RO

NF

UF

MBR

'TORAY'

Innovation by Chemistry

Toray RO

State-of-Art Cross-Linked Polyamide Composite Membranes

Toray RO

60 years of Pioneering Towards Sustainable Water

Toray Industries, Inc. has been developing Reverse Osmosis membranes since 1968. Today we offer a full lineup of membranes backed by our sixty years of experience. Our advanced membrane technologies and global operations ensure the success of any project.

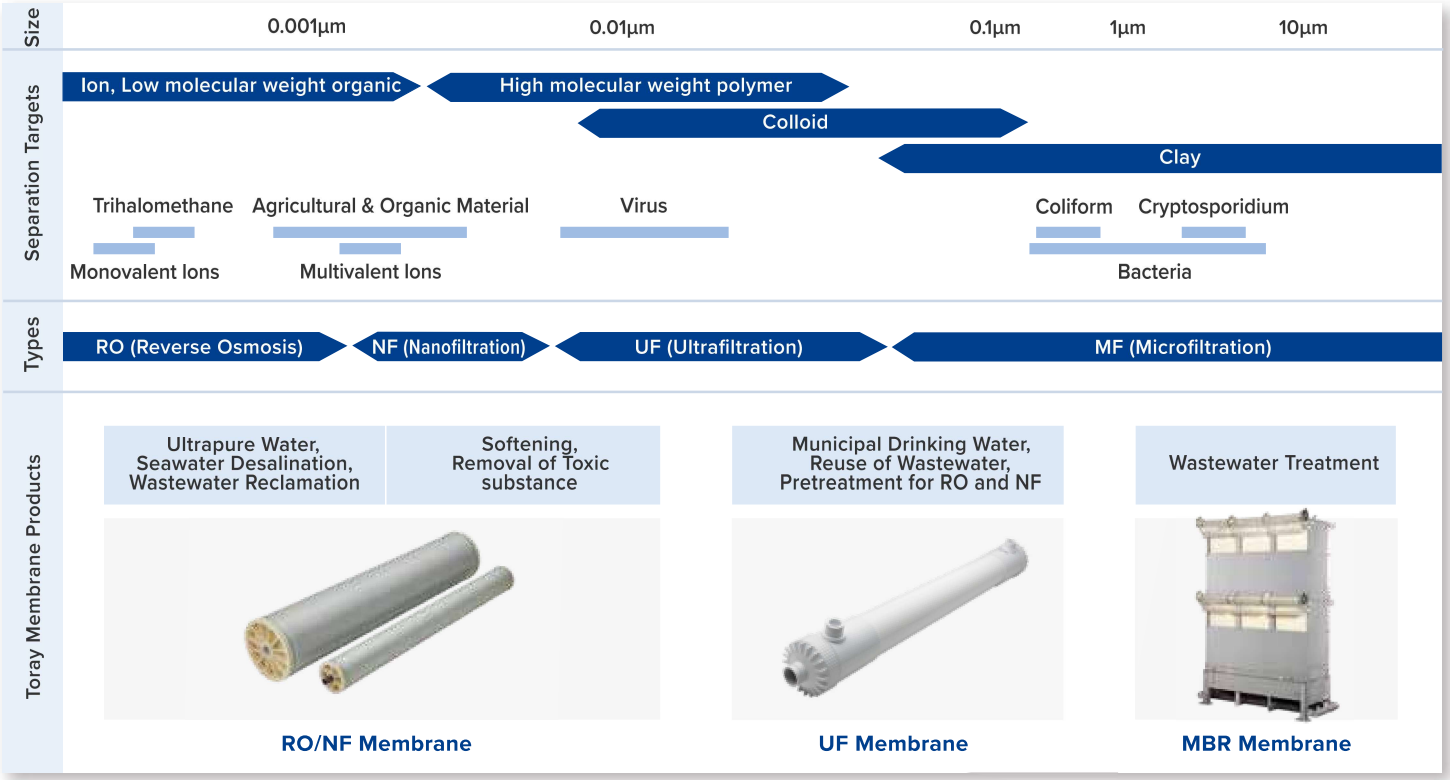
At the Toray Group, we consider sustainability to be the most important global issue of the 21st century. Toray's Sustainability Vision for water treatment aims to triple the water treated annually with our membranes by 2030 (compared to 2013). We will continue to provide advanced membrane technology such as RO membranes, further strengthen our technical services, and contribute to solving water problems worldwide.

Toray RO accumulated plant capacity :

105,000,000 m³/day (March, 2022)

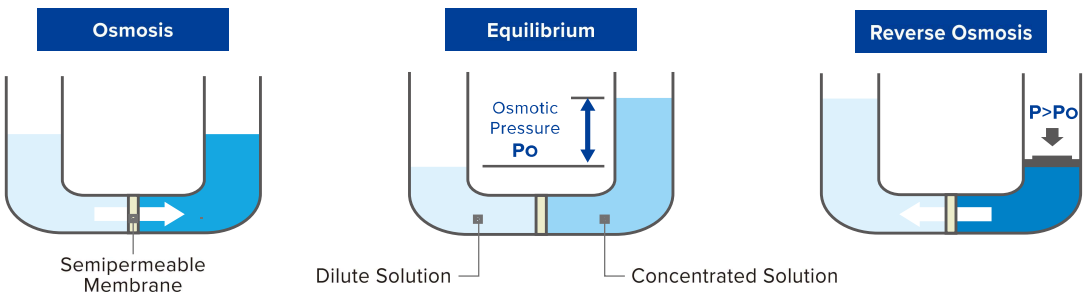
Toray Membrane Lineup

Toray provides the best water treatment products suitable for all types of feed water.



Principle of Osmosis and Reverse Osmosis

Reverse osmosis is a water purification process using a semi-permeable membrane to remove dissolved contaminants such as salts and ions from feed water. (For the theory of reverse osmosis, please refer to the images below)

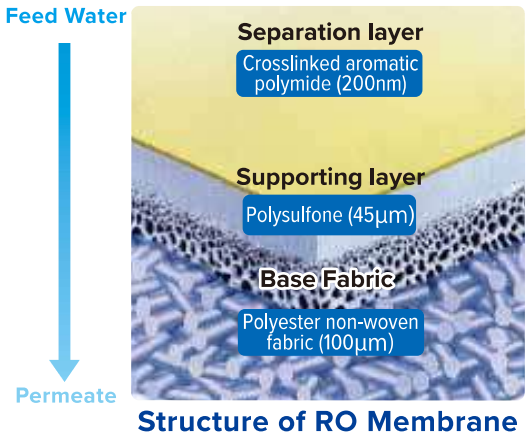


Separation Charateristics of Toray RO

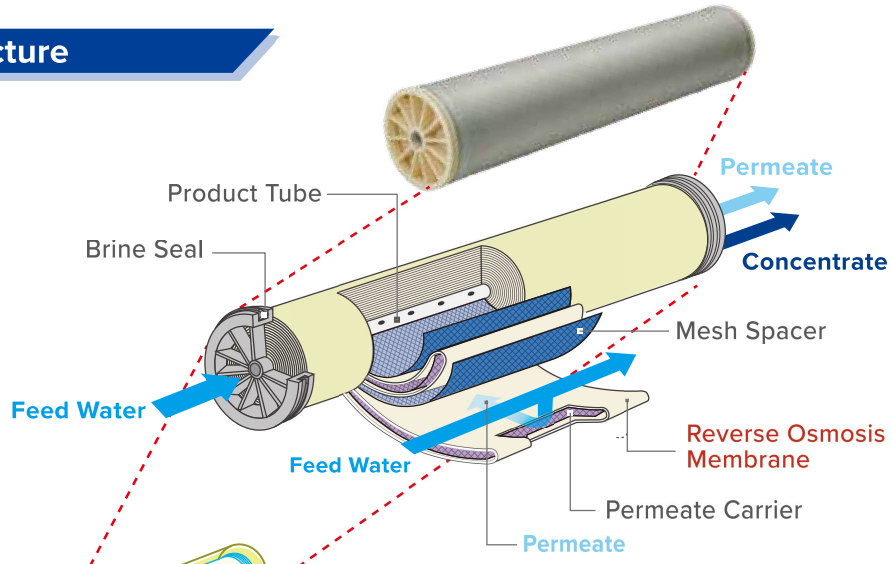
Depending on the type and pore size of the membrane, the separation mechanism will differ, and the objects that can be separated will also change.

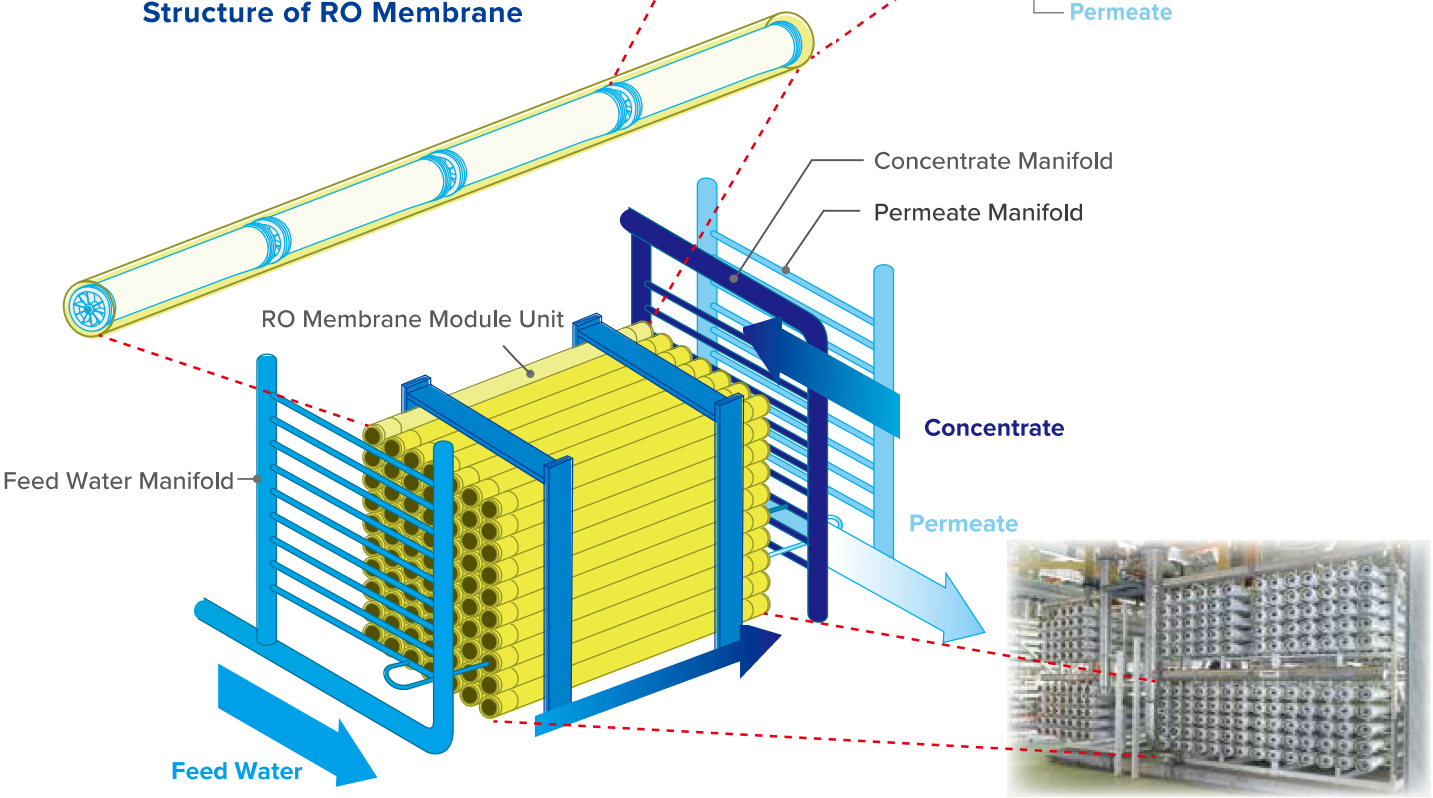
	RO/NF Membranes	UF/MF Membranes
Permeation and Rejection	-Low MW Organic Materials (MW ≦200) -Monovalent Ions -Middle to High MW Materials (MW >200) -Multivalent Ions Water	Water Ions Dissolved Matter Suspended Solid Particles
Separation Mechanism	-Molecular interaction -Solution diffusion -Electric repulsion -Size exclusion	-Dynamic separation -Size exclusion
Pore Size	RO : <1nm NF : 1-5nm	UF : 5-100nm MF : >100nm

Toray RO Structure



Structure of RO Membrane

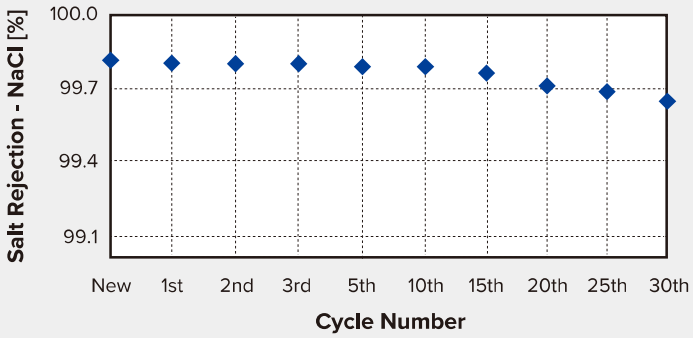




Brackish Water

Brackish Water Reverse Osmosis (BWRO) membrane elements are used in many applications, including electronics, power, petrochemical, refinery, food, and beverage industries, where high dissolved solids rejection at low pressure are critical. With high rejection and durability, Toray's BWRO membrane elements treat over 60 million m3/day of water worldwide. Toray strives to continue improving our RO products' performances to provide the best solutions for our customers.

Integrated Endurance of Toray BWRO (TM720D-400)

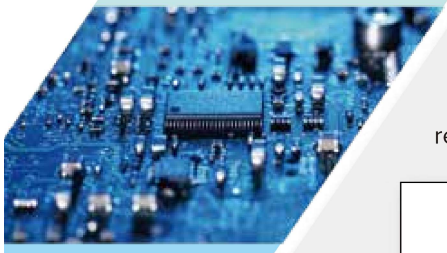


- Performance trend for 30 cycles with acid-alkaline cleaning (pH1-13)
- Test condition: 1 Cycle = 1hr circulation and soaking with alkaline (pH13) + 1hr circulation and soaking with acid (pH1) + Standard evaluation

Electronics

Semiconductor and liquid crystal factories need ultrapure water for their products. For the production of ultrapure water, there are cases of wastewater containing impurities discharged in the cleaning process and used as raw water, which requires RO to efficiently and continuously remove ions and neutral molecules such as alcohol and silica.

The TBW-HR series is a new product developed for improved rejection of low molecular weight soluble organics and small size neutral molecules such as SiO2. These high rejection rates help improve production yields in the electronics industry by reducing the burden on subsequent processes such as electrodionization, allowing for reduced maintenance frequency and energy costs.



Model		Ultra Low Pressure, High Neutral Molecule Rejection
		TBW-440HR
Diameter	inch	8
Membrane Area	m^2	41
NaCl Rejection	%	99.8
IPA Rejection	%	95 (reference)
SiO_2 Rejection	%	99.7 (reference)
Product Flow Rate	m^3/d	31
Feed Spacer Thickness	mil	28

Power

RO is essential in producing pure water for boilers used for power generation. In particular, large power generators with high-pressure specifications require highly pure water to prevent equipment wear and tear and realize efficient power generation. For this purpose, an RO that maintains a high level of rejection is necessary.

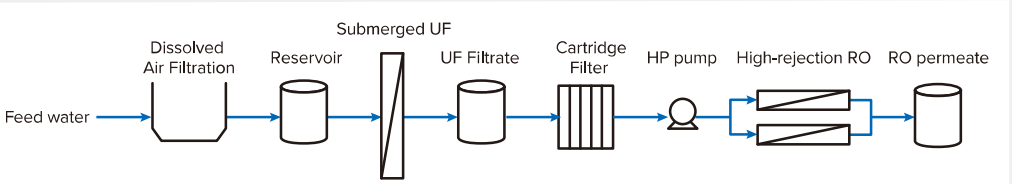
Petrochemical and Oil Refinery

Petrochemical and petroleum refining plants require RO with high removal rates and high durability for producing water used in boilers, cooling towers, and various other processes. Toray's RO is useful in producing materials and fuels that are the foundation of many industries.

Food, Beverage and Potable water

The water used for tea and other delicately flavored beverages must not affect the flavor. Juices and coffee are concentrated without heating, so the flavor is not lost. In addition, drinking water must be free of pesticides and other harmful substances to ensure safe drinking water. For these applications, RO membranes able to sustain high removal rates are required.
Toray's RO enables the production of food and beverages essential for human life.

Case Study :
Toray's Integrated Membrane System (IMS) Alleviates Pressures of Indonesia's Rapid Urbanization



Toray Brackish Water RO Product Lineup

Brackish Water RO		
Model	Permeate flow [gpd(m³/d)]	Salt rejection [%]
	Nominal	Nominal
High Rejection - TM700D Series		
TM710D	2,600(9.8)	99.8
TM720D-400	11,000(41.6)	99.8
TM720D-440	12,100(45.8)	99.8
Test Condition: 225psi (1.55MPa), 2,000mg/L NaCl, 77°F(25°C)		
Low Pressure - TMG (D) Series		
TMG10D	2,650(10.0)	99.7
TMG20D-400	12,100(45.8)	99.7
TMG20D-440	13,300(50.3)	99.7
Test Condition: 150psi (1.05MPa), 2,000mg/L NaCl, 77°F(25°C)		
Ultra Low Pressure - TMHA Series		
TMH10A	2,400(9.1)	99.3
TMH20A-400C	11,000(41.6)	99.3
TMH20A-440C	12,100(45.7)	99.3
Test Condition: 100psi (0.69MPa), 500mg/L NaCl, 77°F(25°C)		
High Neutral Molecule Rejection - TBW-HR Series		
TBW-440HR	8,200(31)	99.8
Test Condition: 110psi (0.75MPa), 500mg/L NaCl, 77°F(25°C) IPA rejection 95%*, SiO2 rejection 99.7%* (*reference)		

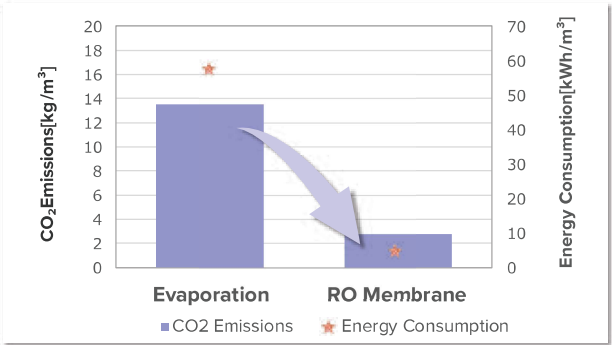
CSM™		
Model	Permeate flow [gpd(m³/d)]	Salt rejection [%]
	Nominal	Nominal
Residential		
RE1812-80	100 (0.379)	98
RE2012-150	150 (0.568)	98
RE2812-300	350 (1.325)	97
RE2812-450	450 (1.703)	96
Test Condition: 60psi (0.41MPa), 200mg/L NaCl, 77°F(25°C), pH6.5-7.0, Recovery 15%		
Nanofiltration		
NE8040-40	12,000 (45.3)	20-40
NE8040-70	9,000 (34.1)	30-70
NE8040-90	8,000 (30.3)	90-97
NE4040-40	2,500 (9.5)	20-40
NE4040-70	1,900 (7.2)	30-70
NE4040-90	1,700 (6.4)	90-97
Test Condition: 75psi (0.5MPa), 2,000mg/L NaCl, 77°F(25°C), pH6.5-7.0, Recovery 15%		

Seawater

Industry Leading Seawater RO

Reverse osmosis membranes for seawater applications are an innovative technology enabling the desalination of seawater to be affordable for both industrial and municipal use. Seawater Reverse Osmosis (SWRO) can cut the operating cost by more than 25% compared to the previous seawater desalination technologies (such as distillation). SWRO also contributes to CO_2 reduction in the plants. Many customers use Toray SWRO globally, especially in the Middle East region, where our historical reference and technical sales service are highly regarded.

Energy Consumption and CO2 Emissions in Each Methods



Reference：Masahide Taniguchi, Bulletin of the Society of Sea Water Science, Japan, 63, 214-220（2009）

Toray Installation in Middle East

KSA
-Rabigh 3
-Shuaibah
-Shuaibah 3-ex2
-Shuaibah 4
-Jubail4
-Jeddah 3
-Yanbu
-KAUST

OMAN
-Ghubrah
-Salalah

KUWAIT
-Shuwaikh

BAHRAIN
-Al Dur
-Al Dur 2

QATAR
-Umm Al Houl
-Umm Al Houl-ex
-RAF A3

UAE
-Taweelah
-Umm Al Quwain
-Fujairah 1-ex
-Fujairah 2
-Ghalilah
-Al Zawrah

Totaling > 25,000,000m³/day of production globaly.
Toray membranes are used in the world's top 3 SWRO plants.

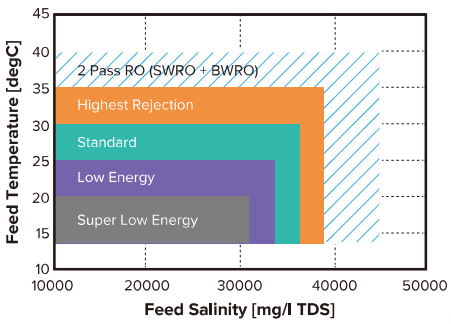
©Rabigh Three Copmany

Toray Seawater RO Lineup

Designing the most optimal sea water RO system using suitable SWRO elements is essential. Seawater characteristics such as temperature and TDS concentration vary depending on different areas of the world with various permeate water quality requirements. Toray offers a wide range of SWRO product line-ups with varying performance specifications to fulfill customer demands.

Seawater RO		
Model	Permeate flow [gpd (m³/d)] Nominal	Salt rejection [%]
Highest Rejection - TM800K Series		
TM820K-400	5,800(21.9)	99.86
TM820K-440	6,400(24.2)	99.86
Test Condition: 800psi (5.52MPa), 32,000mg/L NaCl, 77°F(25°C)		
Standard - TM800M Series		
TM820M-400	7,000(26.5)	99.8
TM820M-440	7,700(29.2)	99.8
Test Condition: 800psi (5.52MPa), 32,000mg/L NaCl, 77°F(25°C)		
Low Energy - TM800V Series		
TM810V	1,900(7.2)	99.8
TM820V-400	9,000(34.1)	99.8
TM820V-440	9,900(37.5)	99.8
Test Condition: 800psi (5.52MPa), 32,000mg/L NaCl, 77°F(25°C)		
Super Low Energy - TSW-LE Series		
TSW-400LE	12,100(45.8)*	99.6*
TSW-440LE	13,000(49.2)	99.6
*Referential Performance at 800psi (5.52MPa), 32,000mg/L NaCl, 77°F(25°C) / Please check datasheet condition performance at 600psi (4.14MPa)		

Typical Model for SWRO Membrane*



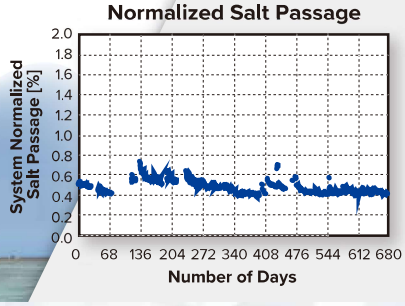
*Recommended conditions are dependent on recovery rate and design flux.

Case Study

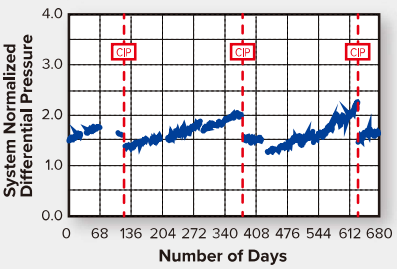
Stable Operation using Toray SWRO (Shuaibah plant)

One example illustrating the performance of our SWRO element is shown in the normalized data below. Toray SWRO element operates with stable salt passage with distinct recovery after CIP, enabling stable plant operation long-term, contributing to minimized plant downtime and optimized energy consumption .

Normalized Salt Passage



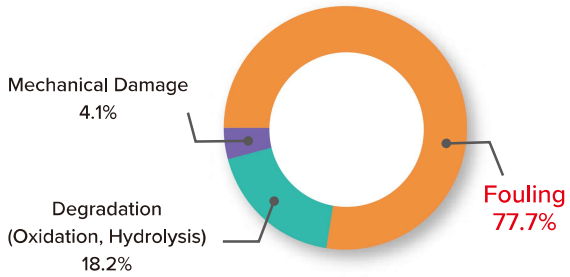
Normalized Differential Pressure



Fouling Potential Water

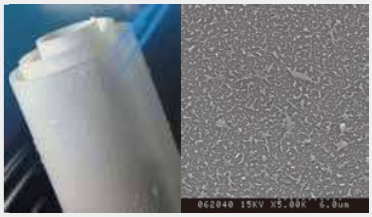
A common problem with RO membrane elements is fouling. Fouling does not change the structure of RO membrane elements, but the foulant on the membrane surface can significantly reduce its performance.
Toray Low Fouling RO (LFRO) prevents fouling by applying a hydrophilic coating on the membrane surface, enabling long-term stable operation. By preventing fouling, reduced cleaning frequency eventually contributes to lower OPEX at the water treatment plant. Toray LFRO fits your demand of treating urban sewage water for industrial application.

Analysis of RO Trouble at Site



Dr.Khedr, Desalination & Water Reuse,vol10/3 (2000) 8-17

Surface Image of RO Membrane

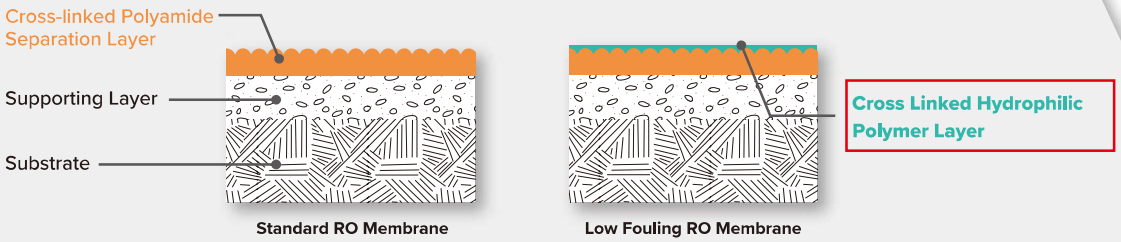


Before Fouling

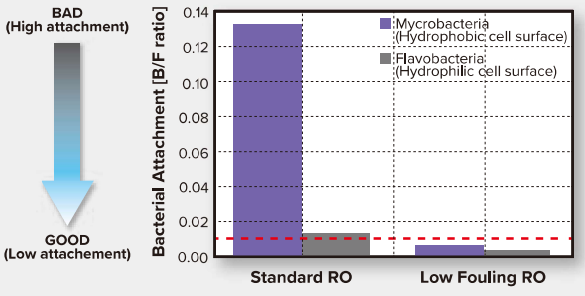
After Fouling

Characteristics of Low Fouling RO

To mitigate membrane fouling, submicron-order hydrophilic polymers are coated through a chemical reaction to improve the durability of the coating layer.

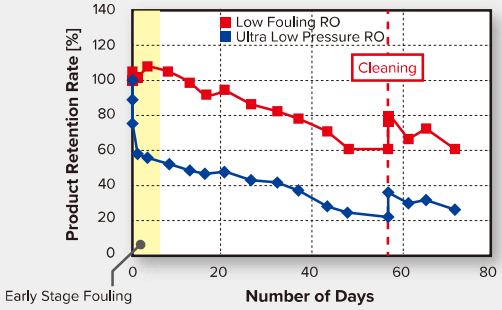


Results of Membrane Biofouling (MBP) Assay



*Reference : Orange County Water District / Dr. Ridgway

Comparison of Retention Rate of RO Product Water



Operation condition : Constant Permeate of 3L/min, Brine 20L/min, no Biocide, Feed SDI (FI) 5 or more, Conductivity 330μScm^{-1}, pH7.3, Water Temperature 19-26°C

Toray Low Fouling RO Lineup

Model		Ultra Low Pressure, Low Fouling	Low Pressure, Low Fouling	
		TLF-400DG	TML20D-400	TML10D
Permeate flow [gpd(m^3/d)]		11,500 (43.5)	10,500 (39.7)	1,900 (7.2)
Salt rejection [%]		99.5	99.8	99.8
Test Condition	Pressure	150psi (1.05MPa)	225psi (1.55MPa)	
	Others	2,000mg/L NaCl, 77°F (25°C)		

GLOBAL LOCATIONS

HEADQUARTERS Tokyo, Japan : +81-3-3245-4540

THE AMERICAS
California (TMUS) : +1-858-218-2360

EUROPE & SUB-SAHARAN AFRICA
Switzerland (TMEU) : +41-61-415-8710
Spain (TMSP) : +34-915-726-504

MIDDLE EAST
Saudi Arabia (TMME) : +966-13-568-0091
United Arab Emirates (TMME) : +971-4-392-8811

ASIA PACIFIC
China (TBMC) : +86-10-8048-5216
Singapore (TAS) : +65-6226-0525
South Korea (TAK) : +82-2-3279-1000

Toray RO Installations

Case Studies ➡

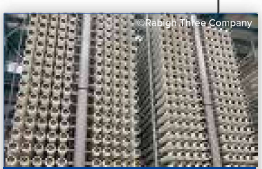

Wastewater Reuse: 70,900m³/d


Seawater Desalination: 70,900m³/d


Drinking Water: 100,000m³/d


Wastewater Reuse: 90,000m³/d


Industrial Wastewater Reuse: 6,000m³/d



Seawater Desalination: 600,000m³/d

Wastewater Reuse: 228,000m³/d


Industrial/ Brine Concentration : 1,000m³/d

Toray Group

www.water.toray.com