



# REVERTA

SUSTAINABLE MEMBRANE  
FILTRATION SOLUTION WITH  
FLOW REVERSAL



# INTRODUCTION

# PENTAIR X-FLOW

Pentair® X-Flow™ delivers membrane solutions and application know-how to OEMs and contractors. As a leading pioneer and developer of membrane-based filtration solutions, we believe membranes will be essential in the purification processes of the future. Considering the increasing global health and environmental concerns, and dwindling natural resources, we see membrane technology as essential for the health of our world and for continued access to safe, clean water.





In many parts of the world, water scarcity is a growing issue. In order to secure future access to reliable water sources, crucial reuse opportunities have to be seized today. Our strong belief in the need for ongoing development has made knowledge sharing part of our business model. New applications and better solutions start with exchange and cooperation. That is why we regard our customers as partners.



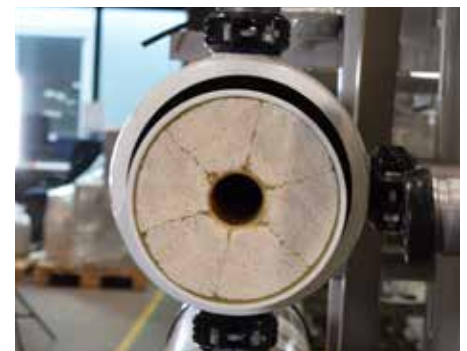
X-Flow started manufacturing Pentair X-Flow Membranes and Membrane Elements in 1984. Be confident in your filtration solution decisions by relying on our 35+ years of practical experience and countless project references around the world.



We aim to maximize our results for you with our world-class X-Flow Membrane Elements, engineering services, and Pentair X-Flow Membrane+ Approach.



The Pentair X-Flow facilities in Enschede, the Netherlands, feature a membrane element production plant and R&D laboratory. Dozens of specialists work here to bring you enhanced X-Flow membrane solutions and other continuous improvements to support your needs.



Focused on practical and economic progress, X-Flow develops membrane-based filtration solutions that help enable a lower total cost of ownership and higher efficiency.

# PENTAIR X-FLOW MEMBRANE+ APPROACH

Pentair X-Flow Membrane+ Approach provides technological support to OEMs and contractors in connection with the membrane filtration solutions we provide. This expert assistance, especially when provided from an early stage onward, makes the difference for the membrane filtration portion of your plant in terms of quality, safety, efficiency and reliability.

Excellent performance starts with choosing the right solution and design for a particular membrane application. Once up and running, the system has to keep working well. As these choices typically involve multiple and interrelated considerations, X-Flow Membrane+ Approach offers crucial help from the very start. Feel confident and at ease taking on the challenging task of selecting the right solution. Our experts with years of combined experience are available to give you a helping hand.

We support you not only with superior X-Flow Membrane Elements, but also with engineering know-how, monitoring tools and automation solutions specifically related to our membrane elements.

X-Flow Membrane+ is our approach to helping you solve any specific project-related issue. Our engineers are committed to provide all the practical support required in every project phase from conceptual design to piloting, start-up and beyond in connection with the X-Flow Membrane Elements. Gain peace of mind from our support at every project phase.

## DEVELOPMENT PHASE

To help ensure your technical knowledge is up-to-date, Pentair X-Flow offers advanced education in membrane technology and engineering through Pentair University.

Our convenient and insightful training sessions also help you to get the basic parameters right and avoid costly errors which can affect short-term and long-term performance of your plant as they relate to the membrane filtration elements.

You can readily validate design choices and establish KPIs by making use of our test applications in real-life circumstances. Our engineers offer you plug & play pilot possibilities and piloting assistance. Pilot performance optimization is a continuous process of data exchange between engineers. The information from the pilot test gives you important data about how to run a large-scale project before you commit a significant amount of time, energy or money.

## DESIGN PHASE

Our process design engineers help your bid evaluations run smoothly in connection with the membrane filtration portion of your plant. We can work alongside your plant design engineer and technical experts to review the system's preliminary P&IDs and layout drawings.

This stage usually comprises in-depth consultations between all parties involved. Our engineers can join you through in-person or virtual meetings to help clear up any remaining uncertainties and offer substantive support on design choices when you may need it most. This will give you the opportunity to closely look



into the membrane filtration portion of your plant together with our engineers. They will support you in optimizing the membrane filtration element portion of your plant.

**EXECUTION PHASE**

The backbone of your membrane filtration system will be built by our process engineers.

They finalize the basic design, produce detailed drawings and documentations and review the drafts of the P&IDs, system layout, software protocols, and commissioning manual.

Commissioning assistance includes hardware and software testing, as well as fine-tuning for optimal operation. Our engineers verify performance data and fully support you during commissioning to help ensure a successful start-up.

**OPERATION PHASE**

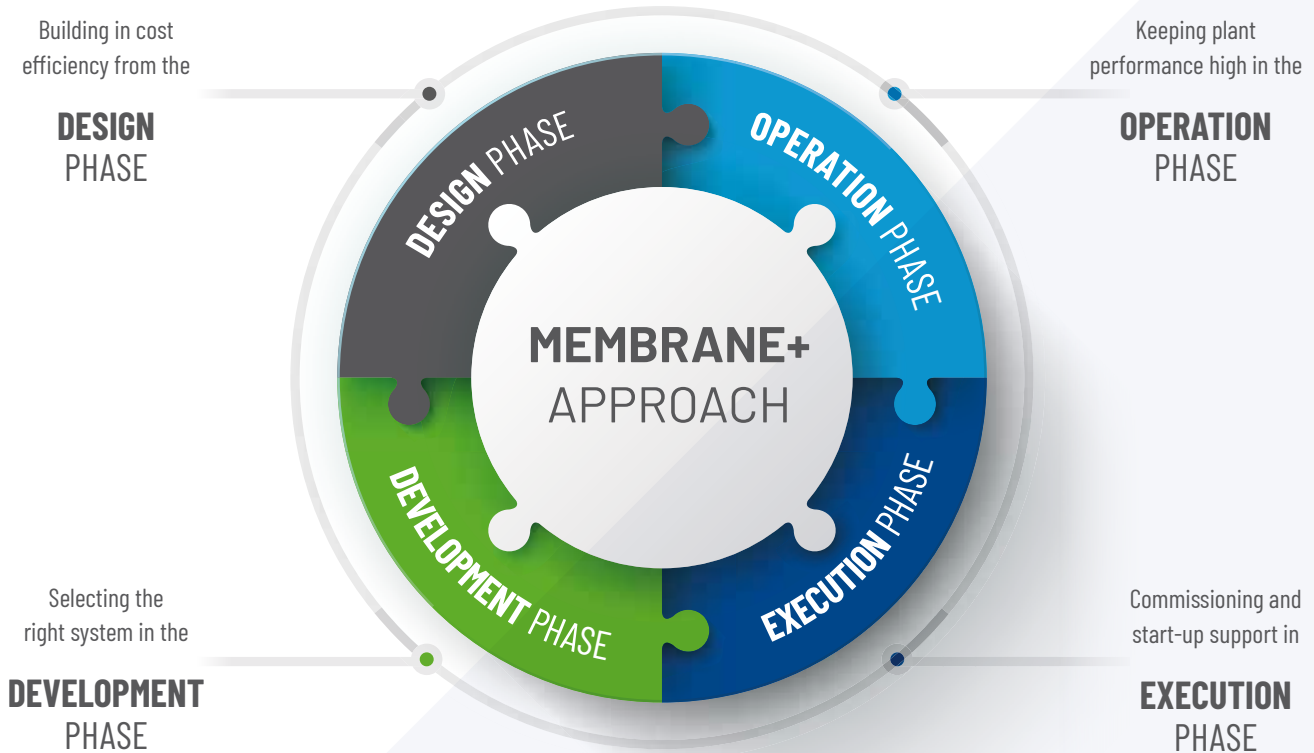
X-Flow Membrane+ Approach offers you continued support when the system is built, commissioned and running as intended.

Real-time monitoring of your plant generates data to enable long-term optimized operation, providing peace of mind for both contractors and operators.

Our service engineers offer extensive operational support. They analyze membrane performance to optimize your system and advise on further performance improvements.

We are always ready to help you ensure your plant continues to perform even after delivery. Our local service partners are available if and when support issues arise. Service training is a great way to continuously upgrade the skills and knowledge of your plant operators.

You can rely on a worldwide network of service representatives that will assist in ensuring your X-Flow Membrane Elements perform according to design specifications and operations manual. This helps to make life much easier and allows you to focus on other important work without having to worry about your system running as it should.



# REVERTA: ENSURES TOGETHER WITH ANMBR HIGH QUALITY EFFLUENT AND BIOGAS

Many industries are facing increasing challenges in water and wastewater treatment to reduce the impact on the environment.

Selecting the most effective technology can seem like a daunting and overwhelming task. Issues such as mandatory and strict water usage requirements, carbon footprint, effluent quality, and reusability must all be taken into account.

Rely on anaerobic membrane bioreactors (AnMBR) for an effective solution to treat your wastewater streams and slurry that contain high concentrations of organic matter, solids, high salinity, and/or fats, oils and grease (FOG).

Compared to conventional anaerobic technologies, the AnMBR offers you significant benefits. Pentair X-Flow AnMBR partners

have found the technology assist in meeting their regulatory requirements, protect the environment and reduce dependence on fossil fuels.

Pentair X-Flow Reverta Solution started over a decade ago with the introduction of the encased X-Flow UF system developed especially for our AnMBR-building partners. With X-Flow Reverta you can rely on consistent delivery of high-quality effluent while producing the maximum amount of biogas, all with minimal operator interference.

## CASE STUDY

Economics, regulations and space limits determined the choice at American brewery



## CUSTOMER

Deschutes Brewery in Oregon, USA

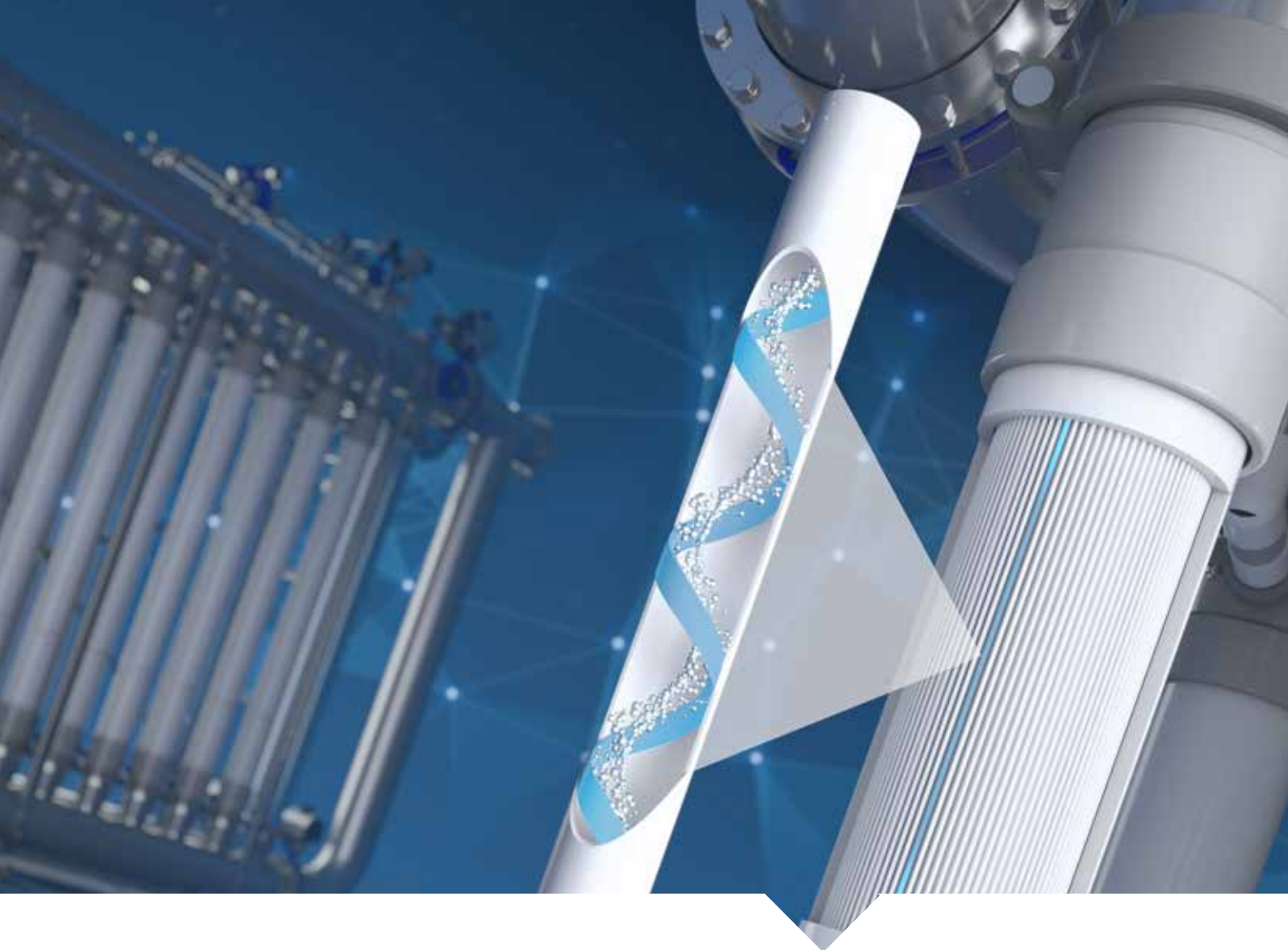
## APPLICATION

The treatment and reuse of the brewery wastewater.

## RESULTS

The pilot showed Reverta's ability to accommodate the variable and high-strength wastewaters typically generated by craft breweries. The system assisted in addressing fouling issues were firmly under control due to the external set-up and Pentair X-Flow Helix Flux Enhancement Technology. The membrane elements provide a durable and reliable barrier for many years of demanding operations. The almost absolute separation between solids and fluids keeps the biomass in the reactor and delivers a superior effluent quality.

Read the full story on our Pentair X-Flow website:  
<https://xflow.pentair.com/en/case-studies/deschutes>



## HOW PENTAIR X-FLOW REVERTA OPTIMIZES YOUR ANMBR SYSTEMS

- Pentair X-Flow Compact 33V Helix Membrane Elements resist fouling, are easy to clean and deliver **effluent of high quality**.
- **Flux rates are 25 to 50% higher\***
- **Pretreatment is reusable, no operator interference required.**
- Feed Flow Reversal (FFR) setup **prevents potential clogging**
- Encased UF system has built-in technology for fully **automated maintenance cleaning**
- **It is a non-hazardous zone** because gas scouring is not required in the membrane system
- Fixed crossflow velocity of 1 m/s results in the potential for **significantly lower OPEX** due to reduced power consumption.

\* With X-Flow Helix Membrane Elements, compared with the conventional smooth PVDF membrane elements under the same process conditions. Based upon Pentair X-Flow internal testing measuring performance against Pentair X-Flow manufactured PVDF membrane elements.



Pentair X-Flow Reverta Skid with Pentair X-Flow Membrane Elements.

# PENTAIR X-FLOW REVERTA: YOUR POWERFUL ALLY FOR ANMBR

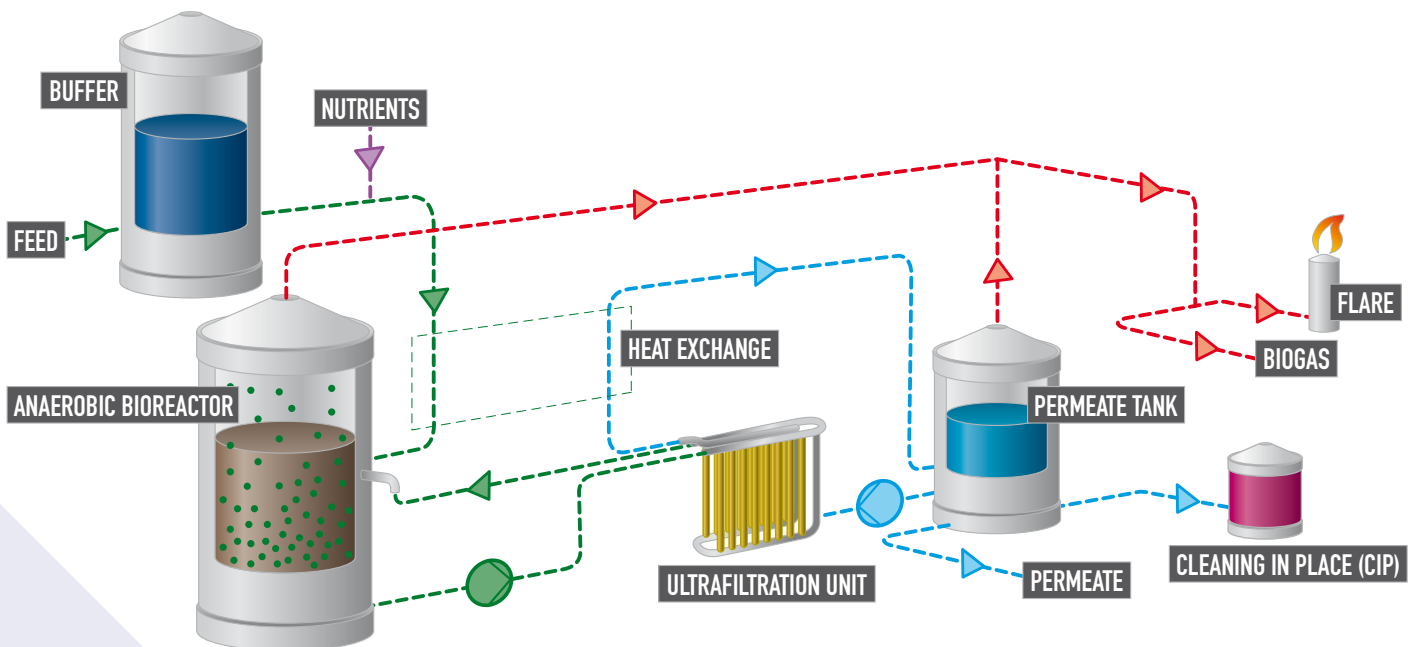
## WHEN DO YOU CHOOSE ANMBR TO TREAT WASTEWATER?

- Concentrations of COD >7,000 ppm
- Total amount of COD >3,000 kg/day
- High salinity
- High FOG levels without DAF being applied (up to ca 1,000 ppm)

While the above is a good indication of wastewater strengths that warrant the choice for AnMBR, the ideal solution is

determined by your site-specific conditions and your wastewater type.

In general, COD levels drive the choice between aerobic and anaerobic treatment. Conventional anaerobic treatment has difficulties in coping with high concentrations of salt and FOG.



*Pentair X-Flow Reverta Solution: AnMBR with the UF unit outside the bioreactor*

When comparing the AnMBR to conventional anaerobic treatment methods, the biggest difference is the separation of water and solids. Conventional systems rely on the settling capability of biomass particles inside the reactor tank that also produces the biogas. Settling often requires some form of granulation to weigh down the particles. High levels of salt and FOG can hamper this process. AnMBRs with X-Flow Reverta use the reactor as the biogas-producing unit. The UF unit, located outside the reactor on a membrane skid, separates the biomass from the water and returns the biomass to the reactor to further boost biogas

production. The effluent is now clean enough for discharge or can be further upgraded to recycling quality.

Taking the membrane elements out of the reactor offers several advantages. The tank is a simple mixed liquor tank as no settling is required. A decreased amount of energy is required to recycle the sludge through the UF system. Gas scouring is not required, which means you can avoid biogas compression and a hazardous zone altogether. It also makes it much easier and quicker to effectively clean the membranes, as they are not submerged in the reactor.



## APPLICATION AREAS

### TYPICAL INDUSTRIES USING ANMBR WASTEWATER TREATMENT

AnMBR systems are built around the world at production plants with the most nutrient-rich wastewater streams:

- Wastewater very high in organic content: COD 7,000 to 80,000 ppm
- Food & Beverage industry
- (Bio)ethanol production: pot ale, spent wash, thin stillage and vinasse
- FOG in waste streams from ice cream, candy, and biodiesel production
- Starch slurries

**1** Industrial wastewater  
Membrane bioreactor (MBR)  
Anaerobic MBR

**2** Municipal wastewater  
Membrane bioreactor (MBR)

## TAKE A HOLD ON YOUR WASTE STREAMS

Nowadays you need to recognize environmental responsibilities as well as the expectations of your local government. The organic compounds in your wastewater are highly polluting and can be devastating for aquatic life when discharged without appropriate treatment. Wastewater treatment protects ecosystems and enables you to reuse water at your plant.

In an MBR the organic contents of the wastewater are biologically degraded into water and carbon dioxide by aerobic bacteria which need continuous oxygen input.

In an AnMBR, the organic contents in wastewater are biologically degraded into biogas (primarily methane and carbon dioxide) by bacteria that live in a strictly anaerobic (oxygen-free) environment.

UF membrane elements made from polyvinylidene fluoride (PVDF) separate the biomass with the bacteria from the water.

PVDF membranes provide you with excellent permeate quality, low fouling, and high resistance against (cleaning) chemicals. X-Flow Reverta Solution brings the membranes outside the bioreactor, contained in Pentair X-Flow Membranes Elements mounted on skids.

You can tackle the waste streams from your plant by recycling the water for reuse in the process, preventing pollution of water bodies and relieving pressure on your natural resources.



## BUILDING WORLD-CLASS ANMBR SYSTEMS

### SERVICES (M+)

Pentair University, aftersales service

- ▶ - Commissioning and installation services
- ▶ - Pentair University training & education

### ENGINEERING (M+)

Mechanical, automation, process

- ▶ - Process engineering
- ▶ - Mechanical engineering
- ▶ - Electrical engineering
- ▶ - Automation

### UNITS

Design and fabrication

- ▶ X-Flow Reverta units, RVT12, RVT18, RVT26

### CONNECTING PARTS

Proprietary

- ▶ Couplings

### ELEMENTS

Minimum scope

- ▶ X-Flow Compact 33V Helix Membrane Elements

### MEMBRANES

Core value

- ▶ X-Flow tubular Helix Membranes, inside-out filtration PVDF

# THE CRUCIAL ADVANTAGES OF X-FLOW MEMBRANE ELEMENTS IN (AN)MBRS

The X-Flow Membrane Elements are built to offer you efficient separation in membrane bioreactors, both aerobic and anaerobic. In the Reverta configuration, accessibility is easy because of the side stream approach.

There is limited stress on the presence of fibrous material entering the membrane elements due to the flow reversal principle in this configuration. You can also rely on decreased power consumption because of the low crossflow velocity within the membrane system that will lower the OPEX.

AnMBR not only produces clean reusable water for your plant, but also has the potential to produce various other benefits. It has no need for granulation, offers you easy access and potentially lower OPEX.

- All biomass stays in the reactor, leading to higher mass transfer rates. Longer retention times allow FOG to be easily degraded. This translates to more biogas produced from the wastewater<sup>1</sup>.
- Excellent effluent quality: COD removal efficiency typically reaches over 98 percent, while Total Suspended Solids (TSS) in the effluent reach to < 1 ppm<sup>2</sup>.
- Easy access: Fouled membrane portions can quickly be isolated and cleaned.
- No biogas scouring means safer operations<sup>3</sup>.
- Lower OPEX: reduced energy and chemicals use, minimal disposal and discharge levies<sup>4</sup>.

## PLUS, NO NEED FOR:

- Granulation: suspended bacteria simplify and expedite bioreactor startup.
- Expensive pretreatment, such as dissolved air flotation (DAF).



- 1 There is no route for the biomass to escape from the reactor because it cannot pass the membrane elements. FOG is floating with biomass that is sticking. FOG is COD and can be biodegraded to make more biogas. With floating FOG/biomass and separation by settling, this part cannot be treated in conventional systems. With the membrane barrier, both stay inside the reactor and will transform to biogas.*
- 2 Results of the past decade of our Pentair X-Flow anaerobic MBRs show a COD influent versus COD effluent reduction of 98% or more. In < 5% this can drop below 98% during start-up processes or anomalous events.*
- 3 Alternative submerged membrane processes require biogas scouring. This requires the collection of biogas and recompressing the biogas to return into the membrane filtration system. With this extra equipment for treating combustible gas, there is an extra risk to the process that is completely avoided with the Reverta Solution, making for much safer operation.*
- 4 Operational expenses are: primary power input, chemicals usage for cleaning, and discharge of the chemicals when special cleaning materials (e.g. citric acid and hypochlorite) are used that should not go down the drain. The side stream tubular process Pentair X-Flow is using is lower. This is because we are taking the production rate against the required energy input and compare this against the required power and production rates of alternative processes (e.g. submerged systems). The chemical cleaning requirements compared to the size of the filtration system show the same outcome which results in beneficial process conditions and settings.*

## CASE STUDY

Delivering biogas and high-quality effluent

## CUSTOMER

Humansdorp, South Africa

## APPLICATION

The treatment and reuse of dairy wastewater

## RESULTS

Pentair has led the way in optimizing the membrane elements and the process. To separate the sludge from the treated water, polyvinylidene fluoride (PVDF) UF membranes are installed outside the bioreactor in a clean setup to deliver high chemical resistance, low fouling, and excellent permeate quality. It is now possible to achieve a COD reduction of over 98 percent, down to less than 100 or even 50 parts per million. Pentair X-Flow Reverta has proven its worth as a reliable and cost-effective technology that generates energy and high-quality reusable water.



The system was developed in a cooperation between Veolia subsidiary Biothane and Pentair.

Read the full story on our Pentair X-Flow website:  
<https://xflow.pentair.com/en/case-studies/woodlands>

## FIND OUT MORE

For more information, contact your local Pentair X-Flow representative or visit <https://xflow.pentair.com/en/products/x-flow-reverta>



Marssteden 50  
7547 TC Enschede  
The Netherlands

P.O. Box 739  
7500 AS Enschede  
The Netherlands  
Ph: +31(0)53 428 70 00

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