

PoroCep®

# THE DISTINCTIVE MBR SOLUTION



*Hyflux*®

# ABOUT HYFLUX

Hyflux is one of the world's leading provider of an innovative suite of water and wastewater process technologies, **providing cost-effective and sustainable solutions in seawater desalination, water recycling, wastewater treatment, and potable water treatment.**



Founded since 1989, Hyflux has established its headquarters in Singapore and various sales offices in China, India, Indonesia, Oman, Algeria, Saudi Arabia and Nigeria. Hyflux is listed on the Singapore Stock Exchange since 2001. It is currently one of the top desalination players in the industry with a revenue of S\$445.2 million in 2015 and approximately 2,400 employees serving customers in over 130 countries.

At the core of Hyflux's business is the design and development of the award winning and proprietary Kristal<sup>®</sup> ultrafiltration and PoroCep<sup>®</sup> MBR membranes.

Leveraging the unparalleled engineering know-how and experience from our large EPC projects, Hyflux has developed pre-engineered compact and modular PoroCep<sup>®</sup> MBR Packaged Systems, specially designed to achieve better energy efficiencies and ease of installation.

At Hyflux, we provide our clients with flexibility and peace of mind in addressing their water and wastewater challenges across industries.



# EXPERIENCE SUPERIOR RELIABILITY AND EFFICIENCY.

Designed for use in MBR systems, Hyflux's PoroCep® hollow fibre submerged membrane combines an **innovative, compact design** with **sustained high performance efficiency** that helps save energy and reduce costs throughout a wastewater plant's lifecycle.

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## Product Features and Benefits

- Enhanced hydrophilic material
- Asymmetric slit pore structure
- Consistently excellent permeate quality
- High packing density
- High pH and chemical tolerance

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## Operation Features and Benefits

- Low fouling rate
- Long lifespan
- Small footprint
- Low energy requirements
- Efficient system recovery

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## Key Applications

- Industrial wastewater treatment and reclamation
- Municipal wastewater treatment and reclamation
- Pre-treatment filtration

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# POROCEP® APPLICATIONS

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PoroCep® membranes may be applied for various uses, including:

## Industrial Wastewater Treatment and Reclamation



- Wastewater treatment and reclamation for industries like oil and gas, food processing, pulp and paper, steel mills, slaughterhouse and textile.

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## Municipal Wastewater Treatment and Reclamation



- Sewage treatment and reclamation.
- Containerised MBR waste treatment plants for military use, rural communities.
- Standardised wastewater treatment systems for hospitals and pharmaceutical purposes.

## Pre-treatment Filtration



- Pre-treatment of high solids-loading feed water for nanofiltration, reverse osmosis, ion exchange, electrodeionisation (EDI).

The image features a grayscale scanning electron micrograph (SEM) of a porous membrane structure, showing a complex, interconnected network of fibers and voids. This texture is visible in the top-left and bottom-left corners, separated by a curved boundary from a solid gray area on the right. A horizontal band of teal color spans the middle of the image, containing the text.

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THE DISTINCTIVE  
MBR SOLUTION

# POROCEP® THE DISTINCTIVE MBR SOLUTION

## INTRODUCTION

With its high filtration capacity and superior performance efficiency, PoroCep® can help industries and municipalities **save energy and reduce costs throughout a wastewater plant's lifecycle.**



Growing populations, rising industrialisation and urbanisation, with attendant problems such as water pollution and depleting water resources, have prompted the search for more sustainable sources of water. As a result, water reuse is becoming an increasingly viable solution for municipalities and industries.

Water reuse enables municipalities to become less dependent on freshwater sources. It can also address the stringent restrictions many industries face on their water usage and on the quality and quantity of water that can be discharged from their facilities.

A pioneer in providing NEWater (municipal wastewater recycling) solutions in Singapore, Hyflux has drawn on its experience in wastewater filtration and membrane research to develop PoroCep®, a submerged hollow fibre membrane designed for use in membrane bioreactor (MBR) systems. PoroCep® is a reliable, high performance solution particularly well suited for industrial wastewater treatment and reclamation.

## POROCEP® THE DISTINCTIVE MBR SOLUTION

### INTRODUCTION



Manufactured and assembled in Singapore, PoroCep® membranes are made from high-density polyethylene (HDPE), a non-toxic, non-leaching material with excellent tensile strength as well as strong pH and oxidation resistance. Each hollow fibre membrane is produced through environmentally friendly processes such as melt-spinning and stretching which do not use harmful chemicals. The membranes are housed in unit boxes that are in turn mounted on a skid that comes with its own air diffusing module.

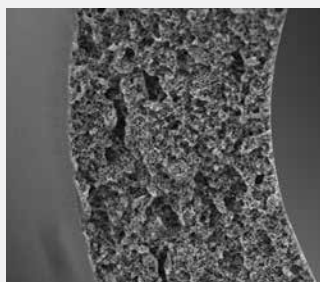
Unlike conventional wastewater treatment systems, MBR systems require less footprint, produce less sludge and allow for higher mixed liquor suspended solids (MLSS) content with less hydraulic retention time. The compact design of the PoroCep® skid allows a higher packing density to be achieved within an MBR. With its high filtration capacity and superior performance efficiency, PoroCep® can help industries and municipalities save energy and reduce costs throughout a wastewater plant's lifecycle.

# POROCEP® THE DISTINCTIVE MBR SOLUTION

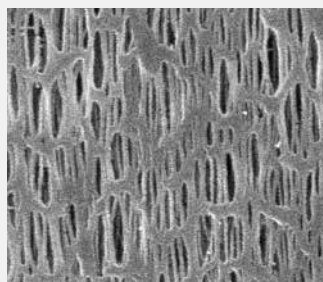
## ASYMMETRIC, SLIT PORE STRUCTURE

### Improved contaminant rejection and membrane permeability

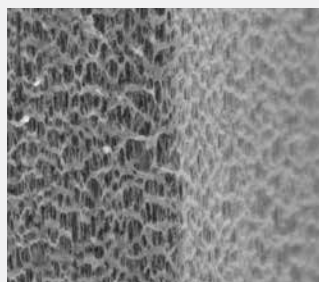
The slit pores of the PoroCep® membrane reject contaminants such as suspended solids and microorganisms more efficiently and are not clogged as easily as the regular circular pores. This slit pore structure is created by an exact stretching method which ensures a narrow pore size distribution. In addition, the asymmetry of the membrane gives it good permeability for high flux rates, and at the same time, high rejection efficiency.



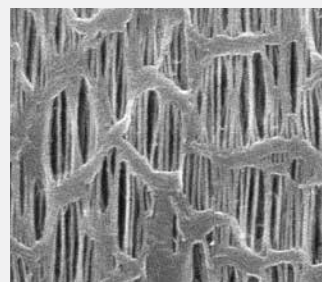
Front cross-section structure



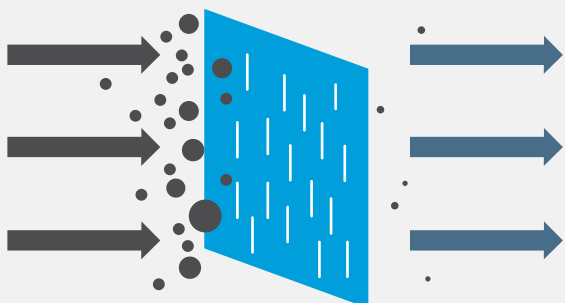
Outer surface morphology



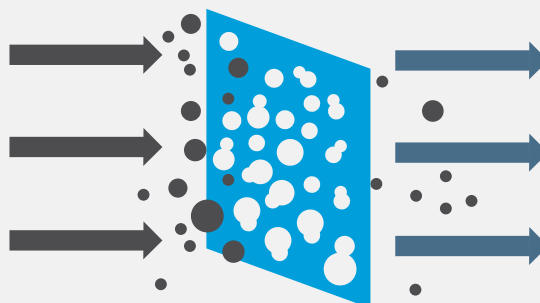
Section along membrane's slit pore structure



Inner surface morphology



Slit Pores



Normal Pores

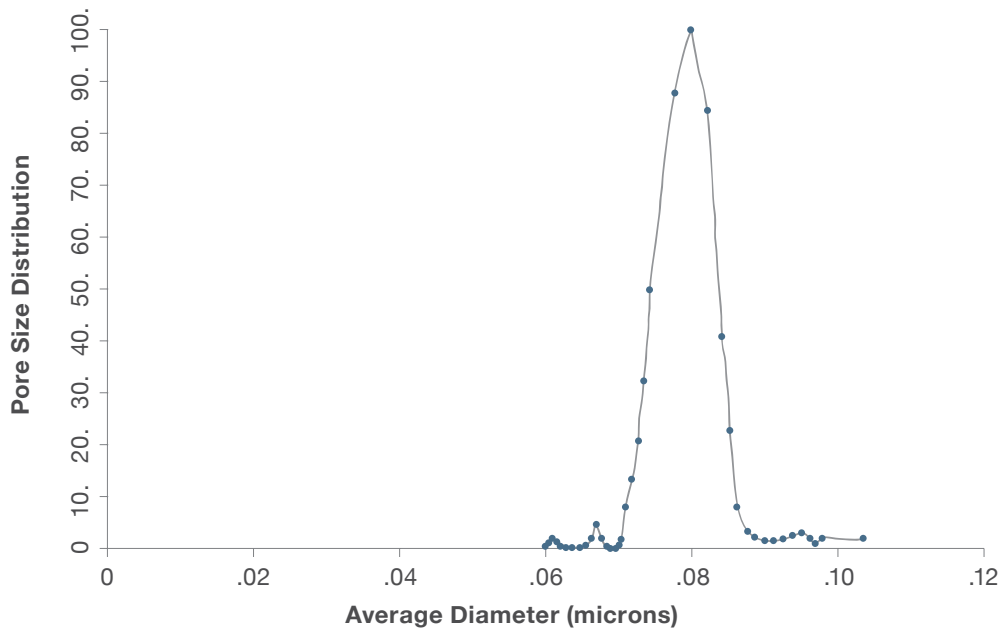
Rejection provided by slit pores compared to normal pores



# POROCEP® THE DISTINCTIVE MBR SOLUTION

## ASYMMETRIC, SLIT PORE STRUCTURE

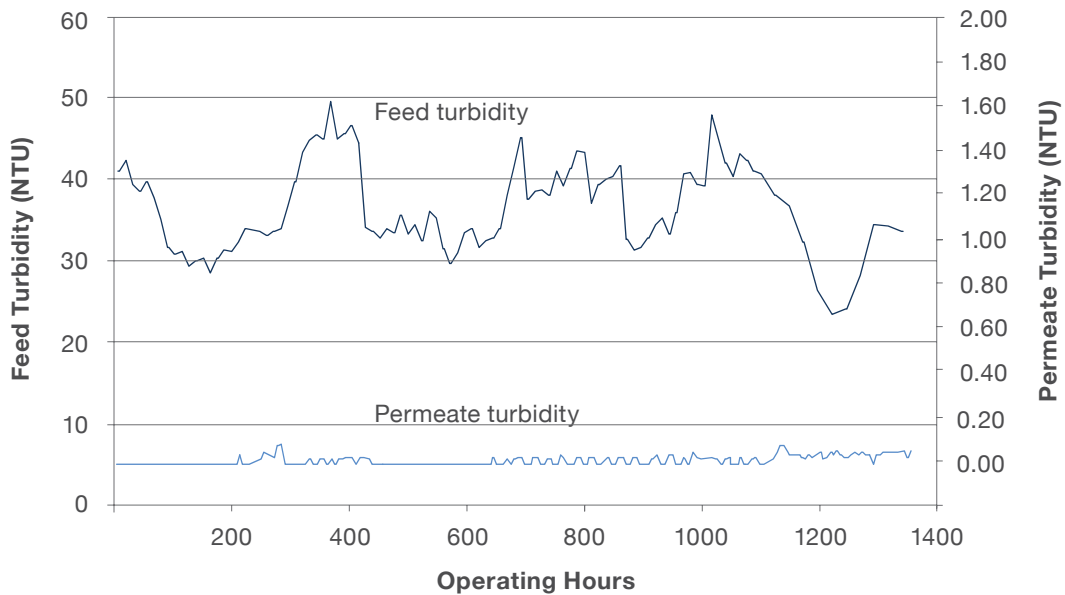
Pore size distribution vs average diameter



Narrow pore size distribution of a PoroCep® membrane

### Consistent, high quality permeate

PoroCep® delivers consistent, high quality permeate regardless of the fluctuations in feed water quality. This is illustrated in the graph below.



# POROCEP® THE DISTINCTIVE MBR SOLUTION

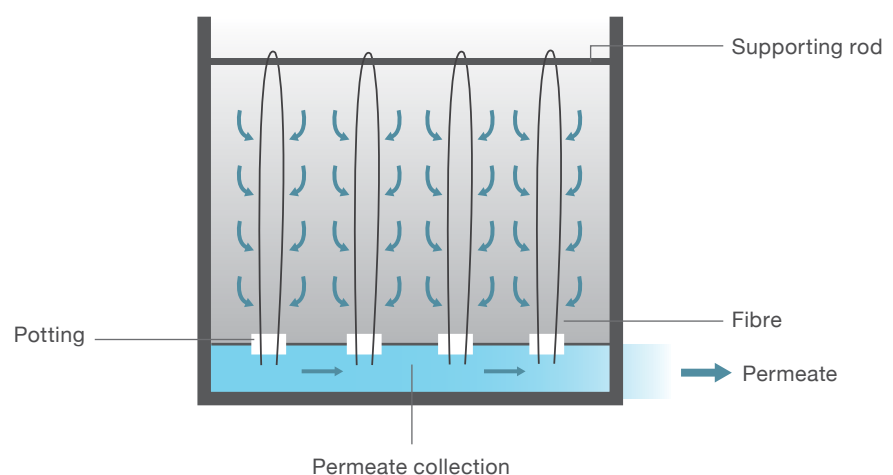
## FREE-FLOATING FIBRE DESIGN

PoroCep® is designed to **minimise fouling and maximise membrane packing density through a unique free-floating fibre design.**

### Lower rate of membrane fouling

One of the key concerns with membrane filtration is fouling and the buildup of a cake layer on the surface of the membranes. Fouling causes membrane permeability to decrease. While a higher cleaning frequency can restore membrane performance, it gradually reduces the lifespan of the membranes. PoroCep® is designed to minimise fouling and maximise membrane packing density through a unique free-floating fibre design.

Hollow fibres made of HDPE material are looped over a supporting rod and potted at the ends. They float freely when submerged in water, preventing contaminants and fibrous material from being trapped within the fibres. At the same time, a steady stream of air bubbles scour the membrane surface to keep it free from solids buildup. As a result, PoroCep® can function for extended periods of time without the need for chemical cleaning. This translates to cost savings and minimal system downtime.



Simplified drawing of free-floating PoroCep® membrane elements

## POROCEP® THE DISTINCTIVE MBR SOLUTION

### LOW ENERGY REQUIREMENTS

The aeration required for air scouring is a key component of energy costs for an MBR system. PoroCep® requires an air flow of approximately 0.1 - 0.2 Nm<sup>3</sup>/hr/m<sup>2</sup> which is possibly the lowest in the market today. Users can thus enjoy significant savings on operational expenses with this energy-efficient membrane system.

### HIGH PACKING DENSITY

With a membrane per footprint area of approximately 835 m<sup>2</sup>/m<sup>2</sup> for a double-deck skid, PoroCep® has one of the highest membrane packing densities among submerged membranes for MBR systems today. Its greater filtration capacity and smaller tank footprint means savings on capital and operating expenditure for users.



# POROCEP® THE DISTINCTIVE MBR SOLUTION

## STACKABLE UNIT BOX ARRANGEMENT



PoroCep® membranes are housed in unit boxes which are then “stacked” together onto a skid. Operation and maintenance are made easier with this modular, stackable design as each individual unit box can be simply mounted and dismantled without hassle when installing, inspecting and cleaning.

## OPTIMISED AIR FLOW

Air scouring plays a key role in membrane performance by inhibiting and removing foulants from the membrane surface. PoroCep®’s stackable design, coupled with the even distribution of air from the air diffusing module at the bottom of the skid ensures that the scouring action of the air bubbles is effectively channelled throughout the skid, reaching all parts of the membranes and preventing any “dead zones” from forming.

# THE CASE FOR MBR OVER CONVENTIONAL TREATMENT

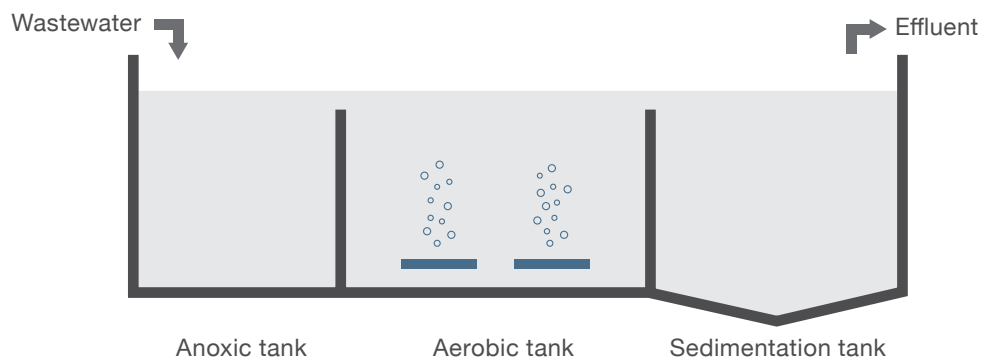
## BENEFITS OF MBR VS CONVENTIONAL TREATMENT

Conventional wastewater treatment generally involves the biological degradation of organic content in the influent followed by secondary gravity sedimentation to settle out the sludge from the aqueous activated sludge solution. Rather than employing sedimentation, an MBR system passes the aqueous activated sludge solution through membrane filtration to separate water from the sludge. By using membranes in place of a secondary sedimentation tank or clarifier, the MBR system offers several benefits over conventional wastewater treatment.

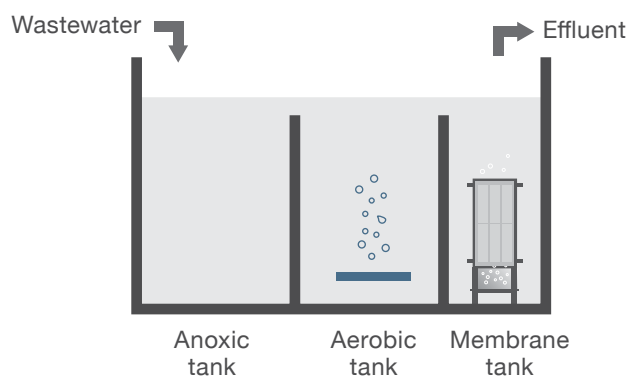
### 1. Smaller footprint

MBR systems can operate at a considerably higher mixed liquor suspended solids concentration compared to conventional activated sludge systems (CAS). This high concentration results in a lower tank volume and a substantial reduction in the footprint of the plant which is an advantage for highly populated areas where space availability is a chief concern. Conventional treatment systems typically take up 30% or more footprint as compared to MBR systems.

#### Conventional Treatment (Activated Sludge) Process



#### Membrane Bioreactor Process



Simplified schematic of conventional treatment and MBR processes

# THE CASE FOR MBR OVER CONVENTIONAL TREATMENT

## 2. Superior effluent quality independent of influent quality

Membrane filtration in MBR systems provide an effective and reliable barrier that removes suspended solids, including harmful microorganisms to produce consistent, higher quality effluent compared to conventional treatment systems. This can be seen from the parameters in the following table where Hyflux's PoroCep® membrane effluent quality is compared with that of typical CAS systems.

**Comparison of typical effluent quality between MBR and CAS**

Parameter	Feed/Influent	Effluent		
	Municipal Wastewater (Typical)	MBR System Using PoroCep®	CAS	
Turbidity (NTU)	-	Membrane process	< 0.2	5 - 20
SDI	-		< 3	> 5
TSS (mg/L)	100 - 300		< 1	10 - 30
BOD <sub>5</sub> (mg/L)	300	Biological process	< 5	< 30
COD (mg/L)	600		< 30	< 100
NH <sub>3</sub> -N (mg/L)	30		< 0.5	5 - 10
TN (mg/L)	40		< 15	> 25
TP (mg/L)	10 - 20		< 0.5	5 - 8

**Additional Notes:**

- BOD and COD removal depends on the efficiency of the biological process.
- The removal of ammonia nitrogen can vary based on the degree of nitrification.
- The removal of TN can vary based on the degree of denitrification.
- Chemical addition (e.g. ferric chloride) may be required for TP removal.

## 3. Less sludge production, longer sludge age

MBR systems typically generate about 25% less sludge than conventional treatment systems and have a longer sludge age. This makes MBRs more environmentally friendly and also translates to cost savings in terms of lower sludge disposal frequency and volume.



02 | TECHNICAL  
SPECIFICATIONS

# POROCEP® SPECIFICATIONS

PoroCep® Membrane Specifications				
Material		HDPE		
Type		Hollow fibre		
Pore structure		Asymmetric slit pore		
Nominal pore size	µm	0.1		
Outer diameter	mm/inch	0.4 / 0.016		
Inner diameter	mm/inch	0.3 / 0.012		
Wall thickness	mm/inch	0.05 / 0.002		
Tensile strength	MPa	80		
Chlorine resistance	ppm-hrs	1,000,000		
PoroCep® Unit Box Specifications				
Dimensions: Box (L x W x H)	mm/inch	345 x 500 x 1,000 / 13.6 x 19.7 x 39.4		
Box material		PVC		
Membrane elements per box		10		
Membrane area per box	m <sup>2</sup> /ft <sup>2</sup>	85 / 915		
Permeate outlet diameter	inch	1.5		
Specific membrane area per box	m <sup>2</sup> /m <sup>3</sup>	493		
Dry weight	kg/lbs	19 / 42		
PoroCep® Skid Specifications				
Skid model		POR 101-510	POR 102-1,020	POR 103-2,340
Membrane area per skid	m <sup>2</sup> /ft <sup>2</sup>	510 / 5,490	1,020 / 10,980	2,340 / 25,189
Specific membrane tank area	m <sup>2</sup> /MLD	16 - 20	16 - 20	16 - 20
Dimensions: Skid (L x W x H)	mm/inch	1,163 x 1,050 x 1,744 / 45.8 x 41.3 x 68.7	1,163 x 1,050 x 2,748 / 45.8 x 41.3 x 108.2	2,683 x 1,050 x 3,832 / 105.6 x 41.2 x 150.9
Connection - Permeate Outlet	inch	2", Union, SW	3" Flange, ANSI B16.5, 150#	4" Flange, ANSI B16.5, 150#
Connection - Air Inlet	inch	2", Union, Female NPT	3" Flange, ANSI B16.5, 150#	3" Flange ANSI B16.5, 150#
Material - Permeate Outlet		PVC	PVC	PVC
Material - Air Inlet		SS304	PVC	PVC
Dry weight	kg/lbs	260 / 572	450 / 990	1,284 / 2,825
No. of unit boxes per skid		6	12	36
Unit boxes arrangement		Single deck	Double deck	Triple deck
Skid frame material		SS304		



## OPERATING, FEED AND PERMEATE PARAMETERS

Typical Operating Parameters	
Flow type	Outside-in
Filtration duration (min)	7 - 10
Relaxation duration (min)	1 - 3
Operating temperature (°C)	5 - 40
Operating pH range	6 - 8
Cleaning pH range	2 - 13
Operating TMP (bar)	0.1 - 0.5
Specific air demand (Nm <sup>3</sup> /m <sup>2</sup> -hr)	0.15
Maintenance cleaning frequency (day)	5 - 15
Maintenance cleaning duration (hour)	1 - 3
NaOCl dosage for maintenance cleaning (mg/L)	500
Recovery cleaning (by NaOCl) frequency (day)	90 - 180
NaOCl dosage for recovery cleaning by NaOCl (mg/L)	2,000 - 4,000
Recovery cleaning (by citric acid) frequency (day)	180 - 360
Citric acid dosage for recovery cleaning by citric acid (%)	1 - 2
Recovery cleaning duration (hour)	3 - 5

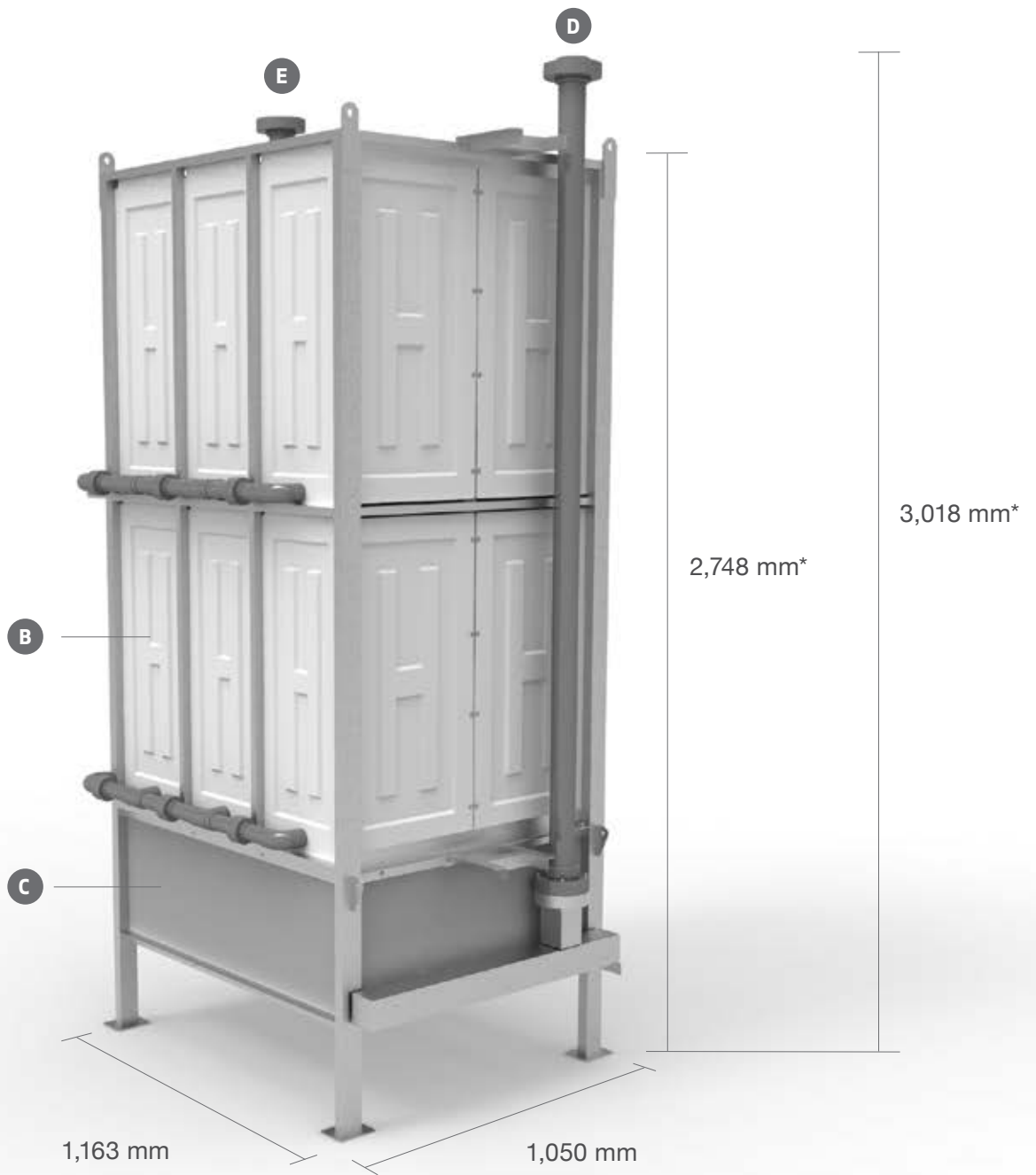
MBR Tank Feed Water Requirements	
MLSS in membrane tank (mg/L)	< 12,000
Temperature (°C)	< 40
Animal or vegetable oil/fat (mg/L)	< 50
Mineral oil and/or grease (mg/L)	< 3

**Additional Notes:**

- Silicon-based anti-foaming agents should not be used for foam control in an MBR system.
- The feed to the membrane tank should be filtered with a 0.5 - 1 mm screen.

Typical Permeate Quality	
Turbidity (NTU)	< 0.2
TSS (mg/L)	< 1
SDI	< 3

# POROCEP® SKIDS

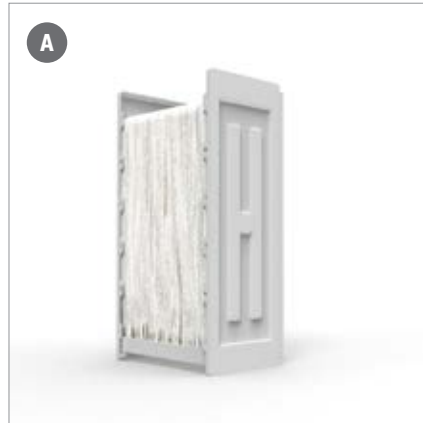


Item	Description
A	Membrane element
B	Unit box
C	Air diffusing module
D	Air inlet port
E	Permeate outlet port

*\*Measurements given are for a double deck skid*

# POROCEP® SKIDS

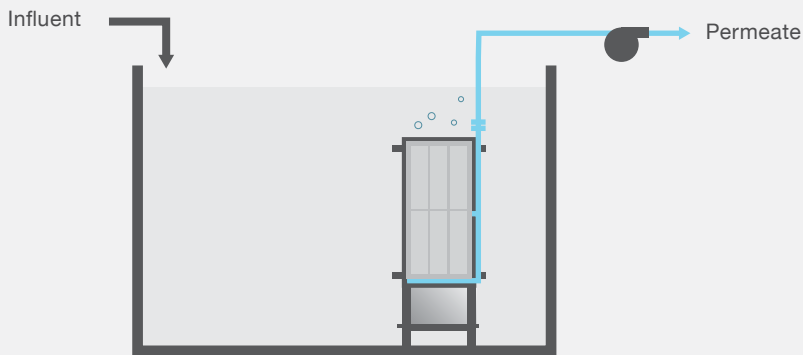
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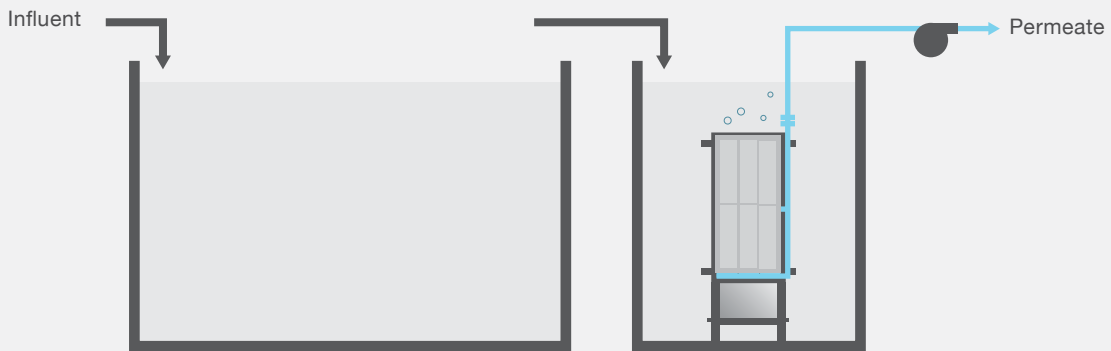
# BASIC CONFIGURATION

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Porocep® can be used in either internal submergence or external submergence mode. This means that the user can either choose to have the membrane skid placed inside the bioreactor tanks (internal submergence) or in a separate membrane tank which is isolated from the main bioreactor system (external submergence) depending on the needs of the situation.

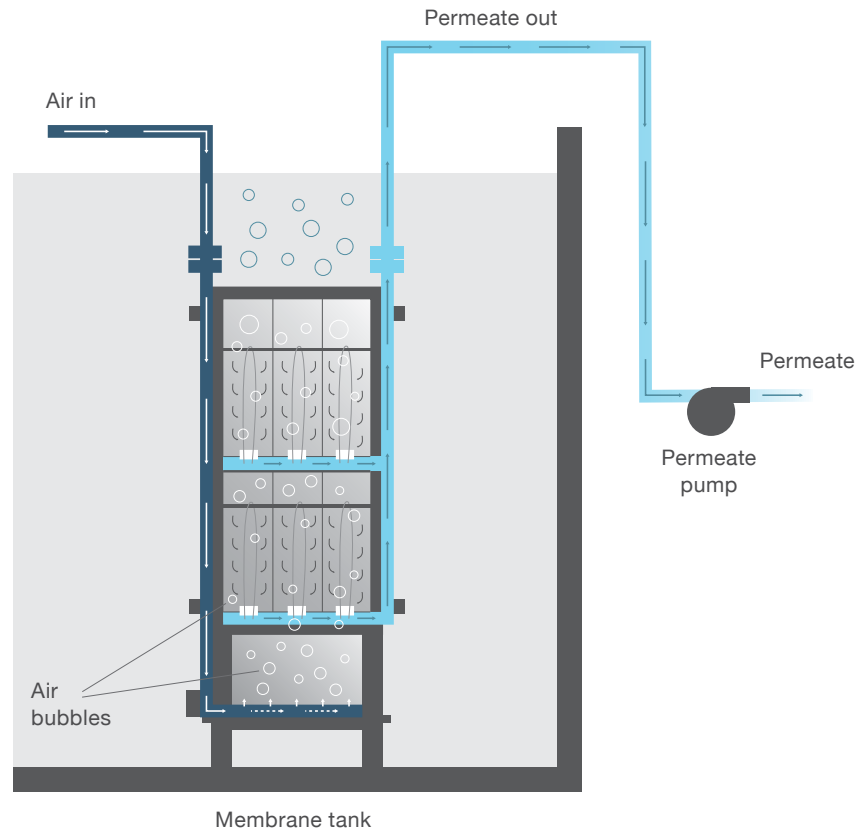


Internal submergence

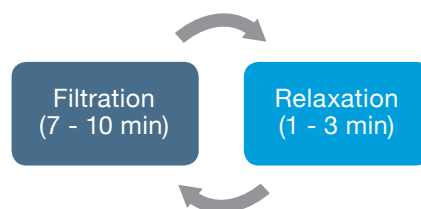


External submergence

## FILTRATION PROCESS



PoroCep® membranes housed in a skid are immersed inside the membrane tank of an MBR system, in direct contact with the mixed liquor. The membranes are operated in a continuous cycle in which filtration and relaxation alternate. During filtration, a vacuum is applied through the use of a permeate pump to draw permeate through the hollow fibre membranes. The effluent produced is of a consistent, high quality that meets stringent requirements. Filtration typically lasts nine minutes and is followed by relaxation of one minute. During relaxation, filtration stops and the membranes are allowed to “rest”.

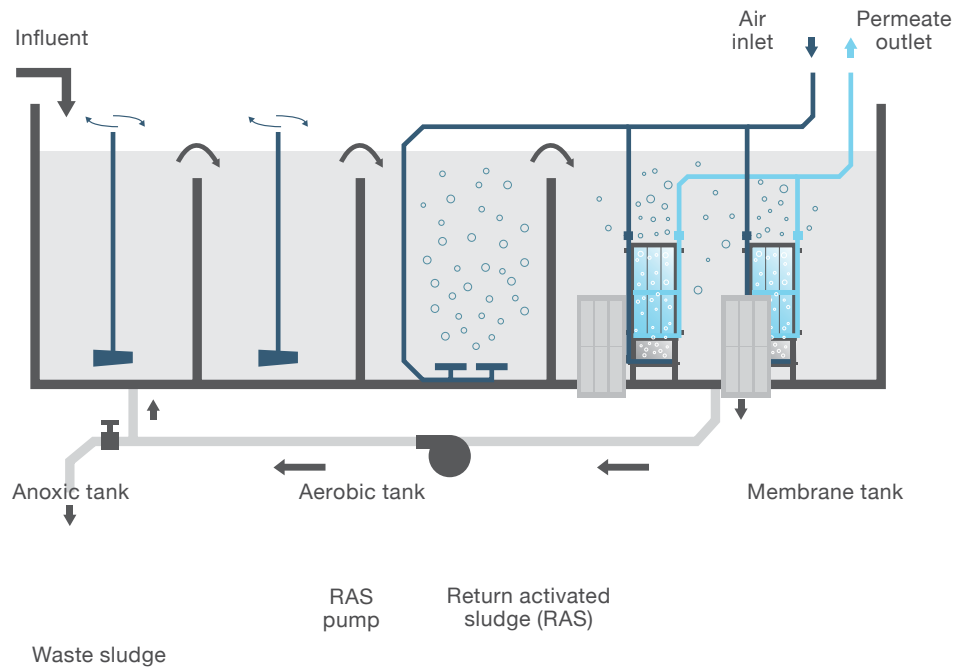


Typical operation cycle for PoroCep® membranes

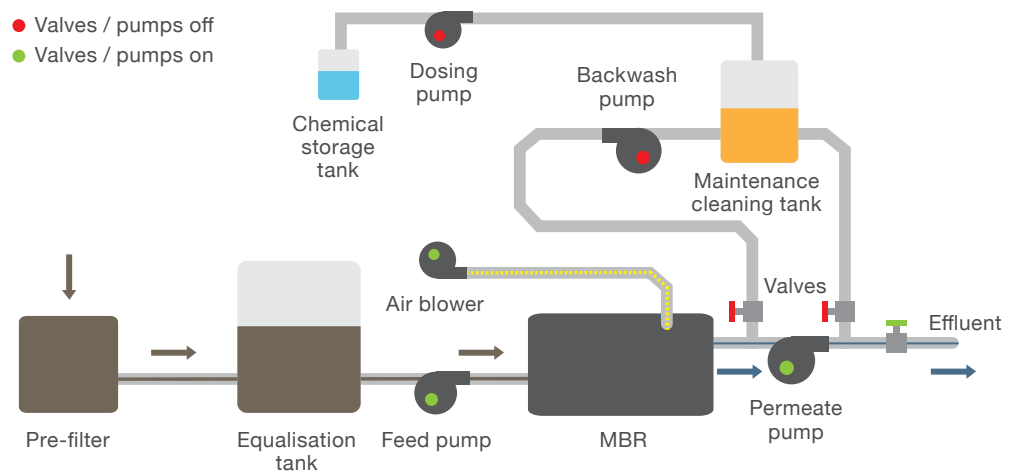
The air diffusing module at the bottom of the skid introduces a constant airflow to the membranes, producing a turbulence that scours the external surface of the hollow fibres to prevent foulants from building up.

# BASIC CONFIGURATION

The PoroCep® MBR process combines biological treatment with membrane filtration technology that uses PoroCep® hollow fibre membranes to filter out suspended solids including harmful microorganisms such as viruses, bacteria and cysts.



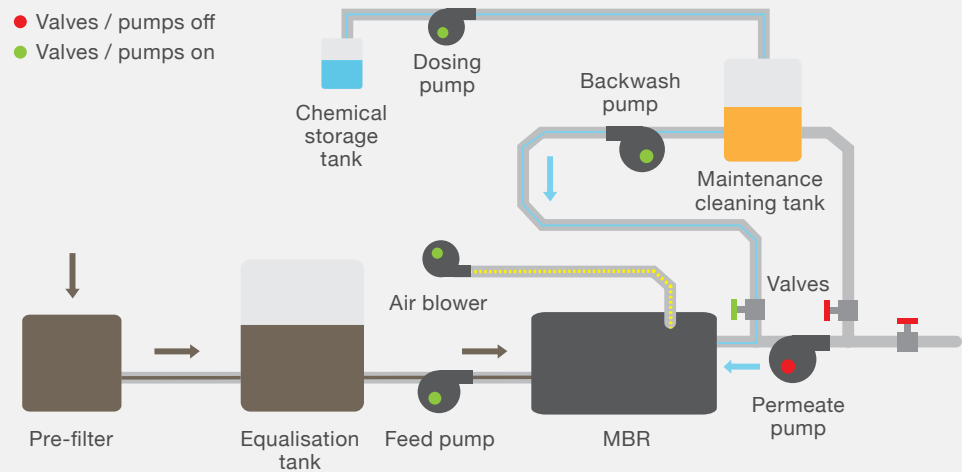
The schematic below shows an example of a typical MBR system including the pre-filtration, equalisation and clean-in-place (CIP) system during operation.



Schematic diagram for filtration

## BASIC CONFIGURATION

While air scouring in conjunction with relaxation removes contaminants accumulated on the surface of the membranes, maintenance cleaning (MC) and recovery cleaning (RC) using chemicals may still be required after extended periods of operation to maintain membrane permeability. During such cleaning, cleaning chemicals are added to the permeate which is then back flushed through the membranes.



Schematic diagram for chemical cleaning

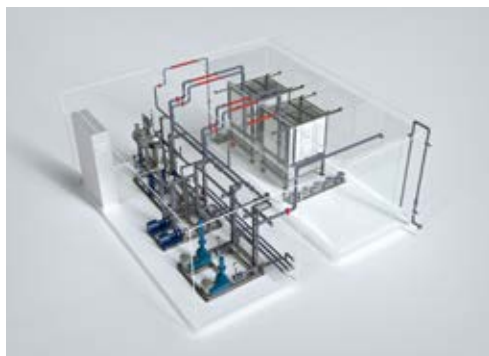


03 | POROCEP®  
MBR PACKAGED  
SYSTEMS



# POROCEP® MBR PACKAGED MBR SYSTEMS

## INTRODUCTION



Hyflux's PoroCep® Packaged MBR Systems simplify the end-user experience by providing innovatively designed, ready-to-install skid-based systems or containerized systems. These systems are resilient to flow and loading fluctuations and ideal for both municipal, industrial wastewater treatment and recycling applications for industries and small communities.

Also available in containerised versions, the smaller systems are portable and suits situations where temporary wastewater treatment systems are required such as pilot testing, wastewater treatment at temporary work sites, small-scale industrial facilities, disaster areas and rural settlements.

### Applications

- Residential and Commercial Developments
- Food & Beverage
- Textile
- Petrochemical
- Leachate
- Sports and Recreational Facilities
- Defence and Military
- Healthcare Institutions
- Educational Campuses
- Vessels and Cruises
- Camp Sites and Parks
- Disaster Relief

### Standard and customised configurations

The standard PoroCep® Packaged MBR Systems feature Anoxic-Aerobic systems with customisation options to suit more complex feed water requirements and discharge criteria.

Some of the other process configurations that can be supplied include:

- Anaerobic-Anoxic-Aerobic systems
- Anoxic-Aerobic-Anoxic-Aerobic systems

*\*All images are for illustration only. Design of the system is subjected to change based on feed water conditions.*

*\*All 40 feet containers are high-cube containers. \*All membrane containers are open top containers.*

*\*Ladders, platforms, electrical cabling, all building, civil and construction related (concrete/decanter tanks, exhaust fans, sprinkler, flooring/plinth, etc.), interconnecting pipes, RAS pipes etc. may be depicted in the pictures for illustration purposes but are excluded by Hyflux's scope of supply.*

*\*Manpower for supervised installation and commissioning can be provided by Hyflux at our quoted man-hours and rates upon request.*

*\*Client's scope to handle own installation, provide a level floor based on stated footprint and site layout for Hyflux engineering team to optimize system(s) and space planning.*

# POROCEP® MBR PACKAGED MBR SYSTEMS

## FEATURES & BENEFITS

### System Features

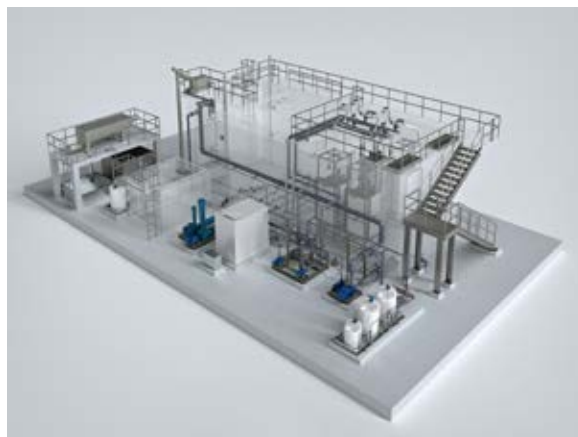
- Pre-engineered, plug-and-play systems
- Modular and scalable
- Extremely compact design
- Energy efficient
- High quality system components

### Benefits

- Outstanding performance, comply to regulatory wastewater discharge standards
- Lower capital costs
- Easy to install
- Designed and built for minimal maintenance
- Consistent, excellent permeate quality
- Efficient, reliable operation with minimum downtime
- Low chemical usage
- Portable and re-usable
- Fast delivery

### Options and Add Ons

- Pre and post treatment options for challenging feed water conditions
- SuperBiotiX® microbes for improved biological stability
- Enhanced Performance Program (EPP)
- Remote Assistance Monitoring (RAM)



PoroCep® MBR Packaged Systems are available in seven models and capacities:

Model	Treatment Capacity* (m <sup>3</sup> /day)	No. of Decks	Configuration
MPO-100	100	Single	Choice of Skid-mounted or Containerised
MPO-200	200		
MPO-400	400		
MPO-600	600	Double	Skid-mounted
MPO-1000	1,000		
MPO-2000	2,000		
MPO-3000	3,000		

*\*Dependent on feed water quality*

For more information, please refer to the PoroCep® MBR Packaged Systems Brochure.

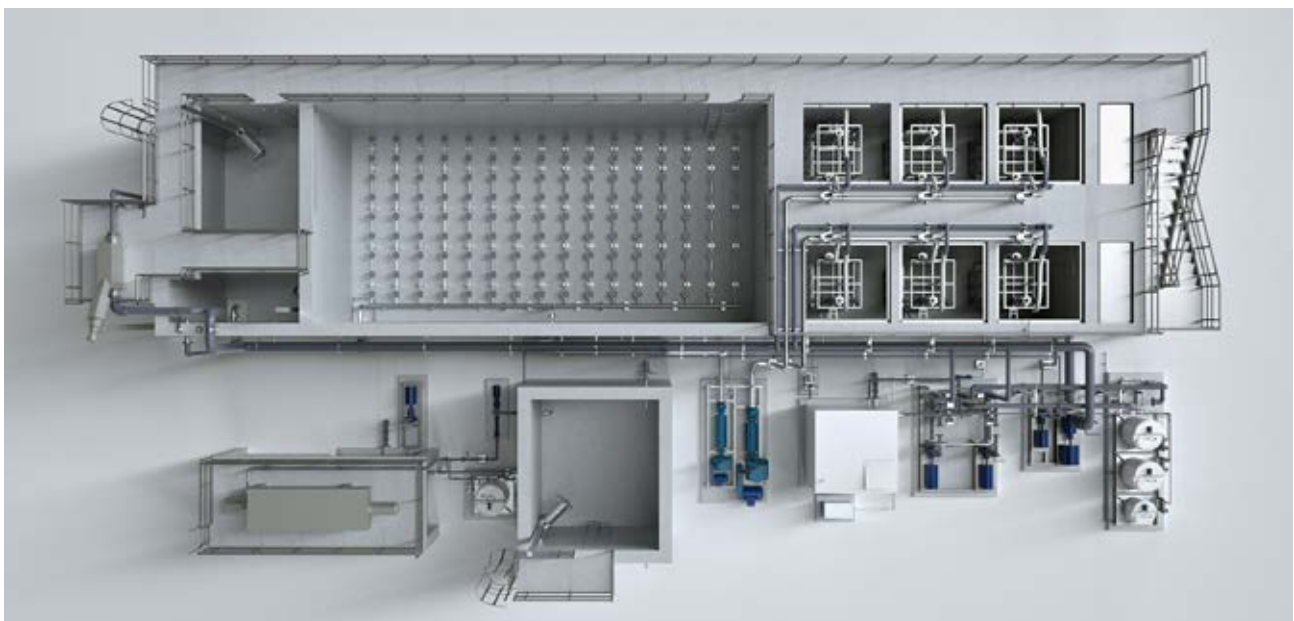
## POROCEP® MBR PACKAGED MBR SYSTEMS

### STANDARD EQUIPMENT LIST

Delivering a standard full system package, Hyflux's PoroCep® MBR Packaged Systems provide comprehensive, pre-designed, ready-to-install systems within standard-sized containers or skids, simplifying end-user's experience. The standard equipment provided in the systems:

✓✓Included   ✓Optional   ✗Excluded

Items	MPO 100-400	MPO 600-3000
Feed Pump	✓	✓
Anoxic Tank Mixing	✓✓	✓✓
Diffuser Aeration System	✓✓	✓✓
Membrane Skids and Assembly	✓✓	✓✓
Process and Membrane Blowers	✓✓	✓✓
Permeate, WAS and RAS Pumps	✓✓	✓✓
DO, Flow and Pressure Instrumentations	✓✓	✓✓
Interconnecting Pipes, Valves and Associated Level and Controls	✓✓	✓✓
Maintenance and Recovery Cleaning Tanks and Pumps	✓✓	✓✓
Tanks (Anoxic-Oxic-MBR)	✓✓	✗
Screen and Screening Containers	✓	✓
Instrumentation	✓	✓
Enhanced Performance Program (EPP)	✓	✓
Remote Assistance Program (RAM)	✓	✓
Air-Conditioning Unit	✓	✓
Sludge Dewatering System	✓	✓



MPO 600 top view

## HEADQUARTERS

Hyflux Ltd  
Hyflux Innovation Centre  
80 Bendemeer Road  
Singapore 339949

Tel: +65 6214 0777  
Fax: +65 6214 1211

[sales@hyfluxmembranes.com](mailto:sales@hyfluxmembranes.com)  
[www.hyfluxmembranes.com](http://www.hyfluxmembranes.com)

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