苏州润膜

SU ZHOU RUN MO

2023 RUNMO MembranesInformation Catalog

Suzhou Runmo Water Treatment Technology Co.,Ltd.

苏 州 润 膜 水 处 理 科 技 有 限 公 司

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Chapter 1 Company Introduction

Suzhou Runmo Water Treatment Technology Co., Ltd. is a rising high-tech enterprise in Chinese membrane industry. The company is mainly engaged in the processing and production of various reverse osmosis membranes and ultra-filtration membranes. The products include domestic membrane element series and industrial membrane element series.The reverse osmosis membrane production base was put into production in 2014. The main product specifications include Domestic series and 4 inches and 8 inches series. The ultra-filtration membrane production base was put into production in 2010. The main product specifications include 4 inches, 6 inches, 8 inches to 10 inches, and alternative ultra-filtration membranes for various imported products.

By the establishment of strategic partnerships with well-known international reverse osmosis membrane companies, the company has introduced advanced international production technology. The key raw materials used in the membrane come from well-known Chinese and foreign manufacturers. Every piece of membrane produced by this company has been well tested to ensure its salt rejection rate and permeate flow are above the standard requirement. The qualified rate of finished products has always been above 99%. After years of digestion, absorption and innovation, with the spirit of perseverance and the meticulous attitude towards the products, the performance of the company's full range of membrane product has reached the international advanced level.

The company always adheres to the business philosophy of “forging brand with technology; showing strength with innovation” and “customer-centered, market-oriented”, and serves to water treatment industry with high-quality products and complete techniques.

“***GOOD MEMBRANE GOOD WATER COMES, GOOD MEMBRANE RUNMO MAKES***”


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有效期：三年
苏州市名牌产品认定委员会

Suzhou City Famous Brand

ISO9000 Management Certificate

Advertising Pictures


计量合格确认证书
CERTIFICATE FOR MEASUREMENT QUALIFIED
ISMA

Measurement Qualification


NSF International
NSF
NSF International
NSF

NSF Certificate

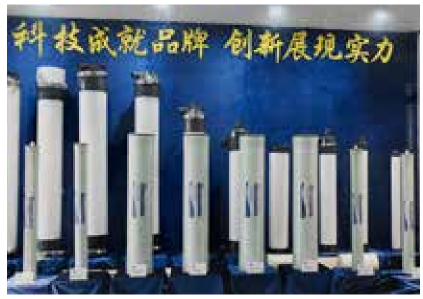

实用新型专利证书

Utility Model Certificate

诚信 务实 开拓 创新

Automatic Membrane Rolling Machines

Membrane Testing Machines



Samples Displaying Window

Superconducting Fabric Machines

Automatic Membrane Cutting Machine

Membrane Sheets Production Line


实用新型专利证书

Utility Model Certificate


实用新型专利证书

Utility Model Certificate


实用新型专利证书

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Trademark Registration Certificate

Trademark Registration Certificate

Trademark Registration Certificate

Utility Model Certificate

Approval of Health Permit

Approval of Health Permit

Chapter 2 RUNMO Reverse Osmosis Membrane Elements

Ⅰ.RUNMO Reverse Osmosis Membrane Elements Naming Rules

1. RUNMO Industrial Reverse Osmosis Membrane Elements Naming Rules

RM -BW- 4040 -1900

1900: Permeate Water Flow, GPD,(Optional)
FR : Fouling Resistant Membranes, (Optional)

Length of the Membrane Element, Inches (")
21 : Length of the 21" Membrane Element
40 : Length of the 40" Membrane Element

Diameter of the Membrane Element, Inches (") , (Data X 0.1)
40 : Diameter of the 4" Membrane Element
80 : Diameter of the 8" Membrane Element

Membrane Element Series

BW : High Pressure Membrane Element Series
ULP : Low Pressure Membrane Element Series
XULP : Extreme Low Pressure Membrane Element
SeriesNF : Nano Filtration Membrane Element Series
SW : Sea Water Desalination Membrane Element Series

Registered Trade Mark
RM : RUNMO Brand

2. RUNMO Domestic Reverse Osmosis Membrane Elements Naming Rules

RM - 1812 -50

50 : Permeate Water Flow, GPD
12 : Length of the Membrane Element, Inches (")
18 : Diameter of the Membrane Element, Inches ("), (Data X 0.1)
RM : RUNMO Brand (Registered Trade Mark)

Ⅱ. RUNMO Reverse Osmosis Membrane Elements Performance & Selecting Guide

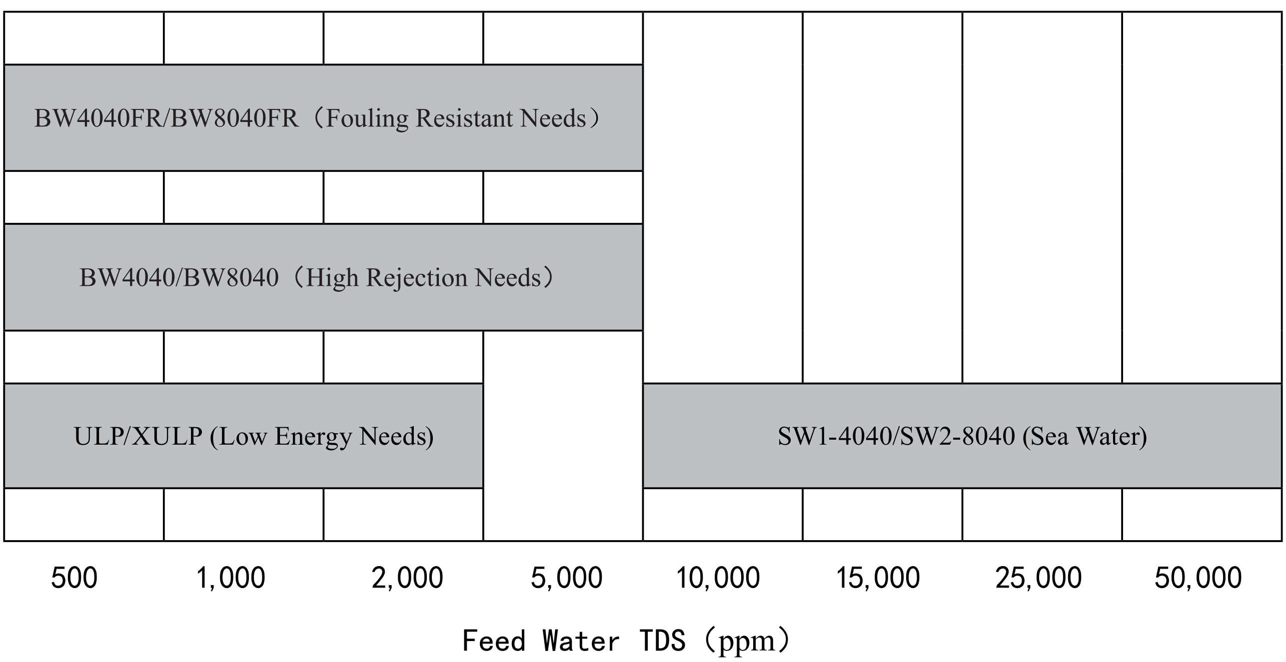
1. RUNMO Industrial Reverse Osmosis Membrane Elements Performance Quick Check

<table>
<tr><th rowspan="2">TYPE</th><th rowspan="2">MODEL NO.</th><th rowspan="2">STABLE REJECTION (%)</th><th rowspan="2">AVERAGE FLOW GPD (m^3/d)</th><th rowspan="2">WORKING PRESSURE AND APPLICATION</th><th colspan="3">TESTING CONDITIONS</th></tr>
<tr><th>TESTING PRESSURE psi (MPa)</th><th>CONCENTRATION OF TESTING SOLUTIONS NaCl (ppm)</th><th>RECOVERY RATE (%)</th></tr>
<tr><td rowspan="12">INDUSTRIAL GENERAL BRACKISH WATER</td><td>RM-XULP-4021</td><td>99.0</td><td>1000 (3.8)</td><td rowspan="2">Working at extremely low pressure,
Apply to very low concentration of brackish water</td><td rowspan="2">100 (0.69)</td><td rowspan="2">1500</td><td>8</td></tr>
<tr><td>RM-XULP-4040</td><td>99.0</td><td>2000 (7.6)</td><td>15</td></tr>
<tr><td>RM-ULP-2521</td><td>97.5</td><td>300 (1.13)</td><td rowspan="7">Working at ultra low pressure,
Apply to medium low concentration of brackish water</td><td rowspan="2">150 (1.03)</td><td rowspan="2">1500</td><td rowspan="2">8</td></tr>
<tr><td>RM-ULP-4021</td><td>99.0</td><td>950 (3.6)</td></tr>
<tr><td>RM-ULP-2540</td><td>99.0</td><td>750 (2.83)</td><td rowspan="5">150 (1.03)</td><td rowspan="5">1500</td><td rowspan="5">15</td></tr>
<tr><td>RM-ULPD-4040</td><td>98.5</td><td>2500 (8.7)</td></tr>
<tr><td>RM-ULPH-4040</td><td>99.0</td><td>2000 (7.6)</td></tr>
<tr><td>RM-ULP31-4040</td><td>99.5</td><td>1900 (7.2)</td></tr>
<tr><td>RM-ULP-8040</td><td>99.0</td><td>10500 (39.5)</td></tr>
<tr><td>RM-BW-4021</td><td>99.5</td><td>950 (3.6)</td><td rowspan="3">Working at high pressure,
Apply to high / very high concentration of brackish water</td><td>225 (1.5)</td><td>2000</td><td>8</td></tr>
<tr><td>RM-BW-4040</td><td>99.5</td><td>2600 (9.8)</td><td rowspan="2">225 (1.55)</td><td rowspan="2">2000</td><td rowspan="2">15</td></tr>
<tr><td>RM-BW-8040</td><td>99.5</td><td>10500 (39.5)</td></tr>
<tr><td rowspan="2">SW</td><td>RM-SW1-4040</td><td>99.7</td><td>1900 (7.2)</td><td rowspan="2">Working at very high pressure,
Apply to sea water desalination</td><td rowspan="2">800 (5.5)</td><td rowspan="2">32800</td><td rowspan="2">8</td></tr>
<tr><td>RM-SW2-8040</td><td>99.7</td><td>8200 (31)</td></tr>
<tr><td rowspan="2">FR</td><td>RM-BW-4040FR</td><td>99.6</td><td>1900 (7.2)</td><td rowspan="2">Working at high pressure,
Apply to very high concentration of brackish water containing some pollutants (Organic substances, colloids)</td><td rowspan="2">225 (1.55)</td><td rowspan="2">2000</td><td rowspan="2">15</td></tr>
<tr><td>RM-BW-8040FR</td><td>99.6</td><td>9500 (36)</td></tr>
<tr><td rowspan="2">NF</td><td>RM-NF-4040</td><td>50~75</td><td>2200 (7.9)</td><td rowspan="2">Working at extremely low pressure,
Apply to brackish water containing many TOC</td><td rowspan="2">75 (0.52)</td><td rowspan="2">1200</td><td rowspan="2">15</td></tr>
<tr><td>RM-NF-8040</td><td>50~75</td><td>9000 (33.9)</td></tr>
</table>

2. RUNMO Domestic Reverse Osmosis Membrane Elements Performance Quick Check

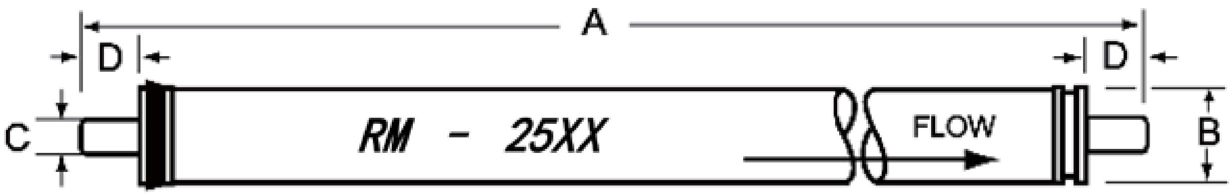
TYPE	MODEL NO.	STABLE REJECTION (%)	AVERAGE FLOW GPD (m^3/d)	WORKING PRESSURE AND APPLICATION	TESTING CONDITIONS		
					TESTING PRESSURE psi (MPa)	CONCENTRATION OF TESTING SOLUTIONS NaCl (ppm)	RECOVERY RATE (%)
DOMESTIC MEMBRANE ELEMENTS	ULP-1812-50G	97.0	50 (0.19)	Working at ultra low pressure, Apply to domestic RO machine, hospital & laboratory purified water machine, feed water TDS below 500ppm.	60 (0.6)	500	15
	ULP-1812-75G	97.0	75 (0.28)				
	ULP-1812-100G	95.0	100 (0.38)				
	ULP-1812-150G	97.0	150 (0.56)				
	ULP-2012-100G	97.0	100 (0.38)				
	ULP-2018-200G	97.0	200 (0.75)				
	ULP-3012-300G	97.0	300 (1.13)				
	ULP-3013-400G	97.0	400 (1.51)				
	ULP-2514	97.0	120 (0.45)				

3.RUNMO Reverse Osmosis Membrane Elements Selecting Guide



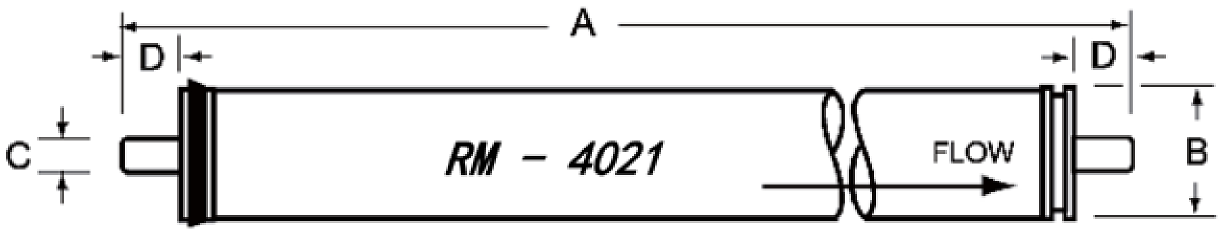
Ⅲ. RUNMO Reverse Osmosis Membrane Elements Product Detailed Data

1. Membrane Elements Size

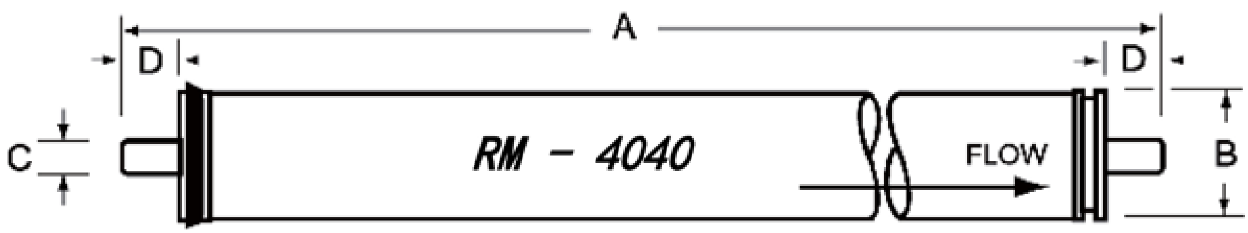


2540: A=1016.0mm(40") B=61.0mm(2.4") C=19.1mm(0.75") D=30.2mm(1.19")

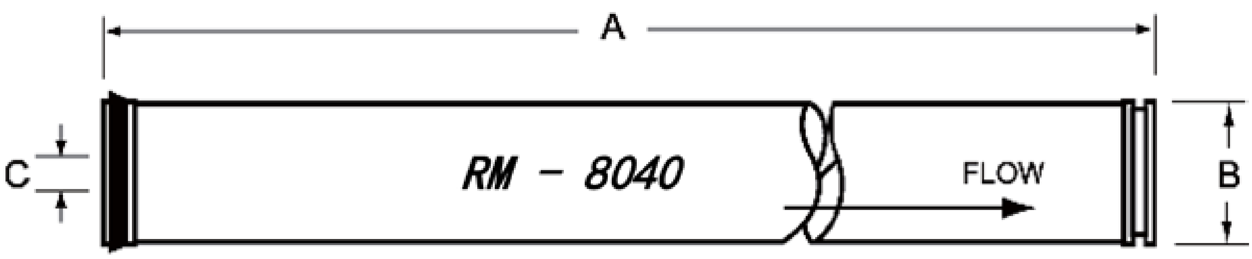
2521: A=533.4mm(21") B=61.0mm(2.4") C=19.1mm(0.75") D=30.2mm(1.19")



A=533.4mm(21") B=99.7mm(3.9") C=19.1mm(0.75") D=26.7mm(1.05")



A=1016.0mm(40") B=99.7mm(3.9") C=19.1mm(0.75") D=26.7mm(1.05")



A=1016.0mm(40") B=201.9mm(7.95") C=28.6mm(1.125")

2. ULP/XULP Series Membrane Elements:

ULP/XULP series of membrane elements (TFC - Thin Film Composite) are made of Polyamide composite membrane materials, which can achieve the desired permeate water and high desalination rate under ultra-low/extreme-low pressure operation conditions. The operating pressure is 2/3 of the conventional composite membrane pressure, and the desalination rate can reach 99.3%. It can improve economic benefits, including reducing the investment cost of related pumps, pipelines, containers and other equipment as well as the operation cost of the whole reverse osmosis system.

ULP/XULP series of membrane elements is suitable for desalination treatment of surface water, groundwater, tap water and municipal water with salt content less than 2000 ppm. It is mainly used in various fields of industry, such as pure water, boiler recharge water, food processing and pharmaceutical manufacturing.

ULP/XULP series of membrane elements performance

Model	Membrane ft^2 (m^2)	Average Permeate GPD (m^3/d)	Stable Rejection %	Min. Rejection %
RM-XULP-4021	42 (3.9)	950 (3.6)	99.0	97.5
RM-XULP-4040	85 (7.9)	2000 (7.5)	99.0	97.5
RM-ULP-2521	16 (1.5)	300(1.13)	97.5	97.0
RM-ULP-2540	33 (3.0)	750(2.83)	99.0	97.0
RM-ULP-4021	42 (3.9)	950 (3.6)	99.0	98.0
RM-ULPD-4040	85 (7.9)	2300 (8.7)	98.5	98.0
RM-ULPH-4040	85 (7.9)	2000 (7.6)	99.0	98.5
RM-ULP31-4040	89 (8.3)	1900 (7.2)	99.5	99.0
RM-ULP-8040	400 (37)	10500 (39.5)	99.0	98.5

ULP/XULP series of membrane elements Testing Conditions:

Testing Pressure	150 psi (1.03MPa)/100 psi (0.69MPa)
Temperature of Testing Solution	25 ℃
Concentration of Testing Solution (NaCl)	1500ppm
pH Value of Testing Solution	7.5
Recovery Rate of Single Element	15%(8040、4040、2540); 8% (4021、2521)

ULP/XULP series of membrane elements Operation Limits & Conditions:

Max. Working Pressure	600psi (4.14MPa)	Max. Feed Water SDI_{15}	5
Max. Feed Water Flow	75gpm (17 m^3/h) For 8040 16gpm (3.6 m^3/h) For 4040、4021 6.0gpm (1.4 m^3/h) For 2521、2540	Max. Feed Water COD	10ppm
		Max. Feed Water BOD	5ppm
		Max. Feed Water TOC	10ppm
Max. Feed Water Temperature	45℃	Residual Chlorine Concentration of Feed Water	＜0.1ppm
Max. Feed Water TDS	2000ppm	pH Range of Feed Water During Continuous Operation	2～12
Max. Feed Water Hardness	60ppm	Max. Pressure Drop of Single Element	15psi (0.1MPa) For8040、4040、2540 10psi (0.07MPa) For2521、4021
Max.Turbidity NTU	1.0		

3. BW Series Membrane Elements:

BW series is an aromatic polyamide composite membrane element for desalination of brackish water. It has the characteristics of high water production and good desalination performance. In addition, it has high performance of removing soluble salts, TOC and SiO_2, and is especially suitable for the making of high purified water in the electronics and power industries.

It is suitable for desalination treatment of surface water, groundwater, tap water and municipal water with salt content less than 10,000 ppm. It is mainly used for industrial pure water of various scales, boiler feed water of power plants and other industrial water. It can also be used for the treatment of brackish water applications such as high concentration saline waste water and beverage water manufacturing.

FR series, the surface of this membrane was treated by special technology, which changed the electric charge and smoothness of the membrane surface, increased the hydrophilicity of the membrane surface, thus reducing the contamination of pollutants and microorganisms on the membrane surface, and achieving the purpose of reducing the contamination of membrane components and prolonging the service life.

BW series of membrane elements performance:

Model	Membrane ft2 (m2)	Average Permeate GPD (m3/d)	Stable Rejection %	Min. Rejection %
RM-BW-4021	36（3.3）	950（3.6）	99.5	99.0
RM-BW-4040	85（7.9）	2000（7.6）	99.5	99.0
RM-BW-8040	400（37）	10500（39.5）	99.5	99.0
RM-BW-4040FR	85（7.9）	1900（7.2）	99.6	99.0
RM-BW-8040FR	400（37）	9500（36）	99.6	99.0

BW series of membrane elements Testing Conditions:

Testing Pressure	225 psi（1.5MPa)
Temperature of Testing Solution	25 ℃
Concentration of Testing Solution (NaCl)	2000ppm
pH Value of Testing Solution	7.5
Recovery Rate of Single Element	15%(8040、4040、2540)；8%（4021、2521)

BW series of membrane elements Operation Limits & Conditions:

Max. Working Pressure	600psi (4.14MPa)	Max. Feed Water COD	10ppm
Max. Feed Water Flow	75gpm (17 m^3/h) For 8040 16gpm (3.6 m^3/h) For 4040、4021	Max. Feed Water BOD	5ppm
		Max. Feed Water TOC	10ppm
Max. Feed Water Temperature	45°C	Residual Chlorine Concentration of Feed Water	＜0.1ppm
Max. Feed Water TDS	5000ppm	pH Range of Feed Water During Continuous Operation	2～12
ax. Feed Water Hardness	60ppm	Max. Pressure Drop of Single Element	15psi (0.1MPa) For8040、4040 10psi (0.07MPa) For4021
Max. Feed Water SDI_{15}	5		
Max.Turbidity NTU	1.0		

4. SW **Series Membrane Elements**:

SW Series is an aromatic polyamide composite membrane element for seawater desalination. By optimizing the structure of membrane element, this series of membrane elements can increase water production. Under the same water production requirement, the number of membrane elements can be reduced. It has the characteristics of low operating pressure, low equipment investment, good desalination performance and stability. In particular, its high desalination rate ensures that drinking water can be obtained from seawater through first-order reverse osmosis.

SW series membrane elements are suitable for the treatment of seawater and brackish water with high concentration. They can be used for the treatment of seawater desalination, desalination of brackish water with high concentration, boiler feed water in power plants, wastewater reuse, concentration and recovery of high value-added substances such as food and medicine, etc.

SW series of membrane elements performance:

Model	Membrane ft2 (m2)	Average Permeate GPD (m3/d)	Stable Rejection %	Min. Rejection %
RM-SW1-4040	80（7.4）	1900（7.2）	99.7	99
RM-SW2-8040	380（35.2）	8200（31）	99.7	99

SW series of membrane elements Testing Conditions:

Testing Pressure	800 psi（5.5MPa）
Temperature of Testing Solution	25 ℃
Concentration of Testing Solution (NaCl)	30000ppm
pH Value of Testing Solution	7.5
Recovery Rate of Single Element	8%

SW series of membrane elements Operation Limits & Conditions:

Max. Working Pressure	1000psi（6.9MPa）	Max. Feed Water SDI_{15}	5
Max. Feed Water Flow	75gpm（17 m^3/h）For 8040 16gpm（3.6 m^3/h）For 4040、4021	Max. Feed Water COD	10ppm
		Max. Feed Water BOD	5ppm
Max. Feed Water Temperature	45℃	Max. Feed Water TOC	10ppm
Max. Feed Water TDS	5000ppm	Residual Chlorine Concentration of Feed Water	＜0.1ppm
ax. Feed Water Hardness	60ppm	pH Range of Feed Water During Continuous Operation	2～12
Max.Turbidity NTU	1.0	Max. Pressure Drop of Single Element	15psi（0.1MPa）

5. NF Series Membrane Elements:

NF Series of nanofiltration membrane elements can achieve high permeate water and excellent desalination performance. Therefore, it is suitable for large-scale industrial and municipal water treatment systems. In use, it shows excellent ability to remove pesticides, viruses and bacteria. It has high ability to remove natural organic substances and medium ability to remove total hardness. Through innovative technology, the product has a stronger film surface, strong anti-oxidation performance, and the use of ultra-low pressure mode of operation can significantly improve the system and operation economy.

NF series of membrane elements performance:

Model	Membrane ft^2 (m^2)	Average Permeate GPD (m^3/d)	Stable Rejection %	Min. Rejection %
RM-NF-4040	85（7.9）	2200（7.9）	55~75	-
RM-NF-8040	400（37）	9000（33.9）	55~75	-

NF series of membrane elements Testing Conditions:

Testing Pressure	70 psi （0.48MPa）
Temperature of Testing Solution	25 ℃
Concentration of Testing Solution (NaCl)	2000ppm NaCl; 2000ppm $MgSO_4$
pH Value of Testing Solution	8
Recovery Rate of Single Element	15%

NF series of membrane elements Operation Limits & Conditions:

<table>
<tr><td>Max. Working Pressure</td><td>600psi (4.14MPa)</td><td>Max. Feed Water COD</td><td>10ppm</td></tr>
<tr><td rowspan="2">Max. Feed Water Flow</td><td rowspan="2">75gpm ($17m^3/h$) For8040
16gpm ($3.6m^3/h$) For4040</td><td>Max. Feed Water BOD</td><td>5ppm</td></tr>
<tr><td>Max. Feed Water TOC</td><td>10ppm</td></tr>
<tr><td>Max. Feed Water Temperature</td><td>45℃</td><td>Residual Chlorine Concentration of Feed Water</td><td>＜0.1ppm</td></tr>
<tr><td>Max. Feed Water TDS</td><td>2000ppm</td><td>pH Range of Feed Water During Continuous Operation</td><td>3～10</td></tr>
<tr><td>ax. Feed Water Hardness</td><td>60ppm</td><td rowspan="3">Max. Pressure Drop of Single Element</td><td rowspan="3">15psi (0.1MPa) 8040、4040</td></tr>
<tr><td>Max. Feed Water SDI_{15}</td><td>5</td></tr>
<tr><td>Max.Turbidity NTU</td><td>1.0</td></tr>
</table>

Note:

1. For the recommended design scope, please refer to the latest version of the technical manual, design guide, or consult with membrane technology experts. If the user does not strictly follow the operating conditions provided by the sample, Suzhou Runmo Water Treatment Technology Co., Ltd. will not bear all the consequences arising therefrom.

2. The average water yield listed in the table shows that the error of water yield of single membrane element in series is within (+10%). The difference between the minimum water yield and the nominal value of other series of single membrane elements is not more than 20% of the nominal value.

3. Wet membrane components are strictly tested before they leave the factory. They are stored in 1.0% sodium bisulfite solution. Then they are packed in vacuum and packed in cardboard boxes. The safe storage temperature of wet membrane components is 4-45 C.

4. RO production water to be discharged in the first hour of operation.

5. During storage and operation, it is prohibited to add any chemicals that affect membrane components. In case of violating the use of such chemicals, Suzhou Runmo Water Treatment Technology Co., Ltd. will not bear all the consequences arising therefrom.

Ⅳ．Reverse Osmosis Membrane Elements Application Manua

Reverse Osmosis System Designing Guidelines

A complete reverse osmosis system consists of pretreatment system, membrane filtration system, post-treatment system and cleaning system. According to different water sources and different requirements of water quality, the design of a reasonable reverse osmosis system can reduce the speed of system pollution, prolong the cleaning cycle, reduce the cleaning frequency, improve the long-term stability of the system, and reduce the cost of system operatio

The general design steps are:

1) Analysis of Water Quality of Water Source;

2) Reasonable and effective pretreatment is designed for water quality of source water to meet the requirement of feed water of membrane elements;

3) Design a reasonable membrane filtration system according to the requirement of water yield and water quality;

4) Design post-processing parts (e.g. ion exchange treatment system) according to the water quality requirement;

5) Design of Reasonable Physical and Chemical Cleaning System;

The most important factor affecting the design of membrane system is the tendency of fouling. The fouling of membrane components is due to the presence of particulate matter, colloidal matter, organic matter in the influent and deposition on the membrane surface. The deposition rate of fouling plugs increases with the increase of the average water production rate (water production load per unit membrane area) and component recovery rate (influencing concentration polarization). Therefore, excessive average water yield and system recovery can easily lead to higher fouling rate and more frequent chemical cleaning.

The design guideline is based on a large number of engineering project design and operation data in different types of water sources. The system designed according to the guideline has longer operation period and lower cleaning frequency. Note that this guideline is a reference for designing systems and cannot be used as a guarantee of commitment.

1. Water Quality Index on Pretreatment Design

1.1. SDI

SDI is (under 0.21MPa(30psi)feed water) the percentage of fouling in a specific 0.45mm filter membrane per unit time and area. SDI measurement is a very effective tool for water treatment system maintenance and management. By measuring the SDI values of raw water, before and after filters, before and after ultrafiltration, before and after precision filters, the operation of pretreated water system can be effectively monitored and the normal process steps can be judged. It has been widely accepted and recognized by the membrane industry, and it is an important index that must be tested in reverse osmosis/nanofiltration pretreatment system.

1.2. Turbidity

ISO International standards define turbidity as a decrease in liquid transparency due to the presence of insoluble substances. According to the different turbidity standard liquids used in the test, the turbidity values and units obtained are also different. At present, the standard solution of turbidity is formed by reaction of hexamethylenetetramine + hydrazine sulfate. The turbidity measured by scattering light turbidimeter is expressed as NTU. The turbidity of RO system water is less than 1NTU.

1.3. PH value

PH=7 is neutral; PH=0-7 is acidic; PH=7-14 is alkaline.Regulating PH is the simplest way to control calcium carbonate scaling. The possibility of calcium carbonate scaling can be judged by measuring and calculating Lagrange saturation index (LSI) or Steve Davis stability index (S&DSI) of concentrated water. However, too low or too high PH value may cause membrane damage.Because the change of PH affects the desalination rate of the system, and the optimum desalination rate of the membrane element is 6.5-8, so PH is an important parameter in the pretreatment design. In addition, reducing the influent PH value is an effective means to control the precipitation and precipitation of calcium carbonate.

In the daily operation of the system, the PH value range of RO device and nanofiltration device is 3-11 and 3-10 respectively.

1.4. Hardness

Water hardness refers to the concentration of calcium and magnesium ions in water, and the hardness unit is mg/L(mg/L as $CaCO_3$).For water sources with high hardness and alkalinity, special attention should be paid to preventing $CaCO_3$ scaling in pretreatment process.

1.5. Ionic composion

Soluble inorganic salts in water, formed by the combination of anions and cations, have a certain solubility at a certain temperature. In the membrane filtration system, as the water is continuously concentrated, beyond its solubility limit, they will scale on the surface of membrane components.Common insoluble salts are $CaCO_3$,$CaSO_4$; Other compounds that may produce scaling are CaF_2,$BaSO_4$,$SrSO_4$ and $Ca_3(PO_4)_2$. If the anions and cations in raw water can form the above insoluble salt or slightly soluble salt, scaling control measures must be considered in the pretreatment to prevent precipitation and scaling caused by insoluble salt or slightly soluble salt exceeding its solubility. Some design software can be used to determine whether insoluble or slightly soluble salts will precipitate under the designed recovery conditions.

1.6. COD , BOD

In water treatment, chemical oxygen demand (COD) and biochemical oxygen demand (BOD) are commonly used to express the organic content in water. There are many kinds of organic species in nature. The main organic components in water are humic acid, surfactant, oil, microorganism, pesticide and so on.

Chemical oxygen demand (COD) is the amount of oxidation consumed when water samples are treated with a certain strong oxidant under certain conditions. It is an indicator of the number of primary substances of X in water.Reductive substances in water include various organic substances, nitrite, sulfide, ferrous salts and so on, but the main ones are organic substances. Therefore, chemical oxygen demand (COD) is often used as an index to measure the content of organic matter in water.

Biochemical oxygen demand (BOD) is the total amount of dissolved oxygen consumed by organic matter in water due to the biochemical action of microorganisms to oxidize and decompose it into inorganic or gasified water. Its unit is ppm(mg/L). At present, the oxygen consumed by incubation time of 5 days at 20°C is commonly used as the index, which is called BOD_5. BOD is a nutrient source for microbial growth. When microorganisms enter the membrane system, they will adsorb or reproduce on the surface of the membrane, especially in the concentration side, microbial contamination will occur due to the large-scale storage of nutrients such as organic matter.

In the daily operation of the system, it is suggested that COD of reverse osmosis influent should be less than 15PPm.

1.7. Oxidant

Because the material of reverse osmosis/nanofiltration membrane itself can not withstand oxidant, free chlorine, permanganate, persulfate, hexavalent chromium, peroxide, ozone and other oxidizing substances must be removed from the influent water. Removal of oxidizing substances in influent water by adding sodium bisulfite.

1.8. Chemical contaminants

The influent of reverse osmosis/nanofiltration must not contain cationic macromolecule flocculant, cationic interfacial activator, epoxy resin coating and anion exchange resin leachate. These chemicals will form chemical contamination on the surface of the membrane and cause irreversible damage to the membrane components. Such chemical contaminants need to be removed by pretreatment before reverse osmosis/nanofiltration enters the water.

2. **Factors on Affecting Membrane Filtration System**

2.1 The influence of temperature of feed water

Feed temperature is an important factor affecting the water yield of reverse osmosis/nanofiltration system. For raw water with lower temperature, appropriate measures can be taken to adjust it. Raw water whose temperature exceeds the maximum endurance temperature of the membrane element is strictly prohibited from entering the membrane system. High temperature will seriously harm the performance of the membrane element. In the daily operation of the system, the maximum temperature of feed water of reverse osmosis/nanofiltration is required to be less than $< 45℃$.

Water production conductivity of membrane system is very sensitive to the change of inlet water temperature. With the increase of water temperature, water flux increases almost linearly, which is mainly due to the decrease of viscosity of water molecules passing through the membrane and the increase of diffusion ability. Increasing water temperature will lead to a decrease in desalination rate or an increase in salt permeability, mainly because the diffusion rate of salt through the membrane will be accelerated by the increase of temperature.

2.2 The influence of PH

PH value also has a certain effect on the conductivity of product water, because most of the reverse osmosis membranes have some active groups. PH value can affect the electric field on the membrane surface and then affect the ion migration. In addition, PH value has a direct impact on the morphology of impurities in influent water. For dissociatable organic matter, its retention rate decreases with the decrease of PH value. Dissolved CO2 in water is greatly affected by PH value. When PH value is low, it exists in the form of gaseous CO2, which is easy to penetrate through reverse osmosis membrane. When PH is low, the desalination rate is low, PH increases, and gaseous CO2 is converted into HCO 3-and HCO 32-ions. The desalination rate also increases gradually. The desalination rate is the highest in the range of 7.5~8.

2.3 The influence of Salt Concentration

Osmotic pressure is a function of the concentration and type of salt or organic matter in water. With the increase of salt concentration, osmotic pressure also increases. Therefore, the driving pressure of influent which needs to reverse the direction of natural osmotic flow mainly depends on the salt content in the influent. If the pressure remains constant, the higher the salt content, the lower the flux. The increase of osmotic pressure counteracts the driving force of water inflow, resulting in the decrease of water flux and the increase of salt flux through the membrane.

2.4 The influence of recovery rate

The reverse osmosis process is realized by applying pressure to the influent when the natural osmosis flow direction between the concentrated solution and the dilute solution is reversed. If the recovery rate is increased (the inlet pressure is constant), the salt content remaining in the raw water is higher, and the natural osmotic pressure will continue to increase until it is the same as the applied pressure, which will counteract the impetus of the influent pressure, slow down or stop the reverse osmosis process, and reduce or even stop the permeation flux.
The discharged concentrated water must have sufficient flow to remove impurities and prevent mechanical blockage or precipitation on the inlet side of the membrane. In order to facilitate the operation of the system, the ratio between water production and water inflow is usually used as an important operational parameter. This ratio is called "recovery rate", and is usually expressed as a percentage. For example, if the influent flow rate of the membrane filtration system is 100 m3/h and the product flow rate is 70 m3/h, the recovery rate is 70%. The remaining 30 m3/h that does not pass through the membrane, that is, concentrated water is usually discharged.

Recovery rate is mathematically defined as:

recovery rate (%)= permeate water x 100/feed water.

If the feed water TDS is high, a lower recovery rate is needed; on the contrary, if the feed water TDS is low, a higher recovery rate can be adopted.

3. Designs of Membrane Filtration System

The design of reverse osmosis membrane filtration system includes membrane components, pressure vessel arrangement, high pressure pump, pipeline, instrument and so on. The designer's duty is to reduce the operating pressure and the cost of membrane components as much as possible, but to increase the water yield and recovery rate as much as possible, as well as the long-term stability of the system and the cost of cleaning and maintenance (low failure rate, cheap chemicals can be used for effective cleaning).

3.1 Define the water source, determine the type of membrane elements, and set the average water yield of the system.

According to the water quality characteristics of the influent source, the appropriate type of membrane elements is selected. Ultra-low pressure membrane element (ULP) is selected when the inlet conductivity is less than 1000 us/cm and the desalination rate of Ultra-low pressure membrane meets the requirement; the BW series is used for the inlet water; the FR series is used for the reuse of wastewater; and the SW series is used for the desalination of seawater.

Average water productivity of the system: It can be determined by field test data, empirical data, or recommended data by other design software.

Reference of Average Water Production Rate of Runmo Brand Membrane Elements

Water supply type		RO Permeate SDI＜1	Underground water SDI＜3	Tap water SDI＜3	Surface water SDI＜5	Sea water SDI＜3	Waste water SDI＜3
Suggested system permeate(GPD)		25～30	20～25	16～20	12～16	8～12	8～12
Max. Recovery rate of single element（%）		25	15	15	15	10	10
Permeate flow m3/h	2540	0.13~0.14	0.09~0.11	0.07~0.09	0.06~0.08	0.04~0.06	0.04~0.06
	4040	0.33~0.40	0.25~0.33	0.21~0.25	0.16~0.21	0.10~0.19	0.10~0.19
	8040	1.50~1.90	1.20~1.60	1.00~1.20	0.75~1.00	0.50~0.75	0.50~0.75

3.2 According to the flow rate, recovery rate and water quality, the number of elements, segments and stages of the system are determined.

Stage: refers to the number of penetrations of raw water, that is the number of penetrations of produced water through reverse osmosis membrane elements.

Segment: The number of times the raw water passes through the pressure vessel, that is, the number of times the concentrated water passes through different pressure vessels.

The multi-segments system can avoid the aggravation of pollution caused by the low concentration water flow and high recovery rate of the end-membrane elements under the condition of high system recovery rate. The level of segment is sometimes not as clear as that of stage, which flows through several pressure vessels, but not necessarily many segments. If a longer pressure vessel can not be used under certain site conditions, several short vessels will be used in series. Therefore, when determining the number of RO system segments, it can be noted that the water intake is divided into several parts, whether to re-mix after entering the pressure vessel separately, and every re-mixing of the water intake (concentrated water) will be symbolized for End of each segment.

The number of membrane elements in series can be determined according to the expected design recovery rate. However, too many membrane elements in series will lead to an increase in the final recovery rate of membrane elements and increase the risk of inorganic salt scaling. Therefore, pressure vessels capable of connecting more than six membrane elements in series are seldom used, and segment method is adopted.

Recovery design of reverse osmosis system refers to the following table

Number of Series Elements	System Max. Recovery	Number of Series Elements	System Max. Recovery
1	15～20%	5	43～52%
2	28～33%	6	50～60%
3	38～43%	12	70～80%
4	43～48%	18	85～90%

4. Attentions on Designing Membrane Filtration System

4.1 In order to prevent the film from being cut by hard particles, a reliable 5um security filter without back-washing should be adopted in the design;

4.2 When high-pressure pump starts and stops, water hammer will occur. If it acts directly on the membrane components, it will cause the damage of the membrane components. Therefore, corresponding measures should be taken to prevent it, such as adopting frequency conversion pump, soft starting or installing electric slow-opening door at the outlet of high-pressure pump, etc.

4.3 In the design of reverse osmosis system, it should be noted that there must be enough space at both ends of pressure vessel to facilitate the installation and replacement of membrane elements.

4.4 Reverse osmosis membrane components can not withstand back pressure under any conditions. Static back pressure must be considered in design. The pressure on the water side of the membrane elements at any time should not be higher than that of the feed water/concentrated water. The static back pressure of the composite membrane elements must be less than 5 psi.

4.5 In the design of reverse osmosis system, low pressure flushing of membrane components should be considered at the start-up and shutdown of each system. The flushing water should meet the requirement of reverse osmosis inflow. It is better to use RO product water. For long-term continuous operation system, low pressure flushing procedures should be set, while short-term shutdown and long-term shutdown protection should be considered.

General Low Pressure Flushing Conditions

Use water to flush	Feed water after pretreatment
Pressure	Low pressure (0.1-0.2MPa)
Maximum feed water velocity per vessel	8”: 200 L/min; 4”: 50 L/min
Temperature	25°C
Flushing time	0.5-1.0 min

4.6 The design of reverse osmosis cleaning system should pay attention to cleaning each segment separately. The direction of cleaning should be the same as the direction of operation, and not the reverse cleaning.

4.7 In order to make the reverse osmosis system run safely and reliably, necessary instruments should be set up to monitor the operation process of the system. Generally, there are thermometers, pressure gauges, flow meters, pH meters, conductivity meters, redox potential (ORP) meters to be installed.

The position and function of each instrument are shown in the table below:

Name of instrument	Installation location	Note
Thermometer	Feed water	Membrane elements can be damaged if the temperature is too high; Over-temperature alarm and shutdown protection should be set up
Pressure gauge	Feed water, filter inlet and outlet,Each segment ,inlet/outlet and concentrate water	Used to calculate the differential pressure of each segment; Standardized monitoring of permeate water and desalination rate can also be carried out; Alarm and Automatic Control of Pump
Flow meter	permeate water, concentrate water	It's better to set each segment separately.
Conductivity meter	Feed water , permeate water	Estimated desalination rate of membrane filtration system
PH meter	Feed water	Judging Scaling Tendency and Maintaining Optimum pH Value for Membrane
ORP meter	Feed water	Measurement of water supply after removing residual chlorine by adding sodium bisulfite; Judging whether the amount of reductant is enough
Hardness meter	Feed water, After softening and filtering	Judging whether the feed water meets the requirement of membrane element

5. Reverse Osmosis Membrane Elements Chemical Cleaning Instructions

Once the pretreated feed water has a high SDI_{15} (even within this allowable range), with the increase of operation time, there will be fouling on the surface of reverse osmosis membrane caused by suspended solids, colloids and salt scales. The fouling will result in the performance degradation of membrane elements, such as lower flow rate and/or higher solute permeability and/or increased pressure difference between feed water and concentrated water

The following factors may cause fouling in membrane system:

- Imperfect pretreatment system
- Pretreatment is not working properly
- Inappropriate material selection of the system (pumps and pipelines, etc.)
- Failure of Pretreatment Chemical Dosing System
- Insufficient or untimely flushing after system shutdown
- Improper operation control
- The membrane surface long time accumulation of sediment (barium and silicon scale etc.)
- Change of feed water components or Other Conditions
- Feed water is biologically contaminated

5.1 Cleaning Time

In order to achieve the best cleaning effect, membrane components must be cleaned before a large amount of fouling is produced. If the cleaning is delayed too late, it will be very difficult or impossible to completely remove fouling from the membrane surface and restore the membrane performance to its initial state. The membrane system should be cleaned when the standardized pressure difference between the in-fluent and concentrated water increases by 15%, or the standardized water production decreases by 10%, or the standardized salt permeability increases by 5%

5.2 Fouling Types

It is very important to determine the type of fouling on the membrane surface before cleaning. The best way to determine the type of fouling is to carry out chemical analysis of the residues collected on the SDI test diaphragm in order to determine the main types of pollutants for targeted chemical cleaning.

Without chemical analysis, the color and density of the sediment on the security filters and the fouling intercepted on the membrane surface can be analyzed, and then the fouling can be classified. For example, Brown residues lead us to judge whether it is iron dirt; white residues may be silicon, sandy clay, calcium dirt, etc; lens shape is a feature of inorganic colloids, calcium dirt; biological dirt or organic dirt, in addition to odor analysis, usually can also see that such pollutants present a sticky shape.

5.3 Selection of Cleaning Procedures

To determine the contaminants on the membrane surface, the correct cleaning procedure must be selected. If the fouling is considered to be metal hydroxides, such as iron-containing hydroxides, or calcium fouling, then citric acid cleaning can be used; if the main fouling is determined to be organic matter or microorganisms, then alkaline cleaning method is recommended.

5.4 Effectiveness of Cleaning

Fouling is easily attached to the membrane surface or retained in the inlet channel. Compliance with the recommended cleaning methods usually yields better results. For example, the pressure difference of the whole membrane system should be reduced to the initial value, and the flow rate and desalination rate can be restored. In many cases, several continuous cleaning methods are needed to remove membrane fouling. It is more effective to use cleaning agent alternatively than to use any kind of agent alone.

5.5 Selection and Conditions of Chemical Cleaning Agents

Selection of Chemical Cleaning Agents

Fouling	Preferred chemical cleaning agents	Cleaning conditions	Optional Chemical Cleaning Fluid
Inorganic scale	0.2%HCl	pH: 1–2 Tem<35°C	2.0% citric acid+1.0%$Na_2S_2O_4$+0.5%phosphoric acid
Metallic oxide	1.0%$Na_2S_2O_4$	Tem<35°C	0.5%phosphoric acid、2.0% citric acid
Acid-insoluble scale	0.1%NaOH+1.0%Na_4EDTA	pH: 12 Tem<30°C	SHMP concentration 1%
Inorganic colloid	0.1%NaOH+0.025%Na-SDS		
Silicate deposits	0.1%NaOH+0.025%Na-SDS		0.1%NaOH solution+1.0%Na_4EDTA solution
Microorganism	0.1%NaOH+0.025%Na-SDS		0.1%NaOH solution+1.0%Na_4EDTA solution
Organic Compound	0.1%NaOH+0.025%Na-SDS		0.2%HCl solution, Usually the second step after alkali washing

***Note*:**

The above percentages are all the Mass percentages of their active ingredients.;SHMP refers to sodium hexametaphosphate;Na-SDS refers to Sodium dodecyl sulfonate;Na4EDTA refers to Tetrasodium ethylenediamine tetraacetate.

Conditions of Chemical Cleaning Agents

Chemical cleaning content	Cleaning conditions
Cleaning agent allocation water	Softened or produced water, free of heavy metals, residual chlorine or other oxidants
Cleaning agent dosage	Each 8” element:40-80L;Each 4” element;10-20L (Depending on the level of fouling)
Cleaning operation pressure	Lower pressure (0.1-0.2MPa) normally < 0.3MPa
Cleaning velocity	Each 8” element pressure vessel:6-9m^3/hr ; Each 8” element pressure vessel:1.8-2.3m^3/hr
Cleaning fluid temperature	Normally 25-35°C
Cleaning type	Each element pressure vessel should be recycled and soaked alternately
Cycle period	Suggested every 0.5-1 hour(repeat 2–3 times)
Soaking time	2-24 hours (Depending on the level of fouling)
Cleaning method	better to wash in stages.
Cleaning time	Min.1-2 hours,Depending on the level of fouling and cleaning method

***Note*:**

It is most effective to clean bacterial contaminants with disinfectants and detergents. First disinfect, then decontaminate with detergent.

For the coexistence of multiple pollutants, it usually needs a combination of cleaning methods to achieve good results. The cleaning sequence is usually first iron removal cleaning, then acid cleaning, and then alkaline cleaning.

If the desalination rate after cleaning is not ideal, the surface of the membrane can be washed by acid reagent. Finally, the cleaning solution can be thoroughly washed with pretreated water (preferably RO produced water).

6. Reverse Osmosis Membrane Elements Common Faults

Faults usually occur in at least one of the following situations:

1. When permeate water decreases after standardization, it is usually necessary to increase the operating pressure to maintain the designed permeate water;
2. After standardization, the desalination rate decreases and the conductivity of permeate water increases in reverse osmosis system;
3. With the increase of pressure drop, the pressure difference between permeate and concentrated water increases while maintaining the constant inflow rate.

When the above-mentioned faults occur in the membrane system, the steps of analysis and treatment are as follows:

(1) According to the symptoms, locations and data records of daily operation, it is preliminarily judged which type of pollution belongs to (fouling, scaling, microorganisms, etc.). If there is no daily operation record, water quality analysis of raw and concentrated water and control index of pretreated effluent should be carried out to help analyze the possible causes of the failure.

(2) The causes of the faults were further determined by means of visual inspection, weighing and on-site anatomy of membrane elements.

Visual Inspection: Open the first inlet and second outlet end plates of the pressure vessel, and check the end faces of the membrane elements and the inner walls of the pressure vessel. If the inner walls are slippery and have a fishy smell, there is microbial contamination; if the inner walls feel rough, there is scaling contamination.

Weighing: If the first membrane in the first stage and the last membrane in the second stage are weighed, suspended solids and colloidal contamination may occur if the first membrane in the first stage is heavier; scaling contamination may occur if the last membrane in the second stage is heavier.

On-site anatomy of membrane elements: Observation and analysis of membrane contaminants, adding acid or alkali on the membrane surface to observe the phenomenon.

(3) If the cause of the failure can not be determined from the above two steps, a membrane element can be taken out from the system for comprehensive analysis. Each membrane element manufacturer has this service. The cause of the failure can be basically determined by comprehensive analysis. Comprehensive analysis includes visual inspection, weighing, performance testing, anatomy, membrane contamination analysis, pressure dyeing, chemical treatment, etc.

(4) Through the above analysis, the cause of the failure can be basically determined, and reasonable cleaning scheme and corrective measures can be formulated according to the cleaning method of reverse osmosis membrane system. In addition, the single fault situation is very few, and the overlapping of two or more faults is the most common. The phenomenon presented in this way will become more complex, and the operation data will show overlapping characteristics. Therefore, in order to avoid miscarriage of justice, we should not draw conclusions based on single evidence.

Judgment and analysis of various fouling conditions of membrane elements

NO.	Fault Type	Operating pressure	System (Between Stages) differential pressure	Permeate water	Salt rejection	Notes
1	Microbial contamination	increased	significantly increased	decreased	Unchanged /Slightly decreased	Microbial growth conditions are available, accompanied by the odor of corruption (rotten eggs, fishy odor, odor, etc.), metabolites are black and sticky.
2	Particle fouling	increased	significantly increased	decreased	Unchanged	Particulates can be observed, such as sand, activated carbon, etc.
3	Colloid fouling	increased	significantly increased	decreased	Unchanged / decreased	Flocculants (iron, aluminium or other), colloidal silica in raw water, etc.
4	Metal oxide fouling	increased	increased	decreased	Unchanged /Slightly decreased	Metal oxides, such as brown rust, can be observed.
5	Soluble fouling	increased	increased	decreased	Unchanged / decreased	Scale samples can be dissolved by acid droplets, and calcium carbonate scales can release bubbles.

NO.	Fault Type	Operating pressure	System (Between Stages) differential pressure	Permeate water	Salt rejection	Notes
6	Insoluble fouling	increased	Unchanged /Slightly increased	significantly decreased	Unchanged /Slightly decreased	Common standards such as acid, alkali and disinfectant are ineffective in cleaning, and the cleaning cycle is gradually shortened.
7	Organic contamination	increased	Unchanged /Slightly decreased	significantly decreased	Unchanged /increased	Hazardous organic matter has a clear source and a small but dense amount of pollutants.
8	Oxidant destruction	decreased	Unchanged /Slightly increased	significantly increased	significantly decreased	Pretreatment or raw water containing oxidant, leak detection test and dyeing test can assist in diagnosis.
9	Organic solvents destruction	decreased	Unchanged / increased	increased	decreased	Disruptive solvents in pretreated or raw water
10	Back-pressure destruction	Unchanged	Unchanged	Unchanged /Slightly increased	decreased	If back-pressure occurs, it can be positioned by leak detection test and confirmed by anatomical test.
11	Membrane mechanical rupture	Unchanged / decreased	Unchanged /Slightly increased	increased	significantly decreased	It can be positioned by leak detection test and confirmed by anatomical test.
12	Degumming of Film Line	Unchanged	Unchanged	Unchanged /Slightly increased	significantly decreased	It can be positioned by leak detection test and confirmed by anatomical test.
13	Membrane mechanical scratch	increased	Unchanged / increased	Unchanged	significantly increased	It can be positioned by leak detection test and confirmed by anatomical test.
14	Injury of permeate water pipe	Unchanged	Unchanged	Unchanged	significantly increased	After leak detection and location, the fault can be diagnosed by opening and checking the system.
15	Injury of adapter	Unchanged	Unchanged	Unchanged /Slightly increased	significantly increased	After leak detection and location, the fault can be diagnosed by opening and checking the system.
16	Injury of connector	Unchanged	Unchanged	Unchanged / increased	significantly increased	After leak detection and location, the fault can be diagnosed by opening and checking the system.
17	Injury of adapter O-ring	Unchanged	Unchanged	Unchanged /Slightly increased	increased	After leak detection and location, the fault can be diagnosed by opening and checking the system.
18	Injury of connector O-ring	Unchanged	Unchanged	Unchanged /Slightly increased	increased	After leak detection and location, the fault can be diagnosed by opening and checking the system.

The following will discuss in detail the three main causes of failure, identification methods and preventive measures:

1、 Permeate water decreases after stable operation

After the standardization of RO system, the permeate water decreases. The reasons can be found according to the following three situations:

1. When the first stage of RO system produces less water, there is deposition of particulate pollutants.
2. When the last stage of RO system produces less water, there will be fouling.
3. Water production in all sections of RO system decreases, and then there is fouling.

According to the above symptoms, the location of the problem, determine the cause of the failure, and take appropriate corrective measures, according to the "reverse osmosis membrane elements cleaning instructions" for cleaning. In addition, the reverse osmosis system will have a decline in water production, but also accompanied by a decrease/increase in desalination rate and so on.

Decreasing desalination rate after standardization is the most common system failure, and its possible reason is that:

① Colloid fouling

Reasons for colloid fouling:

a. In pretreatment, the dosage of flocculant is insufficient, the optimum dosage is not determined by beaker test, and the effect of online flocculation is not good;

b. The filtration load of multimedia and activated carbon is too large, the design of filtration flow rate is too large, and back-washing and forward washing are not carried out in time; the pore size of microfiltration or ultrafiltration membranes is too large.

c. SDI and turbidity values are not monitored in daily operation management, and insufficient attention is paid to them.In order to identify colloidal fouling, it is necessary to:

1. Check SDI of the Raw water;
2. Analysis of SDI Testing of Retained Material on membrane Surface;
3. Inspection and analysis of sediments on the end surface of the first membrane element in the first stage.

② Metal oxide fouling

Metal oxide fouling mainly occurs in the first stage, the common cause of failure:

a. Iron, Manganese and Aluminum Containing in feed Water;

b. Intake water contains H2S and air enters to produce sulfide salts;

c. Corrosion products from pipes, pressure vessels and other components.

Means of identifying metal oxide fouling:

a. Observe the contaminants intercepted in the safety filter and the end surface of the first membrane element and the inner wall of the pressure vessel;

b. The first membrane element was picked out and the metal ions on the surface of this membrane were dissected and analyzed.

③ Scaling

Scaling is the deposition of slightly soluble or insoluble salts on the surface of the membrane. It usually occurs in brackish water systems with high hardness, alkalinity and recovery of raw water. It often occurs in the last stage of RO system, and then gradually diffuses forward. The raw water containing calcium, heavy-carbonate or sulfate may scale and block the membrane system within a few hours, while other scales generally form slowly.

Causes of fouling pollution:

a. Water quality analysis of raw water is not carried out, the dosage of scale inhibitor is small or the effect is poor.

b. The hardness of raw water is high and the recovery rate is too high. The precipitation can not be inhibited by adding scale inhibitor alone.

Method of distinguishing scaling or not:

1. Check whether there is scaling on the side of concentrated water in the system and check the inner wall and end plate of pressure vessel if it feels rough;
2. Take out the last membrane element and weigh it. The membrane element with serious scaling is usually heavier;
3. Analysis of raw water quality data.

The possible reason for the decrease of permeate water and the increase of desalination rate after standardization:

(1) **Membrane compaction**

When the membrane is compacted, it usually shows that the permeate water decreases and the desalination rate increases.

Causes of membrane compaction:

a. The feed water pressure is too high to exceed the allowable limit;

b. The feed water temperature is higher, and the water hammer phenomenon is more serious. The instantaneous pressure exceeds the allowable limit value.

Discrimination of membrane compaction: dissection of membrane components, and analysis of the micro-structure of the diaphragm.

(2) **Organic contamination**

Organic matter adsorbed on the surface of membrane elements in the feed water causes flux loss, mostly in the first stage. The causes of organic contamination are basically the same as those of colloidal contamination.

Methods for identifying organic contamination:

a. Analysis of interceptions on filter elements of security filters;

b. Examine pretreated flocculants, especially cation polymers;

c. Analysis of Oil and Organic Pollutants in feed Water;

d. Check detergents and surfactant.

2. **Desalination rate decreases after stable operation**

After standardization, the decline of desalination rate and normal water production are the causes of this symptom:

(1) **"O"-Ring Leakage**

When the "O" ring is lubricated by some incompatible chemicals or damaged by mechanical stress (such as the movement of membrane elements due to water hammer), the "O" ring will leak, sometimes the "O" ring is not installed, and the "O" ring is not installed correctly, which will also lead to leakage. Methods to prevent leakage of O-ring: when lubricating, the formulated lubricant "glycerin" is used; when installing, gaskets are added to prevent the membrane elements from moving back and forth.

(2) **Membrane surface damage**

The damage of membrane surface is mostly caused by the interaction of sharp particles, crystals and water hammer in water.

Measures to Prevent Membrane Surface Damage:

a. Replacement of filter element of security filter in time to prevent sharp and hard particles or activated carbon particles from entering membrane elements in water;

b. Before starting the high-pressure pump, the first step is to exhaust the membrane system, or install an electric slow-opening door, or start the high-pressure pump with frequency conversion to prevent water hammer;

c. When cleaning scaled membrane components, the initial flow rate should be as small as possible to prevent damage caused by excessive flow scouring;

(3) **Back-Pressure**

At any time, when the water production pressure is 0.3 bar higher than the feed water or concentrated water pressure, the composite membrane may be peeled off between layers, thereby damaging the membrane components.

The reasons for the decrease of desalination rate after standardization and the increase of water yield are as follows:

Membrane oxidation

a. When the membrane is exposed to oxidizing substances in water, the membrane is oxidized and destroyed, which is an irreversible chemical damage. Once this happens, only all membrane components can be replaced.

b. Possible Reasons for Membrane Oxidation:

1. Excessive residual chlorine or other oxidizing substances in membrane system water
2. When cleaning and disinfecting, not strictly in accordance with the requirements of cleaning and disinfection, cleaning time or temperature exceed the standard, resulting in membrane oxidation.
3. Whether the membrane element is oxidized or not can be determined by pressure dyeing test.

3、 Increased pressure-drop after stable operation

Pressure difference between feed water and concentrate is called pressure drop, which leads to the decrease of permeate water or desalination rate;The max of pressure drop for each pressure vessel with multi-membranes is 3.5 bar, The max of pressure drop for a single FRP shell is 1 bar. Excessive pressure drop will lead to the “phenomenon of membrane element telescope” and the rupture of FRP shell,which will cause the mechanical damage of membrane element.When the inflow rate is constant, the increase of pressure drop is often due to the presence of pollutants or scales in the element inflow spacer net channel.Once the inflow channel is blocked, it is often accompanied by a decrease in permeate water.

Here are the common causes of increased pressure drop:

① Microbial contamination

Microbial contamination often results in a significant increase in pressure drop across all segments of RO system;Microbial contamination often occurs in systems where water sources are surface water and waste water reuse.

Solutions to microbial contamination:

a. Adding fungicides into the water, pay attention to preventing oxidative fungicides from entering membrane components, and avoid oxidation of membrane components

b. Replace with antioxidant membrane components and add fungicides (including reverse osmosis membrane system) throughout the system.

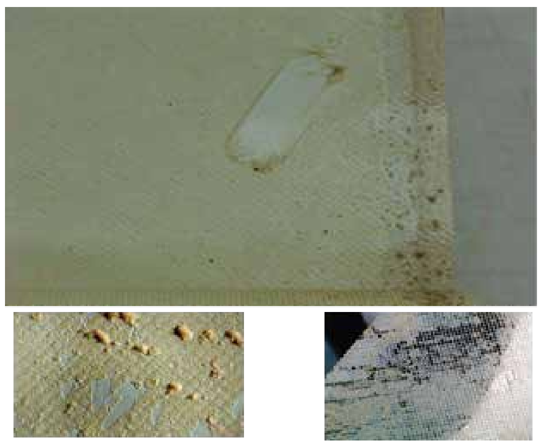
② Fouling pollution

Fouling blockage in the inflow spacer net channel often leads to an increase in the pressure drop of all membrane elements in last segment of the RO system.It is necessary to ensure that appropriate measures are taken to control fouling/scaling, and appropriate chemicals are used to clean membrane components, at the same time controlling the appropriate recovery rate.

Analysis of Scaling/Fouling Membrane Surface

1. Biological contamination on membrane surface

Contamination in feed water end-surface of membrane element



Contamination of membrane sheet surface

2. Fouling of metal oxides

Contamination in feed water end-surface of membrane element

Fouling of membrane filter surface

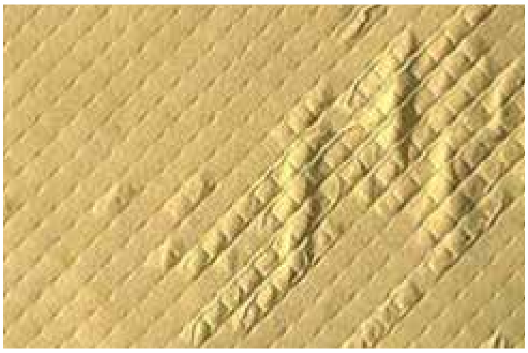
Fouling of membrane filter surface

3. Particulates/Carbonate Scaling

Scaling Particle Pollution on the feed water end-surface of membrane element

Fouling of membrane sheet surface

4. Damage of Back Pressure and High Pressure Difference in Permeate Water



Damage of filter layer caused by back pressure

Damage caused by high pressure difference

NOTES:

Chapter 3 Ultra Filtration Membrane Elements

Ⅰ、Ultra Filtration Membrane Elements Features

1、Ultra Filtration Membrane Elements Features

Ultrafiltration is a screening process using membrane (nano-scale) separation technology. With pressure difference on both sides of the membrane as driving force and ultrafiltration membrane as filtering medium, many tiny micro-pores densely distributed on the surface of ultrafiltration membrane only allow water and small molecule substances and soluble solids to pass through, while substances larger than the micropore diameter on the surface of the membrane in the original solution are intercepted at the inlet side of the membrane and become permeable liquids. The purpose of purifying, separating and concentrating raw liquor is realized by concentrating liquid. Ultrafiltration accuracy ranges from 0.002 to 0.1 microns, and the interception molecular weight ranges from 1,000 to 100,000.

2、Filtration Range of Moistening Membrane Ultrafiltration Membrane：

Macromolecular organic Matter

Fats, oils, proteins, starch, emulsions, latex, pigments, enzymes, fermentation broth, PVA, pigments, nucleic acids, polysaccharides, peptides, pectin, electrophoresis paints, antibiotics, glucose, egg whites, etc.

Microorganisms

Bacteria, viruses, Cryptosporidium, Jia Flagellates, heat sources, parasites, Escherichia coli, vaccines, algae, etc.

Colloid

Colloidal silicon, colloidal aluminum, colloidal iron, etc.

Suspended matter

Metal sediment, suspended solids, etc.

3、Application range of ultrafiltration membrane：

▲ Municipal Waste water Treatment Reuse
▲ Water supply plants for water works
▲ Industrial Waste water Treatment
▲ Reverse Osmosis system pretreatment
▲ Residential and commercial water treatment
▲ Preparation of pure water and ultrapure water for industrial use
▲ Enrichment and purification of bio-pharmaceutical
▲ Antibacterial purification of water in food industry

In order to ensure the excellent performance of the membrane, the surface and supporting structure of the membrane must be controlled during the production of ultrafiltration and microfiltration, and the material of the membrane must also have good mechanical properties. To ensure high strength and flexibility of membrane components. Moreover, the film material should also have excellent chemical resistance.

Common materials include polyvinylidene fluoride (PVDF), polyacrylonitrile (PAN), polyethersulfone (PES), polysulfone (PS), cellulose acetate (CA), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), etc

Characteristics of Ultrafiltration Membrane Materials in Common Use

Material	Hydrophillic nature	Anti-pollution performance	Antioxidant properties	Other characteristics
PAN	good	So so	normal	Good acid resistance
PVDF	normal	good	good	Good acid and alkali resistance, Good temperature resistance.
PVC	bad	bad	So so	Good acid and alkali resistance
PES	normal	So so	So so	Normal acid and alkali resistance, Good temperature resistance.
PP/PE	poor	poor	So so	Good acid and alkali resistance, Good temperature resistance.

4、Runmo Inside-Out Ultra Filtration Membrane Elements：

Using modified PAN material, the ultrafiltration membrane has outstanding separation performance, good oxidation resistance, thermal stability, good mechanical properties and permanent hydrophilicity. Despite the advantages mentioned above, the disadvantage is that the anti-pollution performance is slightly worse. For this reason, we overcome the above shortcomings by modifying the materials and membranes, and make their performance more excellent. Membrane filament has high strength and breakage rate less than three thousandths: Unique central pipe bracket with uniform filament distribution and smooth water flow can prolong the service life of the membrane filament; reliable performance, water washing and medication washing will not affect the normal use of the membrane, according to the water quality conditions, full filtration and cross-flow filtration can be selected.Full-volume filtration has the advantages of energy saving and high water utilization rate; cross-flow filtration can discharge pollutants in time, reduce the times of membrane cleaning and prolong the service life of membrane components. Compared with traditional filtration methods, this system has the advantages of high automation, small floor area (only 1/2 of traditional filtering methods), high filtration accuracy, unattended, and it is a good option of reverse osmosis pretreatment.

5、Runmo Outside-In Ultra Filtration Membrane Elements：

Polyvinylidene fluoride (PVDF) is used as the material, and its greatest characteristic is its high chemical stability.The chemical stability determines its outstanding antioxidant ability and acid and alkali resistance. In order to ensure the normal operation of membrane components and stabilize water flux, it is necessary to clean the membrane regularly. The most effective method is oxidant cleaning. But oxidants can damage the membranes. The ability of polyvinylidene fluoride (PVDF) to withstand oxidants (sodium hypochlorite, etc.) is more than 10 times that of polyethersulfone, polysulfone and other materials, thus greatly prolonging its service life.Polyvinylidene fluoride (PVDF) film also has strong flexibility. The results of practical case investigation show that the PVDF film has the advantage of minimum breakage rate. It has been more and more widely used in the field of sewage treatment.Sketch of characteristics of Runmo PVDF membrane module :

1. High antioxidant and cleaning resistance: High quality polyvinylidene fluoride material determines the enhanced chemical stability of membrane products, and the high chemical stability of membrane makes the membrane resistant to high concentration oxidant cleaning, thus effectively preventing microbial reproduction such as bacteria;
2. High Flux: High Porosity of Products, High Flux of Components;
3. High Strength: Good flexibility: Membrane wire has high strength and good flexibility. It is not easy to break during cleaning;
4. High pollution resistance: through hydrophilic modification, the product's pollution resistance is greatly improved;
5. Good Water quality : Ultrafiltration membrane has a small nominal aperture, so it can remove almost all suspended particles, microorganisms, colloids, pathogens and bacteria in the application of this product;
6. Long service life: Components usually adopt external pressure structure which is not easy to plug. They have larger filtering area and higher pollution interception, easy to clean, and more thorough. They can remove the fouling on the membrane surface in time, so that the service life of the membrane is longer.

Ⅱ. Ultra Filtration Membrane Elements Naming Rules

RM- UF -4046 - XX

W: Outside-In(PVDF material)

N : Inside-Out(PAN material, can be omitted)

D : Double Membrane Elements

4040: Dia 4”,length 40” UF membrane elements

4046: Dia 4”,length 45.5” UF membrane units

160B: Dia 6” UF membrane

8040: Dia 8”,length 40” UF membrane elements

8060: Dia 8”,length 55.7” UF membrane units

8060A : Dia 8”,length 57” UF membrane units

2860: Dia 9”,length 73.2” UF membrane units

2880: Dia 9”,length 92.9” UF membrane units

1060: Dia 10”,length 66.1” UF membrane units

Ultrafiltration membrane series

Registered Trade Mark:
RM -Runmo

Ⅲ. Ultra Filtration Membrane Elements Performance Quick Check

Quick Check Table for Performance of PAN Inside-Out Ultrafiltration Membrane Units

Dia Spec	4’’			6’’	8’’			10’’
Model	UF4040	UF4046	UF4046 short	160B	UF8040	UF8060 UF8060L	UF8060A	UF1060 UF1060D
Membrane area (m^2)	4.0	4.5	2.2	13.7	18	25/26	27	50
Hollow fiber id/od size (mm)	1.0/1.6							
Design Flux (L/h/m^2)	40~120							
Molecular weight cut off (Dalton)	50,000~100,000							
Permeate NTU	＜1							
Max. Operation pressure(MPa)	0.3							
Max. Trans-membrane pressure difference (MPa)	＜ 0.2							
Suggested. Trans-membrane pressure difference (MPa)	0.03~0.15							

Quick Check Table for Performance of PVDF Outside-In Ultrafiltration Membrane Units

Dia Spec	4’’	8’’		6’’	9’’	
Model	UF4046W	UF8060W	UF8060A	UF2660	UF2860	UF2880
Membrane area (m^2)	7.0	40	45	33	55	75
Hollow fiber id/od size (mm)	0.7/1.3					
Design Flux (L/h/m^2)	50~100					
Molecular weight cut off (Dalton)	100,000					
Permeate NTU	＜1					
Max. Operation pressure(MPa)	0.3					
Max. Trans-membrane pressure difference (MPa)	＜ 0.2					
Suggested. Trans-membrane pressure difference (MPa)	0.03~0.1					

Quick Check Table for Performance of PVDF lining MBR Membrane Units

Dia Spec	Hollow fiber tubes 1m long	Hollow fiber tubes 1.5m long	Hollow fiber tubes 2m long
Model	LM10	LM15	LM20
Membrane area (m^2)	10	15	20
Hollow fiber id/od size (mm)	1.1/2.2		
Design Flux (L/h/m^2)	15~30		
Filtering accuracy (μm)	0.1		
Permeate NTU	≤1		
Operation pressure (MPa)	0.01~0.05 (Negative Pressure)		

Remarks:

① *The flux criteria are designed for feed water as : tap water, groundwater, surface water, seawater or sewage from municipal secondary sewage treatment plants meeting the secondary discharge criteria of GB8979-1996.*

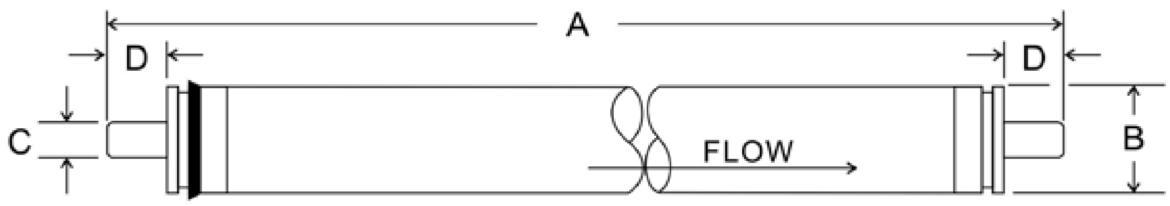
- *Oil content < 2mg/L, water temperature range 5~40℃ ;*
- *PH range (PAN material: 3 ~ 9; PVDF material: 2 ~ 10)*
- *The maximum diameter of influent particles is less than 500 microns, the total TSS of suspended solids is less than 100 mg/L, and the turbidity NTU is less than 70.*

② *It is suggested that the backwashing flux be 0.5-1.5 times of the water production flux,Operating pressure should not exceed 0.3 MPa at any time, even if it exceeds this pressure instantaneously, the membrane structure may be damaged.*

Ⅳ . Ultra Filtration Membrane Elements Sizes Chart

1. Inside-Out Ultra Filtration Membrane Elements Series

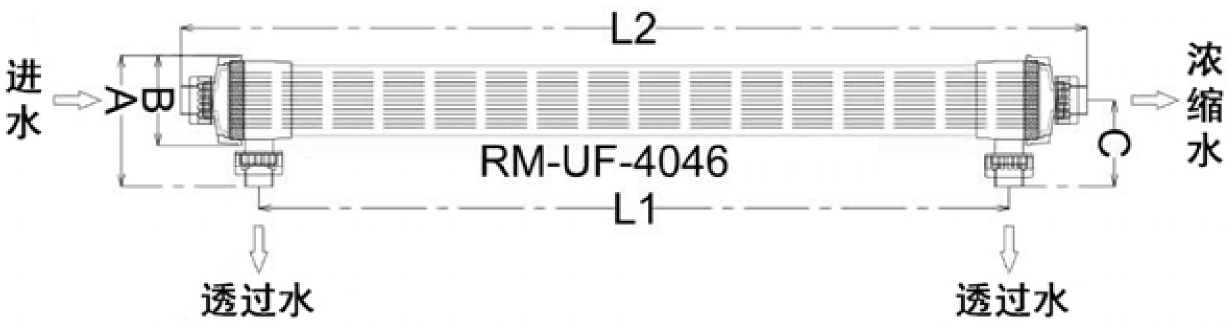
① UF-4040 Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)	D(mm)
RM-UF-4040	1016	101	19.1	27
RM-UF-4021	533.4	101	19.1	27

Basic parameters	Model no.	RM-UF-4040	RM-UF-4021
	Membrane area（m^2）	4	2
	Design Flux (m^3/hr,0.1Mpa,25℃)	0.2	0.1
	Permeate NTU	< 1	< 1
Unit specs	Shell Material	UPVC	
	Pouring form	epoxy resin	
	Sealing Form and Material	O-Ring/EPDM	
	Unit weight（N.W/G.W）	3.4kg/3.6kg	

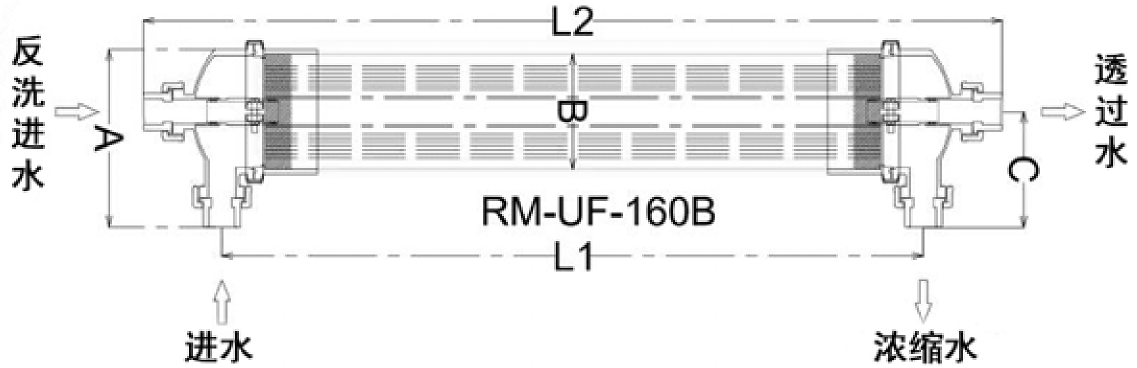
② UF-4046 Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)	L1 (mm)	L2 (mm)
RM-UF-4046	167	115	110	966	1166
RM-UF-4046 short	167	115	110	483	680

Basic parameters	Model no.	RM-UF-4046	RM-UF-4046 short
	Membrane area（m^2）	4.8	2.4
	Design Flux (m^3/hr,0.1Mpa,25℃)	0.3	0.15
	Permeate NTU	< 1	< 1
Unit specs	Shell Material	UPVC	
	Pouring form	epoxy resin	
	Inlet and Outlet	Φ32-UPVC	
	Sealing Form and Material	O-Ring/EPDM	
	Unit weight (N.W/G.W)	4.4kg/4.8kg	

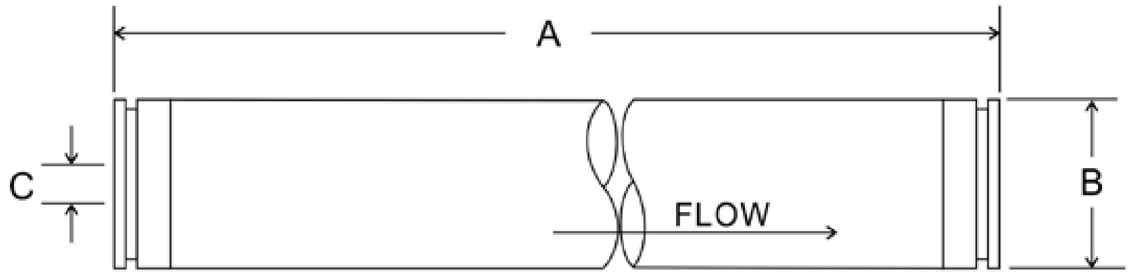
③ UF-160B Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)	L1 (mm)	L2 (mm)
RM-UF-160B	260	160	163	1130	1355

Basic parameters	Model no.	RM-UF-160B
	Membrane area（m^2）	13.7
	Design Flux (m^3/hr,0.1Mpa,25℃)	0.8
	Permeate NTU	＜ 1
Unit specs	Shell Material	UPVC
	Pouring form	epoxy resin
	Inlet and Outlet	Φ40-UPVC
	Sealing Form and Material	O-Ring/EPDM
	Unit weight (N.W/G.W)	13.1kg/16.4kg

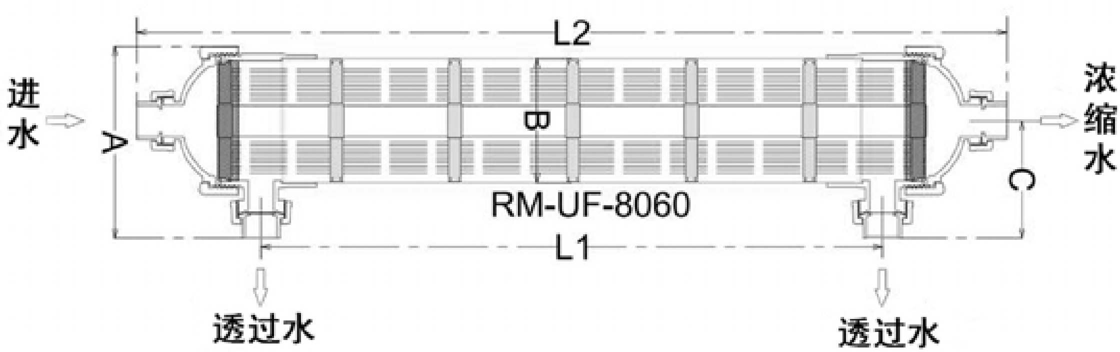
④ UF-8040 Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)
RM-UF-8040	1016	201.9	28.6

Basic parameters	Model no.	RM-UF-8040
	Membrane area（m^2）	21
	Design Flux (m^3/hr,0.1Mpa,25°C)	1.2
	Permeate NTU	< 1
Unit specs	Shell Material	UPVC
	Pouring form	epoxy resin
	Sealing Form and Material	O-Ring/EPDM
	Unit weight（N.W/G.W）	15.7kg/17.9kg

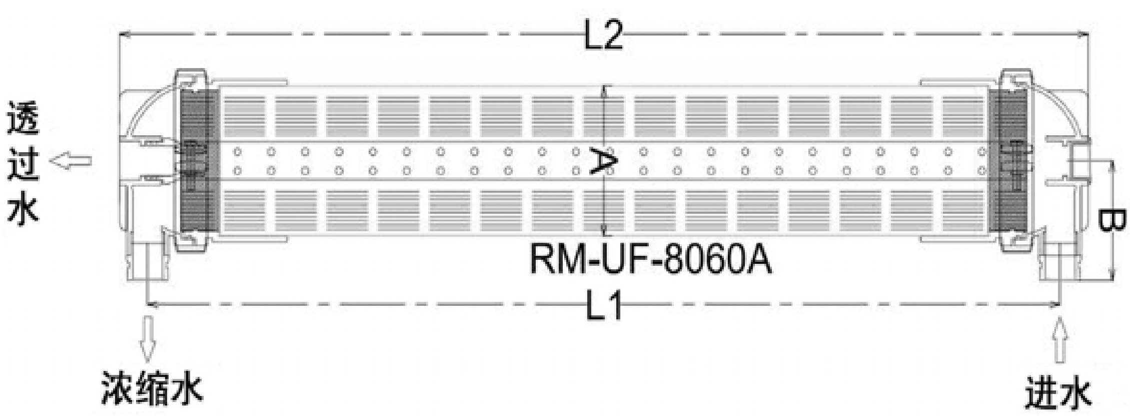
⑤ UF-8060 Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)	L1 (mm)	L2 (mm)
RM-UF-8060	309	200	189	995	1415
RM-UF-8060L	309	200	189	1055	1475

	Model no.	RM-UF-8060	RM-UF-8060L
Basic parameters	Membrane area（m^2）	25	26.4
	Design Flux (m^3/hr,0.1Mpa,25℃)	1.25	1.3
	Permeate NTU	< 1	< 1
Unit specs	Shell Material	UPVC	UPVC
	Pouring form	epoxy resin	epoxy resin
	Inlet and Outlet	Φ50-UPVC	Φ50-UPVC
	Sealing Form and Material	O-Ring/EPDM	O-Ring/EPDM
	Unit weight (N.W/G.W)	25.2kg/28.7kg	25.7kg/29.2kg

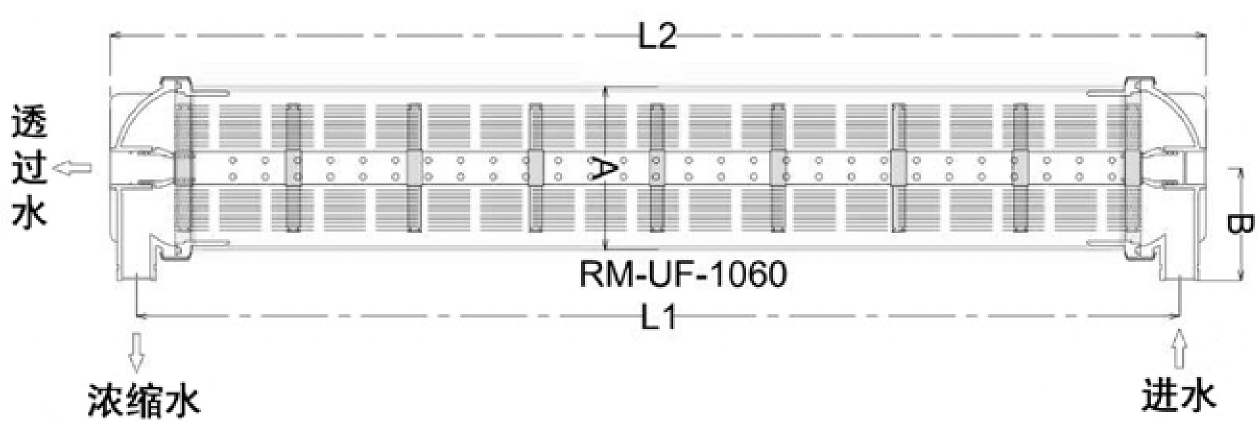
⑥ UF-8060A Ultra Filtration Membrane Elements Sizes Chart

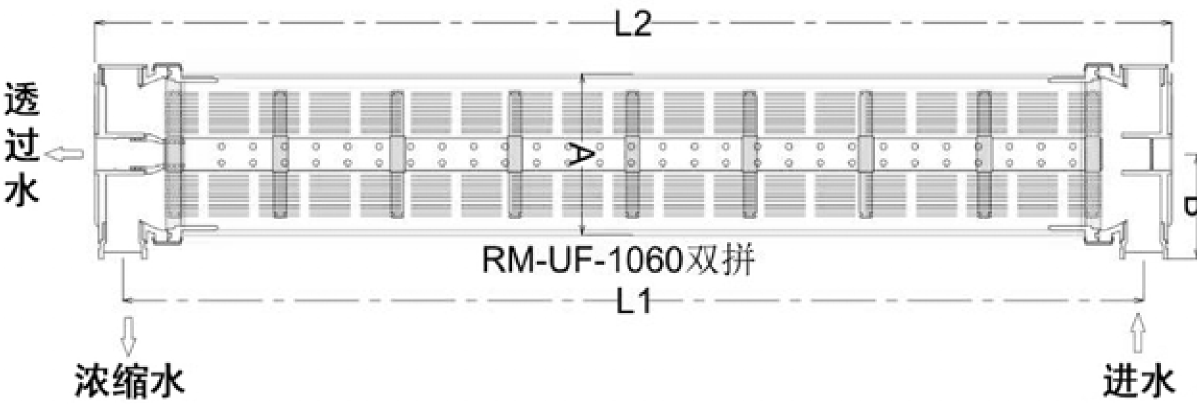


Model No.	A(mm)	B(mm)	L1 (mm)	L2 (mm)
RM-UF-8060A	200	165	1344	1430

Basic parameters	Model no.	RM-UF-8060A
	Membrane area（m^2）	25.9
	Design Flux (m^3/hr,0.1Mpa,25℃)	1.3
	Permeate NTU	＜ 1
Unit specs	Shell Material	UPVC
	Pouring form	epoxy resin
	Inlet and Outlet	Φ50-UPVC
	Sealing Form and Material	O-Ring/EPDM
	Unit weight (N.W/G.W)	25.2kg/28.7kg

⑦ UF-1060(D) Ultra Filtration Membrane Elements Sizes Chart





Model No.	A(mm)	B(mm)	L1 (mm)	L2 (mm)
RM-UF-1060	250	173	1600	1680
RM-UF-1060D	250	173	1614	1780

Basic parameters	Model no.	RM-UF-1060/RM-UF-1060D
	Membrane area （m^2）	51
	Design Flux (m^3/hr,0.1Mpa,25℃)	2.5
	Permeate NTU	< 1
Unit specs	Shell Material	UPVC
	Pouring form	epoxy resin
	Inlet and Outlet	DN50\G65
	Sealing Form and Material	O-Ring/EPDM
	Unit weight (N.W/G.W)	42.8kg/48.5kg

Important information:

The designed water yield and water quality data are for reference only, and the optimal operation flux should be determined according to the actual water quality or the pilot test results.Water production flux is greatly affected by the temperature of treated water: the higher the temperature, the smaller the viscosity of water molecules, the more active the water molecules, thus increasing the water production.The design flux is used to test the design value of water temperature at 25 C. In actual operation, the water yield will change because of the influence of water temperature coefficient. Therefore, the water yield flux can be measured by the water temperature correction formula.:

Actual water production flux = Designed water production flux ÷ C（Temperature Correction Coefficient)

C = 1.0215×（25-T） T = Actual water temperature

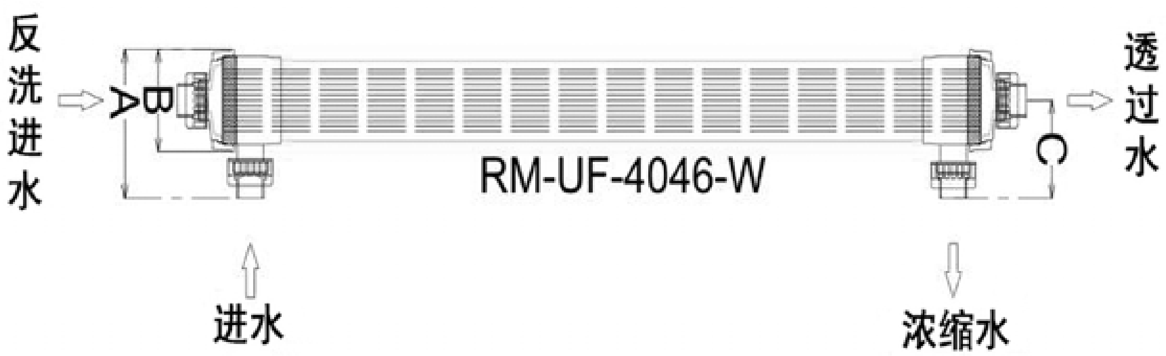
2. Suggested Designs of Inside-Out Ultra Filtration System

Table 1 Suggested design parameters for Flux

Feed water type	Tap water	Underground water	Surface water				Reclaimed Water	Waste water
NTU	< 1	< 2	< 2	< 5	< 15	< 50	< 20	< 20
Security filter	Adopted			Suggested				
Design Flux	90-100	80-90	70-80	70-80	60-70	50-60	50-70	20-40
Recovery rate	95%	90%			85%		80%	70%
Back wash time period	60m		30m	20m				
Back wash time	60s	60s	60s	60s	60s	100s	100s	60s
Back wash pressure	0.15MPa-0.2MPa							
Back wash flow	150-200		100-150				60-100	
Chemical wash	Not suggested		Adopted		Suggested			

3. Outside-In Ultra Filtration Membrane Elements Series

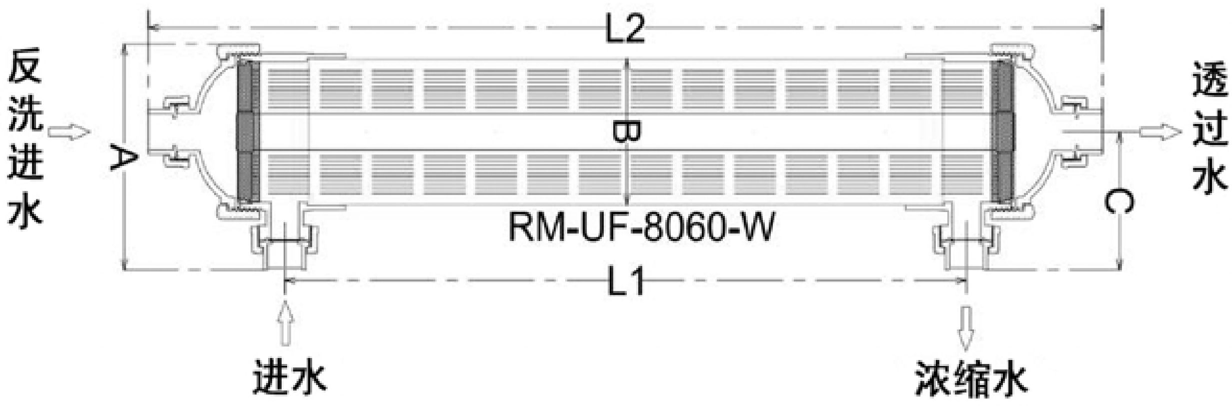
① UF-4046-W Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)	L1 (mm)	L2 (mm)
RM-UF-4046-W	167	115	110	966	1166

Basic parameters	Model no.	RM-UF-4060-W
	Membrane area（m^2）	6.0
	Design Flux (m^3/hr,0.1Mpa,25˚C)	0.3
	Permeate NTU	< 1
Unit specs	Shell Material	UPVC
	Pouring form	epoxy resin
	Inlet and Outlet	Φ32-UPVC
	Sealing Form and Material	O-Ring/EPDM
	Unit weight (N.W/G.W)	4.4kg/4.8kg

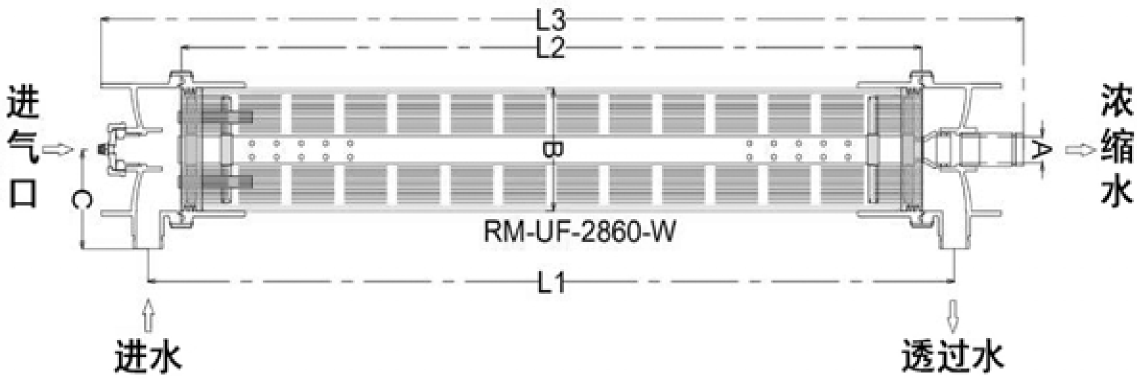
② UF-8060-W Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)	L1 (mm)	L2 (mm)
RM-UF-8060-W	302	200	183.5	995	1415

Basic parameters	Model no.	RM-UF-8060-W
	Membrane area（m^2）	34.9
	Design Flux (m^3/hr,0.1Mpa,25℃)	1.7
	Permeate NTU	＜ 1
Unit specs	Shell Material	UPVC
	Pouring form	环氧树脂
	Inlet and Outlet	Φ50-UPVC
	Sealing Form and Material	O-Ring/EPDM
	Unit weight (N.W/G.W)	25.2kg/28.7kg

③ UF-2860/2880-W Ultra Filtration Membrane Elements Sizes Chart



Model No.	A(mm)	B(mm)	C(mm)	L1 (mm)	L2 (mm)	L3 (mm)
RM-UF-2860-W	50	225	180	1630	1500	1860
RM-UF-2880-W	50	225	180	2130	2000	2360

Basic parameters	Model no.	RM-UF-2860-W	RM-UF-2880-W
	Membrane area（m^2）	55	75
	Design Flux (m^3/hr,0.1Mpa,25˚C)	2.7	3.8
	Permeate NTU	< 1	< 1
Unit specs	Shell Material	UPVC	
	Pouring form	epoxy resin	
	Inlet and Outlet	DN50	
	Sealing Form and Material	O-Ring/EPDM	
	Unit weight (N.W/G.W)	42.5kg/50.5kg	43kg/51kg

4. Suggested Designs of Outside-In Ultra Filtration System

Table 1 Suggested design parameters for Flux

Feed water type	Tap water	Underground water	Surface water				Reclaimed Water	Waste water
NTU	< 1	< 2	< 2	< 5	< 15	< 50	< 20	< 20
Security filter	Adopted			Suggested				
Design Flux	90-100	80-90	70-80	70-80	60-70	50-60	50-70	20-40
Recovery rate	95%	90%			85%		80%	70%
Back wash time period	60m		30m	20m				
Back wash time	60s	60s	60s	60s	60s	100s	100s	60s
Back wash pressure	0.15MPa-0.2MPa							
Back wash flow	150-200		100-150				60-100	
Chemical wash	Not suggested		Adopted		Suggested			

Table 2 Recommended maintenance parameters

Back wash parameters	Mode	Air/water
	Frequency	48 times/day
	Air pressure when back washing	≤150KPa
	Flow	0.5 ~ 1.5 times as permeate water
	Air flow rate	8 ~ 12 Nm^3/h (each membrane unit)
	Operation mode	Every cycle 30mins
Maintainable cleaning	Maintainable cleaning methods	Circulating flushing of low concentration citric acid or sodium hypochlorite solution
	Time required	50min（Including washing time）
	Citric acid Frequency	1 times/1~3days
	Sodium hypochlorite Frequency	1 times/1~3days
	Cleaning flow	1 ~ $2m^3$ /membrane unit
	Maintainable cleaning concentration	300 ~ 500ppm
Restorative cleaning (Chemical cleaning)	Chemical cleaning method	Cyclic flushing alternately between citric acid solution and NaOH+sodium hypochlorite solution
	Chemical cleaning time	90~180min
	Acid washing Frequency	1times/30~90days/system（PH =2）
	NaOH+sodium hypochlorite Frequency	1times/30~90days/system（PH =10）
	Circulating flow	1 ~ $3m^3$/membrane unit
	Chemical cleaning concentration	1000 ~ 3000ppm
	Optimum temperature range of cleaning solution	20 ~ 30˚C

Important information:

The designed water yield and water quality data are for reference only, and the optimal operation flux should be determined according to the actual water quality or the pilot test results.Water production flux is greatly affected by the temperature of treated water: the higher the temperature, the smaller the viscosity of water molecules, the more active the water molecules, thus increasing the water production.The design flux is used to test the design value of water temperature at 25 C. In actual operation, the water yield will change because of the influence of water temperature coefficient.

Actual water production flux = Designed water production flux ÷ C (Temperature Correction Coefficient)

$C = 1.0215 \times (25-T)$　T = Actual water temperature

Ⅴ. Ultra Filtration Membrane Elements Cleaning Instructions:

When the ultrafiltration system works, the impurities such as colloids, suspended solids and macromolecule organic matter in the influent water are intercepted on the surface of the membrane. With the passage of time, the thickness of the impurity layer on the membrane surface increases, which increases the overflow resistance, and the pressure difference across the membrane will increase accordingly.When the trans-membrane pressure difference rises to a certain extent, it is necessary to clean the membrane filament, prevent excessive deposition of pollutants on the membrane filament, and maintain the normal water production capacity of the membrane filament.

Membrane surface will be polluted to varying degrees in the process of filtrate. Therefore, the membrane components need to be cleaned. Users can choose appropriate cleaning agent and cleaning cycle according to their own process.

(1) Physical cleaning

① Forward washing: This operation has no filtering effect. The purpose is to remove the residual material in the module with clean water. When the clean water passes through the outside of the fiber filter at a certain flow rate, the membrane pollutants can be washed out. At this time, the concentrated water valve is fully open and the water production valve is completely closed. The cleaning time depends on the specific situation, generally 3-10 minutes.;

② Back-washing: The operation is in reverse with the filtration process. Under a certain pressure, the clean water (tap water or membrane filtered water) is permeated from the raw water to the raw liquid side, and the contaminants on the feed side and the blockages infiltrated into the micropore are washed out. In practice, the back-washing frequency and intensity can be determined by monitoring the parameters such as trans-membrane pressure difference, cumulative working time and membrane flux.;

③ Soaking: Membrane components can be soaked in water or liquid medicine. Soaking can make pollutants loose. Soaking for a certain time is often an effective way to remove pollution.;

④ Gas-water back-washing (for external pressure membrane elements): While back-washing of membrane components, a certain amount of compressed air is introduced into the intake, and hollow fiber membranes will swing due to the action of updraft, thus achieving friction and collision, so that pollutants adhering to the surface of hollow fiber membranes are peeled off and discharged from the sewage outlet.。

(2) Restorative cleaning (chemical cleaning)

In most cases, physical cleaning method can be used to achieve better decontamination effect for PAN and PVDF hollow fiber membranes. If physical cleaning is not ideal, chemical cleaning is needed.

① In the continuous membrane filtration equipment system, chemical cleaning is usually carried out once every 3 to 5 weeks, and water treatment agents with excellent bactericidal properties such as NaClO and ClO 2 can be used to carry out systematic bactericidal treatment;NaClO/NaOH solution was used to remove organic contamination, acid or EDTA sodium salt solution was used to remove inorganic salt fouling and other contamination, so that membrane flux was restored.

② Alkali cleaning: Use 0.I%~0.2% NaOH solution, circulate within the membrane system (<0.05 MPa) for 20 minutes, soak for 20~40mins, then rinse with water to neutral.Solid alkali must be fully dissolved before it is prepared.

③ NaClO cleaning: 300-3000ppm (0.3-3% volume ratio) NaClO solution for 40-60mins. This cleaning agent is suitable for microbial contamination. The available chlorine of general industrial NaClO is 10%.

④ Dilute acid cleaning: soak in HCL solution with concentration of 0.1-0.3% for 40-60mins.This cleaning agent is suitable for inorganic pollution, such as high hardness water quality. Generally, the daily Cl concentration is 30%.In addition to HCL (30%), oxalic acid (0.3%), citric acid (0.05mol/L), nitric acid (O.1mol/L) can also be used for cleaning.EDTA sodium salt, can use disodium salt, tetrasodium salt, the general concentration is 0.5-2%.The concentration varies according to the concentration of the medicines sold in the market. In addition, the concentration varies with the season.It is suggested that the drug be used before it is confirmed by experiments and other methods. The temperature of standard solution is 20-30℃ .

(3) Maintenance cleaning

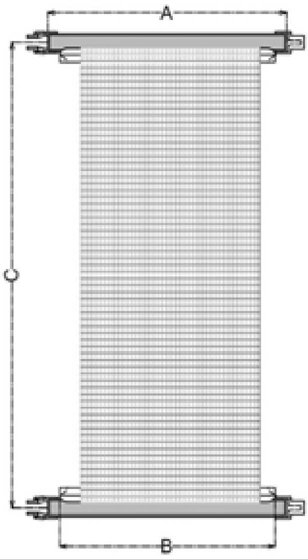
The basic process is the same as the restorative cleaning, but the cleaning time is shorter, and the concentration of reagent is lower than the restorative cleaning. Maintenance cleaning is usually done once or twice a day.

Ⅵ． PVDF lining MBR Membrane Elements Series

LM10、LM15、LM20 units data:

Model No.	A(mm)	B(mm)	C(mm)
RM-LM10	535	45	1010
RM-LM15	535	45	1515
RM-LM20	535	45	2000

Basic parameters	Model No.	RM-LM10	RM-LM15	RM-LM20
	Membrane area (m2)	10	15	20
	Design Flux L/m2/h	15 ～ 30		
	Permeate NTU	＜ 1		



Ⅶ． Suggested Designs of MBR System

Parameters	Membrane material	PVDF
	Bore hole	0.1μm
	Hollow fiber id/od	0.8/1.5 ; 1.2/2.3
	Water catchment pipe	ABS
Operation Conditions	Filtering mode	Negative pressure type
	Operation pressure	0.01 – 0.05MPa
	Operation Temperature	5-45℃
	pH value range	2-11
	Maximum residual chlorine concentration in feed water	200mg/L（Maximum residual chlorine concentration of cleaning agent 5000mg/L）
	Suggested air-water ratio	20:1-40:1
Operation mode	Operation time/day	18 hours
	Operation cycle	Permeate 8mins；Aeration 2mins
Backwash conditions	Backwash frequency	Decision based on specific water sources and water production
	Backwash time	Decision based on specific water sources and water production
	Backwash flow	Twice the actual permeate
	Backwash pressure	＜0.1MPa
Clean In Place	Chemical Clean In Place frequency	Weekly-monthly (Adjustment according to specific water quality and water production conditions)
	Chemical Clean In Place time	120 mins
	Chemical Clean In Place agent	Sodium hypochlorite cleaning 0.1%NaClO；acid washing：0.1%HCL or 0.5% citric acid alkali cleaning：0.05%NaOH + 0.1%NaClO (Effective chlorine)
Impregnated chemical cleaning	Impregnated chemical cleaning frequency	3-6months (Adjustment according to specific water production situation)
	Impregnated chemical cleaning time	2-6 hours
	Cleaning fluid temperature	20-40℃

Note:

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Chapter 4 Engineering Projects

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