PROBLEM SOLVING
ARTICLE

The benefits of replacing your aging tertiary filter with disc technology

USA

August 2020

Introduction

It is a common occurrence to see vintage tertiary filter equipment at wastewater treatment plants such as travelling bridge filters, multi-media deep basin filters, or continuous backwash moving bed filters that are causing the facility headaches.

Populations are growing, and regulations become more stringent, forcing wastewater plants to consider how they can add or expand tertiary capacity to accommodate future requirements. They often discover that their old technology isn't up to the task and they don't have the available land and/or budget to expand with the same type of design.

Fortunately, there are options. Disc filters have rapidly become the technology of choice for many wastewater treatment facilities when it comes to adding or retrofitting tertiary filtration capacity. They can be outfitted with media that can deliver the necessary performance needed to meet current effluent or reuse requirements. Also, they can pack a lot more filtration capacity into a smaller area than traditional technology, and may even be able to utilize the same basins as an original travelling bridge or other filter types. However, they are not all the same so there are some things you should know when considering your options.

In this paper, you will learn:

- The challenges of older tertiary filter technology such as travelling bridge style filters and how growth and regulations required new solutions such as the disc filter
- The pros and cons of the most common disc filter (and similar style) replacement / retrofit designs on the market
- How a flexible rectangular media design addresses some key disc filter challenges and maximizes tertiary capacity in existing basins

Early tertiary filtration technology

Before the launch of disc filters in the 1990's, tertiary treatment of secondary effluent was considered to be very expensive, and only done in the more extreme circumstances where reuse or very high-quality effluent was required. Technology options were more limited and consisted of relatively complicated and/or large footprint solutions such as the traveling bridge filter, continuous backwash moving bed filters, multi-media deep basin filters, or a few others that were lesser used. Each of these could meet the tertiary filtration needs of the day for the given flow rates, however, they all came with certain challenges.

Mechanical challenges

Some of the biggest challenges the technologies faced were that they were mechanically complicated and often prone to maintenance issues. The equipment often had many moving parts, so when something went wrong it could take a lot of effort to fix. Traveling bridge filters were notoriously known for issues with the bridge itself as they could become derailed, meaning that the cleaning bridge would not move along to clean the filter media. Once that happened the filter was dead in the water. Some filters, such as the continuous backwash moving bed filters, had higher head requirements meaning pumping was required and therefore could be more expensive to operate.

Operation and filter media issues

Another challenge faced by many of these older style filters can be the media itself. The cleaning and backwash cycles of traveling bridge and multi-media deep basins, for example, could lead to media loss or uneven distribution of the media which would reduce filter capacity and effectiveness. Biological and other fouling is also possible, which could cause these filters to blind and lose their filtration capability. When this happens, the filter will backwash almost continually sending large volumes of backwash water back to the headworks of the facility and potentially upsetting the balance of the plant. Even when clean, these older technologies could require large backwash volumes, so in an upset condition this could create some significant issues. Replacement of sand and/or addition to make up for sand loss must also be taken into account at varying intervals during the life cycle of the project. This could be a very significant expense especially considering transportation and disposal of the fouled sand.

Large footprints

Finally, the inefficient use of space of many of these older style filters started to present real issues for many facilities as time went on. Sometimes, environmental regulations would demand higher performance that existing filters could not deliver. The filters could sometimes meet this performance, but often not at the necessary flow rates. Population growth put further pressure on many facilities and plants found themselves at their maximum capacity.

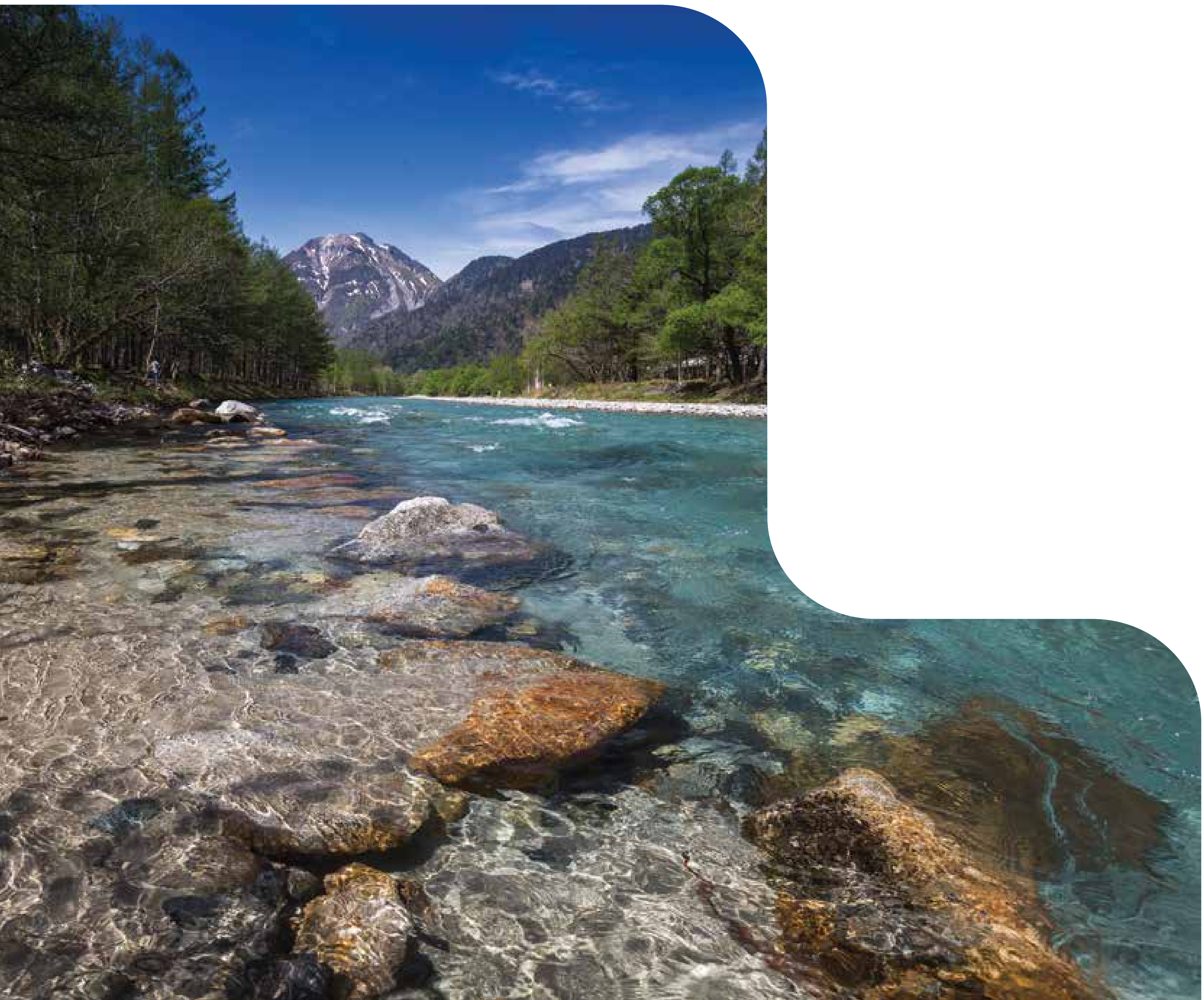
Also, as regulations and the requirements for more water reuse grew, the need to expand tertiary capacity to more wastewater plants did as well. Unfortunately, many wastewater treatment plants did not have the land needed, or the large budget

Aerial image of a traveling bridge tertiary filter

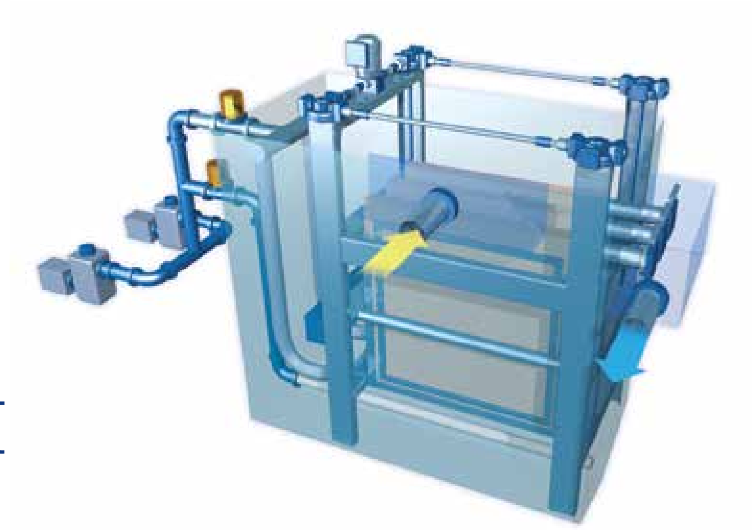
required, to build the additional filter structures necessary to increase the capacity with this existing technology. As an example, most traveling bridge filters were designed for average and peak filtration rates of 2 and 4 gpm/ft2 respectively (0.46-0.92 m3/hr), based on the flat surface area (effective length x effective width of the filter basin), resulting in very large footprint requirement.

As the industry requirements became greater and greater, the need for innovation became apparent. Manufacturers began to look at new ways to provide the high quality of tertiary filtration while addressing the challenges of size, complexity, and efficiency related to vintage technology. Disc style filters began their role as a leading technology for tertiary filtration in the early 1990's. Since then, various iterations and styles of this solution have arisen. While sand/traditional media filters still may have a role to play in wastewater, their role in municipal wastewater is declining.

Let's look at some of the common configurations of this now popular solution and what you should consider when evaluating the technology for a wastewater plant.



Disc (and related) filters - inside and out



Example of disc filter (Alfa Laval AS-H Iso-disc) for tertiary filtration

As disc type filters started to become popular, a number of designs entered the market with the goal of a more compact and efficient filter that could handle larger flows in a smaller footprint while meeting stringent environmental standards. Plants were also looking to reduce their maintenance and overall operating costs for what had traditionally been the expensive process of tertiary filtration. Disc filters today have evolved to the top choice for tertiary filtration.

Most disc filters are alike in that they typically utilize a set of rigid frame cartridges that are covered with a filtering media of some kind such as pile cloth, micro-screen, or woven/mesh cloth. The cartridges are arranged in a housing or as a module set inside of an existing basin such as one used for a traveling bridge filter. Secondary effluent typically flows by gravity from either the outside-in or inside-out of the filters and the filtered effluent undergoes appropriate disinfection for a variety of reuse applications ranging from irrigation, such as for golf courses or even crops, to aquifer recharge or various surface water discharge routes.

When the filters require cleaning, a backwash cycle engages to reverse flow through the filter media and remove the built-up solids and return them back to the headworks of the plant. In general, the concept of operation is similar to the old technology, however, there are some distinct advantages that this new technology has over the traveling bridge filter and other designs from the previous generations. These include:

1. Significantly more filtration area for the footprint as filter media could be "stacked" vertically and not onto a flat horizontal surface
2. Significantly higher flow rates per sq. ft. of filtration media
3. Often less complicated operation and lower maintenance needs
4. Lower backwash volume to send back to the headworks
5. No filter media (e.g. sand) migration or loss and more simple replacement of media
6. Operate with low head and lesser overall heights that tend to fit in existing filter basins

These advantages are seen as great positives and led to the rise of the disc technology becoming an accepted standard for tertiary filtration applications. However, there are some differences in the various designs depending on the manufacturer. They are important to understand as evaluating these factors can help ensure the best filter technology for a given application. There are many designs on the market so we won't be able to cover all variations, but we will look to discuss some common options so that you are able to consider their applicability for your individual situation.

Flow direction: Inside-out vs. outside-in

The direction of the flow through a disc can be either outside-in or inside-out. Inside-out designs are often a micro-screen or "woven" style media (more on media style in the next section). Outside-in is the flow pattern for cloth media filters. While some inside-out designs state higher flux rates, outside-in cloth media typically require less backwash frequency due to the depth of filtration associated with the pile cloth media. Both designs will typically achieve the desired effluent quality and have California Title 22 certification, but the inside-out design has characteristics that pose challenges in certain situations.

Inside-out filters often need a cleaning system that have a series of pressurized nozzles. These nozzles can sometimes clog, impacting the effectiveness of cleaning the filter so they require regular maintenance. They also have to clean "through the media" so generally higher pressures are required to ensure effective cleaning. With the higher pressures present these can often lead to the requirement of mist shields and covers to protect the site staff. These systems typically require a dedicated filter bypass as well, which can be expensive to construct. With situations that have higher than normal total suspended solids they are more likely to blind and will typically require more frequent backwashing than outside-in pile cloth filters. This increases the backwash flow back to the headworks, negatively impacting the hydraulics of the overall treatment plant. Another strong consideration is that for the inside-out flow pattern it can be challenging to identify and diagnose issues, and any large debris can become lodged inside the disc, requiring disassembly to address.

Media type/material

One of the biggest differences between disc filter designs will be the style of filter media used. Each style has different attributes that may work better or worse for your needs. We will cover two major categories of media and their differences here: microscreen and cloth media.

Microscreen

A microscreen (sometimes called woven) filter is often constructed of a polyester or stainless steel “fabric” or mesh. The filters may be a series of cartridges or “wedges” inserted around the periphery of a disc or may be fastened directly to the frame of the disc. They work on a nominal opening size to capture particles, so one benefit of a miscroscreen is that the filtration might demonstrate a tighter rejection based on particle size. That said, due to essentially no depth filtration, these screen type filter medias will typically not demonstrate good removal of particles smaller than the screen opening. Also on the downside, microscreens are typically an inside-out design requiring a nozzle type cleaning system to remove the solids that accumulate on the inside surfaces of the disc.

Some microscreen media, in particular the polyester style, may also be more susceptible to damage such as tearing or bursting from the support frame. Microscreens can be prone to chemical and solids fouling over time and so they may require manual chemical cleaning at fairly regular intervals along with the nozzle system used to clean the inside-out elements to avoid clogging and reduced cleaning efficiency.

Cloth media

Cloth media are another popular and commonly used choice for tertiary disc filters. One of their greatest strengths is that the thicker and deeper pile of cloth at the filtration surface allows it to retain and manage higher solids loadings more effectively than microscreens. If the incoming effluent contains higher solids, or there is a possibility of upset conditions creating spikes of solids, the depth filtration of the cloth media is more forgiving and is better able to absorbs the spikes. Because of the thicker surface of the cloth media, it is used for outside-in flow designs only.

To clean a cloth media filter, it is common to use a vacuum-like shoe mechanism that reverses the clean filtrate flow on the surface of the element and draws solids from the surface. The nature of that design also allows larger solids to settle from the surface of the cloth to the bottom of the tank/basin where they can be removed by a system that typically consists of perforated pipes connected to a backwash pump. Larger, floatable solids can also be skimmed from the top of the tank/basin as they are not trapped inside of the disc.

Cloth style filters tend to backwash less frequently than other disc materials and they do not require the spray nozzle cleaning systems that microscreens require thus not generating mist and making a more safe and better environment for the operating staff. They are relatively durable and can last 5-7 years before requiring replacement.

Media geometry for a retrofit

The shape and configurability of the disc filter media can impact its ability to fully utilize an existing basin's footprint effectively.

Circular, hexagonal and octagonal designs

Many of the disc type filters on the market have a circular/hexagonal/octagonal shape to them, while existing filter basins are rectangular and can be shallow and wide. Balancing these two geometries usually comes with tradeoffs that underutilizes either the filtration area of the disc, or the footprint of the basin. That said, many disc filters can get at least 2X the filtration of a traveling bridge using the same basin if they can get the geometry to work. When they can't, a manufacturer may look to switch to a stand-alone design and possibly keep the sand filter as a redundant filter, otherwise the operating costs may get too high. The stand-alone design of a disc filter can typically achieve a more efficient flowrate per sq. ft. of footprint than the same disc trying to retrofit an existing basin due to the fact that the circular discs are only available in a small number of diameters. We will talk later in this paper about an alternative geometry provided by Alfa Laval that helps address maximizing the profile of more shallow basins.

On circular/hexagonal/octagonal designs, either the disc or the cleaning apparatus rotates to clean solids from the surface of the media. Some challenges with this are that there are often bearings or seals to maintain and it is typical that they are situated underwater. The drawbacks of this method can be further complicated for a retrofit using an "in existing basin". In those cases, if there's a bearing seal failure, the filter could become inoperable. Also, since the backwash cleaning motion is generally "circular", the speed of cleaning at the outside perimeter of the disc moves faster than towards the inside near the center (this is also true for non-circular discs that use a circular motion of the cleaning arm). This means that cleaning efficacy can vary along the radius of the disc creating a nonuniform cleaning pattern.

Hybrid style tertiary filters

There are also "hybrid" designs on the market that essentially combine the traveling bridge and cloth media filter. Utilizing pile cloth filters over long frames that sit completely in an existing basin, they can achieve in the realm of 2-3 times the capacity of the former traveling bridge filter sand media. These are designed to retrofit an existing traveling bridge filter basin, however, they still utilize a traveling bridge cleaning mechanism so are still prone to the maintenance issues associated with that design. The hybrid design also needs to be completely shut down if the media need to be addressed with manual cleaning or maintenance as the basin needs to be emptied to access the filter elements. Also, since the cost of the travelling bridge itself can be significant, these designs are typically not cost effective for small traveling bridge filter basins.

Considerations for selecting a tertiary disc filter

Now that we have discussed some of the different aspects of the disc (and related) style tertiary filters, let's review some of the major considerations you may want to evaluate when selecting a fit for your specific application.

Performance

This is, of course, the most important baseline criteria. A common standard that is applied in industry is that the filter be "California Title 22" reuse certified. You will see this from a number of manufacturers as well as in many engineering specifications. Many manufacturers can provide TSS of < 5 mg/L and filtration 30 day average turbidity < 2 NTU that complies with Title 22 certification. It is also often a goal to reduce Phosphorous to < 0.1-1 mg/L.

There are a number of methods that a manufacturer can use to achieve these performance goals, however, it is important to know what the tradeoffs are. Typically, as the goals become more stringent, it will require tighter filtration media. When that happens, you may require more head (driving force) or the need for more frequent backwash. This backwash is often returned to the headworks of the plant to be reprocessed. Knowing the volume of backwash and the cost of treating it can have a long-term impact on overall costs. If possible, it is highly recommended that lab or pilot testing be completed on the secondary effluent to be treated so that a selection can be optimized.

Capacity

Because of the differing media, as well as the overall design setups, disc filters can have very different performance per sq. ft of filter area. Mesh/opening size will obviously impact the flux capability of the filter media. For many years, a nominal cloth pore size of 10 microns was the standard that was set to meet most tertiary applications. In recent years, manufactures can deploy tighter media (Alfa Laval for example has a cloth that provides less than 5-micron filtration), for applications where tighter effluent limits are desired. Tighter openings do come with the tradeoffs of potentially less capacity per sq. ft of filter area and more frequent (and a higher volume of) backwash. For the California Title 22 standard, you will often see flux rates in the range of 6 GPM/sq.ft (14.8 m3/hr per sq. meter), though some manufacturers are certified at higher flux rates that come with the other disadvantages mentioned above.

Maintenance

One thing about the varying designs of disc filters that can sometimes be challenging to understand is the maintenance needs of each and the corresponding costs. Generally, if starting from a place where you used to have an older filter, then any of the new designs will be a welcome change. The need for unplanned maintenance should not be as prevalent, but as we all know, things can happen that require a plant to diagnose and address problems. Each type of modern filter, as well as each manufacturer, will have different requirements. There are a few things to think about that we can discuss.

How the design is set up to discharge clean effluent can be a major factor to potential maintenance. If the media are set up to discharge into a common header or pipe without visibility or the ability to isolate flow from each media element, then diagnosing an issue with an individual disc can be difficult. If you can't visually see the effluent from each disc, or even better, measure the turbidity for each one, then you will likely not know which disc is causing an issue. It may require taking apart the filter to diagnose, and in worst cases, require you to replace all the filter media if the culprit can't be determined. That can be an expensive troubleshooting session.

Maintenance and planned replacement of the media can vary based on the type of filter selected, but also on the conditions and frequency of cleaning required. Generally, a pile cloth media can last 5-7 years, which is comparable to other media types and depends on frequency of backwashing and other considerations.

The motion of the discs and cleaning mechanisms also create a need for periodic maintenance. For rotating discs there are bearings to maintain and if it's a basin retrofit, then the bearing could be underwater which can be a "short circuit" opportunity for untreated effluent if failure occurs. For units that require pressure washing for cleaning, there will be a number of nozzles associated with the process. Potential clogging of these nozzles means that regular cleaning may be needed by the plant's crew. Whether and how often this will need to happen is a function of nozzle design, and whether there is the presence of particles or biological growth in the spray water. They may also require a separate filtration system for the wash water that needs to be maintained.

Finally, maintenance access and flexibility are important considerations. Especially when it comes to the ability to service an individual problematic filter element/disc. Not all designs allow maintenance on a single filter element without shutting down the entire filter. It is often the case that the filter must be taken offline to remove or clean individual elements. This is an important consideration, especially where redundant capacity may not be available as it can stop the filtration process altogether until the issue is diagnosed and addressed.

All of these aspects of maintenance accrue in ongoing costs of operation. Costs can be in absolute forms, such as electricity, labor, filter media replacement, and retreating backwash,

but also in the form of opportunity cost. If the maintenance and operations personnel at a wastewater treatment plant are needing to frequently clean or deal with other maintenance issues with the tertiary filter, they are not using that time to deal with other pressing issues. This could include time to perform routine maintenance on other parts of the facility and/or effectively monitoring and adjusting plant operations. This cost is often hidden and shows up in failures of equipment that the maintenance staff didn't have time to maintain properly.

Installation/capital cost

For any given filtration application, there are several factors that will influence the total installation cost of the disc filter installation. Many of these have already been discussed so will only be touched on here.

Obviously, the difficulty of filter application will drive the filter media selection and can influence the efficiency of the filter. Severe duty filter applications lead to lower filter efficiency and a larger nominal pore size filter media.

The ability to reuse any existing filter basins effectively can be a significant difference in the cost. If the filter fits the basin space well and maximizes the basin footprint, it can deliver more capacity, great filtration efficiency, and not require filter housings or major infrastructure. When this is not the case, installing new filters may require building modifications to achieve the desired results which can get to be expensive very quickly.

Future capacity

Related to the efficiency discussions in the previous sections, having the ability to add more filters for future growth may be a serious consideration for many plants. If one design meets the current need but uses all of the available space, it may be worth considering paying for a more efficient design that allows for flexibility in the future without major modifications.

Capability of the manufacturer

Finally, it is critical to understand the importance of working with a manufacturer that has deep process knowledge, experience, and financial strength to ensure that they will support your installation both now and for many years to come. An ideal partner will not only understand the application of tertiary filtration, but also have a deep understanding of the entire wastewater process. This knowledge will be invaluable when understanding the facility-wide impact of the decisions related to the selection.

While many of the modern-day disc filters are designed to reduce maintenance vs. older technology, there are times when you may need the support of a manufacturer. Selecting a supplier that has a strong service team and the financial strength to ensure they will be there long into the future is a consideration worth adding to your decision matrix.

A unique and flexible choice for tertiary filtration

In the previous sections, we discussed the reasons for considering disc filters for tertiary filtration; the different types of disc filters you may discover; and key considerations for selecting a disc filter. Now, we are going to briefly discuss how Alfa Laval has used its extensive experience in wastewater (including the strong history of Ashbrook Simon-Hartley) to address the key needs of the market in its one-of-a-kind Iso-Disc™ cloth media filter that also solves many of the challenges some other designs have still today.

High performing outside-in design

The Iso-Disc is a cloth media filter that utilizes an outside-in flow pattern and requires a very low gravity head to operate. This makes it easy to clean without the need for pressurized nozzles and allows heavier solids to settle and light solids to float for easy removal if needed. The cloth media material comes in sizes as small as less than 5 microns (effective filtration), and Alfa Laval is always innovating to bring new media options to the market. Iso-Disc meets or exceeds California Title 22 reuse standards.

Customizable rectangular cloth media element

The key design feature of the Iso-Disc is the filter element itself. Using rectangular media, the discs come in a wide variety of sizes that allow a wastewater plant to customize the geometry to maximize the utilization of existing basins. Because of this design, it is sometimes possible for Iso-Disc to get up to 4 times the filtration capacity in the same footprint of a corresponding traveling bridge style filter.

With the Iso-Disc design, you can see the clean effluent flow exiting each disc so any issue with an individual disc could be observed visually. It is also possible to take a grab sample and measure turbidity and/or TSS concentration of each individual disc making it simple to identify any change in a single disc's filtration performance. The flow from each disc can be easily observed to determine whether additional backwashing of a disc is needed. The discs are fully submerged in the influent allowing full utilization of the filter's available surface area. This is not the case for some other designs.

Additionally, Iso-Disc's filter media are stationary, and they can be completely isolated at any time and removed for inspection or maintenance without interrupting the flow (if procedures and regulations allow) to the rest of the individual discs so you can continue operating without interruption. If stopping the flow is necessary, this can be a short-term and temporary condition to allow simple plugging of the suspect disc for isolation. For other systems, if there is only one filter system, and individual discs can't be isolated as they can in Iso-Disc, the plant would need to bypass the entire filter. This is not a desirable situation.

Even cleaning motion

Another unique feature of Iso-Disc is in the cleaning mechanism. It uses a set of simple reverse flow headers with shoes that clean a subset of the discs at a given time. What is different with Iso-Disc is that it uses a linear motion cleaning device that travels up and down over the rectangular discs. As mentioned above, most designs use a circular motion to clean which moves the cleaning device faster at the outer edge of the perimeter than towards the center of the element. Iso-Disc cleans at the same speed over the entire cloth width, meaning more thorough and efficient cleaning of the surface of the filtration elements. Frequency of backwash can be set a number of ways including timed, manual and/or by water level differential. The latter happens as suspended solids collect on the exterior surface of the cloth, the liquid level rises to a predetermined backwash level triggering a filter backwash.

Simple, infrequent maintenance needed

The Iso-Disc filter itself has no rotating seals that could become worn. This is a common area where unexpected maintenance happens in other designs. It has very few moving parts that ensure that maintenance is kept to a minimum. Filter media last in the range of 5-7 years (depending on in-coming solids level and backwash frequency) before requiring replacement and since the flow from each individual disc is observable, you can more easily identify and address issues with an individual disc and not necessarily shut down the entire filter. Alfa Laval has also developed the capability to remotely monitor and collect data on the Iso-Disc. This allows customers to immediately identify any deviations in operation, as well as use data to optimize their process. The ease and simplicity of maintenance makes Iso-Disc a reliable and cost-saving partner in the quest for tertiary filtration excellence.

Backed by decades of global wastewater expertise

Trusting someone in the design and ongoing support of your tertiary filtration process can be the difference between great success and ongoing headaches. Your tertiary filter will play a huge role in the quality of your outgoing effluent, in meeting compliance standards, and in the overall operational balance of your wastewater facility.

Experience with tertiary filtration equipment is of course a critical part of this, but also a deep understanding of how this equipment ties into everything from headworks forward will also help ensure that a well integrated approach will be taken in selecting the best fit for your individual needs. With a filter retrofit situation, the partner needs to have a good grasp of the existing equipment and conditions so that it is 100% clear to everyone what may change with the adoption of the disc filter technology.

For example, Alfa Laval has a team of engineers and designers intimately familiar with the wastewater treatment process including experts in tertiary filtration equipment. With installations of Iso-Disc worldwide (between legacy Ashbrook Simon-Hartley and Alfa Laval since they acquired Ashbrook in 2012), they have extensive experience in both new tertiary filtration applications as well as retrofits of traveling bridge and other existing filters.

Alfa Laval AS-H Iso-Disc retrofit installed in an existing traveling bridge basin

What you will notice with the strongest partners, is that they will have a customer first approach in key areas, including:

- A detailed consultation where your specific application needs are discussed, and a thorough and honest assessment is provided
- Advanced features that address shortcomings and challenges present in older designs that haven't been updated
- Presenting options in a clear and logical way so that you may easily identify tradeoffs and make the best decision possible
- The ability to test or pilot your application
- A strong warranty and/or process guarantee and a reputation of standing behind their equipment in the long term

Be sure to fully understand the capabilities and approach of anyone you are considering partnering with by asking questions about the above. A partner who can confidently discuss the above can be a big part of a successful installation and ongoing service of your tertiary filtration equipment. Alfa Laval is here to ensure your success, first and foremost.

Where do you go from here?

Now that we've talked about vintage tertiary filtration options, variations of the newer disc filter options, and considerations for upgrading, you're ready to get started! There are many options available to you, but you can now better understand them and can ask the right questions to evaluate the options and their fit to your specific process needs.

A great next step is taking this information and the questions you have and having a conversation with an expert that can guide you through the selection process. Alfa Laval has experts that will work with you in selection, a dedicated engineering team, and a nationwide representative network to address all your needs.

Learn more by visiting www.alfalaval.us/iso-disc.

Whatever you choose for your tertiary filtration, we hope this information has helped prepare you to make the best decision possible and that you and your facility meets its effluent discharge and reuse goals!

Sheldon Young is a Digital Business Development manager in Alfa Laval's Food and Water Division. He has been involved in the process equipment industry for 15 years of his career of which over 10 have been with Alfa Laval.

This is Alfa Laval

Alfa Laval is active in the areas of Energy, Marine, and Food & Water, offering its expertise, products, and service to a wide range of industries in some 100 countries. The company is committed to optimizing processes, creating responsible growth, and driving progress – always going the extra mile to support customers in achieving their business goals and sustainability targets.

Alfa Laval's innovative technologies are dedicated to purifying, refining, and reusing materials, promoting more responsible use of natural resources. They contribute to improved energy efficiency and heat recovery, better water treatment, and reduced emissions. Thereby, Alfa Laval is not only accelerating success for its customers, but also for people and the planet. Making the world better, every day. It's all about Advancing better™.

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