Optimize Your Headworks System Design Through Onsite Testing: How Treatment Plant Operators Can Improve Process Protection and Reduce Expenditures by Selecting Optimal Screen Equipment

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Evolution of Wastewater Treatment

The wastewater industry is trending toward tighter effluent standards, which is due to stricter environmental regulations and advancements in treatment technologies. These advancements can treat higher-volume flows, but the improved processes continue to require proper attention to each stage.

These improvements demand finer and more-efficient screening. Many new treatment technologies, such as membrane systems, cloth filters, integrated fixed-film activated sludge (IFAS), and moving bed biofilm reactor (MBBR) systems, rely heavily on the performance of fine screens that are located upstream from them. The screens protect them from debris that can cause the process to fail or be damaged.

Process equipment has become more sophisticated and, in turn, more sensitive to foreign material. It's becoming commonplace that the main downstream process at the plant either dictates or plays a significant role in determining the specific type and opening size of the screening equipment (Figure 1) that precedes it. Some processes even require screens

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Figure 1. Center flow fine band screen installed in headworks channel.

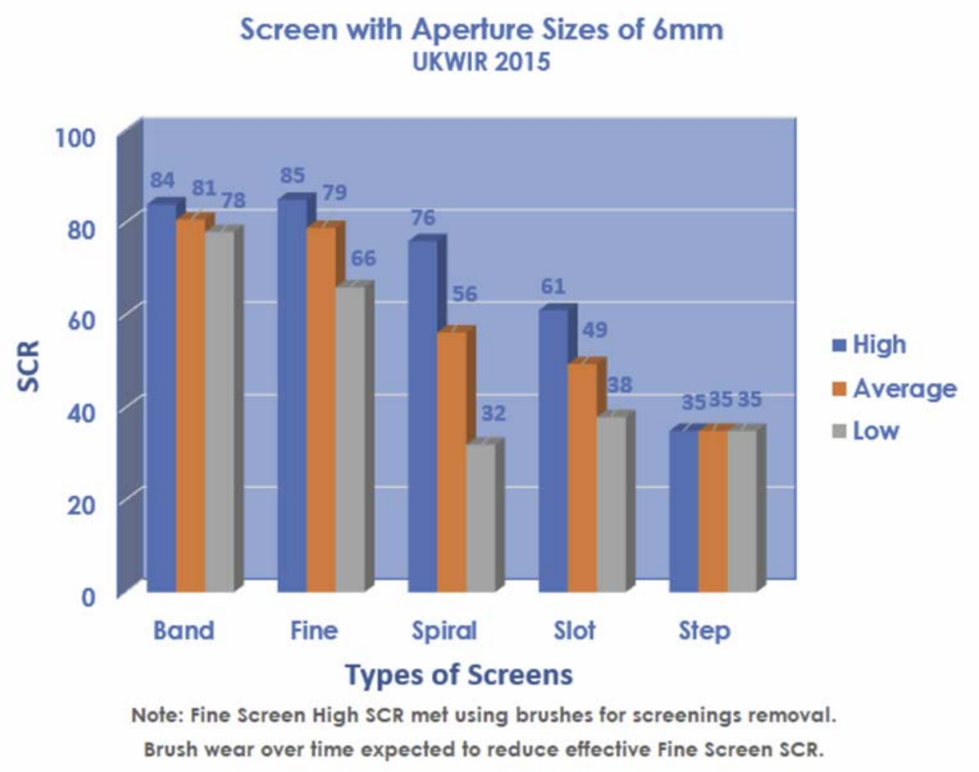

Figure 2. Screen capture ratio performance for 6 millimeter fine screen types.

Factors affecting fluctuations in the quantity, size, and consistency of screenings in the wastewater influent of a municipal wastewater treatment plant can include:

Collection System
- Inflow and infiltration
- Area of collection system and length of sewer lines
- Number and size of pump stations
- Type of pumps and presence of coarse screening or grinding at stations
- Equalization or storage basins
- Septage and grease hauler dumping

Population
- Density
- Hotels/resorts/hospitals/stadiums/laundry facilities
- Correctional/institutional facilities
- Local industry
- Seasonal population (vacation locations/college campuses)

Headworks Design
- Pumped to or gravity fed
- Length and slope of influent channel
- Number of channels and flow distribution
- Pretreatment, such as coarse screening or grit removal

Flow Variations
- Infiltration and Intrusion
- Weather conditions, like drought or heavy precipitation
- Water use restriction

Figure 3. Screening fluctuation factors.

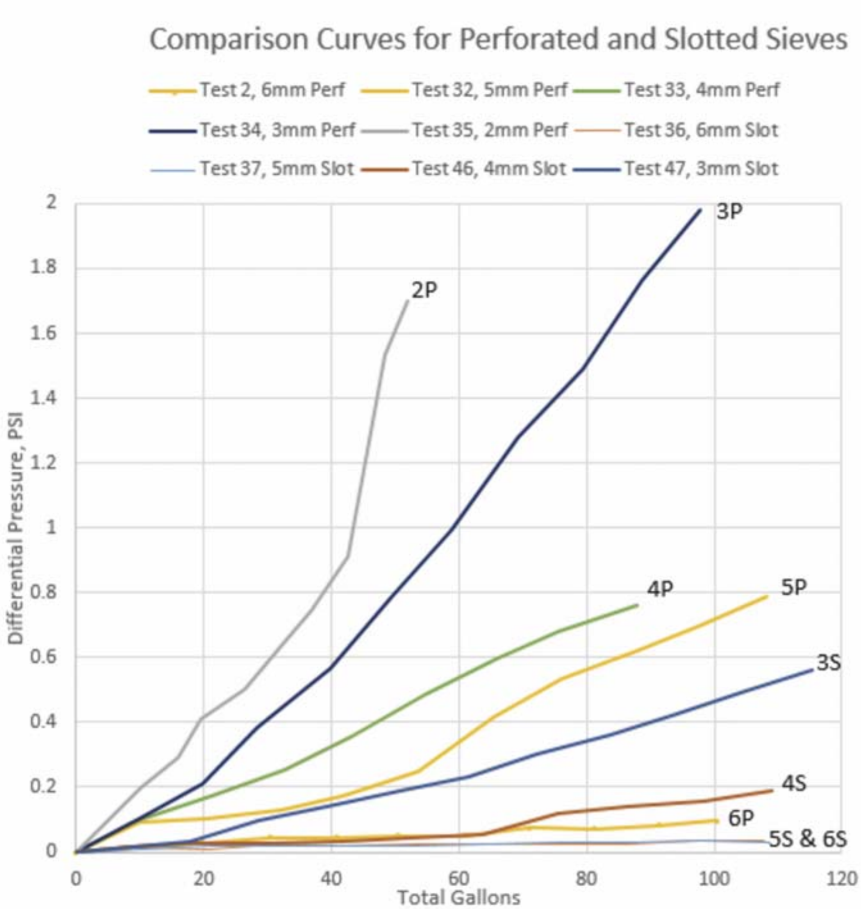

Figure 4. Comparison sieve blinding curves.

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with specific screenings capture ratio (SCR) and maximum opening size for warranty validity.

Challenge with Traditional Screen Sizing

Each plant has its own unique characteristics that dictate the amount of screening protection it requires based on influent flow and collection systems. In any given treatment plant, several items have a direct impact on the quantity, size, and consistency of screenings in the influent flow. This includes the design of a collection system, local industries feeding the plant, size and number of pumping stations, storm water infiltration, and variations in flow.

Engineers specify and manufacturers generally size screens using industry standard blinding factors based on a screen's SCR. The SCR is the measurement of the percentage of screenings a screen captures and can be relative to the screen opening size (or some arbitrary opening size) depending on the test procedure. There are many factors that contribute to the screen SCR, including design and wear life of the unloading mechanism, such as a rotating brush or spray wash. A rotating brush may perform well at first, but have reduced effectiveness due to brush wear over time. This brush wear would reduce the screen SCR, while a spray wash would be more consistent over time with minimal wear.

Thompson RPM, an independent testing facility based in the United Kingdom, is currently the only independent company actively engaged in testing screening equipment. The company recently published findings on tests of SCR for 59 different screen designs.

The graph in Figure 2 illustrates maximum, minimum, and average SCRs for various types of screening technologies tested at the facility. The National Screen Evaluation Facility Inlet Screen Evaluation Comparative Report (1999-2015) tested five different families of screens (band, fine, spiral, slot, and step) built by 18 different manufacturers, with opening sizes from 1 millimeter (mm) to 7 mm. This gave an accurate representation of the types of capture to be expected from the most common screen families.

Screen opening size, however, should not be the only factor considered when determining the proper screen for an application. As shown in Figure 2, even screens with the same opening size can have drastically different SCRs. For example, the 6-mm opening size recorded an SCR as low as 32 percent for a spiral style screen and as high as 85 percent for a through flow fine screen.

Several factors must be addressed when

determining the proper screen for an application (Figure 3). The first step in this process is to recognize the limitations of the plant and narrow the applicable technologies; consideration must be given to channel dimensions, hydraulic conditions, budget, screenings handling requirements, and site restrictions.

Onsite Testing to Address Challenges

A hammerhead onsite screen sizing (HOSS) test, as shown in Figure 5, can characterize the properties of wastewater influent and effluent. Solids loading characteristics can now be expanded from generalized total suspended solids (TSS) or biological oxygen demand (BOD) ranges to include stratification of solid sizes present in the waste stream and clarification and visual inspection of material types (organic and inorganic). A HOSS test, in addition to data from the plant operator, helps to capture critical information for the application demands and headworks system. The analysis of the individual plant's unique influent and downstream process equipment determines the appropriate screen type, size, and operational sequence.

A technical report is generated with recommendations for confident selection of the optimal screen equipment. Other objectives can be covered, including SCR performance of installed equipment and optimum screen combinations for dual stage screening, as well as insight into blinding rates for screen sizing (Figure 5).

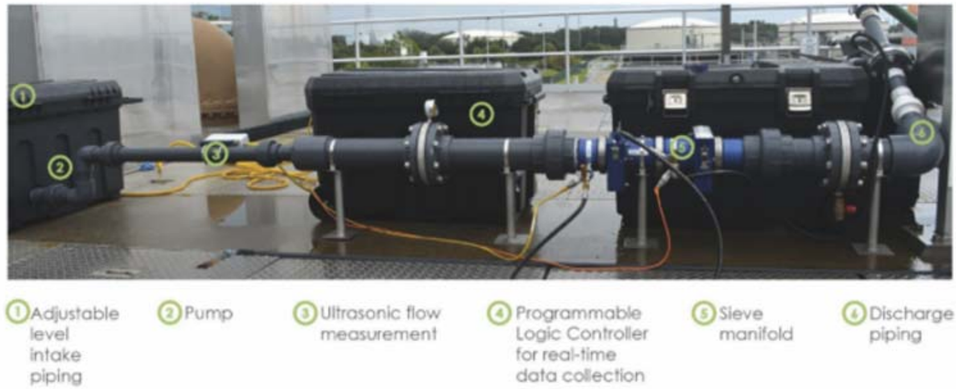

Figure 5. Hammerhead onsite screen sizing test.

Test sieve in front of installed screen | **Test sieve downstream of installed screen**

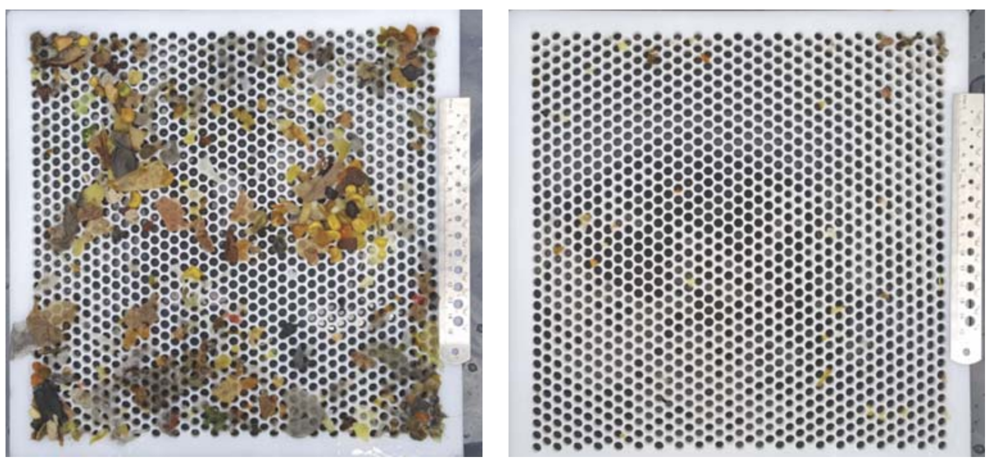

Figure 6. Largo-screen capture test samples.

The Importance and Benefits of Properly Sized Screens

The primary purpose of screening is to remove as much nonorganic material from the influent flow as possible to protect downstream processes from excessive wear and damage. Proper screen selection, sizing, and operation directly impact all downstream processes. If a screen is not protecting subsequent equipment as intended, maintenance costs can increase substantially, while the life of that equipment can be reduced dramatically. Improper screening can also remove more organic material than desired, which can starve biological plant processes of the nutrients they were designed to treat, while simultaneously increasing screening handling and disposal costs.

It has been shown that proper fine screening at the head of a plant will significantly reduce maintenance costs and extend the equipment life of downstream processes. Ideally, the goal would be to remove nearly all nonorganic material at the head of the plant to reduce the strain on the equipment downstream. Realistically, limitations in allowable head losses, channel sizing, equipment cost, and screening equipment capabilities prevent this goal from being an option.

Thorough analysis of influent flow to a treatment plant provides an excellent return on investment. The benefits of focusing on the headworks screen extend from initial operation through the life cycle of the equipment selected. The advantages of understanding the characteristics of solids in the waste stream begin with proper screen sizing to balance capital expense with long-term operation.

Review of Case Studies

Several case studies showcase what the HOSS test offers.

Case Study 1: Largo

A wastewater reclamation facility (WRF) located in the City of Largo purchased a center flow band screen with a 6-mm perforated screen. As part of the contract, a HOSS test was performed to ensure that a minimum of 80 percent SCR was met with the newly installed screen equipment. The SCR test was performed using a 6-mm perforated plate, both upstream and downstream of the existing screen. The test demonstrated visual results (Figure 6), with a SCR of 99 percent for the new 6-mm perforated center flow screens. This SCR for the 6-mm perforated screen was relative to a 6-mm sieve.

Case Study 2: Destin

A WRF evaluated the replacement of existing 6-mm opening step-style screening

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equipment. The challenge in the past was equipment failing to capture rags, which would bypass the 6-mm continuous slotted belt screen and enter the downstream pumps; because of this, the pumps required continuous maintenance. A HOSS test was conducted to determine the optimal size and type of screen for higher screening capture with emphasis on rag removal. After evaluating multiple screen opening sizes and types, the conclusion was to use a 6-mm perforated screen to capture rags, which in turn eliminated pump maintenance. The advantage in using this screen in this unique influent stream is its ability to remove inorganics (rags, wipes, etc.), while keeping the waste disposal costs low.

Case Study 3: Tampa

The Falkenburg Advanced Wastewater Treatment Plant was in the process of obtaining replacement screens as part of a major plant upgrade project. The downstream treatment process required a specified 3-mm perforated screen opening. A dual-stage screening approach was required for screening load sharing of a relatively large flow. One advantage of the HOSS test is that it can use a multiple-stage sieve approach to better characterize the screen capture of each stage; different sieve combinations are tested to confirm the best choice. It was determined that, for long-term results, the ideal first-stage screen would use a 6-mm perforated plate. This combination of 6-mm and 3-mm perforated screen equipment would be a balanced solution for screening load sharing.

Conclusion

The HOSS test is an essential tool for utilities, as it ascertains the appropriate screen size to give the proper amount of grid surface or open area for the blinding expected in order to balance initial capital outlay and long-term screen operating costs. It also determines the most-effective screen size to obtain a healthy balance of eliminating inorganics, while minimizing disposal waste costs. Inorganics, rags, and insoluble particles are detrimental to downstream processes and equipment; optimal screening of these inorganics will significantly lower the treatment plant maintenance cost. In addition, the test can empirically establish the optimal dual-stage screen combination for maximum equipment life and minimum impact on downstream processes and equipment.

The benefits of a properly selected screen include:

- Maximized SCR
- Proper balance of idle versus run time reduces maintenance and extends operating life of headworks screens
- Decreased maintenance across the plant
- Decreased capital costs attributed to oversized equipment and channels
- Proper design and sizing of screening handling equipment

The benefits of a properly selected screen include:

- Maximized screenings capture ratio
- Proper balance of idle versus run time reduces maintenance and extends operating life of headworks screens
- Decreased maintenance across plant
- Decreased capital costs attributed to oversized equipment and channels
- Proper design and sizing of screenings handling equipment