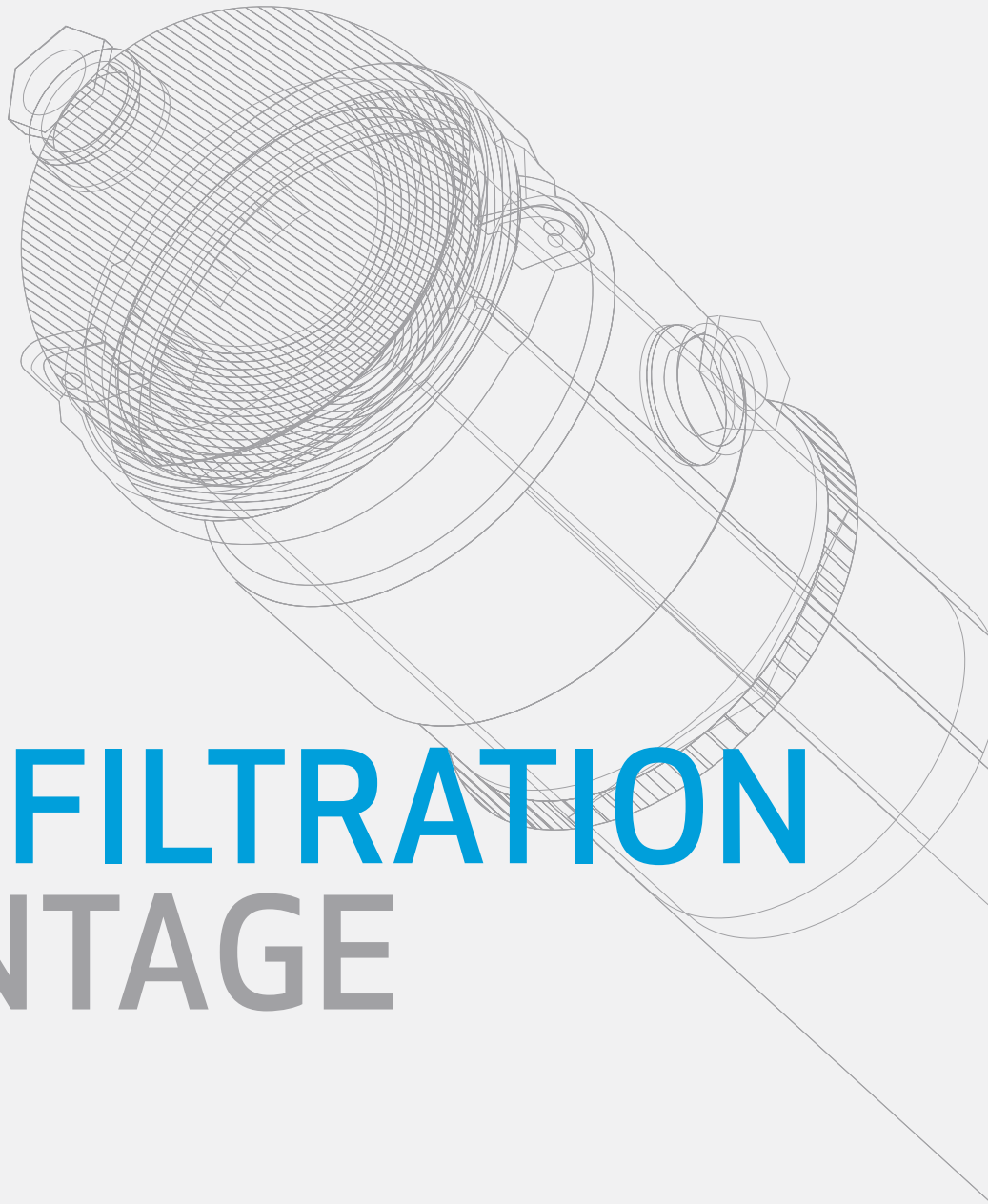


KRISTAL®

THE ULTRAFILTRATION ADVANTAGE

Hyflux®

ENGINEERED FOR CONSISTENT, HIGH WATER QUALITY.

When it comes to filtration, Hyflux's Kristal® polymeric hollow fibre ultrafiltration membranes and systems offer a superior level of performance, efficiency and reliability. Designed with **cross-flow** and **outside-in** configuration, Kristal® membranes deliver consistent, high quality product water even in challenging feed water conditions.

Product Features and Benefits

- Reinforced PES material
- Asymmetric membrane structure
- Improved hydrophilicity
- Consistent, high quality permeate

Operation Features and Benefits

- Sharp rejection profile
- Long lifespan
- Small footprint
- Automatic backwash function

Key Applications

- Pre-treatment filtration
- Water treatment/purification
- Wastewater recycling
- Industrial process/waste fluid treatment

KRISTAL® APPLICATIONS

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

Water Treatment/Purification

- Production of potable water from reservoirs, rivers, ground water.
- Water purification for hotels, resorts, spas, condominiums.
- Mobile water purification systems.

Pre-treatment Filtration

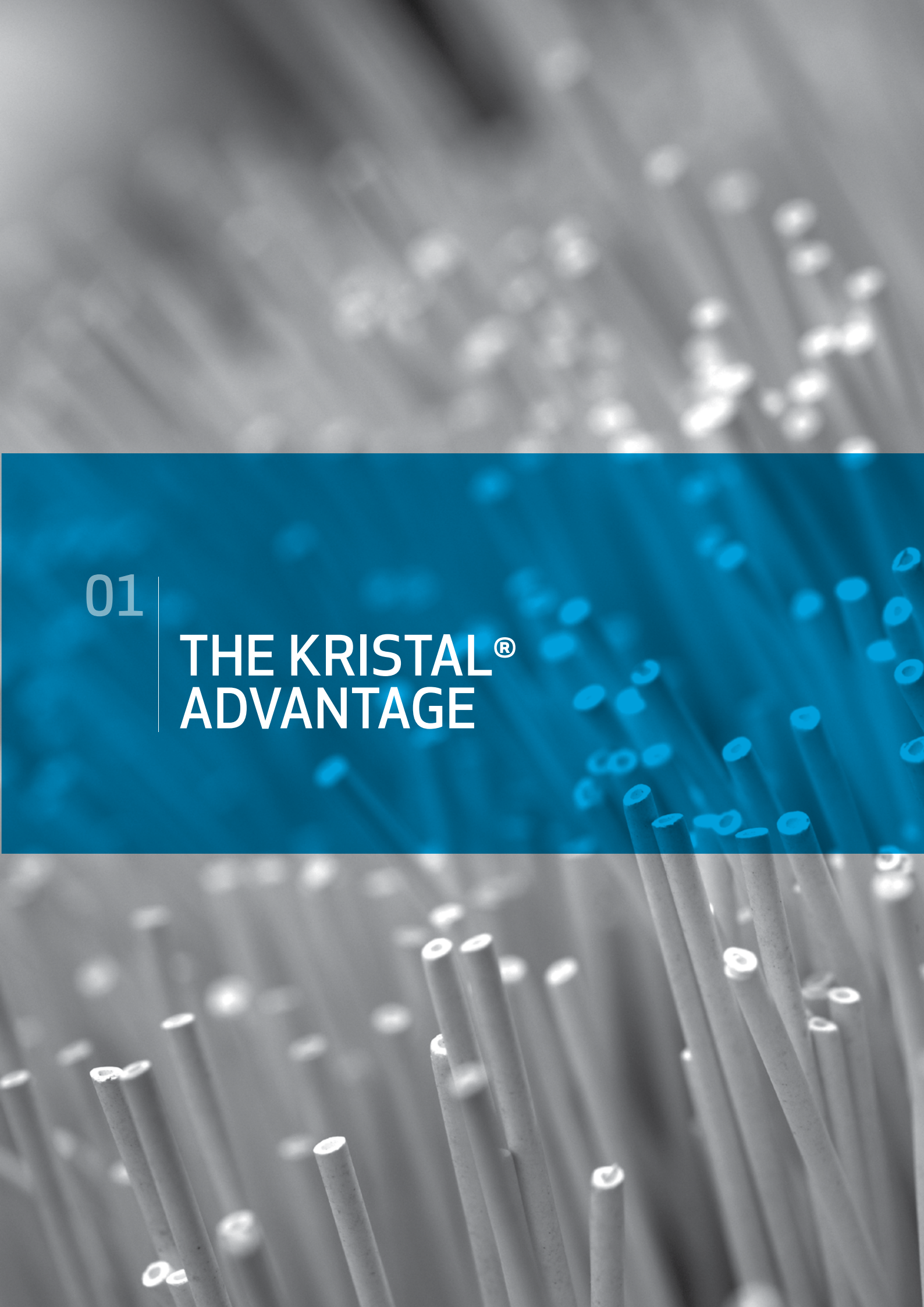
- Seawater desalination reverse osmosis (RO) pre-treatment.
- Pre-treatment option before RO or ion-exchange system in production of ultrapure water for power plant, semiconductor and pharmaceutical industries.

Wastewater Recycling

- Municipal wastewater reclamation.
- Wastewater recycling for semiconductor, pulp and paper, textile and dye, and agricultural processes.

Industrial Process/Waste Fluid Treatment

- Treatment of various aqua-based industrial waste streams.
- Recovery of valuable resources from industrial waste streams.
- Regeneration of useful process streams by selective removal of contaminants.



01

THE KRISTAL® ADVANTAGE

THE KRISTAL® ADVANTAGE

Kristal® has been employed in more than 1,300 installations worldwide, from the largest desalination plants to small and medium-sized water treatment facilities across some 400 locations in Asia, Europe, the Middle East, North Africa and other parts of the world.

Developed, tested and fabricated in Singapore, Kristal® polymeric ultrafiltration (UF) hollow fibre membrane has been one of Hyflux's main product lines since its launch in 1999. Hyflux's technological innovations have taken Kristal® ultrafiltration technology to the next level. Today, Kristal® membranes are used in a wide range of applications in water treatment and wastewater recycling.

The development of the Kristal® series has benefited from Hyflux's combined knowledge and experience as a membrane maker, system designer, user and plant operator.

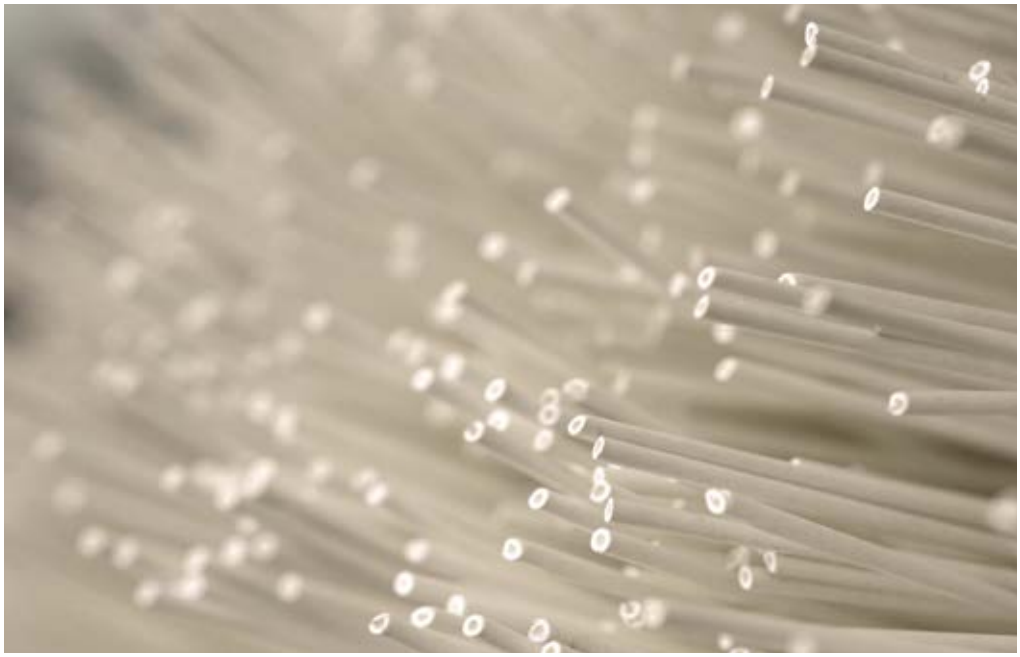
Kristal® membranes have been employed in more than 1,300 installations worldwide, from the largest desalination plants to small and medium-sized water treatment facilities across some 400 locations in Asia, Europe, the Middle East, North Africa and other parts of the world. In fact, the membranes are used in over 40% of seawater reverse osmosis (SWRO) desalination pre-treatment systems worldwide, including some of the world's largest SWRO desalination plants.

This is a key testament to the effectiveness and quality of Hyflux's Kristal® membranes, and its widespread use on a global scale. Industries and communities can draw on Hyflux's expertise in the operation and maintenance of Kristal® membranes and the integration of different water technologies, to improve the efficiency and performance of water and wastewater applications.

THE KRISTAL® ADVANTAGE

REINFORCED POLYETHERSULFONE MATERIAL

Superior fibre strength from reinforced Polyethersulfone [PES] Membrane Material



As a result of Hyflux's continuous efforts in research and development, the new Kristal® ultrafiltration membranes that now makes use of the reinforced PES fibres have achieved higher levels of tensile strength and better membrane performance.

The high grade PES material selected for the Kristal® ultrafiltration membrane is further reinforced to achieve superior fibre strength. It can withstand harsh chemical conditions and at the same time promises better hydrophilicity for better filtration flux.

Combined with the upgrades in design that embodies stability and efficiency improvements, Kristal® ultrafiltration membrane is set to be at the forefront in the market for superior performance.

THE KRISTAL® ADVANTAGE

SUPERIOR HYDROPHILICITY, LOW FOULING

Membrane material, surface properties and structural make-up are crucial to any membrane's performance.
PES membranes has a high level of hydrophilicity that helps reduce fouling rate. Coupled with Hyflux's proprietary technology, the PES used in the Kristal® membranes is further enhanced to boost even higher hydrophilicity level.

The result is high flux rates, low fouling tendencies and enhanced chemical resistance that requires less frequent chemical cleaning.

ASYMMETRIC MEMBRANE STRUCTURE

Scanning Electron Microscope (SEM)

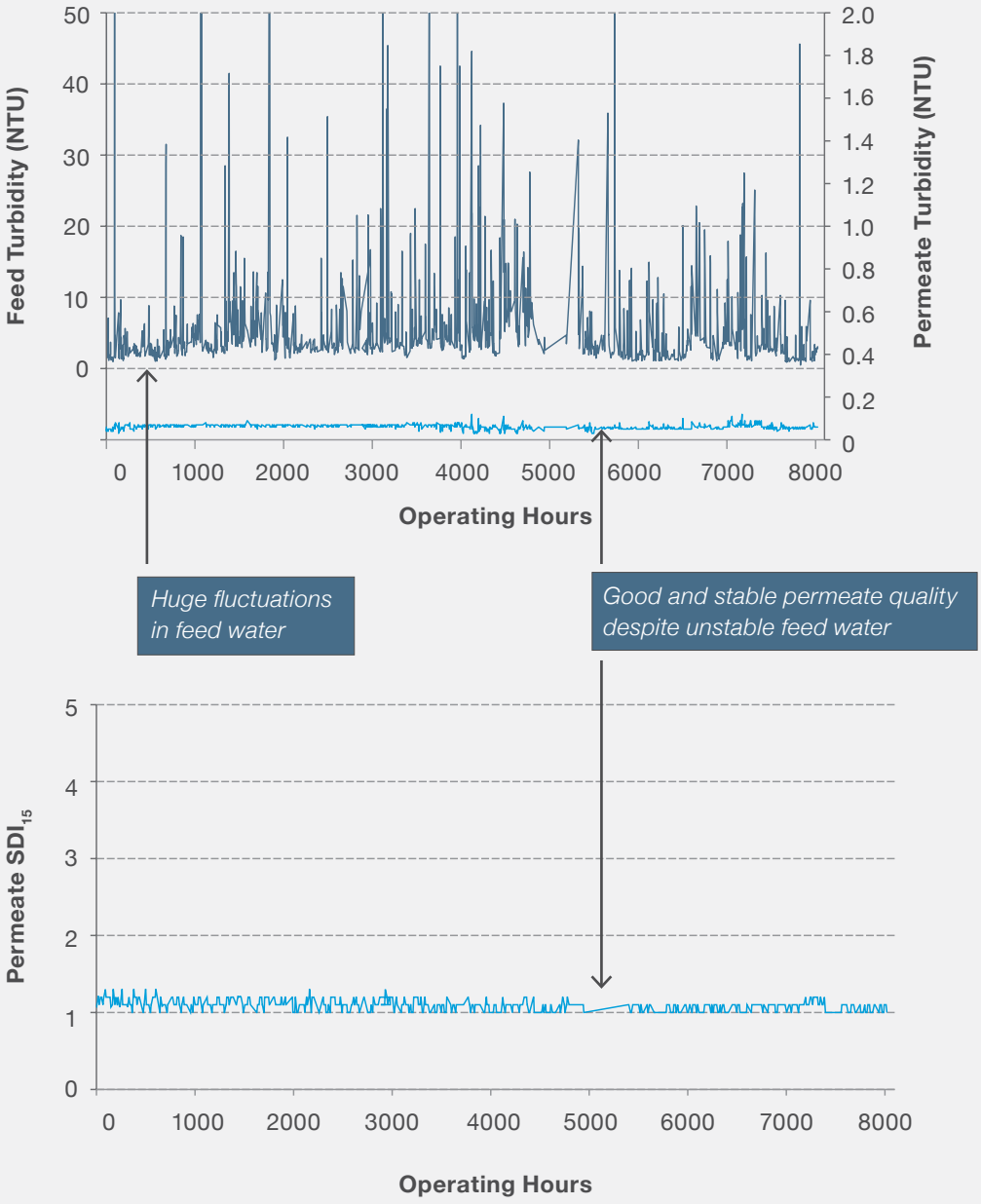
The asymmetric structure of the Kristal® membrane allows for more efficient cleaning and smooth filtrate flow. This in turn enhances overall performance and flux rates.

THE KRISTAL® ADVANTAGE

CONSISTENT, HIGH QUALITY PERMEATE

One of the key strengths of the Kristal® membrane is its proven ability to produce **high quality permeate regardless of fluctuations in feed water.**

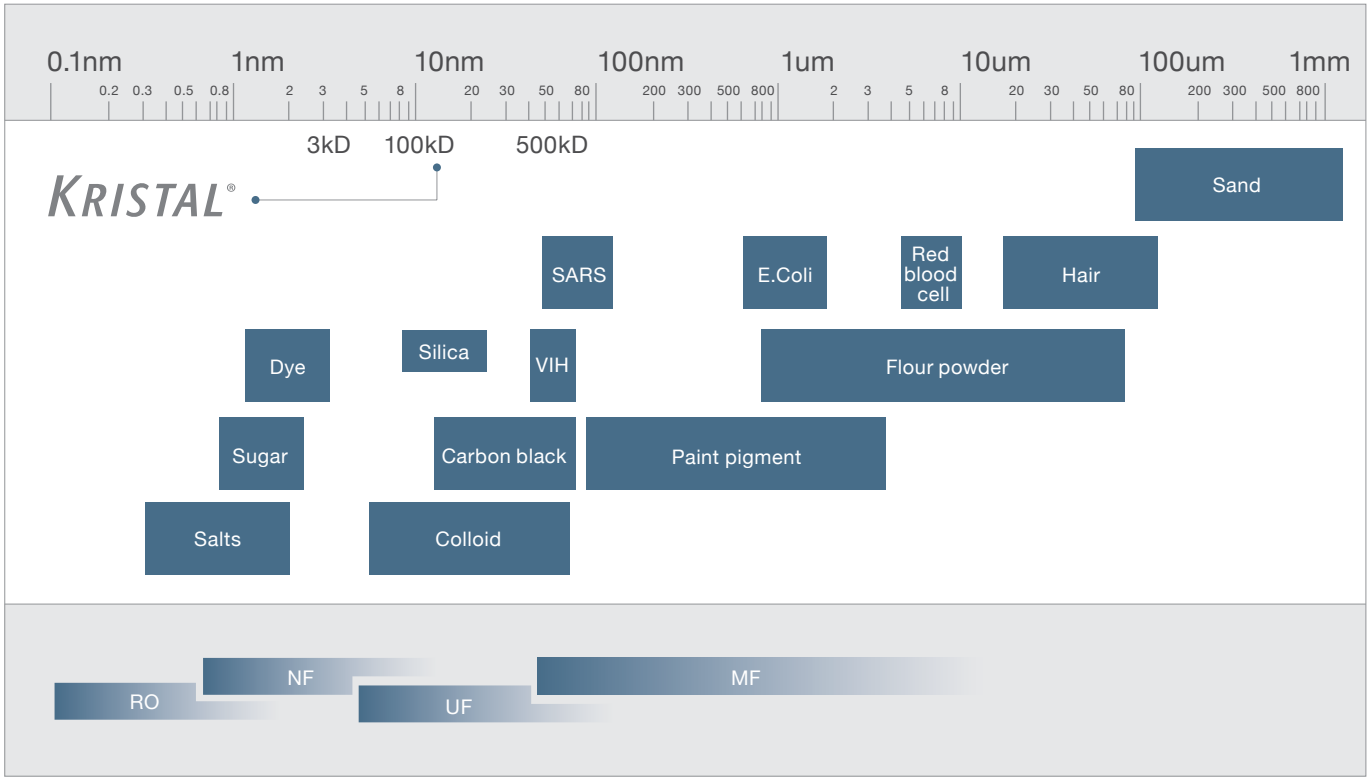
The following graphs illustrate the permeate's turbidity and silt density index (SDI) levels of a desalination plant using Kristal® for RO pre-treatment over a year's operation.



THE KRISTAL® ADVANTAGE

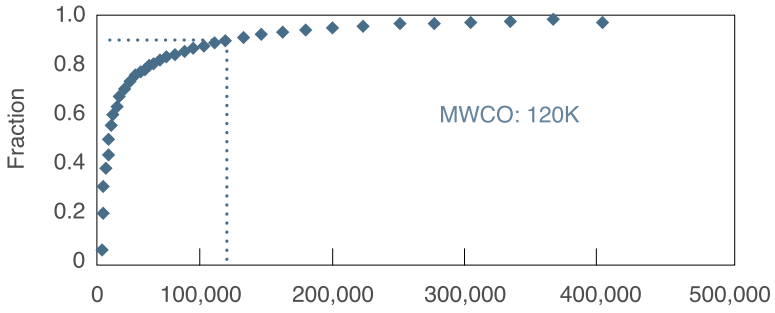
SMALL PORE SIZE AND SHARP REJECTION PROFILE

Kristal® membranes operate on the lower scale of the ultrafiltration spectrum. The consistent, high quality permeate is made possible by Kristal®'s small pore size and sharp rejection profile.



Membrane separation spectrum

Molecular weight cut-off for Kristal® 600ETI-55



Rejection profiles for Kristal® membranes

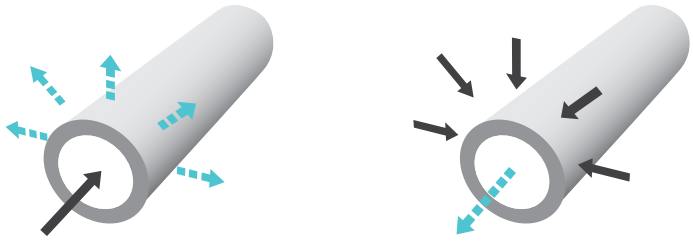
THE KRISTAL® ADVANTAGE

OUTSIDE-IN FLOW MODE

Kristal® membranes operate in an outside-in flow mode. In contrast to inside-out membranes, outside-in membranes tend to be more tolerant towards fouling, minimising the impact on the performance and overall permeate production of the membranes.

Furthermore, the **outside-in flow mode allows for more effective removal of foulants** during backwash with air scouring and chemical cleaning, and prevents the irreversible choking of membrane fibres during surges in feed water quality.

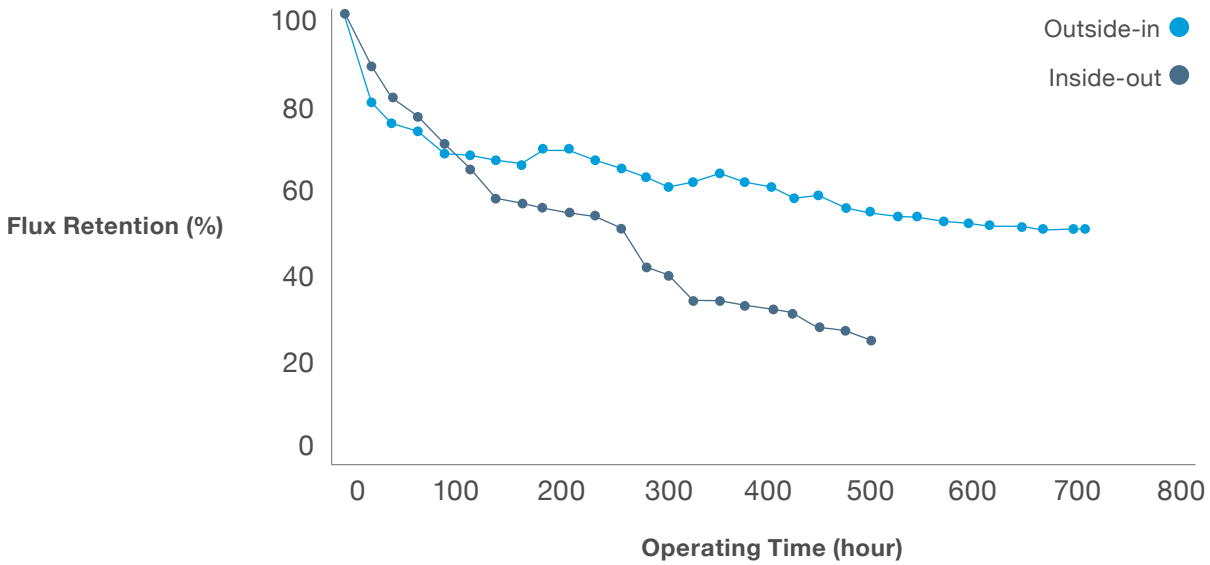
This makes Kristal® membranes suitable even for feed waters with high solids loading such as seawater, river water and treated waste streams.



Inside-out flow mode | Outside-in flow mode

Cross-sectional drawings of inside-out versus outside-in flow of a hollow fibre membranes.

Inside-out membranes tend to have a more dramatic drop in flux retention over time. In the graph below, over an operating time of approximately 500 hours, outside-in membranes' flux retention rates is almost 30% higher than inside-out membranes.



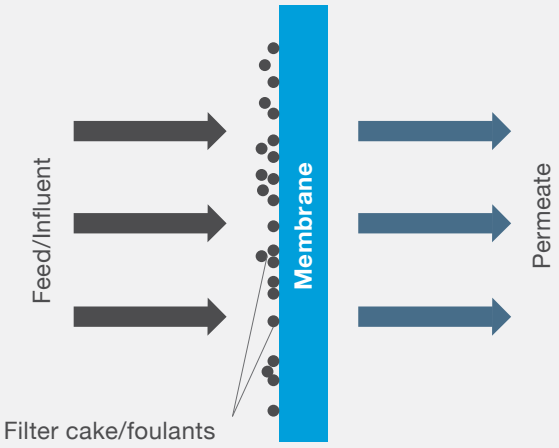
Flux performance graph of outside-in vs inside-out membranes

THE KRISTAL® ADVANTAGE

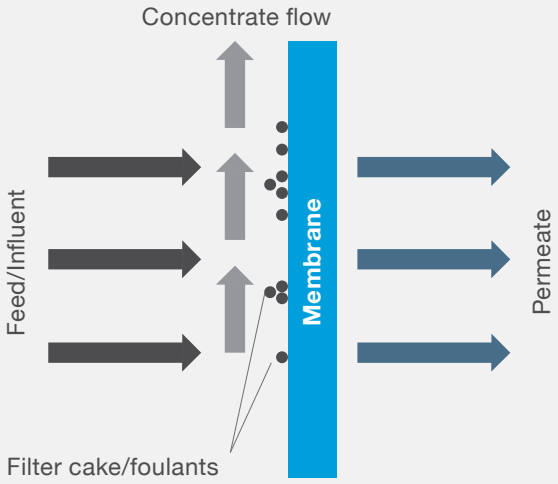
VERSATILE FLOW DESIGN

Kristal® membranes are typically operated in cross-flow recirculation mode. However, the versatility of the Kristal® design allows it to run in other modes of operation as well, including dead-end and bleed, depending on the feed water quality.

Cross-flow operation lets the recirculation/concentrate stream create a shear force along the surface of the membrane. This prevents the accumulation of solids on the surface. Slower fouling rates will in turn reduce operational costs and downtime required for cleaning purposes. In instances of very poor feed water quality, bleeding may be employed in place of recirculation to prevent the buildup of solids in the UF feed tank.

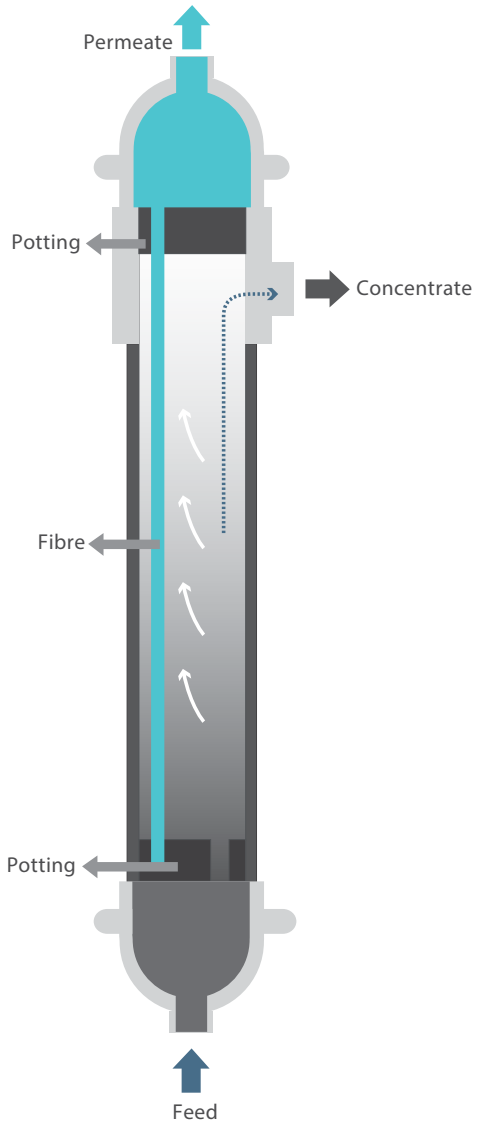


Dead-end filtration



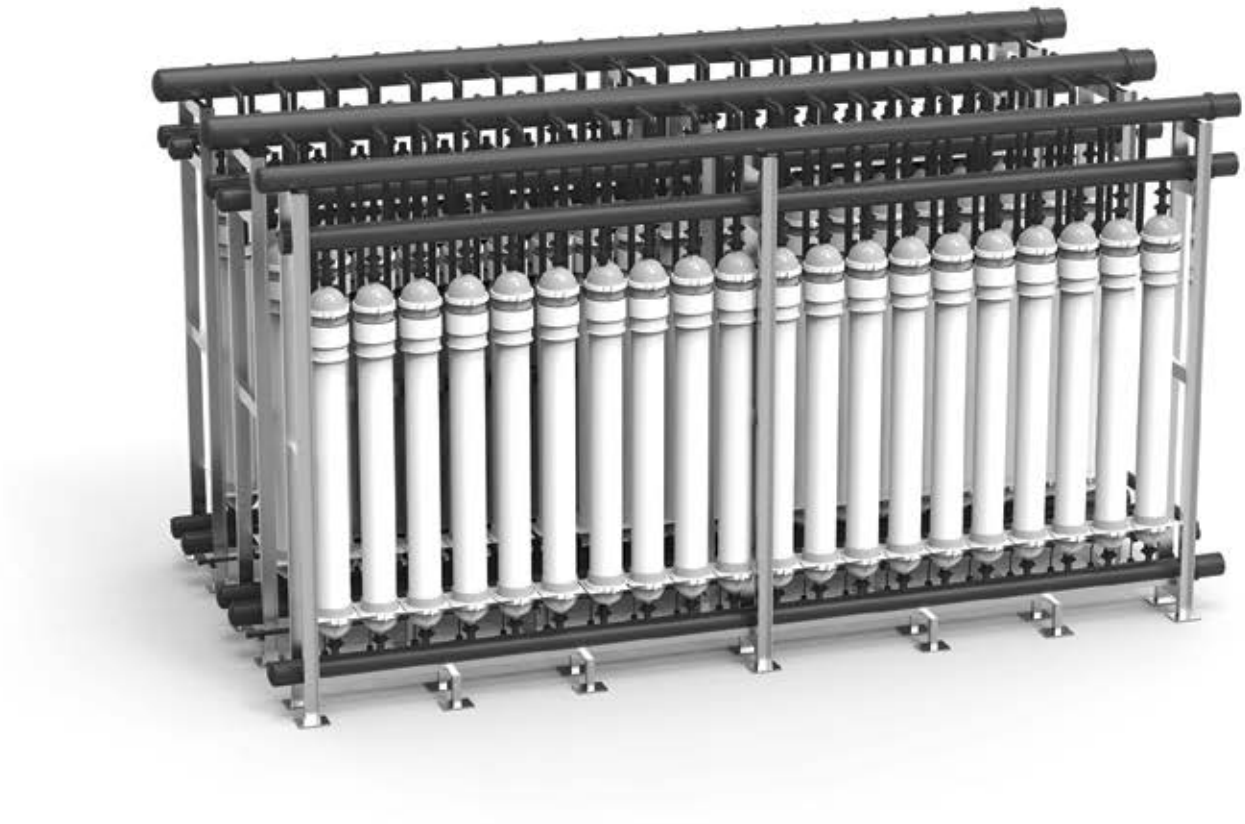
Cross-flow filtration

KRISTAL® FILTRATION PROCESS



The Kristal® module operates in a pressurised mode to drive filtration through the membrane fibres. Feed water enters the bottom of the module, and the filtered water is channelled through the top permeate line into a collection tank. A concentrate port allows for recirculation or discharge of the feed.

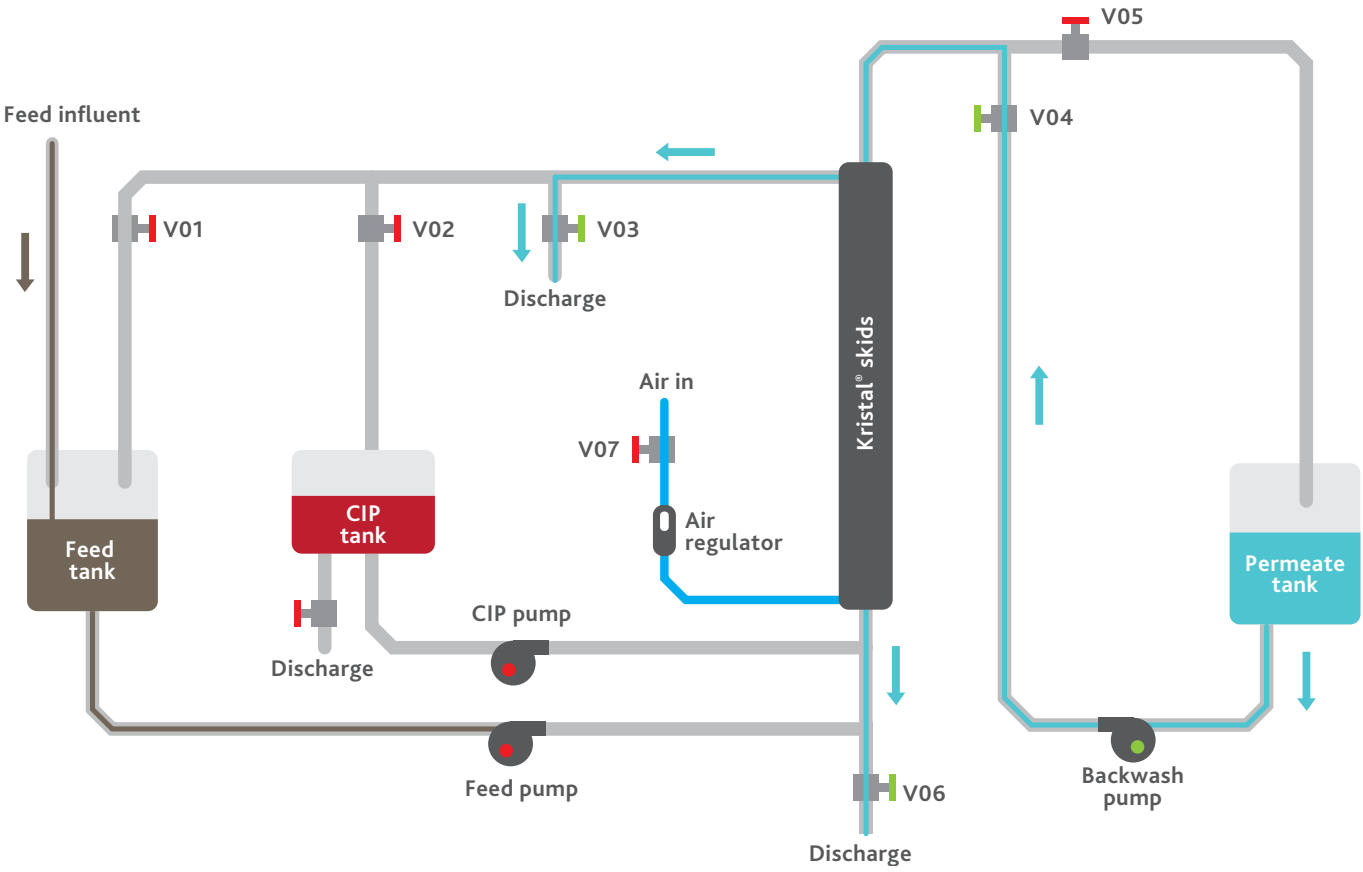
BASIC CONFIGURATION



Kristal® modules are commonly arranged in parallel rows and connected through headers to form a train. The entire train is operated, backwashed, cleaned and integrity tested as a single entity. Kristal® modules can be installed in trains of varying sizes to cater to different plant capacities.

Before entering the Kristal® UF system, the intake water is pumped through a set of screen filters to remove any debris and large objects. The water is then circulated in the UF membrane system. This filtered water is stored temporarily in a collection tank and can be directly used or sent for further treatment, such as nanofiltration or reverse osmosis.

BACKWASH & CLEAN-IN-PLACE



In a Kristal® UF system, backwashing is a necessary part of normal operation to maintain membrane permeability. Backwashing uses a reverse flow of clean water to 'unplug' the solids accumulated on the membrane surface during filtration. Air scouring is performed concurrently to provide extra mechanical force and enhance the effectiveness of the backwash.

Backwashing is usually carried out after every 30 to 40 minutes of operation.

While backwashing can remove most contaminants from the membrane, periodic chemical cleaning is necessary to remove stubborn foulants that are not easily displaced by physical methods. This cleaning-in-place (CIP) involves the use of both alkaline and acid solutions.

CIP is considered a part of a membrane maintenance routine and is performed after about 120 hours of operation. CIP is also recommended every time the Kristal® module shows evidence of fouling.

THIRD PARTY CERTIFICATION

Users of Kristal® membranes can be assured of the commitment of Hyflux to the quality of its products which have received certification from international organisations, government agencies as well as consultants.

Kristal® membranes are manufactured according to ISO standards and undergo independent testing by NSF International, a widely respected and recognised global third-party testing and certification organisation.

Kristal® is the first UF membrane to achieve certification to the NSF Public Drinking Water Equipment Performance Certification Programme, which tests and certifies the performance of water treatment products. Kristal® has been certified to effectively remove cryptosporidium in drinking water.

In addition, Kristal® is certified to the NSF/ANSI Standard 61 Drinking Water System Components - Health Effects.

NSF certification

ISO certification

Chinese Ministry of Health certificate for drinking water applications in China

Fichtner Consulting certificate

REFERENCES

Through the years, Hyflux has established its dominance in the UF membrane market, particularly in the SWRO pre-treatment segment where it is acknowledged as a market leader.

While recognised internationally for its role in large-scale municipal water projects, Hyflux has also demonstrated its experience in customising water treatment plants of varying sizes for industries such as cement, electronics, petrochemical, semiconductor, steel, textile as well as the production of boiler water for power plants. The following table shows a selection of projects that has benefited from Kristal®.

Industry / Application	Source Water	Country	UF Capacity (m^3/d)	Contract Year
Fertiliser	Chemical Effluent	India	4,800	2016
Textiles	Textile Effluent	India	2,000	2015
Brewery	Brewery Effluent	India	650	2015
Power	Surface Water	China	38,400	2014
Food and Beverage	Brackish Water	Brazil	3,000	2014
Hospitality	Bore Well Water	Myanmar	1,536	2014
Power	Ground Water	Kazakhstan	2,880	2013
Automobile	Surface Water	China	3,600	2013
Chemicals	Sea Water	Indonesia	9,600	2013
Power	Treated Wastewater	China	26,400	2012
Power	Sea Water	Turkey	9,600	2012
Glass	River Water	Russia	1,800	2012
Pharmaceutical	Pharmaceutical Effluent	India	840	2012
Chemicals	Ground Water	China	11,040	2012
Municipal	Sea Water	Singapore	819,000	2011
Chemicals	Treated Wastewater	China	32,400	2011
Metals	Surface Water	China	4,800	2011
Textiles	Textile Effluent	India	10,000	2010
Electronics	Running Water	China	9,360	2010
Oil Refinery	Sea Water	Indonesia	2,400	2009
Municipal	Sea Water	Algeria	1,114,000	2008

CASE STUDIES

SEAWATER DESALINATION TO PRODUCE POTABLE WATER

Hyflux's Kristal® membranes act as an effective barrier to suspended solids and microorganisms, thereby enhancing the performance and extending the lifespan of the RO membrane system downstream.

Location:
Tuas, Singapore

UF Capacity:
Approximately 819,000m^3/day

Commissioned In:
2013

Background

Singapore is a small city state with limited water resources and land to collect and store rainwater. In response to these water challenges, the national water agency PUB has developed a diversified and robust water supply through the Four National Taps (local catchment water, imported water, NEWater and desalinated water). Singapore's second and largest seawater reverse osmosis desalination plant Tuaspring Desalination Plant was planned in 2010.

Hyflux won an international tender to develop a 318,500 m^3/day SWRO desalination plant on a design-build-own-operate model with a 25-year concession to operate and maintain the plant. With a UF capacity of 819,000 m^3/day, the Tuaspring Desalination Plant has one of the largest UF pre-treatment systems for seawater desalination in the world.

Due to the high levels of suspended solids and microorganisms in the feed water, one of the key challenges was to design a cost-efficient and reliable pre-treatment system that would optimise the performance of the RO membranes and prolong the membranes' lifespan.

CASE STUDIES

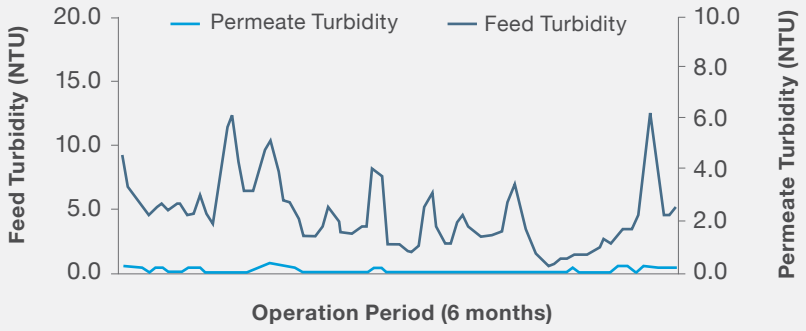
SEAWATER DESALINATION TO PRODUCE POTABLE WATER

Solution

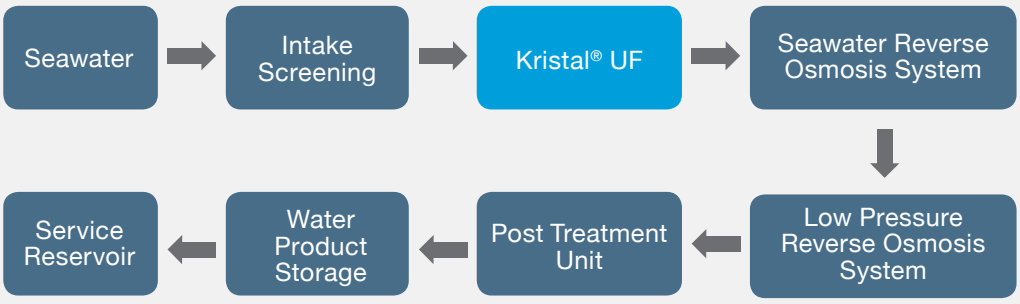
To observe Kristal®'s performance at the Tuaspring Desalination Plant, a pilot test was conducted. The test showed that regardless of the fluctuations in the feed water, the permeate turbidity remained consistently low.

Kristal® membranes are able to effectively remove micro-organisms and suspended solids which can foul the downstream RO system. The result is a permeate of consistently high quality that will boost the performance and lifespan of the RO membranes. The use of ultrafiltration has also allowed the plant to optimise the footprint for the pre-treatment stage.

Tuaspring Desalination Plant won Distinction at the GWI Global Water Awards 2014 for Desalination Plant of the Year.



Tuaspring Desalination Plant UF Feed vs Permeate Quality



Process flow chart for Tuaspring Desalination Plant

CASE STUDIES

TEXTILE WASTEWATER RECOVERY

With the help of Kristal®, the textile company has been able to achieve significant savings by cutting down on water and energy consumption as well as wastewater discharge fees imposed by the government.

Location:
Bogota, Colombia

UF Capacity:
Approximately 2,000 m^3/day

Commissioned In:
2011

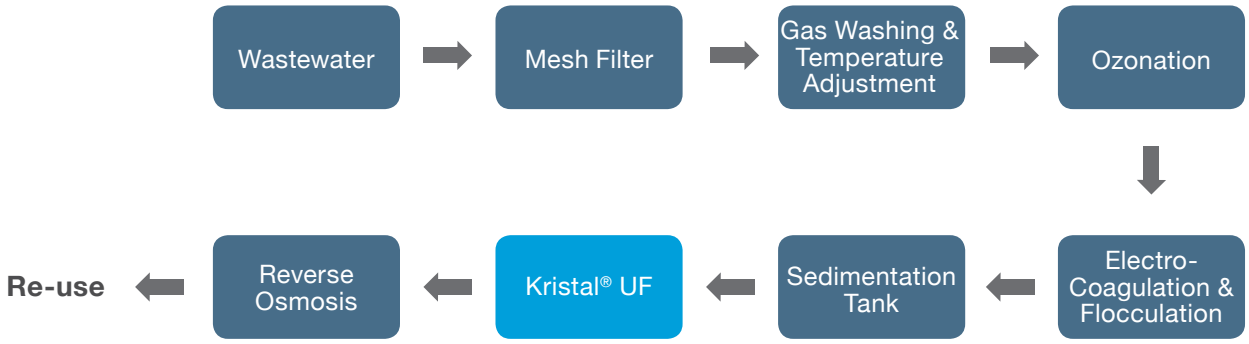
Background

A textile company in Colombia was keen to improve the quality of the wastewater discharge from one of its factories while lowering water consumption. To reclaim the wastewater, a combined UF and RO wastewater treatment was required. The entire treatment process involved a number of steps to first remove lint, chemicals, colour and large suspended solids before the wastewater was fed into the UF-RO system.

Solution

Hyflux's proprietary Kristal® membranes were selected for the UF pre-treatment. A total of 30 Kristal® modules were installed, producing close to 2,000 m^3/day of UF permeate to be fed into the RO system. The UF system has been operating at a recovery rate of close to 93% while the UF-RO plant's overall recovery rate is about 85%.

With the help of Kristal®, the textile company has been able to achieve significant savings by cutting down on water and energy consumption as well as wastewater discharge fees imposed by the government. In addition, the high quality permeate from the UF membranes ensures a longer lifespan for the RO membranes, resulting in savings from RO membrane replacement.



Process flow chart for textile wastewater recycling plant

CASE STUDIES

SEAWATER DESALINATION TO PRODUCE BOILER FEED WATER

Location:
Sumatra, Indonesia

UF Capacity:
Approximately 8,300 m^3/day

Commissioned In:
2010

Background

A crude palm oil refinery situated in a rural part of Sumatra depended on deep well water or trucked surface water from other provinces to supply clean water to its refinery boilers. At times, it was a challenge to maintain a steady supply from these sources.

The refinery needed a reliable supply of water to ensure operations would not be disrupted. As the facility was located near the coast, it hoped to tap on seawater desalination for a sustainable source of water to meet its needs. However, the turbidity of the seawater could fluctuate widely between 30 to 151 NTU because the sea was near a zone of peat swamps and had been badly polluted by poorly treated discharge from surrounding factories.

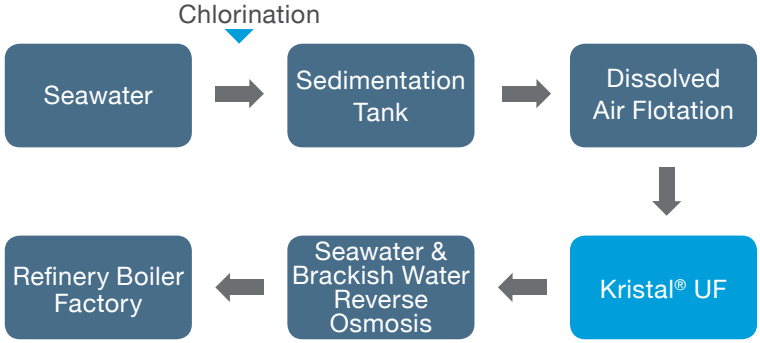
For seawater desalination to be feasible, a combined UF and double-pass RO system was required.

Solution

Hyflux was approached to supply a system that would incorporate its proprietary Kristal® ultrafiltration membranes for pre-treatment, to make the seawater suitable as a source for the boiler feed water. 144 Kristal® modules were installed to remove suspended solids and colloids in the turbid water. It has been able to produce close to 8,300 m^3/day of UF permeate water with low turbidity values of 0.02 to 0.13 NTU which is then fed into the RO system. The overall production capacity of the combined system is 2,400 m^3/day.

The Kristal® membranes optimise the performance of the RO system and protect it from the variable seawater quality. This ensures a constant supply of consistent, high quality feed water for the refinery's boilers.

By using Hyflux's proprietary ultrafiltration technology, the refinery is able to draw on the sea for a cost-effective, reliable water solution that does not leave it vulnerable to supply disruptions. It can now operate round the clock with improved efficiency and productivity.



Process flow chart for refinery desalination plant.

CASE STUDIES

RECYCLING SEWAGE TO HIGH-GRADE INDUSTRIAL WATER

With the improved BWRO feed water quality, the feed pressure as well as the cleaning frequency is lower. This translates to savings on chemical and electricity costs, and a longer lifespan for the BWRO membranes.

Location:
India

UF Capacity:
Approximately 5,000 m^3/day

Commissioned In:
2010

Background
A government-linked company in India relied on high-grade industrial water produced from a sewage recycling plant for its production processes.

The sewage recycling plant used a conventional pre-treatment system with the most advanced water recycling technologies at the time. It comprised clarification, gravity filtration and multi-grade filtration to reduce the amount of suspended solids from the secondary treated effluent before the permeate was fed to a brackish water reverse osmosis (BWRO) system to further eliminate dissolved solids.

While the BWRO membranes were able to produce high quality product water for the company's production needs, the high levels of suspended solids in the BWRO feed affected the system's effectiveness and ultimately, the membranes' lifespan.

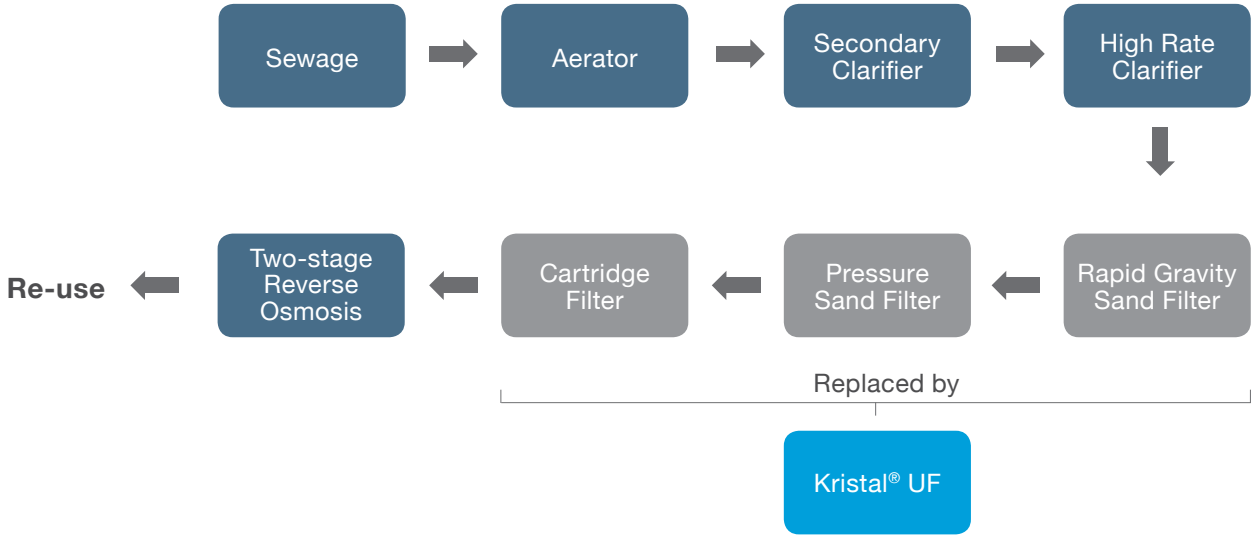
Solution
A more effective pre-treatment system was needed to optimise the performance of the BWRO system and protect them from fouling. The solution rested in the introduction of Hyflux's Kristal® membranes as a replacement for the current conventional pre-treatment system.

Once installed, the Kristal® UF system effectively removed suspended solids, silicates, colloids, organics, bacteria and other microorganisms. The SDI of the permeate was reduced from 5 to less than 3, and the fouling rate dropped significantly.

With the improved BWRO feed water quality, the feed pressure as well as the cleaning frequency is lower. This translates to savings on chemical and electricity costs, and a longer lifespan for the BWRO membranes.

CASE STUDIES

RECYCLING SEWAGE TO HIGH-GRADE INDUSTRIAL WATER



Process flowchart for sewage recycling plant

Pre-treatment Permeate Water	Conventional System	Contractual Obligations	Kristal® UF System
SDI	≥ 5	< 3	< 2.5*
Turbidity (NTU)	≥ 1	< 0.2	< 0.1*
TSS (ppm)	3 - 5	Nil	Nil
Stability when source water quality changes	Fluctuating	-	Stable

**SDI and turbidity depend on feed quality. The values shown in the table are for reference only.*

Comparison of permeate water quality between conventional and Kristal® UF systems

CASE STUDIES

SEAWATER DESALINATION TO PRODUCE HIGH-GRADE INDUSTRIAL WATER

Location:
Tianjin Dagang, China

UF Capacity:
Approximately 220,000 m^3/day

Commissioned In:
2009

Background

Tianjin, situated in north China, is home to a fast expanding petrochemical industry. Competing demands for water for agricultural, industrial and municipal purposes have exerted strains on the depleting water resources. The lack of water is also becoming a bottleneck for industrial development. Thus, the government has to look at non-traditional sources of water, including desalination, to tackle the situation.

Hyflux was invited to develop a seawater desalination plant in the Dagang district of Tianjin. At 100,000 m^3/day, the Tianjin Dagang Desalination Plant is currently the largest SWRO plant in China and one of the world's northern-most large-scale desalination plants.

The feed water quality presented a challenge because the water had to be drawn from the discharge canal of a neighbouring power plant's cooling water system instead of directly from the sea. Not only did turbidity levels fluctuate between 20 to 200 NTU in a short period of time, the TOC also tended to be in a relatively high range of 8 to 14 mg/L.

To optimise the performance of the RO system downstream and protect the membranes from fouling, an effective pre-treatment was required.

CASE STUDIES

SEAWATER DESALINATION TO PRODUCE HIGH-GRADE INDUSTRIAL WATER

The Kristal® pre-treatment system has been able to produce consistently high quality permeate for the RO process despite fluctuations in the feed water turbidity.

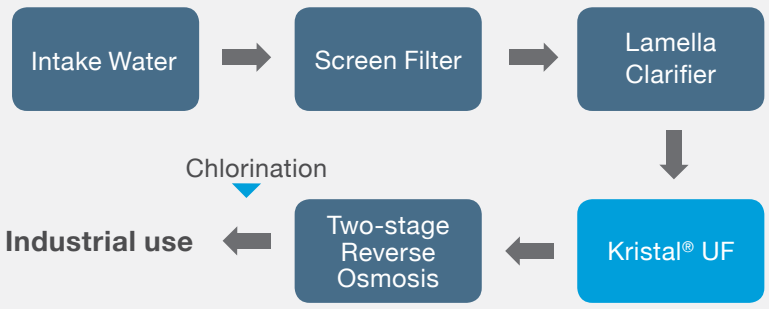
Solution

As Hyflux's Kristal® membranes can effectively produce a consistent stream of high quality permeate even in challenging feed water conditions, the membranes were selected for the pre-treatment process at Tianjin Dagang Desalination Plant.

A pilot test was conducted to observe Kristal®'s performance over a six-month period. The test showed that while feed turbidity at Tianjin Dagang Desalination Plant could spike up to 80 NTU as a result of wastewater discharge into the canal, the permeate turbidity remained consistently low at approximately 0.1 NTU. The pilot plant also experienced minimal differential pressure drop throughout the UF pre-treatment process. The effectiveness of the performance of the Kristal® membranes is evident at the actual plant, where the RO membranes have been operating optimally since start up in 2009.

By acting as an effective barrier to suspended solids and microorganisms, Hyflux's Kristal® membranes ensure stable, high quality feed water is delivered to the RO membranes, thereby enhancing the performance and extending the lifespan of the RO system downstream.

Tianjin Dagang Desalination Plant won a highly commended mention at the GWI Global Water Awards 2010 for Desalination Plant of the Year.



Simplified process flow diagram for Tianjin Dagang Desalination Plant

02

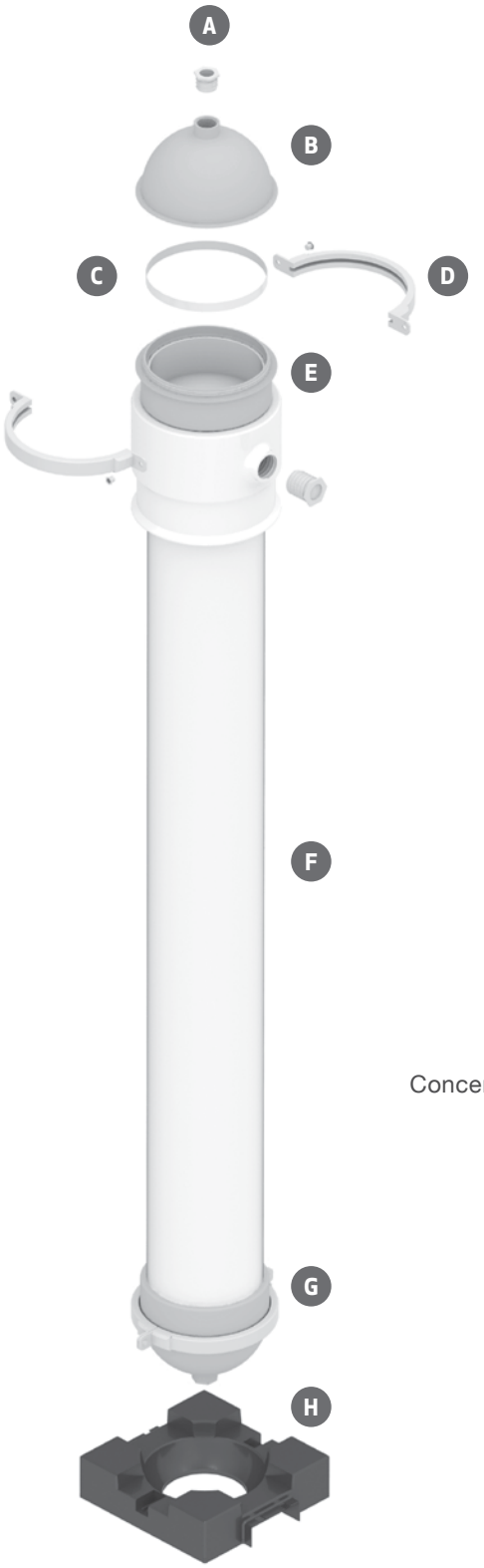
TECHNICAL SPECIFICATIONS

KRISTAL® SPECIFICATIONS

Kristal® Membrane Specifications		
Membrane type	K600ETI - 55	K600ETI - 32
Structure	Asymmetric	
Material	Reinforced polyethersulfone (PES)	
Outer diameter (mm/inch)	1.48 / 0.058	
Inner diameter (mm/inch)	0.65 / 0.026	
Nominal molecular weight cut-off (Dalton)	120,000	
Bacteria rejection (%)	> 99.9999	
Tensile force (N)	11-12	
Kristal® Module Specifications		
Overall dimensions: diameter x length (mm/inch)	344 x 2,350 / 13.54 x 92.52	344 x 1,600 / 13.5 x 63.0
Nominal membrane area (m^2/ft^2)	55 / 592	32 / 344
Feed inlet (inch)	1.5 NPT	
Permeate outlet (inch)	1.5 NPT	
Concentrate outlet (inch)	1.5 NPT	
Dry weight (kg/lbs)	60 / 132	50 / 110
Wet weight (kg/lbs)	100 / 220	90 / 198
Housing shell	PVC	
End caps	PVC	
Sealant	Proprietary composite potting materials	
Operating Parameters		
Flow type	Outside-in	
Operating temperature (°C)	5 - 40	
Clean water flux at 30°C (LMH/GFD)	200 / 118	
Operating pH range	2 - 10	
Cleaning pH range	2 - 11	
Max. NaOCl - cleaning (ppm)	500	
Max. NaOCl - continuous (ppm)	10	
Operating TMP (bar)	0.2 - 1.5	
Max. feed pressure (bar)	2.5	
Max. backwash TMP (bar)	2.0	
Max. cleaning TMP (bar)	2.0	

**Verified by accredited third-party laboratory*

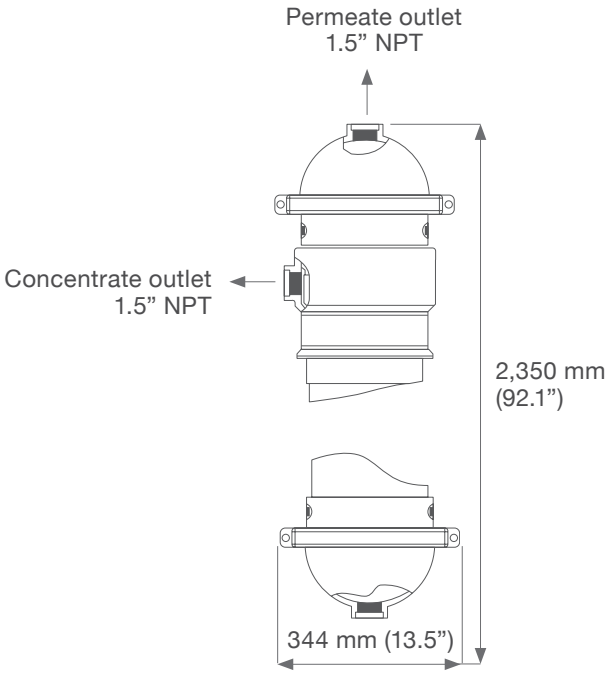
KRISTAL® MODULES



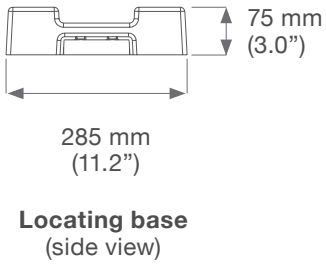
Each Kristal® module is a collection of thousands of Kristal® UF hollow fibres secured on both ends by a proprietary composite potting material and enclosed in a compact PVC housing.

Every Kristal® module goes through a membrane integrity test before it is delivered to customers.

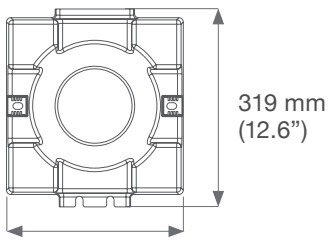
Item	Description	Material
A	Permeate port	PVC
B	Permeate end cap	PVC
C	O-ring (permeate side)	EPDM
D	Clamps (permeate side)	POM
E	Concentrate chamber/port	PVC
F	Housing	PVC
G	Feed end cap	PVC
H	Locating base	ABS



Module
(side view)



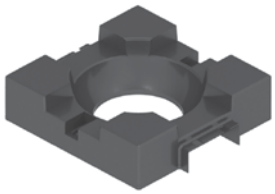
Locating base
(side view)



Locating base
(top view)

KRISTAL® MODULE SPARE PARTS AND ACCESSORIES

Every Kristal® accessory is carefully crafted to fit seamlessly with our Kristal® modules with its quality assured and approved through Hyflux's membrane production expertise.

Item	Description	Function	Material
	Air Scour Connector	Connection of the air tube to the module	PVC
	Connector Assembly	Connection of the flexible hoses / pipes of the skid to the module	PVC
	Locating Base	Seat for the Kristal® T-type module to protect end cap from shock and keep the module steady on the skid platform.	PVC
	Half Clamp	Securing of modules to the skids. Provides the strength and flexibility and protects from rusting.	Mild Steel+PP

ABOUT HYFLUX

At the core of Hyflux's business is its membrane innovation that is focused on the development of membranes, membrane applications, and the design and development of membrane-based plants to deliver solutions for a wide range of applications in water treatment and industrial manufacturing processes.

Hyflux is the leading provider of fully-integrated water and power management and innovative environmental solutions, with operations and projects in Southeast Asia, China, India, Latin America and the Middle East & North Africa region. Hyflux is committed to providing cost-effective and sustainable solutions in seawater desalination, water recycling, wastewater treatment, including membrane bioreactor (MBR) and potable water treatment.

Hyflux's full suite of services range from research and development, design, membrane manufacturing, process engineering, engineering, procurement and construction to operations and maintenance. Asia's first strategic integration of water and power at Tuaspring Integrated Water and Power Plant (IWPP) also marks Hyflux's entry in the energy generation and retail market.

In the field of membrane technology, our award-winning and proprietary Kristal® ultrafiltration (UF) membrane is among the world's leaders in terms of market share. The Kristal® range of UF membranes has applications in the treatment of aqua-based industrial waste streams, water purification, wastewater recycling and seawater desalination pre-treatment. Hyflux's membranes and materials R&D centre is one of the largest in Asia.

With membrane products and systems installed in more than 1,400 locations worldwide, Hyflux's track record includes Singapore's first NEWater plant and two SWRO desalination plants and some of the world's largest SWRO desalination plants in China and Algeria.

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