PALL Food and Beverage

Membralox® Crossflow Ceramic Membranes and Related Products

Introduction

Pall's **Membralox** crossflow ceramic products are ideal for applications that involve difficult processes (such as high solids bulk processes, use of high temperatures during production and/or CIP, aggressive chemicals or solvents, etc...) and where significant long-term reliability and durability is required.

The Best Choice for Long Service Life Even Under Extreme Conditions

Available ratings covers from fine Ultrafiltration (UF) range for concentration/purification/phase separation/etc... up to open Microfiltration (MF) range for clarification/fractionation or even cold pasteurization of complex solutions.

Membralox membranes are available in different channel diameters to allow optimization for solids loading.

Some configurations are available with unique longitudinal permeability gradient (Membralox GP), that facilitates the control of permeate rate along the length of the module and optimizes the transmission of macromolecules.

Membralox membranes are available in sizes ranging from small laboratory devices (single tube) to multichannel with large surface area, ensuring the ability to evaluate and scale up processes to any size.

Membralox ceramic membranes are featuring a strongly asymmetric structure including highly controlled filtration layer that is formed on the inner (feed-side) surface of a more open filtration layer or directly onto the support structure.

The Membralox support itself has a unique structure, exceptionally strong and permeable for easy permeate drainage, even for complex Membralox IC multichannel geometries, resulting in products with large chemical and thermal compatibility and high permeability.

For liquid processing, MF filtration layers are made of high purity α-Alumina (α-Al_2O_3) while UF filtration layers are made of Zirconia (ZrO_2).

All Membralox Membranes are Food Contact Compliant

The compact multichannel geometries with high membrane permeability are optimized for bulk processing applications in batch, fed batch or continuous production mode.

Membralox membranes are loaded into Stainless Steel housings (SS 316L) and sealed with gaskets to create modules:

- **SD module:** ceramics are sealed to housing with individual polymer gaskets (typically EPDM or FPM)
- **HCS modules:** ceramics are sealed to housing with global PTFE gaskets; other housing seals are made of polymer
- **HCB modules:** ceramics are sealed to housing with global PTFE gaskets; other housing seals are made of PTFE

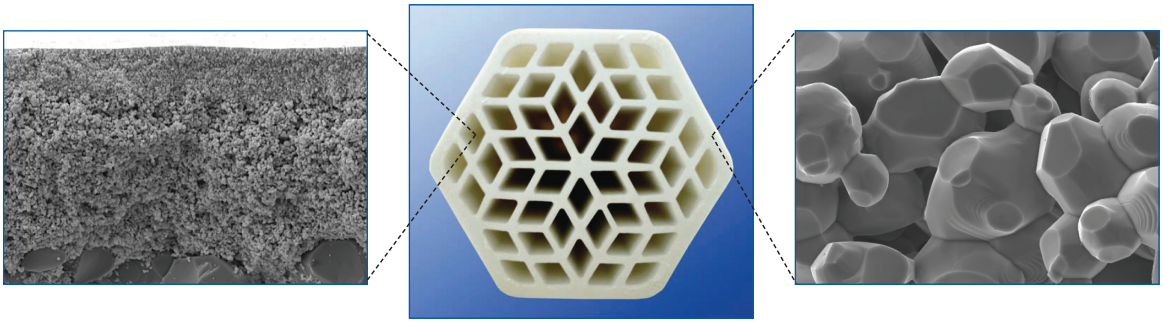
Sanitary housings (SD) are 3-A certified.

Multiple modules can be easily assembled on manifolds to create filtration loops of required membrane area.

Multiple filtration loops can be connected in serial or in parallel to handle any scale of operation.

Features and Benefits

- High flux and sharp pore size distribution
- High mechanical strength thanks to unique support structure
- Proven long term reliability / long service life
- Ceramic end sealing embedded into the support porosity
- Wide chemical and pH (0-14) compatibility
- Excellent thermal stability
- Food Contact Compliant
- Membralox membranes are 100% bubble point integrity tested



Ceramic Membrane Structure:
Electron Micrograph showing Membralox membrane layers on top of a more open support structure

Typical Applications on Liquid Feed Streams

Clarification or Concentration or Fractionation of:

- Fermentation broth
- Milk and dairy products
- Sugar and sweeteners
- Proteins (from plants or animals)
- Ingredients and additives
- Beverages
- Etc.

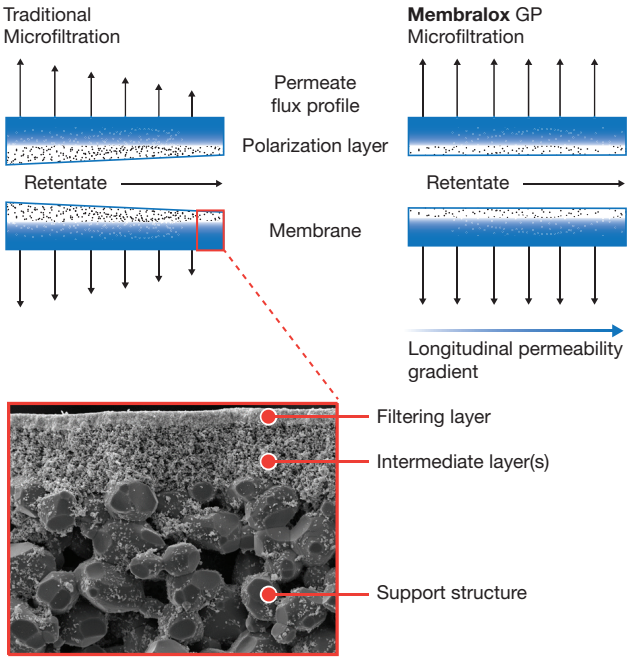
Membralox GP Ceramic Microfiltration Membranes

The **Membralox GP** ceramic membranes have a calibrated longitudinal permeability gradient designed to maintain a uniform flux along the length of the element despite the high pressure drop in the membrane lumens.

This feature optimizes the transmission of macro-molecules (proteins, enzymes, polysaccharides, etc…) during the clarification or fractionation of complex feed streams (milk and milk products, fermentation broth, plant proteins, fruit juices, etc…).

A comprehensive range of calibrated permeability gradient options are available to suit different applications, feed stream characteristics, target permeate flux.

Comparison of flux profiles in standard crossflow microfiltration and Membralox GP crossflow microfiltration



Cross section view of **Membralox** ceramic membrane (x 1010)

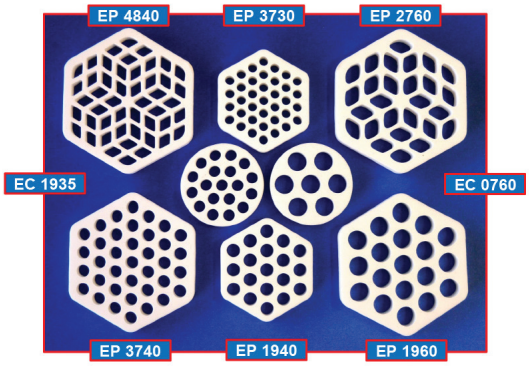
Membrane Module Versatility

Large Membralox modules (housing + membranes + gaskets) range allows optimal selection (pore size, lumen diameter, housing design, etc…) and sizing (total membrane area), for each filtration loop / complete system size.

Technical Specifications

Membralox Ceramic Membranes

Membrane Geometries



Pall Membralox ceramic membrane geometries

Cross section	Hexagonal						Cylindrical	
Membrane type	**EP3730**	**EP1940**	**EP3740**	**EP4840**	**EP1960**	**EP2760**	**EC1935**	**EC0760**
Channel diameter (mm)	3	4	4	4	6	6	3.5	6
Number of channels	37	19	37	48	19	27	19	7
Filtration area (m^2)	0.35	0.24	0.47	0.69	0.36	0.50	0.25	0.16
Length (mm)	1020						1178	

The Membralox membrane **support** (12 µm pore size) and membrane **end sealing** are made of sintered ultrapure alpha-Alumina.

Membrane Pore Sizes

Pall Membralox ceramic membrane pore sizes[1]

Microfiltration	1.4* – 0.8* – 0.5 – 0.2 – 0.1* µm	alpha-Alumina
Ultrafiltration	100* – 50 – 20 – 10 nm	Zirconia

[1] Some pore sizes are not available on all membrane type. Please contact Pall for further information.

* Pore sizes available in Membralox GP membrane format.
Note: Pore sizes 0.8 and 1.4 µm are available with single or double layer (for improved bacteria retention).

Membralox Modules

SD Sanitary Modules

The **Membralox** SD module features a fully sanitary design for F&B and stringent pharmaceutical processes. All wetted components are swept by cleaning solutions ensuring compliance with requirements of cleaning validation.
Module hardware and gaskets are available in materials that meet the demands of all cleaning regimes.

- All wetted parts fully accessible by cleaning chemicals
- Vertical operating position enables total air purge and liquid drainage
- High-performance sealing assembly, with gasket leak detection, eliminates by-pass possibility between retentate and permeate side
- Modules and membrane components fully traceable, materials certificate available upon request
- Long-life, stable and reliable performance
- Membralox SD modules are 3-A certified

Note: on request, SD housings could be electro-polished for demanding Biopharm applications

M-1P / M-7P / M-37P SD modules

M-37P SD module

SD Modules Range

Pall Membralox SD 3-A Sanitary Modules

SD Module type	M-1P / M-3P / M-7P / M-19P / M-37P	M-1P / M-3P / M-12P / M-22P
Membrane type	**EP3730 / EP1940**	**EP3740 / EP4840 / EP1960 / EP2760**
Number of membranes	1 - 3 - 7 -19 - 37	1- 3- 12 -22
Filtration surface area	up to 13 m^2	up to 15.2 m^2
Retentate connections	J-clamps up to M-12P / M-19P or bolts for M-22P / M-37P. 3-A clamp gaskets	
Permeate connections	Tri-clamps with 3-A clamp gaskets	
Wetted materials	SS316L housing, ceramic membranes, EPDM or FPM polymer gaskets	
Operating limits	up to 10 Barg[1] @ up to 95 °C on aqueous liquids[2]	

[1] 1 Bar = 100 kPa

[2] According to Pressure Equipment Directive 2014-68EU

Membralox HCB and HCS Modules

The **Membralox** HCB and HCS module range takes advantage of the unique hexagonal shape of the Membralox ceramic membrane elements to obtain a high membrane packing density, thus significantly reducing filtration system costs.

Features of the HCB and HCS module—increased surface area, reduced permeate hold-up volume, PTFE gaskets for a wider chemical compatibility—provide economical solutions from bulk fermentation broth clarification up to heavy duty industrial applications and effluent treatment.

- Highly compact for cost-effective system design and small footprint
- Reduced permeate hold-up volume
- Proprietary built-in gasketing solution to ensure perfect sealing
- Wide chemical compatibility
- Long service life

HCB module

HCS module

Membralox HCB Industrial Modules Range

Pall Membralox HCB Industrial Modules

HCB Module type	M-60P	M-19P	M-36P
Membrane type	**EP3730 / EP1940**	**EP3740 / EP4840 / EP1960 / EP2760**	
Number of membranes	60	19	36
Filtration surface area	up to 21 m^2	up to 13.1 m^2	up to 24.8 m^2
Retentate connections	Bolted flanges / o-ring gasket		
Permeate connections	Bolted flanges / flat gasket		
Wetted materials	SS316L housing, ceramic membranes, PTFE gaskets		
Operating limits	up to 10 Barg[1] @ up to 95 °C on aqueous liquids[2]		

Membralox HCS Sanitary Modules Range

Pall Membralox HCS Sanitary Modules

HCS Module type	M-60P	M-36P
Membrane type	**EP3730 / EP1940**	**EP3740 / EP4840 / EP1960 / EP2760**
Number of membranes	60	36
Filtration surface area	up to 21 m^2	up to 24.8 m^2
Retentate connections	Bolted flanges / o-ring gasket	
Permeate connections	Tri-clamps with 3-A clamp gaskets	
Wetted materials	SS316L housing, ceramic membranes, PTFE and polymer gaskets	
Operating limits	up to 10 Barg[1] @ up to 95 °C on aqueous liquids[2]	

[1] 1 Bar = 100 kPa

[2] According to Pressure Equipment Directive 2014-68EU

Membralox Pilot Units

Feasibility Trials

Potential applications can be conveniently evaluated at lab scale using T1-70 modules with single lumen ceramic membrane. Feasibility testing with this module allows selecting the most appropriate membrane pore size to achieve the expected separation performance.

Note: nevertheless, due to the specific geometry of this membrane, feasibility trials results cannot be used for direct up-scaling/system sizing. On site pilot trials with multichannel membranes is highly recommended.

Membralox T1-70 modules can be tested using various Pall bench top pilot units, specially the XLab 5 test rig shown here. This unit is specifically designed to run feasibility trials with Membralox T1-70 ceramic membrane.

XLab 5 bench top pilot unit

Membralox T1-70 Module

- **Housing:** SS 316L
- **Gaskets:** EPDM or FPM polymer (O-ring gaskets)
- **Membrane (single tube):**
  - ID/OD: 7/10 mm
  - Length: 250 mm
  - Filtration area: 0.005 m² (0.054 ft²)

The T1-70 module holds one ceramic single tube; please specify desired membrane pore size at time of order. This module is suitable for use with Pall laboratory test systems. Contact Pall for additional information.

On Site Pilot Testing with Membralox Multichannels

The pilot unit should be equipped with Membralox multichannel membranes (pore size defined during bench scale testing). Crossflow filtration application development and industrial system design are based on thorough on site pilot trials to define (at least):

- Operating conditions to achieve the optimal filtration performances and product quality
- CIP procedures that guaranty consistent recovery of membrane permeability after each run

Examples of highly instrumented semi-automatic Membralox pilot unit available for rent

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