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Ask Tom! Column

Grinders and Comminutors - An Evolving Technology

Guest article by William Galanty, President, Franklin Miller, Inc

Introduction

Particle size reduction technology has been evolving quite rapidly in response to the increasing burden entrained solids have placed on wastewater treatment facilities. The result has been an exciting race between the leading manufacturers to develop the best size-reduction device. The latest grinder innovations to be introduced have coupled the powerful grinding with higher flow capabilities and screw screening systems. Here’s a rundown on the past and present state-of-the-art in wastewater solids reduction.

Wastewater solids such as tampons, sanitary napkins, plastic-laden disposables like diapers and other solids are becoming commonplace. Even entire shirts, blankets and uniforms are found in wastewater downstream of correctional and other institutions. Where screening is employed, some percentage of solids remain in the system and often weave into formidable bundles that can ensnare rotary equipment and plug nozzles. These solids must either be screened out or ground to a size so that they can pass through the system without plugging of equipment.

Since the 1950s, each decade has seen the development and installation of a new breed of solids reduction or comminution devices. Each major new development contributed a set of improvements in performance. Over time many of these units have evolved and found specialized applications where they excel.

Of late, the pace of twin-shaft comminutor innovation has accelerated markedly. These units use two counter-rotating banks of intermeshing cutters to cut and shred solids to fine particles. The shortfall of these units in their banks of cutters provided little open area for fluids to pass through. The latest designs discussed below have solved this problem to form a compact solids screening system.

What is a Comminutor?

Comminutors (a.k.a. grinders, macerators) are used to reduce the particle size of wastewater solids. The terms “Sewage Grinder” and “Comminutor” are two terms for a cutting device for sewage solids. The term “comminutor” originated with a device for chopping meat. It was later applied to equipment used for grinding pharmaceuticals and wastewater solids. The term grinder, as in meat grinder, is commonly used to imply a comminutor that reduces solids finely and often has multitudes of cutting edges. However, this is a loose terminology. There are units that finely reduce solids with only a few working elements.

Where are comminutors are used?

An important use for comminutors (grinders) is in the primary treatment of raw sewage solids in plant headworks and pump stations. Large, stringy solids can easily plug even supposedly “non-clog” pump impellers and necessitate the use of size-reduction devices. In sludge, inline grinders are often installed ahead of pumps in recirculation lines and also to enhance the operation of dewatering equipment, digestors and nozzles which can easily become plugged. Belt filter presses and centrifuges are especially sensitive to oversized particles that can puncture filter membranes, reduce their efficiency or damage expensive centrifuge drums. As a result, grinders can easily pay for themselves in damage and downtime prevention.

Comminutors are commonly employed where it is undesirable, impractical or uneconomic to remove solids due to the lack of disposal options. Even when screening equipment is employed, some solids inevitably slip through, so the use of a comminutor is useful as a backup. Alternatively, some plants find it desirable to put the solids through the plants' digestion processes and thus require size reduction equipment and not screening.

Early Comminution Equipment

Drum-type Comminutors

Sewage comminutors date back to the early 1950s with the introduction of the bottom-discharge comminutor. This unit featured a rotating drum with attached cutter teeth. Solids would get caught on and rotate with the drum and get reduced as the teeth passed through a fixed comb. This design featured a large active screen area and heavy construction. The drawbacks of this unit's design included: a bottom discharge that required a special "L" shape channel construction; trouble handling certain solids, the rotating drum was subject to wear from bottom grit, and the teeth were extremely difficult to remove to service.

Straight-thru Comminutors

Next to be introduced was the Worthington Comminutor that fit into straight-thru channels. Its oscillating cutters wipe a semi-circular screen surface clear and sweep and cut the solids against vertically mounted stationary cutters. This design featured easier maintenance and a straight through configuration. The drawbacks were the screens were light and subject to puncturing. The unit was incapable of handling the increasingly heavy solids encountered due to low power and a lack of torque at the end of each stroke. The straight-thru comminutor generally had a good reputation when maintained. However, if maintenance schedules were missed, unit performance would suffer.

Inline Comminutors

The first machine to address the problems of reducing solids directly inline was the pipeline delumper. Originally developed in the 1960's for the chemical process industry, this pressure-rated unit quickly became invaluable to water treatment plants. It could reduce heavy solids directly inline and improve flow properties of the system thus reducing maintenance problems for operators. The pipeline delumper was the pioneer inline processor that helped treatment plants with a difficult and previously unsolved maintenance problem.

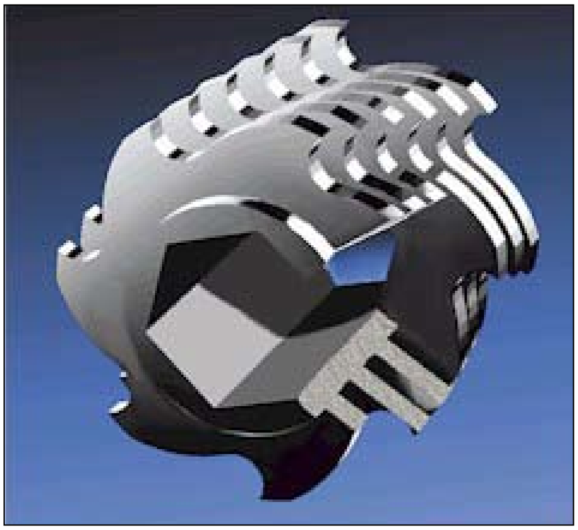
Twin-Shaft Comminutors

After the US Navy in the early 1970s adapted the pipeline delumper as the wastewater processor of choice for its frigate fleet, a competing inline comminutor was introduced with a twin-shaft design. This unit was adapted from a German twin-shaft solid waste shredder. Others subsequently also started marketing this design for municipal applications.

Twin-shaft grinders use two slowly counter-rotating shafts with intermeshing cutter disks. As one cutter passes the other cutter, it shears solids trapped between the two and passes them downstream. This design provided good dry solids reduction and feeding capability.

The design came originally from solid waste shredders with up to 300 hp motors for reduction of everything from steel drums and tires to construction debris. The drawbacks of these miniaturized shredders for liquid waste systems were poor ability to pass liquids. They were also excessively complicated assembly due to the use of multiple individual cutter and spacer disks. Another problem was the possibility of cutter stack collapse and disk cracking as every thin cutter was dependent on every other one for its position in the stack.

Enhanced, Twin-Shaft Comminutors



An improvement to the original twin-shaft design was the introduction of cutter cartridge elements. These cartridges replace the multiple individual cutters and spacer disks with one-piece, solid-cartridge elements.

This increased cutter strength and eliminated multitudes of small gaps and associated re-tightening requirements. The cutter cartridge design is often used to retrofit older, twin-shaft units with individual cutter disks.

High-Flow, Twin-Shaft Comminutors with Diverters

To improve the flow capability of twin-shaft units, various flow "diverters" have been employed to move solids to the grinder while allowing the liquid flow to bypass the grinder. The first of these grinders with a "diverter" design was introduced the 1950's. This unit employed a grinder unit in combination with a vertical rotating drum screen to handle high flows.

In the later 1980s, the diverter concept was again introduced. Several units implemented flat diverter screens such as the "disc screen" which employed multiple parallel banks of rotating disks to convey solids to an adjacent grinder. Another design re-introduced the drum screen with an adjacent grinder.

While these designs increased the flow capability of their grinders, they also had a number of drawbacks. Flat screen or disc designs were subject to "plastering" or bridging of solids across the screen. Screen wear against bottom grit was problematic. Also, solids tend to get trapped within the screen center. Solids could also bypass the grinder altogether as these units have no way to assure that the solids don't escape in the gap between the screen and the grinder. In the drum type screen, only 1/4 of the screen can be active as the rest rotates in the wrong direction or doesn't feed the solids effectively. This results in increased headloss.

The Latest Developments

Franklin-Miller's latest innovations in twin-shaft channel grinding, the FMI Super Shredder, Taskmaster Rover and the Taskmaster Titan. These units feature designs that handle higher flows than and avoid the pitfalls of the earlier units.

Inline Shaftless Comminution

The FMI Super Shredder employs a spherical rotor design with a completely open "shaftless" center. It combines the benefits of an open flow configuration for low headloss with a high shear principle that produces a finely ground output. The Super Shredder features a bi-directional cutting operation, heavy solids handling, abrasion resistant hard-faced cutters and stainless steel cutter construction.

The Super Shredder excels at handling high flow rates with a minimum of headloss. As it only has two cutting elements, it is simple to maintain. The design uses the flow to help in feeding the unit, so it is best applied to applications where the flow velocity is greater than 2 ft/sec.

Traveling Grinder Technology

The Taskmaster Rover mates the power of twin-shaft grinders with effective fine screening. In this unit, a grinder travels (roves) back and forth across a semicircular sizing screen to intercept and grind the solids to a size that must be fine enough to pass through the screen slots.

Oversized solids are continuously recycled back through the grinder for further reduction. The unit's screen is positioned across the entire unit so there are no gaps through which unprocessed solids can pass. As the screen is positioned behind the grinder, it acts like a solids classifier to recirculate oversized particles back to the grinder for further processing. This design assures a high level of effectiveness and a completely processed output.

The Taskmaster Rover uses a stainless semi-circular screen. This design eliminates the possibility of trapping of solids as occurs with screen drums. Even in the event of a power outage, the unit may be automatically restarted without the need for the operator to manually clear out imbedded debris. In fact, The Rover's twin-shaft grinder has an excellent screen sweeping capability and has the ability to self-clear its screen, even if solids have accumulated during the outage.

Twin-Shaft Grinders Using Two Cutter Diameters

Another recent improvement in high-flow grinding is the Taskmaster Titan. This unit employs twin-shafts with intermeshing cutters but each stack has a different sized cutter disks.

The benefit of this design is that the smaller disks efficiently perform the cutting against an apposing cutter disks while the larger disk allows much more fluid to pass through. The result is a twin shaft grinder that requires no more power than previous units but handles much higher flows without the need for diverter screens and their potential operational problems. It can also more effectively feed larger solids into its cutters without repelling them.

Things to look for when selecting a grinder:

An important criteria in choosing a grinder is hydraulic performance. Can the unit be placed in the flow without raising the head excessively to the point of backing up the system or cavitating the pump? For this, it is important to work closely with the manufacturer in sizing of the unit to the application. In general, a more open design will pass more flow and cause less backup than a unit with a higher percentage of closed area.

- Will the design handle the present and future flow capacity without excessive upstream head?
- Is the design easy to maintain in the given installation?
- Is the unit built for long term reliability and ease of maintenance?
- Is the unit built with materials that are resistant to the corrosive or abrasive conditions of your flow?
- Is the unit capable of handling the specific solids encountered in your system such as industrial waste or institutional solids?

About our Author

William Galanty is the President of Franklin Miller Inc., a manufacturer of size reduction processors for municipal as well as industrial applications. He is experienced in the design and application of high powered industrial solid waste shredders, design and production of high pressure and complex industrial size reduction systems in addition to his experience in wastewater treatment comminution.

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Welcome to Ask Tom!, a monthly column by our resident water treatment guru, Tom Keenan of National Environmental Services Agency (NESA). Tom addresses the issues that bug you the most. And Tom knows!! With 35 years experience in providing environmental support services to public and private sector clients on a wide range of environmental issues.

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