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NO MATCH FOR THESE MONSTERS: *GAME-CHANGING TECHNOLOGY FOR ELIMINATING THE WIPES NIGHTMARE*

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INTRODUCTION

The composition of modern sewage is vastly different than influent from just a few decades ago, and pump stations, headworks facilities, and other equipment within water resource recovery facilities (WRRFs) were never designed to handle it. One of the biggest culprits is the increased use of "flushable" consumer wipes and other non-dispersible fabrics that end up in the waste stream, which eventually clog pumps, pipelines and sensitive treatment equipment. Combined with the funding constraints of the North American wastewater system, municipalities require cost-effective, reliable solutions to deal with tough debris and to protect downstream equipment — without the luxury of a total system retrofit.

The aging wastewater infrastructure in the U.S. alone is sorely in need of maintenance and improvements. The recently released Clean Water Needs Survey (CWNS) report to the U.S. Congress from the Environmental Protection Agency (EPA) details the $271 billion needed to meet the water quality goals of the country's Clean Water Act. Additionally a 2013 study done by the American Society of Civil Engineers, the United States has approximately 700,000 to 800,000 miles of U.S. public sewer mains in need of upgrade or refurbishment due to age or declining functionality.

The consumer adoption of disposable wipes is not helping the situation. Wipes manufacturers are experiencing resounding success in the sale of household, industrial and healthcare cleaning wipes because they offer a convenient, hygienic and inexpensive cleaning option. Their success is so good that wipes usage is expected to grow 16 percent year-over-year, according to a 2013 report by the Association of the Nonwoven Fabrics Industry (INDA), the trade group for disposable wipes producers. This has led to sewage composition that continues to evolve and wreak havoc on wastewater systems.

The momentous growth of disposable wipes finding their way into sewage systems has led to multiple studies into the problem. The State of Maine did a well-documented study looking at what items were being flushed. They found that only 8% of the items were labeled "flushable." The other 92% were items not designed for flushing such as baby wipes, cleaning wipes, feminine products and paper towels. The reality is that the consumers for various reasons are utilizing toilets as a disposable option for soiled disposable products.

PATHWAYS TO A SOLUTION

Wastewater treatment operators have several pathways to a solution when fighting the wipes epidemic.

Public Education

Public education campaigns is one that has been proven to have some level of success. Studies such as the marketing research study on best public outreach campaigns conducted in early 2014 INDA and the Maine Water Environment Association concluded that month-long TV campaigns work but ongoing follow-up is required to ensure messaging stays top of mind. The study also found that TV was the most effective media when compared to the use of mailers or radio ads but was also the most expensive.

Wipes Technology

Altering the design of flushable wipes is another pathway to resolve some of the problems. Wipes manufacturers have focused on improving the 'dispersability' of their flushable wipes. In 2015 Kimberly Clark introduced reformulated flushable wipes with Safe Flush Technology™ designed to start breaking up in as little as 30 minutes. Unfortunately this type of technology would only apply to the approximately 8-10% of the problematic wipes and debris flushed that are specifically labeled "flushable". The non-flushable wipes that are flushed would not benefit from these advances.

Technology - Pumps

Technical equipment or technology solutions are a third potential pathway for solving the problems that disposable wipes are causing.

Pumps are the obvious first place to look for a means to resolve this problem in the collections systems since this is where the issue most frequently presents itself.

Numerous pump manufacturers have attempted to respond to the industries immediate needs with modifications to their "non-clog" pump offerings. Non-clog pumps, like all submersible wastewater pumps, rely on an impeller to add energy to the liquid being pumped through a system. Impellers come in a variety of design configurations, depending on the specific pump application. Non-clog impellers typically come in a two- or three-vane design to improve pump performance while still allowing the passage of solids. This type of pump is perfectly suited for standard sewage and typical wastewater handling requirements.

In order to be classified as non-clog, these types of pumps must be able to pass a 3-inch (75mm) diameter solid without fouling the pump. An appropriately-sized spherical solid is usually used during the design and testing phase, and if the object is able to go through the impeller passage, then the pump is deemed to be successfully non-clog.

The problem with implementing this type of pump within a pump station to deal with wipes, however, is twofold:

Obviously, wipes behave completely differently than solid, spherical objects within a pump or pipeline. Long, stringy pieces of wipes and other fabrics can easily wrap around an impeller, causing it to become partially or fully blocked — something round, solid debris is incapable of doing. The second issue is that many of these newer, higher-efficiency multi-vane impeller designs are no longer able to even pass a 3-inch solid — but some manufacturers are still labeling these products as non-clog, which is causing confusion and frustration for pump station engineers and operators. And, it's causing frustration on the part of pump manufacturers who do insist their non-clog pumps do live up to their name.

According to a recent article in **Pollution Solutions**, Danish submersible pump manufacturer Landia spoke out against other pump manufacturers who label their products as non-clog when they really are not. "We see no shortage of pumps that claim to be non-clog – and they are true to their word until the second something vaguely solid comes into contact with them. Regular pumps can handle basic sewage, but they simply cannot cope with the tough synthetic fibers of wipes," said Landia spokesperson Hugh Vaughan in the article. Wipes, especially in the volume that most municipal pump stations see on a weekly basis, are just too tough and strong for a non-clog pump to handle, and engineers should consider other, more powerful options, to combat wipes.

Technology - Sewage Grinders

One technology, the two-shafted grinder, has been used in wastewater systems, particularly collections systems, to prevent pump clogging for over 40 years. The more recent changes in sewage composition have made some traditional wastewater grinding systems less effective than they need to be to prevent pump clogging.

In 2012 JWC Environmental embarked on a testing and development program to understand the differences in grinding technologies and how they deal with wipes. Additionally JWC Environmental wanted to better understand the different types of disposable wipes and how they react to grinders as well as how they react and reweave in sewer systems.

METHODOLOGY

JWC's approach to the disposable wipes problem was to develop technology solutions that can eliminate or significantly decrease the problems seen in collections systems and reduce the associated costs. The focus was on preconditioning of non-dispersibles and other waste through grinding before it reaches the pumps. The goal was finding the most effective solution for preventing pump damage, eliminating safety risks, and reducing the time and energy costs associated with pump clogging.

JWC's technical team first took the approach of performing benchmark testing on multiple types of disposable wipes products that could commonly be found in sewage systems. This included baby wipes, adult disposable diapers, cleaning wipes, high strength paper towels and wipes labeled as flushable as shown in Figure 1. These products were shredded through both JWC grinders with various existing cutter configurations as well as grinders from other manufacturers.

Figure 1 Tested Materials

Next alternate designs for the grinder systems were investigated and tested. The focus of the design changes were in three areas:

1. Capture – Making sure that all materials making it to the grinders were directed into the cutting chamber. This eliminated opportunities for wipes to "bypass" the grinder through other openings.
2. Cutting – Developing a cutting systems that would shred down wipes to a size that would not reweave after cutting.
3. Reweaving – A study was performed on the output materials of the grinders to test likelihood of reweaving after processing. This was investigated with the cut wipes being mixed with Fats, Oils, and Grease (FOG) and hair in a bench level test environment shown in Figure 2.

Figure 2 - Reweave Testing Pond

Through various trials of equipment designs an optimum grinder configuration was developed. This best case solution was tested at a bench scale and later put into real world lift station applications.

RESULTS

Benchmark Testing

The initial testing of various types of disposable materials revealed that there are some differences end products once shredded. Figure 3 (blue shop towels) and Figure 4 (adult diapers) are representative of the types of output products that came from the grinders.

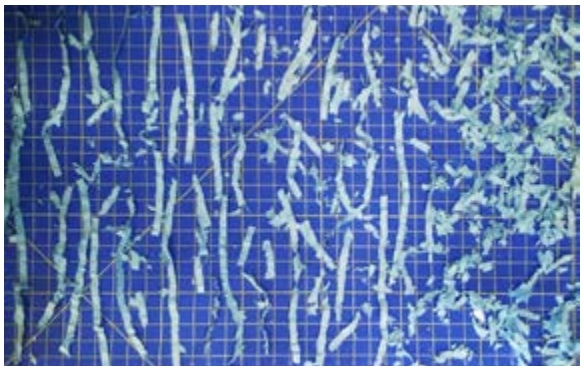

Figure 3 - Blue Shop Towels on 1 Inch (25.4mm) Grid

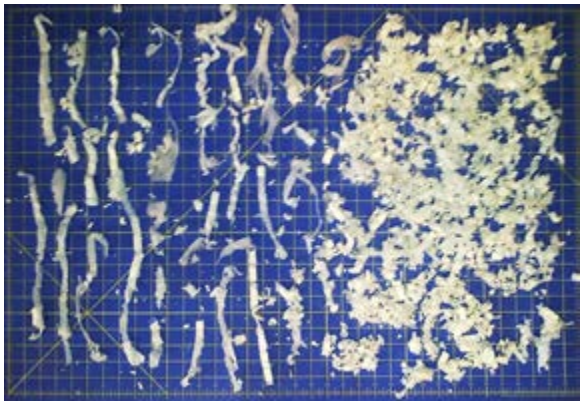

Figure 4 - Adult Diapers on 1 Inch (25.4mm) Grid

All items tested were significantly altered from their original form but there was a range of particle sizes. As can be seen in Figures 3 & 4 there were some smaller particles but also longer strips produced during the benchmark testing. The width of the output materials were similar to the width of the cutters or the spacing between the individual cutters. The length of the strips produced varied but some strips were 6 inches (152mm) or longer.

Capture

During the capture investigation grinders of various types were placed within a wet testing tank and evaluated for the amount of wipes materials that would bypass them in a pumped flow.

The two primary types of grinders tested that exhibited significant differences in capture were ones with perforated capture drums (Figure 5) and those with horizontal bar type capture drums (Figure 6).

Figure 5 - Perforated Drum in Test Tank

Figure 6 - Horizontal Bar Drum

The perforated drum style of grinders were shown to capture the majority of debris placed into the test channel and divert the debris into the grinder's cutters. It was shown the horizontal bar style of drums had a higher likelihood of allowing disposable wipes products to flow through the drums without being ground up. When comparing the amount of bypassed materials the perforated drums showed a 59% better "capture" of test materials – meaning a higher likelihood of diverting the materials into the cutters.

Cutting

With the stated goal of cutting wipes materials to a size that would not lead to reweaving JWC Environmental researched multiple cutter configurations. The alternate cutter and spacer tooth profiles such as the ones shown below (Figures 7 & 8) did not produce the desired results.

Figure 7 - Grooved Spacer

Figure 8 - Long Land Cutter

The final cutter configuration that did exhibit the desired smaller particle size on the wipe materials utilized serrations on the cutter teeth and knurling on the mating spacer. It also had a higher number of individual teeth on the cutters at 17 compared to the 7, 11 or 13 teeth on the typical wastewater grinders. This cutter is shown in Figure 9.

Figure 9 - 17-Tooth Serrated Cutter For Wipes

The output of the final cutter configuration showed a repeatable production of smaller particle sizes. Compared to testing with traditional cutters the new cutter configuration demonstrated at least a 51% reduction of longer strips that would be prone to reweaving after passing through the grinder. A sample of the results is shown in Figure 10.

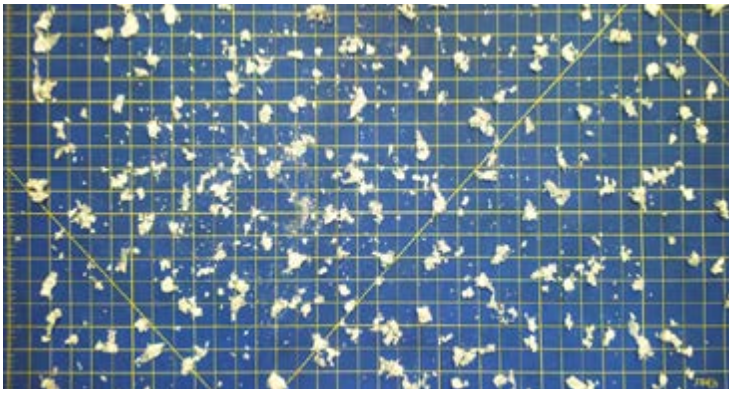

Figure 10 - Wipes After 17-Tooth Serrated Cutter

Reweaving

The reweaving test protocol called for pre-soaking wipes items for 15 minutes, grinding them, allowing them to circulate through the pumps in the flow test tank for seven minutes and then capturing the material to transfer to the reweave pond.

Inside the pond the team added the ground material and a pre-set amount of hair to recreate what's typically found in sewage. In later tests grease was also added, but 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 similar to the one shown in Figure 11.

Figure 11 - Wipes Strips and Hair Reweave

A similar sort of reweaving could not be duplicated with the wipes that were cut with the 17-tooth serrated cutter configuration.

CONCLUSIONS

- Grinding was shown to be a viable solution to reduce the size of disposable wipes and keep them in suspension and therefore able to be pumped.
- It was also shown through the benchmark testing that some traditional grinders on the market will produce longer strips of cut wipes. These longer strips are subject to reweaving when combined with hair as well as FOG.
- Cutters especially designed for dealing with disposable wipes materials can consistently produce smaller particles which remain in suspension, even in the presence of hair.
- Horizontal or vertical bar type screening devices do not do an adequate job in preventing the bypass of wipes through the systems. Perforated plate materials offer superior capture and prevention of bypass of whole wipes.

The use of disposable wipes is anticipated to keep growing and history has shown a high probability these items will be flushed into wastewater systems. The results are often clogged pumps and other damage within wastewater conveyance and treatment systems. Pumps today, even those described as "non-clog", are not a viable solution for many pump stations facing an influx of wipes.

As the expansion of disposable wipes use continues it is important for municipalities to consider a strategy that utilizes technology-based solutions like two-shafted grinders which compliments a comprehensive public outreach program.

Since its founding in 1973, JWC Environmental has become a world leader in solids reduction and removal for the wastewater industry with its Muffin Monster grinders and Monster Separation Systems for screening, compaction and washing. JWC also solves challenging size reduction and processing problems in commercial and industrial applications through its Monster Industrial division. JWC Environmental is headquartered in Santa Ana, California, and has a global network of representatives, distributors and regional service centers to provide customer support. For more information, visit JWC Environmental at www.jwce.com.

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