JUNE 2022
Volume 59 Number 2

# Filtration + Separation

LEADING THE WORLD OF FILTRATION

## Wine filtration
The technologies and techniques and why they are so important

## Baghouse filtration media management
Research that shows its critical role in controlling air pollution

## Exclusive interview
Martin Klein, vice president of engineering filter elements, Mann+Hummel

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# Hello and welcome to the June issue of Filtration+Separation.

I'd like to take this opportunity to introduce myself as the new editor of Filtration+Separation. We have a lot of loyal readers who have always found our features thought-provoking, so I'll be sure to carry on the now-retired editor Alan Burrows' legacy – and to build on his success too!

Going forward, my eyes are set firmly on the future and to help you stay a step ahead of the filtration game, ensuring the industry is ready for change and to help support you on your transformation journey.

In this issue, you'll discover insight into the wine industry and the crucial role filtration has in the winemaking process - turn to p.6.

Another feature not to be missed on p.20 is the research that has been done by the University of Sheffield and Durham Filtration on baghouse filtration media management controlling air pollution.

Elsewhere on p.10, we examines some of the developing filtration technologies fighting the tide of microplastics pollution, with some recent research that has found microplastics in both human blood and the lungs of living people.

An exclusive on p.14 is an interview with Martin Klein, vice president of engineering filter elements at Mann+Hummel, where we get his views on how he sees the industry concentrating on recycling and sustainability in the future. "For example, filters mounted in our buildings for HVAC, more than 90% of their CO2 footprint comes from the operation. So, you look at it and go if we reduce the material a little, the impact will be not significant enough, but if we were able to come up with a different material to reduce the differential pressure by 10%, then we could significantly reduce the CO2 footprint," says Klein.

Don't miss our ACHEMA preview (p.32). You'll get an exclusive look at what our advertisers will be showcasing at this August's show.

I hope you enjoy this issue, and if you still haven't got enough, then be sure to visit our website and social media channels. Subscribe, like, and help us keep the conversation going!

**Bunny Richings**
*editor*

Filtration+Separation
LEADING THE WORLD OF FILTRATION

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Filtration plays a crucial role in the winemaking process. Here we discover more about the techniques and filter types employed and why they matter.

# From grape to glass

Any amateur wine maker will tell you that producing a decent batch is a balancing act between yeasts and sugar to produce the right kind of reaction and the best result.

It's a 'live' product that must be controlled. Any residual yeast remaining after fermentation can cause unwanted refermentation while residual sugar can produce carbonation. The undesired presence of bacteria such as acetobacter can be disastrous by turning wine into vinegar.

Drew Horton, Enology Specialist at the University of Minnesota, said: "If a volume of wine has any residual sugar – and you're not diligent about removing all the bacteria, and more importantly, the yeast cells – the wine can referment in the bottle.

"It's a disaster because it causes the wine to get bubbly or cloudy, or the cork pushes up, or in the worst scenario, the bottles start exploding."

## MICROBIOLOGICAL STABILISATION

The solution lies with filtration throughout the process to produce wine with the required quality, flavour and aroma while microbiological stabilisation eliminates yeasts and bacteria that can destroy the taste.

Several methods are available. Common techniques

**DID YOU KNOW...**

**It takes up to 660 grapes to make a standard bottle of wine. One vine produces about ten bottles.**

include flat sheet filtration, a traditional technique still used by small wineries. This method has more recently been adapted into lenticular modules assembled in an enclosed housing which avoid drip losses and provide additional flexibility, hygiene and ease of use.

Diatomaceous earth filtration which uses skeletons of microscopic water plants called diatoms has now largely been replaced by crossflow filtration, a separation method where a particle-containing fluid passes tangentially along the surface of a membrane filter.

Media smaller than the pores of the membrane pass through the filter while larger components are retained and move along the surface before being swept away. Advantages include a reduction in wine loss, less waste and lower labour costs.

### DID YOU KNOW?

**For red wines, membrane filtration of about 0.65µm can be enough to cut out organisms that could cause spoilage but for white wines, 0.45µm is typically used.**

Most crossflow filter technologies use polymeric membranes made of polypropylene, polysulfone, polyvinylidene fluoride or other typical membrane materials. As such, the operating environment of the crossflow technology may be limited by the temperature tolerance or material compatibility.

**Below right:** *Final membrane filters such as Graver Technologies' ZTEC-B remove unwanted organisms. (image: Graver Technologies)*

**Below:** *Graver Technologies' Scepter range features membrane tubes welded together into all-stainless steel module assemblies. (image: Graver Technologies)*

## FILTRATION PROCESS

Companies such as US-based Graver Technologies have developed a range of products for each stage of the filtration process in wine making.

These include polypropylene and microfiberglass filters such as the QMC which has been tested to prove the reliable removal of larger organisms during primary clarification.

During storage or transport ongoing fermentation can occur while other contamination is possible for example through tank vents. Carbonation gas impurities can also negatively affect the consistency of sparkling wines. Graver Technologies' TefTEC filter effectively sterilizes gases and removes sub-micron contaminants.

At the end of the process, final membrane filters such as the ZTEC-B remove organisms such as Dekkera intermedia, Lactobacillus brevis, and Leuconostoc oenos.

## HIGHER TEMPERATURES

Crossflow filtration requires technology that can withstand the higher temperatures and

**Left:** *Bottling at the small Californian Vindemia Winery. (image: Vindemia Winery)*

**Right:** *Donaldson's LifeTec filters are custom-manufactured in Haan, Germany. (image: Donaldson)*

## CUT THE WASTE

Recovery of wine and juice from lees (deposits of dead yeast and other particles) is an important way of cutting waste as lees can comprise up to 10% of a winery's production volume.

Traditionally lees filtration is performed with rotary vacuum drum (RVD) filters or chamber press filters which can handle high solids content. However, the open design potentially causes oxygen pick up which can affect quality.

As a result, the recovered wine or juice is used in lower-tier blends instead of being added back to the original batch.

To overcome the drawbacks of RVD and chamber press filters, global filter specialist Pall developed the Oenoflow HS system which uses microporous membranes similar to hollow fiber membranes seen in wine clarification.

*The Pall Oenoflow HS system features hollow fiber membranes with a larger internal diameter to process up to about 80% solids. (image: Pall)*

Oenoflow HS membranes have hollow fibers with a larger internal diameter so they can process up to about 80% solids. This improves filtrate quality, resulting in a higher value of the recovered wine or juice. This means it can be blended back to the original batch instead of being used in lower-

**Left:** *The Donaldson LifeTec Absolute filter includes elements with 20% more media than comparable filters. (image: Donaldson)*

**DID YOU KNOW...**

**Crossflow filtration is a useful tool for removing larger molecules such as proteins and phenolics, achieving protein and colour stability.**

tier products. Since filtration is achieved with membranes without the need for filter aids, operation is more hygienic with less waste.

For example, an Australian winery saw a considerable improvement in filtrate quality after switching to the system.

In a five-month period, it recovered over 1,000 hectolitres of wine from lees, worth US$168,000 more than would have been obtained with an RVD filter. This meant the winery recouped its investment in the system in about a year.

Also, by adding the Oenoscreen rotary screen filter upstream of the base hollow fiber system, the unit can be used to process must lees during harvest while it can also be incorporated into a standard wine clarification system.

aggressive chemicals use in wine production. Graver Technologies' Scepter range features membrane tubes welded together into all-stainless steel module assemblies with no gaskets, O-rings or polymeric components. This enables ease of cleaning, durability and compatibility.

Other companies such as US-based Donaldson take a different route by offering one kind of filter. Its LifeTec Absolute filter includes elements with 20% more media than comparable filters with a triangular shape designed to stay intact under high flow rates.

While designed to remove organisms in one filtration step, pre-filtration is usually necessary to save costs. The LifeTec filter is reusable and its strong cage structure is made to withstand the rigors of steam sterilization, again reducing costs.

Colter Marcks, lead engineer for Process Filtration at Donaldson, said: "Filter one is capturing the bulk of the contaminant and making sure the final one doesn't get blocked up as quickly. Because a membrane filter is more expensive, you try to do most of the work with the first one.

"Once you've worked in a winery and 200 cases of wine are either cloudy or refermenting and you have to pull in a crew of extra people to pull every cork, dump the wine back into a tank and restabilize, refilter, and rebottle them, you swear you'll never let it happen again."

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## RESEARCH & DEVELOPMENT

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*Research has shown that microplastics are not just in our oceans, affecting marine life, but can also travel through the atmosphere to reach even the remotest corners of the world.*

# Stemming the microplastics tide

Recent research has found microplastics both in human blood and deep inside the lungs of living people. As scientists try to determine how exposure might affect human and marine life, we examine some of the developing filtration technologies fighting the tide of microplastics pollution.

Microplastics are small pieces of degraded plastic less than 5 mm in size that can travel huge distances in the open sea and remain there at various depths. Research has shown that they are not just in our oceans, affecting marine life, but can also travel through the atmosphere to reach even the remotest corners of the world.

Richard Thompson OBE, Professor of Marine Biology and Director of the University of Plymouth's Marine Institute, was the first to coin the term 'microplastics' in 2004. "Our work has so clearly shown that microplastics are present in every sample of beach sand…We've looked in the deep sea, in Arctic ice, in the gut of hundreds of fish from the English Channel, and we've found microplastic contamination everywhere."

## MICROPLASTICS TSUNAMI

According to the UN, plastic production is forecast to more than double by 2050 and the scale of the resulting microplastics pollution is shocking in terms of sheer size. In September 2021, a team of oceanographers led by researchers from Kyushu University in Japan, estimated there are 24.4 trillion pieces of microplastics in the world's upper oceans. It's harder to measure microplastics within the atmosphere but one US study in 2020 found that atmospheric microplastics can travel long distances and originate from sources such as roads (84%), the ocean (11%) and agricultural soil dust (5%).

**DID YOU KNOW...**

**Today, we produce about 400 million tonnes of plastic waste every year.**

## FILTRATION SOLUTIONS

While scientists battle with the potential risks to human and marine life, those in the filtration industry are developing technologies to prevent microplastics from becoming an even bigger problem. Although it is relatively early days in terms of research and development, industry experts are working to tackle this apparently insurmountable problem.

## TYRE ABRASION & MICROPLASTICS

Research funded by the German Federal Ministry of Education and research (BMBF) found links between tyre abrasion and microplastics' emissions,

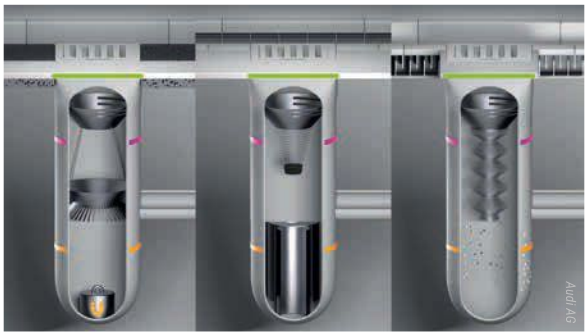
### DID YOU KNOW?

**In the early 2000s, the amount of plastic waste we generated rose more in a single decade than it had in the previous 40 years.**

which then enter the environment through road run off. Its findings informed a joint project between German car manufacturer Audi, specifically its Environmental Foundation and the Technical University in Berlin (TU Berlin) to develop a solution which could prevent tyre particles from being washed into sewers and other water sources when it rains. Daniel Venghaus, research associate in the Department of Urban Water Management at TU Berlin explains: "One important finding showed up to seven times more tyre wear on inner-city curves than on corresponding straights or inclines. Our research found up to three times more abrasion at traffic lights in the crossing area. This defined the hot spots where our filters can be used in a targeted and effective manner."

> **"One important finding showed up to seven times more tyre wear on inner-city curves than on corresponding straights or inclines. This defined the hot spots where our filters can be used in a targeted and effective manner."**
>
> Daniel Venghaus, research associate in the Department of Urban Water Management at TU Berlin.

Their response is the development of the UrbanFilter concept which prevents tyre particles from being washed into sewers and other water sources when it rains. The sediment filters consist of nine modules, divided into three zones: the road area with a special runoff channel; the sewer where larger solids are filtered out with a filter skirt, and the drain where a magnet module is used to filter the smallest solids such as microplastics. Up to three of the nine modules (one at each level) can be combined to achieve the best result depending on the location.




**Above:** *TU Berlin has been working with the Audi Environmental Foundation to develop the UrbanFilter which prevents tyre particles from being washed into sewers and other water sources when it rains.*

## LAB AND ROAD TESTING

Tests in the laboratory at TU Berlin have shown that without clogging, the filters can permanently trap microplastics in the form of plastic granulates up to 3mm in size. In-situ testing continues to take place on a busy road in Berlin and the UrbanFilter successfully passed its first test during a series of storms.

## CHALLENGES

Some parts of the development are still presenting the researchers with problems. "A major challenge is being able to retain a wide variety of contaminants of different densities, shapes and sizes. In the event of heavy rainfall, it is particularly challenging to ensure that particles already retained are not flushed out again," said Venghaus. Testing and development work with the UrbanFilter continues and its major goal is,"to develop a flexible filter concept from technically robust subsystems which, together with the intelligent networking of relevant data… relieve our surface waters and improve water quality."

## MICROPLASTICS IN WASTEWATER

Everyday activities such as washing clothes and using

### VACUUMING THE SEA

Grimaldi Group has been working for years to tackle the problem of microplastics in the world's oceans. Working with Wärtsilä, Grimaldi has now developed a filter system which uses the shipboard exhaust gas cleaning system to filter microplastics. Known as open loop scrubbers and already installed on Grimaldi ships to clean their exhaust gases, they suck in enormous quantities of water every day and return it to the sea. Before doing that, the new system filters the water and captures the microplastics, preventing them from being ingested by fish and other marine organisms. Wärtsilä will take the microplastics filtration system to market and the ability to filter microplastics will be an integrated feature of Wärtsilä's future wash-water treatment system.




**Right:** *Working with Wärtsilä, the Grimaldi Group has developed a filter system which uses the shipboard exhaust gas cleaning system to filter microplastics.*

Microgen /stock.adobe.com

**Left:** *While scientists battle with the potential risks of microplastics to human and marine life, the filtration industry is developing technologies to prevent them from becoming an even bigger problem.*

### HUMANS AND MICROPLASTICS

A study recently undertaken by scientists in the Netherlands analysed blood from 22 anonymous donors and found plastic particles in 17 of them. Some particles came from the plastic used in drinks bottles, others from polystyrene and some from polyethylene which is used to make plastic carrier bags. A separate study by scientists at the University of Hull took samples of lung tissue from 13 patients undergoing surgery and found microplastics deep in the lungs of 11 of them.

personal care products mean that microplastics enter wastewater treatment plants (WWTPs), making them the main sources of microplastic contaminants in the aquatic environment. However, they are also where efficient removal can take place.

German wastewater treatment specialist Mann+Hummel Water & Fluid Solutions (previously Microdyn-Nadir) has been working on a pilot project at a municipal sewage plant in Hünxe in North Rhine-Westphalia, Germany. It is one of four projects the company is currently involved in around the country, funded by the Department of Environment, Nature and Consumer Protection of North Rhine-Westphalia, and one of the largest wastewater providers in the country (EGLV). All pilot projects are investigating different applications of the BIO-CEL activated carbon process in collaboration with universities, engineering firms and utility companies.

Mann+Hummel's BIO-CEL activated carbon process is a combination of activated carbon and immersed membrane filtration. Already a physical barrier for solids and bacteria, it also retains microplastics. WWTPs have a conventional aerated system (CAS) which consists of a mechanical treatment, a biochemical treatment and a sedimentation stage where the overflow is released to a water channel. Tobias Steube, global product manager, Life Sciences & Environment, Mann+Hummel Water & Fluid Solutions, explains the problem with microplastics: "The CAS has no physical barrier for any solids or bacteria that get through the first stage of mechanical separation. Sometimes activated carbon is used downstream but sand filters are also required and while they reduce microplastics in the effluent, costs are high for the operator." However, "the BIO-CEL activated carbon process is able to remove micropollutants, bacteria and microplastics in one process and offers a capacity increase, high saving potential and high safety standards."

Mann+Hummel

**Above:** *Mann+Hummel's BIO-CEL technology is a combination of activated carbon and immersed membrane filtration.*

## MUCH MORE TO BE DONE

These are just two of the filtration technologies currently being developed in the fight against microplastics. While the race is on for scientists to collect more data and identify the risks to human and marine health in more detail, another race is taking place within the filtration industry for more research, development and data.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MANN+HUMMEL

# Future Filtration

Martin Klein vice president of engineering filter elements at Mann+Hummel, has had a long career spanning almost two decades in the filtration industry. Filtration+Separation talks to him about the future of the industry and what will be the most surprising change yet.

Martin Klein became vice president of engineering filter elements for Mann+Hummel back in 2020 just before the pandemic broke out and his responsibilities became global. "We have engineering locations for filter elements in the US, Brazil, Germany, Bosnia, Poland, India, Korea and China," explains Klein. "When I started this role, I thought I would be travelling around the globe to meet the engineers and visiting the labs, but during Covid, everything began online. Being the new guy, it was hard to transition to Teams, because when you have long lasting relationships with colleagues you already know each other, but, being new and not being able to meet face-to-face, it's harder to inspire interaction and really get to know each other."

Throughout Covid, Mann+Hummel had three company principles: Keep staff safe, keep customers focused and support them and make sure the company stay financially stable. "We immediately invested in enough masks for our staff

**DID YOU KNOW...**

**Mann + Hummel produces over one billion filters a year for large OEMs throughout the automotive industry.**

**Right:** *More sustainability and less fine dust in urban traffic with innovative fine dust particle filters.*

**"An electric engine doesn't have the need for filters like a diesel engine does, however, a battery engine still needs filtration and we are providing solutions for that."**

members and their families and ensured everyone could work from home. Of course, this proved more difficult for our production team, the people working in the labs, but we put things in place to make sure they were safe while working for example our own antiviral air purifiers and our labs have always been heavily ventilated and air-conditioned," comments Klein.

"Of course as soon as the pandemic hit, lots of OEMs were stopping production, so we came to a crossroads: Do we stop production too and close some of our production plants, or do we continue and hope this only lasts a few weeks and there will be a huge demand for parts again? We decided to continue. Then of course the supply chain issues hit us, so we had to all work together, R&D, operations and purchasing to find alternative materials to work with and make sure we could continue delivery to our customers, this wasn't easy, but we got there and made it happen," Klein explains.

**Above:** *The Mann+Hummel cathode air filter protects fuel cell stacks from airborne particles and gases. The combination of adsorption and filtration enables clean air supply to the stack and keeps its performance.*

Two years on and Klein is looking at other factors that are affecting the growth of the filtration industry. "There are various angles to look at, on the one hand we believe there will always be a need for filtration, but if we look at the automotive industry, there are fundamental transformation changes now, right? The change from the combustion engines over to an electric vehicle. An electric engine doesn't have the need for filters like a diesel engine does, however, a battery engine

still needs filtration and we are providing solutions for that. Our smart cabin air filter systems do not only provide the highest level of vehicle occupant protection against the finest particles and gases but they do also increase the range of the car by reducing the energy needed for heating and cooling," says Klein.

"Saying that, we still have around 1.5 billion diesel and petrol cars on the road globally, which won't change over the next 10–20 years, so we will continue to supply and service parts.

## STAYING A STEP AHEAD

Klein was excited to talk about was fuel cells and what Mann+Hummel has been doing to ensure it is a step ahead of the game. "The fuel cell is pretty sensitive when it comes to impurities," Klein comments. "The oxygen which is supplied to a fuel cell is being taken out from the surrounding air and this air needs to be cleaned from particles, but also from gases like NO2 and SO2. So for quite some years we have been providing so called cathode air filters, filters that clean the surrounding air from pollutant gases and you can really see the effect of such filter on the voltage of a fuel cell when you have NO2 concentrations in the outside world, you can see the reduction of the voltage from a fuel cell, whereas when you install a filter it keeps it at a high level, so then you need filtration for this."

**DID YOU KNOW...**

**Oxygen which is supplied to a fuel cell is being taken out from the surrounding air and this air needs to be cleaned from particles and gaseous pollutants.**


**Left:** *Multi-stage cabin air filter systems reliably protect vehicle occupants from even ultra-fine particles thanks to HEPA filter elements.*


**Right:** *Ion exchanger filters from Mann+Hummel are optimized for automotive operation, which ensure system safety.*

**"When I think about the most surprising change that we will see over the coming years, I think it will be recyclable filtration solutions."**

## A BRIGHT FUTURE

Klein and his team are working hard on changes and how they can implement them to ensure that they are driving sustainability. "The problem with parts for filters is, they aren't usually parts you can reuse. So we have been doing life cycle assessments on our products, from cradle to grave to understand what is their CO2 footprint. Interestingly enough for a filter, the major contribution of its CO2 footprint comes from operation because you have a filter you mounted somewhere and you need energy to put air flow or liquid through it. For example, filters mounted in our buildings for HVAC, more than 90% of their CO2 footprint comes from the operation," says Klein. "So, you look at it and go if we reduce the material a little the impact will be not significant enough, but if we were able to come up with a different material to reduce the differential pressure by 10%, then we could significantly reduce the CO2 footprint."

Another big concern of Klein's is recycling, and how they can make changes to ensure that they are doing their part for the environment with sustainability being such a huge issues in all industries, espcially filtration. "When I think about the most surprising change that we will see over the coming years, I think it will be recyclable filtration solutions," explains Klein. "When you think of all the filters in Heathrow Airport that get changed every three to six months, what happens to them? They aren't recycled, so they are just thrown away and dumped. So, when planning and designing filters for tomorrow, we need to think of recycling and sustainability, so I'm certain they will look different to today, as we have a company strategy to become carbon neutral within the next 10–20 years – and I'm happy to be a part of this."

**ABOUT THE AUTHOR**

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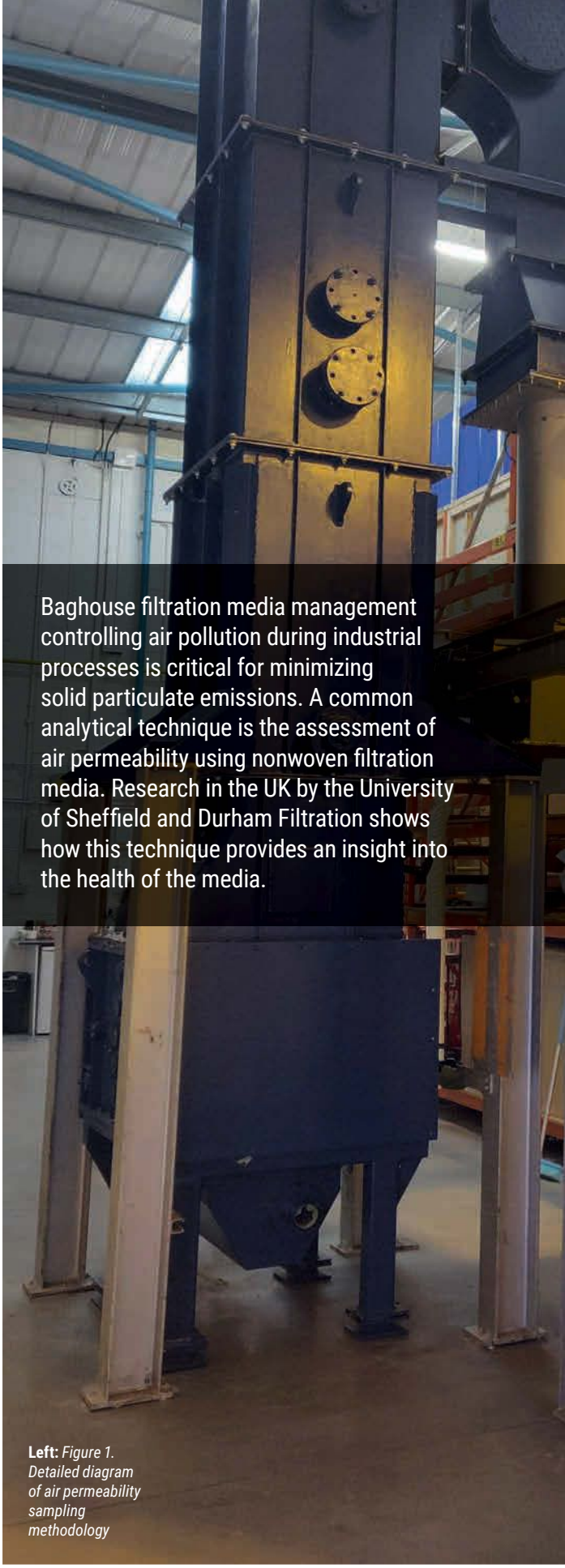
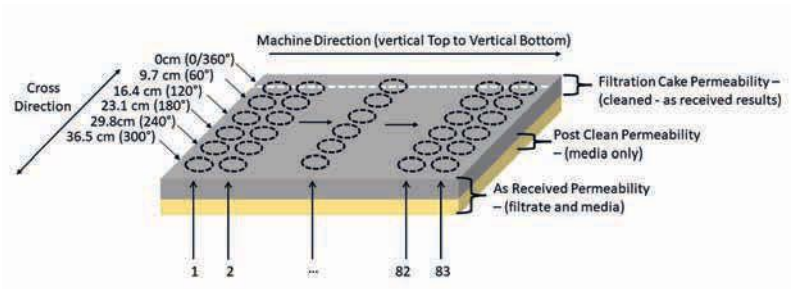
# Testing air permeability in baghouse filtration



Baghouse filtration media management controlling air pollution during industrial processes is critical for minimizing solid particulate emissions. A common analytical technique is the assessment of air permeability using nonwoven filtration media. Research in the UK by the University of Sheffield and Durham Filtration shows how this technique provides an insight into the health of the media.

Common practice during baghouse filtration is to assess a sample, in accordance with the BS22031:2021 quality standard in the 'as received' and 'post-cleaned' state. This sample, of 30cm in the vertical height direction, is removed from the top, middle, and bottom of the bag. The stitch is cut to allow the media to be flattened. This is the 'as received' state. Three air permeability readings are then taken, at which point the filtrate on the air entry side is removed.

Removal of the filtrate is carried out to simulate an effective pulse clean - at this point the sample is in the 'post-cleaned' state. Once the filtrate is removed, three additional air




**Left:** *Figure 1. Detailed diagram of air permeability sampling methodology*


**Left:** *UK Research is showing how the baghouse filtration media management is critical for minimizing solid particulate emissions.*

permeability readings are taken and recorded.

Data from the 'as received' and 'post-cleaned' states are then calculated and reported. However, one of the problems with this standard is its unstated assumption that the sample size represents a third of the overall bag.

## METHODICAL APPROACH

Utilizing a used filtration bag, from an energy from waste site, air permeability could be mapped across its vertical height and diameter. Figure 1 illustrates this method which resulted in 498 data points. This led to a total surface area of more than 10% being analyzed as opposed to 0.38% required by the standard. This structured, methodical approach to air permeability assessment allowed for a map to be constructed.

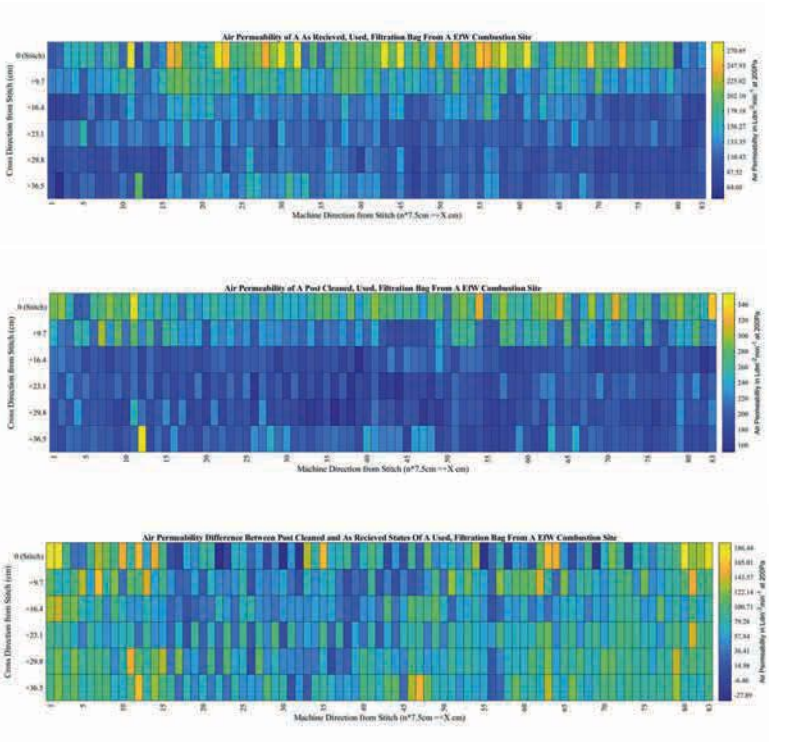
The effect on the filtration cake can be calculated from the difference between the 'as received' and 'post-cleaned' states. And whilst the standard doesn't require this, its inclusion illustrates the effect filtrate has

on the overall air permeability at the given location.

Figure 2 illustrates the resultant air permeability maps for the 'as received' state (top), the 'post-cleaned' state (middle) and the effect that filtrate has on the air permeability (bottom).

As shown in figure 2, there is a large variation within the data for each state. The use of BS22031:2021, in conjunction with BS9073-15:2008, assumes that the three sample points are representative of the bag's respective third. Furthermore, the use of a random sampling position could subliminally yield a lower/higher air permeability in relation to other areas of the sample.

From these graphs, particularly for the 'as received' and 'post-cleaned' states, it could be suggested that analysis in the fixed machine variable cross direction (FMVC) could give a better result as opposed to random sampling. For 'as received' and 'post-cleaned' states, analysis of the FMVC direction showed that a parabolic feature is exhibited, with coefficients of variation greater than 0.95.



**Above:** *Figure 2. Air permeability maps of various states.*

## STATISTICAL TESTING

Further statistical testing, using a two-tailed t-test, showed that the likelihood of obtaining a statistically significant result for the 'as received' state was higher for the FMVC direction as opposed to the fixed cross variable machine direction (FCVM).

This was conducted across both states and against a representative sample of the vertical top, middle, and bottom of the sample. Overall, the probability of obtaining a more extreme result was determined to be 26.7% at a 5% level of significance. However, for the sample in the 'post-cleaned' state no probability of a statistically significant result was found.

Whilst this study assessed the full filtration bag, completion of this method across a representative sample of the baghouse would take a significant amount of time to complete. Therefore, a balance between the sample data and associated time costs needs to be considered.

One of the potential downfalls of random sampling is that the translation between states assumes the means give clear representation of the sample. However, as the sample position is different each time, this can lead to further exacerbations of the perceived air permeability value. Therefore, when sampling for air permeability, the same position should be assessed in both the 'as received' and 'post-cleaned' states.

This allows for a direct comparison between the two states. Further information about the air permeability variability across the bag's cross direction can also be obtained by sampling in the FMVC direction and recording the positions at which testing was performed.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### CONTACTS

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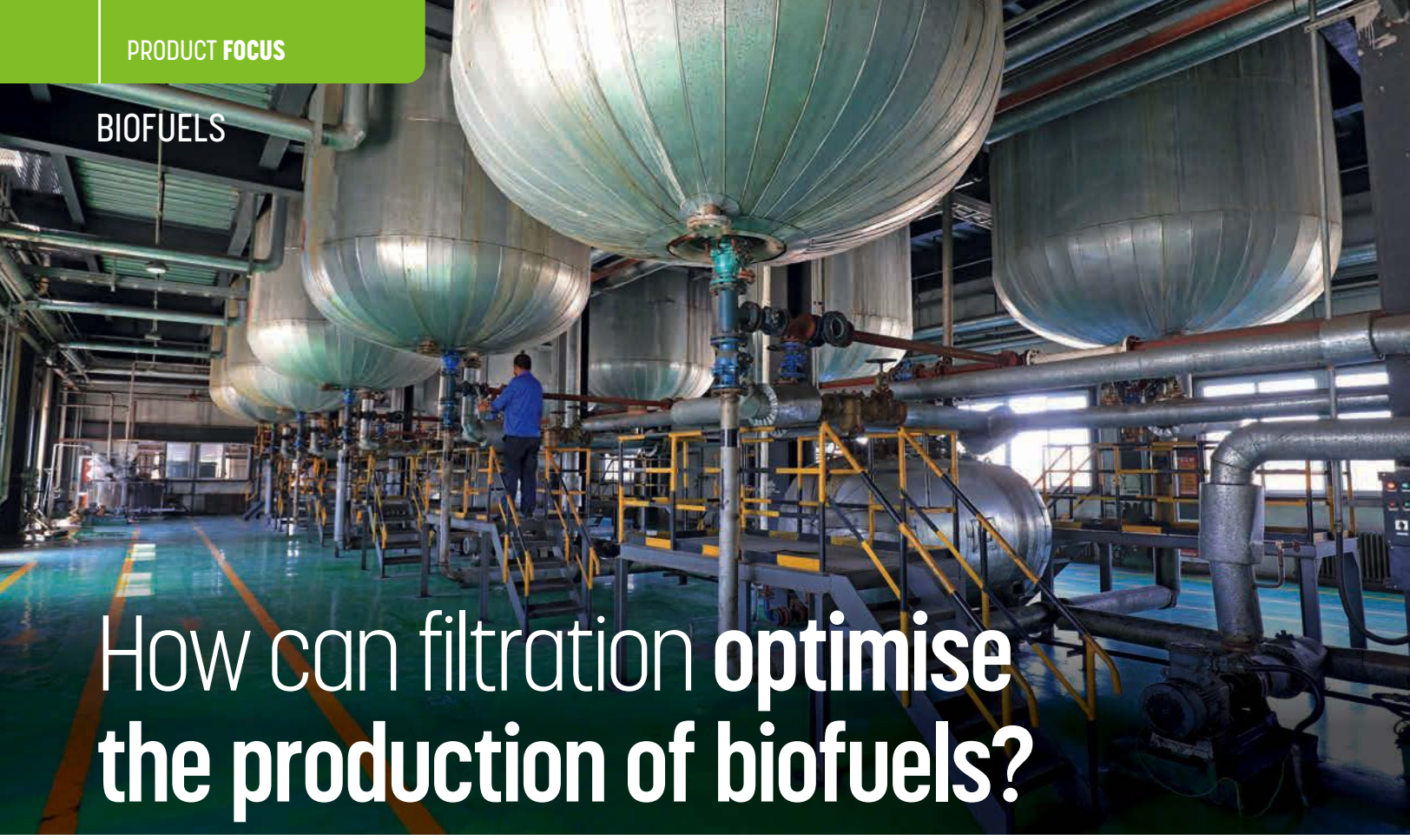


# How can filtration **optimise the production of biofuels?**

**As emission targets become more stringent and the Russia-Ukraine conflict sees countries move towards greater energy security, renewables are pivotal for sustainability. Are advanced biofuels a key part of a greener future?**

The need to decarbonise and increase production of renewable energy is becoming critical from numerous perspectives. The Intergovernmental Panel on Climate Change (IPCC) warns that we are at 'make or break' in the race to limit global warming to 1.5°C above pre-industrial levels. In November, COP27 will see country leaders required to show what steps are being taken to meet emissions targets. The US financial regulator, the Securities and Exchange Commission, is proposing regulations for companies to include information on climate-related risks and greenhouse gas (GHG) emissions in reports. Draft amendments to the EU's Renewable Energy Directive (RED II) include increasing energy from renewable sources to 45% by 2030, as well as a push for more biofuels in transport and an introduction in innovation quotas for the development of renewables.

In addition to the rising oil and gas prices are elevating the cost of living, causing problems for consumers and businesses. Now is the time to take advantage of solutions that can accelerate the production of renewable energy.

**Above:** *Biodiesel can be mixed with petroleum diesel for use in existing engines without the need for modifcations.*

## A KEY PART

When looking at biofuels we should differentiate between 'first generation' and 'advanced' biofuels. First generation biofuels are produced from crops such as corn, soy and sugar cane/beet, and so their use as a fuel is in direct competition to usage as a food source. Advanced biofuel sources include wood chippings, non-edible plant material, residential waste such as cooking oil, industrial and commercial waste including beef tallow, and algae. These materials are the biomass that might otherwise end up in landfill sites and therefore it is environmentally beneficial for them to be converted to fuel and contributing to a circular economy.

The use of existing refineries to produce renewable hydrocarbon fuels from these bio-feedstocks can reduce carbon emissions without large investments in refinery assets, and they can be distributed under existing petroleum infrastructure because they are functionally equivalent to petroleum fuels.

They are also known as: Hydro processed Esters and Fatty Acids (HEFA); Green diesel/Renewable diesel/ hydrogenation derived renewable diesel (HDRD); Sustainable aviation fuels/Hydrotreated

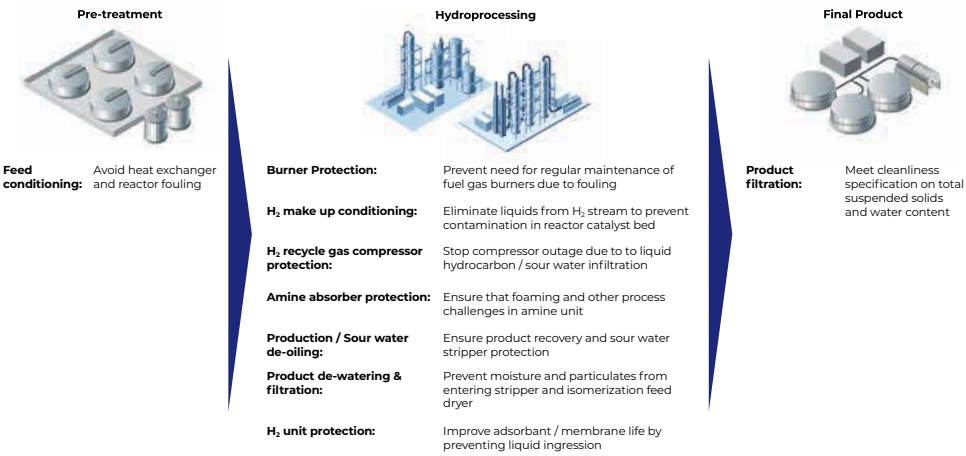
Renewable Jet fuel (HRJ)/ synthetic paraffinic kerosene (HEFA-SPK); Hydrotreated Renewable Oils (HRO) and Hydrotreated Vegetable Oils (HVO)/Hydrotreated Renewable Vegetable oils (HRV).

## FILTRATION IS CRITICAL

The degradation of biomass during transportation and storage can cause severe damage to downstream equipment if left unfiltered. Depending on the type and proportion of the feedstock inserted into the refinery for the production of liquid biofuels, the volume of gaseous products and moisture generated may differ significantly and impact refinery operations.

Challenges include: pressure build-up over the catalyst bed and heat exchanger; additional hydrogen demand; higher gas treatment and removal capacity required; and removal of additional co-produced water. In addition to solid particulate removal, separation of water from the final biofuel product is an essential step in the biofuel refinery process. To achieve 'premium diesel' quality, Pall liquid/liquid coalescers can be installed downstream of the hydrotreater to separate and remove water content to an acceptable level.

For example, a major EU producer of biodiesels and SAF (sustainable aviation fuels) uses Pall Aquasep XS liquid/ liquid coalescer filters to 'polish' the refined biodiesel product to an acceptable water content specification of <100 ppm. The coalescer media agglomerates water molecules as the biodiesel flows through it, creating larger water droplets that can be separated from the feed fluid.




**Above:** *The hydrogen production process. Creating green hydrogen has been proven technically possible but scaling up has proved extremely difficult. (image: Pall Corporation)*

**Below:** *Pall's Ultipleat High Flow solutions are used in hydrotreater feed filtration.*

The dense coalescer media provides optimum separation capacity (typ. ≤15ppm separation level achievable), protected by appropriate particulate pre-filters that can retain the gels and waxes that might otherwise blind and therefore reduce coalescer performance.

The production of biogas via anaerobic technology consists mainly of methane and carbon dioxide, with small amounts of hydrogen sulphide, siloxanes and moisture, all of which can have a detrimental effect on the production process. To maximise methane output and protect compressors and membranes, impurities must be eliminated through particle filtration and liquid/gas coalescence methods. Without efficient filtration and separation technologies, heavily contaminated gases can lead to compressor corrosion, abrasion in moving parts, and degradation of purification units.

A US refinery was using Pall's Vector filters in the hydrotreating of melted beef tallow and soybean oil to produce HVO diesel. The customer wanted to increase production and so needed greater filtration capacity. Pall scientists evaluated both process and performance to establish the best filter media solution to arrive at a balance of acceptable filter service life and consistent downstream asset protection (protection of the heat exchanger and extended catalyst life). Pall's polyester Vector High Flow in an 80" length, 1-micron rating with temperature capacity of 212°F (100°C) was applied downstream of the original 25 micron rated filter. This enabled the client to increase production capacity and maintain predictable reliable operation.

## MOVING TO GREATER SUSTAINABILITY

The production of liquid biofuels and biogas can be used as an alternative to fossil fuels or added as 'drop-in' fuels to mix with the traditional fuel, depending on capabilities and statutory guidelines. In some applications advanced biofuels can make a significant reduction in emissions compared to fossil fuels. In using appropriate filter media, production of advanced biofuels can be optimised and scaled up to help meet climate change goals and move us all towards a sustainable energy future.


### ABOUT THE AUTHOR

This article was written by the team at Pall Corporation.
**www.pall.co.uk**


# Hollow fibre nanofiltration

**A simple and robust approach to produce drinking water from surface water using breakthrough hollow fibre nanofiltration technology.**

NX Filtration provided a Mexpert pilot system to Jacobs Engineering to perform pilot testing of direct nanofiltration (dNF) technology at the Melbourne Water Treatment Plant (WTP) in Florida, USA for over three months spanning from mid November 2021 to late February 2022. The goal of the pilot was to remove colour, turbidity, and total organic carbon (TOC) from the influent water, which was successfully proven to be robust and efficient.

The Melbourne WTP intakes surface water from the nearby Lake Washington, which is treated to provide drinking water to the local area and surrounding communities. During winter, the shallow lake experiences turbidity spikes due to heavy rains and wind-related lake turnover, while higher organic content is experienced in the summer. Jacobs aimed to test the efficacy of the 400 Dalton MWCO direct nanofiltration hollow fibre membranes (dNF40) as a potential replacement for its current coagulation, high-rate sedimentation, ozonation, and media filtration process.

**Above:** *Figure 1: NX Filtration Mexpert pilot unit on-site.*

Next to hollow fibre nanofiltration Jacobs was also pilot testing an alternative setup based on biologically active filtration, hollow fibre microfiltration, and spiral wound nanofiltration. Figure 1 (above) shows the Mexpert pilot system on site and Figure 2 (bottom) shows the basic processes being compared, where the simplicity of hollow fibre nanofiltration clearly stands out.

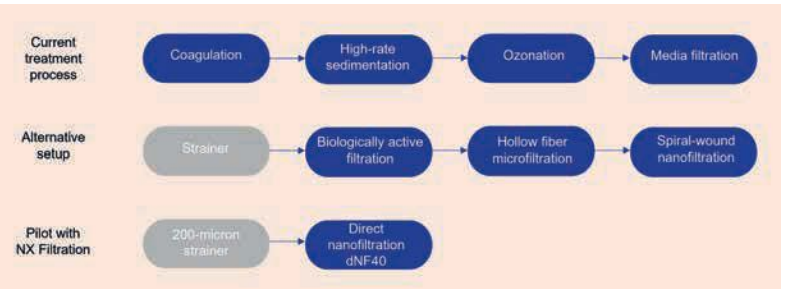
## OPERATING DATA

Overall, the dNF40 membranes demonstrated stable and robust operation in terms of fouling and permeate quality produced.

Table 1: Properties of raw feed water at plant inlet (Aug 2021 – Feb 2022)

| | Temp (°C) | pH | Turbidity (NTU) | Alkalinity (mg/L) | Color (Pt-Co) |
|---|---|---|---|---|---|
| Min | 13 | 6.9 | 0.5 | 19 | 64 |
| Average | 24 | 7.4 | 4.5 | 79 | 226 |
| Max | 33 | 8.5 | 97.7 | 99 | 537 |

**Above:** *Table 1: Properties of raw feed water at plant inlet (Aug 2021–Feb 2022).*




**Right:** *Figure 2: Direct nanofiltration replaces a train of technologies with one simple and robust process.*

### PILOT DATA ANALYSIS

The following conclusions were made from the pilot data analysis:

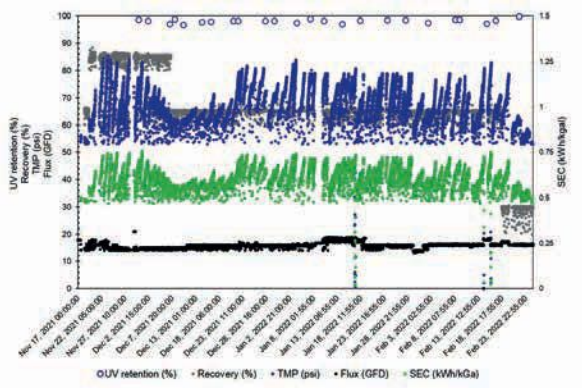
- Permeate was produced with excellent quality, particularly for color, TOC, turbidity, sulfates, and partial hardness removal. The majority of monovalent ions passed through the membrane as expected.
- Stable operation, with consistent membrane permeability, was achieved at each recovery tested.
- Sustainability.
- High operating recovery of >85% is achievable to minimize water waste.
- Low energy demand for full scale design: 0.5 – 0.8 kWh/kgal (0.13 – 0.21 kWh/m3) of product water.
- A stable cleaning regimen for full-scale operation was determined during the pilot test.
- No coagulants or flocculants required.

Various recoveries (from 30–85%) were tested throughout the pilot period, at fluxes in the range of 14-18 GFD. While Table 1 shows the raw feed water quality, the KPIs of the pilot for the duration of operation are shown in Figure 3 (above).

Stable operation is indicated by small transmembrane pressure (TMP) variations over the course of the run. During the piloting period, any fouling was easily removed, typically via physical means (e.g. backwashing or air-scouring). Occasionally a cleaning in place (CIP) (based on NaOCl follow by an acid step) was performed. The stable performance also resulted in a process with a relative specific energy consumption (SEC in terms of kWh per kgal of permeate produced) without dosing of any coagulants, flocculants or anti-scalants. Very high removal of colour and organics was continuously obtained (as indicated by the retention of UV absorption at 254 nm), independent of process conditions.

The dNF membranes are primarily developed to remove low molecular weight organics, colour (NOM), turbidity, and partially remove hardness while allowing monovalent salts to pass. The membranes also offer a solution that is in line with future legislation on PFAS and organic micropollutants – especially the dNF40 membrane, which removes both types of compounds. The dNF40 membrane had high rejection performance as expected, with high rejection of TOC, DOC, iron, and sulphates, and partial removal of hardness. Figure 4 (left) shows the rejection performance of the membrane during the pilot. The data in this figure is based on samples taken for lab analysis, during operation at 30% and 65% recovery.

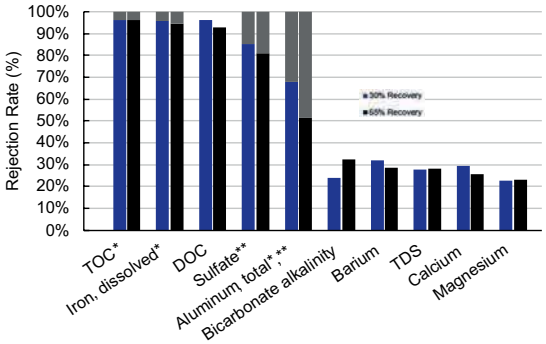
NX Filtration is working closely with a Florida based system integrator specialized in membrane systems to provide a full cost estimate for the proposed 20 MGD full-scale system based on the pilot results.



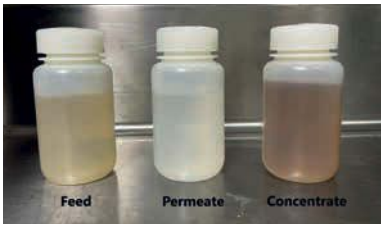

**Above:** *Figure 3: KPIs demonstrate stable operation over the course of operation.*

### THE KEY FEATURES OF THE DNF SYSTEM

- Single-step treatment process with simple operation
- Stable and robust operation on a difficult feed water
- Low energy consumption
- No pretreatment chemicals and limited cleaning chemical requirements
- High organics (including PFAS) and colour rejections




**Below:** *Figure 4: Rejection based on lab analysis results meets the requirements.*



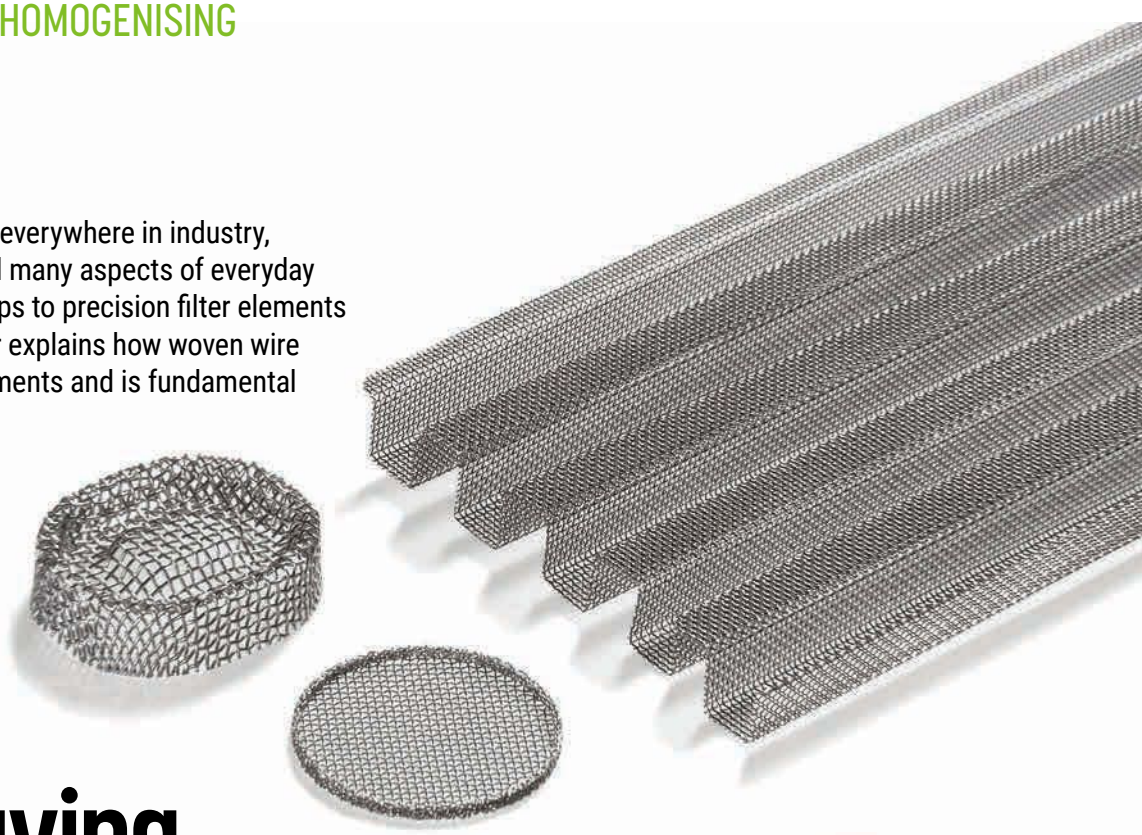

**Left:** *Figure 5: Aerial view of Melbourne WTP and feed (left), permeate (right), concentrate from pilot.*

### ABOUT THE AUTHOR

This article was written by NX Filtration and Jacobs Engineering
**www.nxfiltration.com**
**www.jacobs.com**

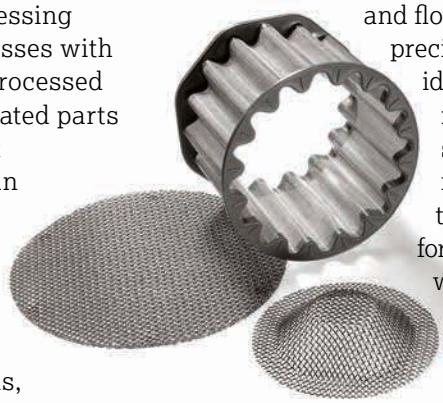
FILTERING, CLEANING & HOMOGENISING

Metal woven wire cloth is used everywhere in industry, research, the building trade and many aspects of everyday life, from flow filters in water taps to precision filter elements in space craft. Haver & Boecker explains how woven wire cloth fulfils a variety of requirements and is fundamental to the areas of application.



# **Wire weaving** for all applications

Haver & Boecker has been a pioneer in the technology of wire weaving, developing and possessing manufacturing processes with which wire cloth is processed into filters and fabricated parts that meet the highest standards. Whether in aerospace and aviation, the automotive industry, electrical engineering, medical technology, chemicals, water filtration, mechanical engineering or plastics processing - customised solutions from Haver & Boecker offer the basis for efficient production processes, reliable function, optimum product quality and distinctive design.



*Wire mesh is provided with plastic injection coating as edge protection, sealing, joining, support or mounting elements and for shaping.*

Woven wire cloths are exact geometric structures whose pore sizes and thus the material and flow properties can be precisely defined. They offer ideal conditions for filtering and separating solid, liquid and gaseous media. They are used for the recovery of solids and for clarification filtration, as well as for the purification of fuels, hydraulic fluids or for water treatment and the homogenisation of polymer melts.

Haver & Boecker's filter media made of wire cloth cover an extremely wide spectrum from the finest structures in the micrometre range to coarse structures and have decisive advantages compared to other

filter media: they enable a consistent filter performance over the entire filter area, are versatile to process and easy to clean. Furthermore, the mechanical, chemical and physical properties can be adapted to the requirements of the respective application by selecting the type of weave and the material.

**ABOUT THE AUTHOR**

This article was written by
Haver & Boecker
**www.haverboecker.com**

SLOP OIL & BILGE WATER

# **All in one** solution

Solutions for slop oil and bilge water are now on-site with Polat Makina's Mobile Slop Oil Recovery System without having an allocated space.

Polat Makina, which has been operating in industrial centrifuge technologies since 1978, continues to offer cost effective solutions with the new Mobile Slop Oil Recovery System designed for the treatment of slop oil and bilge water on-site.

A Mobile Slop Oil Recovery System located in a 40ft container, designed by Polat Makina for a European customer, will reduce operating costs for the customer by getting rid of the transportation cost of the product, thanks to being fully mobile and containing all the equipment that is necessary for the recovery process of valuable substances from slop oil and bilge water.

The most important equipment in the container is the three-phase decanter and the two three-phase separators. In addition to these, there are control valves, buffer tanks, heat exchangers, a chemical dosing unit and pumps to ensure that the product transfers between the main equipment safely and a screw conveyor to discharge dewatered solid materials out of the process. Also, there is control equipment in order to ensure the safe operation of the whole process; modulation valves, temperature sensors, pressure transmitters, and flow meters. Furthermore, the PLC system, which continuously monitors and automates this entire system thanks to SCADA software, is also in the container.

## HOW DOES THE PROCESS WORK?

Before the product input, the Mobile Slop Oil Recovery System should be firstly preheated after all the connections (air, water, and electrical connections and the product input-output channel) are ensured to be made.

Then, the in-put product is transported to the three-phase decanter via the pump. In the decanter, the product is separated into three phases: the solid phase, the heavy phase and the light phase. At the end of this stage, the solid phase is discharged.

After that, the light phase and the heavy phase are sent to the buffer tanks. The heavy phase, which contains mostly water and less oil, is sent to the first separator to reduce the water in oil to obtain the light phase. This light phase is then sent to the buffer tank including also the light phase coming out of the decanter. The remaining heavy phase is also sent to another buffer tank.

Following this, the light phase in the buffer tank is sent to the second separator to completely separate water in the light phase. After this process, the light phase is sent to the buffer tank and the heavy water is sent to the buffer tank which contains the heavy phase coming out of the first separator. As a result of the process, the light phase contains valuable substances, while the heavy phase and solid phase are discharged from the system for disposal by different systems.

In short, the Mobile Slop Oil Recovery System now makes it possible to treat the slop oil and recover the oil on-site without having an allocated space needed.

**ABOUT THE AUTHOR**

This article was written by Polat Makina.
**www.polatas.com.tr**


# Liquid **gold**

International partner for liquid purification processes, Novasep Process Solutions, supplies systems in resin membrane separation and performance management services.

With more than 30 years of industrial experience, Novasep's efficient filtration technology is demonstrated in this article in two product ranges: ceramic and organic. Its filtration expertise relies on efficient industrial design, including ecofriendly performance boosters. Lab and pilot scale systems are also available for rental or purchase, as is or combined with development services.

The company has created a flexible development method for the installation of filtration units. This method, based on Novasep's process and system expertise, and its high quality Kerasep membranes allow customers to do the development by themselves, with expert support. Kerasep ceramic membranes are the references for microfiltration and ultrafiltration of products no matter the viscosity and concentration, and are resistant to harsh cleaning conditions with a long lifetime.

**Left:** *Kerasep filtration units. (image: Novasep)*

Five key system features allow customers to boost performance. A carrousel mode permits a non-stop process, leading to smaller utility equipment and easier recycling of effluent solutions. The utility recovery participates to reduce chemical and water consumption. An additional way to reduce chemical consumption is to decrease the frequency of CIP. Novasep manages to do it with back pulse implementation. A way to reduce water consumption is to work on diafiltration with a permeate recycling loop. This eco-friendly management is supported by the compacity of the system, allowing a reduction in the number of membranes used and a reduced electrical consumption.

**ABOUT THE AUTHOR**

This article was written by Novasep
**www.novasep.com**

# The **ACHEMA** Preview

With manufacturers and service providers from over 50 countries presenting their products for chemical, pharmaceutical and biotech research and manufacturing, as well as energy and environmental services, ACHEMA is the driving force and ground breaker for the international process industries and their suppliers.

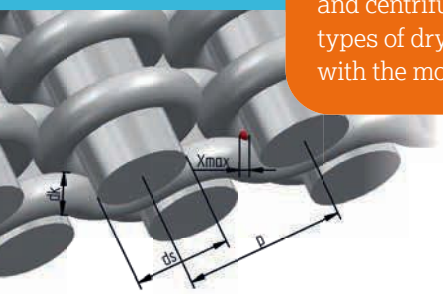
The 2022 world forum and exhibition will be held on 22–26 August 2022 in Frankfurt am Main, Germany. Filtration+Separation explores what Andritz and Haver & Boecker will be showcasing at the event this year.


## **Smart process solutions** for dewatering and drying

Andritz will be presenting its latest insights into its comprehensive portfolio covering the broadest range of technologies and services for mechanical and thermal solid/liquid separation as well as fully integrated systems. From filters and centrifuges to many different types of dryers; all optimized with the most innovative automation solution on the market today – the Metris addIQ control system. One highlight will be the newly launched Andritz screen scroll centrifuge HX. It can process bulk chemicals, minerals, agrochemicals, and food, even under difficult feeding conditions. It is designed for improved product quality and maintainability. New features include a gentle feeder feeding system, a modular scroll, and a rotating assembly that can be removed and replaced in one piece (express cartridge).

The express cartridge design enables the entire rotating assembly to be replaced without dismantling any process piping, reducing downtime. These new features minimize maintenance costs and maximize uptime.

**Hall 12**
**Booth C19**




## New developments in **woven wire filtration media**

In addition to its MINIMESH filter cloth, Haver & Boecker has developed a high performance filter cloth that is fundamentally different from all previous woven metal media. Its three-dimensional weave technology offers properties that make industrial filtration processes quicker, safer and more efficient. The open surface over an area is significantly increased due to the weaving structure. The medium's flow-through rate can be doubled when compared to conventional filter cloth having the same pore size and can be calculated beforehand. With these "precision pores" it is possible to attain a higher separation effect and shape stability. The pore size within a batch can be calibrated as desired from 5 µm to 40 µm.

The depth structure of RPD HIFLO-S offers a high separation effect without rapid blinding. RPD HIFLO-S can be manufactured from standard diameter wires, which has a positive effect on cost. Moreover it is now possible to weave special materials such as Avesta, Hastelloy, Inconel or titanium in the small pore size range, which previously had not been possible.

**Hall 12**
**Booth C1**

# Mark Allen

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## *Passionate* about engineering

# Events

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### June

**28 June–1 July 2022**
*Milan, Italy*
**Mostra Convegno Expocomfort 2022**
www.mcexpocomfort.it

### August

**22–26 August 2022**
*Frankfurt, Germany*
**ACHEMA 2022**
www.achema.de/en

**23 August–1 September 2022**
*Stockholm, Sweden*
**World Water Week 2022**
www.worldwaterweek.org

### September

**6–8 September 2022**
*Mexico City, Mexico*
**Aquatech Mexico**
www.aquatechtrade.com/mexico

**11–15 September 2022**
*Copenhagen, Denmark*
**The IWA World Water Congress & Exhibition 2022**
www.worldwatercongress.org

**14–16 September 2022**
*Bangkok, Thailand*
**Thai Water Expo 2022**
www.thai-water.com/thw/2022/en/index.asp

**22 September 2022**
*Brussels, Belgium*
**Circular Nonwovens Forum**
www.edana.org/events/circular-nonwovens-forum

**27–29 September 2022**
*Nuremberg, Germany*
**Powtech 2022**
www.powtech.de/en

### October

**5–9 October 2022**
*San Diego, California, USA*
**WFC13**
www.wfc13.com

**8–12 October 2022**
*New Orleans, Louisiana, USA*
**WEFTEC 2022**
www.weftec.org

**9–13 October 2022**
*Sydney, Australia*
**IDA World Congress 2022**
https://wc.idadesal.org

**13–15 October 2022**
*Taipei, Taiwan*
**Taiwan International Water Week 2022**
www.taiwanintlwaterweek.com

**19–21 October 2022**
*Malta*
**Outlook 2022**
www.edana.org/events/outlook/outlook-2022

**24–30 October 2022**
*Munich, Germany*
**Bauma 2022**
www.bauma.de

### November

**8–9 November 2022**
*Berlin, Germany*
**FILTREX Europe**
www.edana.org/events/filtrex/filtrex-europe

**15–16 November 2022**
*Dubai, United Arab Emirates*
**The Mining Show**
www.terrapinn.com/exhibition/mining-show

**16–17 November 2022**
*Shanghai, China*
**FILTREX Asia**
www.edana.org/events/filtrex/filtrex-asia

**30 November–1 December 2022**
*Nantes, France*
**Bluetec Sea & Coastline by Pollutec**
www.pollutec.com/en-gb/bluetec.html

## 2023

### February

**2–3 February 2023**
*New Delhi, India*
**Filtrex India**
www.edana.org/events/filtrex/filtrex-india

**6–8 February 2023**
*Atlanta, Georgia, USA*
**AHR Expo 2023**
www.ahrexpo.com

**14–16 February 2023**
*Cologne, Germany*
**FILTECH 2023**
www.filtech.de

**20–23 February 2023**
*Indianapolis, Indiana, USA*
**WWETT Show 23 - Water & Wastewater Equipment, Treatment & Transport**
www.wwettshow.com

### March

**13–17 March 2023**
*Frankfurt, Germany*
**ISH**
www.ish.messefrankfurt.com

### April

**18–21 April 2023**
*Geneva, Switzerland*
**INDEX 23**
www.indexnonwovens.com

### May

**1–3 May 2023**
*Louisville, Kentucky, USA*
**AFS Filtcon 2023**
www.indexnonwovens.com

**10–12 May 2023**
*Atlanta, Georgia, USA*
**Techtextil North America 2023**
www.techtextil-north-america.us.messefrankfurt.com

### September

**13–16 September 2023**
*Jakarta, Indonesia*
**Water Indonesia**
www.waterindonesiaexpo.com

**30 September–4 October 2023**
*Chicago, Illinois, USA*
**WEFTEC 2023**
www.weftec.org

### October

**9–11 October 2023**
*Seville, Spain*
**IDA Water Reuse and Recycling Conference**
www.wrr.idadesal.org

**10–12 October 2023**
*Chicago. Illinois, USA*
**FiltXPO**
www.filtxpo.com

**10–13 October 2023**
*Lyon, France*
**Pollutec**
www.pollutec.com

### November

**6–9 November 2023**
*Amsterdam, the Netherlands*
**Aquatech Amsterdam**
www.aquatechtrade.com/amsterdam

More diary dates are listed in our events page on the Filtration+Separation website: http://www.filtsep.com/events/

All events are subject to change and/or cancellations. Filtration+Separation accepts no responsibility for any changes. Further information can be obtained only by contacting the relevant parties.

**If you are organising an event concerning filtration, separation or related disciplines, and would like to be included in this list, please send details to: Roisin Reidy. email: roisin.reidy@markallengroup.com**

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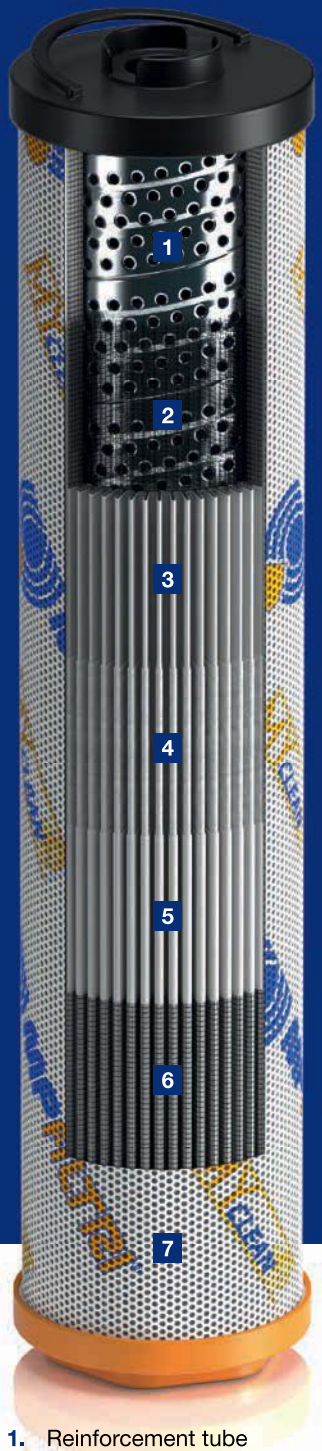


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6. Metal mesh support
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