Wastewater filtration sees new drivers for primary and tertiary treatment

Filtration product providers are exploiting markets such as water reuse, micropollutants and nutrient removal. Some now see primary and wet weather treatment as ripe for disruption.

Market Map Published: 23 October 2024 Kelly Thompson

Non-membrane filtration methods are seeing a significant uptick in wastewater treatment with the growth of the tertiary treatment niche, as well as increased stormwater events.

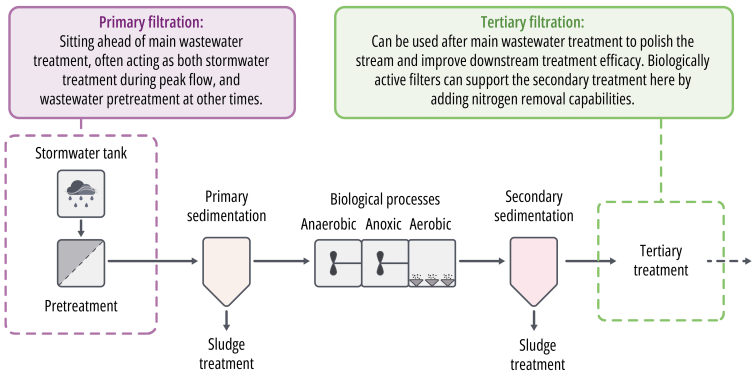
Although there are still sales for granular media filtration in wastewater treatment, which is a method that has been used historically, newer, more compact methods such as disc filtration are seeing more interest at footprint-constrained sites.

The war on nutrients in effluent and new phosphorus discharge consents of 1mg/L or less, as well as increasing enthusiasm for reuse projects across the globe, are pushing a 5-year compound annual growth rate (CAGR) of 5-10% for tertiary wastewater filtration. More novel applications like micropollutant removal, particularly in Europe, are providing fresh drivers for tertiary filtration now and into the near future, and microplastics is also increasingly rising up the agenda.

Outside of tertiary wastewater filtration, vendors are now seeing fresh demand for the installation of non-membrane filtration technologies for wet weather flows. The flexibility of some products on the market for use as peak flow management, as well as providing filtration outside of storm events, is the key to success for these products.

TECHNOLOGY APPLICATION OVERVIEW

Filtration methods can be applied for solids removal across a range of places in the treatment train. Stormwater treatment is the most emerging market for filtration, however there is the potential to install very large systems in this niche.



Source: GWI, adapted from Sulzer

Tapping into tertiary treatment

The non-membrane filtration methods covered in this market map include the more historically used granular media filtration techniques, such as sand and multi-media, as well as more modern compressed media and disc filtration options. Since the 1990s, these have grown in their popularity – offering smaller

footprints and lower sludge production compared to granular media. Compressed medias, such as the Schreiber Fuzzy Filter, boast the ability to manually change the porosity by changing the compression on the media. The media material can vary, but popular options include sand, fibres, or foams. Disc filters, which usually have a cloth or woven media, have seen the most significant interest in recent years, with many key filtration market players offering this option. Cartridge and bag filtration are not covered in this article, and neither are low pressure membranes.

Although many acknowledge that granular media filtration still has a place in the market for plants with lower budgets or those who are more comfortable with its robustness, disc filtration is increasingly chosen as operators become more familiar with the technology and its ease of operation. "With a disc filter, you can look at it and see what is happening, whereas you can't always see what is going on at the bottom of a sand filter. Disc filtration is easier to take offline and evaluate," commented Patrick Harden, product manager at Sulzer. The company offers both granular media and disc filtration options to the market.

Furthermore, non-membrane filtration techniques can be used throughout the water and wastewater treatment train, and are used for the removal of solid constituents such as organic matter and particulates. An application seeing significant uptick is in the tertiary stage of wastewater treatment. Tertiary filtration comes after secondary biological treatment in a typical wastewater treatment train, and can constitute a filter alone, or can be followed with membrane-based tertiary treatment or further polishing, particularly if the intended use is for water reuse. "Tertiary filtration helps downstream processes. If you want to do for example UV treatment, and if you don't have a tertiary filter, it is unlikely to work properly," outlined Onder Caliskaner, president of environmental engineering firm Caliskaner Water Technologies. Ultraviolet (UV) disinfection methods are seeing growth as an alternative to chlorination in the face of increased concerns over disinfection by-products, and UV needs good transmission of light through the stream to work effectively.

GWI estimates a 5-year CAGR of between 5 and 10% for non-membrane filtration in the tertiary filtration space, with some industrial verticals such as food & beverage (F&B) hitting the upper end of that range, due to the increased rate of water reuse. Both the increased cost of water, and corporate social responsibility pledges is driving this in the industry.

Nutrient removal – the here and now

The most immediate driver for providers of non-membrane filtration techniques is the crackdown on nutrients in wastewater treatment effluent, which is happening on a global scale and particularly in developed economies where there is a drive to reduce eutrophication. For example, it is not uncommon to see plant phosphorus permits at 0.1mg/L or lower in parts of the United States with sensitive watersheds, such as in the Great Lakes or Chesapeake Bay – and in some plants, previously installed biological treatment systems will not be able to reach such low levels. Filtration methods are able to bridge this gap. There is also traction towards the East, with some provinces in China seeing a reduction in total phosphorus consents from 0.5mg/L to 0.3mg/L.

Phosphorus can be removed by filtration through physical/chemical methods, by adding flocculant and removing the solids that form. For US-based leader in cloth media disc filtration, Aqua Aerobic Systems, this application is proving to be very fruitful. "A lot of our work has been in low-level phosphorus removal – nutrients associated with particulates," commented vice president – process group, James Horton, who continued to explain that the UK is a key market for the company. As part of the 2020-2025 AMP7 period, many utilities in the UK have been required to remove phosphorus down to 1mg/L or below in their wastewater treatment plants, and many will need to get this down to 0.25mg/L by the end of AMP8 (2030).

Other vendors with activities in Europe are seeing phosphorus removal to be a key driver for their activities. German company Huber stated that the European Wastewater Treatment Directive (EWWTD), which is mandating phosphorus levels in treatment plant discharges of 0.5mg/L, as well as tertiary treatment for treatment plants serving agglomerations over 150,000 p.e., is one of the biggest drivers of its sales of filtration technologies, particularly disc filtration.

Although there is a debate as to whether it can be called a tertiary treatment technology, some vendors are now combining filtration after the secondary treatment with biological processes in order to further reduce nutrient loads. Tomorrow Water, a subsidiary of Korean company BKT, is offering a biologically active filtration (BAF) product, combining a polypropylene media with nitrogen removal capabilities. The company indicated that nutrient removal is the biggest driver in the sales of the product. "We wouldn't propose our BAFs purely for solids removal, it's not their primary application," outlined Amit Kaldate, vice president of business development. He explained that most of the company's sales are for plants needing to improve capacity or denitrification capabilities, although he acknowledged that the filter could be used for physical/chemical removal of phosphorus too.

Although there is lots of opportunity for tertiary filtration technologies (including Tomorrow Water's BAF product Proteus) in the municipal space, the company also has a large installed base of the product in livestock wastewater treatment – particularly in South Korea, due to regulations that followed a number of disease outbreaks in the last 15 years. Membrane bioreactors (MBRs) could be a competing technology for biologically active filtration, particularly in applications where very high quality effluent is required,

however Tomorrow Water commented that its BAFs are able to offer lower capex and opex costs, as well as simpler operation when compared to MBR.

The company is now exploring the combination of Proteus with a partial denitrification-anammox (PdNA) process, which would reduce the amount of carbon and energy required to achieve nitrogen removal. The company is to test this technology using $4 million of US federal funding, as part of a Department of Energy project starting in 2025. "The willingness to go for decarbonisation is the driver to combine tertiary filtration with PdNA," outlined Kaldate.

A SNAPSHOT OF KEY PLAYERS

The graphic shows an overview of key market players offering either disc filtration or BAFs within the wastewater filtration market - two of the most exciting spaces. Disc filtration is seeing significant traction due to its compact size, and the players landscape is reasonably consolidated. Large technology providers often offer their products through licensees for increased global reach – such as Aqua-Aerobic Systems, however these licensees are not covered in the graphic. Elsewhere, biologically active filters are helping to bring non-membrane filtration into new applications. Other filtration types, such as granular media filtration, are not covered in this graphic.

Company	Technology types	Notes
Leaders		
Aqua-Aerobic Systems	Disc filtration	One of the first to offer cloth media filtration in a disc filter configuration. The company also owns Mecana, a cloth media filtration giant with over 3000 installations worldwide.
Veolia	Disc filtration, Biologically active filtration	Claims to have the largest disc filter installation in the world, at a 5,000,000m³/d wastewater treatment and water reuse plant in Sinai, Egypt. The installation has 120 disc filter units.
Established		
Alfa Laval	Disc filtration	Has installations in municipal and industrial plants globally.
De Nora	Biologically active filtration	Has over 300 installations of its denitrifying biologically active filter.
Huber	Disc filtration	Significant footprint in Europe. Specialises in tertiary filtration applications.
MITA Water Technologies	Disc filtration	Its disc filter has been installed in over 1000 wastewater treatment projects across all applications.
Sulzer	Disc filtration	Historically has been strong in Asia and Europe for tertiary filtration. Is now looking to enter the North American and primary filtration spaces.
Xylem	Disc filtration, Biologically active filtration	Has products through both Xylem and Evoqua brand names. Active globally, particularly after the merger of the two companies.
Challengers		
Nuove Energie	Disc filtration	Focuses on industrial tertiary treatment.
Tomorrow Water	Biologically active filtration	Installed base mostly in South Korea. Works in both primary and tertiary applications, with its largest installations in wet weather flows.
WCS Group	Disc filtration	Active mostly in the UK for tertiary treatment applications.

Key: Disc filtration Biologically active filtration

Source: GWI

Supporting water reuse

Although non-membrane filtration methods alone would not produce clean enough effluent for potable reuse applications, vendors are still seeing water reuse as a strong driver. Many providers in the US have got Title 22 certification for their products, the California standard for non-potable reuse, which is used widely in the United States as a guideline to follow. A non-membrane filtration method could be used with little to no downstream treatment for agricultural uses if it has this certification. Filtration can also contribute to a wider treatment train for potable reuse, with the addition of downstream membrane technologies. Generally, non-membrane filtration and membrane filtration methods do not compete in the same space, with the former often instead sitting upstream of the latter in order to improve membrane performance.

Xylem expressed that reuse is the strongest driver for its tertiary filtration sales. In the United States, the company receives a lot of interest from the water scarce states, with projects in California and Texas. "On the industrial side there is a more imminent economic driver, because the cost coming into a plant has increased," commented Xylem Water Solutions and Services segment vice president, North America, Rod

McNelly. Xylem is seeing particular success in the reuse of water in the food & beverage industry, as well as microelectronics, and chemicals processing. The company's proportion of industrial projects is also increasing relative to municipal sales. It provides a range of filtration options for tertiary treatment, including cloth media filtration and biologically active filters.

Xylem is not the only technology provider active in this space. "We have three apertures of cloth, 10µm, 5µm and 2µm, and we can get down to less than 2mg/L of solids. All of the cloth apertures meet California Title 22 reuse standards. If you are looking at higher level reuse, you would follow our system with micro- and ultrafiltration, or RO," outlined Aqua-Aerobics Systems' Horton. Furthermore, Sulzer has historically seen success in the Asian and European markets for its pile cloth filtration products (a type of disc filter), but is now looking to get Title 22 approval on its cloth disc filter option and penetrate the North American market, expecting reuse to be a stronger driver in the future.

Moving to more novel applications

Outside nutrient removal and reuse, some technology providers are now seeing more novel applications for non-membrane filtration technologies. The most immediate of these is for micropollutant removal. Huber stated that the quaternary stage of wastewater treatment due to be mandated under the EWWTD is the key driver for this. "The removal of endocrine disruptors and pharmaceutical residues are influencing the use of filtration methods," commented sales director Franz Heindl, who also mentioned that disc filtration is in demand for these projects, where space is often limited. "Switzerland were the early adopters, and there are now more projects in Germany coming up," he continued – also commenting that other EU members are due to follow with the change in the Directive.

There are two ways in which technology providers are improving micropollutant treatment with their filtration technologies. "Tertiary technologies prepare the water to make technologies downstream function better, shrinking that equipment and reducing backwash rates," outlined McNelly. He continued to explain how this is particularly useful when treating for micropollutants and PFAS, where activated carbon and resins can be affected by other constituents in the water, allowing for lower costs for these advanced treatment types. Fewer backwashes also provide reduced wastewater volumes to be dealt with from downstream micropollutant treatment systems.

Another way in which filtration can help remove micropollutants from wastewater is as part of the polishing step. "We use a carbon substrate such as powdered activated carbon (PAC), which adsorbs the micropollutants, then the filtration is the final step to remove that PAC," described Horton. Aqua-Aerobic Systems and Mecana, its Swiss subsidiary, installs around 100 cloth media (disc filter) projects a year, distributed globally, but with significant focus on North America, Europe, and China.

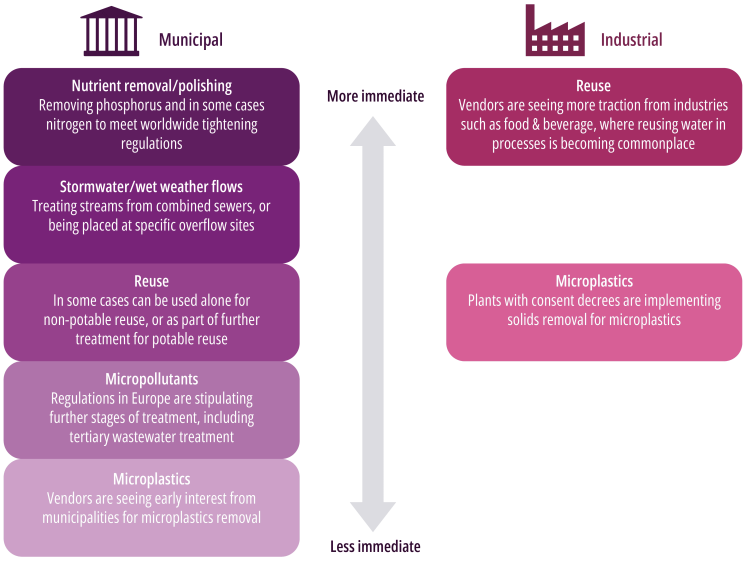
Aqua-Aerobic Systems has also seen an increase in interest for the removal of alternative solids such as microplastics. "We're seeing an interest in that municipally, but we see implementation with industrial clients. We have several installs for this application," explained Horton. Although there are few regulations for microplastics in the municipal water space globally, consent decrees or legal cases in specific industries are driving installations currently.

A push into other stages of treatment

Although the tertiary stage of wastewater treatment is a large and growing market for filtration vendors, non-membrane filtration products are seeing growing success in other stages of the wastewater treatment train. The primary treatment of wastewater at treatment plants, particularly with wet weather flows from combined sewer systems, is going to be a significant market in the future for some technology providers, particularly as stormwater begins to rise up the agenda across the world. GWI estimates that this vertical is also seeing a CAGR of 5-10%.

THE MOST IMMEDIATE OPPORTUNITIES

Nutrient removal has provided filtration system providers with ample opportunities in the municipal space over the last five years, with further tightening regulations providing fresh momentum in the near future. Novel applications include micropollutant and microplastic removal, although this is seeing faster uptake in the industrial market.



Source: GWI

For example, Aqua-Aerobic Systems has modified its cloth media and system configuration to cope with the high solids load associated with wastewater influent, and the filters can be used in primary or tertiary filtration applications or as peak flow management filters during storm events. This type of installation is attractive to utilities, because the filtration systems can be placed at the treatment plant and used year-round as a filtration treatment step, and as a stormwater treatment technology during periods of high flow – meaning the technology is in continuous use. "The high solids filter can outperform a primary clarifier with regards to footprint and solids removal. For example, we could take 200-300mg/L of influent solids and we can get between 80 and 90% solids removal without chemical addition," described Horton. The company's product can be installed centrally at the treatment plant, or out in the field at specific overflow sites. Aqua-Aerobic Systems' largest product available can handle a throughput of 90,100 m^3/d, in a footprint of 12x36ft. The company's largest wet weather installation is with Fox Metro Wastewater Reclamation District, Illinois, with a capacity of 636,000m^3/d.

Tomorrow Water is also finding the wet weather flow application to be fruitful. More specifically, Proteus is available for installations at centralised wastewater treatment plants with peak flows coming in, as well as flows coming from separate storm sewers. The technology in this application can be used without biological treatment, working as a high-rate filter without the residence times required by a biofilm. However, in some parts of the US, there are requirements to biologically treat combined flows from wet weather events to remove soluble biochemical oxygen demand (BOD). In these cases, Tomorrow Water offers its dual-use option Proteus Plus, which serves as a BAF and a primary filter.

The company has also found success with this application in the far East. "We perhaps have the world's largest stormwater plant, in Korea, which is 750,000m^3/d," detailed Kaldate. The plant has been in operation for four years.

Terminology

Biologically active filtration: The combination of filtration with the growth of a biofilm to remove extra constituents outside of filtration alone. Generally, these extra constituents are nutrients.

Compressed media filtration: Often composed of similar media materials to granular media filtration, but include a compression mechanism that can change the pore size of the filter to react to different influent conditions.

Disc filter: A configuration of filter that arranges the media into discs, which allows a higher treatment surface area when comparing to granular media options like sand filtration. The media is generally composed of cloth.

Granular media filtration: A filtration configuration that contains loose media inside a tank, where water flows through. The media is often composed of materials such as sand or anthracite, but mixed-media configurations are available.

Non-membrane filtration: A type of filtration that excludes membrane processes. Non-membrane filtration methods discussed in this article include granular media filtration, disc filtration and compressed media filtration.

Partial denitrification-anammox (PdNA): A biological nutrient removal process that removes ammonia and NOx from wastewater. It uses less aeration and external carbon compared to traditional biological nutrient removal.

Peak flow: Excessive flows experienced during hours of high demand, usually determined to be the highest two hour flow expected to be encountered under any operational conditions.

Primary filtration: Placing a filter ahead of the secondary biological treatment to remove larger particulate matter.

Tertiary filtration: The use of filtration after secondary biological treatment, to remove particulate constituents like coagulated organics.

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