Hollow Fiber Membranes

Cartridge Information

Description and Use

GE ultrafiltration (UF) and microfiltration (MF) membrane cartridges are provided with a wide range of hollow fiber and tubule lumen diameters, membrane pore sizes, surface areas and dimensions. Each cartridge contains a bundle of polysulfone fibers or tubules potted in parallel in a plastic housing. During processing, fluid flows through the hollow tubes, and some of the fluid (and solutes) passes through pores in the membrane to be collected as permeate.

GE cartridges are operated in a cross flow mode. In sharp contrast to single pass filtration, cross flow involves recirculation of the feed stream pumped across the membrane surface (see Figure 1). The “sweeping action” created by fluid flow across the membrane surface promotes consistent productivity over the long term.

![Typical industrial cartridge](image)

**Figure 1—Cross flow filtration creates a sweeping action that helps keep membrane pores open.**

In operation, as the feed stream is pumped through the membrane cartridge, the retentate, including species excluded by the membrane pores, continues through the recirculation loop while the permeate, including solvent and solutes transported through the membrane pores, is collected on the shell side of the cartridge.

**Typical Applications**

Membranes are used in Food and Industrial applications to perform the following functions:

- Clarification
- Concentration
- Separation
- Fractionation

Membranes compete with many other filtration technologies in these industries and are typically selected where the product has higher value or the membrane can establish better overall process economics.

Hollow Fiber Membranes are used in the following industries:

- **Wine Process** (Clarification)
- **Citrus Upgrading** (Separation)
Dairy (Concentration & Fractionation)

Beer (Clarification)

Bottled Water (Clarification)

Treatment and Feeding Requirements

General Operating Recommendations

- A prefilter with a 200 µm rating may be desirable to protect the pumps and membrane.
- Pressure gauges (particularly the inlet gauge) should be glycerin filled or mechanically dampened.
- The cartridge’s second permeate port may be used or blocked.
- Submerge recirculation lines in the feed solution so that returning fluid does not create foam or entrain air in the feed solution.
- Circulating water at a high flow rate through the cartridge filter helps to remove air from the cartridge. Removing air is particularly important when processing viscous streams, to maintain even flow distribution within the cartridge.

Ultrafiltration cartridges should be started up with the permeate ports closed, allowing the cross flow velocity to be established prior to permeate withdrawal. If a positive displacement pump is used, both the feed inlet valve and the retentate valve should be wide open. If a centrifugal pump is used, the feed inlet valve should be cracked open and the retentate valve should be open. The ideal system includes a variable speed control on the pump motor. This allows the recirculation flow rate to be increased gradually until the specified pressure drop is achieved.

After turning on the pump, the inlet valve should be opened and the retentate valve slowly closed to establish the preferred feed flow rate and/or pressure. If necessary, the inlet pressure may be reduced by adjusting the feed inlet valve or by installing a by-pass loop on the pump outlet. Since feed flow rate is proportional to the feed-to-retentate pressure drop along the length of a cartridge.

When the correct inlet pressure and feed flow are established, the permeate lines should be opened. Concentrate return to the feed reservoir should be below the liquid level to avoid splashing, foaming and excess air generation that could cavitate the pump.

Additional Consideration for High Viscosity Feed Streams

Use of a high recirculation rate for a few minutes to fast flush the lumen side of the fibers will assure air removal. This is especially important when processing viscous streams to maintain even flow distribution within the cartridge. Since a highly viscous stream cannot be pumped at high flow rates due to pressure drop considerations, one should circulate either water or a buffer solution prior to introducing the viscous feed material.

General Properties

MaxCell* and ProCell* cartridges are our largest elements. With 0.5 mm ID fibers, MaxCell cartridges provide up to 13 m² (140 ft²) of membrane area in a single, lightweight housing. MaxCell cartridges have an integrally-bonded threaded ring at each end. A sealing gasket (o-ring) and adaptor to 2 in tri-clamp are positioned on each end and secured with a locking nut. The nut is easily tightened with a MaxCell wrench set. Permeate ports on the MaxCell cartridges are 1.5 in tri-clamp.

MaxCell Cartridge  Competitive Cartridge

MaxCell cartridges can easily retrofit competitive 5-inch diameter cartridges.
Housing 45
Length = 50.3 cm (19.8 inches )
Diameter = 10.8 cm (4.25 inches )
Permeate ports = 1.5 inch Tri-Clamp
Feed/retentate ports = 2 inch Tri-Clamp

Housing 65
Length = 73.2 cm (28.8 inches )
Diameter = 10.8 cm (4.25 inches )
Permeate ports = 1.5 inch Tri-Clamp
Feed/retentate ports = 2 inch Tri-Clamp

Housing 85
Length = 131 cm (51.5 inches )
Diameter = 10.8 cm (4.25 inches )
Permeate ports = 1.5 inch Tri-Clamp
Feed/retentate ports = 2 inch Tri-Clamp

Length includes straight adaptors.
Elbow adapters are available.
MaxCell Cartridge 45, 65, 85.

Housing 152M
Length = 81.3 cm (32 inches )
Diameter = 16.8 cm (6.63 inches )
Permeate ports = 1.5 inch Tri-Clamp
Feed/retentate ports = 2 inch Tri-Clamp

Housing 154M
Length = 139 cm (54.8 inches )
Diameter = 16.8 cm (6.63 inches )
Permeate ports = 1.5 inch Tri-Clamp
Feed/retentate ports = 2 inch Tri-Clamp

Length and diameter values above are for ProCell cartridges within their respective stainless steel housings.

ProCell cartridge elements require stainless steel housings for operation. These 6-in diameter modules provide 28 m² (300 ft²) of membrane area with 0.5 mm ID lumen fibers.
Packaging Information

GE Hollow Fiber Cartridges are individually packaged in a corrugated box. The ends of the cartridge and the permeate ports are capped to prevent contamination of the membrane.

Storage and Handling

Ultrafiltration cartridges must be stored wet or re-glycerized. Cartridges shipped from the factory have been glycerized.

Removal of Glycerol Preservative

New ultrafiltration (UF) membrane cartridges are pre-treated with an alcohol/glycerol solution within the pore structure to prevent drying of the membrane. This mixture enhances wetting but may cause the fibers to appear wavy. Trace amounts of isopropyl alcohol (IPA) may remain when the cartridges are shipped, and the glycerol must be thoroughly rinsed from the cartridge prior to use. In addition to the prevention of drying, the glycerol minimizes entrained air within the pore structure of the membrane wall, air that may become locked-in, reducing permeability until the air has been displaced by liquid. Glycerol removal and wetting out will occur simultaneously when performing the New Cartridge Rinsing Procedure.

New Cartridge Rinsing Procedure

The New Cartridge Rinsing Procedure should be performed on all UF cartridges.

1. Install the cartridge and connect to system.
2. Connect the retentate and the permeate lines to an appropriate waste container.
3. Fill the feed reservoir with clean water (WFI or 10,000 NMWC UF permeate). Use room temperature or warm (up to 50 °C) water for rinsing. Cold water will be less effective. Addition of 100 ppm NaOCl to flush water will enhance glycerol removal.
4. Start the pump on slow and adjust transmembrane pressure to
   - 1 barg (15 psig) for 1,000 NMWC and 3,000 NMWC pore sizes
   - 0.7 barg (10 psig) for 5,000 NMWC through 30,000 NMWC pore sizes
   - 0.34 barg (5 psig) for larger pore sizes.

5. Be certain retentate flow rate is at least 1/10th of the permeate flow.
6. Continue rinsing for 90 minutes.
7. If NaOCl is used, thoroughly rinse cartridge before introducing process solution.

Used Cartridge Storage (long term)

Before storage the cartridges should be thoroughly flushed, cleaned and rinsed with clean water. For short-term storage, up to two weeks, cartridges need only be water-wet.

For storage up to 1 month, cartridges may be filled with a storage solution and sealed at all end fittings and permeate ports, or submerged in a storage bath. Acceptable storage solutions are:

1. Water with 5 to 10 ppm active chlorine (10 to 20 ppm sodium hypochlorite). Monitor levels weekly.
2. 0.1 N sodium hydroxide.
3. Up to 3% formalin.
4. 30% ethanol in water.
5. Up to 1% sodium azide.

For storage of longer than 1 month, check periodically to be certain that the membranes remain wetted. Prior to reuse it is recommended that the cartridge be rinsed with a 100 ppm sodium hypochlorite solution.

Thoroughly rinse all storage solution prior to reuse.

Safety Precautions

A Material Safety Data Sheet containing detailed information about this product is available on request.

The three primary risks of working with cartridge filtration systems:

• Unexpected rupture of a filter system component due to over pressurizing the system
• Unexpected release of hazardous process fluids or cleaning agents such as hot water, steam, or caustic from the filtration system due to over pressurizing, worn parts, or incorrect assembly of the system
• Handling of potentially harmful cleaning and storage solutions