It's the fibers: Attacking the wipes problem at the pump station

A three-phase approach to eliminating the clogging, maintenance costs, and safety issues caused by nondispersibles in the wastestream

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Municipalities throughout the U.S. are seeing significant wear on their sewer pipelines and equipment due to age and a dramatic change in the types of influent. The most notable shift has been the introduction of nondispersible fabrics and other debris, which are causing significant problems in the wastestream, at pump stations, and inside water resource recovery facilities (WRRFs). While the ideal solution is to convince everyone not to flush trash and completely rebuild the system itself – for example, rehabbing all pump stations and switching to advanced treatment facilities – such a plan comes with a massive price tag.

◀ **Engineers at Segerstrom Lift station perform application tests on a newly installed grinder.** JWC Environmental

Even if adequate funding were available, the cost in time to complete these outreach campaigns and upgrades is significant. According to a 2013 study done by the American Society of Civil Engineers (Reston, Va.), the U.S. has 1.1 million to 1.3 million km (700,000 to 800,000 mi) of public sewer mains in need of upgrade or refurbishment due to age or declining functionality. Alternative infrastructure solutions that can quickly bring relief to collection systems, while also eliminating the costs of a complete system upgrade, must be considered.

Several solutions exist on the market that are cost-effective, quick to implement, and simple to retrofit into older pump stations and WRRFs. Modern wastewater grinding systems installed directly at the pump station can effectively precondition solids – including nondispersibles – into smaller pieces so the wastewater and debris can pass through pumps without clogging.

As the following case examples and test results indicate, this simple change saves municipalities money on energy costs as well as equipment maintenance, while reducing downtime and risks to operator safety. Retrofitting a grinder is part of a three-phase strategy – capture, cut, and remove – for nondispersibles.

Wipes usage today

Pump stations particularly are susceptible to damage from nondispersibles and other trash. Consumer product goods manufacturers are experiencing resounding success selling household, industrial, and healthcare cleaning wipes. So much so that wipes usage is expected to grow 16% annually, according to a 2013 report by the Association of the Nonwoven Fabrics Industry (INDA; Cary, N.C.).

Since many of these products are getting flushed by the consumer, WRRF operators are seeing a surge of debris entering the system. This surge is wreaking havoc on the equipment and presenting significant safety risks to operators who must derag pumps and valves. While many wipes manufacturers have relabeled their products and several public awareness campaigns have started, there is still a public perception that just about anything is flushable.

By confronting the wipes problem at the pump station through more effective grinding of wipes, wastewater professionals will be better positioned to tackle tough debris at the treatment facility. Handling the problem early also maintains the integrity of the collections system equipment.

Grinding technology success in action

Proper preconditioning of nondispersibles and other waste through grinding before pumping is the most effective solution for preventing pump damage, eliminating safety risks, and reducing the time and energy costs associated with pump clogging. Some of today's wastewater grinders are designed specifically for quick and efficient reduction of nonwoven fabrics.

When wastewater is driven through the grinder, the rotating screens or side rails direct solids into the dual cutter stacks, resulting in smaller particles that easily flow through pumps and pipes. In addition, both the capital and operating costs of a grinder are lower than installing a screening system inside a pump station. In some cases, adding a screen is five times more expensive than adding a grinder.

Segerstrom lift station

At the Segerstrom Lift Station in Santa Ana, Calif., operators noticed an escalation in pump ragging and blockages starting in the mid-2000s. The station would be shut down for hours (and sometimes a full day), so the crew could derag the pumps. Contributing to loss of man-hours and maintenance expenses, the operators needed to break open pump fittings to pull out the rag balls every time this problem occurred. They experienced 105 clogged pump incidents in 2011. Engineers installed a channel grinder in October 2011, and in 2012 they stopped the pumps only twice to clean and check them.

Thornwood lift station

The Otter Creek Water Reclamation District (South Elgin, Ill.) faced mounting recurring cleanup costs at their Thornwood lift station due to a buildup of rags, trash, wrappers, and other debris clogging the system and forcing pump shutdowns. The district engineer noted that the WRRF was filling with more polyester-reinforced rags than ever before.

As a result, the district required a vacuum truck to remove rags from the wet well four times a year at a cost of $4900 per visit. In addition, the rag balls accumulated over submersible pump cables and would disconnect them, inadvertently shutting off and short-circuiting the pumps. Altogether, the maintenance and repair issues were costing the district more than $19,000 a year.

The district engineer suggested a grinder unit and since the installation in 2012, the lift station has had zero pump maintenance issues and eliminated the previous costs associated with clogging problems.

Santa Margarita Water District

Starting in 2012, disposable wipes were degrading the performance of the lift pumps at the Santa Margarita Water District (Rancho Santa Margarita, Calif.) reclaimed water facility. The situation required all four pumps to run continuously, instead of cycling two pumps at a time. Once the pumps could no longer keep up with reclaimed water production, the staff needed to derag the pumps by hand. This forced a shutdown about every 4 weeks for 2 hours. It also exposed workers to potential sticks from hypodermic needles in the rag balls. The loss of an acre-foot of reclaimed water production per month and the labor costs added up to about $15,000 per year.

After realizing the huge expense that came with a new set of chopper pumps, the facility operators decided to upgrade their existing grinder. Since the upgrade in 2013, the district has had zero pump clogging issues at the facility, and has returned to using two pumps at a time instead of all four. Energy costs have decreased by $78,000 per year, and manual pump clean out is eliminated. A fine screen removes the wipes and trash after the pumps lift the wastewater to the headworks.

Capturing and cutting

Two factors are crucial to containing nondispersibles: screening and grinding. Testing these factors in a closed environment simulates actual waste debris scenarios.

Installing new grinders at the Santa Margarita reclaimed water facility eliminated pump clogging from rag balls. JWC Environmental

Rag balls form in collections systems when debris and hair knit together. Research revealed that hair is the main catalyst for the rag balls. JWC Environmental

In March 2014, a manufacturer research team began a project to gain insight into the benefits of waste grinders in pump stations. The team used their results to design a new generation of grinders capable of handling larger amounts of wipes and debris while providing complete pump protection.

During the first stage, the team interviewed 10 current users of large grinding systems at pump station facilities. Seven sites reported an increase in wipes and other nondispersibles, but their current grinders were handling the load and protecting the pumps. Three sites expressed concern about an issue called reweaving. This occurs when material passing through a grinder turns into long, thin strips that subsequently knot themselves together into rag balls and get stuck inside pumps.

To understand reweaving and test new grinding systems, the research team built two large-scale test environments: a 9-m-long (30-ft-long) test tank with variable speed pumps and a grinder, and a "reweave pond" that uses a recirculation pump to recreate the swirling flow inside a wet well.

The team purchased a wide range of consumer wipes to test, including flushable wipes, household cleaning wipes, healthcare wipes, shop towels, shop rags, and diapers – all of which are found regularly in the wastestream. The protocol called for presoaking items for 15 minutes, grinding them, allowing them to circulate through the pumps for 7 minutes and then capturing the material to transfer to the reweave pond. Figure 1 (p. 53) shows the long strips created by a traditional cutter configuration.

Inside the pond, the team added a preset amount of hair to the ground material to recreate what is found typically in wastewater. In later tests, grease also was added. However, the team discovered hair is the key catalyst for promoting long strips to knit together and create stronger debris balls. The team also discovered any long strips would congregate in corners of the swirling pond and – once a catch point was added – start to knit together with hair to form a rag ball.

When the team studied ground debris cut into smaller squares (using a new cutter design), they found the particles appeared "ghostlike". (See Figure 2, p. 53.) These smaller pieces would not congregate and would not build up on the catch points. These particles never reweaved and instead had no trouble passing through the pump.

Operator interviews and test tank data focused the researchers on the need to develop a new grinder that produced smaller particles and not long strips. Three design goals emerged from the baseline research: capture, cut, and remove.

Capturing all of the wipes and passing them through the cutting chamber were essential to preventing rag balls. Every area of vulnerability where flow passed through the grinder was addressed either by closing interfaces or creating a new geometry to direct solids into the cutting teeth. For municipal grinder models, a new high-flow side rail design was added to decrease the pressure gradient across the openings so material would be washed into the cutting teeth. The improved design was patented.

The team also needed to address larger, higher-flow wastewater grinders, which use rotating drums instead of side rails to direct flow into cutter stacks. The team found that by converting traditional coil drums to a perforated drum they could effectively capture the wipes material. The perforated drums provide two-directional screening, which a coil drum is unable to do.

To cut debris into smaller pieces, the research team focused on finding a cutter geometry that would grind debris in two directions. Traditional wastewater grinder cutters work well by slicing debris in one direction, but they can create varied lengths of strips as material exits the cutter teeth.

After testing, the team selected a 17-tooth cutter design with serrated edges and established a tolerance of 1 mm (0.04 in.) between the cutters. An optimized cut control system spins the two rotating shafts at a rate that maximizes the tearing action of the cutters as the teeth pass one another and pass the opposing spacer.

During testing, this design configuration eliminated rag balling and reweaving and produced smaller particles. It reduced the number of long strips by 51% compared to the older style of cutters.

Capturing more debris and cross-cutting are key features for this new generation of grinders. Now, debris can pass through a pump station consistently without requiring operators to unclog pumps. The final strategy was to improve the capture rate and removal of wipes and debris at the headworks of the WRRF.

The final stop for wipes: removal

In addition to in-line and in-channel grinders, fine-screen and band-screen products are becoming popular worldwide due to their high capture rate – up to 93%, according to studies by UK Water Industry Research (London). Fine screens use perforated panels with 6-mm (0.25-in.) circular openings to capture debris, including small bits of wipes, plastics, and even fruit stickers that commonly pass through a traditional bar screen.

Key to the success of all fine screens is ensuring that the captured materials are removed successfully from the panels and not carried over and back into the wastestream. The research team developed and site-tested new technologies for fine screens to enhance the removals step. A new brushless cleaning system was developed that includes ultrahigh molecular weight (UHMW) plastic screening panels. This new system not only allows the screen panels to withstand the harsh environment, but also prevents debris from "stapling" or getting stuck to the panels. Stringy debris can get caught when the two ends are pushed into two adjacent perforated holes at the same time. The debris has become "stapled" to the panel, similar to the way a staple goes through a piece of paper and gets locked in.

A rotating cleaning brush typically is used at the top of the screen where material is discharged from the fine screen. The brush is used to remove material that is stuck to the panels. With the newly designed UHMW panels, debris can be washed off the panels into the compactor without the use of the separate rotating brush. In addition, debris does not "staple" to the perforated panels due to the greater thickness of the UHMW panel.

Ultimately, a brushless fine-screen system reduces the number of moving parts and ensures a longer service life for the screen. Using this kind of product in combination with a grinder will further protect wastewater infrastructure from nondispersible debris.

Improving efficiency

Large-scale improvements to North America's sewer systems are crucial for a functional and prosperous society, yet such an undertaking requires an enormous amount of funding, time, and labor. Recent changes to the influent wastestreams have created issues that must be addressed by municipalities to maintain operable collection systems. By incorporating modern grinders and screening systems at the pump station and headworks, facility managers can better combat clogging and equipment failures from nondispersible wipes.

These new grinding and screening products are financially sound, efficient solutions that yield long-term cost savings and safety benefits. However, these machines need to go hand-in-hand with more public education about what items are safe to flush. Properly disposing of trash in the trash can and human waste in the toilet will lead to even more efficient wastewater facilities.

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Figure 1. Results using a traditional cutter design

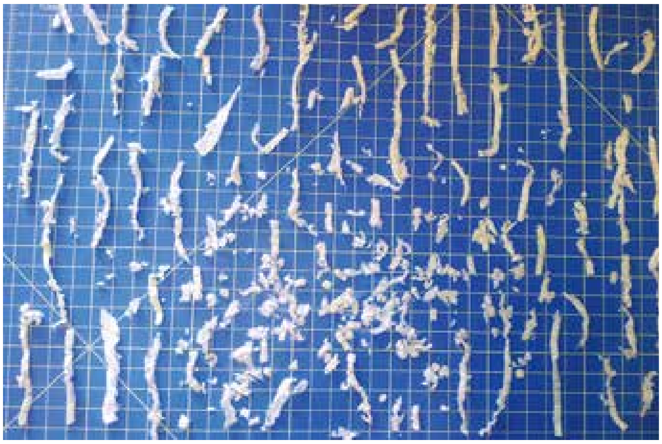

Figure 2. Updated cutters eliminate wipes reweaving issues