KeenSen®

RO and NF Membrane Element Products Manual (2019)

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KeenSen®

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Company Profile

Hunan Keensen Technology Co., Ltd., established in 2008, located in high-tech development district, Changsha (Lu Valley · Hunan · China), specializing in R&D, production, sales and service for reverse osmosis and nanofiltration membrane elements.

Keensen has the top technology ,automatic membrane sheet and element production line . It has the annual output capability of six million square meters membrane sheet. Keensen has made significant breakthrough in material formulation, processing skills, testing and products application ,including RO and NF membranes, hundreds of membrane flat sheets and elements. Moreover, OEM or ODM orders were acceptable.

Keensen membranes have been widely applied in the drinking water, sewage, seawater, brackish water treatment, and material concentration and separation, and enjoyed many customers in steel industry, electricity, civil engineering, medicine, food and beverage, hospital both in the domestic and overseas market.

Corporate Philosophy: Technology Creates the Future, Low Carbon Changes the World.

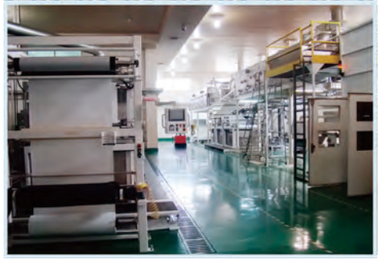
Vision: To Be the Leading Manufacturer and Service Provider of Professional Separation Membrane Products in Worldwide.

Service Philosophy: Based on concept of service dedication, Keensen established an one-stop customer centralized service system, created a worry-free brand, providing the customer with characteristic, fast, high-quality and credible service through attentive service concept, concentrated service image, patient service attitude and careful service process. The customers can fully experience Keensen's perseverance and responsibility.

Service Including:

- OEM or ODM Service for Flat Sheet Membrane and Element.
- Model Selection and Calculation for Flat Sheet Membrane and Element.
- Water Quality Analysis and Tests Training.
- Bug Diagnosis and Analysis of Membrane System.
- Designs and Evaluations of Membrane System.
- Membrane System Maintenance and Staff Training.

Technology Creates the Future
Low Carbon Changes the World



History

2008 Hunan Keensen Technology Co., Ltd. was founded.

2011 Casting and coating lines installed.

2012 Achieved the ISO9001 quality management system certificate.

2013 Achieved the wading health and safety license.

2015 Achieved USA National Sanitation Foundation "NSF58" certificate in July, and identified as "New and High-tech Enterprise" in October.

2014 Passed safety standard in September, and it was identified as Hunan famous trademark in December.

2016 Reverse osmosis membrane joint R&D base was founded.

2016 Keensen was awarded the second prize of technology by China Membrane Industry Association in April, and achieved "AAA Grade Evaluation for Enterprise Credit " in June.

Achieved USA National Sanitation Foundation “NSF 61” certificate in December, and developed Keensen RO System design software.

Enterprise Qualification

NSF/ANSI 58,61(National Sanitation Foundation)

ISO9001:2008–
English Version

Sanitary Permit of Nanofiltration
Membrane Elements

Sanitary Permit of Reverse
Osmosis Membrane Elements

Member of MIAC

Hi–tech Energy Conservation and
Environmental Protection Certificate

Member of Drinking water
Products Committee

Advanced Environmental Protection Unit

Member Institution

Work Safety Standardization Certificate

Independent Brand Award

AAA Grade Evaluation for
Enterprise Credit

High–tech Enterprise

Reverse Osmosis Membrane
Joint R&D Base

Famous Brand of Hunan Province

Science and Technology Awards
Honored by Membrane
Industry Association of China

Member of HPECEPA

Member of CDA

Patent Certificate

Invention Patent—
A High Rejection Rate, High Flux,
Controllable and Composite RO Membrane
Elements & Making Process

Invention Patent—
Control Method and System
for Spacer Welding Machine

Invention Patent—
Spacer Welding Machine

Invention Patent—
A Method for Improving Oxidation
Discoloration of RO Membrane Elements

Invention Patent—
A Cleaning Method and Fluid
for RO Membrane Elements

Utility New Model Patent—
A Performance Test Equipment
of RO Membrane Elements.

Utility New Model Patent—
A Dyeing Test Device of
Reverse Osmosis Membrane

Utility New Model Patent—
A Dedicated Cutting Device of
Reverse Osmosis Membrane Housing

Utility New Model Patent—
A Membrane Housing End Plugging
Device Used for Membrane
Testing System

Utility New Model Patent—
A Stereo Storage Rack for
Reverse Osmosis Membrane

Utility New Model Patent—
A Dyeing Test Device to
Analyze the Glue Lines of
RO Membrane Elements

Utility New Model Patent—
A Solvent Drum Seal Cap

Keensen has declared thirty kinds of patents which included ten invention patents and eighteen utility model patents by keeping innovating. It has been authorized eight invention patents and fifteen utility model patents at present.

Models and Applications of Membrane Elements

Models

- Reverse osmosis (RO) and nanofiltration (NF) membrane elements can be divided into “industrial", "commercial", "residential" three series according to the application field.
- RO membrane has brackish water (BW), ultra-low pressure (ULP), extreme low pressure (XLP), fouling resistant (FR), sea water desalination model (SW) etc. according to its performance.
- NF membrane has high flux (NF2), high rejection (NF1), material separation model (NF-F) etc. according to its performance.
- Flat sheet membrane types：brackish water (BW), high rejection(ULP-HR), high flux(ULP), extreme low pressure (XLP), high rejection (NF1), high flux (NF2).

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Application Fields

Keensen RO and NF membrane elements can be widely used in municipal drinking water supply, surface water reuse, sea water desalination, landfill leachate treatment, coal chemical industry, power generation, pharmaceuticals, wine, process water of food industry, textile printing and dyeing, electroplating industry, and aviation aerospace field, etc.

No.	Membrane Series	Membrane Type	Model	Application Field
1	Industrial Series	XLP	XLP-8040HR/4040HR	Municipal Water Pure Preparation (TDS<1000ppm)
2			XLP-8040/4040	
3		ULP	ULP-8040HR/4040HR	Municipal and Underground Water Preparation (TDS<1500ppm)
4			ULP-8040MR/4040MR	
5			ULP-8040/4040	
6		BW	BW-8040HR/4040HR	Desalination Processing for Brackish and Surface Water (TDS 2000-8000ppm)
7			BW-8040/4040	
8		BW-FR	BW-8040FR/4040FR	Reuse of Recycled Water and Waste Water Treatment
9			BW-8040XLFR/4040XLFR	
10			BW-8040MXFR	
11		BW-OR	BW-8040-OR/4040-OR	Chlorine Resistant Ability：2000ppm/12.5h, Rejection Rate >98%
12		BW-HF	BW-8040HF/4040HF	Industrial and municipal areas
13		SW	SW-8040HR/4040HR	Sea Water Desalination
14			SW-8040MR	
15			SW-8040/4040	
16		NF	NF1-8040/4040	Direct Drinking Water ,Spring Water and Low Pressured Boiler Softened Water Preparation
17			NF1-8040R/4040R	
18			NF2-8040/4040	
19		NF-F	NF1-8040F/4040F	Concentration and Separation, Sea Water Concentration and Separation for Salt Making, Reuse of Recycled Water
20			NF2-8040F/4040F	
21	Commercial Series	XLP	XLP-4021/2540/2521	Automatic Water Dispenser, Pure Water Machine in Medical Laboratory, Direct Drinking Equipment in Office
22		ULP	ULP-4021/2540/2521	
23		BW	BW-4021/2540/2521	
24		SW	SW-4021/2540/2521	Small-sized Sea Water Equipment for Deslination of Seawater or High Concentration of Brackish Water.
25		NF	NF1-4021/2540/2521	Mineral Water Machine, Energy Machine
26			NF2-4021/2540/2521	
27	Residential Series	RO	RO-1512/1812/2012/2812 RO-3012/3013/3020	Household Direct Drinking Water
		NF	NF-1812/2012/2812/3012/3013	

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Performance of Common Industrial Membrane Element

No.	Membrane Series	Membrane Model	Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable Rejection Rate (%)	Concentration of Solution (ppm) (NaCl / $MgSO_4$)	Operating Pressure psi(MPa)	Recovery Rate (%)
1	Industrial Series	XLP	XLP-8040HR	400(37.2)	9000(34.1)	99.3	NaCl：500	100(0.69)	15
2			XLP-8040	400(37.2)	11000(41.6)	99.2			
3			XLP-4040HR	85(7.9)	2000(7.6)	99.3			
4			XLP-4040	85(7.9)	2400(9.1)	99.2			
5		ULP	ULP-8040HR	400(37.2)	9000(34.1)	99.7	NaCl：1500	150(1.03)	
6			ULP-8040MR	400(37.2)	10000(37.8)	99.6			
7			ULP-8040	420(39.0)	12000(45.4)	99.3			
8			ULP-4040HR	85(7.9)	1800(6.8)	99.7			
9			ULP-4040MR	85(7.9)	2200(8.3)	99.6			
10			ULP-4040	85(7.9)	2600(9.8)	99.3			
11		BW	BW-8040HR	400(37.2)	9500(35.9)	99.7	NaCl：2000	225(1.55)	
12			BW-8040	400(37.2)	10500(39.7)	99.6			
13			BW-4040HR	85(7.9)	2000(7.6)	99.7			
14			BW-4040	85(7.9)	2400(9.1)	99.6			
15		BW-HF	BW-8040HF	400(37.2)	12000(45.4)	99.3	NaCl：2000	150(1.03)	
16			BW-4040HF	85(7.9)	2800(10.5)	99.3			
17		BW-FR	BW-8040FR	365(34.0)	9000(34.1)	99.7	NaCl：2000	225(1.55)	
18			BW-4040FR	78(7.2)	2000(7.6)	99.7			
19			BW-8040XLFR	400(37.2)	10500(39.7)	99.6			
20			BW-4040XLFR	85(7.9)	2200(8.3)	99.6			
21			BW-8040MXFR	440(41)	12000(45.4)	99.6			
22		BW-OR	BW-8040-OR	400(37.2)	9000(34.1)	99.5	NaCl：2000 NaClO:2000	225(1.55)	
23			BW-4040-OR	85(7.9)	2000(7.6)	99.5			
24		SW	SW-8040HR	400 (37.2)	6500(24.6)	99.8	NaCl：32000	800(5.5)	8
25			SW-8040MR	400 (37.2)	7500(28.3)	99.7			
26			SW-8040	400 (37.2)	9000(34.1)	99.7			
27			SW-4040HR	78 (7.2)	1500(5.7)	99.8			
			SW-4040	85 (7.9)	1800(6.8)	99.7			
28		NF1 NF2	NF1-8040R	400(37.2)	8500(32.2)	>85(NaCl) 99($MgSO_4$)	NaCl：500 $MgSO_4$：2000	70(0.48)	15
29			NF1-8040	400(37.2)	10000(37.8)	50-70(NaCl) 98($MgSO_4$)			
30			NF2-8040	400(37.2)	12000(45.4)	30-50(NaCl) 97($MgSO_4$)			
31			NF1-4040R	85(7.9)	1800(6.8)	>85(NaCl) 99($MgSO_4$)			
32			NF1-4040	85(7.9)	2000(7.6)	50-70(NaCl) 98($MgSO_4$)			
33			NF2-4040	85(7.9)	2400(9.1)	30-50(NaCl) 97($MgSO_4$)			
34		NF1-F NF2-F	NF1-8040F	400(37.2)	10500(39.7)	98 ($MgSO_4$)	$MgSO_4$：2000	70(0.48)	
35			NF1-4040F	78(7.2)	2000(7.6)				
36			NF2-8040F	420(39.0)	12000(45.4)	97 ($MgSO_4$)			
37			NF2-4040F	78(7.2)	2200(8.3)				

Performance of Common Commercial and Residential Membrane Element

No.	Membrane Series	Membrane Model	Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable Rejection Rate (%)	Concentration of Solution (ppm) (NaCl / $MgSO_4$)	Operating Pressure psi(MPa)	Recovery Rate (%)
1	Commercial Series	XLP	XLP-4021	36(3.34)	800(3.04)	99.2	NaCl: 500	100(0.69)	15
2			XLP-2540	27(2.50)	600(2.27)				8
3			XLP-2521	14(1.30)	300(1.13)				
4		ULP	ULP-4021	36(3.34)	950(3.6)	99.3	NaCl: 1500	150(1.03)	15
5			ULP-2540	27(2.50)	750(2.84)				8
6			ULP-2521	14(1.30)	400(1.51)				
7		BW	BW-2540	36(3.34)	800(3.04)	99.6	NaCl: 2000	225(1.55)	15
8			BW-4021	27(2.50)	1000(3.8)				8
9			BW-2521	14(1.30)	350(1.32)				
10		SW	SW-4021	36(3.34)	800(3.04)	99.7	NaCl: 32000	800(5.5)	4
11			SW-2540	27(2.50)	600(2.27)				8
12			SW-2521	14(1.30)	300(1.13)				4
13		NF	NF1-4021	36(3.34)	900(3.4)	50-70(NaCl) 97($MgSO_4$)	NaCl: 500 $MgSO_4$: 2000	70(0.48)	
14			NF1-2540	27(2.50)	700(2.64)				15
15			NF1-2521	14(1.30)	300(1.13)				
16			NF2-4021	36(3.34)	1100(4.16)	30-50(NaCl) 96($MgSO_4$)			
17			NF2-2540	27(2.50)	800(3.04)				
18			NF2-2521	14(1.30)	350(1.32)				
19	Residential Series	RO	RO-1512-50	2(0.19)	50(0.19)	96	According to GB34914-2071《Reverse OsmosisWater Purifier Water Efficiency Limit Value and Water Efficiency Rating》standard, the test solution is prepared with anhydrous $CaCl_2$ 277.5ppm, anhydrous $NaHCO_3$ 268.87ppm, NaCl 50ppm.	60(0.41)	50
20			RO-1812-50	4(0.37)	50(0.19)	97			
21			RO-1812-75	4(0.37)	75(0.28)				
22			RO-2012-100	6(0.56)	100(0.38)				
23			RO-2012-150	6(0.56)	150(0.57)				
24			RO-2812-200	10(0.93)	200(0.76)				
25			RO-3012-300	14(1.30)	300(1.14)				
26			RO-3013-400	17(1.58)	400(1.51)				
27			RO-3012-600	14(1.30)	600(2.27)			100(0.69)	
28			RO-3013-700	17(1.58)	700(2.64)				
29			RO-3020-1000	27(2.51)	1000(3.78)				
30		NF	NF-1812	4(0.37)	100(0.38)	30-50(NaCl) 96($MgSO_4$)	NaCl: 500 $MgSO_4$: 2000	60(0.41)	15
31			NF-2012	6(0.56)	150(0.57)				
32			NF-2812	10(0.93)	250(0.95)				
33			NF-3012	14(1.30)	350(1.32)				
34			NF-3013	14(1.30)	400(1.51)				

Performance of Common Flat Sheet Membrane

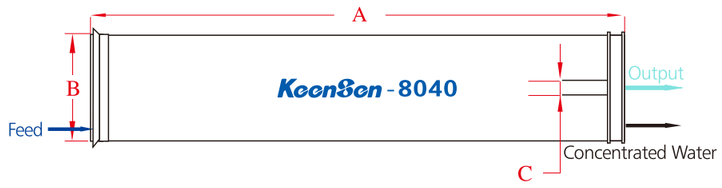
No.	Project / Model	Membrane Model	Min. Rejection Rate (%)	Permeate Flow(GFD)	Test Condition			
					Temperature	pH Value	Concentration of Feed Water	Operating Pressure psi(MPa)
1	RO	XLP	99.2	≥55	25℃	7.5-8.0	500ppm (NaCl)	100psi (0.69MPa)
2		BW	99.6	≥35			2000ppm (NaCl)	225psi (1.55MPa)
3		ULP-HR	99.6	≥30			1500ppm (NaCl)	150psi (1.03MPa)
4		ULP	99.4	≥45				
5	NF	NF1	60-80(NaCl) >99($MgSO_4$)	≥40(NaCl) ≥35($MgSO_4$)			500ppm (NaCl) 2000ppm ($MgSO_4$)	70psi (0.48MPa)
6		NF2	30-50(NaCl) >97($MgSO_4$)	≥45(NaCl) ≥40($MgSO_4$)				
7	SW	SW	>99.7(NaCl) >90(Boron)	≥25			32000ppm (NaCl))	800psi (5.5MPa)

Membrane flat sheet performance can be customized

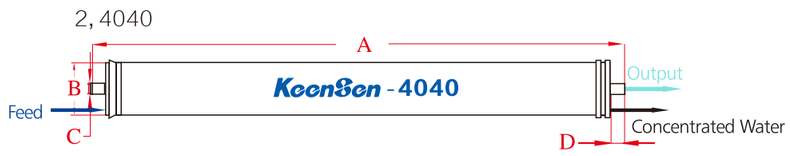
Industrial Series

Membrane Element Size

1, 8040



2, 4040



	8040	4040	tolerance Value
A	40.0"(1016mm)	40.0"(1016mm)	1.0mm
B	7.9"(201mm)	3.9"(99mm)	1.0mm
C	1.12"(28.5mm)	0.75" (19.1mm)	0.5mm
D	/	1.04" (26.5mm)	0.5mm

Industrial Series

Extreme Low Pressure RO Membrane Element

Model No.: XLP-4040/8040 , XLP-4040HR/8040HR

Usage: It is applicable to the desalination of municipal water, groundwater with salt concentration less than 1000ppm. It can be widely used in pure water preparation and related industries.

Features: It can save energy and increase economic efficiency with its advantage of extreme low working pressure.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable. Rejection Rate (%)
XLP-8040HR	400(37.2)	9000(34.1)	99.3
XLP-8040	400(37.2)	11000(41.6)	99.2
XLP-4040HR	85(7.9)	2000(7.6)	99.3
XLP-4040	85(7.9)	2400(9.1)	99.2

Standard Test Condition:

Concentration of Solution (NaCl)	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
500ppm	25	7.5-8	100(0.69)	15

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element:

Max. Working Pressure	600 psi(4.14MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	17.0m^3/h (8040) 、3.6m^3/h (4040)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	2-11
pH Range of Feed Water during Chemical Cleaning	1-13
Max. Pressure Drop of Single Membrane Element	15psi(0.1Mpa)

Industrial Series

Ultra Low Pressure RO Membrane Element

Model No.: ULP-4040HR/8040HR (High Rejection)
ULP-4040MR/8040MR , ULP-4040/8040

Usage: It is applicable to the desalination of municipal water, groundwater with salt concentration less than 1500ppm. It can be widely used in residential dual water supplying system, pure water preparation plant, industry, food production and other fields etc..

Features: High rejection rate and low working pressure.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable. Rejection Rate (%)
ULP-8040HR	400(37.2)	9000(34.1)	99.7
ULP-8040MR	400(37.2)	10000(37.8)	99.6
ULP-8040	420(39.0)	12000(45.4)	99.3
ULP-4040HR	85(7.9)	1800(6.8)	99.7
ULP-4040MR	85(7.9)	2200(8.3)	99.6
ULP-4040	85(7.9)	2600(9.8)	99.3

Standard Test Condition:

Concentration of Solution (NaCl)	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
1500ppm	25	7.5-8	150(1.03)	15

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element:

Max. Working Pressure	600 psi(4.14MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	$17.0m^3/h$ (8040) 、$3.6m^3/h$ (4040)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	2-11
pH Range of Feed Water during Chemical Cleaning	1-13
Max. Pressure Drop of Single Membrane Element	15psi(0.1Mpa)

KeenSen®
Industrial Series

Brackish Water、Fouling Resistant、Oxidation Resistant and Energy Saving RO Membrane Element

Model No.: BW-8040/4040、BW-8040HR/4040HR(High Rejection)、BW-8040FR/4040FR、
BW-8040XLFR/4040XLFR(Fouling Resistant)、BW-8040-OR/4040-OR(Oxidation Resistant)、BW-8040HF/4040HF(High Flux)

Usage: BW-8040/4040/FR/XLFR:It is applicable to the desalination of surface water, groundwater and water treatment with salt concentration between 2000 and 8000ppm.It can be widely used in the medicine, chemical industry, beverage, electricity and other various industries etc.

BW-8040/4040HR:It is applicable to treatment with high hardness、high fluorine content groundwater and surface water in northwest China.

BW-8040-OR/4040-OR:It is applicable to the municipal desalination processing for brackish and industrial wastewater.

BW-8040HF/4040HF:It is the latest energy-efficient model.

Features: High rejection rate, large flux ,excellent anti-fouling and energy-saving property.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable. Rejection Rate (%)
BW-8040	400(37.2)	10500(39.7)	99.6
BW-8040HR	400(37.2)	9500(35.9)	99.7
BW-8040FR	365(34.0)	9000(34.1)	99.7
BW-8040XLFR	400(37.2)	10500(39.7)	99.6
BW-8040MXFR	440(41)	12000(45.4)	99.6
BW-8040-OR	400(37.2)	9000(34.1)	99.5 Chlorine resistant ability :working in 12.5hoursunder 2000ppm NaClO,rejection > 98
BW-8040HF	400(37.2)	12000(45.4)	99.3
BW-4040	85(7.9)	2400(9.1)	99.6
BW-4040HR	85(7.9)	2000(7.6)	99.7
BW-4040FR	78(7.2)	2000(7.6)	99.7
BW-4040XLFR	85(7.9)	2200(8.3)	99.6
BW-4040-OR	85(7.9)	2000(7.6)	99.5 Chlorine resistant ability :working in 12.5hours under 2000ppm NaClO,rejection > 98
BW-4040HF	85(7.9)	2800(10.5)	99.3

Industrial Series

Standard Test Condition：

Concentration of Solution (NaCl)	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)	Model
2000ppm NaCl Solution	25	7.5–8	225(1.55)	15	BW–8040/FR/HR/XLFR BW–4040/FR/HR/XLFR
2000ppm NaCl Solution 2000ppm NaClO Solution	25	7.5–8	225(1.55)	15	BW–8040–OR/4040–OR
2000ppm NaCl Solution	25	7.5–8	150(1.03)	15	BW–8040HF/4040HF

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element：

Max. Working Pressure	600 psi(4.14MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	17.0m^3/h (8040)、3.6m^3/h (4040)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	2–11
pH Range of Feed Water during Chemical Cleaning	1–13
Max. Pressure Drop of Single Membrane Element	15psi(0.1Mpa)

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Industrial Series

High Rejection and High Flux Nanofiltration Membrane Element

Model No.: NF1–8040/4040, NF1–8040R/4040R (High Rejection), NF2–8040/4040 (High Flux)

Usage: It is applicable to the desalination of direct drinking water, spring water, boiler water, also desalination and decolorization of wastewater with high salt concentration.

Features: It has the selective desalination mechanism for removal of high polyvalent ions and partial maintaining of monovalent ions with health benefits. Moreover, the equipment operating cost can be reduced effectively with the advantage of low working pressure.

Specifications and Parameters：

Model	Active Membrane Area ft^2(m^2)	Permeate Flow GPD(T/D)	Rejection Rate(%)	
			500ppm NaCl	2000ppm $MgSO_4$
NF1–8040R	400(37.2)	8500(32.2)	>85	99
NF1–8040	400(37.2)	10000(37.8)	50–70	98
NF2–8040	400(37.2)	12000(45.4)	30–50	97
NF1–4040R	85(7.9)	1800(6.8)	>85	99
NF1–4040	85(7.9)	2000(7.6)	50–70	98
NF2–4040	85(7.9)	2400(9.1)	30–50	97

Standard Test Condition：

Concentration of Solution	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
500ppm(NaCl) 2000ppm($MgSO_4$)	25	7.5–8	70(0.48)	15

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element：

Max. Working Pressure	600 psi(4.14MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	17.0m^3/h (8040)、3.6m^3/h (4040)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	2–11
pH Range of Feed Water during Chemical Cleaning	1–13
Max. Pressure Drop of Single Membrane Element	15psi(0.1Mpa)

Industrial Series

Material Separation Nanofiltration Membrane Element

Model No.: NF1-8040F/4040F (High Rejection)
NF2-8040F/4040F (High Flux)

Usage: It is applicable for the removal or concentration of dye, removal of heavy metal and the concentration and desalination of whey protein. It will intercept divalent ions and higher ions preferentially, the interception of monovalent ions will be affected by the liquid concentration. This membrane model was widely applied to the desalination and decoloration treatment on the raw water, such as surface water, landfill leachate, dyeing wastewater, coking plant waste water, etc.

Features: Low working pressure and good restoration after cleaning.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Rejection Rate(%)
			2000ppm $MgSO_4$
NF1-8040F	400(37.2)	10500(39.7)	98
NF1-4040F	78(7.2)	2000(7.6)	98
NF2-8040F	420(39.0)	12000(45.4)	97
NF2-4040F	78(7.2)	2200(8.3)	97

Standard Test Condition:

Concentration of Solution ($MgSO_4$)	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
2000ppm	25	7.5-8	70(0.48)	15

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element:

Max. Working Pressure	600 psi(4.14MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	17.0m^3/h (8040) 、3.6m^3/h (4040)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	2-11
pH Range of Feed Water during Chemical Cleaning	1-13
Max. Pressure Drop of Single Membrane Element	15psi(0.1Mpa)

KeenSen®

Industrial Series

Sea Water Desalination Membrane Element

Model No.: SW-8040/4040 , SW-8040HR/4040HR
SW-8040MR

Usage: It is applicable to the desalination of raw water with salt concentration between 15000ppm and 40000ppm, and make removal for the boron is more than 90%. This membrane model was widely applied to the desalination of sea water and high concentration brackish water, concentration and recycle treatment for high salt wastewater.

Features: High rejection rate and large flux.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable. Rejection Rate (%)
SW-8040HR	400 (37.2)	6500(24.6)	99.8
SW-8040MR	400 (37.2)	7500(28.3)	99.7
SW-8040	400 (37.2)	9000(34.1)	99.7
SW-4040HR	78 (7.2)	1500(5.7)	99.8
SW-4040	85 (7.9)	1800(6.8)	99.7

Standard Test Condition:

Concentration of Solution (NaCl)	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
32000ppm	25	7.5-8	800(5.5)	8

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element:

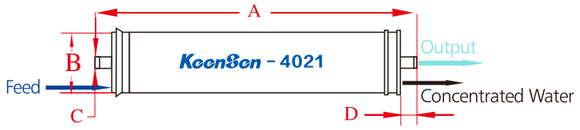
Max. Working Pressure	1200 psi(8.3MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	17.0m^3/h (8040) 、3.6m^3/h (4040) 1.4m^3/h(2540)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	2-11
pH Range of Feed Water during Chemical Cleaning	1-13
Max. Pressure Drop of Single Membrane Element	15psi(0.1Mpa)

Commercial Series

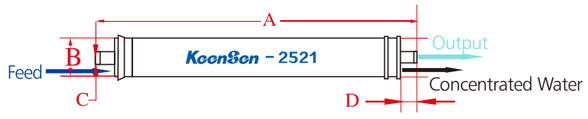
Membrane Element Size

1, 2540

2, 4021



3, 2521



	2540	4021	2521	tolerance Value
A	40.0"(1016mm)	21.0"(533mm)	21.0"(533mm)	1.0mm
B	2.4"(61mm)	3.9"(99mm)	2.4"(61mm)	1.0mm
C	0.75" (19.1mm)	0.75" (19.1mm)	0.75" (19.1mm)	0.5mm
D	1.12" (28.5mm)	1.04" (26.5mm)	1.12" (28.5mm)	0.5mm

KeenSen®

Commercial Series

Keensen Commercial Series Ro Membrane Element

Model No.: XLP-4021/2540/2521 , ULP-4021/2540/2521 BW-4021/2540/2521 , SW-4021/2540/2521

Usage: It is widely used for automatic water dispenser in residential area and school, direct drinking equipment in office, pure water machine in medical laboratory， small-sized desalination device etc.

Features: High rejection rate and low working pressure.

Specifications and Parameters：

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable. Rejection Rate (%)
XLP-4021	36(3.4)	800(3.04)	99.2
XLP-2540	27(2.5)	600(2.27)	99.2
XLP-2521	14(1.3)	300(1.13)	99.2
ULP-4021	36(3.4)	950(3.6)	99.3
ULP-2540	27(2.5)	750(2.84)	99.3
ULP-2521	14(1.3)	400(1.51)	99.3
BW-4021	36(3.4)	1000(3.78)	99.6
BW-2540	27(2.5)	800(3.04)	99.6
BW-2521	14(1.3)	350(1.32)	99.6
SW-4021	36(3.4)	800(3.04)	99.7
SW-2540	27(2.5)	600(2.27)	99.7
SW-2521	14(1.3)	300(1.13)	99.7

Standard Test Condition：

Concentration of Solution (NaCl)	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
1500ppm (For ULP series) 500ppm (For XLP series) 2000ppm (For BW series) 32000ppm (For SW series)	25	7.5-8	ULP:150(1.03) XLP:100(0.69) BW/225(1.55) SW/800(5.5)	15(2540) 8 (4021/2521) 4 (4021/2521) 8(2540)

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element：

Max. Working Pressure	600 psi(4.14MPa) SW:1000psi(6.9Mpa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	$3.6m^3/h$ (4021) $1.4m^3/h$ (2540、2521)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	3-10
pH Range of Feed Water during Chemical Cleaning	2-12
Max. Pressure Drop of Single Membrane Element	10psi(0.07Mpa)

Commercial Series

Keensen Commercial Series NF Membrane Element

Model No.: NF1-4021/2540/2521 , NF2-4021/2540/2521

Usage: It is applicable to the desalination of raw water with salt concentration 500ppm, and it was widely used for small household water purifier, mineral water machine and energy machine etc.

Features: It has the selective desalination mechanism for removal of high polyvalent ions(heavy metal ion) and partial maintaining of monovalent ions with health benefits. Moreover, it only needs low operating pressure.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Rejection Rate(%)	
			500ppm NaCl	2000ppm $MgSO_4$
NF1-4021	36(3.4)	900(3.4)	50-70	97
NF1-2540	27(2.5)	700(2.64)	50-70	97
NF1-2521	14(1.3)	300(1.13)	50-70	97
NF2-4021	36(3.4)	1100(4.16)	30-50	96
NF2-2540	27(2.5)	800(3.04)	30-50	96
NF2-2521	14(1.3)	350(1.32)	30-50	96

Standard Test Condition:

Concentration of Solution	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
500ppm(NaCl) 2000ppm($MgSO_4$)	25	7.5-8	70 (0.48)	15(2540) 8 (4021/2521)

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element:

Max. Working Pressure	600psi(4.14MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water Flow	3.6m^3/h (4021) 1.4m^3/h (2540、2521)
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	3-10
pH Range of Feed Water during Chemical Cleaning	2-12
Max. Pressure Drop of Single Membrane Element	10psi(0.07Mpa)

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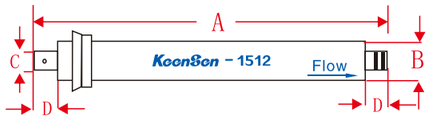
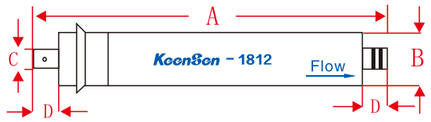
Residential Series Membrane Element Size

1, 1512



A	298mm	± 1mm
B	35mm	± 1mm
C	17.0mm	± 0.5mm
D	21.5mm	± 0.5mm

2, 1812

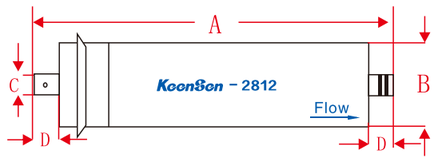


A	298mm	± 1mm
B	43mm	± 1mm
C	17.0mm	± 0.5mm
D	21.5mm	± 0.5mm

3, 2012

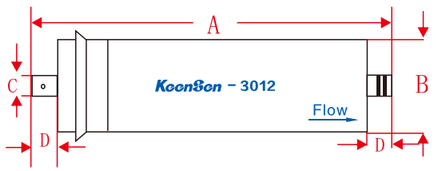
A	298mm	± 1mm
B	47mm	± 1mm
C	17.0mm	± 0.5mm
D	21.5mm	± 0.5mm

4, 2812



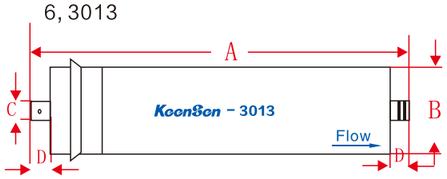
A	298mm	± 1mm
B	67mm	± 1mm
C	17.0mm	± 0.5mm
D	21.5mm	± 0.5mm

5, 3012



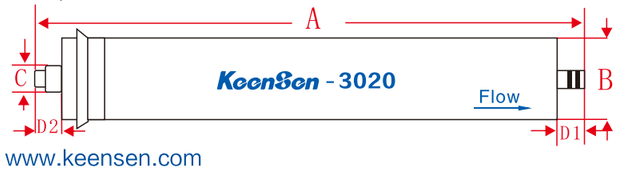
A	298mm	± 1mm
B	70mm	± 1mm
C	17.0mm	± 0.5mm
D	21.5mm	± 0.5mm

6, 3013



A	333mm	± 1mm
B	69mm	± 1mm
C	21.5mm	± 0.5mm
D	21.5mm	± 0.5mm

7, 3020



A	512mm	± 1mm
B	75mm	± 1mm
C	26mm	± 0.5mm
D1	25.5mm	± 0.5mm
D2	23.5mm	± 0.5mm

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Residential Series

Keensen Residential Series RO Membrane Element

Model No.: RO-1512-50 (Special Membrane Flat Sheet)
RO-1812-50/75、RO-2012-100/150、RO-2812-200、
RO-3012-300、RO-3013-400、RO-3012-600、
RO-3013-700、RO-3020-1000

Usage: It is widely applicable to household water purification, direct drinking in building or office and other small water purification equipment etc.

Features: High rejection rate and low working pressure.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Stable. Rejection Rate (%)
RO-1512-50	2 (0.19)	50 (0.19)	96
RO-1812-50	4 (0.37)	50 (0.19)	97
RO-1812-75	4 (0.37)	75 (0.28)	97
RO-2012-100	6 (0.56)	100 (0.38)	97
RO-2012-150	6 (0.56)	150 (0.57)	97
RO-2812-200	10 (0.93)	200 (0.76)	97
RO-3012-300	14 (1.30)	300 (1.14)	97
RO-3013-400	17 (1.58)	400 (1.51)	97
RO-3012-600	14 (1.30)	600 (2.27)	97
RO-3013-700	17 (1.58)	700 (2.64)	97
RO-3020-1000	27 (2.51)	1000 (3.78)	97

Standard Test Condition:

Concentration of Solution (NaCl)	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)	Model
According to GB34914-2071 《Reverse Osmosis Water Purifier Water Efficiency Limit Value and Water Efficiency Rating》 standard, the test solution is prepared with anhydrous $CaCl_2$ 277.5ppm, anhydrous $NaHCO_3$ 268.87ppm, NaCl 50ppm.	25	7.5-8	60 (0.41)	50	RO-1512-50 RO-1812-50/75 RO-2012-100/150 RO-2812-200 RO-3012-300/3013-400
	25	7.5-8	100 (0.69)	50	RO-3012-600 RO-3013-700 RO-3020-1000

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element:

Max. Working Pressure	300psi(2.07MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	3-10
pH Range of Feed Water during Chemical Cleaning	2-12
Max. Pressure Drop of Single Membrane Element	10psi(0.07Mpa)

KeenSen®

Residential Series

Keensen Residential Series NF Membrane Element

Model No.: NF-1812/2012/2812/3012/3013

Usage: It is applicable to the desalination of raw water with salt concentration less than 500ppm. It can be widely applied to various small size household water purification, mineral water machine and energy machine etc.

Features: It has the selective desalination mechanism for removal of high polyvalent ions and partial maintaining of monovalent ions with health benefits. Moreover, it has the advantage of ultra-low operating pressure.

Specifications and Parameters:

Model	Active Membrane Area $ft^2(m^2)$	Permeate Flow GPD(T/D)	Rejection Rate(%)	
			250ppm NaCl	250ppm $MgSO_4$
NF-1812	4 (0.37)	100 (0.38)	30-50	96
NF-2012	6 (0.56)	150 (0.57)	30-50	96
NF-2812	10 (0.93)	250 (0.95)	30-50	96
NF-3012	14 (1.30)	350 (1.32)	30-50	96
NF-3013	14 (1.30)	400 (1.51)	30-50	96

Standard Test Condition:

Concentration of Solution	Temperature (℃)	pH Value	Operating Pressure psi(MPa)	Recovery Rate (%)
250ppm(NaCl) 2000ppm($MgSO_4$)	25	7.5-8	60 (0.41)	15

Notes: The permeate flow of single membrane element may vary with in ± 15%.

Operating Limits and Conditions of Membrane Element:

Max. Working Pressure	300psi(2.07MPa)
Max. Feed Water Temperature	45 ℃
Max. Feed Water SDI_{15}	5.0
Free Chlorine Concentration of Feed Water	0.1mg/L
pH Range of Feed Water during Continuous Operation	3-10
pH Range of Feed Water during Chemical Cleaning	2-12
Max. Pressure Drop of Single Membrane Element	10psi(0.07Mpa)

OEM and ODM Orders Accepted

1.Customized Membrane Sheet

Special membrane sheet what is according to the customers' flux and rejection rate requirement.

2.Customized Membrane Element

Special size and performance of membrane element what is according to the customers' requirement.

3.Customized Requirement

Customers should provide the technical specification document for customized product to Keensen's sales manager or application engineer (AE).

Information about Component Packaging

1512/1812/2012 Packing information

Size	315mm*315mm*330mm		
Product Type	Residential 1512	Residential 1812	Residential 2012
Dry Type Membrane Gross Weight	5kg	6.2kg	7.6kg
Quantities Per Box	25pcs	25pcs	25pcs
Maximum Cartons Per Pallet	45		
Cautions	Place upward, protect against sun, moisture and pressure		

2812/3012/3013 Packing information

Size	345mm*345mm*345mm		
Product Type	Residential 2812	Residential 3012	Residential 3013
Dry Type Membrane Gross Weight	7.6kg	9.2kg	9.4kg
Quantities Per Box	16pcs	16pcs	16pcs
Maximum Cartons Per Pallet	45		
Cautions	Place upward, protect against sun, moisture and pressure		

8040 Packing information

Size	1130mm*240mm*250mm
Product Type	Industial 8040
Dry Type Membrane Gross Weight	12.8kg
Quantities Per Box	1pcs
Maximum Cartons Per Pallet	28
Cautions	Place upward, protect against sun, moisture and pressure

4040/2540 Packing information

Size	1090mm*115mm*130mm	
Product Type	Industial 4040	Commercial 2540
Dry Type Membrane Gross Weight	3.4kg	1.8kg
Quantities Per Box	1pcs	1pcs
Maximum Cartons Per Pallet	108	
Cautions	Place upward, protect against sun, moisture and pressure	

4021/2521/3020 Packing information

Size	570mm*115mm*130mm		
Product Type	Commercial 4021	Commercial 2521	Residential 3020
Dry Type Membrane Gross Weight	1.9kg	1.1kg	1.3kg
Quantities Per Box	1pcs	1pcs	1pcs
Maximum Cartons Per Pallet	192		
Cautions	Place upward, protect against sun, moisture and pressure		

Purchase Confirmation of Membrane Sheets' Technical Specification

Quality Requirement	☐ According to the Keensen's standard ☐ According to the customer's requirement	Usage	
Information Customer Provided	☐ Design drawing (including product size and logo) ☐ Purchasing technical specification ☐ Packaged sample		
Special Specifications	Membrane Sheets Types	Membrane Sheets Series	Quantity (Roll)	Remark 1
	☐RO ☐NF	☐ BW ☐ ULP-HR ☐ ULP ☐ NF1 ☐ NF2		☐500m/roll ☐1000m/roll
Special Specifications and Parameters	Rejection Rate (%)	Membrane Flux GFD (NaCl)	Time for Stable Performance(h)
	☐NaCl ☐$MgSO_4$		
Test Condition	Temperature	pH Value	Concentrate Flow
	25℃	7.5-8.0	1.1GPM
	Concentration of Feed Water	Operating Pressure	Remark 2 (optional)
	NaCl ☐500ppm ☐1500ppm ☐2000ppm $MgSO_4$ ☐2000ppm	☐225psi (1.55MPa) ☐150psi (1.03MPa) ☐70psi (0.48MPa)	
Approved	Approved by Customer Signature: Date:		Approved by Engineer Signature: Date:

Purchase Confirmation of Membrane Elements' Technical Specification

Quality Requirement	☐ According to the Keensen's standard ☐ According to the customer's requirement		Usage	
Information Customer Provided	☐ Design drawing (including product size and logo) ☐ Purchasing technical specification ☐ Packaged sample			
Special Specifications	Membrane Elements Types	Membrane Sheets Series	Quantity	Remark 1(optional)
	☐ RO ☐ NF			
Special Specifications and Parameters	Rejection Rate (%)	Membrane Flux GFD (NaCl)	Time for Stable Performance(h)	
	☐NaCl ☐$MgSO_4$	(± 15%)	Dry: Wet:	
Test Condition	Temperature	pH Value	Recovery Rate	
	25℃	7.5-8.0		
	Concentration of Feed Water	Operating Pressure	Remark 2 (optional)	
	NaCl ☐500ppm ☐1500ppm ☐2000ppm $MgSO_4$ ☐2000ppm	☐225psi (1.55MPa) ☐150psi (1.03MPa) ☐100psi (0.69MPa) ☐70psi (0.48MPa) ☐60psi (0.41MPa)		
Approved	Approved by Customer Signature: Date:		Approved by Engineer Signature: Date:	

Guide to Design of RO and NF System

According to the water quality of feed and requirements of output, users need to design the membrane system with reasonable recovery rate and permeate flow in unit membrane area by applying suitable model membranes to achieve the high efficiency.

If the designed permeate flow of unit area is much higher than the reasonable value, it will greatly rises the membrane fouling rate and reduces the permeate flow, meanwhile, the membrane system will need much more extra cost for maintaining. To extend membranes service life, the recovery rate should be designed with 15%. However, some users need to design the higher recovery rate (more than 18%) to improve the system efficiency. Therefore, it is necessary to choose the reasonable array about membrane system to achieve the higher system recovery rate. Such as series or parallel design which can extend the membranes service life and also save the energy.

Detailed design advice:

1. As for the single membrane system, the system recovery rate can be improved to 50% by adjusting the backflow device of concentrated water; if the membrane system designed recovery rate is higher than 18% without concentrated water backflow device, the membranes cannot achieve the best performance and it will lead to fouling or damage for membrane.

2. As for single stage membrane system (single pressure vessel), it can adopt series design with two or more membranes to improve the membrane system recovery rate. But the system recovery rate should be higher than 50 %(sea water should be higher than 45%)

3. As for multi-stage membrane system, it can achieve the high recovery rate by designing membrane housing in series, or first connected in parallel then connected in series. The detailed suggestion as below:

For 1-2 core pressure vessels, recovery rate of membrane system can achieve to 40-60% by using three stage arrays (4:2:1)

For 3-5 core pressure vessels, recovery rate of membrane system can achieve to 55-70% by using two stage arrays (2:1).

For 6 core pressure vessels, recovery rate of membrane system can achieve to 75% by using two stage arrays (2:1).

For 6 core pressure vessels, recovery rate of membrane system can achieve to 85%-90% by using three stage arrays (4:2:1).

Note:It is normal that the membrane element will still have different degrees of contamination under the correct working condition, which will decrease the permeate flow.

Feed Quality Requirements of RO and NF Membrane System

As a kind of new type physical desalination technology, membranes have special structure, material and desalination mechanism. So quality of feed water has strict requirements, which is crucial to maintaining the good separation performance, extending the working life and economize the operating cost.

Items		Permissible Value	Probably Consequence of Excessive Standard	Improvement Suggestions
Suspended Solids	Turbidity	<1.0NTU	Sludge, Colloid Pollution	Flocculation and Filtration
	SDI_{15}	<5		
Metal Oxides	Fe(mg/L)	<0.05	Iron Pollution	Oxidation, Precipitation/ Filtration
	Mn(mg/L)	<0.05	Manganese Contamination	Application of Dispersing Agents
Scale Forming Matter	$CaCO_3$	LSI<0	Concentrated Water Side does not Permit Scaling	Decrease Recovery Rate, pH Value, or Add Scale Inhibitor
	Other Insoluble Salt	/		
Organics	Oil	0	Organics and Oil Pollution	Air Flotation, Absorption
	TOC (mg/L)	<10	Organics Pollution	Activated Carbon Absorption, Filtration
	COD_{cr} (mg/L)	<20		
	BOD_5 (mg/L)	<10		
Si (mg/L)		<20	Colloid Pollution	
pH		3-10	Too Low or too High pH will Accelerate the Aging Speed of Membrane	Regulation of Acid-Base
Temperature		5-45℃	Low Temperature will Easy Produce Scaling of Undissolved Salt High Temperature will Accelerate the Aging Speed of Membrane	Heat Exchanger
Oxidizer	Residual Chlorine (mg/L)	<0.1	Membrane System will be Oxidized	Reductant or Activated Carbon Absorption
	Ozone and Others	0		

Note:

1. Membrane has a certain residual chlorine resistance capability (200-1000ppm HR), and when it's in the different temperature, pH value and other conditions, the damage speed of residual

chlorine is different to aromatic polyamide membrane. Hence, it must keep the residual chlorine of feed water under 0.1mg/L；

2. Iron and manganese in feed water cannot be higher than 0.05mg/L. They usually dissolved in water with bivalent or present with insoluble trivalent hydroxide. If the concentration of iron and manganese are higher than 0.05mg/L, and they are oxidized by air to form the Fe $(OH)_3$ and $Mn(OH)_2$, precipitate will be existed in the membrane system when the pH value is higher than standard level.

3. Silicon usually exists in most of nature water with 1-100mg/L concentration. When the pH value is lower than 9.0, Silicon will be exist in Si $(OH)_4$. When the pH value is too low, it will form colloidal silica. When the pH value is higher than 9.0, it will exist in SiO_3^{2-} or form hydrate precipitation through combine with calcium, magnesium， iron, or plumbum.

4. Water alkalinity is mainly formed by HCO_3-. When the pH Value is higher than 8.3, HCO_3- will transfer to be CO_3^{2-} . Raw water will be concentrated in the process of RO and NF system, so $CaCO_3$ is easy to form the scaling matter in the system.

5. If one or more above indicators in non-compliance, which may have following influence for membranes or permanent damage.

●Membrane elements are oxidized by residual chloride or contaminated by metal oxide.

●Suspended solid may plug the membrane elements, even following with serious colloidal contamination.

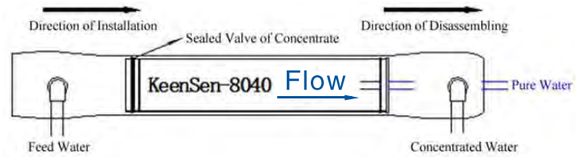
●An increasing output of CODcr may occur as a result of organic and microbiological contamination.

Membrane Installation and System Operating Maintenance

——To Improve the Utilization Efficiency and Extend the Working Life

1.Installation and Disassembling of Membrane Element (Please see the below image)

Installation: The concentrated water V-groove seal on the inlet side is opposite to the feed water inlet direction. Membrane element force direction is same as feed water, and please kindly use the professional tool to push the membrane element into housing.



Disassembling: When users remove the membrane element, the direction should be consistent with install process. Installer need to stably push the membrane element from the side of inflow. Please notice the connection of central connector, adapter and central tube of element. Avoid installing or disassembling forcefully. Make sure to use the water or glycerin as lubricant.

The inner length of membrane element's pressure vessel has a little surplus size, which enables membrane element length to change in a small range. However, the surplus size may result in a gap between the adapter and membrane element after installation. Membrane element will slide back and forth in the pressure vessels during the process of boot and shut down the system because of the gap, which will accelerate the damage of sealing element. Besides, pressure vessels will extend when pressure rises. In extreme condition, the component closer to inflow water side and concentrated water maybe drop from end-plate, which will cause more serious leakage. Installers should adjust membrane axial clearance of membrane element in pressure vessels to decrease the axis motion, thus to ensure the firm seal between the inner joint and the front and the elements ends.

2. Initial Operation Notice of Membrane Element System

(1). Before the system booting, operator should inspect all the notice in operation checklist in the situation that raw water did not enter the membrane element, which including completely wash the pre-treatment section to prevent the impurities and other contaminants from entering the high pressure pump and membrane element, check the effluent SDI15 value of pre-treatment, residual chlorine of inflow water should be lower than 0.1mg/L, inflow water cannot have oxidizer, etc.

(2). Operator should fully ensure all the setting of valves is correct after careful inspection. Drain valve, inlet valve, concentrate valve of membrane system should be totally switched on. Pre-treatment system should use the low pressure and low flow expels the air in the membrane element and pressure vessel. The flushing pressure should control between 2.5 to 3 bars.

(3).Five hours of cleaning in low working pressure or one to two hours of flush recommended,

when the wet or dry type of new membranes installed. One to two hours of flush again recommended after soaking in 1–2 hours. The wet membrane system usually will reach the stable performance after 12 hours continuously working. The dry membrane system may need around 48 hours or longer time working to reach the stable performance .

(4). Open the inlet valve slowly after started the high pressure pump. Evenly raise the flux of concentrate to the designed value. The rate of pressure rise should be lower than 0.7bar per second.

(5). Inspect the quality of production water after one hour continuously operating of membrane system. Record the initial data of operating system. Then switch on the qualified water valve and switch off the drain off valve to deliver the water to following device.

3. Notice of Membrane System Halt

Membrane system stop running for 15–30 days is short-term halt. Operator should wash the membrane system and completely release the air per each five days. Switch off the related inlet valves and drain valve after washing. If the raw water quality is bad, please use the permeated flow of RO or NF system cleans the membrane system.

If membrane system needs to halt more than 30 days and membrane element still have to remain in pressure vessel, membrane system must wash with chemical cleaning after its stop. Then recycle wash the membrane system with the 1% sodium bisulfite of disinfection and fill the membrane system to achieve the purpose of long term storage. If water temperature is higher than 27℃, bactericide needs to change per each 15 days. When the membrane system start to work next time, please use the low pressure and high flux permeated flow clean the membrane system at least one hour till the permeated flow is to be the standard of qualified water.

4. The Cleaning of Membrane System

(1). Standard of Cleaning

The film of membrane element will be contaminated by inorganic salt, microbial, colloidal solid and not soluble organics after a period of running. These contaminants are deposited on the surface of membrane film, which cause the standard flux rate and salt rejection rate decline or even deteriorate. Membrane system needs to chemical clean when the following conditions appears:

a. Standardization water production permeate flux is lowered than 10–15%.

b. The difference of system pressure between inflow water and concentrated water reach the 1.5 times of initial value.

c. Standard salt permeate rate increase more than 10–15%. (RO series is subject to NaCl solution, NF series is subject to MgSO4 solution)

The choosing of cleaning agents will be determined by quality of raw water. The high hardness of water is easy to scale, which usually need to clean through acidic cleaning agents. However, the high content of organic can cause contamination of organic, membrane element need to clean through alkaline cleaning agents. When the membrane system mainly contaminated by the salt scaling, it needs acid pickling first, then alkali washing. When the membrane system is mainly caused by organic pollution, following recommendation is necessary: alkali cleaning first, then acid picking, alkali washing again.

(2). Process of Cleaning

Related cleaning solution should be prepared with permeated flow. Firstly, open or close relevant pipes to form a recycle cleaning pipe. Then, operate the cleaning pump, pour the cleaning solution into pressure vessel of membrane element. The circulation cleaning starts to work. It usually takes 1 – 2 hours for once cleaning. Membrane systems can also be soaking first then cleaning, if it is contaminated terribly. Please notice the flow changes of permeated flow and concentration.

When the pH value changes 0.5, operator should add cleaning agents. Membrane system should be washed with permeated flow after first cleaning. Then re-clean with another kind of cleaning agent. After these processes, membrane system need to be washed with low pressure water first, then gradually exhausting to boost the pressure until the permeated flow is qualified.

If membrane element blocked up in a serious condition or it doesn't have obvious recovery for flow after cleaning, pour the cleaning agent again to the pressure vessels of membrane element and then soaking the membrane element for 6 to 12 hours. Then membrane system can be cleaned again.

(3). The Use and Preparation of Cleaning Agent

Acid cleaner: 2% citric acid solution with pH ranges from 2–3 or 0.2% hydrochloric acid solution with pH ranges from 2–3.

Alkaline cleaner: 0.1% caustic soda solution and 0.025% Sodium Dodecyl Sulfonate (Na-SDS) with pH ranges from 11–12.

(4). Note:

Membrane system should be cleaned with low pressure and high flux water. At the initial five minutes, circulation cleaning should be controlled with 1/3 of deigned flow rate. Then the flux should be adjusted the 2/3 of designed flux to full value in each ten minutes. Usually it needs at least one hour circulation cleaning.

(5) .Cleaning Limit of pH

Scaling, organic compounds and biological film can be cleaned with high efficiency, when the cleaning solution pH at 1 or 13. The cleaning solution temperature must be controlled to avoid damage for membrane elements. If the limit cleaning is necessary, contact the technical support of manufacturer for the guidance.

(6) . Cleaning Limit of Temperature

The regular chemical cleaning solution temperature should be controlled between 30 to 35 ℃. If limit cleaning is necessary, the solution temperature should be controlled within 25 ℃. The membranes system needs to avoid limit cleaning under too low temperature. The suggested cleaning temperature is between 20 to 25℃ to increase the cleaning efficiency.

Packing and Storage of Keensen Membrane Element

1. Majority of Keensen membrane element are dry type, wet type membranes also are available.

The wet membrane element should be stored in 1% food grade sodium bisulfite of standard protective liquid (When the temperatures lower than zero degrees celsius, the wet membranes also need to be protected by 10% of propylene glycol antifreeze). It is protected from microorganism breeding and contamination and frozen in the process of storage and transportation.

2. Precautions for Storage and Transportation

(1). The membrane elements shall be stored in a shade place (within 5-35℃) out of direct sunlight.

(2). Forbidden the rough handing for membrane elements, such as throwing, dropping from high place, etc.

(3). Avoid the membrane element remain in upright for a long period.

(4). It is recommended to use the wet membrane elements within six months. When it is over six months, the protection solution should be replaced.

(5). It is forbidden to add any of chemical agents has influence on membrane elements during storage and transportation process.

3. If users are against above rules, it probably does permanent damage to membrane elements.

Major Project Case

Case 1. Production Waste Water Treatment -- Local Municipal Supply of Water and Production Reuse in Nalco Water (Australia) An Ecolab Company

NALCO Water is the one of world's largest producer, supplier and service of water treatment chemicals. There is a lot of waste water in the production process. As for the complex water quality, the project used the "shaker screen tank + CMF + reverse osmosis" treatment process. Reverse osmosis water is used for municipal water supply and production reuse. Keensen "BW-8040" model used in the RO system since April, 2018. So far, the membrane system is working stable.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate
BW-8040	2000m³/d	25.0LMH	70%	1.2MPa	>98%

Case2.Food Process Water -- Manufacturing Base of Rafhan Maize Products Co,Ltd. in Pakistan.

Pure water is extremely important for food production. Basically the water is produced by purifying municipal tap water with a "membrane" process.

Rafhan Maize Products Co,Ltd is a big maize manufacturer in Pakistan. The pure water system used the multimedium filtration + activated carbon filtration + precision filter + RO system" treatment process. Keensen "ULP-8040" model membrane is using in the RO system. Membrane system running since 2018, the rejection rate is stable at 98.5% with stable permeate flow. It fully meets customer demand.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate
ULP-8040	12000m³/d	25.0LMH	70%	1.0MPa	>98.5%

Case 3. Recycled Water Treatment in Oil Field.

Socar, a government oil company in Azerbaijan adopted Keensen " BW-8040" RO membrane element for recycle watertreatment from October, 2017. The output can fully meet thestandard of production supply water. So far, the membranes system work stably.

System Parameters:

Model	System Scale	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Quantities
BW-8040	6400m³/d	27.0LMH	75%	1.2MPa	>98.5%	198*2sets

Major Project Case

Case 4. Groundwater Treatment--Water Supply Workshop of Shougang Group Power Plant

Shougang Power Plant mainly provides power of water, gas, steam and compressed air etc. The water supply workshop mainly provides living water for the group.

The raw water of desalination system in this workshop is ground water with the characteristic of high hardness. The system adopting Keensen RO series "BW-8040" membrane element with "disc filter + UF + RO" treatment processes, it's running since April 2016, the stable rejection rate is 98.5%, permeate water is stable as well.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Array
BW-8040	4000m³/d	27.0LMH	75%	1.2MPa	>98.5%	11:5

Case 5. Surface Water Treatment--Hang Feng Tap Water Plant in Cixi, Ningbo

Cixi is located at coast of East China Sea, south coast of Hangzhou bay. Reservoir water is the main sources of the Cixi citizen. Hang Feng Tap Water Plant is the earliest and largest running water supplier with advanced "UF+RO" double membrane" treatment technology. Its daily treatment capability reaches to 50,000 tons. Dow membranes have been applied over the past decade.

In May, 2013, Keensen BW-8040 membrane elements replaced the old membrane of Hang Feng Tap Water Plant. Now the system remains stable rejection rate at 98.9%-99.3%, which can fully meet the customer requirements with high permeate flow. The regeneration performance of membrane element is also praised by the owner. This project not only improved municipal tap water quality but also greatly reduced the production cost by using Keensen reverse osmosis membranes elements.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Array
BW-8040	2000m³/d	21.0LMH	75%	0.9-1.2MPa	99.0%	16:8

Case 6. Sea Water Desalination for Boiler Water and Municipal Water Supply.

Sea Water desalination project is not only can guarantee the good quality of drinking water for coast citizens，reasonable price for boiler water supply, also it won't affected by the climate change. As the cost of seawater desalination to a great extent depends on the cost of electricity and steam consumption, therefore joint production of water and electricity can use the steam and electricity of power plant provide power for desalination plant, so as to realize the efficient utilization of energy and reduce the cost of seawater desalination.

System Parameters:

Model	System Scale	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Quantities
SW-8040	5000m³/d	14.67LMH	44%	6.5MPa	99.40%	364

Case 7. Landfill Leachate Treatment--Changsha Solid Wastes Disposal Site in Hunan

Leachate is a kind of high concentration of toxic wastewater, containing large amounts of refractory organics, soluble salts and heavy metals. Changsha Solid Wastes Disposal Plant is one of large scale landfills site in China with 5,000 Tons of disposal capability per day. The Leachate Treatment Plant has adopted the international advanced membrane technology. Its leachate processing capacity up to 1,800 tons per day, the treated wastewater fully meets the national discharged standards, which regards as a demonstrative project for treatment of solid wastes disposal by the National Ministry of Housing and Urban-Rural Development.

The membrane system replaced with Keensen “NF1-8040” and “SW-8040” membrane element in April, 2013. So far, Keensen membranes are working with good performance. Moreover, low operating pressure and high flux of Keensen NF membrane greatly decreased the investment and running cost.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Array
NF1-8040	600m³/d	18.0LMH	85%	0.5MPa	2:2:2
SW-8040	417m³/d	12.0LMH	70%	2.5MPa	2:2:2

Some other examples of landfill leachate

- Landfill Site in Hei Mifeng, Changsha (2000m³ / d, it's running since April, 2013)
- Landfill Site in Chongkou ,Guilin (600m³ / d, it's running since August, 2015)
- Landfill Site in Dapeng New District, Shenzhen (400m³ / d, it's running since August, 2015)
- Landfill Site in Lingui County Pass (400m³/ d, it's running since August, 2015)
- Landfill Site in Leiyang (300m³ / d, it's running since June, 2015)

Case 8. Groundwater Treatment--Sonid Zuoqi Mandula Waterworks（Inner Mongolia)

The raw water of this project is groundwater, which has the characteristics of high TDS, high fluoride, and high hardness. The RO system adopts Keensen "BW-8040" membrane with "sand filter + manganese sand filter + self-cleaning filter + ultrafiltration.” pretreatment process. Membrane system running since 2014, the system rejection rate is stable at 98.5% with stable permeates flow. It fully meets customer demands.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Array
BW-8040	3000m³/d	21.0LMH	75%	1.2MPa	98.5%	10:6

Major Project Case

Case 9. Leather Wastewater Treatment--Reuse of Leather Wastewater in Henan Xiangcheng Tannery.

Leather wastewater is generated from the production process, has a high colority, high organic content, large flux fluctuations and high concentrations of suspended solids with serious pollution. A tanneries in Xiangcheng applying "Biochemical + NF + RO" process to recycle waste water. Keensen "NF1-8040" and "BW-8040FR" model are using in the NF and RO system since October, 2015. So far, it is operating with good performance.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate
NF1-8040	1000m³/d	27.0LMH	70%	0.7MPa	60%
BW-8040FR	800m³/d	27.0LMH	70%	1.5MPa	98%

Case 10. Paper Mill Effluent Treatment--Reuse of Paper Mill Effluent in Lin'an, Hangzhou

Paper-making wastewater is mainly from the production process of pulping and paper making. The pulp process causes the worst water pollution. It contains a lot of fiber, inorganic salts, organic matter, pigments and other pollutants.

The Lingnong Paper Co., Ltd., is located at Hangzhou, apply the traditional "neutralization + coagulating sedimentation + chemical decolorization + biological treatment" method as pretreatment process, introduce the advanced double membrane "UF+RO" treatment process to achieve the sustainable development of enterprises of energy conservation and emission reduction.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate
BW-8040FR	2000m³/d	23.0LMH	70%	1.5MPa	>97%

Case 11. Salt Chemical Engineering of Sea Water--Chlor-Alkali Chemical Projects in North Korea

Salt chemical industry is the use of salt or brine resources, processed into sodium chlorate, sodium carbonate, ammonium chloride, caustic soda, hydrochloric acid, chlorine, hydrogen, sodium metal, as well as the further processing and utilization of above material. A salt chemical project is located in North Korea, apply the Donnan and charge effect of Keensen nanofiltration membranes to remove the calcium, magnesium, sulfate. Other ions, sodium chloride allowed permeating. Keensen nanofiltration membranes "NF2-8040F" model have been applied to the membranes systems.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure
NF2-8040F(1st Stage)	1800m³/d	18.0LMH	50%	1.8MPa
NF2-8040F(2nd Stage)	1500m³/d	21.0LMH	50%	1.0MPa

Case 12. Groundwater Treatment --Centralized Water Supply Plant in Baiqi area (Inner Mongolia)

As for the high hardness, manganese, fluoride of raw water, the project used the "manganese sand filtration + ultrafiltration + reverse osmosis" treatment process. Keensen "BW-8040" model used in the whole system, the supply water is disinfected the mixed permeate flow from RO and precision filter. The RO system working from 2015, the system rejection rate is stable at 98.5% with good permeate flow. The permeate flow quality is much higher than the national "drinking water standards".

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Array
BW-8040	1000m³/d	22.0LMH	75%	1.1MPa	98.5%	4:2

Case 13.Food Process Water-Manufacturing Base of Shanghai Bright Dairy & Food Co., Ltd

Dairy foods are necessary for human life. The production process requires a lot of pure water, which usually apply the large-scale of RO water treatment plant.

Bright Dairy& Food Co., Ltd is specializing in production of dairy food. The pure water system of Shanghai Production Base is applying the Keensen "ULP-8040" RO membrane element with 200 CBM per hour output from June, 2013. So far, membrane systems are working under a well condition. The stable membrane performance has gained recognition of their leader.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Array
ULP-8040	2500m³/d	25.0LMH	75%	1.0MPa	>98%	6:3

Case 14. Surface Water Treatment --- Reuse of Recycled Water in Cixi Xingfa Electroplating Factory

The main projects of Cixi Xingfa Electroplating Factory are matte tin plating, gold plating, semi-gold nickel selective, semi-gold nickel, all nickel, all tin and iron plating etc. They are widely applied for computer connectors, hardware electrical switches, communications, home and electrical appliances etc.

The process water of electroplating production line is using municipal and industrial wastewater as raw water. The water treatment system adopt flocculation clarification and multi-media as pretreatment process, then RO process are using Keensen RO series "BW-8040FR" fouling resistant membrane element. The RO system is running stably since December, 2013. The flow rate and output quality both meet the water supply requirements.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate	Array
BW-8040FR	3600m³/d	24.0LMH	75%	1.5MPa	98.5%	12:6

Case 15.Groundwater and Surface Water Treatment--Boiler Feed of Thermal Power Plant

A large thermal power plant in famous Iron and Steel Enterprise of Shandong is mainly supplies electricity energy and heat. The outputs of reverse osmosis system supply the boiler demands. The raw water of RO system is mixture surface water and groundwater with high hardness and high organism. It combines the clarification and mechanical filtration pretreatments process, meanwhile, Keensen "BW-8040" brackish water series elements are applied for the RO system. The permeated quality and flow are working stable (Rejection rate> 98.5%).

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate
BW-8040	4800m^3/d	25.0LMH	75%	1.0MPa	>98.5%

Some Parts of Other Thermal Power Projects

A Aluminum Power Plant in Binzhou, Shandong (2500 m^3/d)

A Power Plant in Taian, Shandong (2000 m^3/d)

A Power Plant in Linyi, Shandong (1000 m^3/d)

Case 16.Groundwater Treatment-- Production Water Supply for Joincare Pharmaceutical Group in Jiaozuo

Jiaozuo Joincare Pharmaceutical Industry Co., Ltd is a subsidiary of Joincare Pharmaceutical Industry Group Co., Ltd (Factory of Taitai Oral Liquid). It's the important strategy for raw material self-sufficient. The pure process water supply system is using Keensen "BW-8040" series element. It is working from Sep, 2016, so far, the membrane system working stable and get the fully recognition of the owner.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure	Rejection Rate
BW-8040	2000m^3/d	25.0LMH	75%	1.0MPa	98.5%

Case 17. Heavy Metal Wastewater Treatment--Arsenic Wastewater Treatment by NF Technology

A new material company in Hunan is specializing in manufacture and processing for antimony products. It occurs high arsenic concentrated wastewater during the production process.This project use "aerated sedimentation + MF" as the pretreatment process, and NF technology to achieve the output fully meet emission standard. Keensen "NF2-8040F" separation series elements are applied in this project for material separation.

System Parameters:

Model	Output/Set	Membrane Flux	Recovery Rate	Operating Pressure
NF2-8040F	500m^3/d	23.0LMH	65%	0.5MPa

Case 18. Other Applications

Except above mentioned landfill leachate, coking wastewater, municipal water supply, process water of food and other industries, Keensen RO and NF membranes also have wide application for drinking water, food and beverage, industrial ultra-pure, boiler feed water, etc.

KEENSEN Table of Temperature Correction Factor for RO Membrane Permeate Flow

Temperature ℃	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
5	2.014	2.007	2.000	1.993	1.986	1.979	1.972	1.965	1.958	1.951
6	1.944	1.938	1.931	1.924	1.917	1.911	1.904	1.897	1.891	1.884
7	1.878	1.871	1.865	1.858	1.852	1.845	1.839	1.832	1.826	1.819
8	1.813	1.807	1.800	1.794	1.788	1.782	1.775	1.769	1.763	1.757
9	1.751	1.745	1.738	1.732	1.726	1.720	1.714	1.708	1.702	1.696
10	1.690	1.685	1.679	1.673	1.667	1.661	1.655	1.650	1.644	1.638
11	1.632	1.627	1.621	1.615	1.610	1.604	1.598	1.593	1.587	1.582
12	1.576	1.571	1.565	1.560	1.554	1.549	1.543	1.538	1.533	1.527
13	1.522	1.517	1.511	1.506	1.501	1.496	1.490	1.485	1.480	1.475
14	1.470	1.464	1.459	1.454	1.449	1.444	1.439	1.434	1.429	1.424
15	1.419	1.414	1.409	1.404	1.399	1.394	1.390	1.385	1.380	1.375
16	1.370	1.365	1.361	1.356	1.351	1.346	1.342	1.337	1.332	1.328
17	1.323	1.319	1.314	1.309	1.305	1.300	1.296	1.291	1.287	1.282
18	1.278	1.273	1.269	1.264	1.260	1.255	1.251	1.247	1.242	1.238
19	1.234	1.229	1.225	1.221	1.217	1.212	1.208	1.204	1.200	1.195
20	1.191	1.187	1.183	1.179	1.175	1.171	1.166	1.162	1.158	1.154
21	1.150	1.146	1.142	1.138	1.134	1.130	1.126	1.122	1.119	1.115
22	1.111	1.107	1.103	1.099	1.095	1.091	1.088	1.084	1.080	1.076
23	1.073	1.069	1.065	1.061	1.058	1.054	1.050	1.047	1.043	1.039
24	1.036	1.032	1.028	1.025	1.021	1.018	1.014	1.011	1.007	1.004
25	1.000	0.997	0.993	0.990	0.986	0.983	0.979	0.976	0.972	0.969
26	0.966	0.962	0.959	0.956	0.952	0.949	0.946	0.942	0.939	0.936
27	0.932	0.929	0.926	0.923	0.919	0.916	0.913	0.910	0.907	0.903
28	0.900	0.897	0.894	0.891	0.888	0.885	0.882	0.879	0.875	0.872
29	0.869	0.866	0.863	0.860	0.857	0.854	0.851	0.848	0.845	0.842
30	0.839	0.837	0.834	0.831	0.828	0.825	0.822	0.819	0.816	0.813
31	0.811	0.808	0.805	0.802	0.799	0.797	0.794	0.791	0.788	0.785
32	0.783	0.780	0.777	0.775	0.772	0.769	0.766	0.764	0.761	0.758
33	0.756	0.753	0.751	0.748	0.745	0.743	0.740	0.737	0.735	0.732
34	0.730	0.727	0.725	0.722	0.720	0.717	0.715	0.712	0.710	0.707
35	0.705	0.702	0.700	0.697	0.695	0.692	0.690	0.688	0.685	0.683
36	0.680	0.678	0.676	0.673	0.671	0.669	0.666	0.664	0.662	0.659
37	0.657	0.655	0.652	0.650	0.648	0.646	0.643	0.641	0.639	0.637
38	0.634	0.632	0.630	0.628	0.626	0.623	0.621	0.619	0.617	0.615
39	0.613	0.610	0.608	0.606	0.604	0.602	0.600	0.598	0.596	0.594

Remark: [Corrected Permeate Flow] = [Standard Permeate Flow at 25℃] ÷ [Temperature Correction Factor corresponding to Feed Water Temperature]

Analysis and Suggestion for Common Bug of Membrane System

●Analysis and Solution for Common Bug

No.	Permeate Flow	Rejection Rate	Pressure Difference	The Cause of Bug	Solution
1	Decline	Rise	Unchanged	Membrane Flat Sheet Densification by Water Hammer	Replace Membrane Element; Improving Membrane System
2	Decline	Keep	Unchanged	Organic Contamination	Chemical Cleaning Improving the Pretreatment
3	Decline	Keep	Rise	Microbial Contamination	Chemical Cleaning; Disinfection; Improving the Pretreatment
4	Decline	Decline	Rise	Scaling or Colloidal Contamination	Chemical Cleaning; Improving the Pretreatment
5	Rise	Decline	Unchanged	O-ring Leakage	Inspect or Replace the O-ring
6	Rise	Decline	Unchanged	Back Pressure or Oxidation	Replace Membrane Element

●Judgement for Common System Contamination

No.	Type of Contamination	Change of Feed Water Pressure	Change of Pressure Difference	Change of Rejection Rate	Possible Fouling Position
1	Inorganic Salt Scaling	Rise	Rise	Rise	The Membrane Element in the end of Final Stage
2	Organic Contamination	Rise	Keep	Decline or Keep	All the Membrane Element
3	Fouling by Metallic Oxides	Rise Quickly	Rise Quickly	Rise Quickly	The Membrane Element in the front of First Stage
4	Contamination	Rise Quickly	Rise Quickly	Rise Slowly	Anyone of Membrane Element in the front of Stage
5	Colloidal Contamination	Rise Slowly	Rise Slowly	Rise Slowly	The Membrane Element in the front of First Stage
6	Scaling Contamination	Rise	Rise	Rise	The Membrane Element in the Second Stage
7	Polymerization Silicon Deposits	Rise	Rise	Rise	The Membrane Element in the end of Final Stage

Quality Warranty of Keensen Membrane Element

Dear Users,

Thank you for selecting Keensen spiral wound elements!

Keensen Technology Co., Ltd. (hereinafter referred to “Keensen”) spiral wound membrane elements offer following quality guarantee.

1. If there is any quality problem caused by the manufacturing process and raw material after Keensen's inspection. Keensen provides 12 months quality guarantee from the date received by the user in the condition of membrane elements in correct operation and maintenance. Keensen will provide replacement or free repair service. Keensen bear shipping cost. If users fail to follow the correct operation and maintenance rules of product manual and other official files, which bear no reliability for repairing and replacement. Such as the seriously plugging and damage.

2. During the membrane elements are under guarantee period, users shall have the obligation as following:

Feed water conditions :

A: Turbidity shall not exceed 1.0NTU or SDI15 shall not exceed 5.0;

B: Temperature shall not be higher than 45℃.

C: Not contain any harmful substance that may cause physical and chemical damage to the membrane element.

D: Not contain such as chlorine or hypochlorite ions and other oxidizing substances.

Before installing and operation, the membrane elements shall be stored in original packing box and preserved at the temperature lower than 45℃ for dry type membranes and at the temperature within 5-45℃ for wet type.

Under no circumstances should the back-pressure exerted on the membrane element be greater than 0.2bar, which means the pressure of permeate flow higher than feed or concentrate water.

The working pressure of membrane system should be lower than the maximum value that mentioned in product manual.

Compare with the standard operating condition, if the performance of membrane system lower down 10% or the contamination or scaling of membrane element occurs, the membrane element should be chemical cleaned immediately in accordance with specified procedures;

The membrane system design, installation, operation, booting & shut down operation and the feed water quality should follow the standard of Keensen product manual.

3. Keensen RO and NF membrane element has the same specified initial performance as the brochures described in the same test condition. Keensen provide performance guarantee of its

elements for 36 months from the date received by the buyer, performance guarantee as follows:

The average salt permeability doesn't exceed twice of value described in product manual when the membrane elements are used or measured on the testing condition specified in the Keensen product manual. (RO membranes are subject to standard NaCl solution, NF membranes are subject to standard MgSO4 solution.)

The average permeate flow is not lower than 70% of initial permeate flow when the membrane elements are measured under the testing condition specified in the Keensen product manual.(RO and NF series are subject to standard NaCl solution);

4. The user must have the general knowledge about performance of membrane system. It's necessary to have a good training before their actual operation. And they are required to master the basic knowledge of maintenance and accident diagnosis. Besides, the user must systematically record the standardized operating data of whole system, ensure that these data are true, complete and continuous, and keep these data on file for future reference.

5. If the users fail to follow the conditions to use & store the products as product brochures described or Keensen website showed , Keensen will not be responsible for all economic loss or legal liability.

Quality Warranty of Keensen Membrane Flat Sheet

Dear user,

Thank you for using Keensen RO and NF membrane flat Sheet .

Keensen Technology Co., Ltd. (hereinafter referred to “Keensen”) membrane flat sheet offers following quality guarantee:

1、Within 7 working days after the customers receive the membrane flat sheet , if there is any quality problem caused by the manufacturing process, Keensen will provide free treatment or replacement after the inspection and confirmation.

2、Within 7 working days after receiving the membrane flat sheet , the customers need to complete the acceptance, otherwise the acceptance inspection shall be qualified by default; under the test conditions specified in the product manual, the Keensen products meet the performance indexes specified in the product manual.

3、During storage and use, the customer has the following obligations:

The membrane flat sheet should be stored in a dry,dark environment, and the the optimal storage temperature should be controlled between 5℃ and30℃ （The ultimate storage temperature of the membrane flat sheet should be 0-40℃）

After receiving the membrane flat sheet ,the storage time of the membrane flat sheet should not exceed 3 months, otherwise there is a risk of changing the color and the performance of the membrane flat sheet .

During use and testing, it is strictly forbidden to touch or squeeze the front side of the membrane flat sheet to avoid physical damage to the ultra-thin separation layer,resulting in performance degradation.

4、If the users fail to use & store the products in accordance with product manual or published technical documents provided by Keensen , Keensen will not be responsible for all economic loss or legal liability.

Quality Complaints and Replacement & Return Statement

1. If users found the product defects within warranty period, please ask for help from equipment supplier or project provider to exclude design of system, running bug, improper operation and maintenance, users can apply to return and inspect. After reach the agreement, please send the products to the appointed address. The analysis report will be come out within 15 working days after received your membrane element.

2. Keensen will inspect and analyze the returned goods strictly. The analysis report will be come out after inspection and it contains chemical cleaning, mechanical anatomy method, etc.

3.If the prior agreed returned membranes confirmed the quality defects after factory inspection,Keensen shall return or replace the membranes according to the user's request.At the same time, all the expenses for inspection, freight and the loss of destructive test will be afforded by the factory. Otherwise, all the loss should be afforded by the users.

4.Users and engineering corporations should fully understand that in some cases, it is still difficult to judge out exact reasons of membrane performance change through many kinds of existing analysis methods. This is because the limited existing analysis methods or the complicated using process. Most of membrane analyses experiments are permanent damageable, except checking the appearance, chemical cleaning, and performance tests.

5.If the user found the package damaged when receiving the products, please timely open the package and check the membrane element was damaged or not. If it was damaged, please make a note about broken status and quantity on delivery receipt of shipping company. Meanwhile, please take photos about broken package and membrane element to our sales manager in order to timely feedback to the company's technical support department to analyze and decide whether to return or replace.

6.All the goods should be returned with original package and properly protected. After approved by Keensen, please send it directly to the technical support department who is in charge of products status, storage and rechecking of returned goods. If the returned goods have been damaged, Keensen will inform the user and manage it according to the user's proposal, all the relevant charges will be afforded by user.

7. Any guarantee and commercial agreements between Keensen and user shall be valid.

8. Attachment：User Complaints (Quality Feedback) Processing Sheet

Special Note:

1. If user does not strictly follow the operating conditions which provided in this product manual, Keensen will not bear the guarantee or return responsibility.

2. Technical information may be changed at any time due to technology improvement and product update, Keensen does not need to declare in advance. Please kindly pay attention to official website of Keensen, thanks for your understand.

Quality Feedback Processing Sheet

File No.:

<table>
<tr><td colspan="2">User Name</td><td></td><td>Attn.</td><td></td><td>Contact</td><td></td></tr>
<tr><td colspan="2">Contract No.</td><td></td><td colspan="2">Model and Quantity of Faulty Product</td><td colspan="2"></td></tr>
<tr><td colspan="2">Way of Submission</td><td></td><td colspan="2">Receiver / Date</td><td colspan="2"></td></tr>
<tr><td rowspan="11">Faulty Product Application</td><td colspan="6">①Factory Serial No. of Faulty Product</td></tr>
<tr><td colspan="6">② Use Condition of Product</td></tr>
<tr><td>Installation Time</td><td>Failure Time</td><td colspan="2">Type of Failure</td><td colspan="2">Raw Water Quality and Pretreatment Processing Description</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td colspan="2" rowspan="3">①Type of Raw Water
②Conductivity and Temperature of Raw Water
③Pretreatment Processing</td></tr>
<tr><td>Designed Permeate Flow</td><td>Designed Recovery Rate</td><td colspan="2">Membrane System Array</td></tr>
<tr><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="6">Type of Failure: The decline of rejection rate and permeate flow, low initial permeate flow and rejection rate etc., appearance</td></tr>
<tr><td colspan="2" rowspan="2">Project</td><td colspan="3">Pressure (bar)</td><td colspan="2">Flow(L/H)</td><td colspan="2">Conductivity(μ s/cm)</td></tr>
<tr><td>1st Stage before</td><td>1st Stage behind</td><td>2nd Stage behind</td><td>Permeate Flow</td><td>Concentrate</td><td>Raw Water</td><td>Permeate Flow</td></tr>
<tr><td colspan="2">Beginning of Running</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Failure Appearing</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">③ Initial judgements for defective product, user complaints for return or replacement.
Sales Manager: Date:</td></tr>
<tr><td>Suggestion</td><td colspan="6">①Suggestion for causes analysis and judgements
② Suggestion for defective product(whether return for rechecking or local treatment)
AE Supervisor: Date:</td></tr>
<tr><td>Suggestion for Rechecking and Local Treatment</td><td colspan="6">①Return for rechecking or local treatment situation (please attach relative analysis report)
② Type of quality cause and defect description
③Suggestion of corrective and preventive measures
AE Supervisor or QC Minister: Date:</td></tr>
<tr><td>Comments of Corrective and Preventive Measures</td><td colspan="6">①Relevant audit opinion for return or replacement
② Approval opinions for corrective and preventive measures
Representative of Administration: Date:</td></tr>
<tr><td>Approval of Return and Replacement</td><td colspan="6">Approved by: Date:</td></tr>
</table>

Sales Network

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