Nitto

Innovation for Customers

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MEMBRANE

Flexible Technology Creates Beautiful Water

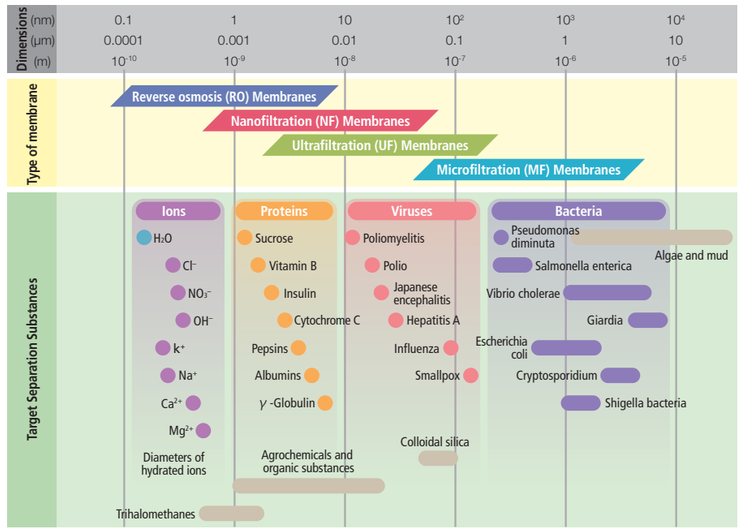
Nitto high-polymer separation membrane technology significantly contributes to securing water resources and the separation, refining and concentration of water and chemicals. Nitto combines various technologies including molecular design, polymer synthesis and membrane manufacturing to provide a wide range of applications to create beautiful water, including ultrapure water production for semiconductor manufacturing, seawater desalination, wastewater processing and water reuse. Nitto membrane products are used in a wide range of ways to give a constant supply of beautiful water and to make people's lives around the world more healthy and abundant.

CONTENTS

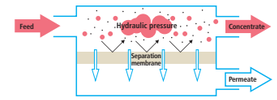
Various Membrane Separation Methods and Their Applications

Separation membranes enable the user to filter, separate, refine and concentrate substances contained in water and solutions; fresh water can be produced by removing salt from seawater. According to the size of the particles of the substance separation membranes are classified into microfiltration (MF) membranes, ultrafiltration (UF) membranes, nanofiltration (NF) membranes and reverse osmosis (RO) membranes. Separation membranes operate in two modalities: cross-flow filtration and dead-end filtration. Nitto's separation membrane elements are mostly based on cross-flow filtration.

Applicable Size Ranges and Target Substances

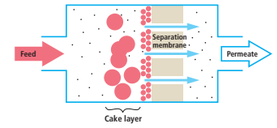


Principles of Membrane Permeation



Cross-flow Filtration

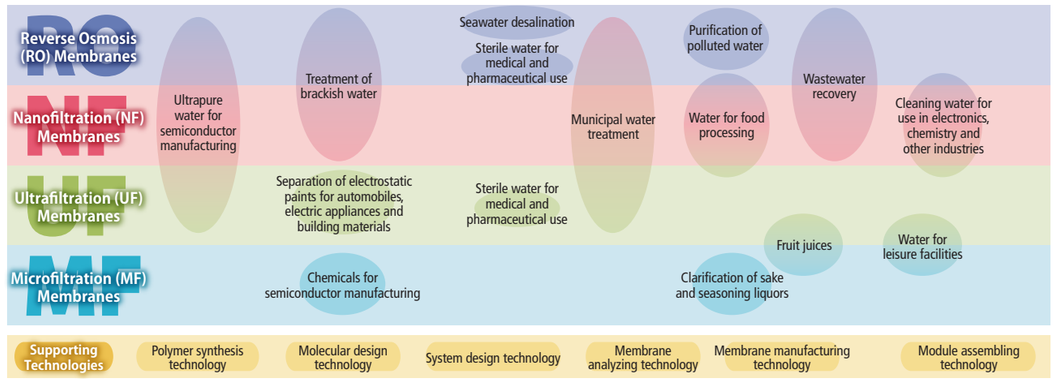
The feed water flows tangentially across the membrane surface at a constant flow rate, separating the permeate and the concentrate. The process produces less gel layer and cake layer on the membrane surface, and gives stable high permeability and a high rejection performance.



Dead-end Filtration

All the feed water passes through the membrane and all particles larger than the pore sizes of the membrane are stopped at its surface so that only the permeate is extracted. It is used for household disposable water purifiers and batch processing.

Applications for Separation Membranes



Principle of Action of Various Membranes

RO / NF

Reverse Osmosis (RO)/ Nanofiltration (NF)

If you place a concentrated solution and a dilute solution into a container partitioned by a semi-permeable membrane, the two solutions will gradually develop the same concentration as the solvent migrates from the dilute side to the concentrated side through the membrane (Fig. 1). This phenomenon is osmosis. In contrast, reverse osmosis (RO) is the phenomenon in which the solvent migrates from the concentrated side to the dilute side through the semi-permeable membrane with a pressure greater than the osmotic pressure applied to the concentrated side (Fig. 2). Based on this principle, the reverse osmosis membrane module performs membrane separation.

The nanofiltration (NF) membrane, a type of RO membrane, selectively permeates monovalent ions such as Na^+ and Cl^-, while rejecting polyvalent ions such as SO_4^{2-}, as well as pigment components and other substances with a valence.

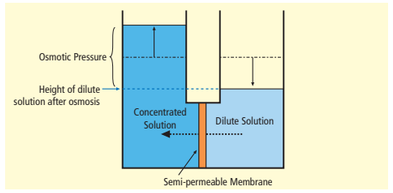


Figure 1: Principle of Osmosis

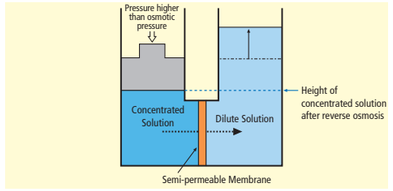
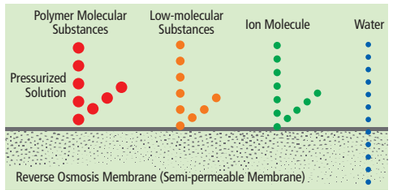
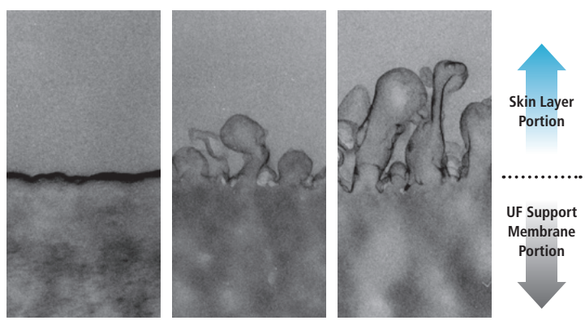


Figure 2: Principle of Reverse Osmosis



History of Development of Reverse Osmosis Membranes (7199-759HR-ES series)



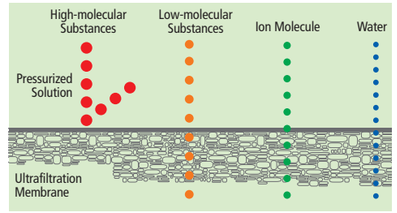
1st generation NTR-7199 | 2nd generation NTR-759HR | 3rd generation ES10

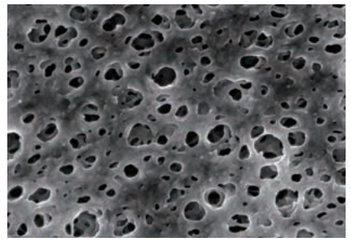
The first compound RO membrane was developed in 1972, and it remains the mainstream for reverse osmosis today. Since then, many advances in low-pressure operation have been made. Nitto developed a cross-linked polyamide low pressure compound RO membrane that can operate at a low pressure of 1.5 MPa with high size-exclusion performance (NTR-759HR). Thus, the range of applications of RO membranes has expanded to include desalination of brackish water, concentration of active ingredients in food products, processing of a wide variety of wastewaters and production of ultrapure water. Aiming at even lower operating pressures with a focus on the folded structure of the skin layer of the NTR-759HR membrane, Nitto succeeded in reducing the operating pressure to an ultralow level (increased permeate flow under constant pressure) by controlling the growth of the folded structure to drastically increase the surface area (ES Series). Today, our ES series is the world standard for ultralow pressure RO membranes for the production of ultrapure water.

UF

Ultrafiltration (UF)

Ultrafiltration (UF) is a method of membrane separation for high-molecular substances with molecular weights of about 1,000 to 300,000. Consisting of an asymmetrical skin layer and sponge layer, the UF membrane allows water, ionized molecules and low-molecular substances to pass through with a particularly high water permeability, while rejecting the passage of high-molecular substances.

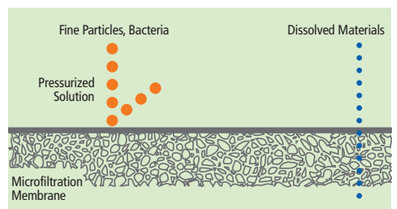


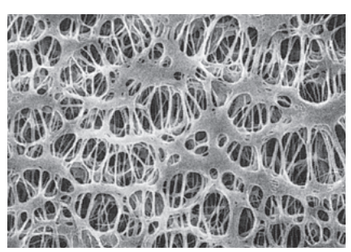


MF

Microfiltration (MF)

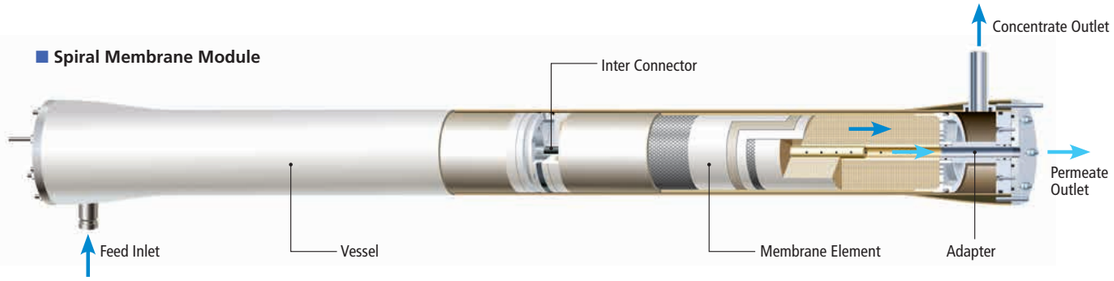
Microfiltration (MF) is a method of membrane separation occupying a position between ordinary filtration and ultrafiltration. A MF membrane has larger pores than an UF membrane, separating fine particles of 0.05-10 μm in diameter contained in liquids.





Spiral Membrane Elements
RO／NF／UF

■ **Spiral Membrane Module**



A spiral membrane element consists of spirally wound multiple flat sheet membranes. It is inserted in a pressure-resistant vessel, and this assembly is used as a spiral membrane module.

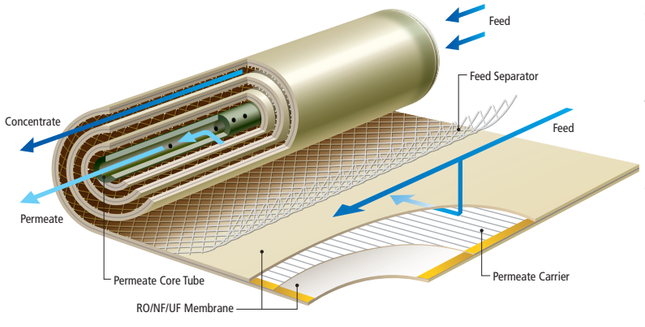
Membrane Materials and Their Features

- Aromatic polyamide: High rejection at low operating pressures
- Polyvinyl alcohol derivative: High permeability
- Sulfonated polyether sulfone: Chargeable skin layer (NF membranes)

Module Features

- A large membrane area per unit volume ensures a compact design and high permeability.
- Low operating pressures contribute to saving energy for RO systems.
- Membrane materials, element structures and component members are optimized for a wide variety of applications, including seawater desalination, ultrapure water production and food processing (ingredient separation and concentration).
- Membrane elements are exchangeable.

■ **Structure of Spiral Membrane Element**



Examples of Applications

- Seawater desalination (potable water, industrial water, etc.)
- Brackish water desalination (potable water, industrial water, etc.)
- Production of boiler feed water
- Production of ultrapure water for semiconductor manufacturing etc. in the electronics industry (primary, polishing and reclamation systems)
- Production of sterile water for the medical and pharmaceutical industries
- Wastewater reuse (tertiary treatment of municipal sewage and treatment of general industrial wastewater)
- Separation, refinement and concentration of active ingredients in the pharmaceutical, food and chemical industries
- Removal of harmful substances (boron, arsenic, etc.)

Available Sizes of Spiral Membrane Elements

2-inch element
(for various tests)
S2 = 61 mm dia. x 1,016 mm length

4-inch element
S4 = 99.5 mm dia. x 1,016 mm length

8-inch element
S8 = 201 mm dia. x 1,016 mm length

Capillary Type Ultrafiltration Membrane Modules
UF

This type of module is composed of a hollow fiber membrane. It has an extremely large membrane area per unit volume, exhibiting excellent permeability in a compact size.

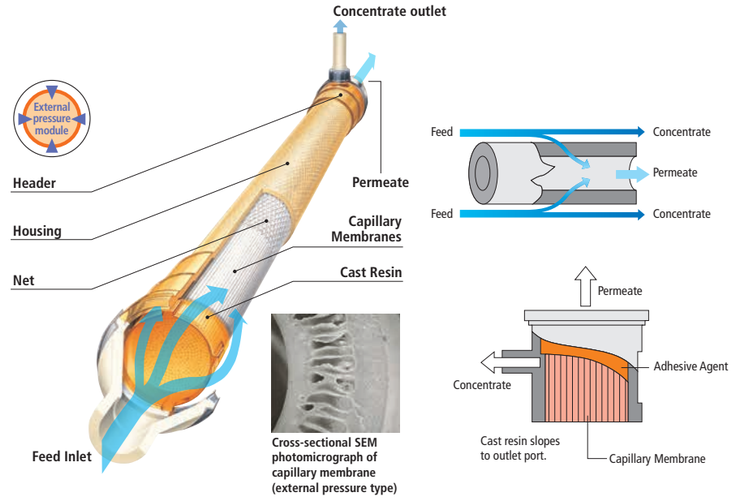
Module Features

- The membrane material is physicochemically tough polysulfone resin, offering sharp fractionation and high permeate flow.
- The asymmetric double-skin structure of the membrane ensures a high degree of cast resin impregnation and makes the membrane unlikely to detach.
- The unique structure with a hydrodynamically optimized design keeps out the retention of liquids and bubbles, thus prevents bacteria and suspended solids (SS) from entering the porous membrane.

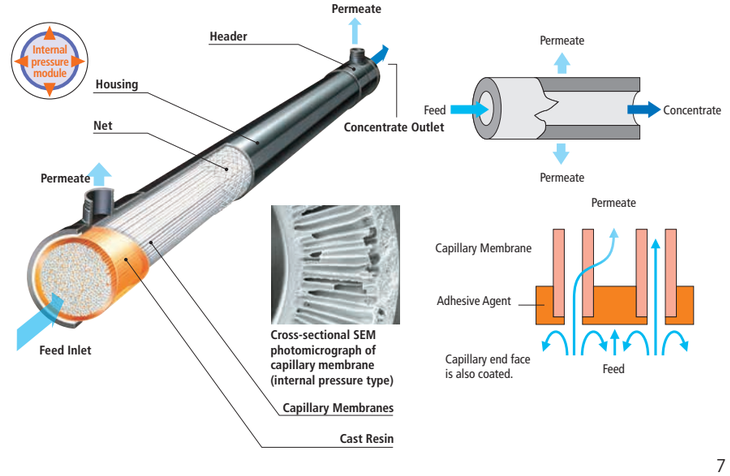
Examples of Applications

- Production of ultrapure water for semiconductor manufacturing etc. in the electronics industry
- Production of sterile water for the medical and pharmaceutical industries
- Separation, refinement and concentration of active ingredients in the pharmaceutical, food and chemical industries

■ **External Pressure Type Capillary UF Membrane Module**



■ **Internal Pressure Type Capillary UF Membrane Module**

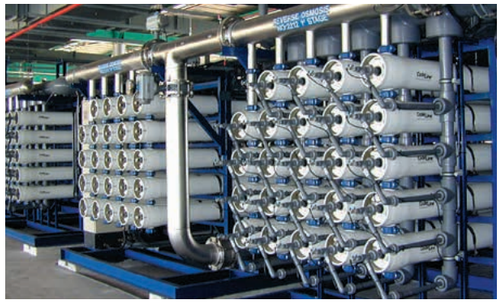


Product Applications

■ Food Process Separation

Aomori, Japan

■ Wastewater Reclamation



Singapore (Public Utility Board)

■ Surface Water Purification

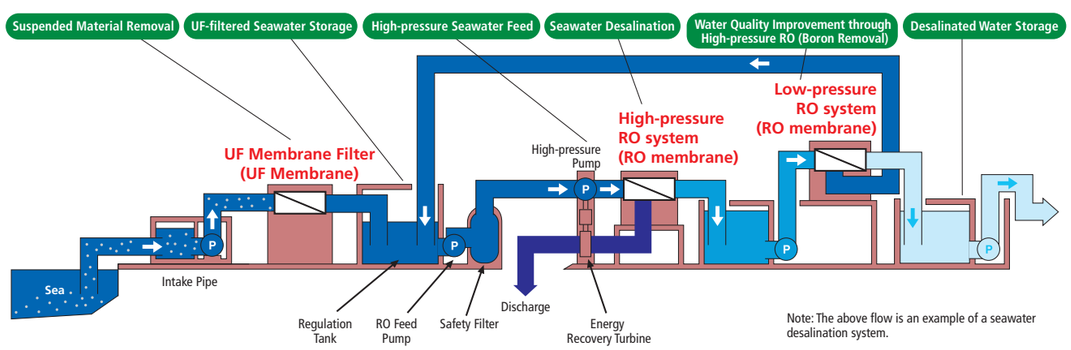
Heemskirk, the Netherlands

■ Seawater Desalination

Okinawa, Japan

Product Applications: Seawater Desalination System Flow

Nitto membrane products are used in a broad range of separation and refining processes in seawater desalination plants, municipal sewage recycling plants, pharmaceutical production and food processing.



Note: The above flow is an example of a seawater desalination system.

Membrane Separation Technology that Supports the Future of the Earth (Shiga Plant)

Nitto Shiga Plant was Japan's first manufacturing facility dedicated to the production of polymer separation membranes. Surrounded by a bountiful natural environment, and furnished with the latest R&D equipment, production and quality management departments, the plant supplies a broad range of membrane products that can meet diverse needs today.

Rapidly entering the membrane technology field, the plant has been working on developing membrane separation techniques by fusing molecular design technology, polymer synthesis technology, membrane manufacturing technology, membrane modularization technology, system design technology and analytical technology.

Currently the Shiga Plant is working on producing reverse osmosis (RO) membranes for separating ions, ultrafiltration (UF) membranes for separating high-molecular substances, and other products. These separation membranes are supplied in the form of a spiral (roll), capillary (hollow fiber) and other modules. Many products that make the best use of the functions of these membranes are contributing to people's lives across the world in term of seawater desalination and other various applications.

■ Membrane products that fulfill the diverse needs of users are supplied under a consistent operating system.

Outline

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Fax: +81-77-565-3515
Certifications acquired: ISO 9001:2008 (Quality)
ISO 14001:2004 (Environment)

Nitto Group R&D and Production System for Membrane Products

The Nitto Group membrane business is implemented at three major production sites (Shiga plant in Japan, a 100% owned subsidiary Hydranautics in the US, and Shanghai plant in China), with more than 20 sales/technical service centers and two R&D centers. With its headquarters located in the United States, the membrane business moves forward through group-wide global management based on speedy decision-making.

Hydranautics–A World Brand of RO Membranes

Hydranautics is Nitto Denko Corporation wholly owned overseas subsidiary founded in 1963, and based in Oceanside, California. Hydranautics entered the reverse osmosis (RO) water treatment field in 1970, and joined the Nitto Group in 1987. Today, Hydranautics is a key production site for supplying membrane products under the Hydranautics brand to overseas markets, mainly in Europe and the United States. The company also serves as a R&D center which is developing spiral RO membrane modules and application technologies for seawater and brackish water desalination. In 1996, Hydranautics acquired ISO 9001 certification, and all group companies are now involved in development and production, and utilizing the same quality control system.

Hydranautics products are now in use on seven continents, achieving a world-leading market share in reverse osmosis membranes for seawater desalination and wastewater reuse.

Global Network

AMERICA

1 Hydranautics Headquarters (CA)
TEL: 1-760-901-2500 FAX: 1-760-901-2578

EUROPE/MIDDLE EAST

1 Hydranautics European Headquarters
TEL: 34-93-473-1722 FAX: 34-93-473-1485

2 Hydranautics Middle East (Dubai)
TEL: 971-4-889-5806 FAX: 971-4-889-5807

ASIA/OCEANIA

1 Nitto Denko Corporation, Head Office
TEL: 81-6-7632-2101 FAX: 81-6-7632-2102

2 Hydranautics South East Asia
TEL: 65-6223-8277 FAX: 65-6223-8239

3 Nitto Denko (Taiwan) Corp.
TEL: 886-7-821-3106 FAX: 886-7-821-3155

4 Hydranautics Australia
TEL: 65-6223-8277 FAX: 65-6223-8239

5 Hydranautics India
TEL: 91-22-4003-0497 FAX: 91-22-4003-0496

6 Nitto (China) New Materials Co., Ltd.
TEL: 86-21-5208-1777 FAX: 86-21-5208-2858

7 Nitto Denko (Shanghai Songjiang) Co., Ltd.
TEL: 86-21-5774-2184 FAX: 86-21-5774-2185

8 Nitto Denko Corporation, Tokyo Sales Branch
TEL: 81-3-6632-2101 FAX: 81-3-6632-2025

9 Nitto Denko Corporation, Shiga Plant
TEL: 81-77-562-7711 FAX: 81-77-565-3515

Be sure to visit Nitto's website at www.nitto.com/jp/en/ for more information.