured at right). This complete system is designed to work in concert for high grit removal and dewatering efficiency.*

draining capability, which minimizes the potential for further clogging. Much like in the airlift, the suction pipe is a vertical rise from the storage hopper where the grit can flow back into the storage hopper. Remote mounted units require additional suction piping where grit material can accumulate and increase the potential for plugging. In addition, top-mounted grit pumps minimize space and construction cost because they don't require additional dry wells; instead they simply reside on top of the grit chamber.

While the successful selection of a grit pump over airlifts can reduce the potential for grit plugging, it does not necessarily eliminate it altogether. Grit plugging can be a real problem if the piping scheme from the grit chamber to the dewatering equipment is not laid out correctly. In addition to the recommendation of mounting the grit pump on top of the grit chamber, the following are further suggestions for proper grit piping design:

1. The discharge grit piping should be kept to a minimum (less than 6m). The shortest distance between two points is a straight line. By doing this, one can eliminate unnecessary elbows. Elbows in the piping scheme are havens for settling grit, which leads to plugging. The bottom line is that for every additional meter of piping, there is an increased potential for grit plugging.

2. The isolation valve on the discharge side of the pump should be a pinch valve. A pinch valve is preferred because it will seal even if grit is present within the valve. The pinch valve should be located in the vertical position to eliminate accumulation of grit within the valve. Check valves should never be used in any grit pumping line. Not only do they provide the opportunity for plugging; they very rarely work properly because of the presence of grit. The grit pump should also pump for a sufficient length of time to clear the line entirely of grit before shut off of each cycle.

3. If a remote-mounted, flooded suction grit pump is used, the pump suction line should be as short as possible, preferably less than 3 m long. The ideal situation is a short, straight suction run directly into the side of the bottom of the grit storage chamber with an eccentric plug valve to isolate the pump.

A slight incline up from the pump to the storage chamber is recommended to prevent air entrapment from occurring. The grit storage hopper should be pumped completely out every cycle. This prevents grit from accumulating within the suction line. A flushing connection should also be incorporated into the grit pump suction line to allow for water flushing, should plugging occur. Elbows should never be used in the suction line; however, if they are absolutely necessary, sanitary tees with a clean out should be chosen.

The eccentric plug valve located in the pump suction line should be turned so that the rubber face seals against the flow from the grit chamber. If it is not turned in this direction, grit will pack around the movable plug on the backside and prevent it from turning. Small details such as this can prevent a real problem from occurring.

4. Many times two grit pumps are specified in order to provide 100% backup. Normally when this occurs, the pumps are tied in together. This is not recommended because it only provides additional elbows and piping; in other words, places for grit to plug the line. A better solution is storing a spare rotating assembly for complete backup. Be sure to select grit pumps that easily facilitate changing rotating assemblies by simply lifting them off the pump.

Grit Washing

After the flow has moved through the grit chamber, the accumulated grit, organics and water are pumped to a second-stage grit washing and

continued on p. 3

*Two **PISTA®** Grit Concentrators (cyclones) that receive flow from separate grit chambers feed into this **PISTA®** Grit Screw Classifer with full-length outlet weir trough. Behind is a top mounted grit pump with a simplified piping arrangement to the cyclone, which significantly minimizes the major problems associated with poorly designed systems: plugging and odors.*

continued from p. 2

system, which includes a grit cyclone and screw classifier. The grit cyclone (also called a grit “concentrator”) separates the lighter substane of organics and excess water from the grit, while the screw classifier further dewaters the grit and carries it to disposal.

Because no grit chamber is 100 percent efficient, a small percentage of organics will be trapped with the grit. The modern second-stage cyclone, located on the grit discharge line, is an important inclusion in the entire grit removal system because it is designed for ultimate separation of the malodorous organics. Inside its cylindrical shape, the grit cyclone causes a vortex movement much like the circular grit chamber. Likewise, this vortex action further separates the grit from organics. As a rule of thumb, top mounted grit pumps provide the pumping head and capacity necessary for optimizing the vortex efficiency of the cyclone.

Approximately 6% of the separated grit continues to the classifer for further processing and the remaining 94% volume overflows back to the head of the grit chamber. The purpose of limiting it to 6% of the flow is that the grit is concentrated and washed from organics. The result is clean grit with a sandy texture, free from the organics that can become a smelly nuisance. The small 6% flow also allows superior dewatering efficiency in the next unit operation.

Superior grit cyclones employ heavy-duty, Ni-Hard iron thick construction, which increases life to 10 times that of steel or stainless steel. Ni-Hard is stronger due to the nickel/alloy components incorporated in the cast in material, thus Ni-Hard has a hardness (BHN 550+) level higher than steel and stainless steel. Thick, solid-cast construction at the base also helps to prevent the concentrated grit from wearing down the bottom. Other units may utilize liners for additional protection, but these liners are wearing parts that will require periodic replacement and increase operating cost and maintenance.

An additional key to look for in selecting grit cyclones is orifice sizing. Inferior units can clog more frequently because of small orifices, which can range in measurement from 2.5 cm – 7 cm in diameter. A very large orifice, with a minimum diameter of 8 cm, is recommended to suitably reduce and even prevent potential clogging.

Grit Dewatering

Following grit washing, the concentrated grit stream then discharges into the final dewatering device, the screw classifier (also called “screw conveyor”). It’s important to understand that most screw classifiers have been developed for other industries – like food and fertilizer – and only a few in the wastewater market have been uniquely designed for dewatering grit from wastewater streams.

The standard classifier is basically a steel trough with an inclined screw. It operates on the settling principle, allowing the grit to settle in the trough while the rotating screw conveys (or lifts) the settled grit out of the trough for disposal as the grit-free overflow fills an outlet weir trough and returns to the grit chamber.

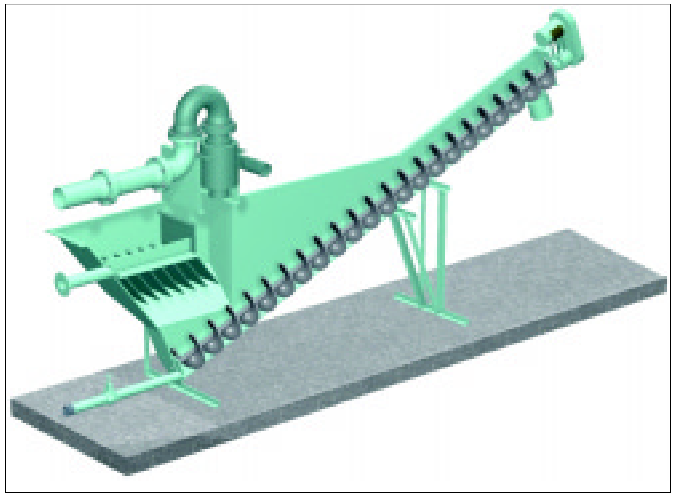
While heavier grit settles to the bottom, the problem often encountered in generic classifier designs concerns the retention of fine grit particles (10µm or 150 mesh and smaller). Finer grit is often suspended because of turbulence from the entering flow. As a result, the fine grit doesn’t settle and is recycled to the grit chamber, lowering the overall removal efficiency of the grit removal system.

A solution to this problem is specifying a grit classifier that has a flow dissipation zone where the underflow of the cyclone is introduced. This allows the flow/grit to enter the classifier without disturbing the already settled grit in the hopper area of the classifier. Flow dissipation directs the incoming flow down along a baffle and up into a parallel plate section. The fine grit contacts with the plates and slides down to the screw while the water is forced upward into a trough to be sent back to the grit chamber.

These plates improve the retention of fine grit by utilizing the entire surface area of the hopper. Essentially, the parallel plates function like a Lamella-type separator by capturing the discrete grit particles. The plates are spaced so that while fine grit is retained, the organics are not trapped, and trash is not built-up. The result is increased settling and retention of fine grit so that the dewatering operation is achieved with a higher level of efficiency. Sizing the classifier is an another important consideration in selecting this equipment.

An undersized classifier will allow for too high an overflow rate and lots of grit being lost or carried over into the overflow trough. Selecting a screw classifier with a full-length outlet weir trough will significantly minimize the overflow rate and the carryover of fine grit back to the grit chamber.

For increased dewatering capability, it is recommended to use a 9"/14" (23 cm/35 cm) screws (depending on pump size) with a slow revolution per minute (9 RPM). A slower rate of revolution facilitates greater accumulation of grit for disposal. The classifier then better facilitates handling and disposal because a smaller volume of grit settles.



This **PISTA®** *screw classifier with connected grit cyclone includes a recommended flow dissipation zone and parallel plate section for improved settling of both heavy and fine grit. For increased dewatering capability, it uses a properly sized screw with a slow revolution rate.*

Conclusion

As vortex grit removal system technology advances with time, it has become increasingly important to understand more than just the dynamics of grit chamber operation, but also the second-stage grit washing and dewatering phase. Grit handling components (pumps, cyclones and classifiers) have evolved over the past few decades resulting in key differences in designs and capability.

Yet, many complete grit removal systems have been installed without proper consideration of the nuances that characterize grit handling. As a result, component equipment is often compiled from different manufacturers based simply on initial equipment cost without understanding the long-term effects of how well these components may actually work in concert.

Today, with maintenance costs rising and budgets being squeezed, proper design and equipment selection becomes even more critical. Properly designed systems are streamlined with quality component equipment – from an experienced, single-source – to not only maximize the entire system efficiency but also minimize costly field maintenance and problems.

The latest market trend demonstrates that more engineers and end-users are paying closer attention to the particulars in the important second-stage grit washing and dewatering process, including the selection of grit pumping equipment, streamlined arrangement of grit piping, cyclone equipment construction, and use of parallel plates in screw classifiers.

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