

Ultrapure Membrane Elements

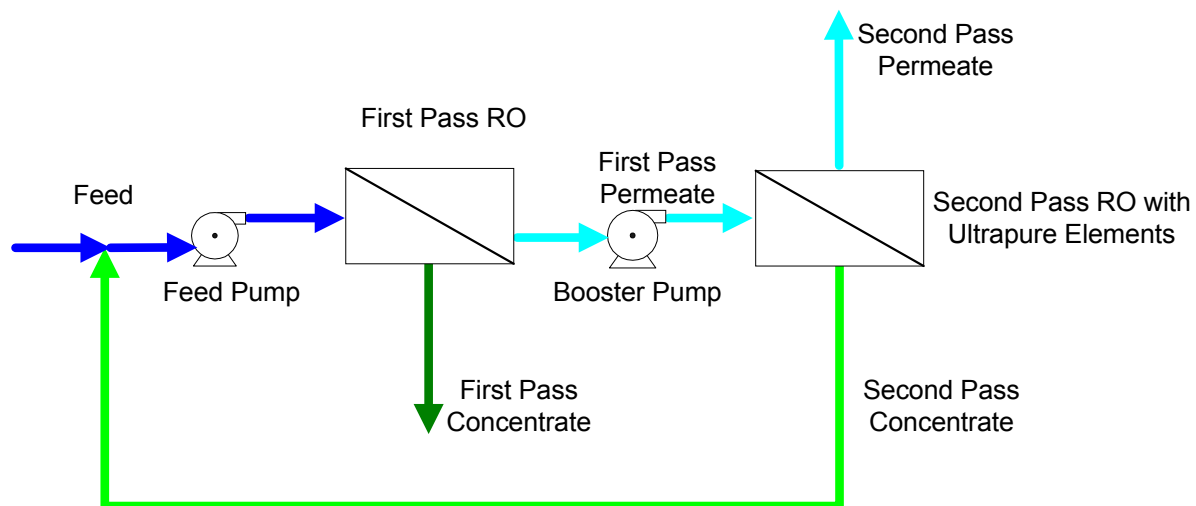
Hydranautics Ultrapure membrane elements are spiral wound reverse osmosis elements specially designed and manufactured for use in high purity water systems. In addition to maintaining Hydranautics' standards for high rejection and flux, these models are guaranteed to rinse down to extremely low TOC levels within hours of start-up when used in high grade ultrapure water applications (see accompanying graphs for details).

This bulletin provides technical information concerning the use, performance, and care of Ultrapure elements. General uses of these elements with flow schematics will be presented, followed by product specifications, materials of construction, and design guidelines. Specifics on performance will be given in a table of typical organic rejections as well as in graphs demonstrating TOC rinse down times and flow/rejection characteristics as a function of pressure. Tolerance to peroxide will be illustrated, and element handling, cleaning, and storage guidelines will be outlined.

Applications

The Ultrapure line of membrane elements is designed for the exacting standards of the microelectronics and pharmaceutical industries. Typically, the membranes are used in the second pass of a two-pass RO system or as a polishing unit after UF treatment. The following diagrams outline these typical configurations.

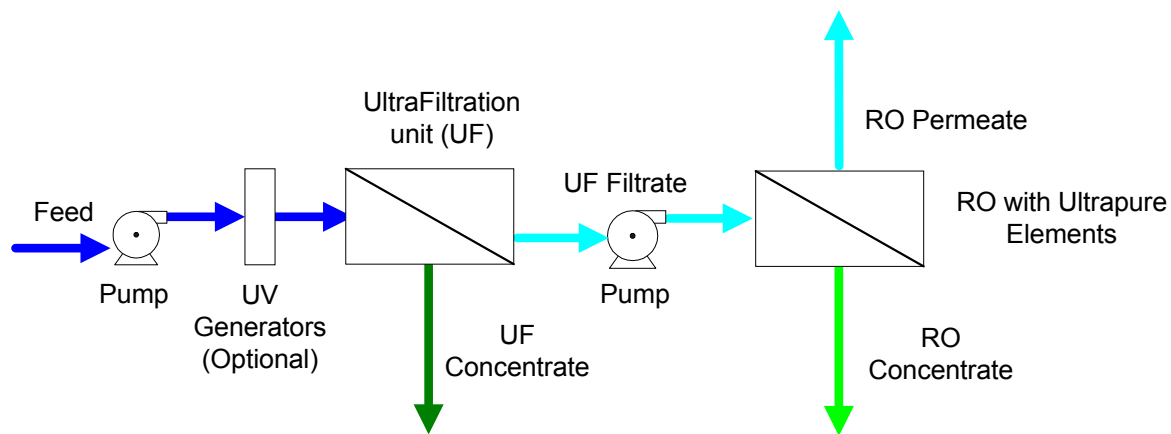
Figure 1: Two pass RO



In figure 1, feed water is pumped to the first pass of a two pass RO system. Permeate water from the first pass is then pumped to the second pass RO unit which contains the Ultrapure elements while concentrate water is run to drain. The Ultrapure elements further treat the water in the second pass by reducing dissolved salts and TOC; moreover, TOC levels due to leaching from the membrane components are minimized by using Ultrapure elements. Reject water from the second pass is sent back to be mixed with the feed water to improve recovery and to dilute slightly the feedwater concentration.

Alternatively, the Ultrapure elements can operate on permeate water from an ion exchange and/or an Ultrafiltration (UF) unit. UV light generators placed up stream of the UF polishers are optional. Figure 2 shows the layout of a UF unit with Ultrapure polishing.

Figure 2: UF with Ultrapure polishing



General Product Specifications

Two element configurations are offered for Ultrapure applications, and are as follows:

Designation	Area ft ² (m ²)
CPA-Ultrapure	400 (37.2)
ESPA-Ultrapure	400 (37.2)

All elements are 40 inches (101.6 cm) long and 8 inches (20.3 cm) in diameter. External adapters are included with each element, but internal adapters may be used, if desired.

Testing conditions

Elements are tested at the following conditions:

- Temperature: 25 °C (77 °F)
- pH: 6.5 -7.0
- Recovery: 15%
- Feed Concentration: 1500 PPM NaCl
- Feed Pressure (ESPA): 150 psi (1.05 MPa)
- Feed Pressure (CPA): 225 psi (1.55 MPa)

Element Materials of Construction

- Permeate Core Tube: Noryl
- Glue: Urethane
- Brine Seal: EPR
- Element Outer wrap: Fiberglass and Epoxy
- Seal carrier: ABS
- Interconnector: ABS
- o-rings: EPR

All permeate flows are within 15% of the nominal value.

Design Criteria

Elements should be operated within Hydranautics' design criteria:

Maximum Applied Pressure:	600 psig (4.16 MPa)
Maximum Chlorine Concentration:	< 0.1 PPM
Maximum Operating Temperature:	113 °F (45 °C)
Feedwater pH Range:	3.0 - 10.0
Maximum Feedwater Turbidity:	1.0 NTU
Maximum Feedwater SDI (15 mins):	5.0
Maximum Feed Flow:	75 GPM (17.0 m ³ /h)
Minimum Ratio of Concentrate to Permeate Flow for any Element:	5:1
Maximum Pressure Drop for Each Element:	10 psi (0.07 MPa)

Hydranautics' Guarantee

Hydranautics will guarantee individual element performance to have less than 50 ppb TOC in the permeate when rinsed with no less than 17.5 MΩ-cm ultrapure water.

Specific Element Rejections

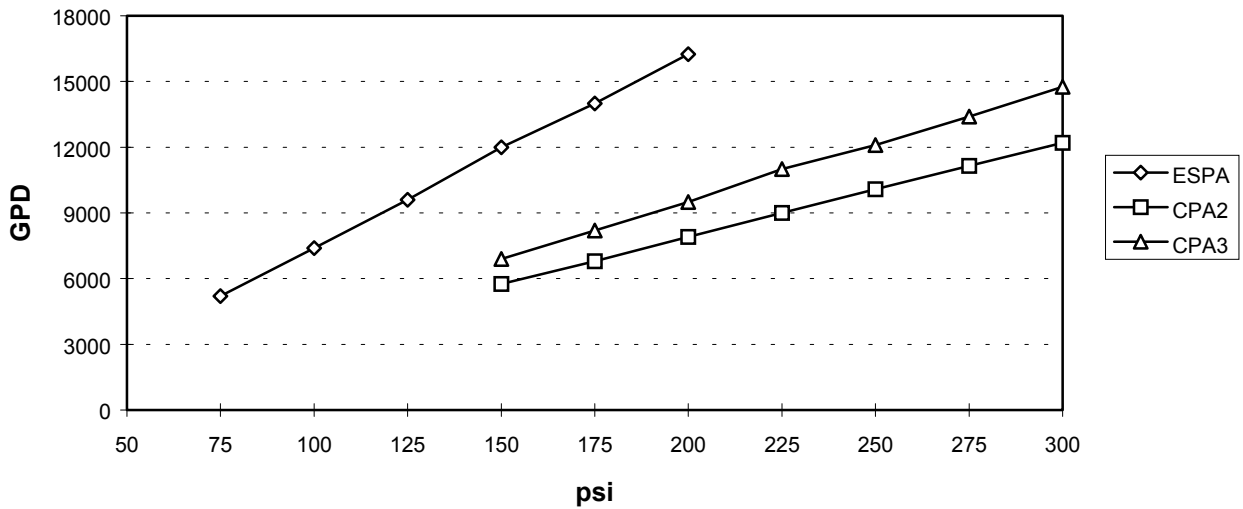
The following table gives expected rejections for a range of organic compounds for both the ESPA and CPA models of the Ultrapure product line.

Organic Compound	Molecular Weight	Rejection (%)
Ethanol	46	44-53
Acetone	58	44-50
Isopropyl alcohol	60	94-96
Glucose	180	>99.7
Sucrose	342	>99.9

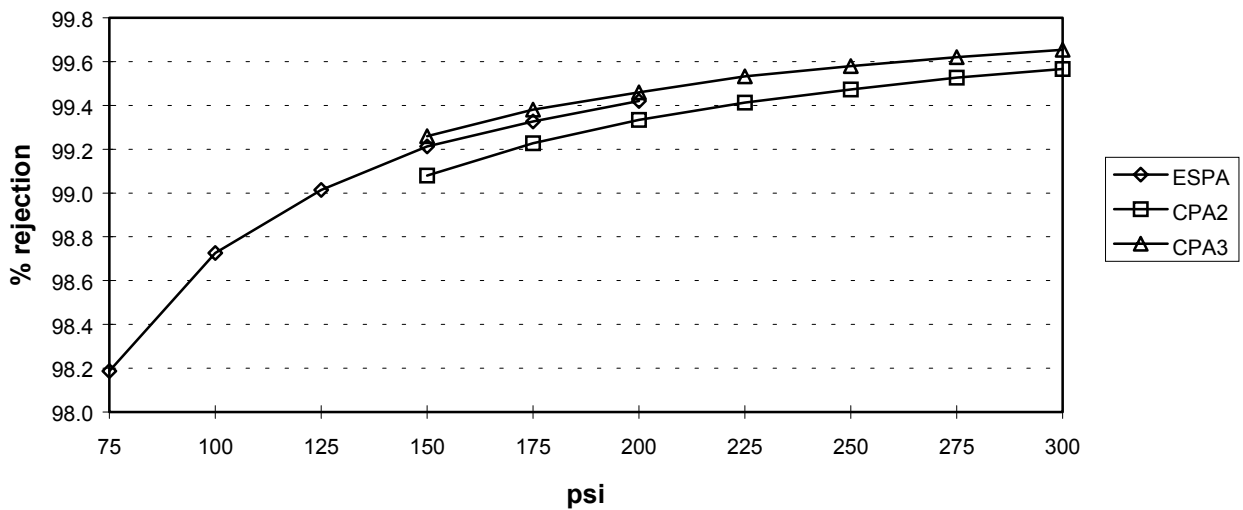
Flow and Rejection as a Function of Pressure

The improvement of flow and rejection of elements with increasing feed pressure is shown for each model in the graphs given below:

Flow vs. Pressure



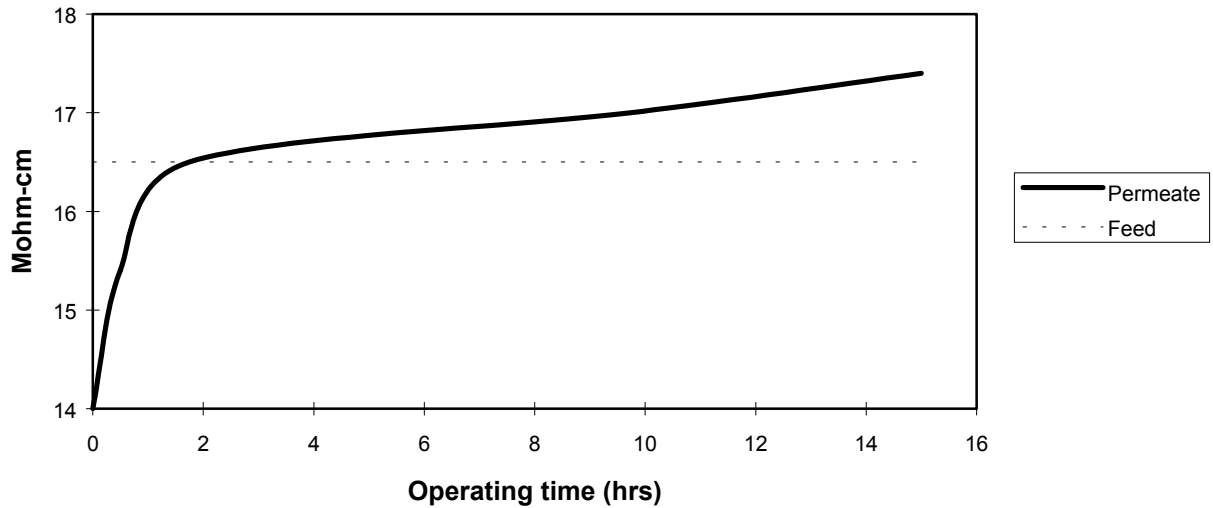
Rejection vs. pressure



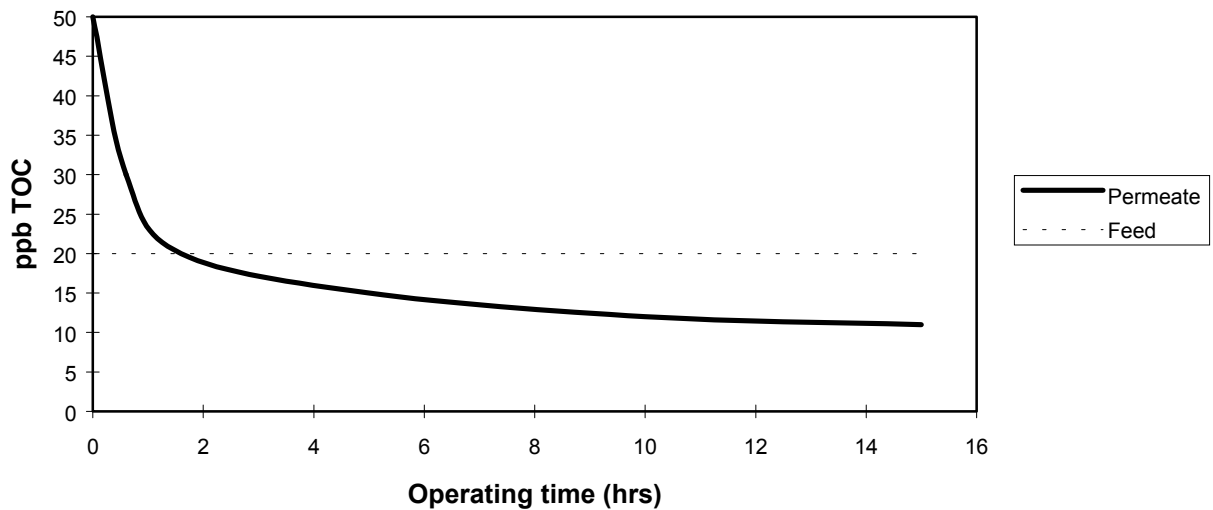
Rinse Down Characteristics

The following graphs show how quickly the Ultrapure elements reach target levels of Resistivity and TOC after start-up.

Ultrapure Permeate Resistivity vs. Time



Ultrapure Permeate TOC Concentration vs. Time



Operating conditions for the above rinse down data are as follows:

- Array: 2:1:1
 Stage 1 & 2: 3 elements/vessel
 Stage 3: 1 element/vessel
- Flow: 73000 GPD (11.5 m³/hr)
- Recovery: 90%
- Pressure: ESPA - 95 psi (6.5 bar)
 CPA - 175 psi (12 bar)

Disinfection Tolerance

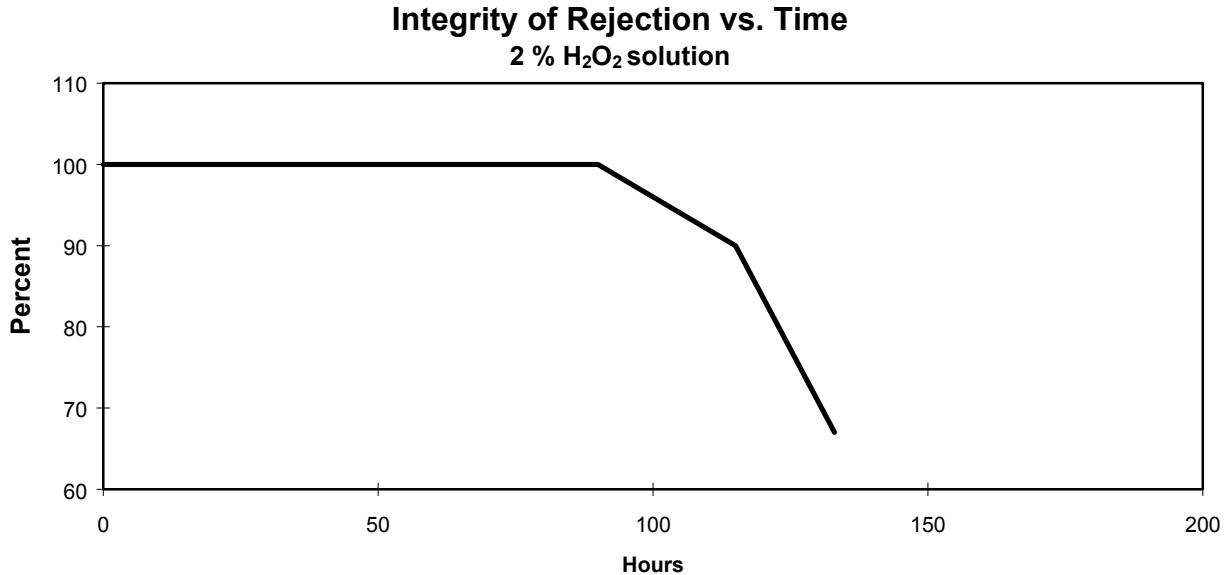
The Ultrapure product line has superior resistance to the oxidative effects of peroxide. The graph shown below demonstrates the maintenance of the integrity of rejection over time of elements run with 2% peroxide in a feedwater where neither iron nor manganese are present. Thus, Ultrapure elements can be disinfected several times with an insignificant loss of rejection.

The graph illustrates the resistance to peroxide attack; 2% hydrogen peroxide shows little degradative effect up to nearly 100 hours of operation. Beyond this point, however, a severe reduction in rejection may occur.

It is recommended to disinfect the elements with 0.2% hydrogen peroxide solution if biological fouling is evident.

NOTE: If the water contains iron, manganese, or other transition metals, do not disinfect with hydrogen peroxide. Use of peroxide on elements when these metals are present may result in severe, irreversible damage to the membrane.

NOTE: The maximum recommended temperature for disinfection with peroxide is 25 °C.



NOTE: The above graph shows results for a solution of 2% peroxide solution. Normal cleaning solutions are recommended to be one-tenth the concentration of this solution, or 0.2% peroxide.

Element Shipping, Handling, and Storage

Hydranautics' Ultrapure product line is manufactured and vacuum packaged without preservatives to minimize the concentration of TOC in the permeate and to reduce the rinse-down time of elements once they are installed. As a result, certain points should be considered when handling and storing elements.

- Hydranautics recommends that elements be shipped refrigerated, but not frozen.
- Elements should be installed as soon after delivery as possible to prevent the growth of organic foulants.
- If on-site storage is required, elements should be stored in refrigerated but not frozen conditions, and storage should not extend beyond one week of arrival.
- In the event of a further delay in loading elements, contact the Technical Support department at Hydranautics for specific instructions.

When installing elements, avoid the use of silicone, detergent, soap or glycerin to lubricate the vessels, o-rings, and brine seals. Rinse and swab vessels with chlorine free water prior to installing elements.

Membrane Cleaning

The Ultrapure product line, though designed to operate on highly pure water sources, may require periodic cleaning. For the removal of biological foulants, the use of 0.2% peroxide solution as listed in the disinfection section is recommended. Alternatively, caustic solution (NaOH, pH 10) at high temperatures, 90 °F - 110 °F (32 °C - 43 °C) can be used.

When cleaning, it is recommended to cycle the solution for one hour through the system at 30 - 60 psi (2 - 4 bar) and at a flow rate of approximately 40 GPM (150 liters/min) per vessel. The elements can then be soaked for 3 hours with the solution before cycling the solution again at the above conditions for one hour. Prior to restarting the system, it is recommended to flush the system adequately with permeate water.

Longer rinse times may be required to achieve permeate TOC levels of less than 50 ppb after cleaning.

Refer to Hydranautics' TSB 107, **RO Membrane Foulants and Their Removal from Composite Polyamide (ESPA, ESNA, CPA, LFC and SWC) RO Membrane Elements**, for complete information on foulants and membrane element cleaning instructions.

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