




MEMBRALOX® CERAMIC

MEMBRANE PRODUCTS

Membralox ceramic membrane filtration is a proven technology first introduced commercially for liquid cross-flow filtration applications in 1984. Today, with hundreds of installations worldwide, high quality Membralox elements are the most widely used ceramic membranes. They are

manufactured with  *the expertise gained from over 35 years of experience making porous ceramics, and have been available longer than any*

other similar products. Their use provides cost effective solutions in high value added macromolecule concentration, effluent recycling or reduction, and demanding fluid clarification. Membralox ceramic membranes can also play the key role in the development of new filtration applications.



A BROAD RANGE OF APPLICATIONS AND INDUSTRIES

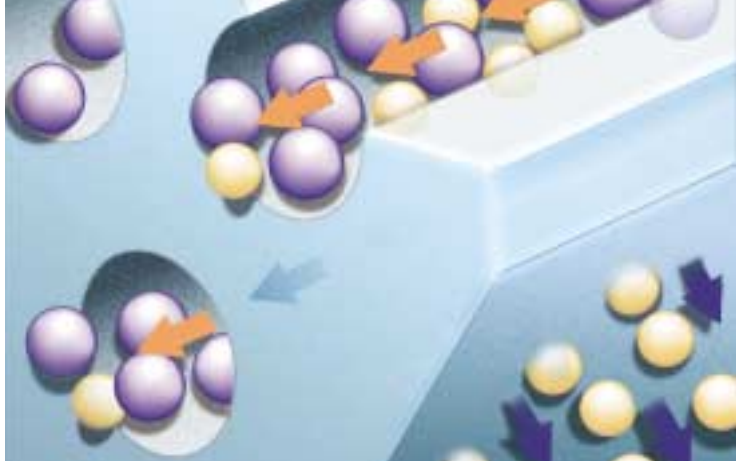


The cross-flow filtration element used in the Membralox line of ceramic membrane products incorporates the original multi-channel monolithic design that has become the industry standard. Our ceramic membranes achieve exceptional results when used in applications requiring selective separations for product recovery. The ability of these membranes to concentrate process streams, recover valuable products, and increase yields has made them a valuable cost-effective alternative to traditional methods of filtration.

Membralox ceramic membranes have been used successfully in a broad range of applications and industries — food and beverage, dairy, pharmaceutical and biotechnology, chemical and petrochemical, semiconductor and other microelectronics, water purification,

metal finishing, wastewater treatment and power generation are a few of the most common. The stability of these ceramic membranes — along with backflush, sterilization, CIP and ease of automation capabilities — makes them a simple yet primary factor in process reliability. Specific fields of application include, but are not limited to, the following:

- Milk products processing
- Fruit juice clarification
- Beer and wine bottoms recovery
- Sugar and sweeteners processing
- Fermentation broth filtration
- Caustic recovery
- Solvent recovery
- Water and effluents treatment
- Surface treatment
- Oil/water separation



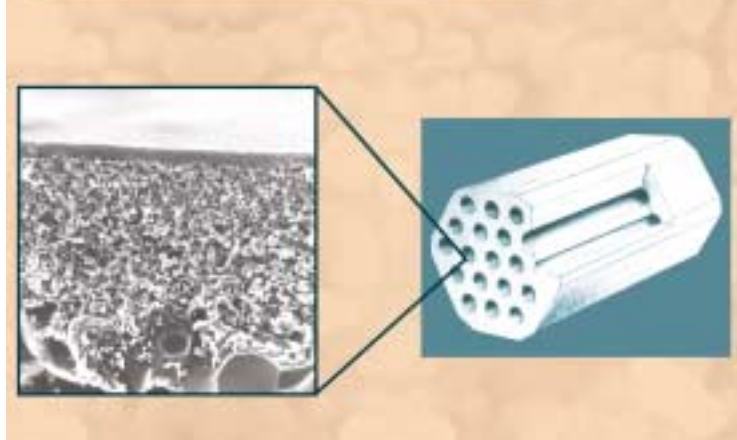
Cross-flow filtration is a continuous process in which the feed stream moves parallel to the membrane filtration surface and purified liquid passes through the membrane. The separation is driven by the pressure difference from one side of the membrane to the other — referred to as transmembrane pressure.

The parallel flow of the feed stream, combined with the boundary layer turbulence created by the cross-flow velocity, continually sweeps away particles and other substances that would otherwise build up on the membrane surface. As a result, cross-flow filters inherently maintain high permeate rates longer than conventional dead-end filters.

Cross-flow filtration streams are divided into three parts:

- Feed - solution that enters the filtration channels
- Permeate - solution that passes through the membrane
- Retentate - solution retained by the membrane

As the feed stream flows into the channels lined with Membralox membrane, permeate passes through the membrane pores and underlying support structure. The retentate is essentially the original feed stream, but now contains a higher concentration of large molecules and/or particles retained by the membrane. It flows through the channels and is recycled back into the feedstream.



CONSTRUCTION

Membralox ceramic membrane filters are constructed from multiple layers of alumina, sintered to form an asymmetric, monolithic element that will not delaminate, swell, or compact even under elevated temperatures, extremes of pH, high operating pressure or reverse flow conditions.

Standard modules are able to operate within the following ranges:

- pH - 0 - 14
- Temperature - 0 - 300° C
- Pressure - 0 - 10 bar (150 psig)

The membranes are manufactured under controlled conditions to assure the narrow and well controlled pore size distribution critical for selective filtration applications. High-strength sintered ceramic bonding of the filtration layers to the substrate support permits high-pressure backpulsing as a flux enhancement method. Membralox

ceramic membrane elements also withstand harsh chemical cleaning and steam sterilization.

The exceptional structure of Membralox membrane elements has enabled the development of a wide range of micro, ultra and nanofiltration ceramic membranes. The feed stream channels within the porous alumina structure are lined with a selective membrane layer. The standard range of Membralox membrane layers and their composition are as follows:

- Microfiltration: 0.1 - 12 microns (μm) (Alpha Alumina)
- Ultrafiltration: 20 - 100 nanometers (nm) (Zirconia)
- Nanofiltration: 1000 - 5000 daltons (D) (Titania)

Modified membrane layers are available for use with phosphoric acid and for other selective filtration applications.



RESISTS CORROSION AND
HIGH TEMPERATURE

Membralox membranes resist repeated chemical or thermal sanitizing cycles. Their wide range of pH compatibility enables the filtration of acid or base solutions. They are also compatible with all organic solvents.

HIGH RELIABILITY AND COST
EFFECTIVE SEPARATIONS

We retain complete control over the entire ceramic manufacturing process (support, membrane layers) and the module specifications (gaskets, housings), insuring the reliability of the final product as well as of each component.

The multichannel element enables the treatment of large volumes of liquid with high throughputs due to its high permeability and high surface-to-volume ratio. The remarkable physical and chemical stability of Membralox membranes allows reproducible performance over long lifetimes, a key feature in cost/benefit analysis proven in numerous industrial installations.



MEMBRANE CHARACTERISTICS
CHANNEL CONFIGURATIONS



Micro and ultrafiltration multichannel membrane elements have been used successfully in hundreds of installations over the past 15 years. The tables shown represent characteristics of Membralox membrane elements.

GENERAL CHARACTERISTICS

SPECIFIC GRAVITY..... > 3.9

BULK DENSITY..... 2.5 - 2.7

POROSITY >30%
DEPENDENT ON THE
MEMBRANE TYPE

CHANNEL

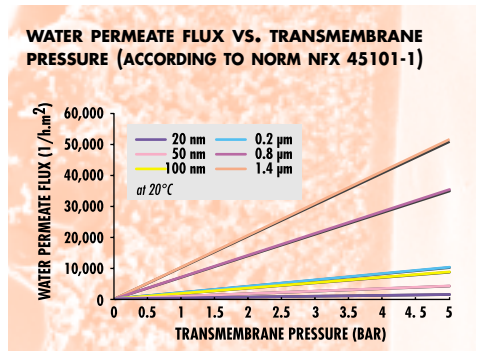
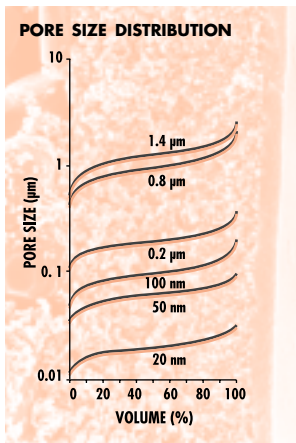
DIAMETER3, 4 OR 6 mm

CHANNEL NUMBER..... 19 OR 37

LENGTH..... 1020 mm

MEMBRANE SURFACE

AREA.....0.24 TO 0.36 sqm



MEMBRALOX PRODUCTS

MEMBRALOX INDUSTRIAL MEMBRANES

The various membrane layers are deposited and sintered on the channel surface of the alpha alumina support (purity > 99.7%) to become the monolithic Membralox element with an asymmetric structure.

Membralox membrane materials are FDA-listed according to the CFR (Code of Federal Regulations) Title 21, paragraph 177-2910. For the most demanding applications, we can design customized membrane configurations to suit your specific requirements.

Three feed channel sizes are available to treat a wide range of fluids (according to viscosity, concentration, etc.). The membrane elements are assembled singly or in parallel in modules that form the heart of complex filtration systems. Our extensive experience in designing filtration modules enables us to optimize housings and high performance sealing assemblies, meeting 3A food grade specifications when required.

Limits on the use of Membralox membranes are determined mainly by the type of housings or gasket materials being employed. Our Technical Assistance Service



Department can provide you with advice in selecting the optimum membrane and module configuration to match your process requirements. Other types of housings (e.g. PVDF housings, ASME coding) or gasket materials may thus be proposed.

MEMBRALOX MODULES AND ELEMENTS

STANDARD MODULES

MEMBRANE SURFACE AREA	0.0055 TO 21 sqm
HOUSING MATERIAL	316L STAINLESS STEEL
GASKET MATERIALS	EPDM, FPM, PTFE, SILICONE
SANITARY RANGE	RETENTATE OUTLET CONNECTION: 3A GASKET FILTRATE OUTLET CONNECTION: TRI-CLAMP
INDUSTRIAL RANGE	RETENTATE OUTLET CONNECTION: BOLT FLANGE FILTRATE OUTLET CONNECTION: THREADED OR BOLT FLANGE



HOUSINGS AND GASKETS



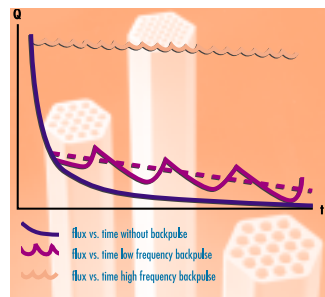
BACKPULSE DEVICES
PREFILTER

Membralox housings are manufactured to sanitary 3A standards, light industrial grade specifications, or as special ASME coded pressure vessels. Sanitary housings incorporate sanitary connection components to attach to system piping. The industrial housings incorporate a standard 150# raised-face bolt flange for connecting to a standard 150# RF counter-flange. The permeate ports are standard threaded pipe connections. The ceramic membrane elements are sealed in housings with polymeric gaskets with a choice of materials (as previously indicated) to fit specific needs.

Our backpulse devices increase and sustain flux mainly in microfiltration applications. The device forces clean filtered permeate under high pressure in a

reverse direction through the membrane to dislodge particles trapped on and in the membrane surface. The backpulse process maintains the flux enabling the filtration cycle to continue over a longer period of time.

We also offer a self-cleaning prefilter (60 μm) to protect filtration membranes against abrasion in the case of heavily contaminated fluids.



YOUR BEST INVESTMENT
FOR RELIABLE SEPARATIONS



Our vertically integrated manufacturing, extensive production capabilities, and state-of-the-art Research and Development Laboratories, enable us to meet challenges encountered by both end-users and our engineering/OEM partners.

The high quality of the Membralox membrane is the key component in the successful separation of your process material. To insure this quality we have built checks into every step of the manufacturing process according to a stringent control program that includes:

- Characterization of each batch during and after manufacturing (permeability, pore size, etc.)
- Test of mechanical resistance of the elements and stability of the membrane layers (crush stability, isostatic compression, backflush testing)

- Bubble point testing of 100% of membranes prior to shipping
- A comprehensive quality program that enables traceability of all products.

To develop and optimize Membralox ceramic membranes for specific, non-standard applications, we offer technical assistance to insure that proper design and performance parameters are met. These include bench-top feasibility studies, the design and commissioning of pilot plants for on-site tests, training courses and more.

We work in collaboration with an international network of OEM companies who are leaders in different application fields. We are at your disposal to provide every facet of service from the initial feasibility test to after sales service in order to insure high quality, totally reliable membrane performance.

MEMBRALOX PRODUCT SUMMARY

Membralox ceramic membrane filtration modules consist of porous ceramic membrane elements, sealed in stainless steel housings with customized gasket designs. These rugged, reliable, long-lasting membrane modules are available in various sizes and configurations to meet your needs. It is necessary to select the appropriate membrane pore and feed channel size, along with the proper gasket and housing type, to optimize the overall system process performance for any given application.

MEMBRANE PORE SIZES

MICROFILTRATION (MICRON):

0.2 0.5
0.8 1.4
3.0 5.0

ULTRAFILTRATION (NANOMETER):

20
50
100

NANOFILTRATION (DALTONS):

1,000
5,000

HOUSINGS

SANITARY
LIGHT INDUSTRIAL

GASKETS

EPDM
SILICONE
FLUOROELASTOMER
PTFE

MEMBRALOX CERAMIC MEMBRANE MODULES

MEMBRALOX MODULE	NUMBER OF ELEMENTS	MEMBRANE SURFACE AREA — NOMINAL	
		m ²	ft. ²
1020 mm LENGTH			
<i>4mm ID CHANNEL SIZE</i>			
1P19-40/1R19-40	1	0.24	2.6
3P19-40/3R19-40	3	0.72	7.8
7P19-40/7R19-40	7	1.7	18
19P19-40/19R19-40	19	4.6	49
37P19-40/37R19-40	37	8.9	96
60P19-40	60	14.4	155
<i>6mm ID CHANNEL SIZE</i>			
1P19-60	1	0.36	3.9
3P19-60	3	1.08	12
12P19-60	12	4.3	46
22P19-60	22	7.9	85
<i>3mm ID CHANNEL SIZE</i>			
1P37-30	1	0.35	3.8
3P37-30	3	1.05	11
7P37-30	7	2.4	26
19P37-30	19	6.6	72
37P37-30	37	13	140
60P37-30	60	21	226
250 mm LENGTH			
<i>7mm ID CHANNEL SIZE</i>			
1T1-70	1	0.006	0.06



YOUR NEXT STEP

Whether your application is in a new market or one that we currently serve, we invite you to put our resources to work by sharing with us the challenges you face for improving your product or process.



PALL/FLUID DYNAMICS
REGISTERED NO. JM-0155



ISO 9001/OS 9000
PALL/FLUID DYNAMICS
REGISTERED NO. FM22367



Pall Corporation

Fluid Dynamics Division
1750 Filter Drive
Deland, FL 32724-2045

368.822.8000 phone
368.822.8040 fax

Visit us on the Web at www.pall.com

Pall Corporation has offices and plants throughout the world in locations including: Argentina, Australia, Austria, Belgium, Brazil, Canada, China, France, Germany, Hong Kong, India, Indonesia, Ireland, Italy, Japan, Korea, Malaysia, Mexico, the Netherlands, New Zealand, Norway, Poland, Puerto Rico, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United States, and Venezuela. Distributors are located in all major industrial areas of the world.