WHITE PAPER

UNCLOGGED

How the Evolution of Grinder Pumps with Axial Cutters Is Addressing an Industrywide Collections System Challenge

If you work in the waterworks sector, then you're likely familiar with the issue of collection system clogging. Both utilities and the industry organizations that represent them have made it known that clogging poses significant problems for clean water authorities and resource recovery facilities for a number of reasons.In addition to the already numerous aging infrastructure and funding challenges that affect the wastewater industry, clogging is yet another challenge that municipalities and their maintenance supervisors face on a regular basis.

PENTAIR MYERS*

Clogged systems can result in decreased flow capacity, increased spending for pit and pipe cleaning, contamination of water sources and other costly repairs like pump maintenance or replacement. Furthermore, clogged systems can create risks to public health and personnel safety from exposure to hazardous materials through sewage overflows or sharp materials that may be encountered when attempting to manually remove a clog.
Another problem is that clogging is not something new in the industry and it continues to worsen.

"Over the last 20-25 years, and really in the last 10, the wastewater media stream has really changed and involves a lot of foreign debris," says Brad Jernigan, key account manager for engineered municipal with Pentair, a provider of industry-leading water and wastewater solutions.

The increasing problems with clogging have driven demand for grinder pumps. Grinder pumps provide a way to break down solids within the collection system before they reach the treatment plant.

Wipes have been a major focus of NACWA's Toilets Are Not Trashcans campaign, and the organization has worked collaboratively with other groups since 2013 to try to find solutions to the wipes problem. In 2017, NACWA, INDA (the trade association of the nonwoven fabrics industry), the Water Environment Federation (WEF), the American Public Works Association (APWA), and the Canadian Water & Wastewater Association (CWWA) collaborated on the 2nd Edition INDA Code of Practice: Communicating Appropriate Disposal Pathways for Nonwoven Wipes to Protect Wastewater Systems, which NACWA says was used as the basis for the labeling requirements in the California bill.

Although grinder pumps have been used for decades, recent advancements in the technology and design of these pumps have made an impact on alleviating collection system clogging. Ultimately, the efficacy of grinder pumps is essential to combatting clogging. But before we delve into the advancements in grinder pump technology, let's examine some of the core issues behind clogs.

CLOGGING & WIPES: WHAT'S THE PROBLEM?

Fats, Oils and Grease (FOG) have long been a leading cause of clogs in sewer mains and, more specific to homeowners, can even lead to sewer backups into basements. FOG build-ups most commonly occur as a result of homeowners or businesses pouring cooking oil or grease down drains. The U.S. EPA's National Pretreatment Program has estimated that about 47 percent of sewer blockages are the result of FOG. In addition, any solids that are flushed down the toilet including paper towels, feminine hygiene products, dental floss or cotton swabs combine with present FOG, exacerbating the clogging issues.

In the past decade, this problem has been intensified by another infamous culprit: wipes.

According to the National Association of Clean Water Agencies (NACWA), wipes, including baby wipes and those used for cleaning, have recently posed serious problems for sewer systems, prompting many of NACWA's utility members to begin calling for action around 2008. To summarize the issue, most wipes are made from nonwoven fabrics and many of these products on the market are labeled as "flushable."

Cynthia Finley, director of regulatory affairs at NACWA, has closely followed the wipes issue and the regulatory discussions surrounding it. She explains that even for wipes that are considered non-flushable, manufacturers in the U.S. market are attempting to design them so that they can be flushed.

No wipe is flushable as they don't break down the same way as toliet paper.

But according to NACWA and Finley, the reality is that no wipes are flushable because they do not break down in the same manner as, say, toilet paper.

"In our view, no wipes on the market in the U.S. are flushable at this point," Finley says. "We've found that wipes, especially baby wipes and cleaning wipes, are so strong that they can cause issues with pumps and other equipment the fastest. Even wipes labeled as flushable, though they're not as bad as the baby wipes, can still cause pumps to increase power usage and they'll also accumulate within the pump."

Finley says one of the biggest challenges surrounding the issue is the simple fact that it's difficult for the waterworks industry to get the proper messaging out to the public that in fact no wipes should be flushed. She adds that even though there is a lot of work to be done on the issue, some progress has been made through NACWA's collaboration with other water sector organizations and the nonwoven fabrics industry.

She adds that the wipes industry has since developed a voluntary code of practice for manufacturers to follow that recommends labeling wipes as non-flushable.

In April 2019, California sponsored legislation that would establish labeling requirements and performance standards for wet wipes based on an International Water Services Flushability Group (IWSFG) specification. But Finley says it will likely be some time before other states follow suit or before federal legislation is introduced.

CONTROLLING CLOGGING: WHAT ARE YOUR OPTIONS?

With limited legal recourse for municipalities or states to better regulate labeling of even "flushable" wipes, what can wastewater systems do to help improve maintenance practices and limit the chances of system clogging?

Jernigan says the answer is grinding efficiency, noting that grinder pumps can have the biggest impact on whether foreign objects can clog the system.

> "Flushable means it will not clog the toilet. It does not mean it's supposed to be in the sewer system.

Grinder pumps, which are typically located at a low point outside a home or business where the wastewater well flows out, grind the waste before it is pumped to the nearest sewer main.

He notes the problem of collection system clogging has worsened consistently over the past 25 years as more foreign debris including anything from construction materials to FOG and diapers can make it into the sewer system.

Jernigan says wipes are no doubt the biggest challenge in the wastewater industry today when it comes to clogs.

"The overall wastewater stream, whether in gravity systems or pressure sewers, has really changed over the last decade, and wipes, which are extremely fibrous and hard to chew up, are the biggest culprit," says Jernigan, "Flushable means it will not clog the toilet. It does not mean it's supposed to be in the sewer system."

WHERE AND HOW DOES CLOGGING OCCUR?

Clogging generally does not occur inside the pipe system, but rather at the inlet of the grinder pump, usually inside the cutters or in the impeller inside the volute of the pump.

There are also two primary means by which clogs can occur. One is a slow build-up that can occur as the cutter of the pump dulls over time, which can lead to an accumulation of small solids that do not get flushed through the pump.

The second is a stall of the motor, which can occur mid-grinding cycle when a solid is inside the cutter being ground, and the flow control shuts off the pump mid-cycle. When the pump attempts to restart, it doesn't have enough starting torque to break through the obstruction.

Both of these instances primarily occur on grinder pumps with an older radial cutter design. Both radial cutters, as well as grinder pumps with the newer and improved axial cutter design and its advantages will be discussed below.

Overall, the clogging problem the wastewater industry is incurring is two-fold. Older grinder pump designs do not unequivocally grind the solid waste, which can pass through the pump and into the sewer system. Or, pumps can be damaged or stressed quicker due to ineffective cutter design that cannot handle the amount or type of foreign material being disposed from homes or businesses.

Patented Axial Cutter Technology by Pentair

THE EVOLVING DESIGN OF GRINDER PUMPS

Prior to the introduction of the axial cutter design, which this paper will highlight further below, two primary grinder pump designs have preceded. One design, a progressive cavity pump, uses positive displacement, which entails more of a "pushing" movement through a series of cavities, which are small openings between the rotating stainless steel rotor and a rubber boot, known as a stator.

The other is a radial cutter design that involves a rotating cutter that spins with the impeller as the pump motor is energized. The rotating cutter, which requires more torque, spins within the inner diameter of a stationary shredding ring with multiple slots that allow the passage of fluid into the wet end. As the rotating portion moves around, it pulls water evenly around the outside circumference through the holes. Material is caught and then ground as it moves through the slots until it either passes through or the pump clogs. Solid objects are reduced to fine slurry via a shearing action between the straight edges of the rotating cutter and shredding ring.

"There has not been much change to the cutter design of grinders until about 10 years ago when flushable wipes became a problem," says

Michael Schlatter, product manager for grinder pumps at Pentair.

AXIAL CUTTER DESIGN

Grinder pumps with axial cutters have now been on the market for about six or seven years. These grinders take single bites out of solid material and push the remaining material away from the inlet of the pump. This

Pentair Myers V2 Series Grinder Pump

action prevents any large mass from building up and blocking the inlet. The combined design of the rotating cutter and the stationary cutter plate also keep the grinder mechanism clear between pump cycles.
Unlike a radial cutter, the cutting surface of an axial cutter is perpendicular to the shaft and between the leading edge of the rotating cutter and the inlet of the stationary cutter plate. As solid material is being pulled through the inlet, the rotating cutter passes over the opening, cutting the object and pushing the rest of the material away so that it can be cut again.

WHY & WHERE TO CONSIDER AN AXIAL CUTTER

On an axial design, the rotating cutter does not have any pointed or sharp edges extending into the flow path. When the pump shuts off at the end of its grinding cycle, the material falls away from the inlet allowing the pump to start up freely on the next cycle. The curved leading edges also create a scissor action between it and the straight inlet slots of the stationary cutter plate.

"Instead of shredding or grinding, it's more of a cutting or slicing action. It is a different method of cutting entirely," says Schlatter, noting that Pentair's unique patent is in the geometry of the blade and inlet slot seen on its Pentair Myers V-Series designs.

Jernigan adds that an axial cutter is specifically designed to handle the modern media stream that municipalities and end users have to deal with today.

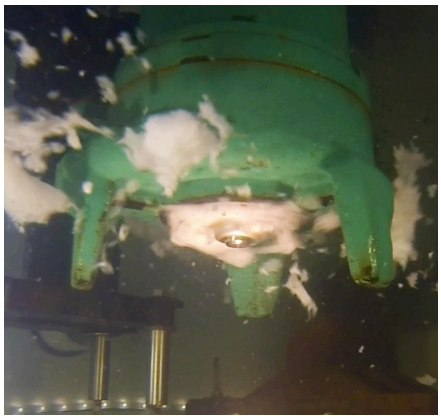
"The easiest way I explain the difference to people is that a radial cutter's function is to suck up all of the sewage and debris out of the well, " he says. "A radial cutter cannot reverse or 'spit' anything out. Once it grabs onto material, it's either going to pass it, or clog the cutter. In contrast, the axial cutter doesn't want any material around it. It grinds smaller pieces of debris and pushes larger pieces away. It's really is a different methodology in terms of how we approach the wastewater stream."

Therefore, a radial cutter is more prone to clogging because once it grabs onto a piece of material, it will not let go. Material will either pass or clog the pump.

Another reason a radial cutter is more prone to clogging is because the design includes open passages, it is possible for small pieces of material to make their way into the pump without ever being touched by the rotating cutter. This differs from axial design, which forces all material to pass between the two parts of the cutter before entering the volute. On an axial design, solid or intact material should not be able to pass through the cutter. The rotating portion exceeds past the outside edge of the inlet slots, so there is no space that is not covered by the rotating portion.

In addition, because the radial cutter has two vertical edges touching, the grinder can dull at a higher rate and it becomes harder to cut through material over time. This causes the cutters to function with more of a tearing than a cutting motion, which requires more torque for the motor. "The longer a radial cutter is in service, the less efficient at cutting it becomes," Schlatter says.

In general, grinder pumps that experience the most wear and tear are those located in areas of a consistently high volume of wastewater flow where there is a higher propensity for clogging. This can include locations such as apartment complexes, mobile home parks, gas stations, truck stops, hospitals and other pockets of dense population. This is where axial cutter pumps have the advantage. Because the lifecycle is longer on an axial cutter pump, they are most



Axial cutter shredding a wipe

cost-effective in the long run for dealing with areas of consistently greater flow and areas where maintenance supervisors are likely to encounter a greater volume of foreign debris in the wastewater stream.

THE AXIAL ADVANTAGE: ALL ABOUT THE COST SAVINGS

Overall, the axial advantage lies in the significant decrease in long-term maintenance costs for municipalities, owners and other end users.

The nature of foreign debris such as wipes in the wastewater stream has been a driver for the improvements in grinder pump design. This design aims to provide improvements in the costs that tend to derive from addressing clogs which includes the maintenance costs from clearing clogs and/or proactive pit cleaning, and pump performance life issues and maintenance from running pumps that are clogged or partially clogged.

"If we take a step back and look at radial vs. axial cutters, it's typically not about what's in the sewer. radial cutter can usually handle a single wipe. It's the abundance of wipes in the system at one time that overwhelms the pump. This is where the axial cutter has the advantage. It's designed to handle mass debris over time." For grinder pumps, maintenance costs are measured over the life of the pump and how many times the pump is stressed. Clogs represent stress on the motor of the pump. The more times a pump clogs, the more stress is induced on the motor, which shortens its life. That's where the decreased maintenance cost is realized.

Since an axial cutter is designed to "spit away" material, there is not nearly the same amperage spike in an axial cutter as with a radial cutter which holds onto that material. Therefore, the axial cutter design is aimed at reducing maintenance costs and extending the life of the pump.

Pentair has found the locations where municipal wastewater utilities should start to explore grinder pumps with axial cutter technology are pump stations or areas that experience consistent problems with grinders, or where current pumps need to be unclogged multiple times a week. Those are the pump stations where municipal wastewater utilities can experience immediate benefits from leveraging these advancements in grinder pump technology.

For more information on how grinder pump technology is moving forward to better handle the amount of material found in the modern wastewater stream visit **pentair.com/cutting-edge.**