

Hollow fiber cartridges and systems for membrane separations

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Introduction

About this handbook

This handbook describes how to select hollow fiber ultrafiltration and microfiltration membrane cartridges manufactured by Cytiva. The handbook provides you with background information on membrane applications; details the broad range of membrane pore sizes, fiber inner diameters, fiber path lengths and cartridge membrane areas offered; and specifies membrane cartridge physical characteristics. Cartridge accessories and Cytiva separations systems well-matched for each cartridge size are highlighted.

Target audience

This handbook is intended for experienced users of ultrafiltration and microfiltration products. Specifically, the handbook addresses the needs of scientists, process engineers, and technicians who operate laboratory, pilot, and production cross flow membrane systems. Our customer service and technical support teams are ready to assist both the experienced and the novice user. For more information, visit [cytiva.com/bioprocessing](https://www.cytiva.com/bioprocessing). To contact your local Cytiva representative, visit [cytiva.com/contact](https://www.cytiva.com/contact).

Safety

When using any laboratory, pilot, or process scale separations equipment, the potential exists for personal injury unless you follow established safety procedures. When using Cytiva products, you should follow OSHA, federal, state, and local safety regulations. You should follow your company’s safety procedures, good engineering practices, and the safety instructions provided in the Cytiva handbooks.

This handbook uses highlighted blocks of text with flags to provide safety information and expert advice:

➔ Safety

WARNING: A safety warning flag describes conditions or actions that can cause bodily harm and describes how to avoid the risk.

➔ Expert Advice

CAUTION: An expert advice caution flag describes conditions or actions that can cause equipment damage and describes how to avoid the risk.

➔ Expert Advice

TIP: An expert advice tip flag provides information to use your hollow fiber membrane cartridge and system efficiently to achieve the best results.

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Selecting hollow fiber cross flow membrane cartridges

Introduction

Cytiva manufactures a complete selection of hollow fiber cross flow ultrafiltration and microfiltration membranes. These membranes are supplied as 25 different self-contained cartridge designs ranging from 16 cm² to 28 m² of effective membrane area. These designs are configured both to afford convenient linear scaling and to optimize any candidate application around reproducible and predictable fluid mechanics.

The combination of these cartridge features results in over 700 hollow fiber cartridge products to draw upon when considering any new separations application, offering the broadest selection range available for membrane separations. When faced with this long list of membrane and cartridge design options, even the most experienced bioprocess scientist may be overwhelmed with how to begin to select the appropriate cartridge. While we invite you to contact us directly to help with this task, we outline here a logical sequence that will serve as your roadmap for any future projects.

Cytiva cartridges are available in a broad spectrum of pore sizes (Table 1).

Table 1. Membrane pore size availability

Ultrafiltration (NMWC)*	Microfiltration (µm)
1000	0.1
3000	0.2
5000	0.45
10 000	0.65
30 000	
50 000	
100 000	
300 000	
500 000	
750 000	

* nominal molecular weight cutoff

Four items to consider for any candidate cross flow application

Membrane selection

Which membrane will result in the best product yield? Users should avoid the temptation to select an “open membrane” hoping to accelerate the process time (see Table 2 for recommended pore sizes). Often these attempts will backfire, resulting in prolonged processes and low yields. Any process time can be abbreviated by utilizing sufficient membrane area and appropriate operating conditions.

Flowpath selection

Cytiva hollow fiber membranes are available in a variety of lumen diameters and three standard cartridge lengths. Selecting the correct flowpath allows the membrane to operate at an equilibrium state with efficient use of recirculation flow.

Process sequence and operating conditions

How will this device be operated? At what temperature? What is an appropriate recirculation flow rate, and at what pressures? What is the target process time? Cross flow membranes perform best under equilibrium conditions such as found in constant volume diafiltration. Cytiva technical services offers you over 10 years of experience in typical GMP membrane separations bioprocesses to suggest an appropriate sequence coupled to a cartridge design with membrane area proportionate to your needs.

Membrane cartridge preparation and maintenance

The Cytiva operating handbook offers detailed protocols for the preparation of hollow fiber cartridges. Once a membrane cartridge has been used in a process, most users will elect to clean and store it for a subsequent process run. Cytiva hollow fiber cartridges are effectively cleaned using a simple treatment with sodium hydroxide at 50°C (122°F). Users usually adopt a clean water flux test to confirm that the cleaning is complete, by comparing the cleaned filter’s flux to a benchmark value that was determined when the filter was new. If the process requires a validated aseptic environment, either an autoclavable cartridge or a cartridge designed for steam-in-place (SIP) operation will be necessary.

Table 2. Recommended pore sizes for select applications

Application	Ultrafiltration (NMWC)	Microfiltration (µm)
Bacterial/pyrogen removal	10 000	
Protein concentration	3000; 5000; 10 000; 30 000	
Enzyme concentration	10 000; 30 000; 50 000	
Virus concentration/purification/ removal	100 000; 300 000; 500 000; 750 000	
Protein/antigen recovery from fermentation broth	500 000; 750 000	0.1, 0.2, 0.45, 0.65
Bacterial cell concentration	500 000	0.1, 0.2
Insect cell concentration		0.1, 0.2
Mammalian cell concentration		0.2, 0.45, 0.65
Yeast concentration		0.1, 0.2, 0.45
Continuous cell culture perfusion		0.1, 0.2, 0.45
Red blood cell washing		0.45, 0.65
Red blood cell stroma removal	500 000	0.1
Hemoglobin concentration	5000; 10 000	
Peptide concentration	1000; 3000	

What type of cross flow application do you have in mind?

Although most biopharmaceutical purification processes involve six or more individual steps that eventually must work in concert with one another, initially each separations task must be approached as a single entity.

By convention, the industry has designated certain operations as “upstream” or “primary recovery” involving cells and/or cell debris. After the suspended solids are removed and the target material reaches a semi-purified condition, the process is often designated as “downstream.” In the end, the product must be processed to achieve the appropriate final drug formulation and format — liquid, powder, capsule, and the like.

Regardless of what expression source is being used or the nature of the final drug, Cytiva hollow fiber cross flow membrane cartridges have proven equally at home in both upstream and downstream applications, delivering reproducible separations run after run.

In addition to a full range of Hollow Fiber cartridges, Cytiva also offers a complete line of Kwick™ flat-sheet cassette products. Kwick cassettes incorporate many design efficiencies that simplify and safeguard separations processes. For example, our cassettes feature a built-in gasket, eliminating the need to stock, clean/replace and assemble individual gaskets. (This feature also eliminates one more risk for contamination.) And our exceptional “anti-dead space” design virtually eliminates corner areas where impurities can hide during the cleaning process. The full line includes:

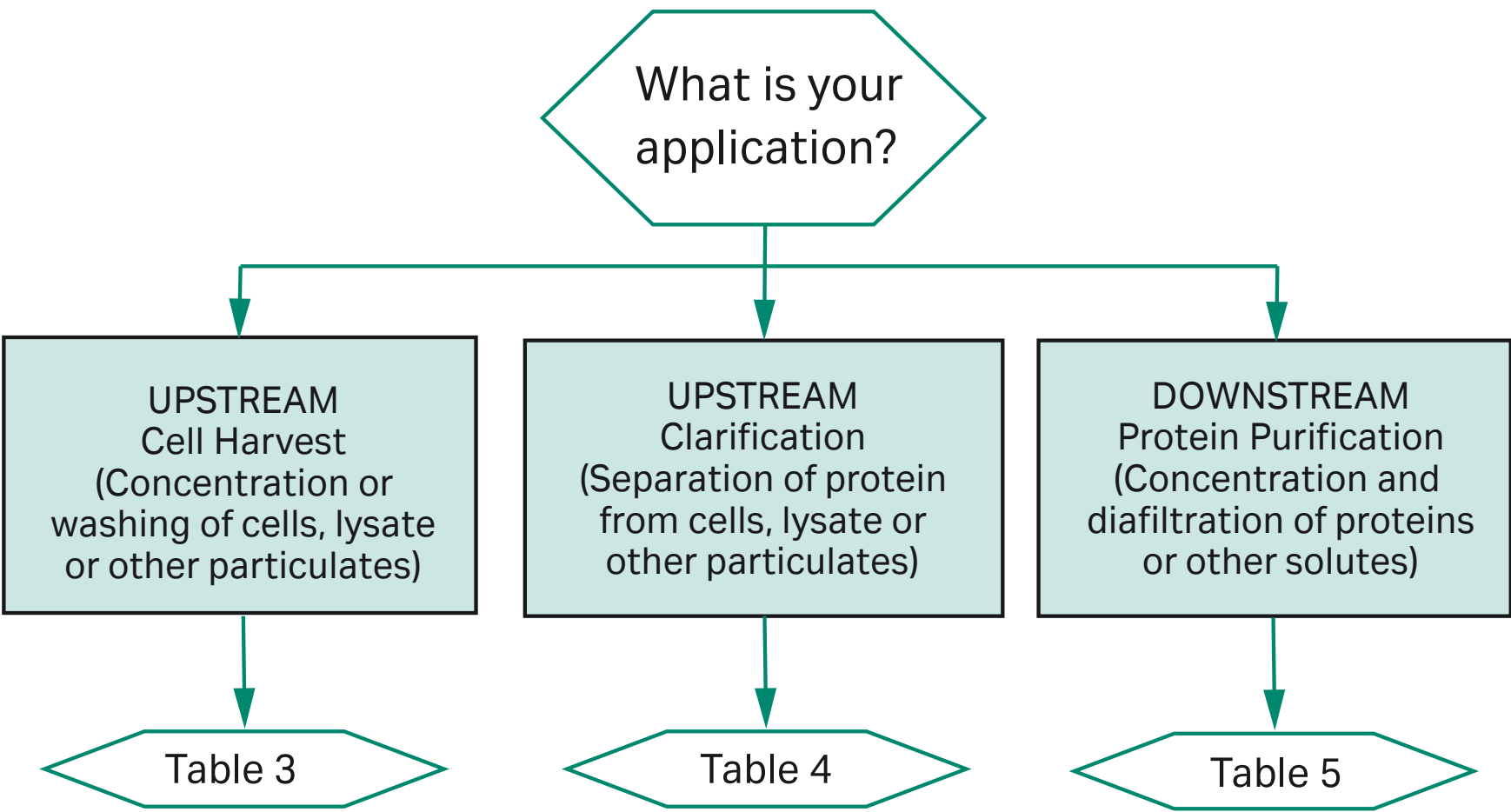
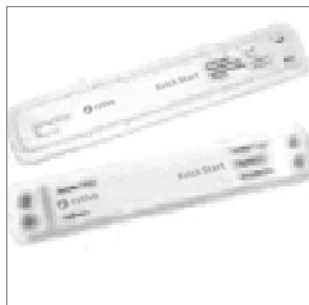
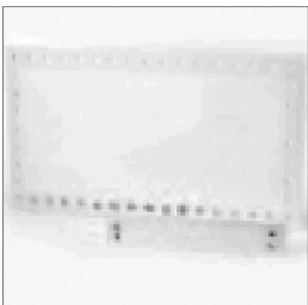


Fig 1. Application roadmap



Kwick Start™ cassettes

A small area device for low working volumes (15-25 mL) with minimal holdup. Ideal for membrane evaluation trials (easy linear scalability), product screening, process development, and optimization of downstream UF processes.



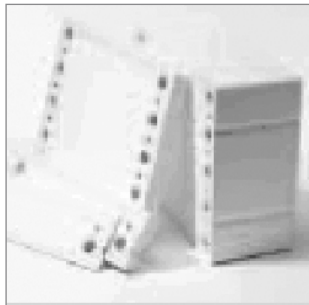
Kwick Pilot and Process cassettes

Six molecular weight cutoffs: 5 kD, 10 kD, 10 kD select, 30 kD, 50 kD and 100 kD to fit a broad range of cross flow applications.



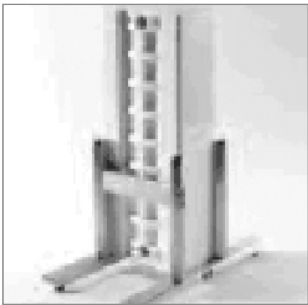
Kwick Lab Packet and Packet Holder

The Kwick Lab packet holder is the latest in the Cytiva line of design-in tools for cross flow applications involving Kwick cassettes. The Kwick Lab packet holder is a versatile device that houses Kwick Lab packets and facilitates their use on ÄKTAcrossflow and on other small-scale cross flow systems.



Kwick Lab™ and Kwick Flow™ cassettes

Kwick family designed for easy setup, enhanced cleanability, minimum product holdup volume, and option membrane selectivity.



Kwick Lab SCU cassettes

Featuring a self-contained housing and holder; available with 0.11 m² (1.2 ft²) of membrane surface area and five molecular weight cutoffs: 10 kD, 10 kD select, 30 kD, 50 kD, and 100 kD.

Applications related to membrane choice, flowpath, and operation

Upstream cell harvest

(Concentrating and/or washing particulated starting materials)

Table 3. Selection guidelines for upstream cell harvest

Selection guidelines

Membrane selection Suggested pore sizes	In order of preference: 500 000 and 750 000 NMWC ultrafiltration (UF) or 0.1 µm microfiltration (MF) Note: some specialized processes, such as bacterin concentration, are designed to retain both particulate and soluble components using very tight pore sizes, e.g., 30 000 or 10 000 NMWC UF membranes.
Flowpath selection Cartridge housing designs are listed on page 19 and 20. Cartridge lengths can be found in chapter 2, Table 7, <i>Nominal dimensions of Cytiva hollow fiber cartridges</i> on page 25.	Short path length cartridges (nominally 30 to 60 cm) Larger lumen diameter fibers (0.75 to 1.0 mm) Consult Cytiva technical support for other cartridge design choices when working with extremely viscous starting feed streams.
Process sequence and operating conditions <i>See Operating Handbook, Hollow fiber cartridges for membrane separations</i> for additional details	Recirculation flow rate: 8000 to 16 000 sec ⁻¹ shear rate for fouling feed streams, 2000 to 4000 sec ⁻¹ for shear sensitive feed streams. Process sequence — flux (and protein passage) is dependent on the concentration of particulates. To get the best protein passage, position a cell-washing step before flux declines significantly. Use low to moderate transmembrane pressure (< 1 barg [15 psig]). Process temperature: room temperature to 37°C (98.6°F) works best, but only if process components are stable in higher temperatures; otherwise 4°C to 12°C (39°F to 53.6°F) works well, but with lower flux.
Typical cartridge models	Laboratory scale: UFP-500-E-4MA (Autoclavable) Pilot scale: UFP-500-E-9A (Autoclavable) Process scale: UFP-500-E-65MSM Steam-in-place, requires stainless steel housing
Membrane cartridge preparation and maintenance Refer to our <i>Operating Handbook, Hollow fiber cartridges for membrane separations</i> for recommendations on standard protocols and further information on cartridge preparation, cleaning, sterilization, storage, and validation procedures.	

Examples:

- Concentration of *E. coli* fermentation broth
- Removal of culture media from mammalian cell culture bioreactors
- A linearly scalable alternative to centrifugation or single-pass depth filtration
- Concentration and washing of latex particles for diagnostic applications

Hollow fiber membrane cross flow filtration is widely employed for cell concentration, which is typically the “dewatering” of bacterial or mammalian cell culture. This process is usually considered a straightforward concentration of particulates, but often includes a cell washing step to remove media components prior to the succeeding steps, such as homogenization (microfluidization). This process is best performed with “tight pore size” microfiltration membranes, or “open pore size” ultrafiltration membranes. Historically, the most popular membrane for harvesting *E. coli* has been our 500 000 NMWC ultrafiltration membrane. Although this may seem counterintuitive, the flow rate curves in Figure 2 may help to illustrate why the largest pore size is often not the best choice for a cell harvesting process.

With all particulated feed streams, larger lumen diameter fibers (0.75 to 1.0 mm i.d.) are the most suitable. Generally, this is at least partly due to the particulated, viscous nature of the starting material. In addition, upstream cell harvest processes may also involve sticky, fouling components, such as lipopolysaccharides in the case of *E. coli*. Permeate flow rates are often uncontrolled and can be fairly high for mammalian cell culture processes — sometimes ranging between 80 and 120 l/h for low cell density starting volumes — but may be lower for higher density processes such as *E. coli*, bacterin, or lysate concentration.

The level of solids loading in the starting material helps determine flowpath length, with shorter flowpath length cartridges often suggested. A cartridge length of 30 or 60 cm is preferred over 110 cm path length cartridges, because the longer cartridges will exhibit higher inlet pressure. This higher pressure differential arises from increased dynamic friction at required recirculation flow rates in the longer cartridges. Pump capacity can be used to its maximum during particulate concentration by arraying multiple cartridges (2 to 4) in series for pilot scale and large scale processes, provided that each permeate stream is separately metered out (see discussion of permeate flow control on page 14).

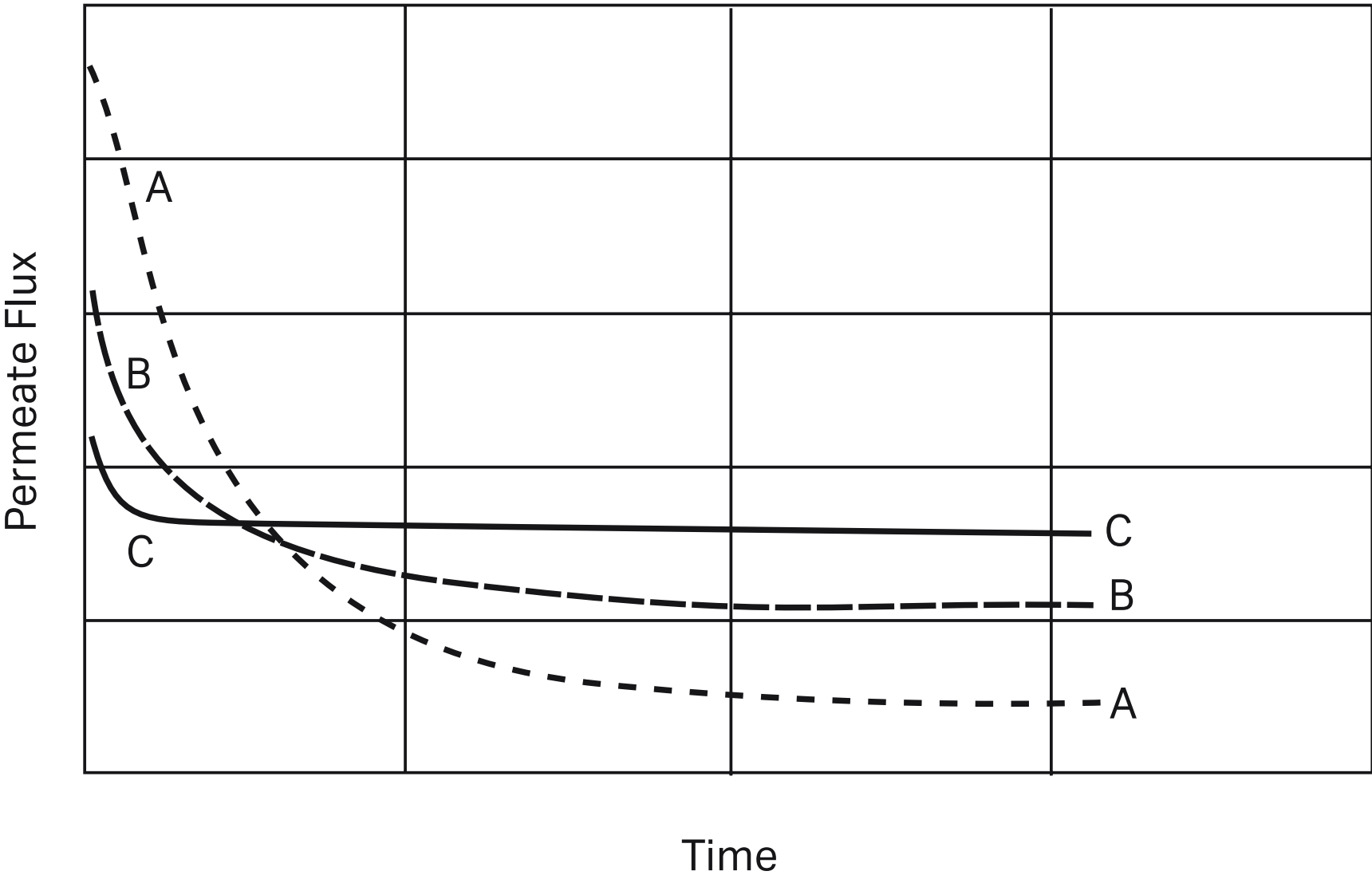


Fig 2. Flux in relation to pore size. Membrane A pore size > membrane B pore size > membrane C pore size

Upstream clarification of target material

(Expressed protein, carbohydrate, virus, etc., from a particulated starting material such as cells or lysate)

Table 4. Selection guidelines for upstream clarification of particulated starting material

Selection guidelines

Membrane selection Suggested pore sizes	Select the smallest pore size that still allows efficient passage of the target molecule (in general, 10× larger opening than the target protein). For most mammalian cell culture clarification, 0.2 to 0.65 µm pore sizes are used.
Flowpath selection Cartridge housing designs are listed on page 19 and 20. Cartridge lengths can be found in chapter 2, Table 7, <i>Nominal dimensions of Cytiva hollow fiber cartridges</i> on page 25.	Short path length cartridges (nominally 30 to 60 cm) Larger lumen diameter fibers (0.75 to 1.0 mm) Consult Cytiva technical support for other cartridge design choices when working with extremely viscous starting feed streams.
Process sequence and operating conditions See <i>Operating Handbook, Hollow fiber cartridges for membrane separations</i> for additional details	Recirculation flow rate: 8000 to 16 000 sec ⁻¹ shear rate for fouling feed streams, 2000 to 4000 sec ⁻¹ for shear sensitive feed streams. Process sequence — flux (and protein passage) is dependent on the concentration of particulates. To get the best protein passage, position a cell-washing step after a partial concentration, but before flux declines. Use of permeate flow control is strongly recommended. Low transmembrane pressure (< 0.7 barg [10 psig]) is usually very important for best protein passage to prevent blinding of membrane by particulates. Process temperature: room temperature to 37°C (98.6°F) works best, but only if process components are stable in higher temperatures; otherwise 4°C to 2°C (39°F to 53.6°F) works well, but with lower flux.
Typical cartridge models	Laboratory scale: CFP-2-E-4MA (Autoclavable) Pilot scale: CFP-6-D-6A (Autoclavable) Process scale: CFP-4-E-65MSM Steam-in-place, requires stainless steel housing
Membrane cartridge preparation and maintenance Refer to our <i>Operating Handbook, Hollow fiber cartridges for membrane separations</i> for recommendations on standard protocols and further information on cartridge preparation, cleaning, sterilization, storage, and validation procedures.	

Examples:

- Separation of monoclonal antibody from hybridoma cell culture
- Purification of adenovirus from 293 cell culture
- Clarification of plasmid from bacterial alkaline lysate

Clarification of particulated starting material demands larger lumen diameter fibers (0.75 to 1.0 mm i.d.). Unlike cell harvesting, or any other simple particulate concentration, clarification of a target molecule from a solution containing particulates requires more attention to process equilibrium. Since protein passage is of paramount concern in clarification processes, open pore size microfiltration membranes, such as 0.2 to 0.65 μm pore size, are typically recommended, especially for larger recombinant proteins and monoclonal antibodies. In general, choose a membrane pore size that is at least 10 $\times$ larger than the target material to pass through the membrane. Operators must exert more deliberate control of transmembrane pressure and more careful timing of concentration and cell washing to promote protein passage. Even though retentate backpressure is almost certainly reduced or even absent, further steps can also be taken to reduce transmembrane pressure to prevent premature fouling of the membrane. Experience has shown that permeate flow control (Fig 3) can be useful in further reducing inlet transmembrane pressure due to feed pump velocity.

When using permeate flow control, the permeation rate is controlled at a lower level than would be achieved initially with an uncontrolled permeate stream. The amount of flow reduction compared to unregulated permeate flow is dependent on the nature of the starting feed stream. Lower flow rates are recommended if the target molecule is very large, if the particulates are variable in size, or if the particulates are very sticky and fouling (Fig 4). A typical monoclonal antibody clarification from hybridoma cell culture with intact cells may be controlled at approximately 30 to 50 l/h, whereas clarification of enzyme from bacterial lysate is almost always at approximately 10 l/h.

In clarification tasks, the presence of upstream particulates demands use of shorter path length (30 to 60 cm) cartridges. Pilot scale and large scale processes often employ multiple 30 cm path length cartridges in series with individually controlled permeate streams to manage frictional pressure drop and reduce inlet transmembrane pressures. Contact Cytiva membrane separations technical support staff for more details on clarification system design when scaling up.

To promote maximum protein passage, good clarification process design is required (for example, partial concentration followed by brief diafiltration). Particulates can interfere with passage of protein as they become more concentrated. Proper timing of the diafiltration step is therefore essential. It is best to perform a brief diafiltration at a point where protein is still passing freely — that is, not being retained by a secondary rejection layer (gel polarization layer) composed of concentrated particulates.

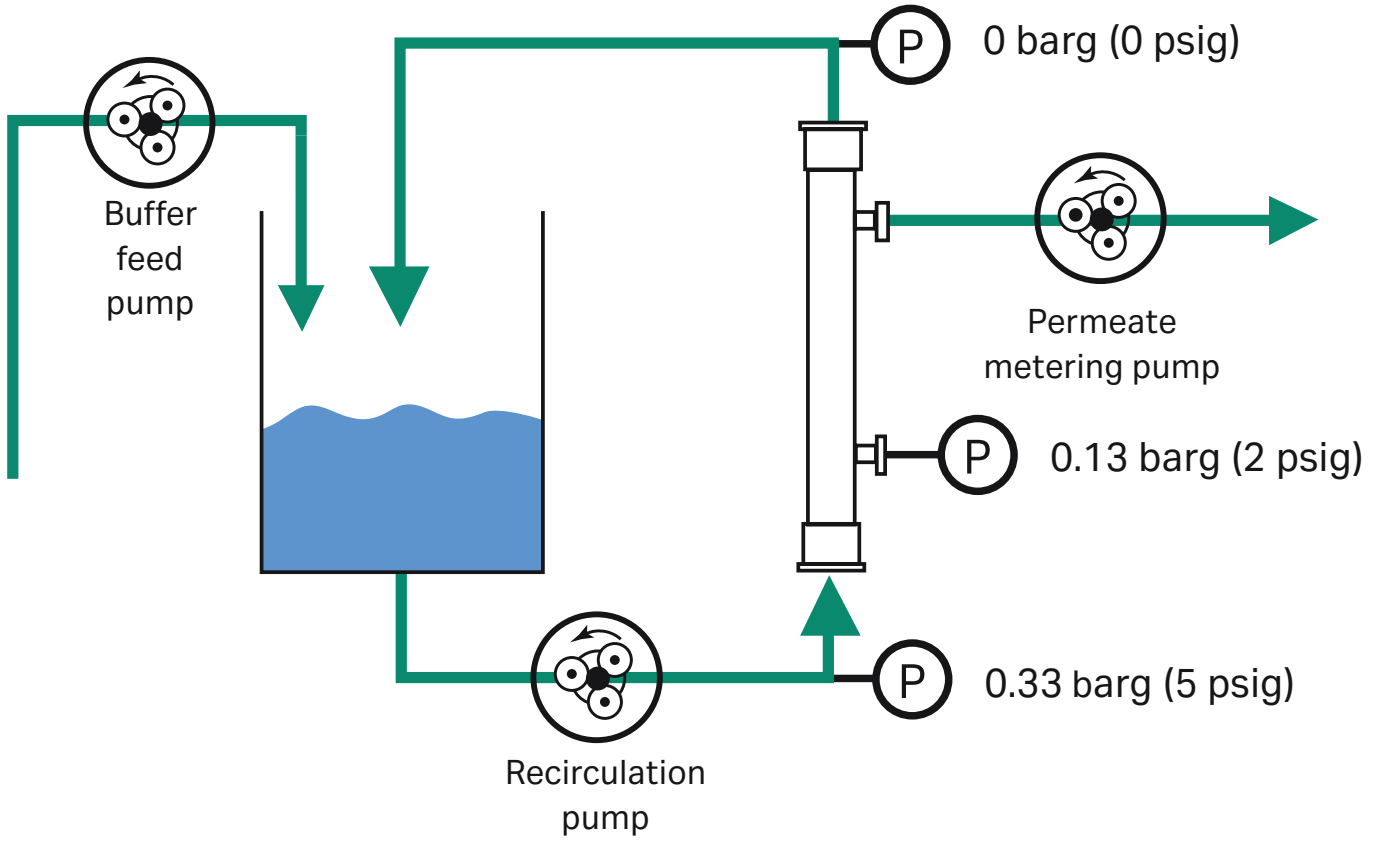


Fig 3. Permeate flow control

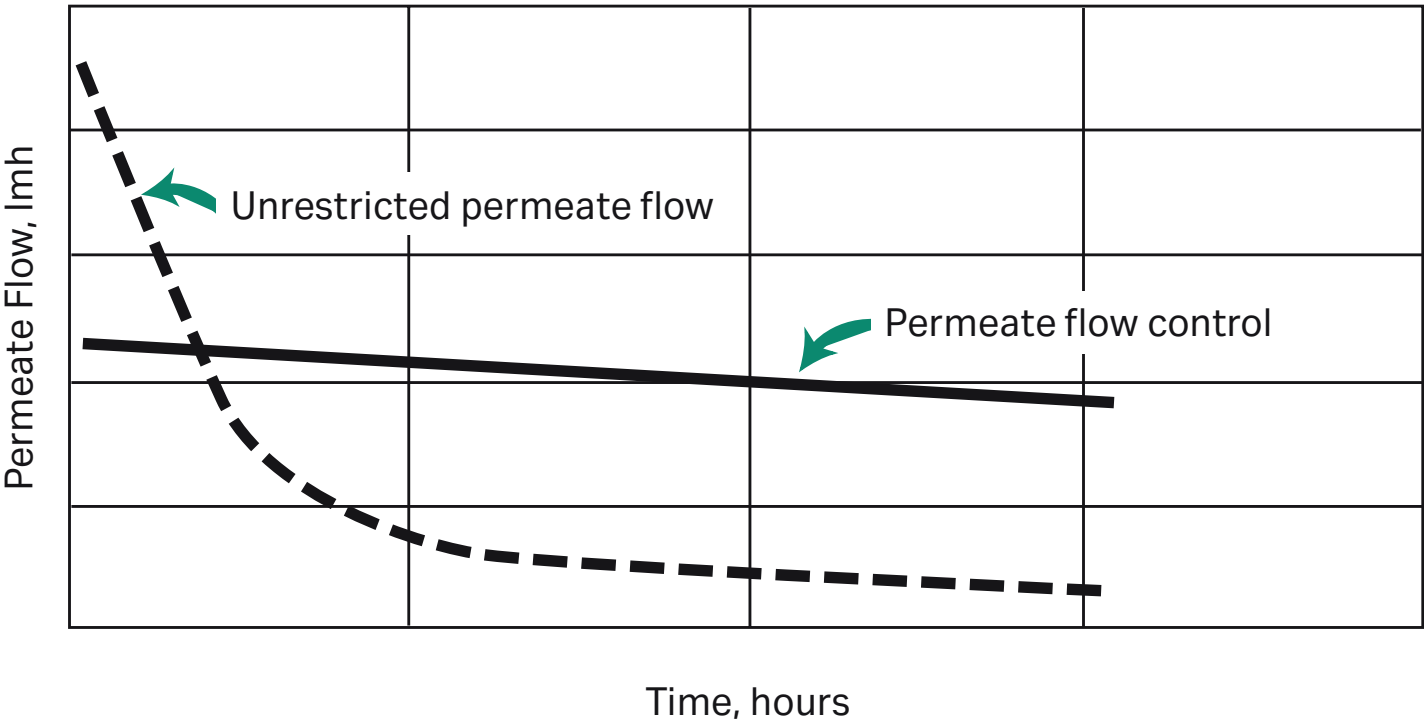


Fig 4. Permeate flow control results in more stable flow, higher protein yields, and often shorter process times

Downstream protein purification by ultrafiltration concentration and diafiltration

The most widely used applications for cross flow ultrafiltration membranes are downstream: concentration and diafiltration of the previously clarified biomolecule, as it is loaded onto and eluted from the chromatography columns. These applications are relatively easy separations to perform due to the purity of the starting materials. Although ultrafiltration cassette products are the dominant design in this type of processing, many users have found favor with the hollow fiber design due to their ease of use as well as the option for steam-in-place sterilization. Users processing materials that are particularly shear sensitive will also appreciate the gentle flowpath in the hollow fiber design, resulting in increased yields.

Table 5. Selection guidelines for downstream protein purification and concentration

Selection guidelines

Membrane selection Suggested pore sizes	Select the largest pore size that retains the target molecule (in general choose a membrane 3–5× smaller than the target protein). For example, either 30 000 or 50 000 NMWC ultrafiltration membranes are recommended for mAb concentration and diafiltration.
Flowpath selection Cartridge housing designs are listed on page 19 and 20. Cartridge lengths can be found in chapter 2, Table 7, <i>Nominal dimensions of Cytiva hollow fiber cartridges</i> on page 25.	Choose long path length cartridges (nominally 60 to 110 cm) Choose cartridges with small lumen fibers (0.5 mm) Consult Cytiva technical support for other cartridge design choices when working with extremely viscous starting feed streams.
Process sequence and operating conditions <i>See Operating Handbook, Hollow fiber cartridges for membrane separations</i> for additional details	Recirculation flow rate: 8000 to 16 000 sec ⁻¹ shear rate for fouling feed streams, 2000 to 4000 sec ⁻¹ for shear sensitive feed streams. Process sequence — flux increase is linear with increasing pressure up to the inflection point. To get the best flux vs time profile, position a diafiltration step after a partial concentration, but before flux declines to the point that diafiltration efficiency is affected (TMPs of 1 to 3 barg [15 to 45 psig] are often used). Typically, a more open pore size (> 30 000 NMWC) membrane offers a flux greater than or equal to 30 lmh, whereas a tighter pore size (3000 to 10 000 NMWC) membrane operates with a flux of ~ 5 to 15 lmh. Use these estimates to size your cartridge by surface area, permeate volumes generated, and process time objective. Process temperature: room temperature to 37°C (98.6°F) work best, but only if process components are stable at this temperature; otherwise 4°C to 12°C (39°F to 53.6°F) works well, but with lower flux.
Typical cartridge models	Laboratory scale: UFP-10-C-4X2MA (Autoclavable) Pilot scale: UFP-5-C-9A (Autoclavable) Process scale: UFP-30-C-85MSM Steam-in-place, requires stainless steel housing
Membrane cartridge preparation and maintenance <i>Refer to our Operating Handbook, Hollow fiber cartridges for membrane separations</i> for recommendations on standard protocols and further information on cartridge preparation, cleaning, sterilization, storage, and validation procedures.	

Examples:

- Concentration and buffer exchange of adenovirus for gene therapy applications
- Concentration of plasmids or oligonucleotides from chromatography column eluates

In general, choose a membrane that is three to five times smaller in NMWC rating than the molecular weight of the target protein. For example, either 30 000 or 50 000 NMWC ultrafiltration membranes are recommended for concentration and diafiltration of monoclonal antibody solutions, such as column chromatography eluates. Always retain the permeate in sequential aliquots for analysis of the target protein, an analysis that can give valuable insight and perhaps suggest process modifications. For example, if you determine that there is target protein in the permeate, but you observe it decreasing from one aliquot to the next, the decreasing yield may be due to a secondary rejection layer caused by components in your starting material forming a gel polarization layer that inhibits subsequent passage of your target molecule. Gaining this knowledge, you may elect to temporarily redirect your permeate stream back to the recirculation reservoir to refilter it and retain more target protein. Alternately, you may also decide to go to the next smaller pore size (NMWC) offered in Cytiva's wide selection of ultrafiltration membranes.

Protein concentration and diafiltration processing is usually suited to smaller lumen diameter fibers, such as 0.5 mm i.d. fibers. This is feasible because protein solutions being processed are typically well-clarified. An exception would be, if your protein solution is very viscous or contains some high-viscosity component such as glycerol or sucrose, or if either condition is accompanied by cold-room processing (i.e., 4°C [39°F]). For these cases, choose a 1 mm i.d. fiber to avoid rapidly increasing inlet pressures as your solution reaches final concentrations.

Longer path length cartridges and higher transmembrane pressures benefit clarified downstream processing. Cytiva ultrafiltration membranes are rated for up to 5 barg (75 psig) inlet pressures in some applications — for example, cold room processing at 4°C (39°F). Most protein purification processes use feed pressures up to 2 barg (30 psig) and transmembrane pressure (TMP) of about 1.4 barg (20 psig). Unlike water flux, process permeate flux is linear with pressure, up to the inflection point, as shown in Figure 5.

Diafiltration efficiency is a function of flux and number of volumes of buffer exchanged in the recirculating protein solution. If the protein solution becomes too concentrated prior to diafiltration, effectiveness of diafiltration is decreased.

The best method for diafiltration is constant-volume, continuous diafiltration, in contrast to discontinuous diafiltration, where the protein solution is subjected to multiple iterations of concentration and redilution. Discontinuous diafiltration is less efficient because of the extra volume of buffer exchange required and disequilibrium created by the constantly changing concentration. Figure 6 illustrates the relationship between number of wash volumes and percent removal of low molecular weight contaminants, while Figure 7 shows the typical equipment setup.

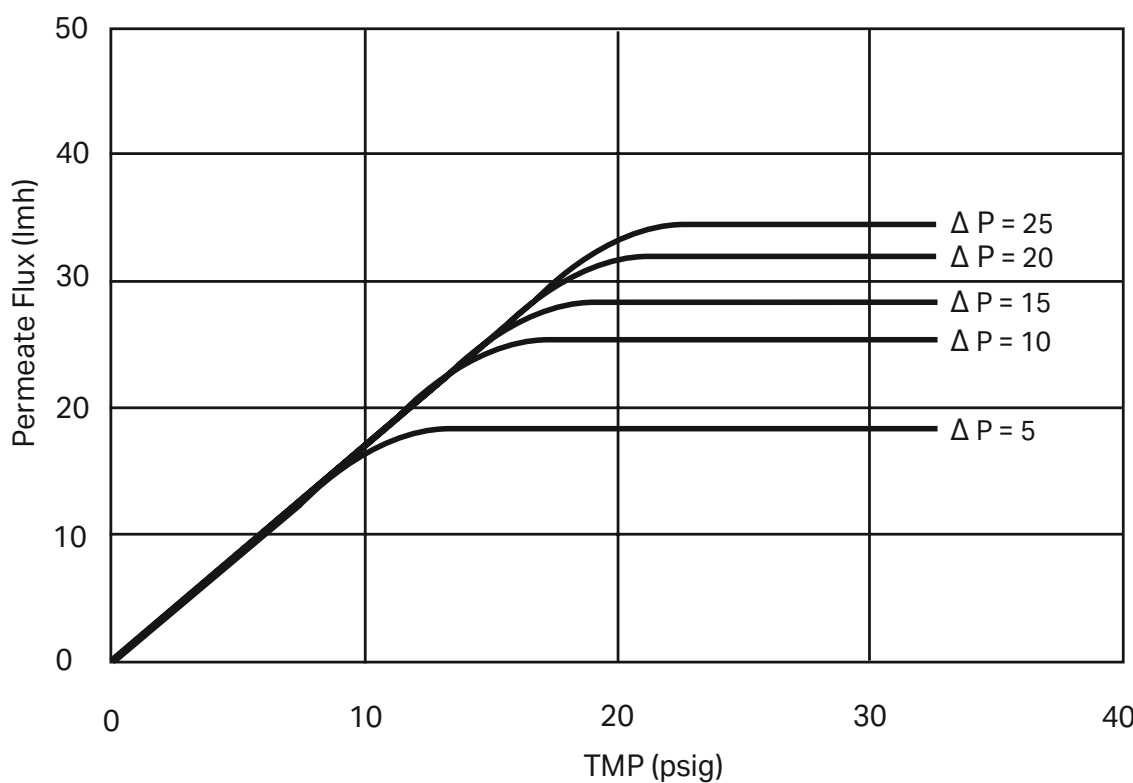


Fig 5. Permeate flux as a function of transmembrane pressure with varying recirculation rates

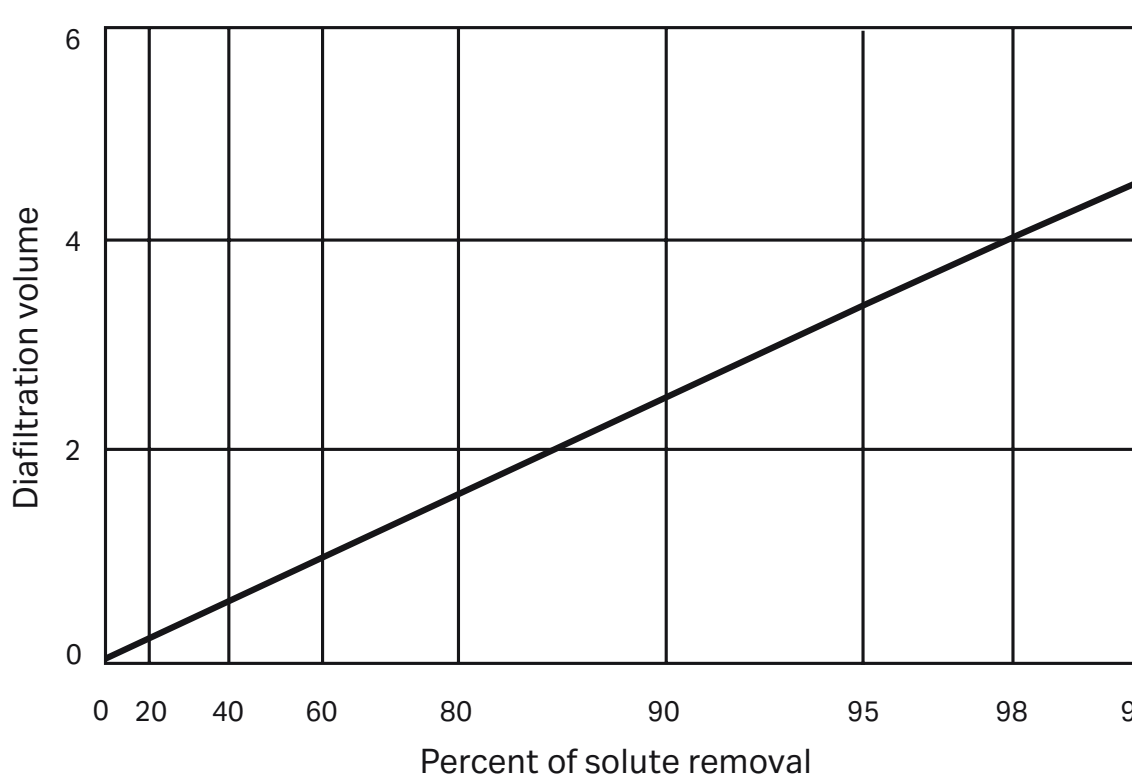


Fig 6. Relationship between diafiltration volume and solute removal

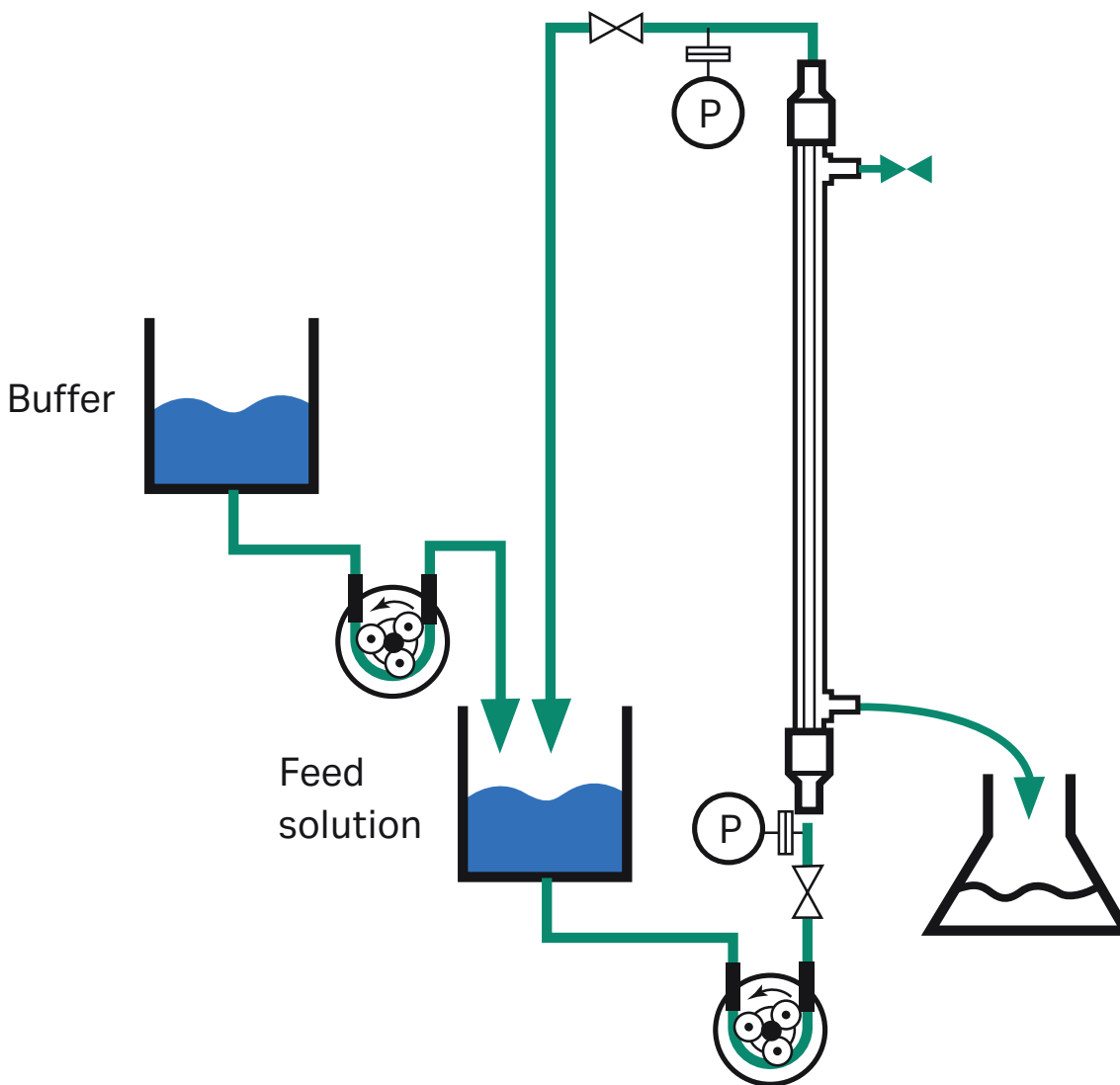


Fig 7. Continuous diafiltration diagram

Cartridge selection illustrated with process examples

When you consider any membrane separations task, always ask these three questions:

1. What is the starting volume? (number of milliliters or liters of cell culture, etc., that you have to process)
2. What is the process description? (concentration factor and volume of diafiltration buffer exchange compared to retentate volume)
3. What is the target process time? (dependent on scale: laboratory [0 to 10 liters]: typically one to two hours;
pilot/process: typically two to eight hours or more)

Process example:

- Monoclonal antibody clarification and concentration, from four liters of hybridoma cell culture
- This is actually two process tasks, each with a separate process description

Step A. The removal of cells and cell debris from the antibody expressed in the culture supernatant

Parameter	Value
Starting volume	4 liters of cells plus mAb
Process description	5× concentration, followed by 3× diafiltration
Process time	< 1 hour

Referring to the selection guidelines in Table 3:

Membrane selection

A 0.2 or 0.45 µm microfiltration membrane is required to provide maximum passage of the antibody.

Flowpath selection

Because of the particulated feed stream, 1.0 mm i.d. fibers and a fiber length of 30 or 60 cm are recommended.

Process sequence and operating conditions

To prevent pore plugging of this open pore size membrane, permeate flow control is employed at a rate of 50 l/h (flow controlled at 50 liters per m² of membrane surface area per hour). The process parameters indicate that the permeate volume generated will be 5.6 liters (5× concentration of 4 liters = 3.2 liters, plus 3× diafiltration of the 0.8 liter retentate = 2.4 liters). Therefore, to complete this task in less than one hour at a constant flow rate of 50 l/h, a membrane surface area greater than 1120 cm² is suggested.

Step B. The concentration and diafiltration of antibody clarified from Step A

Parameter	Value
Starting volume	5.6 liters of clarified mAb culture supernatant
Process description	20× concentration, followed by 5× diafiltration
Process time	< 1 hour

Referring to the selection guidelines in Table 4:

Membrane selection

A 30 000 or 50 000 NMWC ultrafiltration membrane is selected for retention of antibody (a rating 3–5× smaller than the 150 kD antibody).

Flowpath selection

Now that the feed stream has been clarified, 0.5 mm i.d. fibers, and a fiber length of 60 cm are recommended (120 cm fiber length recommended for process scale).

Process sequence and operating conditions

Typically, ultrafiltration hollow fiber membranes such as 30 000 NMWC offer a protein concentration process flux of approximately 30 l/mh. From the process description, the permeate volume generated will be 6.72 liters (20× concentration of 5.6 liters of permeate from Step A = 5.32 liters, plus 5× diafiltration of the 280 mL retentate = 1.4 liters). Therefore, to complete this task in less than one hour at an average flux of 30 l/mh, a membrane surface area greater than 2240 cm² is suggested.

Cartridge selection

For more information on how to interpret cartridge model number designations, see page 21.

Cartridge	Membrane area	Processing time
Step A	1200 cm ²	56 minutes
CFP-2-E-5A or CFP-4-E-5A		
Step B	4800 cm ²	28 minutes
UFP-30-C-6A		
Total process time		1 hour 24 minutes

How do you identify and order the right cartridge?

Cytiva cartridges are provided in a range of housing sizes that enables users to choose the right separations technology for a given application (Table 6).

Table 6. Nominal cartridge specifications

MidGee and MidGee Hoop cartridges			Laboratory and pilot scale cartridges				Process scale cartridges			
Housing identifier	Lumen i.d. (mm)	Membrane area (cm²)	Housing identifier	Lumen i.d. (mm)	Membrane area (m²)	Membrane area (ft²)	Housing identifier	Lumen i.d. (mm)	Membrane area (m²)	Membrane area (ft²)
MM	0.5	26	3M	0.5	0.014	0.15	35	0.5	1.35	14.5
	0.75	24		0.75	0.012	0.13		0.75	1	10.8
	1	16		1	0.011	0.12		1	0.92	9.9
H22	0.75	29	3X2M	0.5	0.029	0.31	35SMO	1	0.92	9.9
	1	38		1	0.023	0.24	35STM	0.75	1	10.8
H24	0.5	42	4, 4M	0.5	0.065	0.70	45	1	0.92	9.9
				0.75	0.046	0.50		0.5	3.5	37
H42	0.5	41		1	0.042	0.45		0.75	2.65	28.5
		4X2M	0.5	0.14	1.5	1	2.5	27		
			0.75	0.095	1.02	45MSM	1	2.3	25	
			1.0	0.085	0.91					
			1.75	0.065	0.70					

Table 6. Nominal cartridge specifications (Continued)

MidGee and MidGee Hoop cartridges			Laboratory and pilot scale cartridges				Process scale cartridges			
Housing identifier	Lumen i.d. (mm)	Membrane area (cm²)	Housing identifier	Lumen i.d. (mm)	Membrane area (m²)	Membrane area (ft²)	Housing identifier	Lumen i.d. (mm)	Membrane area (m²)	Membrane area (ft²)
			5	0.5	0.20	2.1	55	0.5	3.25	35
				0.75	0.16	1.7		0.75	2.5	27
				1	0.12	1.3		1	2.1	23
			6	0.5	0.48	5.2	55SMO	1.75	1.8	19.4
				0.75	0.37	4		1	2.1	23
				1	0.28	3		0.5	3.25	35
				1.75	0.23	2.5		0.75	2.5	27
			8	0.5	0.53	5.7	55STM	1	2.1	23
				0.75	0.41	4.4		0.5	3.25	35
				1	0.36	3.9		1	2.1	23
			9	0.5	1.15	12.5	55R	0.5	3.25	35
				0.75	0.93	10		1	2.1	23
				1	0.84	9		0.5	3.25	35
				1.75	0.59	6.3		1	2.1	23
							65	0.5	6.1	66
								0.75	4.9	53
								1	4.4	47
								1.75	3.5	38
								0.5	5.6	60
								1	4.2	45
							75	0.5	6	65
								1	3.7	40
							75R	0.5	6	65
								1	3.7	40
							85	0.5	13	140
								1	9	97
							85MSM	0.5	11.6	125
								1	9	95
							152M	0.5	14	150
								1	8.3	89
							154M	0.5	28	300
								1	16.6	179

To identify and order the proper cross flow cartridge, you must understand the model numbering convention. Each group of numbers or letters in the model number represents information about the cartridge.

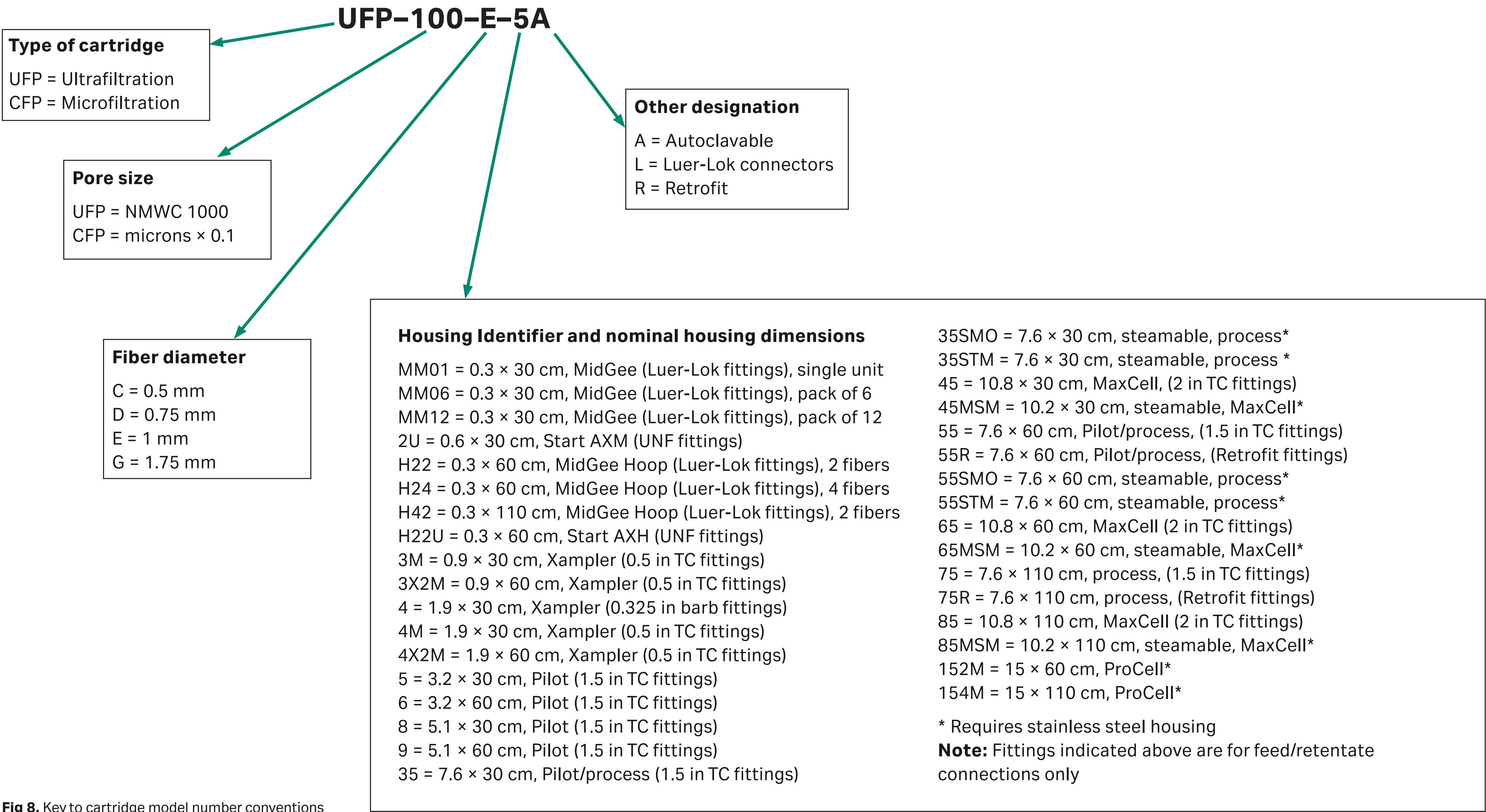


Fig 8. Key to cartridge model number conventions

Unique macrovoid-free structure of Cytiva hollow fiber membranes

Most traditional ultrafiltration membranes — whether flat sheet, hollow fiber, spiral, or tubular — contain large macrovoids in their substructure (Fig 9). Macrovoids are undesirable because:

- They provide weaker support for the separating barrier “skin,” resulting in lower intrinsic strength and increased compaction under pressure
- They sporadically propagate through the skin during manufacture or over time under process conditions. This can cause “pinhole” imperfections that may reduce product recovery or pass undesirable components.
- They may contribute to pore collapse at elevated temperatures reducing permeate flux and altering rejection characteristics

All Cytiva UF membranes have 100% integral, macrovoid-free structures resulting in these advantages:

- Higher membrane strength
- Stable, steady performance over the cartridge lifetime
- Absolute bacteria retention to maintain sterility
- High temperature stability

Quality assurance and documentation

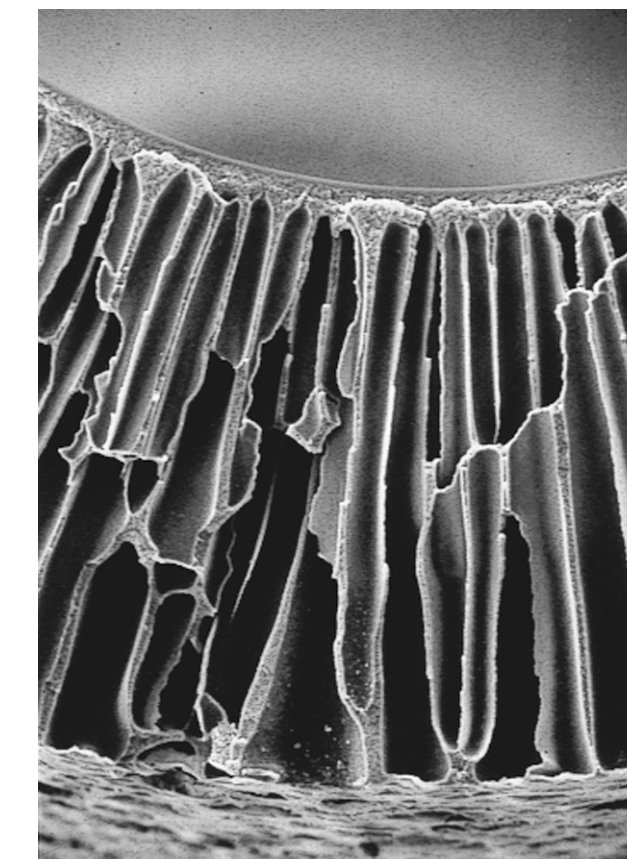
Quality assurance

All Cytiva membrane products are subjected to stringent quality control standards to assure the utmost product integrity and consistency. Every hollow fiber membrane cartridge is quality control (QC) tested prior to shipment.

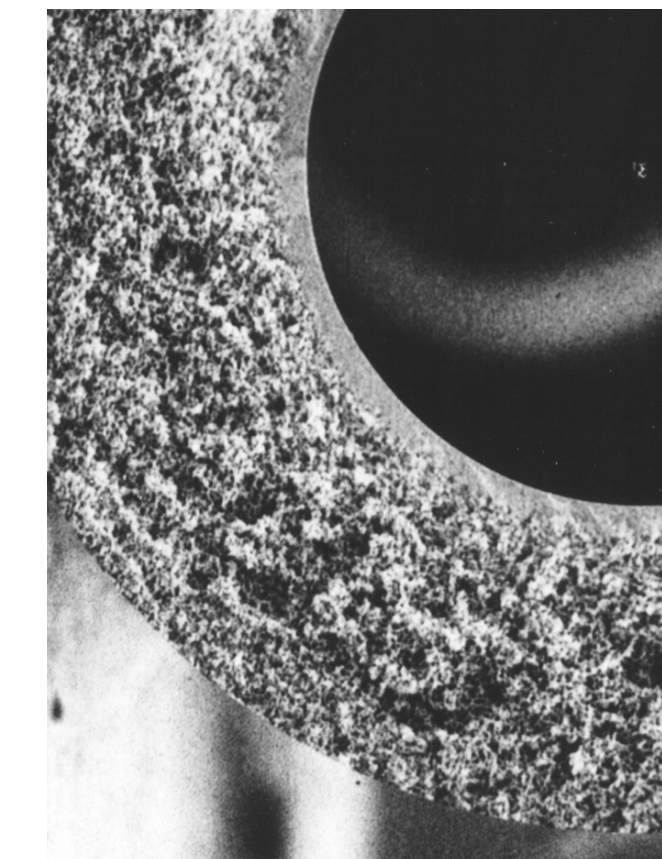
For ultrafiltration products, each lot of membrane is checked for rejection of one or more standard markers and clean water flux measurements are taken. Finished cartridges are tested for air diffusion and device integrity. Water flux measurements are recorded on a representative lot basis. Cytiva air diffusion standards are approximately three times more stringent than any other manufacturer in the industry.

For microfiltration products, each membrane cartridge* lot is bubble point tested for pore size confirmation, and clean water flux measurements are recorded or determined on a representative sample of cartridges. All Cytiva cartridges are pressure stressed prior to shipment. Ultrafiltration cartridges are stressed above their normal operating pressure limit. Microfiltration membranes are stressed to the equivalent of their 50:50 water:ethanol bubble point.

The combination of clean water flux data, chemical marker rejection data, and air diffusion test data clearly define both the separations rating of ultrafiltration membranes and the integrity of the membrane cartridge. Clean water flux and bubble point measurements define microfiltration membrane pore size.



Conventional ultrafiltration membrane



Cytiva ultrafiltration membrane

Fig 9. Scanning electron micrographs showing membrane with macrovoids (left) and without macrovoids (right)

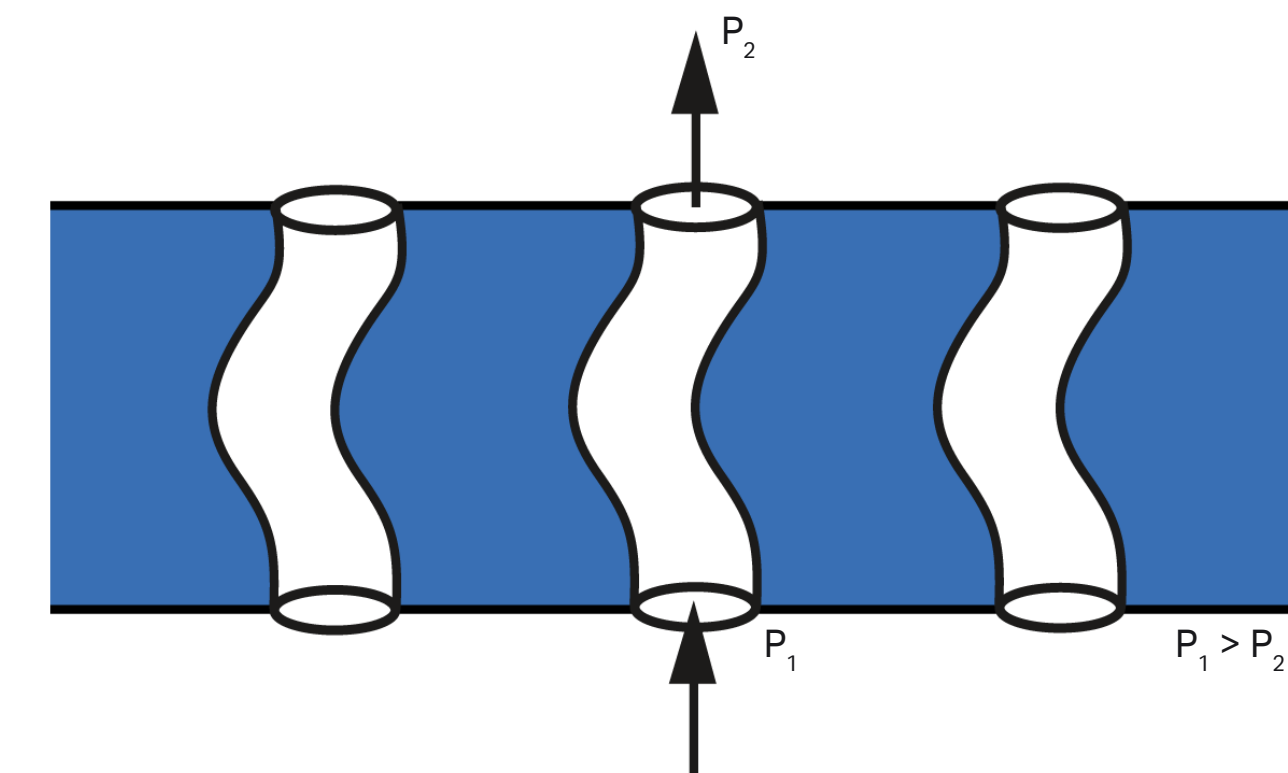


Fig 10. Simplified bubble point diagram for microporous membranes. The pores within a microporous membrane can be considered as fine capillaries. The minimum pressure required to force a liquid out of the membrane pore structure (known as the “bubble point” pressure) determines the largest pore size opening in the filter.

* Excluding our line of disposable MidGee and MidGee Hoop cross flow membrane cartridges

02

Physical dimensions of cartridges

Introduction

Almost all Cytiva hollow fiber membrane cartridges are self-contained in translucent polysulfone housings. The exceptions are steam-in-place (SIP) products, as well as our high-capacity ProCell™ modules. Three alternative SIP product types slip into matching stainless steel housings for safety during the steaming process. ProCell modules use stainless steel housings for support and to permit *in situ* high temperature water sanitization.

The self-contained design permits factory QC of the entire membrane assembly as well as simple and reliable integrity confirmation onsite. The integral housing design minimizes operator contact with process and cleaning solutions and allows for simple, quick membrane replacement or addition.

Throughout the wide range of membrane surface areas offered, the cartridge flowpath lengths have been standardized to be a nominal 30, 60, and 110 cm. This permits scale-up from research through production scale cartridges without a change in device configuration.

Dimensions, end fitting connections, and permeate port connections for each cartridge model are listed in Table 7. Similar data for stainless steel housings are provided in Table 8.

Please note that MaxCell™ cartridges (sizes 45, 65, and 85) require an adaptor kit when first purchased. Both straight (KAMX-16PS) and elbow (KAMX-16EL-PS) kits are offered to provide feed and retentate ports with 2 in, sanitary end fittings.

➔ Expert Advice

CAUTION: Do not hard pipe permeate ports on self-contained polysulfone cartridges or hang heavy parts on the plastic ports. Use flexible tubing to connect to a manifold where heavy fittings and valves can be properly supported.

Table 7. Nominal dimensions of Cytiva hollow fiber cartridges

Housing identifier	Diameter		Length ^{1,2}		End fitting connections	Permeate connections
	(cm)	(in)	(cm)	(in)		
MidGee	0.3	0.125	30.8	12.12	Luer-Lok (male)	Luer-Lok (male)
MidGee Hoop	0.3	0.125	—	—	Luer-Lok (male)	Luer-Lok (male)
Start AXM	0.6	0.25	30.8	12.12	UNF	UNF
Start AXH	0.3	0.125	—	—	UNF	UNF
3M [Xampler]	0.9	0.375	31.7	12.5	0.5 in Tri-Clamp	0.25 in tubing nipple
3X2M [Xampler]	0.9	0.375	63.5	25	0.5 in Tri-Clamp	0.25 in tubing nipple
4 [Xampler]	1.9	0.75	36.2	14.25	0.375 in tubing barb	0.375 in tubing nipple
4M [Xampler]	1.9	0.75	34.5	13.6	0.5 in Tri-Clamp	0.375 in tubing nipple
4X2M [Xampler]	1.9	0.75	66	26	0.5 in Tri-Clamp	0.375 in tubing nipple
5	3.2	1.25	31.8	12.5	1.5 in Tri-Clamp	0.5 in tubing nipple
6	3.2	1.25	63.5	25	1.5 in Tri-Clamp	0.5 in tubing nipple
8	5.1	2	34.9	13.75	1.5 in Tri-Clamp	0.5 in tubing nipple
9	5.1	2	63.5	25	1.5 in Tri-Clamp	0.5 in tubing nipple
35	7.6	3	35.6	14	1.5 in Tri-Clamp	1.5 in Tri-Clamp
35SMO	7.6	3	31.2	12.3	Requires SS housing	Requires SS housing
35STM	7.6	3	40.9	16.12	Requires SS housing	Requires SS housing
45 [MaxCell]	10.8	4.25	39.4 ³	15.5 ³	Adaptor to 2 in Tri-Clamp	1.5 in Tri-Clamp
45MSM	10.2	4	39.4	15.5	Requires SS housing	Requires SS housing
55	7.6	3	67.3	26.5	1.5 in Tri-Clamp	1.5 in Tri-Clamp
55R	7.6	3	63.5	25	Retrofit	1.5 in Tri-Clamp
55SMO	7.6	3	63	24.8	Requires SS housing	Requires SS housing
55STM	7.6	3	73	28.75	Requires SS housing	Requires SS housing
65 [MaxCell]	10.8	4.25	62.5 ³	24.6 ³	Adaptor to 2 in Tri-Clamp	1.5 in Tri-Clamp
65MSM	10.2	4	62.5	24.5	Requires SS housing	Requires SS housing
75	7.6	3	113	44.5	1.5 in Tri-Clamp	1.5 in Tri-Clamp
75R	7.6	3	109	43	Retrofit	1.5 in Tri-Clamp
85 [MaxCell]	10.8	4.25	120 ³	47.3 ³	Adaptor to 2 in Tri-Clamp	1.5 in Tri-Clamp
85MSM	10.2	4	120	47.3	Requires SS housing	Requires SS housing
152M [ProCell]	15	5.9	62.5	24.6	Requires SS housing	Requires SS housing
154M [ProCell]	15	5.9	120	47.3	Requires SS housing	Requires SS housing

¹ Nominal dimensions, not intended for design purposes

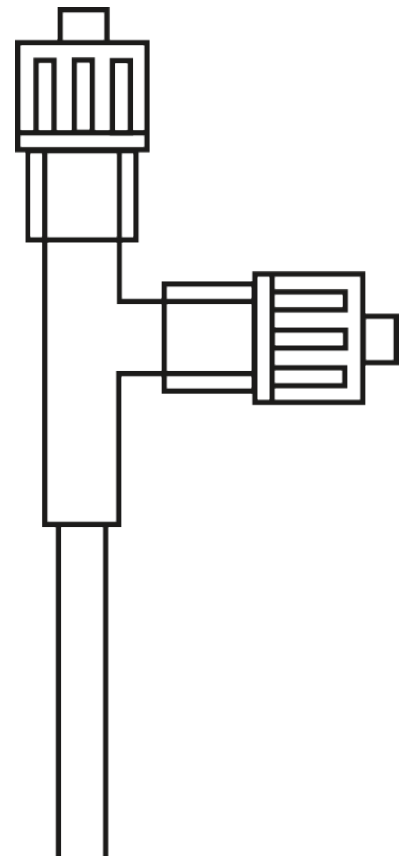
² Drawings showing all relevant reference dimensions are available on request

³ Add 10.8 cm (4.25 in) to MaxCell length for straight adaptors

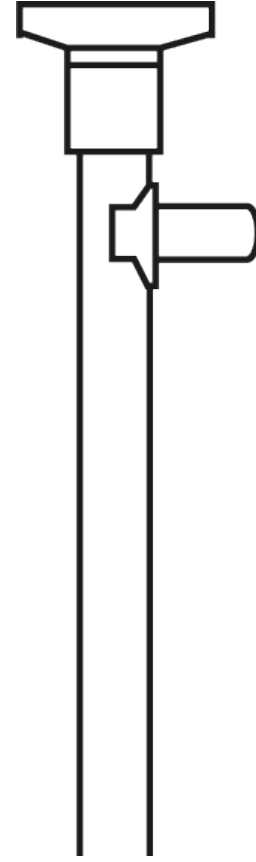
Table 8. Nominal dimensions of stainless steel housings for Cytiva cartridges

Housing identifier	Required housing	Diameter		Length		End fitting connections	Permeate connections
		(cm)	(in)	(cm)	(in)		
35SMO	SS-35SMO-DP	9.1	3.6	37.3	14.7	1.5 in Tri-Clamp	1.5 in Tri-Clamp
55SMO	SS-55SMO-DP	9.1	3.6	69.3	27.3	1.5 in Tri-Clamp	1.5 in Tri-Clamp
35STM	SS-35STM	9.1	3.6	43.4	17.1	1.5 in Tri-Clamp	1.5 in Tri-Clamp
55STM	SS-55STM	9.1	3.6	75.2	29.6	1.5 in Tri-Clamp	1.5 in Tri-Clamp
45MSM	SS-45MSM-DP	11.4	4.5	52.8	20.8	2 in Tri-Clamp	1.5 in Tri-Clamp
65MSM	SS-65MSM-DP	11.4	4.5	75.7	29.8	2 in Tri-Clamp	1.5 in Tri-Clamp
85MSM	SS-85MSM-DP	11.4	4.5	134	52.7	2 in Tri-Clamp	1.5 in Tri-Clamp
85MSM	SS-85MSM-EL-DP	11.4	4.5	150*	59.2*	2.5 in Tri-Clamp, elbow	1.5 in Tri-Clamp
152M	SS-152TC	16.8	6.6	81.2	32	2 in Tri-Clamp	1.5 in Tri-Clamp
154M	SS-154TC	16.8	6.6	139	54.8	2 in Tri-Clamp	1.5 in Tri-Clamp

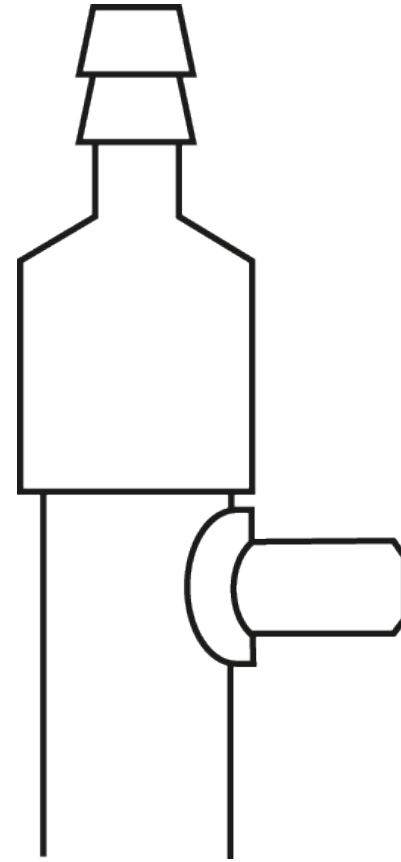
* Length for housings with elbow fittings is the distance between the centers of the end fitting connections



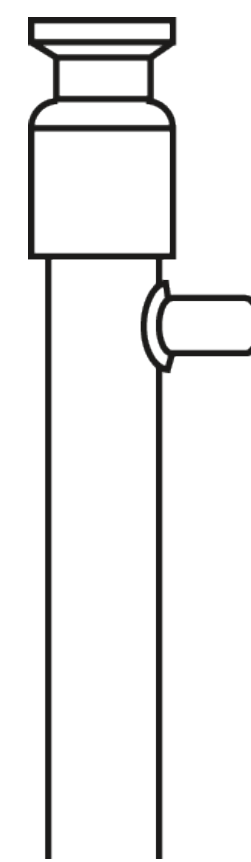
MidGee, MidGee Hoop



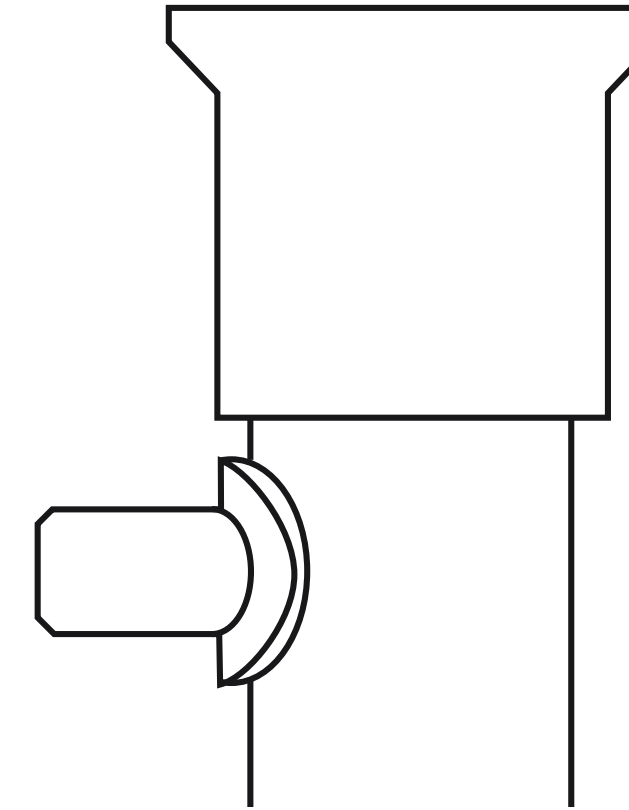
Size 3M, 3X2M



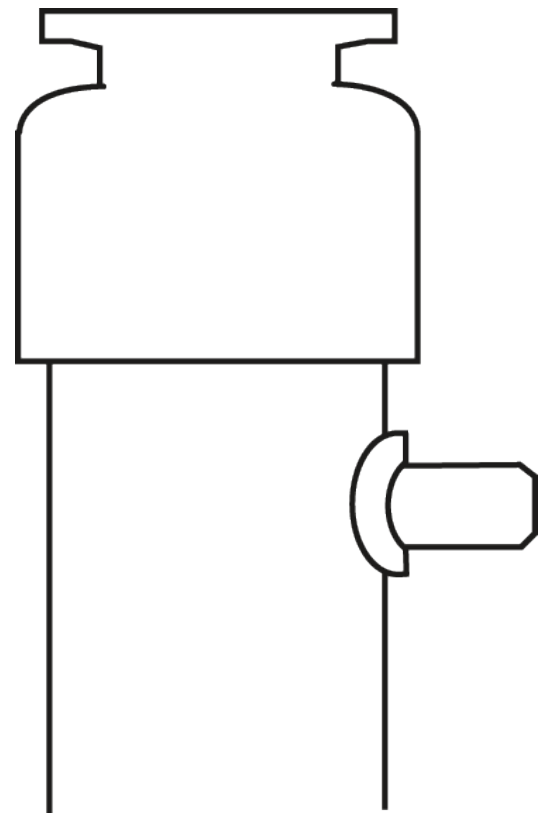
Size 4



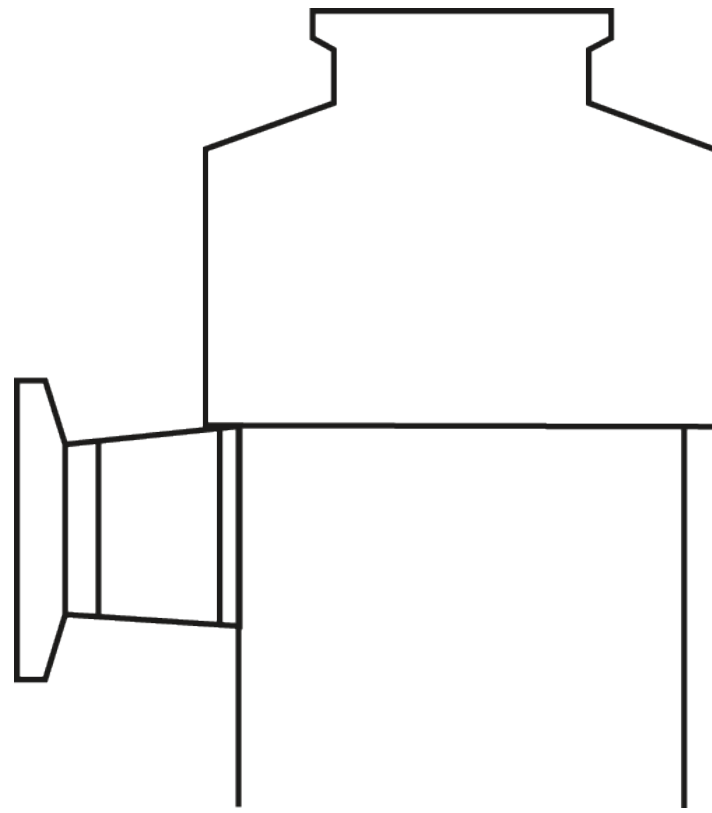
Size 4M, 4X2M



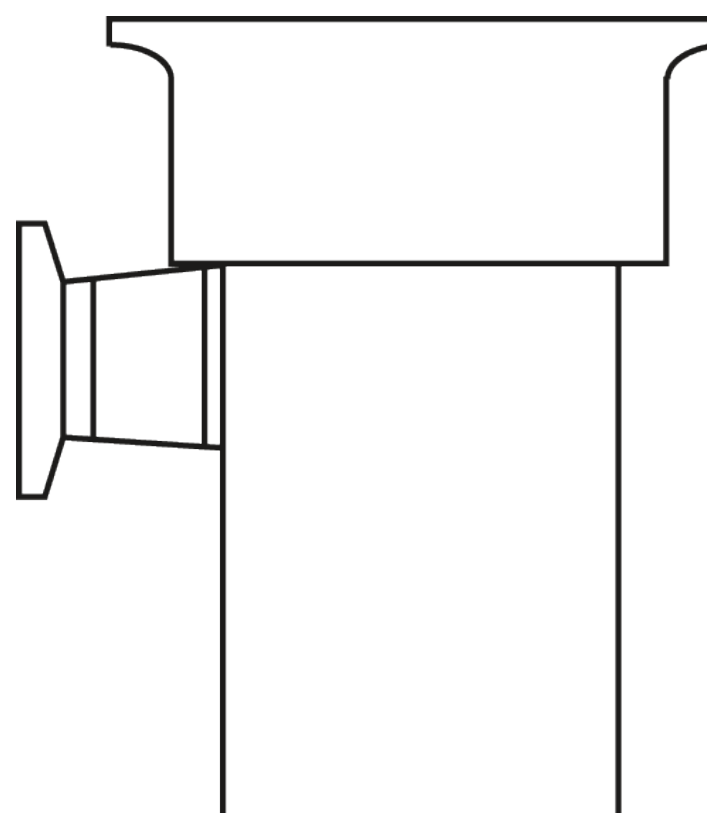
Size 5, 6



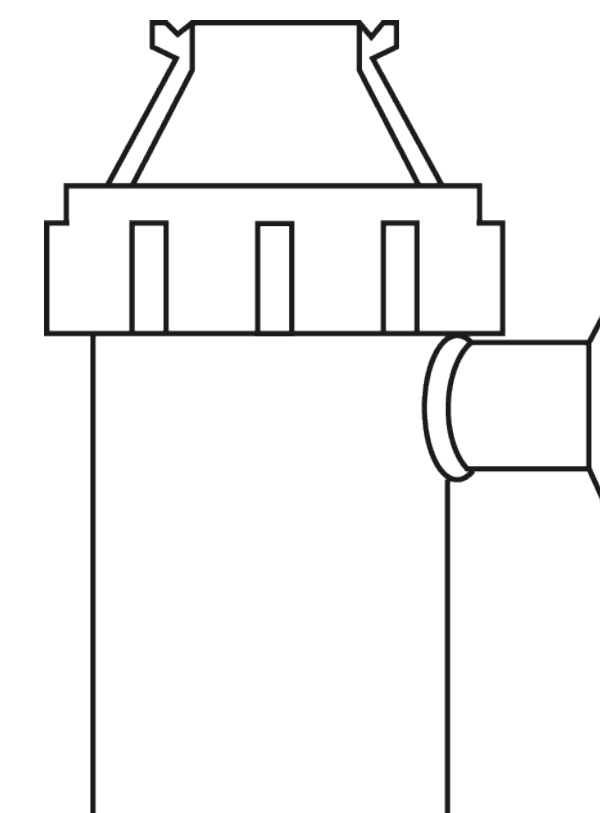
Size 8, 9



Size 35, 55, 75



Size 55R, 75R



Size 45, 65, 85

Fig 11. A partial selection of fittings available on Cytiva hollow fiber membrane cartridges (drawings not to scale)

03

Research/laboratory scale cartridges

Hollow fiber Start AXM and Start AXH cross flow cartridges for the ÄKTAcrossflow system

Hollow fiber Start AXM and Start AXH cross flow cartridges are self-contained, disposable filtration devices enabling process development and optimization of ultrafiltration (UF) and microfiltration (MF) operations for cell processing and upstream clarification of biopharmaceutical solutions.

These cartridges are designed for small scale processing, rapid laboratory concentration, and/or diafiltration of critical biological solutions at research-scale volumes with convenience and speed. These easy-to-use hollow fiber cartridges minimize membrane polarization due to the “sweeping action” generated by a recirculation pump.

Data derived from tests with these cartridges enable process development engineers to perform initial evaluations on Cytiva hollow fiber ultrafiltration and/or microfiltration membranes. Concentration and diafiltration process parameters can be established in preparation for process scale-up to larger cartridge and system designs or for scale-down process optimization and troubleshooting experiments.

Hollow fiber Start AXM and Start AXH cross flow cartridges are designed for use with the ÄKTAcrossflow™ automated cross flow filtration system (see page 85) and feature a small upstream holdup volume to maximize product recovery and to favor low working volumes.

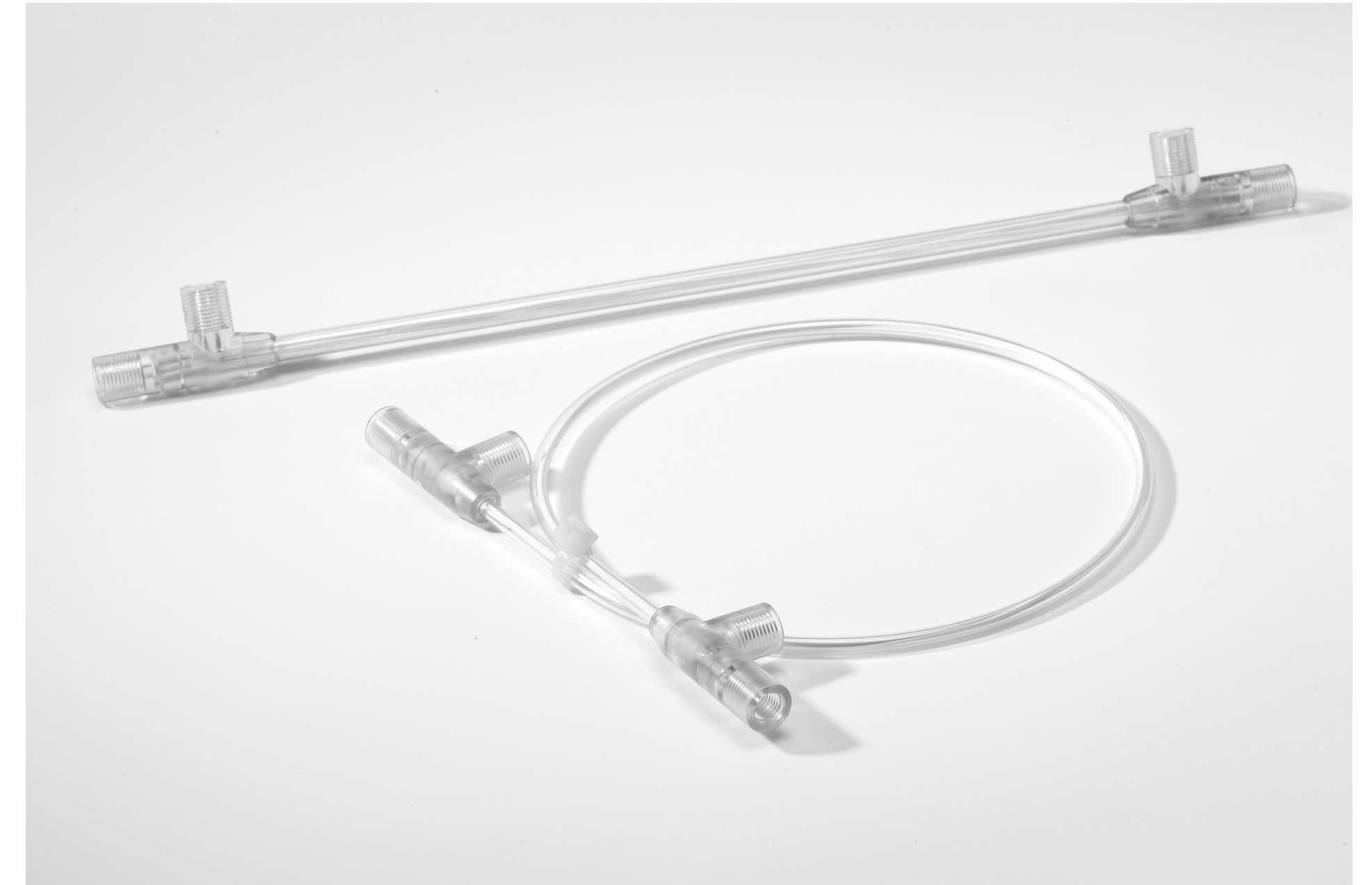


Fig 12. Hollow fiber Start AXM and AXH cartridge

Table 9. Model numbers and specifications for Start AXM ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Nominal flowpath number (cm)
11000543	UFP-3-C-2U	3000	0.5	50	30
11000544	UFP-10-C-2U	10 000	0.5	50	30
11000545	UFP-30-C-2U	30 000	0.5	50	30
11000546	UFP-100-C-2U	100 000	0.5	50	30
11000547	UFP-300-C-2U	300 000	0.5	50	30
11000548	UFP-500-C-2U	500 000	0.5	50	30
11000549	UFP-500-E-2U	500 000	1	50	30
11000550	UFP-750-E-2U	750 000	1	50	30

Table 10. Model numbers and specifications for Start AXM microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm ²)	Nominal flowpath number (cm)
11000551	CFP-1-E-2U	0.1	1	50	30
11000552	CFP-2-E-2U	0.2	1	50	30
11000553	CFP-4-E-2U	0.45	1	50	30
11000554	CFP-6-D-2U	0.65	0.75	50	30

Table 11. Model number for Cell Processing Evaluation Kit

Code number	Model number
11000565	CFP-CELL-KIT 2U*

* Contains 1 each of UFP-750-E-2U, CFP-1-E-2U, CFP-2-E-2U, CFP-4-E-2U, CFP-6-D-2U

Table 12. Model numbers and specifications for Start AXH ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm²)	Nominalflowpath number (cm)
11000537	UFP-3-C-H24U	3000	0.5	40	60
11000538	UFP-10-C-H24U	10 000	0.5	40	60
11000539	UFP-30-C-H24U	30 000	0.5	40	60
11000540	UFP-100-C-H24U	100 000	0.5	40	60
11000541	UFP-300-C-H24U	300 000	0.5	40	60
11000542	UFP-500-C-H24U	500 000	0.5	40	60

Table 13. Nominal feed stream flow rates (mL/min) for Start AXM cartridges

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	25	50	100	200
0.75	40	80	160	320
1.0	75	150	300	600

Table 14. Nominal feed stream flow rates (mL/min) for Start AXH cartridges

Format	Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
H22U	1.0	24	47	94	188
H24U	0.5	8.5	17	33	66

Table 15. Model numbers and specifications for Start AXH microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Nominal flowpath number (cm)
56411028	CFP-1-E-H22U	0.1	1	40	60

MidGee and MidGee Hoop membrane cartridges

Throughout the R&D process, access to product is often limited. As a result, investigations into optimization of operating conditions are sometimes overlooked or even postponed. With MidGee and MidGee Hoop cartridges, scale-up and scale-down has never been easier. These disposable cartridges have exceptionally low lumen-side and shell-side holdup volumes, permitting processing of 25 to 200 mL. When combined with our MidJet™ system, concentration to volumes as small as two milliliters is possible.

MidGee cartridges have a nominal 30 cm path length. Their Hoop counterparts have path lengths of 60 and 110 cm, allowing one to match any of Cytiva larger cartridge path lengths for direct scale-up to pilot/production scale designs.

Schematic drawings of the MidGee and MidGee Hoop cartridges are provided in Figure 13. The Luer-Lok™ connections on these units mate with optional pressure transducers for digital readout of inlet/outlet and/or permeate pressures.

MidGee cartridge model numbers are detailed in Table 9 for ultrafiltration membranes and Table 10 for microfiltration membranes. MidGee Hoop models are listed in Tables 11 and 12.

Accessories for the MidGee product line are noted in Table 13.

➔ Expert Advice

TIP: MidGee and MidGee Hoop filters, in combination with our MidJet cross flow filtration system, replace stirred cells and dialysis tubing for controllable laboratory separations. One can achieve high product recoveries with minimal shear denaturation.



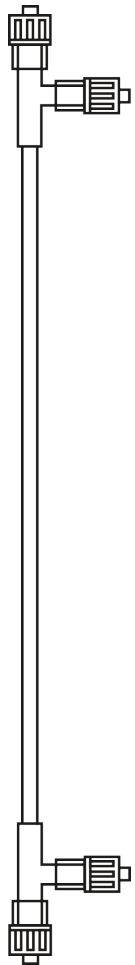
Fig 13. MidGee and MidGee Hoop cartridges

MidGee and MidGee Hoop cartridges are available in 30, 60, and 110 cm (110 cm not shown) flowpath lengths to permit direct scale-up and scale-down of experimental data.

Housing MM

Length = 30.8 cm (12.12 in)
Diameter = 0.3 cm (0.125 in)
Permeate ports = Male Luer-Lok
Feed/retentate ports = Male Luer-Lok

Fig 14. MidGee and MidGee Hoop cross flow cartridges (drawings not to scale)



Housings H22L, H24L, H42L

Nominal flowpath length (H22L & H24L) = 60 cm (23.6 in); (H42L) = 110 cm (43.3 in)
Diameter = 0.3 cm (0.125 in)
Hoop diameter = 15.3 cm (6 in)
Permeate ports = Male Luer-Lok
Feed/retentate ports = Male Luer-Lok

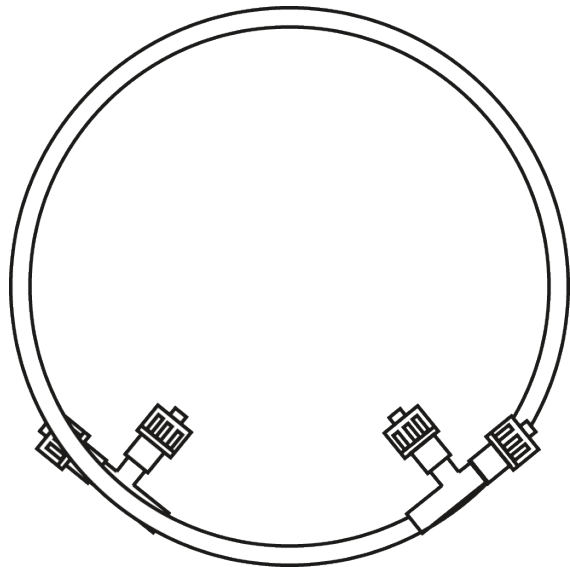


Table 16. Model numbers and specifications for MidGee ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Nominal flowpath number (cm)
56410000	UFP-1-C-MM01	1000	0.5	26	30
56410001	UFP-1-C-MM06	1000	0.5	26	30
56410002	UFP-1-C-MM12	1000	0.5	26	30
56410004	UFP-3-C-MM01A	3000	0.5	26	30
56410005	UFP-3-C-MM06A	3000	0.5	26	30
56410006	UFP-3-C-MM12A	3000	0.5	26	30
11000504	UFP-5-C-MM01A	5000	0.5	26	30
11000505	UFP-5-C-MM06A	5000	0.5	26	30
11000506	UFP-5-E-MM01A	5000	1	16	30
11000507	UFP-5-E-MM06A	5000	1	16	30
56410012	UFP-10-C-MM01A	10 000	0.5	26	30
56410013	UFP-10-C-MM06A	10 000	0.5	26	30
56410014	UFP-10-C-MM12A	10 000	0.5	26	30
56410016	UFP-10-E-MM01A	10 000	1	16	30
56410017	UFP-10-E-MM06A	10 000	1	16	30
56410018	UFP-10-E-MM12A	10 000	1	16	30
56410020	UFP-30-C-MM01A	30 000	0.5	26	30
56410021	UFP-30-C-MM06A	30 000	0.5	26	30
56410022	UFP-30-C-MM12A	30 000	0.5	26	30
56410024	UFP-30-E-MM01A	30 000	1	16	30
56410025	UFP-30-E-MM06A	30 000	1	16	30
56410026	UFP-30-E-MM12A	30 000	1	16	30
56410028	UFP-50-C-MM01A	50 000	0.5	26	30
56410029	UFP-50-C-MM06A	50 000	0.5	26	30
56410030	UFP-50-C-MM12A	50 000	0.5	26	30

Table 16. Model numbers and specifications for MidGee ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Nominal flowpath number (cm)
56410032	UFP-50-E-MM01A	50 000	1	16	30
56410033	UFP-50-E-MM06A	50 000	1	16	30
56410034	UFP-50-E-MM12A	50 000	1	16	30
56410036	UFP-100-C-MM01A	100 000	0.5	26	30
56410037	UFP-100-C-MM06A	100 000	0.5	26	30
56410038	UFP-100-C-MM12A	100 000	0.5	26	30
56410040	UFP-100-E-MM01A	100 000	1	16	30
56410041	UFP-100-E-MM06A	100 000	1	16	30
56410042	UFP-100-E-MM12A	100 000	1	16	30
56410044	UFP-300-C-MM01A	300 000	0.5	26	30
56410045	UFP-300-C-MM06A	300 000	0.5	26	30
56410046	UFP-300-C-MM12A	300 000	0.5	26	30
56410048	UFP-300-E-MM01A	300 000	1	16	30
56410049	UFP-300-E-MM06A	300 000	1	16	30
56410050	UFP-300-E-MM12A	300 000	1	16	30
56410052	UFP-500-C-MM01A	500 000	0.5	26	30
56410053	UFP-500-C-MM06A	500 000	0.5	26	30
56410054	UFP-500-C-MM12A	500 000	0.5	26	30
56410056	UFP-500-E-MM01A	500 000	1	16	30
56410057	UFP-500-E-MM06A	500 000	1	16	30
56410058	UFP-500-E-MM12A	500 000	1	16	30
56410806	UFP-750-E-MM01A	750 000	1	16	30
56410807	UFP-750-E-MM06A	750 000	1	16	30
56411026	UFP-750-E-MM12A	750 000	1	16	30

Table 17. Model numbers and specifications for MidGee microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Nominal flowpath number (cm)
56410064	CFP-1-E-MM01A	0.1	1	16	30
56410065	CFP-1-E-MM06A	0.1	1	16	30
56410066	CFP-1-E-MM12A	0.1	1	16	30
56410072	CFP-2-E-MM01A	0.2	1	16	30
56410073	CFP-2-E-MM06A	0.2	1	16	30
56410074	CFP-2-E-MM12A	0.2	1	16	30
56410080	CFP-4-E-MM01A	0.45	1	16	30
56410081	CFP-4-E-MM06A	0.45	1	16	30
56410082	CFP-4-E-MM12A	0.45	1	16	30
56410084	CFP-6-D-MM01A	0.65	0.75	24	30
56410085	CFP-6-D-MM06A	0.65	0.75	24	30
56410086	CFP-6-D-MM12A	0.65	0.75	24	30

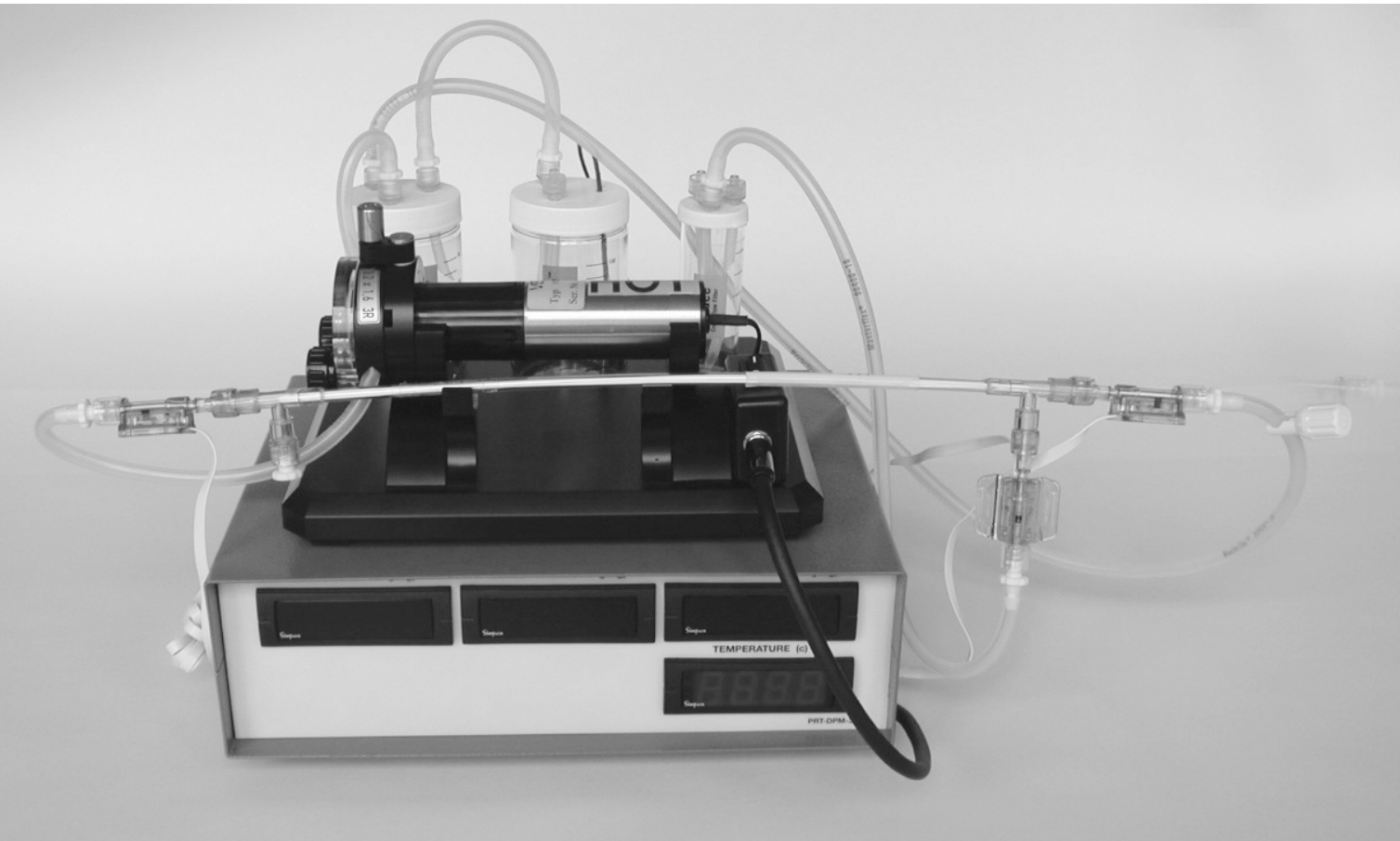


Fig 14. Advanced MidJet system with MidGee cartridge installed

Table 18. Model numbers and specifications for MidGee Hoop ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Nominal flowpath number (cm)
56410088	UFP-3-E-H22LA	3000	1	38	60
56410089	UFP-10-E-H22LA	10 000	1	38	60
56410090	UFP-30-E-H22LA	30 000	1	38	60
56410091	UFP-50-E-H22LA	50 000	1	38	60
56410092	UFP-100-E-H22LA	100 000	1	38	60
56410093	UFP-300-E-H22LA	300 000	1	38	60
56410094	UFP-500-E-H22LA	500 000	1	38	60
56410095	UFP-750-E-H22LA	750 000	1	38	60
11000579	UFP-1-C-H24L	1000	0.5	42	60
56410100	UFP-3-C-H24LA	3000	0.5	42	60
56410101	UFP-10-C-H24LA	10 000	0.5	42	60
56410102	UFP-30-C-H24LA	30 000	0.5	42	60
56410103	UFP-100-C-H24LA	100 000	0.5	42	60
56410104	UFP-300-C-H24LA	300 000	0.5	42	60
56410105	UFP-500-C-H24LA	500 000	0.5	42	60
56410106	UFP-3-C-H42LA	3000	0.5	41	110
56410107	UFP-3-E-H42LA	3000	1	73	110
56410108	UFP-10-C-H42LA	10 000	0.5	41	110
56410109	UFP-10-E-H42LA	10 000	1	73	110
56410110	UFP-30-C-H42LA	30 000	0.5	41	110
56410111	UFP-30-E-H42LA	30 000	1	73	110
56410112	UFP-50-E-H42LA	50 000	1	73	110
56410113	UFP-100-C-H42LA	100 000	0.5	41	110
56410114	UFP-100-E-H42LA	100 000	1	73	110
56410115	UFP-300-C-H42LA	300 000	0.5	41	110
56410116	UFP-300-E-H42LA	300 000	1	73	110
56410117	UFP-500-C-H42LA	500 000	0.5	41	110
56410118	UFP-500-E-H42LA	500 000	1	73	110
56410119	UFP-750-E-H42LA	750 000	1	73	110

Table 19. Model numbers and specifications for MidGee Hoop microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Nominal flowpath number (cm)
56410096	CFP-1-E-H22LA	0.1	1	38	60
56410097	CFP-2-E-H22LA	0.2	1	38	60
56410098	CFP-4-E-H22LA	0.45	1	38	60
56410099	CFP-6-D-H22LA	0.65	0.75	29	60

Table 20. Accessories for MidGee and MidGee Hoop cartridges

Code number	Model number	Description
56410575	RBFL-1	Female Luer-Lok to 1/8 in barb, nylon, pkg. of 10
56410576	RBFL-2	Female Luer-Lok to 3/32 in barb, nylon, pkg. of 10
56411157	RBFL-FL	Female Luer-Lok to female Luer-Lok, nylon, pkg. of 10
56410577	RBFL-ML	Female Luer-Lok to male Luer-Lok, nylon, pkg. of 10
56410578	RBFL-SC	Female Luer-Lok to solid cap, nylon, pkg. of 10
56410588	VT-06	Precision backpressure valve, nylon, size 14 and 16 tubing
56410616	PTSL02-10	Pump tubing, size 14, silicone, 3.1 m (10 ft)
56410617	PTSL03-10	Pump tubing, size 16, silicone, 3.1 m (10 ft)

NOTE: For a complete list of MidGee and MidJet system accessories, please refer to Table 69 and 70 on page 86 and 87

All MidGee and MidGee Hoop cartridges are autoclavable except those with 1000 NMWC ultrafiltration membranes.

Xampler laboratory membrane cartridges

Cytiva Xampler™ ultrafiltration and microfiltration cartridges are offered with nominal flowpath lengths of 30 and 60 cm and membrane areas ranging from 0.01 to 0.14 m² (0.12 to 1.5 ft²). These cartridges are ideal for processing volumes from a few hundred milliliters to about 10 liters of solution.

Xampler cartridges have fully self-contained housings with translucent polysulfone shells and are well-matched to our QuixStand benchtop system. When operated in a vertical orientation there is no potential for “dead” or stagnation spots.

Our entire Xampler product line is offered with mini Tri-Clamp™ end fittings for quick and easy sanitary connection to your laboratory equipment. These cartridges are identified with an “M” in the suffix of the model number. A select portion of the Xampler line is also offered with barbed end fittings for simple flexible tubing connection. Schematic diagrams showing the alternative cartridge sizes and end fittings are provided in Figure 16.

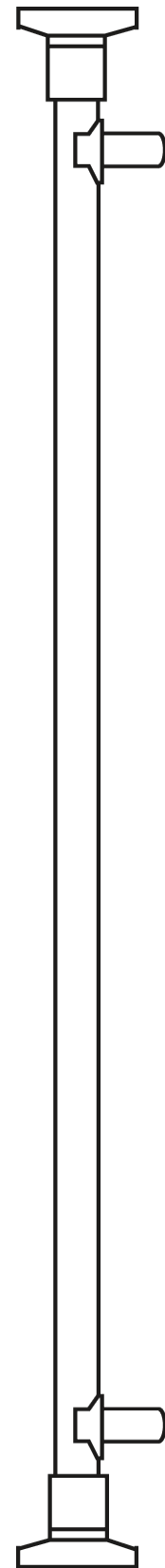
All of Cytiva Xampler microfiltration laboratory scale cartridges are autoclavable. Moreover, all Xampler ultrafiltration cartridges are autoclavable with the exception of 1000 NMWC membrane units. An “A” as the model number suffix signifies that the particular cartridge may be autoclaved. Xampler ultrafiltration cartridge specifications and model numbers are listed in Table 16. Xampler microfiltration cartridge details are provided in Table 17.

➔ Expert Advice

CAUTION: Autoclaving of Cytiva membrane cartridges is straightforward, but requires adherence to a set of well-established guidelines. These guidelines are presented in detail in our publication, *Operating Handbook, Hollow fiber cartridges for membrane separations*.



Fig 15. Xampler cartridges

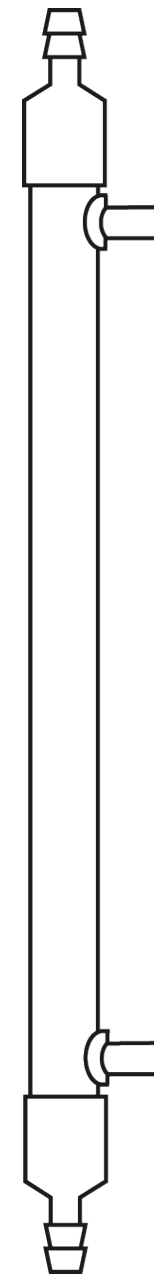


Housing 3M

Length = 31.7 cm (12.5 in)
 Diameter = 0.9 cm (0.375 in)
 Permeate ports = 0.25 in tubing nipples
 Feed/retentate ports = 0.5 in Tri-Clamp

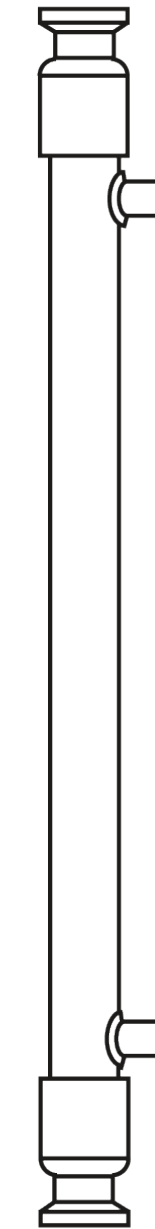
Housing 3X2M

Length = 63.5 cm (25.0 in)
 Diameter = 0.9 cm (0.375 in)
 Permeate ports = 0.25 in tubing nipples
 Feed/retentate ports = 0.5 in Tri-Clamp



Housing 4

Length = 36.2 cm (14.25 in)
 Diameter = 1.9 cm (0.75 in)
 Permeate ports = 0.375 in tubing nipples
 Feed/retentate ports = 0.375 in tubing barb



Housing 4M

Length = 34.5 cm (13.6 in)
 Diameter = 1.9 cm (0.75 in)
 Permeate ports = 0.375 in tubing nipples
 Feed/retentate ports = 0.5 in Tri-Clamp

Housing 4X2M

Length = 66.0 cm (26.0 in)
 Diameter = 1.9 cm (0.75 in)
 Permeate ports = 0.375 in tubing nipples
 Feed/retentate ports = 0.5 in Tri-Clamp

Fig 16. Xampler laboratory scale cartridges (drawings not to scale)

Table 21. Nominal feed stream flow rates (liters/minute) for 3M and 3X2M housings

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	0.06	0.12	0.25	0.5
0.75	0.1	0.2	0.4	0.8
1	0.15	0.3	0.6	1.2

Table 22. Nominal feed stream flow rates (liters/minute) for 4, 4M, and 4X2M housings

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	0.3	0.6	1.2	2.4
0.75	0.4	0.8	1.5	3
1	0.6	1.2	2.5	5
1.75	1.5	3.0	6.0	12

Table 23. Model numbers and specifications for Xampler laboratory scale ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410120	UFP-1-C-3M	1000	0.5	0.014	0.15	30
56410122	UFP-3-C-3MA	3000	0.5	0.014	0.15	30
56410123	UFP-3-E-3MA	3000	1	0.011	0.12	30
56410124	UFP-5-C-3MA	5000	0.5	0.014	0.15	30
56410125	UFP-5-E-3MA	5000	1	0.011	0.12	30
56410127	UFP-10-C-3MA	10 000	0.5	0.014	0.15	30
56410128	UFP-10-E-3MA	10 000	1	0.011	0.12	30
56410129	UFP-30-C-3MA	30 000	0.5	0.014	0.15	30
56410130	UFP-30-E-3MA	30 000	1	0.011	0.12	30
56410131	UFP-50-C-3MA	50 000	0.5	0.014	0.15	30
56410132	UFP-50-E-3MA	50 000	1	0.011	0.12	30
56410133	UFP-100-C-3MA	100 000	0.5	0.014	0.15	30
56410134	UFP-100-E-3MA	100 000	1	0.011	0.12	30

Table 23. Model numbers and specifications for Xampler laboratory scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410135	UFP-300-C-3MA	300 000	0.5	0.014	0.15	30
56410136	UFP-300-E-3MA	300 000	1	0.011	0.12	30
56410137	UFP-500-C-3MA	500 000	0.5	0.014	0.15	30
56410138	UFP-500-E-3MA	500 000	1	0.011	0.12	30
56410139	UFP-750-E-3MA	750 000	1	0.011	0.12	30
56410145	UFP-3-C-3X2MA	3000	0.5	0.029	0.31	60
56410146	UFP-10-C-3X2MA	10 000	0.5	0.029	0.31	60
56410147	UFP-30-C-3X2MA	30 000	0.5	0.029	0.31	60
56410148	UFP-50-C-3X2MA	50 000	0.5	0.029	0.31	60
56410149	UFP-100-C-3X2MA	100 000	0.5	0.029	0.31	60
56410150	UFP-100-E-3X2MA	100 000	1	0.023	0.24	60
56410151	UFP-300-C-3X2MA	300 000	0.5	0.029	0.31	60
56410152	UFP-300-E-3X2MA	300 000	1	0.023	0.24	60
56410153	UFP-500-C-3X2MA	500 000	0.5	0.029	0.31	60
56410154	UFP-500-E-3X2MA	500 000	1	0.023	0.24	60
56410155	UFP-750-E-3X2MA	750 000	1	0.023	0.24	60
56410184	UFP-1-C-4	1000	0.5	0.065	0.70	30
56410186	UFP-3-C-4A	3000	0.5	0.065	0.70	30
56410187	UFP-3-E-4A	3000	1	0.042	0.45	30
56410188	UFP-5-C-4A	5000	0.5	0.065	0.70	30
56410189	UFP-5-E-4A	5000	1	0.042	0.45	30
56410191	UFP-10-C-4A	10 000	0.5	0.065	0.70	30
56410192	UFP-10-E-4A	10 000	1	0.042	0.45	30
56410193	UFP-30-C-4A	30 000	0.5	0.065	0.70	30
56410194	UFP-30-E-4A	30 000	1	0.042	0.45	30

Table 23. Model numbers and specifications for Xampler laboratory scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410195	UFP-50-C-4A	50 000	0.5	0.065	0.70	30
56410196	UFP-50-E-4A	50 000	1	0.042	0.45	30
56410197	UFP-100-C-4A	100 000	0.5	0.065	0.70	30
56410198	UFP-100-E-4A	100 000	1	0.042	0.45	30
56410199	UFP-300-C-4A	300 000	0.5	0.065	0.70	30
56410200	UFP-300-E-4A	300 000	1	0.042	0.45	30
56410201	UFP-500-C-4A	500 000	0.5	0.065	0.70	30
56410202	UFP-500-E-4A	500 000	1	0.042	0.45	30
56410203	UFP-750-E-4A	750 000	1	0.042	0.45	30
56410159	UFP-1-C-4M	1000	0.5	0.065	0.70	30
56410161	UFP-3-C-4MA	3000	0.5	0.065	0.70	30
56410162	UFP-3-E-4MA	3000	1	0.042	0.45	30
56410163	UFP-5-C-4MA	5000	0.5	0.065	0.70	30
56410164	UFP-5-E-4MA	5000	1	0.042	0.45	30
56410166	UFP-10-C-4MA	10 000	0.5	0.065	0.70	30
56410167	UFP-10-E-4MA	10 000	1	0.042	0.45	30
56410168	UFP-30-C-4MA	30 000	0.5	0.065	0.70	30
56410169	UFP-30-E-4MA	30 000	1	0.042	0.45	30
56410170	UFP-50-C-4MA	50 000	0.5	0.065	0.70	30
56410171	UFP-50-E-4MA	50 000	1	0.042	0.45	30
56410172	UFP-100-C-4MA	100 000	0.5	0.065	0.70	30
56410173	UFP-100-E-4MA	100 000	1	0.042	0.45	30
56410174	UFP-300-C-4MA	300 000	0.5	0.065	0.70	30
56410175	UFP-300-E-4MA	300 000	1	0.042	0.45	30
56410176	UFP-500-C-4MA	500 000	0.5	0.065	0.70	30
56410177	UFP-500-E-4MA	500 000	1	0.042	0.45	30

Table 23. Model numbers and specifications for Xampler laboratory scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410178	UFP-750-E-4MA	750 000	1	0.042	0.45	30
11000497	UFP-1-C-4X2M	1000	0.5	0.14	1.5	60
56410209	UFP-3-C-4X2MA	3000	0.5	0.14	1.5	60
56410210	UFP-5-C-4X2MA	5000	0.5	0.14	1.5	60
56411017	UFP-5-E-4X2MA	5000	1	0.085	0.9	60
56410211	UFP-10-C-4X2MA	10 000	0.5	0.14	1.5	60
56411004	UFP-10-E-4X2MA	10 000	1	0.085	0.9	60
56410212	UFP-30-C-4X2MA	30 000	0.5	0.14	1.5	60
56411018	UFP-30-E-4X2MA	30 000	1	0.085	0.9	60
56410213	UFP-50-C-4X2MA	50 000	0.5	0.14	1.5	60
56411019	UFP-50-E-4X2MA	50 000	1	0.085	0.9	60
56410214	UFP-100-C-4X2MA	100 000	0.5	0.14	1.5	60
56410215	UFP-100-E-4X2MA	100 000	1	0.085	0.9	60
56410216	UFP-300-C-4X2MA	300 000	0.5	0.14	1.5	60
56410217	UFP-300-E-4X2MA	300 000	1	0.085	0.9	60
56410218	UFP-500-C-4X2MA	500 000	0.5	0.14	1.5	60
56410219	UFP-500-E-4X2MA	500 000	1	0.085	0.9	60
56410220	UFP-750-E-4X2MA	750 000	1	0.085	0.9	60

Table 24. Model numbers and specifications for Xampler laboratory scale microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410140	CFP-1-D-3MA	0.1	0.75	0.012	0.13	30
56410141	CFP-1-E-3MA	0.1	1	0.011	0.12	30
56410142	CFP-2-E-3MA	0.2	1	0.011	0.12	30
56410143	CFP-4-E-3MA	0.45	1	0.011	0.12	30
56410144	CFP-6-D-3MA	0.65	0.75	0.012	0.13	30
56410156	CFP-1-E-3X2MA	0.1	1	0.023	0.24	60
56410157	CFP-2-E-3X2MA	0.2	1	0.023	0.24	60
56410158	CFP-4-E-3X2MA	0.45	1	0.023	0.24	60
56410204	CFP-1-D-4A	0.1	0.75	0.046	0.50	30
56410205	CFP-1-E-4A	0.1	1	0.042	0.45	30
56410206	CFP-2-E-4A	0.2	1	0.042	0.45	30
56410207	CFP-4-E-4A	0.45	1	0.042	0.45	30
56410208	CFP-6-D-4A	0.65	0.75	0.046	0.50	30
56410179	CFP-1-D-4MA	0.1	0.75	0.046	0.50	30
56410180	CFP-1-E-4MA	0.1	1	0.042	0.45	30
56410181	CFP-2-E-4MA	0.2	1	0.042	0.45	30
56410182	CFP-4-E-4MA	0.45	1	0.042	0.45	30
56410183	CFP-6-D-4MA	0.65	0.75	0.046	0.50	30
56410221	CFP-1-D-4X2MA	0.1	0.75	0.095	1.02	60
56410222	CFP-1-E-4X2MA	0.1	1	0.085	0.9	60
56410223	CFP-2-E-4X2MA	0.2	1	0.085	0.9	60
11000508	CFP-2-G-4X2MA	0.2	1.75	0.065	0.70	60
56410224	CFP-4-E-4X2MA	0.45	1	0.085	0.9	60
56410225	CFP-6-D-4X2MA	0.65	0.75	0.095	1.02	60

All Xampler cartridges are autoclavable except those with 1000 NMWC ultrafiltration membranes.



Fig 17. QuixStand QSM-03SP benchtop system shown with Xampler 4X2M. System includes 1 liter reservoir and PRP-09WM peristaltic pump

04

Pilot scale cartridges

Introduction

To bridge the several steps between research and production volumes, Cytiva offers a full range of pilot scale ultrafiltration and microfiltration hollow fiber membrane cartridges. These cartridges feature industry-standard 1.5 in Tri-Clamp sanitary feed and retentate fittings. Both 30 and 60 cm flowpath lengths are offered with cartridges that provide an order-of-magnitude membrane area span from 0.12 to 1.15 m² (1.3 to 12.5 ft²). Please feel free to contact our technical support team for guidance with linear scaling parameters for small volume processing.

Cytiva’s FlexStand™ benchtop system product line is designed to suit the entire range of pilot scale cartridges. Two basic models are offered with optional peristaltic or rotary lobe pumps and polysulfone feed reservoirs. These systems can be cart-mounted for ease of movement between the laboratory and the cold room.

The tables and figures on the following pages provide model numbers, dimensional diagrams, and specifications for these pilot scale cartridges. Nominal feed stream flow rates as a function of shear rates are also noted.

➔ Expert Advice

TIP: Membrane productivity (flux) is proportional to the processing temperature. To achieve similar productivity between cold room operations and room temperature trials, the cold room configuration should incorporate three to four times the membrane area used in room temperature trials.

Table 25. Nominal feed stream flow rates (liters/minute) for housing sizes 5 and 6

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	1.1	2.1	4.3	8.6
0.75	1.4	2.8	5.6	11.2
1	2	4	8	16

Table 26. Nominal feed stream flow rates (liters/minute) for housing sizes 8 and 9

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	2.7	5.4	10.6	21.5
0.75	4.4	8.8	18	35
1	6.1	12.2	24.5	49

Please consult with Cytiva technical support for recommended recirculation flow rates for 0.2-micron microfiltration fibers with 1.75 mm i.d.



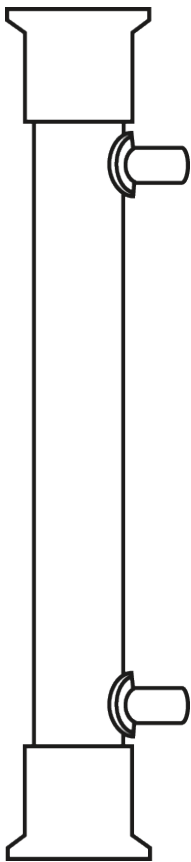
Fig 18. Pilot scale cartridges sizes 5 (foreground) and 6

Housing 5

Length = 31.8 cm (12.5 in)
Diameter = 3.2 cm (1.25 in)
Permeate ports = 0.5 in tubing nipples
Feed/retentate ports = 1.5 in Tri-Clamp

Housing 6

Length = 63.5 cm (25 in)
Diameter = 3.2 cm (1.25 in)
Permeate ports = 0.5 in tubing nipples on opposite sides
Feed/retentate ports = 1.5 in Tri-Clamp



Housing 8

Length = 34.9 cm (13.75 in)
Diameter = 5.1 cm (2 in)
Permeate ports = 0.5 in tubing nipples
Feed/retentate ports = 1.5 in Tri-Clamp

Housing 9

Length = 63.5 cm (25 in)
Diameter = 5.1 cm (2 in)
Permeate ports = 0.5 in tubing nipples
Feed/retentate ports = 1.5 in Tri-Clamp

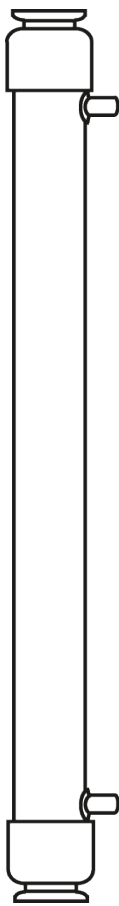


Fig 19. Pilot scale cartridges (drawings not to scale)

Table 27. Model numbers and specifications for pilot scale ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410226	UFP-1-C-5	1000	0.5	0.20	2.1	30
56410228	UFP-3-C-5A	3000	0.5	0.20	2.1	30
56410229	UFP-3-E-5A	3000	1	0.12	1.3	30
56410230	UFP-5-C-5A	5000	0.5	0.20	2.1	30
56410231	UFP-5-E-5A	5000	1	0.12	1.3	30
56410233	UFP-10-C-5A	10 000	0.5	0.20	2.1	30
56410234	UFP-10-E-5A	10 000	1	0.12	1.3	30
56410235	UFP-30-C-5A	30 000	0.5	0.20	2.1	30
56410236	UFP-30-E-5A	30 000	1	0.12	1.3	30
56410237	UFP-50-C-5A	50 000	0.5	0.20	2.1	30
56410238	UFP-50-E-5A	50 000	1	0.12	1.3	30
56410239	UFP-100-C-5A	100 000	0.5	0.20	2.1	30
56410240	UFP-100-E-5A	100 000	1	0.12	1.3	30
56410241	UFP-300-C-5A	300 000	0.5	0.20	2.1	30
56410242	UFP-300-E-5A	300 000	1	0.12	1.3	30
56410243	UFP-500-C-5A	500 000	0.5	0.20	2.1	30
56410244	UFP-500-E-5A	500 000	1	0.12	1.3	30
56410245	UFP-750-E-5A	750 000	1	0.12	1.3	30
56410251	UFP-1-C-6	1000	0.5	0.48	5.2	60
56410252	UFP-3-C-6A	3000	0.5	0.48	5.2	60
56410253	UFP-3-E-6A	3000	1	0.28	3	60
56410254	UFP-5-C-6A	5000	0.5	0.48	5.2	60
56410255	UFP-5-E-6A	5000	1	0.28	3	60
56410256	UFP-10-C-6A	10 000	0.5	0.48	5.2	60
56410257	UFP-10-E-6A	10 000	1	0.28	3	60
56410258	UFP-30-C-6A	30 000	0.5	0.48	5.2	60
56410259	UFP-30-E-6A	30 000	1	0.28	3	60
56410260	UFP-50-C-6A	50 000	0.5	0.48	5.2	60
56410261	UFP-50-E-6A	50 000	1	0.28	3	60
56410262	UFP-100-C-6A	100 000	0.5	0.48	5.2	60

Table 27. Model numbers and specifications for pilot scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410263	UFP-100-E-6A	100 000	1	0.28	3	60
56410264	UFP-300-C-6A	300 000	0.5	0.48	5.2	60
56410265	UFP-300-E-6A	300 000	1	0.28	3	60
56410266	UFP-500-C-6A	500 000	0.5	0.48	5.2	60
56410267	UFP-500-E-6A	500 000	1	0.28	3	60
56410268	UFP-750-E-6A	750 000	1	0.28	3	60
56410274	UFP-3-C-8A	3000	0.5	0.53	5.7	30
56411027	UFP-5-C-8A	5000	0.5	0.53	5.7	30
56410276	UFP-10-C-8A	10 000	0.5	0.53	5.7	30
56410277	UFP-30-C-8A	30 000	0.5	0.53	5.7	30
56410278	UFP-50-C-8A	50 000	0.5	0.53	5.7	30
56410279	UFP-100-C-8A	100 000	0.5	0.53	5.7	30
56410280	UFP-100-E-8A	100 000	1	0.36	3.9	30
56410281	UFP-300-C-8A	300 000	0.5	0.53	5.7	30
56410282	UFP-300-E-8A	300 000	1	0.36	3.9	30
56410283	UFP-500-C-8A	500 000	0.5	0.53	5.7	30
56410284	UFP-500-E-8A	500 000	1	0.36	3.9	30
56410285	UFP-750-E-8A	750 000	1	0.36	3.9	30
56410291	UFP-1-C-9	1000	0.5	1.15	12.5	60
56410292	UFP-3-C-9A	3000	0.5	1.15	12.5	60
56410293	UFP-3-E-9A	3000	1	0.84	9	60
56410294	UFP-5-C-9A	5000	0.5	1.15	12.5	60
56410295	UFP-5-E-9A	5000	1	0.84	9	60
56410296	UFP-10-C-9A	10 000	0.5	1.15	12.5	60
56410297	UFP-10-E-9A	10 000	1	0.84	9	60
56410298	UFP-30-C-9A	30 000	0.5	1.15	12.5	60
56410299	UFP-30-E-9A	30 000	1	0.84	9	60
56410300	UFP-50-C-9A	50 000	0.5	1.15	12.5	60
56410301	UFP-50-E-9A	50 000	1	0.84	9	60
56410302	UFP-100-C-9A	100 000	0.5	1.15	12.5	60

Table 27. Model numbers and specifications for pilot scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410303	UFP-100-E-9A	100 000	1	0.84	9	60
56410304	UFP-300-C-9A	300 000	0.5	1.15	12.5	60
56410305	UFP-300-E-9A	300 000	1	0.84	9	60
56410306	UFP-500-C-9A	500 000	0.5	1.15	12.5	60
56410307	UFP-500-E-9A	500 000	1	0.84	9	60
56410308	UFP-750-E-9A	750 000	1	0.84	9	60

Table 28. Model numbers and specifications for pilot scale microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Membrane area (ft²)	Nominal flowpath number (cm)
56410246	CFP-1-D-5A	0.1	0.75	0.16	1.7	30
56410247	CFP-1-E-5A	0.1	1	0.12	1.3	30
56410248	CFP-2-E-5A	0.2	1	0.12	1.3	30
56410249	CFP-4-E-5A	0.45	1	0.12	1.3	30
56410250	CFP-6-D-5A	0.65	0.75	0.16	1.7	30
56410269	CFP-1-D-6A	0.1	0.75	0.37	4	60
56410270	CFP-1-E-6A	0.1	1	0.28	3	60
56410271	CFP-2-E-6A	0.2	1	0.28	3	60
56410561	CFP-2-G-6A	0.2	1.75	0.23	2.5	60
56410272	CFP-4-E-6A	0.45	1	0.28	3	60
56410273	CFP-6-D-6A	0.65	0.75	0.37	4	60
56410286	CFP-1-D-8A	0.1	0.75	0.41	4.4	30
56410287	CFP-1-E-8A	0.1	1	0.36	3.9	30
56410288	CFP-2-E-8A	0.2	1	0.36	3.9	30
56410289	CFP-4-E-8A	0.45	1	0.36	3.9	30
56410290	CFP-6-D-8A	0.65	0.75	0.41	4.4	30
56410309	CFP-1-D-9A	0.1	0.75	0.93	10	60
56410310	CFP-1-E-9A	0.1	1	0.84	9	60
56410311	CFP-2-E-9A	0.2	1	0.84	9	60
56410562	CFP-2-G-9A	0.2	1.75	0.59	6.3	60
56410312	CFP-4-E-9A	0.45	1	0.84	9	60
56410313	CFP-6-D-9A	0.65	0.75	0.93	10	60

All pilot scale cartridges are autoclavable except those with 1000 NMWC ultrafiltration membranes.

05

Process scale cartridges

Introduction

Process scale hollow fiber cartridges offered by Cytiva are provided in eight basic configurations covering a membrane area range of 0.92 to 28 m² (9.9 to 300 ft²) depending on the fiber internal diameter. Refer to Table 29 for a list of basic configurations.

All of these process scale cartridges feature sanitary connections for both the feed/retentate and permeate ports. Use of this industry standard makes for easy connections to tanks, pumps, manifolds, and instrumentation.

Cytiva GrandStand™ and UniFlux™ systems are cart-mounted units designed to accommodate the full range of ultrafiltration and microfiltration process scale cartridges offered by the company. The various GrandStand configurations are capable of concentration and/or diafiltration of solution volume ranging from 50 to 1000 liters or more.

➔ Expert Advice

TIP: These cartridges may be arranged in parallel to provide any membrane area requirement, and hence to process any feed volume.

Table 29. Process scale hollow fiber cartridges basic configurations

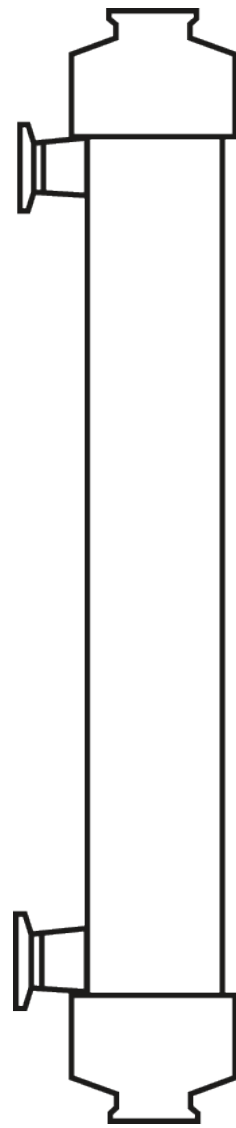
Housing	Cartridge diameter (cm)	Nominal flowpath length (cm)	Membrane area (m ²)			Notes
35	7.6	30	0.92	to	2.7	
55	7.6	60	1.8	to	3.25	Also available with retrofit ("R") end fittings*
75	7.6	110	3.7	to	6	Also available with retrofit ("R") end fittings*
45	10.8	30	2.5	to	3.5	MaxCell, requires end fitting adaptor kit
65	10.8	60	3.5	to	6.1	MaxCell, requires end fitting adaptor kit
85	10.8	110	9	to	13	MaxCell, requires end fitting adaptor kit
152M	15	60	8.3	to	14	ProCell, requires SS housing
154M	15	110	16.6	to	28	ProCell, requires SS housing

* Please refer to Chapter 6, *Retrofit cartridges* for more information



Housing 35

Length = 35.6 cm (14 in)
Diameter = 7.6 cm (3 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 1.5 in Tri-Clamp



Housing 55

Length = 67.3 cm (26.5 in)
Diameter = 7.6 cm (3 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 1.5 in Tri-Clamp



Housing 75

Length = 113 cm (44.5 in)
Diameter = 7.6 cm (3 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 1.5 in Tri-Clamp

Table 30. Nominal feed stream flow rates (liters/minute) for housing sizes 35, 55, and 75

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	6.6	13.2	26	53
0.75	10	20	40	80
1	15	30	60	120

Please consult with Cytiva technical support for recommended recirculation flow rates for 0.2-micron microfiltration fibers with 1.75 mm i.d.

Fig 20. Process scale hollow fiber cartridges sizes 35, 55, and 75 (drawings not to scale)

Table 31. Model numbers and specifications for process scale ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410314	UFP-3-C-35	3000	0.5	1.35	14.5	30
56410315	UFP-3-E-35	3000	1	0.92	9.9	30
56410316	UFP-5-C-35	5000	0.5	1.35	14.5	30
56410317	UFP-5-E-35	5000	1	0.92	9.9	30
56410319	UFP-10-C-35	10 000	0.5	1.35	14.5	30
56410320	UFP-10-E-35	10 000	1	0.92	9.9	30
56410321	UFP-30-C-35	30 000	0.5	1.35	14.5	30
56410322	UFP-30-E-35	30 000	1	0.92	9.9	30
56410323	UFP-100-C-35	100 000	0.5	1.35	14.5	30
56410324	UFP-100-E-35	100 000	1	0.92	9.9	30
56410325	UFP-300-C-35	300 000	0.5	1.35	14.5	30
56410326	UFP-300-E-35	300 000	1	0.92	9.9	30
56410327	UFP-500-C-35	500 000	0.5	1.35	14.5	30
56410328	UFP-500-E-35	500 000	1	0.92	9.9	30
56410329	UFP-750-E-35	750 000	1	0.92	9.9	30
56410959	UFP-1-C-55	1000	0.5	3.25	35	60
56410335	UFP-3-C-55	3000	0.5	3.25	35	60
56410337	UFP-3-E-55	3000	1	2.1	23	60
56410339	UFP-5-C-55	5000	0.5	3.25	35	60
56410341	UFP-5-E-55	5000	1	2.1	23	60
56410343	UFP-10-C-55	10 000	0.5	3.25	35	60
56410345	UFP-10-E-55	10 000	1	2.1	23	60
56410347	UFP-30-C-55	30 000	0.5	3.25	35	60
56410349	UFP-30-E-55	30 000	1	2.1	23	60
56410351	UFP-50-C-55	50 000	0.5	3.25	35	60
56410353	UFP-50-E-55	50 000	1	2.1	23	60
56410355	UFP-100-C-55	100 000	0.5	3.25	35	60
56410357	UFP-100-E-55	100 000	1	2.1	23	60

Table 31. Model numbers and specifications for process scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm²)	Membrane area (ft²)	Nominal flowpath number (cm)
56410359	UFP-300-C-55	300 000	0.5	3.25	35	60
56410361	UFP-300-E-55	300 000	1	2.1	23	60
56410363	UFP-500-C-55	500 000	0.5	3.25	35	60
56410365	UFP-500-E-55	500 000	1	2.1	23	60
56410367	UFP-750-E-55	750 000	1	2.1	23	60
56410380	UFP-3-C-75	3000	0.5	6	65	110
56410382	UFP-3-E-75	3000	1	3.7	40	110
56410384	UFP-5-C-75	5000	0.5	6	65	110
56410386	UFP-5-E-75	5000	1	3.7	40	110
56410388	UFP-10-C-75	10 000	0.5	6	65	110
56410390	UFP-10-E-75	10 000	1	3.7	40	110
56410392	UFP-30-C-75	30 000	0.5	6	65	110
56410394	UFP-30-E-75	30 000	1	3.7	40	110
56410396	UFP-50-E-75	50 000	1	3.7	40	110
56410398	UFP-100-C-75	100 000	0.5	6	65	110
56410400	UFP-100-E-75	100 000	1	3.7	40	110
56410402	UFP-300-C-75	300 000	0.5	6	65	110
56410404	UFP-300-E-75	300 000	1	3.7	40	110
56410406	UFP-500-C-75	500 000	0.5	6	65	110
56410408	UFP-500-E-75	500 000	1	3.7	40	110
56410410	UFP-750-E-75	750 000	1	3.7	40	110

Table 32. Model numbers and specifications for autoclavable process scale ultrafiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410782	UFP-10-E-35A	10 000	1	0.92	9.9	30
56410785	UFP-100-E-35A	100 000	1	0.92	9.9	30
56410787	UFP-500-C-35A	500 000	0.5	1.35	14.5	30
56410788	UFP-500-E-35A	500 000	1	0.92	9.9	30

Table 33. Model numbers and specifications for process scale microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410330	CFP-1-D-35A	0.1	0.75	1	10.8	30
56410331	CFP-1-E-35A	0.1	1	0.92	9.9	30
56410332	CFP-2-E-35A	0.2	1	0.92	9.9	30
56410333	CFP-4-E-35A	0.45	1	0.92	9.9	30
56410334	CFP-6-D-35A	0.65	0.75	1	10.8	30
56410369	CFP-1-D-55A	0.1	0.75	2.5	27	60
56410370	CFP-1-E-55	0.1	1	2.1	23	60
56410372	CFP-1-E-55A	0.1	1	2.1	23	60
56410373	CFP-2-E-55	0.2	1	2.1	23	60
56410375	CFP-2-E-55A	0.2	1	2.1	23	60
56410563	CFP-2-G-55	0.2	1.75	1.8	19.4	60
56410376	CFP-4-E-55	0.45	1	2.1	23	60
56410378	CFP-4-E-55A	0.45	1	2.1	23	60
56410379	CFP-6-D-55A	0.65	0.75	2.5	27	60

Process scale cartridges with model numbers that end in “A” are autoclavable.

MaxCell process scale cartridges

The streamlined design of our MaxCell cartridge with its 10.8 cm diameter is in sharp contrast to the most commonly available 12.7 cm diameter competitive cartridges. MaxCell cartridges have lower holdup volumes and are lighter and easier for operators to handle. Furthermore, a MaxCell size 85 cartridge with 1 mm i.d. diameter fibers contains over 40% more membrane area than the larger diameter competitive unit (please refer to chapter 6, *Retrofit cartridges*, for more information).

MaxCell cartridges are easily manifolded in parallel to handle large process volumes. Their unique end fitting configuration allows excellent visibility of the cartridge ends for inspection and cleaning. Housing size 85, with 0.5 mm i.d. diameter fibers, contains 13 m² (140 ft²) of membrane area.

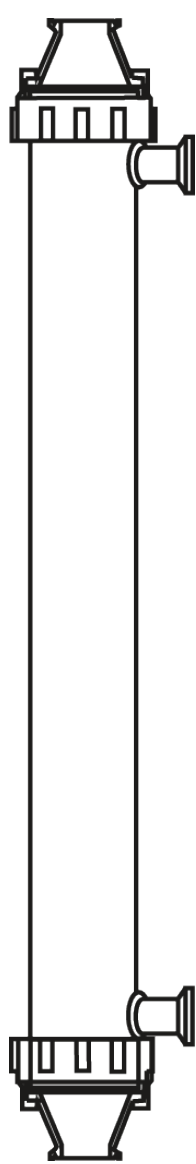
➔ Safety

WARNING: MaxCell cartridge end fittings can be properly tightened with one of our two MaxCell wrench sets. The standard wrench set, SWR-MX01, is sufficient when only a few cartridges are in use. For large installations, we recommend model SWR-MX02, which maintains a predetermined torque to prevent either under- or over-tightening.



Fig 21. MaxCell process scale hollow fiber cartridge

MaxCell cartridge installations require either one straight adaptor kit (Part No. KAMX-16PS) or one elbow adaptor kit (Part No. KAMX-16EL-PS) per cartridge



- Housing 45**
Length (with straight adaptors)
= 50.3 cm (19.8 in)
Diameter = 10.8 cm (4.25 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp
- Housing 65**
Length (with straight adaptors)
= 73.2 cm (28.8 in)
Diameter = 10.8 cm (4.25 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp
- Housing 85**
Length (with straight adaptors)
= 131 cm (51.5 in)
Diameter = 10.8 cm (4.25 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp

Fig 22. MaxCell process scale hollow fiber cartridge (straight adaptors and locking nuts not included; drawing not to scale)

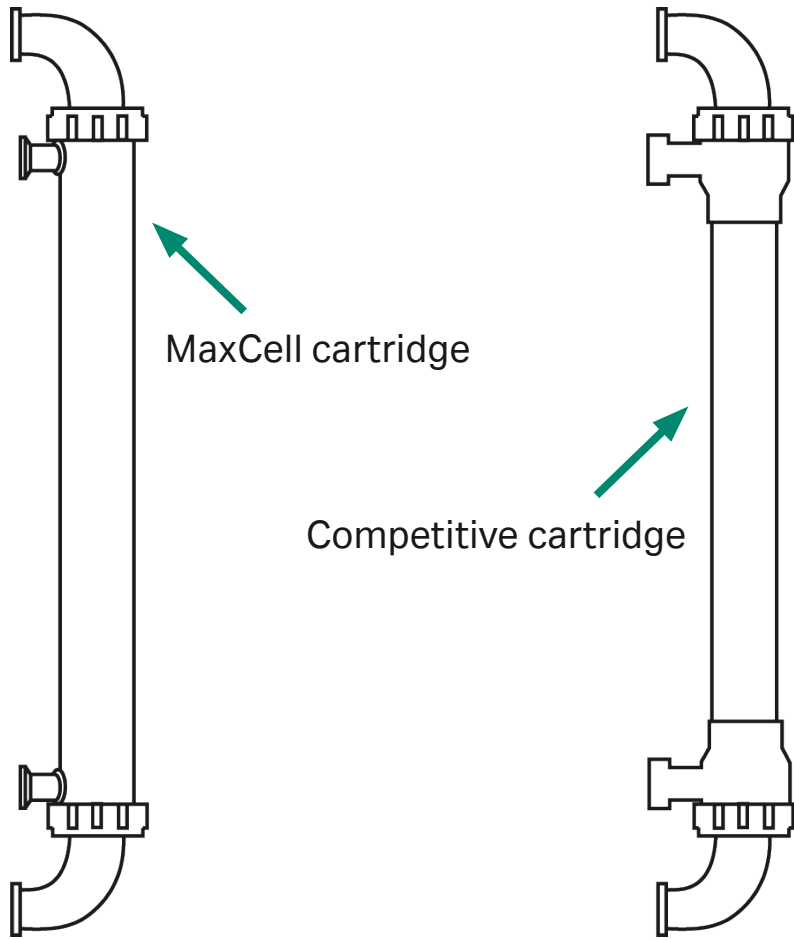


Fig 23. Diagram of MaxCell and competitive hollow fiber cartridges. No feed/retentate adaptors are required to retrofit a MaxCell process scale cartridge to systems designed for competitive hollow fiber cartridges.

Table 34. Nominal feed stream flow rates (liters/minute) for housing sizes 45, 65, and 85

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	14	28	55	111
0.75	19	39	77	154
1	31	61	122	245

Table 35. Model numbers and specifications for MaxCell process scale ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410467	UFP-3-C-45	3000	0.5	3.5	37	30
56410468	UFP-5-C-45	5000	0.5	3.5	37	30
56410469	UFP-10-C-45	10 000	0.5	3.5	37	30
56410470	UFP-30-C-45	30 000	0.5	3.5	37	30
11000517	UFP-100-E-45	100 000	1	2.5	27	30
56410917	UFP-750-E-45	750 000	1	2.5	27	30
56410475	UFP-3-C-65	3000	0.5	6.1	66	60
56410476	UFP-3-E-65	3000	1	4.4	47	60
56410477	UFP-5-C-65	5000	0.5	6.1	66	60
56410478	UFP-5-E-65	5000	1	4.4	47	60
56410479	UFP-10-C-65	10 000	0.5	6.1	66	60
56410480	UFP-10-E-65	10 000	1	4.4	47	60
56410481	UFP-30-C-65	30 000	0.5	6.1	66	60
56410482	UFP-30-E-65	30 000	1	4.4	47	60
56410483	UFP-50-C-65	50 000	0.5	6.1	66	60
56410484	UFP-50-E-65	50 000	1	4.4	47	60
56410485	UFP-100-C-65	100 000	0.5	6.1	66	60
56410486	UFP-100-E-65	100 000	1	4.4	47	60
56410487	UFP-300-C-65	300 000	0.5	6.1	66	60
56410488	UFP-300-E-65	300 000	1	4.4	47	60

Table 35. Model numbers and specifications for MaxCell process scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410489	UFP-500-C-65	500 000	0.5	6.1	66	60
56410490	UFP-500-E-65	500 000	1	4.4	47	60
56410491	UFP-750-E-65	750 000	1	4.4	47	60
56410780	UFP-HTS-P-85*	10 000	0.5	13	140	110
56410495	UFP-3-C-85	3000	0.5	13	140	110
56410496	UFP-3-E-85	3000	1	9	97	110
56410497	UFP-5-C-85	5000	0.5	13	140	110
56410498	UFP-5-E-85	5000	1	9	97	110
56410499	UFP-10-C-85	10 000	0.5	13	140	110
56410500	UFP-10-E-85	10 000	1	9	97	110
56410501	UFP-30-C-85	30 000	0.5	13	140	110
56410502	UFP-30-E-85	30 000	1	9	97	110
56410503	UFP-50-C-85	50 000	0.5	13	140	110
56410504	UFP-50-E-85	50 000	1	9	97	110
56410505	UFP-100-C-85	100 000	0.5	13	140	110
56410506	UFP-100-E-85	100 000	1	9	97	110
56410507	UFP-300-E-85	300 000	1	9	97	110
56410508	UFP-500-C-85	500 000	0.5	13	140	110
56410509	UFP-500-E-85	500 000	1	9	97	110
56410510	UFP-750-E-85	750 000	1	9	97	110

* High-purity water cartridge produces pyrogen-free permeate and is heat sanitizable.

Table 36. Model numbers and specifications for MaxCell process scale microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Membrane area (ft²)	Nominal flowpath number (cm)
56410471	CFP-1-E-45	0.1	1	2.5	27	30
56410472	CFP-2-E-45	0.2	1	2.5	27	30
56410473	CFP-4-E-45	0.45	1	2.5	27	30
56410474	CFP-6-D-45	0.65	0.75	2.65	28.5	30
56410492	CFP-1-E-65	0.1	1	4.4	47	60
56410493	CFP-2-E-65	0.2	1	4.4	47	60
56410564	CFP-2-G-65	0.2	1.75	3.5	38	60
56410494	CFP-4-E-65	0.45	1	4.4	47	60
56410812	CFP-6-D-65	0.65	0.75	4.9	53	60
56411177	CFP-1-E-85	0.1	1	9	97	110
56410612	CFP-2-E-85	0.2	1	9	97	110

Table 37. Accessories for MaxCell process scale cartridges

Code number	Model number	Description
56410726	RBMX-16PS-ST	Straight adaptor for MaxCell cartridge, polysulfone
56410737	KAMX-16PS	Straight adaptor kit for MaxCell cartridge, polysulfone. Kit contains 2 polysulfone straight adaptors, 2 polysulfone cartridge end nuts and 2 silicone o-rings.
56410738	KAMX-16EL-PS	Elbow adaptor kit for MaxCell cartridge, polysulfone. Kit contains 2 RBMX-16PS-EL polysulfone elbow adaptors, 2 polysulfone cartridge end nuts, and 2 silicone o-rings.
56410667	CL12	1.5 in TC quick disconnect clamp, 304 SS
56410670	CL16-LT	2 in TC toggle clamp, 304 SS
56410996	KG12S	1.5 in TC gasket, silicone, pack of 4
56410997	KG12B	1.5 in TC gasket, Buna-N, pack of 4
56410998	KG16S	2 in TC gasket, silicone, pack of 4
11000524	KG16B	2 in TC gasket, Buna-N, pack of 4
56410692	K04ORS	MaxCell o-ring set, silicone, pack of 2
56410693	K04ORB	MaxCell o-ring set, Buna-N, pack of 2
56410697	K04ORE	MaxCell o-ring set, EPDM, pack of 2
56410739	SWR-MX01	MaxCell wrench set, standard
56410740	SWR-MX02	MaxCell wrench set, applied torque

Please consult with Cytiva technical support for more detailed information regarding sterilization of MaxCell cartridges.

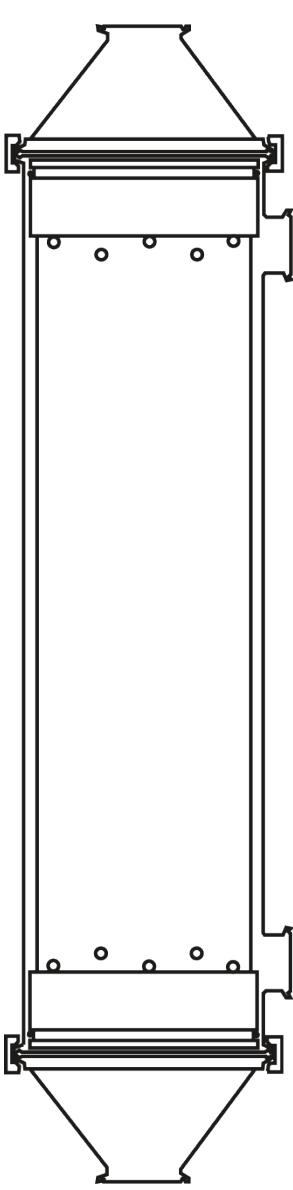
MaxCell process scale cartridges are not autoclavable.

ProCell process scale cartridges

ProCell 15 cm (6 in) diameter hollow fiber cartridges are intended for large production-scale ultrafiltration and microfiltration applications. Containing up to 28 m² (300 ft²) of membrane area in a single, compact module, these cartridges are well-suited to a wide range of biopharmaceutical applications, including protein concentration, buffer exchange, cell harvesting, and depyrogenation.

ProCell cartridges are available in two path lengths (nominal 60 cm and 110 cm) and ProCell ultrafiltration cartridges are capable of withstanding up to 3.4 barg (50 psig) transmembrane pressure. The combination of large surface area and high-pressure capability provides extremely high productivity for large-scale processing applications. Moreover, ProCell cartridges can be manifolded in parallel to provide filtration requirements for any volume of feed material.

ProCell modules are fitted into stainless steel housings and secured at each end with an o-ring seal. End-fitting adaptors reduce the feed and retentate connections to 2 in Tri-Clamp. Side port connections are 1.5 in Tri-Clamp.



Housing 152M

Length = 81.3 cm (32 in)
Diameter = 16.8 cm (6.63 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp

Housing 154M

Length = 139 cm (54.8 in)
Diameter = 16.8 cm (6.63 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp

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

Fig 24. ProCell process scale cartridge

Table 38. Nominal feed stream flow rates (liters/minute) for housing sizes 152M and 154M

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	30	60	120	240
1	70	140	280	560

Table 39. Model numbers and specifications for ProCell process scale ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
11000573	UFP-30-C-152M	30 000	0.5	14	150	60
11000574	UFP-30-E-152M	30 000	1	8.3	89	60
11000575	UFP-100-C-152M	100 000	0.5	14	150	60
11000576	UFP-100-E-152M	100 000	1	8.3	89	60
56410511	UFP-500-E-152M	500 000	1	8.3	89	60
11000578	UFP-5-C-154M	5000	0.5	28	300	110
56410513	UFP-10-C-154M	10 000	0.5	28	300	110
56410514	UFP-500-E-154M	500 000	1	16.6	179	110

Table 40. Model numbers and specifications for ProCell process scale microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410512	CFP-2-E-152M	0.2	1	8.3	89	60
56410515	CFP-2-E-154M	0.2	1	16.6	179	110

ProCell process scale cartridges are not autoclavable.

Table 41. Stainless steel housings for ProCell process scale cartridges

Code number	Model number	Description
56410635	SS-152TC	Housing assembly for ProCell 152M cartridges, 316L SS with 2 gaskets and 2 clamps
56410636	SS-154TC	Housing assembly for ProCell 154 cartridges, 316L SS with 2 gaskets and 2 clamps

Table 42. Accessories for ProCell process scale cartridges

Code number	Model number	Description
56410667	CL12	1.5 in TC quick disconnect clamp, 304 SS
56410670	CL16-LT	2 in TC quick disconnect clamp, 304 SS
56410674	CL48	6 in TC [schedule 5 pipe] clamp, 304 SS
56410996	KG12S	1.5 in TC gasket, silicone, pack of 4
56410997	KG12B	1.5 in TC gasket, Buna-N, pack of 4
56410998	KG16S	2 in TC gasket, silicone, pack of 4
11000524	KG16B	2 in TC gasket, Buna-N, pack of 4
11000528	KG48S	6 in TC [schedule 5 pipe] gasket, silicone, pack of 4
56410696	K06ORS	ProCell cartridge o-ring set, silicone, pack of 2
56410977	K06ORV	ProCell cartridge o-ring set, Viton, pack of 2
56410592	VDM-6SS	Diaphragm valve, 0.75 in TC, 316L SS
56410593	VDM-12SS	Diaphragm valve, 1.5 in TC, 316L SS

06

Retrofit cartridges

Introduction

Cytiva hollow fiber membrane cartridges can retrofit, and thereby upgrade the performance of, most installed membrane systems. Our technical support specialists will work closely with you to select the optimum membrane type and cartridge size for your application.

Depending on the installation, minor changes in system piping may be required, and we are available to assist you with your conversion. For direct retrofits of Amicon™ and Romicon™ process scale cartridges, the greater membrane area provided by Cytiva — up to 50% more — reduces processing time, increases system capacity, or decreases the total number of cartridges required. The result is a more reliable and cost effective operation.

In addition to retrofitting 7.6 cm (3 in) and 12.7 cm (5 in) Amicon and Romicon cartridges, Cytiva offers retrofit solutions for a broad range of Amicon laboratory and pilot scale cartridges, and provides options for Enka™, Koch Membrane Systems, Inc., and Asahi Kasei Corporation hollow fiber products.

➡ Expert Advice

TIP: There are no industry-wide standards for assigning ultrafiltration membrane molecular weight cutoff designations. Each manufacturer uses different challenge markers and retention distribution criteria to establish the molecular weight cutoff of its membranes. Variations between manufacturers are not uncommon, and it is prudent to determine separation and productivity performance as a means of selecting the optimum replacement membrane. Once the preferred Cytiva ultrafiltration membrane is selected, consistency in membrane product quality and separation characteristics is assured.

Table 43. Cross reference table of common retrofit cartridges for Amicon and Romicon units

Type ^{1,3}	Membrane ^{2,3}	Fiber inner diameter		Cytiva hollow fiber cartridge	Notes
		(in)	(mm)		
H1 HF0.8-20	PXXX-20 PMXXX	.020	0.5	UFP-XXX-C-4A UFP-XXX-C-4MA	Cytiva cartridge connects directly to tubing (size 4A) or 0.5 in Tri-Clamp (size 4MA).
H1 HF0.3-43	PXXX-43 PMXXX	.043	1.0	UFP-XXX-E-4A UFP-XXX-E-4MA	No o-rings. Adaptor blocks not required.
H10 HF10-20	PXXX-20 PMXXX-20	.020	0.5	UFP-XXX-C-9A	Cytiva housing size 9 has 25% more membrane area.
H5 HF5-43	PXXX-43 PMXXX-43	.043	1.0	UFP-XXX-E-9A	Cytiva housing size 9 has 80% more membrane area.
H30 HF30-20	PXXX-20 PMXXX	.020	0.5	PXXX-20	Cytiva housing size E-55R has 50% more membrane area. Slight offset of permeate ports.
H15 HF15-43	PXXX-43 PMXXX	.043	1.0	UFP-XXX-E-55R	Cytiva housing size E-55R has 50% more membrane area. Slight offset of permeate ports.
H53 HF53-20	PXXX-20 PMXXX	.020	0.5	UFP-XXX-C-75R	Cytiva housing size C-75R has 20% more membrane area. Slight offset of permeate ports.
H26 HF26-43	PXXX-43 PMXXX	.043	1.0	UFP-XXX-E-75R	Cytiva housing size E-75R has 50% more membrane area. Slight offset of permeate ports.
HF132-20	PMXXX	.020	0.5	UFP-XXX-C-85	Cytiva housing size E-85 has 6% more membrane area. Retentate elbow connectors match center-to-center and permeate port positions are offset as shown in Figure 23 on page 57.
HF66-43	PMXXX	.043	1.0	UFP-XXX-E-85	Cytiva housing size E-85 has 40% more membrane area. Retentate elbow connectors match center-to-center and permeate port positions are offset as shown in Figure 23 on page 57.

¹ Number refers to nominal membrane area in square feet. For example, H10 (Amicon) or HF10 (Romicon) = 10 ft².

² P and PM = polysulfone. Cytiva membranes are polysulfone. XXX = the UF membrane NMWC divided by 1000.
For example, 100 = 100 000 NMWC. To retrofit an MP01 membrane, use Cytiva 0.1 µm microfiltration membrane.

³ The number 20 refers to 20mil (0.5 mm) lumen diameter. Cytiva “C” lumen diameter is 0.5 mm.
The number 43 refers to 43mil (1.1 mm) lumen diameter. Cytiva “E” lumen diameter is 1 mm.

Table 44. Accessories for retrofit cartridges

Code number	Model number	Description
56410724	RB32-12PS-CV	Retrofit TC to 1.5 TC elbow adaptor, polysulfone
56410725	RB32-12PS-ST	Retrofit TC to 1.5 TC straight adaptor, polysulfone
56410667	CL12	1.5 in TC quick disconnect clamp, 304 SS
56410672	CL32	Retrofit TC clamp, 304 SS
56410996	KG12S	1.5 in TC gasket, silicone, pack of 4
56410997	KG12B	1.5 in TC gasket, Buna-N, pack of 4
56410685	KG32B	Retrofit TC gasket, Buna-N, pack of 6 (2 each of 3 thicknesses)
56410683	KG32S	Retrofit TC gasket, silicone, pack of 6 (2 each of 3 thicknesses)
11000526	KG32E	Retrofit TC gasket, EPDM, pack of 4

Table 45. Standard and retrofit cartridge dimensions for 7.6 cm diameter units

Housing identifier	Length		Diameter	
	(cm)	(in)	(cm)	(in)
55	67.3	26.5	7.6	3
55R	63.5	25	7.6	3
75	113.0	44.5	7.6	3
75R	109.0	43	7.6	3

Table 46. Model numbers and specifications for retrofit process scale ultrafiltration cartridges

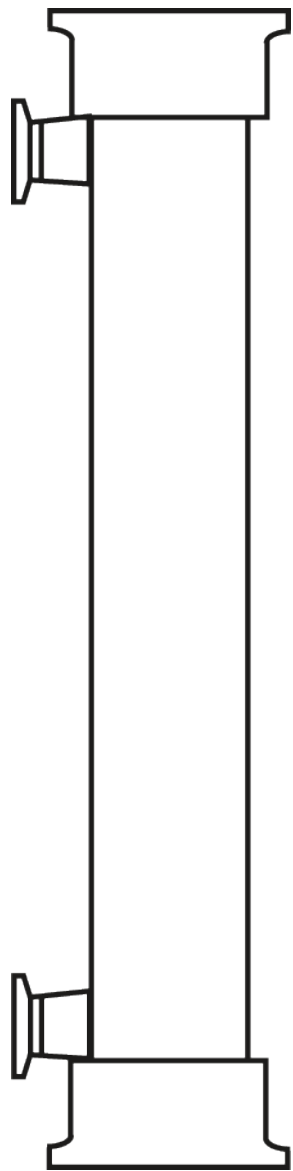
Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm²)	Membrane area (ft²)	Nominal flowpath number (cm)
11000536	UFP-1-C-55R	1000	0.5	3.25	35	60
56410336	UFP-3-C-55R	3000	0.5	3.25	35	60
56410340	UFP-5-C-55R	5000	0.5	3.25	35	60
56410342	UFP-5-E-55R	5000	1	2.1	23	60
56410344	UFP-10-C-55R	10 000	0.5	3.25	35	60
56410346	UFP-10-E-55R	10 000	1	2.1	23	60
56410348	UFP-30-C-55R	30 000	0.5	3.25	35	60
56410350	UFP-30-E-55R	30 000	1	2.1	23	60
56410352	UFP-50-C-55R	50 000	0.5	3.25	35	60
56410354	UFP-50-E-55R	50 000	1	2.1	23	60
56410356	UFP-100-C-55R	100 000	0.5	3.25	35	60
56410358	UFP-100-E-55R	100 000	1	2.1	23	60
56410360	UFP-300-C-55R	300 000	0.5	3.25	35	60
56410362	UFP-300-E-55R	300 000	1	2.1	23	60
56410364	UFP-500-C-55R	500 000	0.5	3.25	35	60
56410366	UFP-500-E-55R	500 000	1	2.1	23	60
56410368	UFP-750-E-55R	750 000	1	2.1	23	60
56410381	UFP-3-C-75R	3000	0.5	6	65	110
56410383	UFP-3-E-75R	3000	1	3.7	40	110
56410385	UFP-5-C-75R	5000	0.5	6	65	110
56410387	UFP-5-E-75R	5000	1	3.7	40	110
56410389	UFP-10-C-75R	10 000	0.5	6	65	110
56410391	UFP-10-E-75R	10 000	1	3.7	40	110
56410393	UFP-30-C-75R	30 000	0.5	6	65	110
56410395	UFP-30-E-75R	30 000	1	3.7	40	110

Table 46. Model numbers and specifications for retrofit process scale ultrafiltration cartridges (continued)

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410397	UFP-50-E-75R	50 000	1	3.7	40	110
56410399	UFP-100-C-75R	100 000	0.5	6	65	110
56410401	UFP-100-E-75R	100 000	1	3.7	40	110
56410403	UFP-300-C-75R	300 000	0.5	6	65	110
56410405	UFP-300-E-75R	300 000	1	3.7	40	110
56410407	UFP-500-C-75R	500 000	0.5	6	65	110
56410409	UFP-500-E-75R	500 000	1	3.7	40	110
56410411	UFP-750-E-75R	750 000	1	3.7	40	110

Table 47. Model numbers and specifications for retrofit process scale microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Membrane area (ft²)	Nominal flowpath number (cm)
56410371	CFP-1-E-55R	0.1	1	2.1	23	60
56410374	CFP-2-E-55R	0.2	1	2.1	23	60
56410377	CFP-4-E-55R	0.45	1	2.1	23	60
11000569	CFP-1-E-75R	0.1	1	3.7	40	110
11000570	CFP-2-E-75R	0.2	1	3.7	40	110



Housing 55R

Length = 63.5 cm (25 in)
Diameter = 7.6 cm (3 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = R style for retrofit

Housing 75R

Length = 109 cm (43 in)
Diameter = 7.6 cm (3 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = R style for retrofit

Fig 25. Retrofit cartridges 55R and 75R (drawings not to scale)

07

Steam-in-place cartridges

Introduction

Steam-in-place (SIP) cartridge elements provided by Cytiva are specifically designed for pharmaceutical manufacturing operations. These elements, which fit securely into stainless steel housings for safe operation during the steaming cycle, are based on the highest quality, most durable membranes on the market today. Steam-in-place cartridges are available in three standard styles, denoted SMO, STM, and MSM.

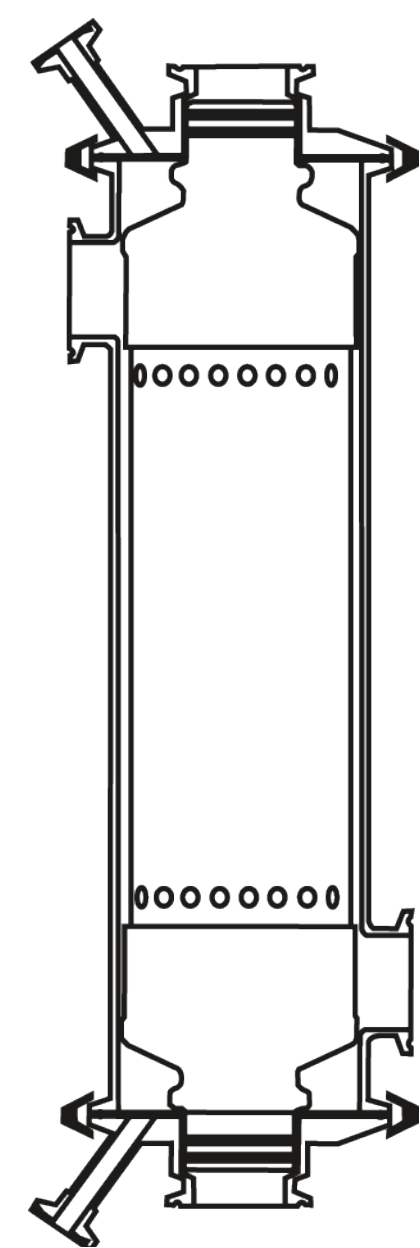
The SMO and STM versions are based on a 7.6 cm (3 in) diameter element. SMO cartridges have an open face and a single o-ring seal at each end. STM units have end caps at each face that neck down to a double o-ring seal, for connection to the stainless steel end fittings. Larger, MaxCell MSM SIP elements have a nominal 10 cm (4 in) diameter and an open face configuration.

You can order a number of accessories for steam-in-place cartridges. In addition, Cytiva can provide custom SIP systems for totally aseptic processing. To learn more about which type of cartridge is best for your application, contact your Cytiva salesperson.

SIP cartridges are available in both ultrafiltration and microfiltration pore sizes, each with a choice of 30 and 60 cm path lengths.

All housing assemblies are of 316L stainless steel with sanitary construction. The standard o-ring material is silicone. Both end fitting and permeate ports are 1.5 in sanitary Tri-Clamp configuration, allowing for quick and easy connection to steam and process piping.

STM steam-in-place cartridges



Housing 35STM

Length = 43.4 cm (17.1 in)
Diameter = 9.1 cm (3.6 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 1.5 in Tri-Clamp
Drain/vent ports = 0.5 in Tri-Clamp

Housing 55STM

Length = 75.2 cm (29.6 in)
Diameter = 9.1 cm (3.6 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 1.5 in Tri-Clamp
Drain/vent ports = 0.5 in Tri-Clamp

Note: Length and diameter values are for STM cartridges within their respective stainless steel housings.

Fig 26. STM steam-in-place cartridge and housing

Table 48. Nominal feed stream flow rates (liters/minute) for housings 35STM and 55STM

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	6.6	13.2	26	53
0.75	10	20	40	80
1	15	30	60	120

Table 49. Model numbers and specifications for STM steam-in-place ultrafiltration cartridges

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56410412	UFP-10-E-35STM	10 000	1	0.92	9.9	30
56410413	UFP-30-E-35STM	30 000	1	0.92	9.9	30
56410414	UFP-100-E-35STM	100 000	1	0.92	9.9	30
56410415	UFP-500-E-35STM	500 000	1	0.92	9.9	30
56410419	UFP-3-C-55STM	3000	0.5	3.25	35	60
56410420	UFP-10-C-55STM	10 000	0.5	3.25	35	60
56410421	UFP-10-E-55STM	10 000	1	2.1	23	60
56410422	UFP-30-C-55STM	30 000	0.5	3.25	35	60
56410423	UFP-30-E-55STM	30 000	1	2.1	23	60
56410424	UFP-50-C-55STM	50 000	0.5	3.25	35	60
56410425	UFP-100-C-55STM	100 000	0.5	3.25	35	60
56410426	UFP-100-E-55STM	100 000	1	2.1	23	60
11000581	UFP-300-E-55STM	300 000	1	2.1	23	60
56410427	UFP-500-E-55STM	500 000	1	2.1	23	60

Table 50. Model numbers and specifications for STM steam-in-place microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Membrane area (ft²)	Nominal flowpath number (cm)
56410792	CFP-1-D-35STM	0.1	0.75	1	10.8	30
56410416	CFP-1-E-35STM	0.1	1	0.92	9.9	30
56410417	CFP-2-E-35STM	0.2	1	0.92	9.9	30
56410418	CFP-4-E-35STM	0.45	1	0.92	9.9	30
56410428	CFP-1-E-55STM	0.1	1	2.1	23	60
56410429	CFP-2-E-55STM	0.2	1	2.1	23	60
56410430	CFP-4-E-55STM	0.45	1	2.1	23	60
56410925	CFP-6-D-55STM	0.65	0.75	2.5	27	60

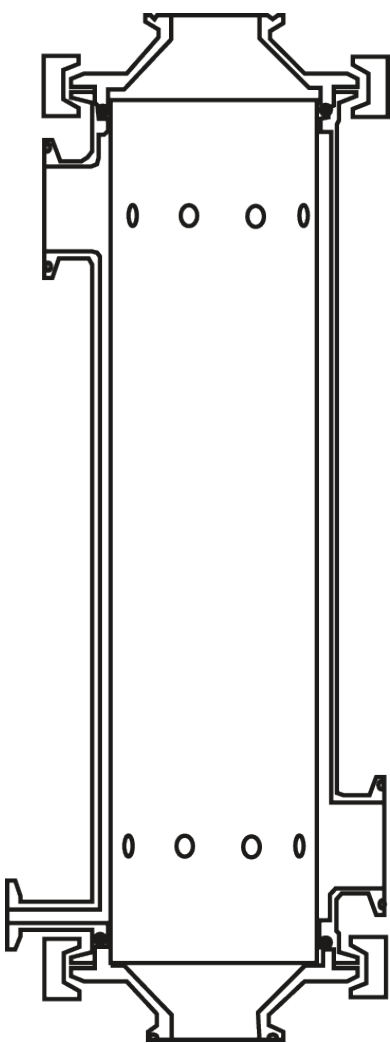
Table 51. Stainless steel housings for STM steam-in-place cartridges

Code number	Model number	Description
56410627	SS-35STM	Housing assembly for 35STM cartridges, 316L SS with 2 gaskets and 2 clamps
56410628	SS-55STM	Housing assembly for 55STM cartridges, 316L SS with 2 gaskets and 2 clamps

Table 52. Accessories for STM steam-in-place cartridges

Code number	Model number	Description
56410665	CL4	0.5 in TC quick disconnect clamp, 304 SS
56410667	CL12	1.5 in TC quick disconnect clamp, 304 SS
56410671	CL24	3 in TC [schedule 5 pipe] clamp, 304 SS
56410994	KG4S	0.5 in TC gasket, silicone, pack of 4
56410996	KG12S	1.5 in TC gasket, silicone, pack of 4
56410997	KG12B	1.5 in TC gasket, Buna-N, pack of 4
11000525	KG24S	3 in TC [schedule 5 pipe] gasket, silicone, pack of 4
56410689	K02ORE	STM o-ring set, EPDM, pack of 8
56410690	K02ORS	STM o-ring set, silicone, pack of 8
56410592	VDM-6SS	Diaphragm valve, 0.75 in TC, 316L SS
56410593	VDM-12SS	Diaphragm valve, 1.5 in TC, 316L SS

SMO steam-in-place cartridges



Housing 35SMO-DP

Length = 37.3 cm (14.7 in)
Diameter = 9.1 cm (3.6 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 1.5 in Tri-Clamp
Drain port = 0.5 in Tri-Clamp

Housing 55SMO-DP

Length = 69.3 cm (27.3 in)
Diameter = 9.1 cm (3.6 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 1.5 in Tri-Clamp
Drain port = 0.5 in Tri-Clamp

Note: Length and diameter values above are for SMO cartridges within their respective stainless steel housings.

Table 53. Nominal feed stream flow rates (liters/minute) for 35SMO and 55SMO steam-in-place cartridges

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
1	15	30	60	120

Table 54. Model numbers and specifications for SMO steam-in-place ultrafiltration cartridge

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area (cm ²)	Membrane area (ft ²)	Nominal flowpath number (cm)
56-4104-31	UFP-10-E-35SMO	10 000	1	0.92	9.9	30
56-4104-32	UFP-30-E-35SMO	30 000	1	0.92	9.9	30
56-4104-33	UFP-100-E-35SMO	100 000	1	0.92	9.9	30
56-4104-34	UFP-500-E-35SMO	500 000	1	0.92	9.9	30
56-4104-38	UFP-10-E-55SMO	10 000	1	2.1	23	60
56-4104-39	UFP-30-E-55SMO	30 000	1	2.1	23	60
56-4104-40	UFP-100-E-55SMO	100 000	1	2.1	23	60
56-4104-41	UFP-500-E-55SMO	500 000	1	2.1	23	60

Fig 27. SMO steam-in-place cartridge and housing

Table 55. Model numbers and specifications for SMO steam-in-place microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area (cm²)	Membrane area (ft²)	Nominal flowpath number (cm)
56410435	CFP-1-E-35SMO	0.1	1	0.92	9.9	30
56410436	CFP-2-E-35SMO	0.2	1	0.92	9.9	30
56410437	CFP-4-E-35SMO	0.45	1	0.92	9.9	30
56410442	CFP-1-E-55SMO	0.1	1	2.1	23	60
56410443	CFP-2-E-55SMO	0.2	1	2.1	23	60
56410444	CFP-4-E-55SMO	0.45	1	2.1	23	60

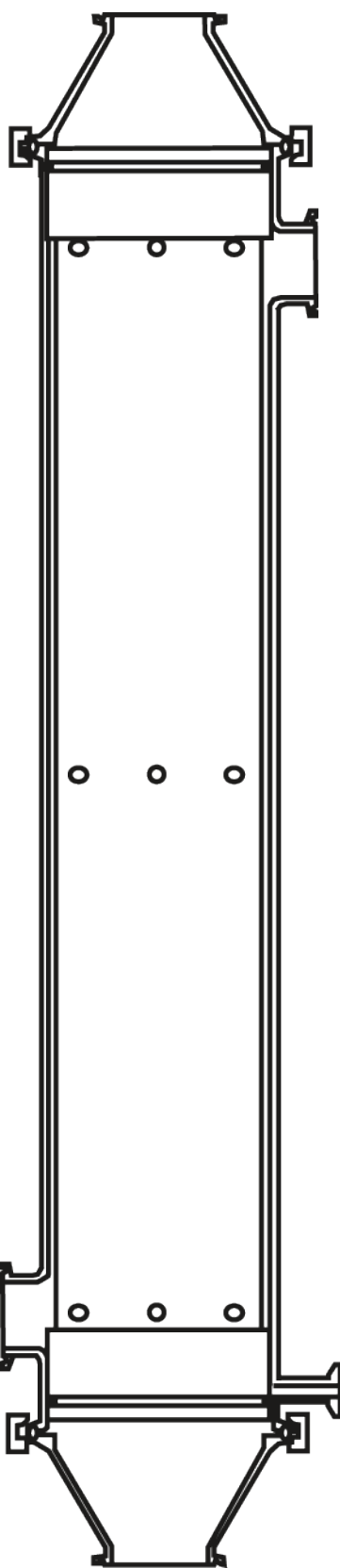
Table 56. Stainless steel housings for SMO steam-in-place cartridges

Code number	Model number	Description
56410629	SS-35SMO-DP	Housing assembly with drain port for 35SMO cartridges, 316L SS with 2 gaskets and 2 clamps
56410630	SS-55SMO-DP	Housing assembly with drain port for 55SMO cartridges, 316L SS with 2 gaskets and 2 clamps

Table 57. Accessories for SMO steam-in-place cartridges

Code number	Model number	Description
56410665	CL4	0.5 in TC quick disconnect clamp, 304 SS
56410667	CL12	1.5 in TC quick disconnect clamp, 304L SS
56410671	CL24	3 in TC [schedule 5 pipe] clamp, 304L SS
56410994	KG4S	0.5 in TC gasket, silicone, pack of 4
56410996	KG12S	1.5 in TC gasket, silicone, pack of 4
56410997	KG12B	1.5 in TC gasket, Buna-N, pack of 4
11000525	KG24S	3 in TC [schedule 5 pipe] gasket, silicone, pack of 4
56410691	K03ORS	SMO cartridge o-ring set, 4 ea., silicone
56410592	VDM-6SS	Diaphragm valve, 0.75 in TC, 316L SS
56410593	VDM-12SS	Diaphragm valve, 1.5 in TC, 316L SS

MaxCell MSM steam-in-place cartridges



Housing 45MSM-DP

Length = 52.8 cm (20.8 in)
Diameter = 11.4 cm (4.5 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp
Drain port = 0.5 in Tri-Clamp

Housing 65MSM-DP

Length = 75.7 cm (29.8 in)
Diameter = 11.4 cm (4.5 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp
Drain port = 0.5 in Tri-Clamp

Housing 85MSM-DP

Length = 134 cm (52.7 in)
Diameter = 11.4 cm (4.5 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2 in Tri-Clamp
Drain port = 0.5 in Tri-Clamp

Housing 85MSM-EL-DP

Length (to center of end fitting connections) = 150 cm (59.2 in)
Diameter = 11.4 cm (4.5 in)
Permeate ports = 1.5 in Tri-Clamp
Feed/retentate ports = 2.5 in Tri-Clamp
Drain port = 0.5 in Tri-Clamp

Note: Length and diameter values above are for MSM cartridges within their respective stainless steel housings.



Fig 29. MaxCell MSM steam-in-place cartridge and stainless steel housing

Table 58. Nominal feed stream flow rates (liters/minute) for housing sizes 45MSM, 65MSM, and 85MSM

Nominal lumen i.d. (mm)	Shear rate ~ 2000 sec ⁻¹	Shear rate ~ 4000 sec ⁻¹	Shear rate ~ 8000 sec ⁻¹	Shear rate ~ 16 000 sec ⁻¹
0.5	14	28	55	111
1	31	61	122	245

Fig 28. MaxCell MSM steam-in-place cartridge and housing

Table 59. Model numbers and specifications for MaxCell MSM steam-in-place ultrafiltration cartridgess

Code number	Model number	Pore size (NMWC)	Fiber i.d. (mm)	Membrane area		Nominal flowpath number (cm)
				area (cm²)	area (ft²)	
56410445	UFP-10-E-45MSM	10 000	1	2.3	25	30
56410446	UFP-30-E-45MSM	30 000	1	2.3	25	30
56410447	UFP-100-E-45MSM	100 000	1	2.3	25	30
56410448	UFP-500-E-45MSM	500 000	1	2.3	25	30
56410452	UFP-10-C-65MSM	10 000	0.5	5.6	60	60
56410453	UFP-10-E-65MSM	10 000	1	4.2	45	60
56410454	UFP-30-C-65MSM	30 000	0.5	5.6	60	60
56410455	UFP-30-E-65MSM	30 000	1	4.2	45	60
56410456	UFP-100-C-65MSM	100 000	0.5	5.6	60	60
56410457	UFP-100-E-65MSM	100 000	1	4.2	45	60
11000501	UFP-500-C-65MSM	500 000	0.5	5.6	60	60
56410458	UFP-500-E-65MSM	500 000	1	4.2	45	60
56410462	UFP-10-E-85MSM	10 000	1	9	95	110
56410938	UFP-30-C-85MSM	30 000	0.5	11.6	125	110
56410463	UFP-30-E-85MSM	30 000	1	9	95	110
56410939	UFP-100-C-85MSM	100 000	0.5	11.6	125	110
56410464	UFP-100-E-85MSM	100 000	1	9	95	110
56410940	UFP-300-C-85MSM	300 000	0.5	11.6	125	110
56410465	UFP-300-E-85MSM	300 000	1	9	95	110
56410466	UFP-500-E-85MSM	500 000	1	9	95	110

Table 60. Model numbers and specifications for MaxCell MSM steam-in-place microfiltration cartridges

Code number	Model number	Pore size (µm)	Fiber i.d. (mm)	Membrane area		Nominal flowpath number (cm)
				area (cm²)	area (ft²)	
56410449	CFP-1-E-45MSM	0.1	1	2.3	25	30
56410450	CFP-2-E-45MSM	0.2	1	2.3	25	30
56410451	CFP-4-E-45MSM	0.45	1	2.3	25	30
56410459	CFP-1-E-65MSM	0.1	1	4.2	45	60
56410460	CFP-2-E-65MSM	0.2	1	4.2	45	60
56410461	CFP-4-E-65MSM	0.45	1	4.2	45	60

Table 61. Stainless steel housings for MaxCell MSM steam-in-place cartridges

Code number	Model number	Description
56410631	SS-45MSM-DP	Stainless steel housing assembly with drain port and 2 in TC straight adaptors for 45MSM cartridges, 316L SS with 2 gaskets (silicone) and 2 clamps
56410632	SS-65MSM-DP	Stainless steel housing assembly with drain port and 2 in TC straight adaptors for 65MSM cartridges, 316L SS with 2 gaskets (silicone) and 2 clamps
56410633	SS-85MSM-DP	Stainless steel housing assembly with drain port and 2 in TC straight adaptors for 85MSM cartridges, 316L SS with 2 gaskets (silicone) and 2 clamps
56410634	SS-85MSM-EL-DP	Stainless steel housing assembly with drain port and 2.5 in TC elbow adaptors for 85MSM cartridges, 316L SS with 2 gaskets (silicone) and 2 clamps

Table 62. Accessories for MSM steam-in-place cartridges

Code number	Model number	Description
56410665	CL4	0.5 in TC quick disconnect clamp, 304 SS
56410667	CL12	1.5 in TC quick disconnect clamp, 304 SS
56410670	CL16-LT	2 in toggle clamp, 304 SS
56410673	CL32TC	MSM 4 in TC (schedule 5 pipe) clamp, 304 SS
56410994	KG4S	0.5 in TC gasket, silicone, pack of 4
56410996	KG12S	1.5 in TC gasket, silicone, pack of 4
56410997	KG12B	1.5 in TC gasket, Buna-N, pack of 4
56410998	KG16S	2 in TC gasket, silicone, pack of 4
11000524	KG16B	2 in TC gasket, Buna-N, pack of 4
11000527	KG32TCS	4 in TC gasket, silicone, pack of 4
56410692	K04ORS	MaxCell o-ring set, silicone, pack of 2
56410693	K04ORB	MaxCell o-ring set, Buna-N, pack of 2
46410697	K04ORE	MaxCell o-ring set, EPDM, pack of 2
56410592	VDM-6SS	Diaphragm valve, 0.75 in TC, 316L SS
56410593	VDM-12SS	Diaphragm valve, 1.5 in TC, 316L SS

08

Laboratory scale systems

ÄKTAcrossflow automated cross flow filtration systems

ÄKTAcrossflow™ is the first fully automated system for cross flow filtration process development and is ideal for filter screening, process optimization and small-scale processing. ÄKTAcrossflow, together with UNICORN™ control software, puts you in control of your cross flow process to allow consistent simulation of large-scale conditions and provides data for comprehensive analysis of results. The benefits of working with ÄKTAcrossflow include:

- Broad range of applications that cover ultrafiltration and microfiltration
- Flexible operation of either hollow fiber cartridges or cross flow cassettes
- Thorough and efficient process development with full TMP and flux scouting
- Single familiar UNICORN interface for both chromatography and membrane separations
- No disruption to proteins or cells with low shear force pumps that require no cooling
- Minimum working volume of 25 mL ensures operation of complete processes using filters between 40 cm² and 150 cm²
- Well-suited for small-scale processing of material for protein or clinical studies

ÄKTAcrossflow consists of the separations unit, a computer with flat screen monitor and UNICORN software. The compact, benchtop system is suitable for installation in laboratories, which reduces facility expenditure. The sanitary design means that it can formally qualify for use in current Good Manufacturing Practices (cGMP) processes.

The system is built with ÄKTAdesign components for reliability, scalability, and flexibility. ÄKTAcrossflow comes complete with UV, pH and conductivity detectors, as well as air, pressure and temperature sensors. The valves and the fittings are specially developed for hygienic, leak-free operation. Electrically actuated diaphragm valves diminish holdup volumes and prevent dead volumes.

A wide range of cross flow devices include Cytiva hollow fiber cross flow cartridges for cell harvesting/cell concentration and Kwick Start cassettes for product concentration/diafiltration. ÄKTAcrossflow is designed to operate up to 150 cm² of membrane area and is suitable for processing small sample volumes.



Fig 30. ÄKTAcrossflow has a compact and sanitary design.

Table 63. Technical specifications for ÄKTAcrossflow automated systems

Operating range	
Feed flow rate	1–600 mL/min
Accuracy	2% within 2–600 mL
Transfer flow rate	0.1–200 mL/min
Accuracy	0.5% within 2–200 mL
Permeate flow rate	0.1–200 mL/min
Accuracy	0.5% within 2–200 mL
Max system pressure	5.2 barg (75.4 psig)
Min recirculation volume	< 25 mL (with 1.7 mm i.d. tubing)
Holdup volume, recirculation line	< 20 mL (with 1.7 mm i.d. tubing kit, empty reservoir)
Reservoir max holdup volume	350 mL (375 mL without floater) 1100 mL (1200 mL without floater), optional
Recommended membrane area	40–150 cm ²
System specifications	
Dimensions (w × l × h):	620 × 400 × 650 mm
Weight, approximate:	70 kg
Operating temperature:	4°C to 40°C (50°C during membrane cleaning)
Detection and control	
Pressure transducers at cartridge accuracy	Feed, retentate, and permeate 0.01 barg (0.15 psig)
TMP control accuracy	0.05 barg (0.73 psig)
UV measurement	Hg lamp: 254 and 280 nm (other wave lengths optional) Zn lamp: 214 nm
pH measurement	Range: 0–14 (spec. valid between 2 and 12)
Conductivity measurement	Range: 1 µS/cm–250 mS/cm

Ordering information

Table 64. ÄKTAcrossflow automated cross flow filtration systems

Code number	Description
18118000	ÄKTAcrossflow

Table 65. Accessories for ÄKTAcrossflow automated cross flow filtration systems

Code number	Description
11003116	1100 mL reservoir

Table 66. Flat sheet membrane cassettes for ÄKTAcrossflow automated systems

Code number	Model number	Description
11000602	UFEST0005050ST	Kvick Start, 50 cm², 5 kD, PES
11000604	UFEST0010050SE	Kvick Start, 50 cm², 10 kD select, PES
11000603	UFEST0010050ST	Kvick Start, 50 cm², 10 kD, PES
11000605	UFEST0030050ST	Kvick Start, 50 cm², 30 kD, PES
11000606	UFEST0050050ST	Kvick Start, 50 cm², 50 kD, PES
11000608	UFEST0100050ST	Kvick Start, 50 cm², 100 kD, PES
11000661	UFESTCPAK045ST	Kvick Start pack, contains 1 each 10 kD, 30 kD, 50 kD, 100 kD

Table 67. Hollow fiber AXM and AXH cartridges for AKTAcrossflow automated systems

Code number	Description	Quantity
11000550	HF Start AXM, 50 cm², 750 kD, 1 mm UFP-750-E-2U	1
11000551	HF Start AXM, 50 cm², 0.1 µm, 1 mm CFP-1-E-2U	1
11000552	HF Start AXM, 50 cm², 0.2 µm, 1 mm CFP-2-E-2U	1
11000553	HF Start AXM, 50 cm², 0.45 µm, 1 mm CFP-4-E-2U	1
11000554	HF Start AXM, 50 cm², 0.65 µm, 0.75 mm CFP-6-D-2U	1
11000565	HF Start AXM PACK, 50 cm² 750 kD, 0.1 µm, 0.2 µm, 0.45 µm, 0.65 µm	1
11000537	HF Start AXH, 40 cm², 3 kD, 0.5 mm UFP-3-C-H24U	1
11000538	HF Start AXH, 40 cm², 10 kD, 0.5 mm UFP-10-C-H24U	1
11000539	HF Start AXH, 40 cm², 30 kD, 0.5 mm UFP-30-C-H24U	1
11000540	HF Start AXH, 40 cm², 100 kD, 0.5 mm UFP-100-C-H24U	1
11000541	HF Start AXH, 40 cm², 300 kD, 0.5 mm UFP-300-C-H24U	1
11000542	HF Start AXH, 40 cm², 500 kD, 0.5 mm UFP-500-C-H24U	1

Table 68. Related literature for ÄKTAcrossflow automated systems

Code number	Description
18115635	UNICORN control system

MidJet laboratory scale systems

The MidJet laboratory scale system enables you to separate, concentrate, and diafilter small volumes (up to 200 mL) of biological solutions. This system permits minimal working volumes — as low as two to five milliliters. The MidJet system is perfectly matched to our entire line of MidGee and MidGee Hoop hollow fiber cartridges, which are available in a wide range of ultrafiltration and microfiltration pore sizes for a variety of laboratory applications.

The basic MidJet system (Fig 31) includes a peristaltic pump, reservoirs, tubing, fittings, backpressure valve and a stand on which to mount the system components. The advanced MidJet system includes a basic MidJet system plus pressure transducers, a temperature sensor, and displays for precise pressure and flow control (Fig 31). Precise process control ensures high product recovery and minimal shear denaturation.

Table 69. MidJet laboratory scale systems

Code number	Model number	Description
56410637	MDG-3SP	Basic MidJet system, includes: peristaltic recirculation pump ¹ and exchangeable saddles for size 14 and 16 tubing, mounting platform and a KMDG-2 MidJet accessory kit. Includes power adaptor and cord. 110 VAC/60 Hz
56411020	MDG-3SP/50	Same as MDG-3SP, 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56410638	MDG-4SP	Advanced MidJet system, includes: MDG-3SP basic system plus a PRT-DPM-3T digital panel meter. Includes power adaptor and cord. 110 VAC/60 Hz
56411021	MDG-4SP/50	Same as MDG-4SP, 220 VAC/50 Hz, but with PRT-DPM-3T/50 digital panel meter. Power cords (2 required) must be ordered separately, see below.
56410611	PRT-DPM-3T	Digital panel meter, includes: panel readout for inlet, outlet, and permeate pressures (psig), and temperature (°C), three pressure transducers, one thermocouple, and power cord. 110 VAC/60 Hz
56411025	PRT-DPM-3T/50	Same as PRT-DPM-3T but pressure displayed in barg. 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56410947	PC01-CH	Power cord, China
56410948	PC02-EU	Power cord, Europe
56410949	PC03-IN	Power cord, India
56410950	PC04-UK	Power cord, United Kingdom

¹ Max. circulation rate: 50 mL/min with size 14 tubing, 140 mL/min with size 16 tubing

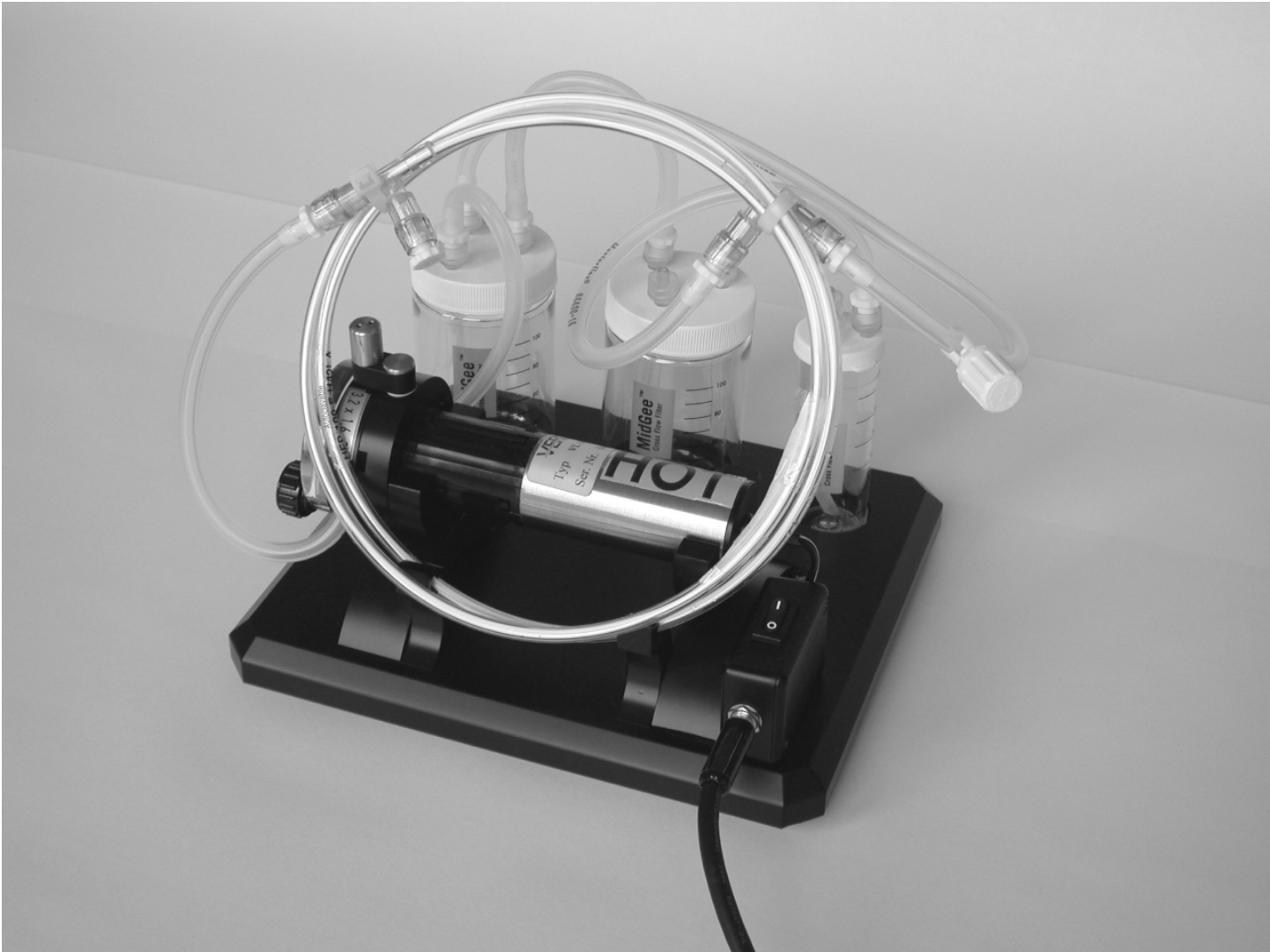


Fig 31. Basic MidJet system with MidGee Hoop cartridge installed

Table 70. Accessories for MidGee cartridges and MidJet systems

Code number	Model number	Description
56410579	KMDG-1	MidJet starter kit for use with variable-speed peristaltic pump PRP-09WM. Pump sold separately. Includes: 6 30 mL reservoirs, polystyrene; 6 30 mL reservoir snap caps, polyethylene; 6 120 mL reservoirs, polystyrene; 6 120 mL reservoir screw caps, polypropylene; 12 male Luer-Lok fittings for reservoir caps; 12 tubing insert sets for 30 mL reservoirs, silicone; 12 tubing insert sets for 120 mL reservoirs, silicone; 1 30 mL reservoir clip; 1 120 mL reservoir clip; 6 cartridge clips; 1 micrometer tubing valve for size 14 and 16 tubing, nylon; 10 female Luer-Lok to 1/8 in barb, nylon; 10 female Luer-Lok to 3/32 in barb, nylon; 8 autoclavable caps; 3 ft size 14 tubing, silicone; 3 ft size 16 tubing, silicone. Note: polystyrene reservoirs are not autoclavable.
56410582	KMDG-2	MidJet accessory kit includes: 6 30 mL reservoirs, polystyrene; 6 30 mL reservoir snap caps, polyethylene; 6 120 mL reservoirs, polystyrene; 6 120 mL reservoir screw caps, polypropylene; 6 tubing insert sets for 30 mL reservoirs, silicone; 12 tubing insert sets for 120 mL reservoirs, silicone; 1 micrometer tubing valve for size 14 and 16 tubing, nylon; 10 female Luer-Lok to 1/8 in barb, nylon; 10 female Luer-Lok to 3/32 in barb, nylon; 6 Luer-Lok to solid cap adaptors; 3 ft size 14 tubing, silicone; 3 ft size 16 tubing, silicone. Note: polystyrene reservoirs are not autoclavable.
56410653	PRP-09WM	Peristaltic recirculation pump, Watson-Marlow (up to 1.4 lpm with size 17 tubing and up to 2.0 lpm with size 18 tubing). Includes: variable speed drive and manual control system, flip-top pump head, pump tubing; 110 VAC/60 Hz, 220 VAC/50 Hz (dual voltage). For 220 VAC/50 Hz version, power cord must be ordered separately.
56410614	PT-109-01	Replacement pressure transducer (single unit). Note: requires calibration
56410615	PT-109-02	Replacement pressure transducer (set of 2). Note: requires calibration
56411005	TC-1308-01	Replacement thermocouple, type J
56410616	PTSL02-10	Recirculation pump tubing, silicone, size 14, (1.6 mm i.d.), 3.1 m (10 ft)
56410617	PTSL03-10	Recirculation pump tubing, silicone, size 16, (3.1 mm i.d.), 3.1 m (10 ft)
56410575	RBFL-1	Female Luer-Lok to 1/8 in barb, nylon, pkg. of 10
56410576	RBFL-2	Female Luer-Lok to 3/32 in barb, nylon, pkg. of 10
56411157	RBFL-FL	Female Luer-Lok to female Luer-Lok, nylon, pkg. of 10
56410577	RBFL-ML	Female Luer-Lok to male Luer-Lok, nylon, pkg. of 10
56410578	RBFL-SC	Female Luer-Lok to solid cap, nylon, pkg. of 10
56410588	VT-06	Micrometer tubing valve, nylon, for size 14 and 16 tubing
56410580	MRV-030	MidJet reservoir, 30 mL capacity, polystyrene
56410581	MRV-120	MidJet reservoir, 120 mL capacity, polystyrene
56410585	MRV-175A	Autoclavable MidJet Reservoir, 175 mL capacity, polycarbonate. Note: reservoir bases to fit MidJet system not included.
56410583	KMRV-030	MidJet reservoir kit, 30 mL capacity, includes: 12 30 mL reservoirs, polystyrene; 12 30 mL reservoir snap caps, polyethylene; 12 tubing insert sets for 30 mL reservoirs, silicone. Note: polystyrene reservoirs are not autoclavable.
56410584	KMRV-120	MidJet reservoir kit, 120 mL capacity, includes: 12 120 mL reservoirs, polystyrene; 12 120 mL reservoir snap caps, polyethylene; 12 tubing insert sets for 30 mL reservoirs, silicone. Note: polystyrene reservoirs are not autoclavable.
56410586	KMDG-175R01A	Autoclavable MidJet reservoir kit, 175 mL capacity, includes: 3 175 mL conical-bottom reservoirs, polycarbonate; 3 solid reservoir caps; 3 reservoir caps with Luer-Lok ports; 3 tubing insert sets for 175 mL reservoirs, silicone; 3 reservoir bases to fit MidJet system
56410587	KMDG-175R02A	Autoclavable MidJet reservoir replacement kit, 175 mL capacity, includes: 6 175 mL conical-bottom reservoirs, polycarbonate; 3 solid reservoir caps; 6 reservoir caps with Luer-Lok ports; 3 tubing insert sets for 175 mL reservoirs, silicone. Note: reservoir bases to fit MidJet system not included.

QuixStand benchtop systems

The QuixStand benchtop system is a compact, laboratory scale cross flow hollow fiber system designed for fast, efficient concentration and/or diafiltration of a wide range of biological solutions. The QuixStand system is capable of rapidly processing solution volumes from as little as 500 milliliters up to 10 liters, depending on the feed solution.

All QuixStand system configurations are designed to accommodate the full range of Cytiva Xampler hollow fiber ultrafiltration and microfiltration cartridges. When equipped with “M” series cartridges, sanitary pressure gauges, and stainless steel sampling/drain valve, the QuixStand system may be used for the preparation of materials for early stage clinical trials.

The basic QuixStand system consists of a cartridge support stand, inlet and outlet pressure gauges, and 400 mL and 1 liter reservoirs. The self-contained system also incorporates a backpressure control valve and a convenient sampling/drain valve. An optional peristaltic pump with a nominal maximum recirculation rate of two liters/minute is available. The low holdup volume design of the QuixStand system allows minimal working volumes as low as 30 to 50 milliliters. The QuixStand system can provide efficiency and speed plus true scale-up data impossible to achieve using conventional dialysis tubing or stirred cells.

Several system options and a number of accessories are available for the QuixStand. Contact your Cytiva salesperson for additional information and assistance in selecting the preferred system for your application.



Fig 32. QuixStand laboratory scale separations system QSM-03SP with Xampler 4M cartridge, shown with 1-liter reservoir and PRP-09WM peristaltic pump

Table 71. QuixStand laboratory scale systems

QuixStand systems without pumps

Code number	Model number	Description
56410741	QSM-02S	QuixStand benchtop system with fractional sanitary fittings and NPT-threaded pressure gauges, non-sanitary design, includes: cartridge stand that accepts size 3M, 3X2M, 4, 4M, and 4X2M cartridges; 1 support rod; 2 pressure gauges, threaded, 0–2 barg (0–30 psig); micrometer tubing valve, nylon; reservoir kit with 400 mL and 1 liter reservoirs, cap, downcomers, clamps, and gaskets; NPT-threaded sampling/drain valve, nylon; QAK-2 accessory kit including clamps, gaskets, o-rings, etc.; assembly guide. Not autoclavable.
56410742	QSM-03S	Same as QSM-02S system, with fractional sanitary fittings, sanitary pressure gauges, and stainless steel sampling/drain valve. Not autoclavable.
56410743	QSM-04SA	Same as QSM-02S system, with fractional sanitary fittings, sanitary pressure gauges, and stainless steel sampling/drain valve. Autoclavable.

QuixStand systems with pumps

Code number	Model number	Description
56410744	QSM-02SP	QuixStand benchtop system with pump, includes: QSM-02S system and PRP-09WM peristaltic recirculation pump (110 VAC/60 Hz), and stainless steel system stand
56410777	QSM-02SP/50	Same as QSM-02SP, 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56410745	QSM-03SP	QuixStand benchtop system with pump, includes: QSM-03S system and PRP-09WM peristaltic recirculation pump (110 VAC/60 Hz), and stainless steel system stand
56410778	QSM-03SP/50	Same as QSM-03SP, 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56410746	QSM-04SAP	QuixStand benchtop system with pump, includes: QSM-04SA system and a PRP-09WM peristaltic recirculation pump (110 VAC/60 Hz), and stainless steel system stand
56410779	QSM-04SAP/50	Same as QSM-04SAP, 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56410947	PC01-CH	Power cord, China
56410948	PC02-EU	Power cord, Europe
56410949	PC03-IN	Power cord, India
56410950	PC04-UK	Power cord, United Kingdom

Table 72. Accessories for QuixStand laboratory scale systems

Code number	Model number	Description
56410747	QRV-2.5	2.5-liter QuixStand reservoir with downcomers only, polysulfone. Not autoclavable.
56410748	KQRVA-0.4	400 mL QuixStand reservoir with cap and downcomers, polysulfone. Autoclavable. Excludes clamps and gaskets.
56410749	KQRVA-1.0	1-liter QuixStand reservoir with cap and downcomers, polysulfone. Autoclavable. Excludes clamps and gaskets.
56410750	QAK-2	QuixStand accessory kit includes: 3 0.5 in TC to 0.375 in barbed adaptors, polysulfone; 5 0.5 in blank-off caps, polysulfone; 2 0.375 in Snapper™ clamps; 2 0.5 in Snapper clamps; 1 micrometer tubing valve, nylon; 2 size 4 cartridge to 0.5 in TC adaptors, polysulfone; 5 0.5 in TC gaskets, silicone; 10 2-014 o-rings, silicone; 4 0.25 in cartridge caps, vinyl; 4 0.375 in cartridge caps, vinyl; 16 size 4 cartridge standoffs, Tygon™.
56410653	PRP-09WM	Peristaltic recirculation pump, Watson-Marlow (up to 1.4 lpm with size 17 tubing, and up to 2.0 lpm with size 18 tubing). Includes: variable speed drive and manual control system, flip-top pump head, pump tubing; 110 VAC/60 Hz, 220 VAC/50 Hz (dual voltage). For 220 VAC/50 Hz version, power cord must be ordered separately.
56410597	PG-01NX04T-30	Pressure gauge, 0-30 psig, 0.125 in NPT with adaptor to “M” fitting, bottom mount
56410598	PG-01NX04T-60	Pressure gauge, 0-60 psig, 0.125 in NPT with adaptor to “M” fitting, bottom mount
56410599	PG-06T-30	Pressure gauge, 0-30 psig, 0.75 in TC, non-autoclavable, bottom mount
56410600	PG-06T-30S	Pressure gauge, 0-30 psig, 0.75 in TC, non-autoclavable, side mount
56410601	PG-06T-60	Pressure gauge, 0-60 psig, 0.75 in TC, non-autoclavable, bottom mount
56410602	PG-06T-60S	Pressure gauge, 0-60 psig, 0.75 in TC, non-autoclavable, side mount
56410590	VPC4	Sampling/drain valve, 0.5 in TC, 316L SS
56410588	VT-06	Tubing valve, size 14 and 16 tubing, nylon
56410589	VT-09	Tubing valve, size 17 tubing, nylon
56410618	PTPM06-10	Peristaltic pump tubing. Bioprene™, size 17, 6.4 mm i.d., 3.1 m (10 ft)
56410619	PTPM09-10	Peristaltic pump tubing. Bioprene, size 18, 9.5 mm i.d., 3.1 m (10 ft)

09

Pilot scale systems

FlexStand pilot scale systems

FlexStand benchtop pilot scale systems are compact, sanitary hollow fiber ultrafiltration/microfiltration systems for laboratory through pilot scale applications. These cross flow systems are designed for fast, efficient concentration and/or diafiltration of a wide range of biological solutions in process volumes from five to 100 liters. The systems accommodate a wide range of Cytiva cartridges with various housing sizes, pore sizes, lumen diameters and membrane areas.

The FlexStand system is offered in two different configurations:

- Standard system with 1.5 in Tri-Clamp fittings for larger surface area cartridges (housing sizes 5, 6, 8, 9, 35, and 55). This unit has a minimal working volume of approximately one to two liters depending on choice of recirculation pump and actual piping setup.
- Low void volume system with 0.75 in Tri-Clamp fittings for smaller surface area cartridges (housing sizes 3M, 3X2M, 4M, 4X2M, 5, and 6). The minimum working volume for this system is in the 400 to 500 mL range.

Within these configurations, both stand-alone and complete systems with rotary lobe pumps are offered. An optional peristaltic recirculation pump is also available.

Ease of hollow fiber membrane cartridge change-out allows change-over from microfiltration to ultrafiltration sequentially with the same system, as well as performance comparison of different pore size and lumen diameter options quickly and efficiently. Moreover, laboratory and pilot evaluation data can be used to project scale-up processing requirements.

The FlexStand systems are designed for autoclavability, using mechanically dampened, autoclavable pressure gauges.



Fig 33. Standard FlexStand system FS-01S with size 9 cartridge installed

Standard FlexStand systems are available both with and without rotary lobe pumps.

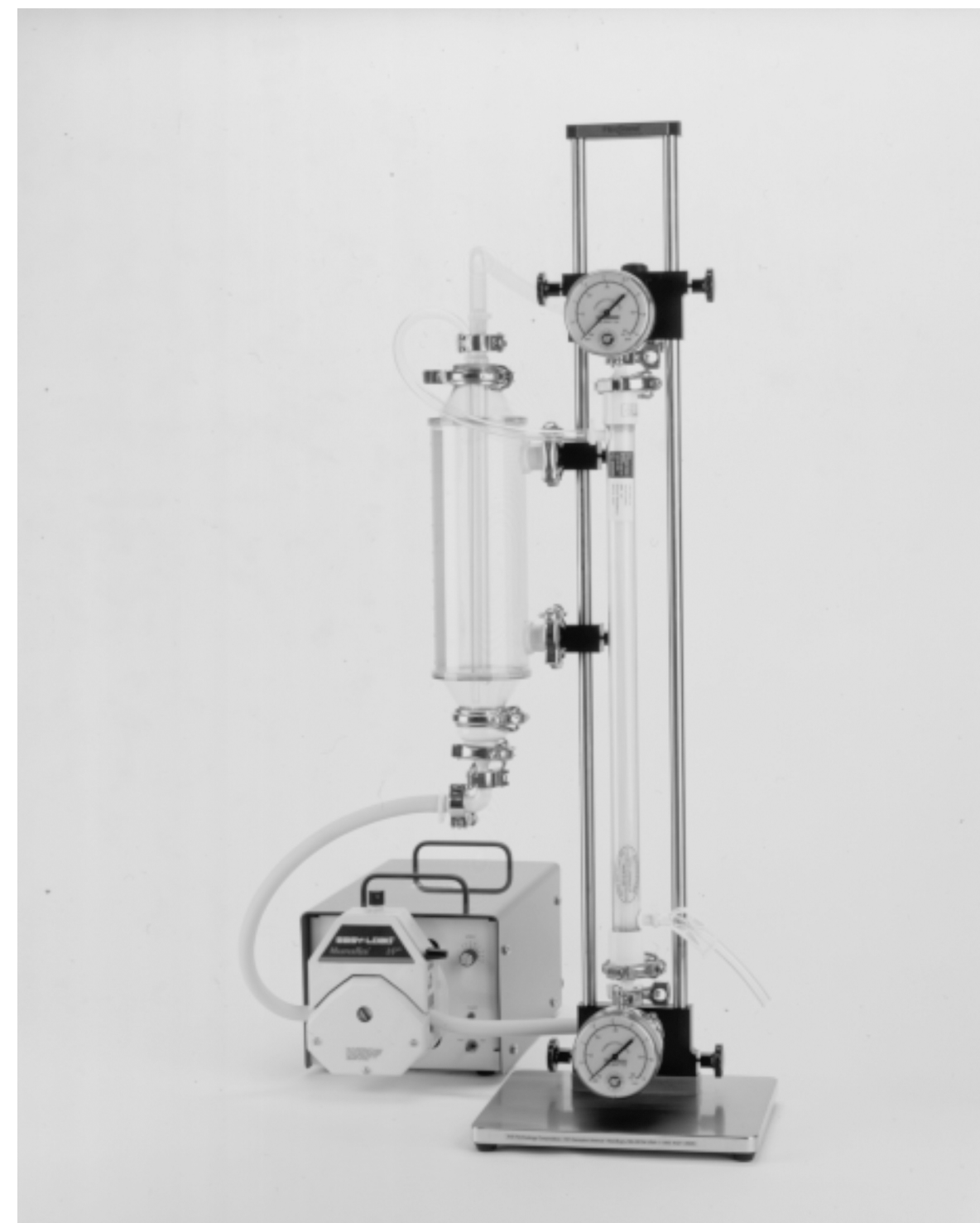


Fig 34. Low void volume FlexStand system FS-03LVS with size 6 cartridge installed, shown with optional 2 liter reservoir FRV-2A and peristaltic recirculation pump PRP-03MF

The low void volume FlexStand system accommodates Xampler cartridges with fractional Tri-Clamp end fittings and small process scale cartridges (size 5 and 6) with 1.5 in Tri-Clamp end fittings. With a system holdup volume of less than 125 ml, this system is ideal for concentration/diafiltration of high-value biological solutions.

→ Safety

WARNING: Rotary lobe pumps should be equipped with an over-pressure safety cutoff switch for operator safety and for protection of membrane filtration cartridges. The rotary lobe pumps offered by Cytiva are equipped with these safety switches. Should you elect to use a rotary lobe pump without this safety device, we suggest that the system never be left unattended during processing or cleaning operations.



Fig 35. Standard FlexStand tubing connector kit



Fig 36. Low void volume FlexStand tubing connector kit



Fig 37. Low void volume to standard FlexStand conversion kit



Fig 38. Standard to low void volume FlexStand conversion kit

Table 73. FlexStand pilot scale systems

FlexStand systems without pumps

Code number	Model number	Description
56-4107-54	FS-01S	Standard FlexStand benchtop pilot system with 1.5 in Tri-Clamp connections for feed/retentate. Includes: stand and support rods with manifolds; pressure gauge, back mount, 0-4 barg (0-60 psig), mechanically dampened; backpressure valve, pinch-type; 1 1.5 in TC blank-off cap, polysulfone; 6 1.5 in sanitary toggle clamps; 6 1.5 in TC gaskets, silicone; tubing connector kit KTC-2; assembly guide. Autoclavable.
56-4109-43	FS-01S-30	Same as FS-01S, but with 0–2 barg (0–30 psig) pressure gauge
56-4107-55	FS-03LVS	Low void volume FlexStand benchtop pilot system with 0.75 in Tri-Clamp connections for feed/retentate. Includes: stand and support rods with manifolds; pressure gauge, back mount, 0–4 barg (0–60 psig), mechanically dampened; backpressure valve, pinch-type; 1 0.5 in TC blank-off cap, polysulfone; 6 0.5 in TC clamps; 6 0.75 in TC gaskets, silicone; tubing connector kit KTC-FS-03VS; assembly guide. Autoclavable.
56-4109-44	FS-03LVS-30	Same as FS-03LVS, but with 0–2 barg (0–30 psig) pressure gauge

FlexStand systems without pumps

Code number	Model number	Description
56-4107-56	FS-02RLP	FlexStand benchtop pilot system with rotary lobe pump (1 10 VAC/60 Hz). Includes: stand and support rods with manifolds; rotary lobe recirculation pump, FlowTech LABTOP™ 350 (includes low point drain); gear box for LABTOP 350 pump; high-pressure shutoff switch; 2 pressure gauges, back mount, 0–4 barg (0–60 psig), mechanically dampened; 1.5 in sanitary diaphragm backpressure valve; 0.75 in sanitary diaphragm drain valve; tubing connector kit KTC-2; clamps, gaskets, piping, tubing; assembly guide
56-4107-57	FS-02RLP/50	Same as FS-02RLP except pump is 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56-4107-58	FS-04LVS-RLP	Low void volume FlexStand benchtop pilot system, with rotary lobe pump (1 10 VAC/60 Hz). Includes: stand and support rods with manifolds; rotary lobe recirculation pump, FlowTech LABTOP 250; gear box for LABTOP 250 pump; high-pressure shutoff switch; 2 pressure gauges, back mount, 0–4 barg (0–60 psig), mechanically dampened; 2 0.75 in sanitary diaphragm valves; tubing connector kit KTC-FS-03VS; clamps, gaskets, piping, tubing; assembly guide
56-4107-59	FS-04LVS-RLP/50	Same as FS-04LVS-RLP except pump is 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56-4109-47	PC01-CH	Power cord, China
56-4109-48	PC02-EU	Power cord, Europe
56-4109-49	PC03-IN	Power cord, India
56-4109-50	PC04-UK	Power cord, United Kingdom

Rotary lobe pumps are offered only with systems. They are not sold separately.

Table 74. Accessories for FlexStand pilot scale systems

Code number	Model number	Description
56410761	KFSM12	Conversion kit to change low void volume FlexStand to standard system. Includes: 2 1.5 in TC tee fittings, SS; 6 1.5 in TC toggle clamps, SS; 6 1.5 in TC gaskets, silicone; 4 1.5 in manifold inserts; 4 6/32 set screws, SS; 1 KTC-2 tubing connector kit
56410762	KFSM04	Conversion kit to change standard FlexStand to low void volume system. Includes: 2 low holdup TC tee fittings, SS; 2 0.5 in TC clamps, SS; 6 0.5 in TC gaskets, silicone; 2 0.5 in TC to 0.375 in barbed adaptors, polysulfone; 4 0.5 in manifold inserts; 2 1.5 in to 0.5 in TC adaptors, polysulfone; 4 6/32 set screws, SS; 1 KTC-FS-03VS tubing connector kit
56410764	KTC-2	Tubing connector kit for FS-01S system (one kit included with basic system). Includes: 4 0.5 in to 0.5 in tubing connectors, polypropylene; 8 0.5 in Snapper clamps; 8 0.375 in Snapper clamps; 2 tubing pinch clamps; 2 1.5 in TC clamps, nylon; 6 1.5 in TC gaskets, silicone; 2 1.5 in to 0.375 in barbed adaptors, polysulfone; 4 1.5 in to 0.5 in barbed adaptors, polysulfone; 2 1.5 in to 0.75 in barbed adaptors, polysulfone; 2 1.5 in TC blank-off caps, polysulfone; 1 #1 Allen wrench, 1 #2 Allen wrench, 2 6/32 set screws, SS; 2 10/32 set screws, SS; 2 5/16-18 × 1 in hex bolts, SS; 2 5/16 flat washers, SS
56410765	KTC-FS-03VS	Tubing connector kit for FS-03LVS system (one kit included with basic system). Includes: 2 0.5 in to 0.5 in tubing connectors; 8 0.5 in Snapper clamps; 8 0.375 in Snapper clamps; 8 0.25 in Snapper clamps; 1 tubing pinch clamp; 6 0.5 in TC to 0.375 in barbed adaptors, polysulfone; 4 1.5 in TC gaskets, silicone; 6 0.5 in TC blank-off caps, polysulfone; 2 1.5 in TC blank-off caps, polysulfone; 6 0.5 in TC gaskets, silicone; 2 0.75 in TC gaskets, silicone; 2 0.5 in TC clamps, SS; 2 0.5 in to 0.25 in tubing connectors, polypropylene; 2 1.5 in to 0.5 in TC adaptors, polysulfone; 4 1.5 in TC toggle clamps, SS; 2 0.5 in TC to 0.5 in barbed adaptors, polysulfone; 2 0.75 in elbows, polysulfone; 2 0.75 in tee fittings, polysulfone; 1 #1 Allen wrench, 1 #2 Allen wrench, 2 6/32 set screws, SS; 2 10/32 set screws, SS; 2 5/16-18 × 1 in hex bolts, SS; 2 5/16 flat washers, SS
11000566	PRP-03MF	Peristaltic recirculation pump, Masterflex™ single head, flow rate up to 13 lpm. Includes: variable-speed drive and manual control system, Easy-Load™ pump head, pump tubing
11000567	PRP-03MF/50	Same as PRP-03MF; 220 VAC/50 Hz. Power cord must be ordered separately.
56410603	PG-TCP30	Pressure gauge, 0 to 2 barg (0 to 30 psig), back mount, mechanically dampened; autoclavable
56410604	PG-TCP60	Pressure gauge, 0 to 4 barg (0 to 60 psig), back mount, mechanically dampened; autoclavable
56410606	PG-TCV30P30	Vacuum/pressure gauge, -1 to 2 barg (-30 in Hg to 30 psig), back mount, mechanically dampened; autoclavable
56410767	FRV-2A	FlexStand reservoir kit. Includes: 2 liter polysulfone reservoir with supports and sealable top for diafiltration; clamps, gaskets, and adaptors; autoclavable.
56410770	FRV-5A	FlexStand reservoir kit. Includes: 5 liter polysulfone reservoir with supports and sealable top for diafiltration; clamps, gaskets, and adaptors; autoclavable.
56410769	FRV-CP2/5A	Replacement reservoir cap, 2 or 5 liter FlexStand reservoir, polysulfone; autoclavable
56410763	TK01-30SS	30-liter reservoir with sight glass and adjustable legs, 316L SS. Includes 0.5 in and 1 in TC dip tubes, 0.75 in and 2 in TC connections on tank cover, 1.5 in TC bottom connection.
56410772	KDV-F1	Drain valve kit (for FS-01S system). Includes: custom 1.5 in TC × 0.5 in TC tee (316L SS), sanitary plug valve (316L SS), 0.5 in TC silicone gasket, and 304 SS clamp
56410773	KPCM-1	Manual permeate control kit. Includes: mechanically dampened vacuum/pressure gauge with clamps, gaskets, backpressure valve, supports, and tubing adaptors.
56410592	VDM-6SS	Diaphragm valve, 0.75 in TC, 316L SS
56410593	VDM-12SS	Diaphragm valve, 1.5 in TC, 316L SS
56410622	PTPM12	Peristaltic pump tubing — Bioprene size 82, 12.7 mm (0.5 in) i.d., 7.6 m (25 ft) long
56410623	PTSL12	Peristaltic pump tubing — silicone size 82, 12.7 mm (0.5 in) i.d., 7.6 m (25 ft) long

10

Pilot/manufacturing scale systems

GrandStand Pilot/Process Modular Cross Flow Filtration System

The GrandStand pilot/process system is a versatile, cart-mounted system intended for pilot through production scale biological separations from 50 to 10 000 liters. It accommodates ultrafiltration and microfiltration hollow fiber cartridges or flat sheet cassettes. The GrandStand system is capable of concentration and/or diafiltration.

Feature rich basic system

The basic GrandStand system consists of a heavy-duty stainless steel frame, positive displacement rotary lobe pump for gentle recirculation of biological solutions, diaphragm type backpressure valve, sanitary inlet and outlet pressure gauges, and a cone bottom clean-in-place (CIP) tank. A programmable AC inverter features a multitude of functions including the ability to set the pump acceleration time as well as to monitor pump speed. A high-pressure switch is incorporated for equipment and operator safety.

Robust streamlined design

The GrandStand system's narrow profile allows it to fit through standard door openings for easy transport from the lab to the cold room to the manufacturing area. Heavy-duty swivel casters with a total locking feature provide mobility and stability. The system is designed to interchange easily between process and cleaning cycles.

The modular design enhances the versatility of the GrandStand system to address changing needs associated with scale up and sophistication from pilot to process scale.

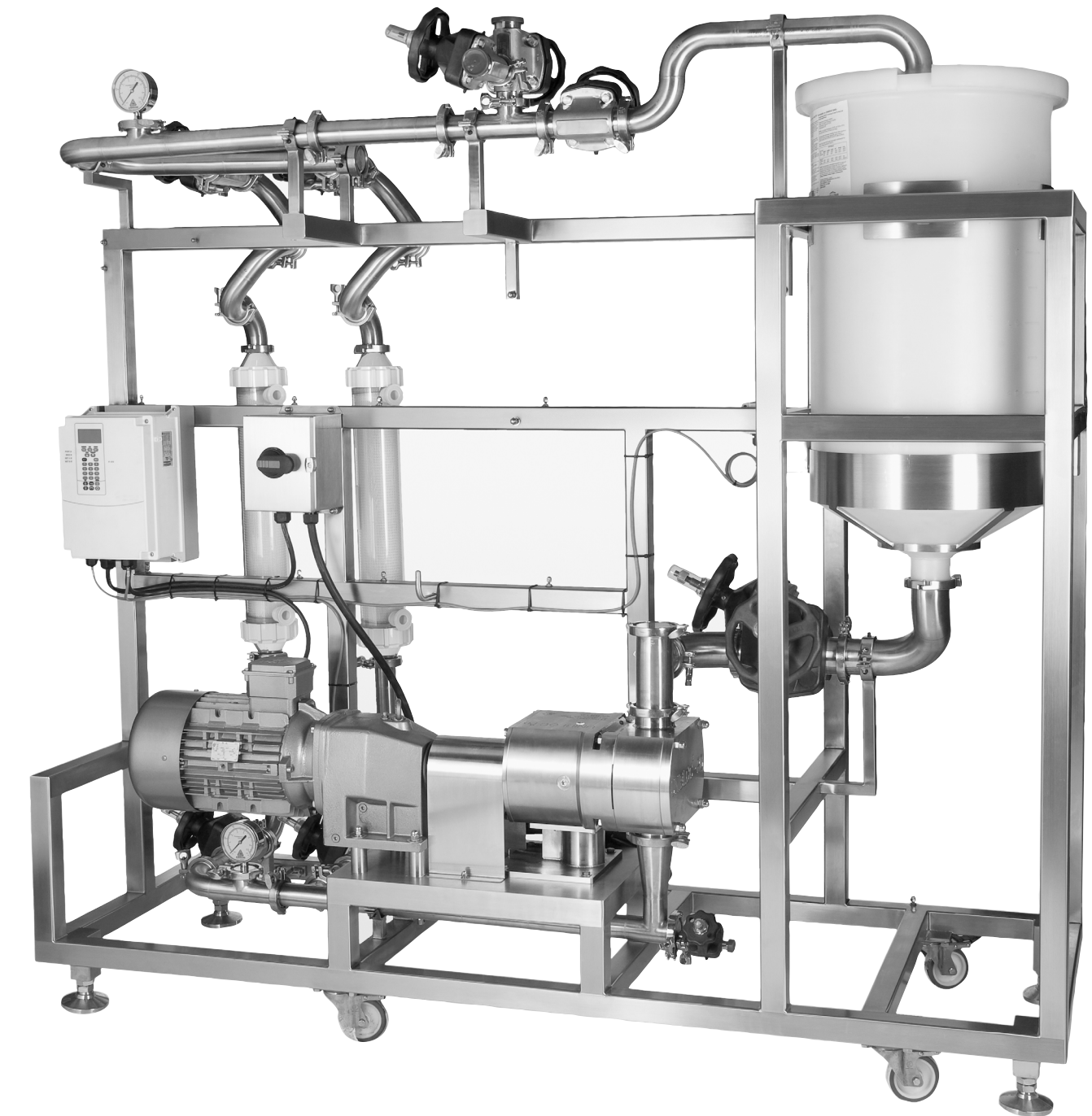


Fig 39. GrandStand 550 base system shown with 2 MaxCell size 65 hollow fiber cartridges.

The GrandStand systems are intended for pilot through process scale biological separations.

The systems accommodate UF and MF hollow fiber cartridges and flat sheet cassettes.

Table 75. GrandStand system specifications

Base system	GrandStand 450	GrandStand 550
Weight (approximate)	1576 lbs (715 kg)	1876 lbs (851 kg)
Materials of Construction		
Frame	304 stainless steel	304 stainless steel
Fluid path	316L stainless steel	316L stainless steel
Fluid path surface finish	< 20 Ra μ in (0.5 Ra μm)	< 20 Ra μ in (0.5 Ra μm)
Kvick Flow holder surface finish	< 25 Ra μ in (0.6 Ra μm)	< 25 Ra μ in (0.6 Ra μm)
Front and back plate	< 20 Ra μ in (0.5 Ra μm)	< 20 Ra μ in (0.5 Ra μm)
Feed, retentate, permeate ports		
CIP tank	15 gal. Polypropylene (56.7 L)	30 gal. Polypropylene (113.5 L)
Pump Type	Rotary lobe	Rotary lobe
Max Pump Flow rate	120 L/min @ 30 psig	400 L/min @ 30 psig
O-rings, gaskets, valve diaphragms	EPDM	EPDM
System dead volume*	9.5 L	18.9 L
Power requirements	GSMRLP450 SYS 220 VAC 3 Phase 50/60 Hz	GSMRLP550 SYS 220 VAC 3 Phase 50/60 Hz
	GSMRLP450 380V 380 VAC 3 Phase 50/60 Hz	GSMRLP550 380V 380 VAC 3 Phase 50/60 Hz
	GSMRLP450 440V 440 VAC 3 Phase 50/60 Hz	GSMRLP550 440V 440 VAC 3 Phase 50/60 Hz

*Approximate base system without tank or filter cartridge

System Overall Dimensions

	Length	Width	Height
GrandStand 550	7’ 0” (2134 mm)	2’ 5.5” (749 mm)	6’ 10.1875” (2088 mm)
GrandStand 450	6’ 3” (1905 mm)	6’ 3” (724 mm)	6’ 6.5” (1993 mm)
GrandStand 450 (Reduced Footprint)	4’ 2” (1270 mm)	1’ 11.5” (597 mm)	6’ 6.75” (2000 mm)

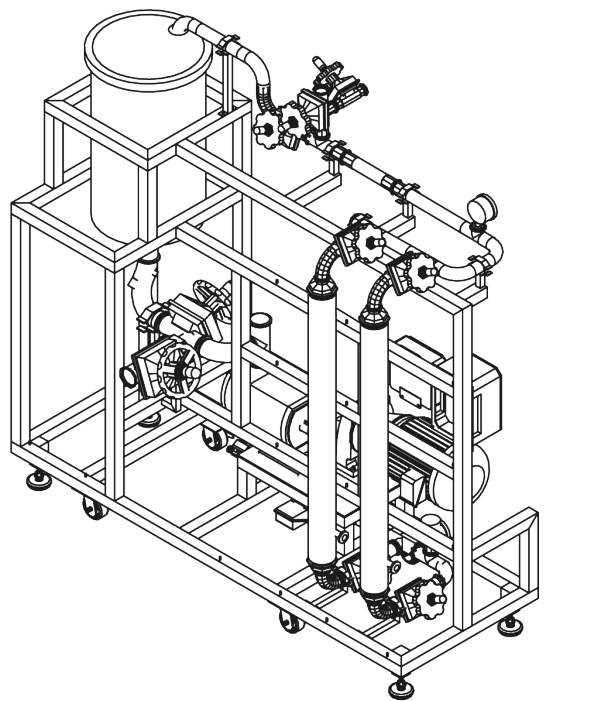
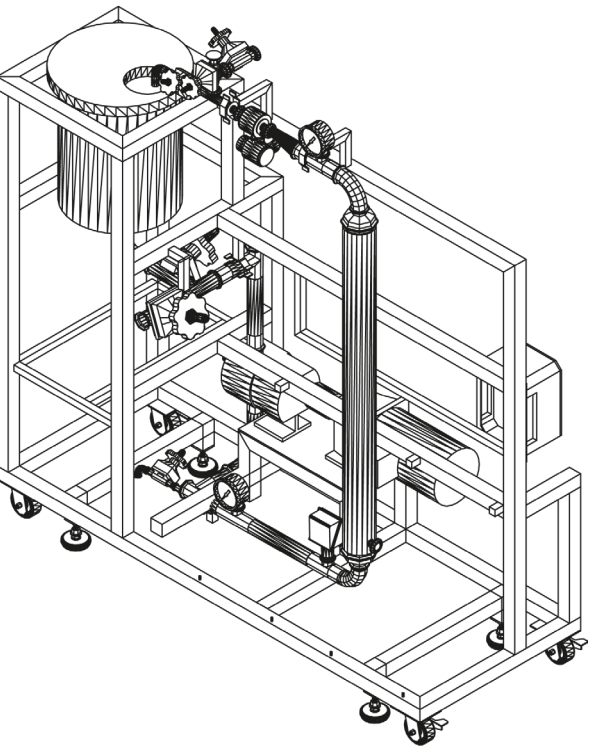
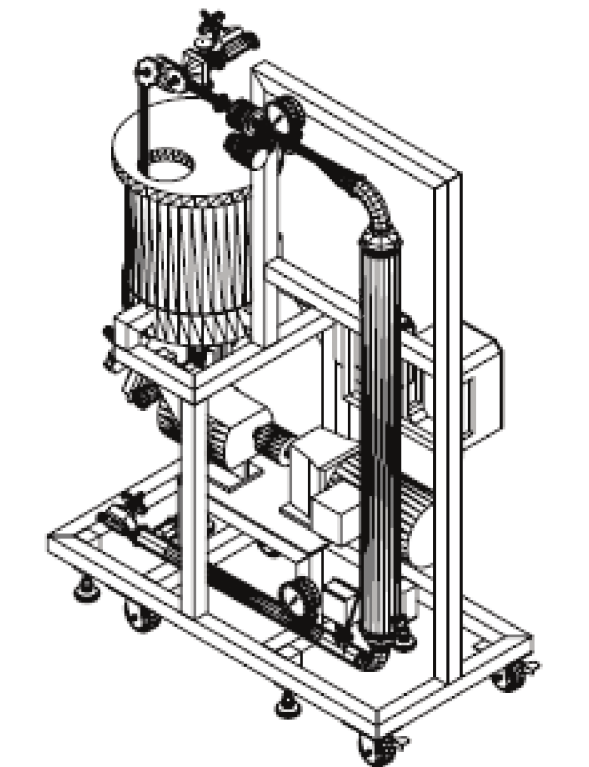


Table 76. Ordering information for GrandStand systems and accessories

Code Number	Catalog Number	Description
Base System		
28400531	GSMRLP550SYS ⁴	GrandStand 550 Modular System
28400532	GSMRLP450SYS ⁴	GrandStand 450 Modular System
28400448	GSMRLP550380V ⁴	GrandStand 550 Mod Sys 380VAC
28400449	GSMRLP450380V ⁴	GrandStand 450 Mod Sys 380VAC
28400453	GSMRLP550440V ⁴	GrandStand 550 Mod Sys 440VAC
28400454	GSMRLP450440V ⁴	GrandStand 450 Mod Sys 440VAC
Filter Modules		
28400545	GSM550HF4KIT	GS 550 HF 4 Position Exp. Kit
28400533	GSMKF2MFDKIT	GS 2 Kwick Flow Adapter Kit
11000667	KFHR0115TQE ³	Kwick Flow Manual Cassette Holder
Data Acquisition		
28400534	GSMDAQENCLKIT ¹	GrandStand PLC Enclosure
28400535	GSMDAQPRESTRA	0–150 psig Pressure Transmitter
28400536	GSMDAQTEMPKIT	Temperature Transmitter
28400446	GSMDAQMFM550	GS 550 Magnetic Flow Meter
28400447	GSMDAQMFM450	GS 450 Magnetic Flow Meter
28400538	GSMDAQUV1KIT	280 µm UV Sensor With Display
28400539	GSMDAQCONTRA	Conductivity Sensor With Display
SIP Modules		
28400540	GSMSIPCMPKIT	GS HF SIP Manifold Kit
56410627	SS-35STM ³	Housing assembly for-35STM cartridges
56410628	SS-55STM ³	Housing assembly for-55STM cartridges
56410629	SS-35SMO-DP ³	Housing assembly for-35SMO cartridges
56410630	SS-55SMO-DP ³	Housing assembly for-55SMO cartridges
56410631	SS-45MSM-DP ³	Housing assembly for-45MSM cartridges
56410632	SS-65MSM-DP ³	Housing assembly for-65MSM cartridges
56410633	SS-85MSM-DP ³	Housing assembly for-85MSM cartridges
56410634	SS-85MSM-EL-DP ³	Housing assembly for-85MSM cartridges

Code Number	Catalog Number	Description
Permeate Pump		
28400541	GSM450PERPRP	GS 450 Permeate Pump Kit
28400542	GSM550PERPRP	GS 550 Permeate Pump Kit
28400543	GSM550PERPRH	GS 550 Add on Permeate Pump Head
Service		
44820007	44-8200-07 ²	GrandStand Module Assembly to System and IQ/OQ

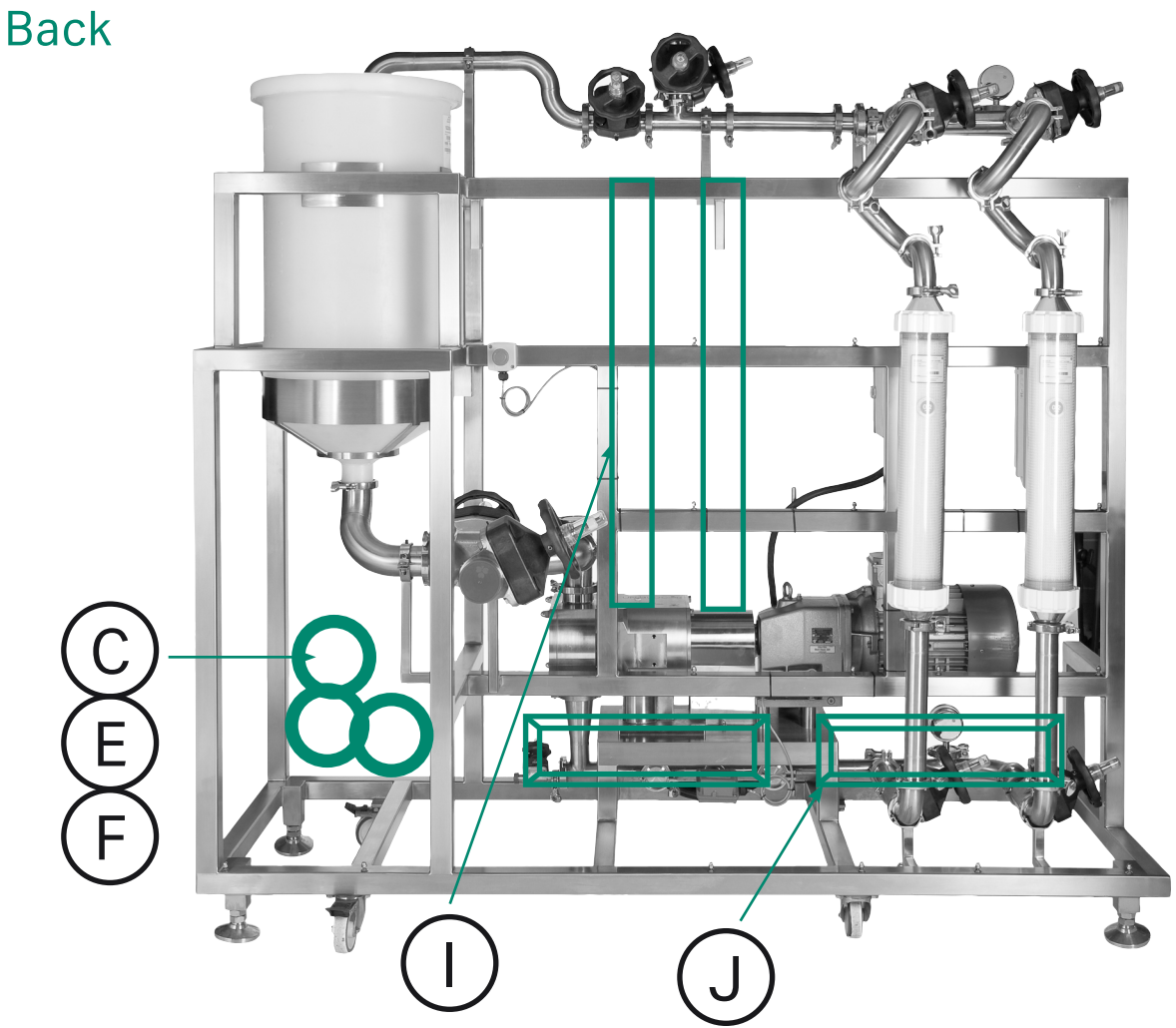
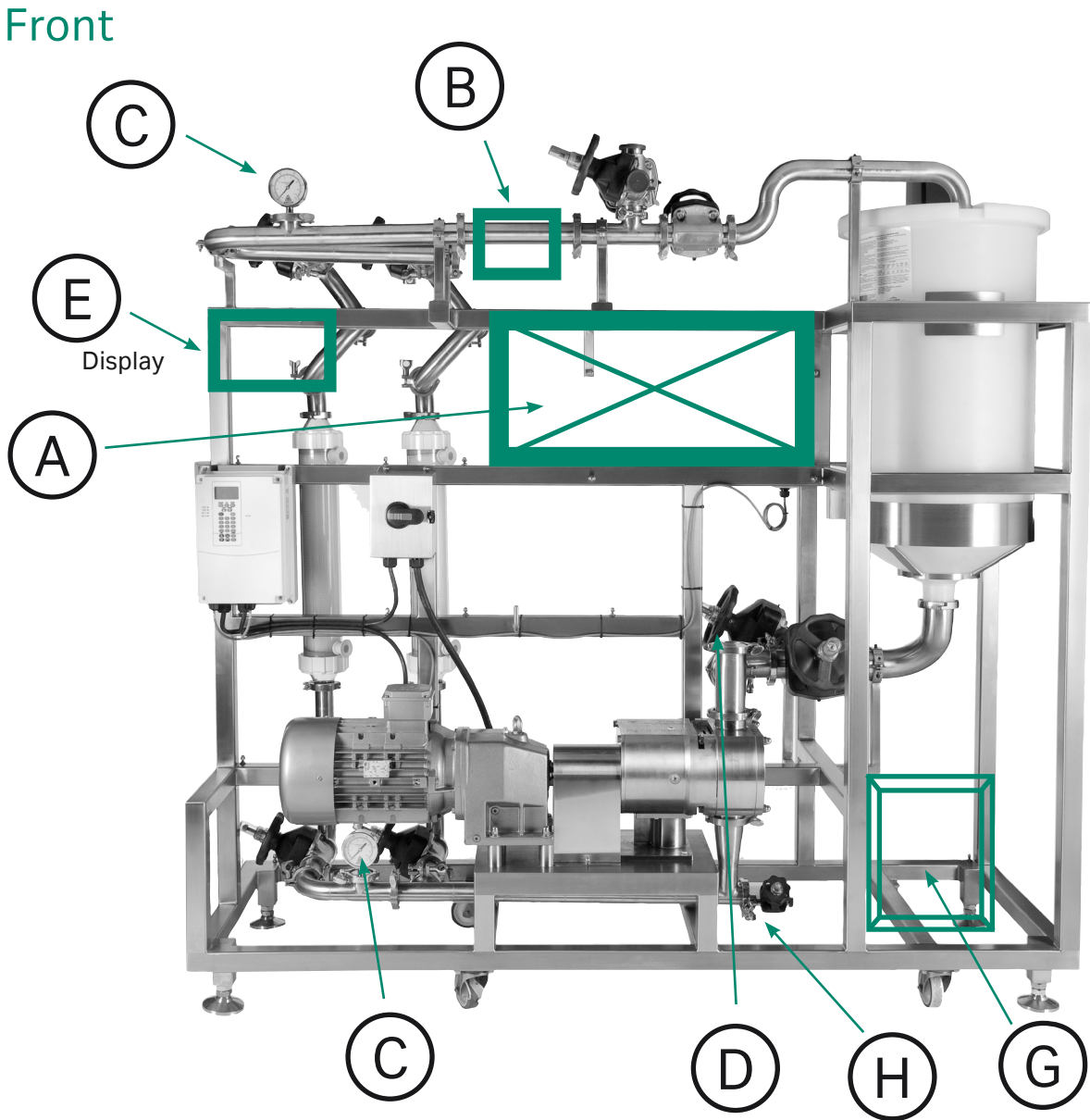
¹ GSMDAQENCLKIT is required to power any data acquisition module that is purchased.

² Assembly of module kits is not available without IQ/OQ service.

³ Items are not included in modular accessory kits and must be purchased separately.

⁴ Includes one set of documentation.

Additional set of documents can be supplied at an additional cost.



- A. Data Acquisition Enclosure
- B. Flow Meter (requires A)
- C. Pressure Sensor (requires A)
- D. Temperature Sensor (requires A)
- E. Conductivity Sensor (requires A)
- F. UV Sensor (requires A)
- G. Permeate Pump
- H. SIP Kit
- I. 4 Position HF Kit
- J. Kwick Flow Cassette Kit (replaces HF filters)

UniFlux filtration systems

Incorporate cross flow filtration with UNICORN control software into an overall downstream process.

- Available in four sizes (10, 30, 120, and 400 lpm) for pilot- to production-scale
- Maximizes productivity in cross flow filtration
- Consistent, repeatable, and validatable results

UniFlux™ filtration systems incorporate cross flow membranes and high performance hardware in a single, easy to set up system. They can be configured to incorporate either hollow fiber or cassette membranes.

Automated configurations use a cross flow filtration-specific version of Cytiva UNICORN control system. UNICORN provides FDA 21 CFR Part 11 compliant software in a form familiar to many operators conversant with Cytiva chromatography systems from benchtop to production-scale ÄKTAdesign systems.

Table 77. UniFlux system ordering information

System	Description
UniFlux 30 AH	CFF system for hollow fiber, 60 lpm
UniFlux 120 AH	CFF system for hollow fiber, 120 lpm
UniFlux 30 AH	CFF system for hollow fiber, 60 lpm
UniFlux 10 AC	CFF system for Kwick Lab cassette, 10 lpm
UniFlux 30 AC	CFF system for Kwick Flow cassette, 60 lpm
UniFlux 120 AC	CFF system for Kwick Flow cassette, 120 lpm
UniFlux 400 AC	CFF system for Kwick Flow cassette, 400 lpm

Note: A computer is not supplied as a standard system component — it must be ordered as a system accessory.

Accessories	Description
UniFlux 10 UV	Permeate UV sensor*
UniFlux 30 UV	Permeate UV sensor*
UniFlux 120 UV	Permeate UV sensor*
UniFlux 400 UV	Permeate UV sensor*
UniFlux 10 Transfer pump	Transfer pump, 2.3 lpm
UniFlux 30 Transfer pump	Transfer pump, 19 lpm
UniFlux 120 Transfer pump	Transfer pump, 19 lpm
UniFlux 400 Transfer pump	Transfer pump, 60 lpm
UniFlux 10 Permeate control pump	Permeate control pump, 2.3 lpm
UniFlux 30 Permeate control pump	Permeate control pump, 19 lpm
UniFlux 120 Permeate control pump	Permeate control pump, 19 lpm
UniFlux 400 Permeate control pump	Permeate control pump, 60 lpm
UniFlux 10 Conversion Kit, Cass to HF	Kit for conversion from cassette to hollow fiber system
UniFlux 30 Conversion Kit, Cass to HF	Kit for conversion from cassette to hollow fiber system
UniFlux 120 Conversion Kit, Cass to HF	Kit for conversion from cassette to hollow fiber system
UniFlux 400 Conversion Kit, Cass to HF	Kit for conversion from cassette to hollow fiber system
UniFlux 30 Conversion Kit, HF to Cass fiber	Kit for conversion from hollow to cassette system
UniFlux 120 Conversion Kit, HF to Cass fiber	Kit for conversion from hollow to cassette system
UniFlux 400 Conversion Kit, HF to Cass fiber	Kit for conversion from hollow to cassette system
UniFlux 30 Spool kit 35	Spool piece kit for size 35 hollow fiber cartridge
UniFlux 30 Spool kit 75	Spool piece kit for size 75 hollow fiber cartridge
UniFlux 120 Spool kit 35	Spool piece kit for size 35 hollow fiber cartridge
UniFlux 120 Spool kit 75	Spool piece kit for size 75 hollow fiber cartridge

* Can only be purchased together with system.

UniFlux systems utilize UNICORN for monitoring and logging process parameters during operation. UniFlux is available in four sizes (10, 30, 120, and 400 lpm) for processing batches from 50 to 10 000 liters or more.



Fig 40. UniFlux filtration system

Table 78. UniFlux automated membrane separations systems

System performance					
Hollow fiber membranes					
System size		10 lpm	30 lpm	120 lpm	400 lpm
No. of cartridges		1	1	2	Up to 4
Min/Max area	ft ²	1.3/5.2	3.9/65	19.8/130	108/560
	m ²	0.12/0.48	0.36/6	1.8/12	10/52
Cartridge size		5 or 6	35, 55 or 75	35, 55 or 75	45, 65 or 85
Lumen diameter		Consult your Cytiva representative for application specific information.			
Cassette membranes					
No. cassette holders		1	1	2	6
Min/Max cassettes		1/5 Kwick Lab™	1/10 Kwick Flow™	2/20 Kwick Flow	6/60 Kwick Flow
Min/Max area	ft ²	1.2/6	5/50	10/100	30/300
	m ²	0.11/0.55	0.46/4.6	0.92/9.2	2.76/27.6
System specifications					
Max recirculation flow rate		10 lpm @ 4 Bar	60 lpm @ 4 Bar	120 lpm @ 4 Bar	400 lpm @ 4 Bar
Min recirculation flow rate		0.5 lpm @ 4 Bar	3 lpm @ 4 Bar	12 lpm @ 4 Bar	40 lpm @ 4 Bar
Feed connection (TC size)		¾" (TC25)	1" (TC50)	1 ½" (TC50)	3" (TC91)
Retentate connection (TC size)		¾" (TC25)	1" (TC50)	1 ½" (TC50)	2" (TC64)
Permeate connection (TC size)		⅜" (TC25)	½" (TC25)	¾" (TC25)	1" (TC50)
Jacketed feed tank capacity	liter	5	N/A	N/A	N/A
System dimensions (W × L × H)		mm	1010 × 880 × 1770*	880 × 1500 × 1800*	880 × 1650 × 1850*
Cassette membrane cart dimensions (W × L × H)		mm	N/A	N/A	920 × 1410 × 1820

* If transfer pump or permeate control pump is used system length will increase by up to 300 mm.

11

Parts and accessories

Introduction

Many types of adaptors, fittings, and accessories are offered by Cytiva to help maximize the ease of use and effectiveness of our hollow fiber membrane cartridges and systems. These parts include several components with fractional Tri-Clamp end fittings for connection to size 3M, 3X2M, 4M, and 4X2M cartridges, as well as our QuixStand systems.

For flexible tubing connection to either the fractional Tri-Clamp or the standard 1.5 in Tri-Clamp fittings on feed, retentate, and permeate ports, we provide a number of kits complete with adaptors, gaskets, clamps, and blank-off caps for cartridge storage.

The following tables and figures detail adaptors, fittings, adaptor kits, clamps, gaskets and o-rings, tubing, valves, pressure indicators, and pumps that support our cartridges and systems.

Table 79. Cartridge adaptors and fittings

Adaptors and fittings		
Code Number	Model Number	Description
56410575	RBFL-1	Female Luer-Lok to 1/8 in barbed adaptor, nylon, pack of 10
56410576	RBFL-2	Female Luer-Lok to 0.09375 in barbed adaptor, nylon, pack of 10
56410577	RBFL-ML	Female Luer-Lok to Male Luer-Lok adaptor, nylon, pack of 10
56410578	RBFL-SC	Female Luer-Lok to solid cap adaptor, nylon, pack of 10
56411157	RBFL-FL	Female Luer-Lok to Female Luer-Lok adaptor, polycarbonate, pack of 10
56410979	KRB4-2PS	0.5 in TC to 0.25 in tubing adaptor, polysulfone, pack of 2
56410980	KRB4-3PS	0.5 in TC to 0.375 in barbed adaptor, polysulfone, pack of 2
56410981	KRB4-4PS	0.5 in TC to 0.5 in barbed adaptor, polysulfone, pack of 2
56410982	KRB4-6PS	0.5 in TC to 0.75 in barbed adaptor, polysulfone, pack of 2
11000529	KRB4-MLPC	0.5 in TC to male Luer-Lok adaptor, polycarbonate and polysulfone, pack of 2
56410703	EL4-4PS	0.5 in TC elbow, polysulfone
56410704	T4-4PS	0.5 in TC tee fitting, polysulfone
56410706	T4M-L-2PS	0.5 in TC to 0.25 in tubing adaptor-male Luer-Lok tee
56410932	RB12-4MPS-EL	1.5 in TC to 0.5 in TC elbow adaptor, polysulfone
56410984	KRB12-4MPS	1.5 in TC to 0.5 in TC adaptor, polysulfone, pack of 2
56410985	KRB12-3PS	1.5 in TC to 0.375 in barbed adaptor, polysulfone, pack of 2
56410986	KRB12-4PS	1.5 in TC to 0.5 in barbed adaptor, polysulfone, pack of 2
56410987	KRB12-6PS	1.5 in TC to 0.75 in barbed adaptor, polysulfone, pack of 2
56410716	RB12-10MNPTK	1.5 in TC to 1.25 in male NPT adaptor, PVDF and polysulfone
56410988	KRB12-MLPC	1.5 in TC to male Luer-Lok adaptor, polycarbonate and polysulfone, pack of 2
56410724	RB32-12PS-CV	“R” end fitting to 1.5 in TC adaptor, polysulfone, sweep
56410725	RB32-12PS-ST	“R” end fitting to 1.5 in TC adaptor, polysulfone, straight

Table 80. Adaptor kits

Adaptor kits with stainless steel clamps

Code Number	Model Number	Description
56410729	KA4-3PS	0.5 in TC to 0.375 in tubing adaptor kit. Contains 2 RB4-3PS polysulfone adaptors, 2 FB4PS polysulfone blank-off caps, 2 G4S silicone gaskets, and 2 CL4 304 SS clamps.
56410731	KA12-3PS	1.5 in TC to 0.375 in tubing adaptor kit. Contains 2 RB12-3PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets, and 2 CL12-LT 304 SS clamps.
56410732	KA12-4PS	1.5 in TC to 0.5 in tubing adaptor kit. Contains 2 RB12-4PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets, and 2 CL12-LT 304 SS clamps.
56410733	KA12-6PS	1.5 in TC to 0.75 in tubing adaptor kit. Contains 2 RB12-6PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets, and 2 CL12-LT 304 SS clamps.

Adaptor kits with nylon clamps

Code Number	Model Number	Description
56410916	KA4-2PS-NY	0.5 in TC to 0.25 in tubing adaptor kit. Contains 2 RB4-2PS polysulfone adaptors, 2 FB4PS polysulfone blank-off caps, 2 G4S silicone gaskets, and 2 CL4-NY nylon clamps.
56410730	KA4-3PS-NY	0.5 in TC to 0.375 in tubing adaptor kit. Contains 2 RB4-3PS polysulfone adaptors, 2 FB4PS polysulfone blank-off caps, 2 G4S silicone gaskets, and 2 CL4-NY nylon clamps.
56410734	KA12-3PS-NY	1.5 in TC to 0.375 in tubing adaptor kit. Contains 2 RB12-3PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets, and 2 CL12-NY nylon clamps.
56410735	KA12-4PS-NY	1.5 in TC to 0.5 in tubing adaptor kit. Contains 2 RB12-4PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets, and 2 CL12-NY nylon clamps.
56410736	KA12-6PS-NY	1.5 in TC to 0.75 in tubing adaptor kit. Contains 2 RB12-6PS polysulfone adaptors, 2 FB12PS polysulfone blank-off caps, 2 G12S silicone gaskets, and 2 CL12-NY nylon clamps.

Table 81. Cartridge blank-off caps

Code Number	Model Number	Description
56410989	KFB4PS	0.5 in TC blank-off cap, polysulfone, pack of 2
56410990	KFB12PS	1.5 in TC blank-off cap, polysulfone, pack of 2
56410992	KFB16K	2 in TC blank-off cap, PVDF, pack of 2

Table 82. Clamps

Code Number	Model Number	Description
56410665	CL4	0.5 in TC quick disconnect clamp, 304 SS
56410666	CL4-NY	0.5 in TC quick disconnect clamp, nylon
56410667	CL12	1.5 in TC quick disconnect clamp, 304 SS
56410668	CL12-NY	1.5 in TC quick disconnect clamp, nylon
56410669	CL12-LT	1.5 in TC toggle clamp, 304 SS
56410670	CL16-LT	2 in TC toggle clamp, 304 SS
56410671	CL24	3 in TC [schedule 5 pipe] quick disconnect clamp, 304 SS
56410672	CL32	“R” end fitting clamp, 301 SS
56410673	CL32TC	MSM 4 in TC [schedule 5 pipe] clamp, 304 SS
56410674	CL48	6 in TC [schedule 5 pipe] clamp, 304 SS

Table 83. Gaskets and O-rings

Code Number	Model Number	Description
56410994	KG4S	0.5 in TC gasket, silicone, pack of 4
56410995	KG6S	0.75 in TC gasket, silicone, for use with 0.75 in pressure gauges and pressure switch, pack of 4
56410996	KG12S	1.5 in TC gasket, silicone, pack of 4
56410997	KG12B	1.5 in TC gasket, Buna-N, pack of 4
56410998	KG16S	2 in TC gasket, silicone, pack of 4
11000524	KG16B	2 in TC gasket, Buna-N, pack of 4
11000525	KG24S	3 in TC gasket, silicone, pack of 4
11000526	KG32E	Retrofit TC gasket, EPDM, pack of 4
56410685	KG32B	Retrofit TC gasket, Buna-N, pack of 6 (2 each of 3 thicknesses)
56410683	KG32S	Retrofit TC gasket, silicone, pack of 6 (2 each of 3 thicknesses)
11000527	KG32TCS	4 in TC gasket, silicone, pack of 4
11000528	KG48S	6 in TC gasket, silicone, pack of 4
56410689	K02ORE	STM o-ring set, EPDM, pack of 8
56410690	K02ORS	STM o-ring set, silicone, pack of 8
56410691	K03ORS	SMO o-ring set, silicone, pack of 4
56410692	K04ORS	MaxCell o-ring set, silicone, pack of 2
56410693	K04ORB	MaxCell o-ring set, Buna-N, pack of 2
56410697	K04ORE	MaxCell o-ring set, EPDM, pack of 2
56410694	K05ORE	MSM o-ring set, EPDM, pack of 4
56410695	K05ORS	MSM o-ring set, silicone, pack of 4
56410696	K06ORS	ProCell o-ring set, silicone, pack of 2
56410977	K06ORV	ProCell o-ring set, Viton, pack of 2

Table 84. MaxCell accessories

Code Number	Model Number	Description
56410737	KAMX-16PS	Straight adaptor kit for new installation. Kit contains 2 polysulfone RBMX-16PS-ST straight adaptors, 2 polysulfone cartridge end nuts, and 2 silicone o-rings.
56410738	KAMX-16EL-PS	Elbow adaptor kit for new installation. Kit contains 2 polysulfone RBMX-16PS-EL elbow adaptors, 2 polysulfone cartridge end nuts, and 2 silicone o-rings.
56410670	CL16-LT	2 in TC toggle clamp, 304 SS
56410692	K04ORS	MaxCell o-ring set, silicone, pack of 2
56410693	K04ORB	MaxCell o-ring set, Buna-N, pack of 2
56410697	K04ORE	MaxCell o-ring set, EPDM, pack of 2
56410739	SWR-MX01	MaxCell wrench set, standard
56410740	SWR-MX02	MaxCell wrench set, applied torque

Table 85. Pressure and temperature indicators

Code Number	Model Number	Description
56410597	PG-01NX04T-30	Pressure gauge, 0–2 barg (0–30 psig), 0.125 in NPT, with adaptor to 0.5 in TC fitting, bottom mount
56410598	PG-01NX04T-60	Pressure gauge, 0–4 barg (0–60 psig), 0.125 in NPT, with adaptor to 0.5 in TC fitting, bottom mount
56410599	PG-06T-30	Pressure gauge, 0–2 barg (0–30 psig), 0.75 in TC, bottom mount, non-autoclavable
56410600	PG-06T-30S	Pressure gauge, 0–2 barg (0–30 psig), 0.75 in TC, side mount, non-autoclavable
56410601	PG-06T-60	Pressure gauge, 0–4 barg (0–60 psig), 0.75 in TC, bottom mount, non-autoclavable
56410602	PG-06T-60S	Pressure gauge, 0–4 barg (0–60 psig), 0.75 in TC, side mount, non-autoclavable
56410603	PG-TCP30	Pressure gauge, 0–2 barg (0–30 psig), 1.5 in TC, mechanically dampened, back mount, autoclavable
56410931	PG-TCP30B	Pressure gauge, 0–2 barg (0–30 psig), 1.5 in TC, mechanically dampened, bottom mount, autoclavable
56410604	PG-TCP60	Pressure gauge, 0–4 barg (0–60 psig), 1.5 in TC, mechanically dampened, back mount, autoclavable
56410605	PG-TCP60S	Pressure gauge, 0–4 barg (0–60 psig), 1.5 in TC, mechanically dampened, side mount, autoclavable
56410606	PG-TCV30P30	Vacuum/pressure gauge, –1 to 2 barg (–30 in Hg to 30 psig), mechanically dampened, back mount, autoclavable
56410609	KPG-NPT30T	Pressure gauge kit, 0–2 barg (0–30 psig), 0.25 in NPT, fitted on nylon tee, 9 mm (0.375 in) barb connections
56410611	PRT-DPM-3T	Digital panel meter includes: panel readout for inlet, outlet, and permeate pressures (psig), and temperature (°C), includes three pressure transducers, one thermocouple, and power cord. 110 VAC/60 Hz
56411025	PRT-DPM-3T/50	Same as PRT-DPM-3T but pressure displayed in barg. 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56410614	PT-109-01	Replacement pressure transducer, requires calibration
56410615	PT-109-02	Replacement pressure transducer, requires calibration, pack of 2
56411005	TC-1308-01	Replacement thermocouple, type J
56410947	PC01-CH	Power cord, China
56410948	PC02-EU	Power cord, Europe
56410949	PC03-IN	Power cord, India
56410950	PC04-UK	Power cord, United Kingdom

Table 86. Valves

Code Number	Model Number	Description
56410588	VT-06	Tubing valve, size 14 and 16 tubing, nylon
56410589	VT-09	Tubing valve, size 17 tubing, nylon
56410590	VPC4	0.5 in TC drain/vent valve, 316L SS
56410592	VDM-6SS	Diaphragm valve, 0.75 in TC, 316L SS
56410593	VDM-12SS	Diaphragm valve, 1.5 in TC, 316L SS

Table 87. Pumps

Code Number	Model Number	Description
11000566	PRP-03MF	Peristaltic recirculation pump, Masterflex single head, flow rate up to 13 lpm. Includes: variable-speed drive and manual control system, Easy-Load pump head, pump tubing
11000567	PRP-03MF/50	Same as PRP-03MF; 220 VAC/50 Hz. Power cord must be ordered separately, see below.
56410653	PRP-09WM	Peristaltic recirculation pump, Watson-Marlow (up to 1.4 lpm with size 17 tubing, and up to 2.0 lpm with size 18 tubing). Includes: variable speed drive and manual control system, flip-top pump head, pump tubing; 110 VAC/60 Hz, 220 VAC/50 Hz (dual voltage). For 220 VAC/50 Hz operation, power cord must be ordered separately, see below.
56410947	PC01-CH	Power cord, China
56410948	PC02-EU	Power cord, Europe
56410949	PC03-IN	Power cord, India
56410950	PC04-UK	Power cord, United Kingdom

Trademarks

Trademarks held by Cytiva

- ÄKTAcrossflow™ automated cross flow filtration systems
- BioProcess™ chromatography systems
- Kvick™ Start cassettes
- MaxCell™ cross flow membrane cartridges
- MidGee™ cross flow membrane cartridges
- MidGee Hoop™ cross flow membrane cartridges
- ProCell™ cross flow membrane cartridges
- UNICORN™ control software
- UniFlux™ membrane separations systems

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- Snapper™ is a registered trademark of Tyton Corporation.
- Tri-Clamp™ is a registered trademark of Tri-Clover/Alfa Laval.
- Tygon™ is a registered trademark of Saint-Gobain Performance Plastics (Norton).

Glossary of terms

Adsorption

The binding of molecules to a surface as a result of a chemical or physio-electric interaction between the membrane surface and the molecule.

Air diffusion rate

The rate at which air diffuses through the wetted pores of a membrane at a given differential pressure. Measuring the air diffusion rate is a method used to check the integrity of a membrane filter.

Asymmetric membrane

A membrane that is made such that the pore size increases through the membrane matrix.

Autoclave, autoclavability

An autoclave is a device that uses saturated steam at a specified pressure over time to kill microorganisms and thus achieve sanitization or sterilization. Because many materials change properties when exposed to moisture, heat, and pressure, products destined for this process must be specially engineered for autoclavability. A sterilizing grade air filter is required to maintain sterility during air inrush after autoclaving.

Back flushing, backwash

Reversing the permeate flow to mechanically clean the membrane.

Binding

The process by which some components in a feed solution adhere to the membrane. Binding can be desirable in some instances, but often, as in the case of protein, can result in a loss of valuable product.

Biosafety tests

A class of tests that determine whether a filter’s materials of construction can induce systemic toxicity, skin irritation, sensitization reaction, or other biological responses. These tests are often completed by labs *in vivo* or *in vitro*. For example, the United States Pharmacopoeia XXVII Class VI Plastics Test involves both the implantation and extraction of drug product contact surfaces to demonstrate that these materials are not toxic to various mammalian cells.

Blinded

When a filter is “blinded”, it means that particles have filled the pores, and the flow through the filter from the feed side to the permeate side is reduced or stopped.

Bubble point

The minimum pressure required to overcome the capillary forces and surface tension of a liquid in a fully wetted membrane filter. The bubble point value is determined by observing when bubbles first begin to emerge on the permeate side or downstream side of a fully wetted membrane filter when pressurized with a gas on the feed (upstream) side of the membrane filter.

Bubble point test

The test procedure for determining the bubble point of the largest pores in a microfiltration membrane.

Buffer exchange

Filtration process used for the exchange of smaller ionic solutes, whereby the feed solution is washed, usually repeatedly, and one buffer is removed and replaced with an alternative buffer.

Cartridge or cartridge filter

A filtration or separations device having a membrane encapsulated within a housing. The housing normally has feed and permeate ports and, in the case of cross flow filters, a retentate port. All of these ports may be used to control the flow parameters of fluid into and out of the housing and through the membrane.

Cassette

A device used for cross flow filtration, typically in a rectangular form, comprised of stacked flat sheets of membrane integrally bonded together. Most cassettes are typically designed to fit into a standard cassette holder where the feed, permeate, and any retentate ports mate with appropriate fittings on the cassette holders.

Cell harvesting

The process of concentrating (dewatering) the cell mass after fermentation. Cell slurries in excess of 70% wet cell weight are achievable. The cells may also be washed to prepare them for further processing, such as freezing or lysing. Unlike clarification processing, with cell harvesting, the cells are the target material.

Channel height

The path height that the feed/retentate solution must pass through in a flat sheet membrane cassette.

Channel length

The total length that the feed solution must travel along a cross flow membrane filter to reach the retentate outlet. See Flowpath length.

Chemical compatibility

The ability of the components of a filter to resist chemicals that can influence the filter’s performance. For example, some chemicals could cause the filter to shed particles, swell, or dissolve filter components. Repeatable performance requires that filters are resistant to all the chemicals that they are exposed to at a given concentration, temperature, and total exposure time.

Clean-in-place, (CIP)

The process of cleaning a filtration device without removing it from its filtration system.

Composite membrane

A membrane that is made up of two or more layers that are usually chemically or structurally different.

Concentrate

Also called **retentate**. The part of the process solution that does not pass through a cross flow membrane filter.

Concentration

Cross flow filtration process in which the components that do not pass through the membrane remain in the feed loop and therefore increase in concentration as filtrate leaves the system.

Concentration factor

The concentration factor equals the ratio of the initial feed volume to retentate volume after separation. For example, if the initial feed volume is 100 liters and the final retentate volume is 20 liters, the concentration factor is 5×

Concentration polarization

The buildup of molecules of dissolved substances (solutes) on the surface of the membrane filter during filtration. The concentration polarization layer increases resistance to filtrate flow and reduces the permeate flux rate, thus decreasing filtration efficiency.

Cross flow filtration

Also called **tangential flow filtration**. In cross flow filtration, the feed solution flows parallel to the surface of the membrane. Driven by pressure, some of the feed solution passes through the membrane filter. Most of the solution is circulated back to the feed tank. The movement of the feed solution across the membrane surface helps to remove the buildup of materials on the surface. By contrast, in direct (normal) flow filters, the liquid flows perpendicular to the filter surface, and all the feed passes through the filter.

Cross flow rate

Also called **retentate flow rate**. The flow rate of solution that remains in the feed loop as measured in the retentate line.

Cutoff

See Molecular weight cutoff (MWCO) and nominal molecular weight cutoff (NMWC).

Dead-ended filtration

Also called **normal flow filtration**. In dead-ended filtration, liquid flows perpendicular to the filtration media, and all of the feed passes through.

Depth filter

A thick filter that captures contaminants within its pore structure using entrapment and adsorption.

Depyrogenate

The removal or decomposition of pyrogens (lipopolysaccharides, endotoxins) from a process solution.

Diafiltration

Diafiltration is a unit operation that incorporates ultrafiltration membranes to remove salts or other microsolute from a solution. Small molecules are separated from a solution while retaining larger molecules in the retentate. Microsolute are generally so easily washed through the membrane that, for a fully permeated species, about three volumes of diafiltration solution will eliminate 95% to 99% of the microsolute.

Dialysis

Removal of small molecules from a solution of macromolecules by allowing them to diffuse through a semipermeable membrane into water or a buffer solution. This pressure separations method is controlled by the concentration gradient of salts across the membrane.

Differential pressure

In cross flow filtration, the pressure drop along the membrane between the feed (inlet) port and the retentate (outlet) port.

Diffusion

Movement of gas molecules caused by a concentration gradient.

Direct flow filtration

Filtration process where the entire feed stream flows through the filter’s media. Also called normal flow filtration or dead-ended filtration.

Downstream processing

Starting with a feed stream free of cells and cell debris, the purification sequences involving chromatography and membrane separations to achieve final product purity.

Effective area, effective filtration area, EFA

In a membrane separations device, the active area of the membrane exposed to flow. It represents the area available for filtration, not the total area of material used to make the filter, some of which is occluded by seals, joints, and so on.

Endotoxin

The outer cell wall of gram-negative bacteria, also known as lipopolysaccharides (LPS) and pyrogens.

Extractables

Substances that may dissolve or leach from a membrane device during filtration and contaminate the process solution. For example, the leachates might include wetting agents in the membrane, membrane cleaning solutions, or substances from the materials used to encase the membrane.

Feed

Material or solution that is introduced into a membrane separations system.

Feed pressure

The pressure measured at the inlet port of a separations device, such as a hollow fiber cartridge or membrane cassette holder.

Filter area

The surface area of filter media inside a separations device.

Filter efficiency

Filter efficiency represents the percentage of a given size particle removed from the fluid by the filter.

Filtrate

Also called **permeate** or **effluent**. The portion of the process fluid that passes through the membrane.

Flowpath length, nominal flowpath length

The total length that a feed solution travels from inlet to outlet. Flowpath length is an important parameter to consider when doing any process development, system design, or scale-up or scale-down experiments. The flowpath length and other fluid channel geometries, such as lumen diameter or channel height, can affect the fluid dynamics of the system and will directly affect pump requirements and differential pressure of the filtration step.

Flux

Flux represents the volume of solution flowing through a given membrane area during a given time. Expressed as lmh (liters per square meter per hour).

Fouling

A buildup of material on the membrane surface that reduces the filtration rate. This material is not redeposited in the bulk stream by higher shear rates.

Fractionation

Separation of molecules in a solution based on differences in the molecular weight of the molecules.

Gamma sterilization

A type of sterilization process accomplished by bombarding the object to be sterilized with electron beam, x-ray, ⁶⁰Co or ¹³⁷Cs irradiators. All generate forms of gamma rays, radiant energy at short wavelength (0.1 nm or less). The governing standard is ISO 11137 — Sterilization of Healthcare Products — Requirements for Validation and Routine Control — Radiation Sterilization. Because some product materials can be adversely affected by gamma radiation, objects destined for gamma sterilization must be engineered specifically for this process.

Gel layer

During the filtration process, the thin layer of particles or molecules that may build up at the membrane surface. It is also referred to as the **concentration polarization layer**. Higher TMP can be the result of an increase in the thickness of the gel layer. Gel layer formation can negatively impact the filtration process by reducing flux and inhibiting passage through the membrane. Operating at a higher shear rate may reduce the thickness of the gel layer.

Holdup volume

Quantity of fluid remaining within the system after the filtration step is complete.

Hollow fiber

A tubular structure made from a membrane and sealed inside a cross flow cartridge. When in use, the feed stream flows into the inner diameter of one end of the hollow fiber and the **retentate** (the material that does not permeate through the walls of the hollow fiber) flows out the other end. The material that passes through the membrane (walls of the hollow fiber) is called the **permeate**.

Housing

A mechanical structure that surrounds and supports the membrane or filter element. The housing normally has feed, retentate, and permeate ports that direct the flow of process fluids into and out of the filter assembly.

Hydrophilic

Filters that wet out easily with water and work well with aqueous solutions.

Hydrophobic

Filters that do not wet out easily with water but typically do wet out easily with nonpolar solvents such as alcohol. Once wetted, many aqueous solutions can be processed in a hydrophobic filter.

In vitro

An experiment performed in a test tube, Petri dish, or other lab apparatus with parts of a living organism, such as testing a drug with tissue samples. From Latin, meaning “in glass.”

In vivo

An experiment performed using a living organism. From Latin, meaning “in live [subjects].”

Inlet pressure

The pressure of a fluid at the feed port of a separations device.

Isoelectric point

The pH at which a protein carries no electric charge.

Lumen

The inner, open space of a hollow fiber.

Macrovoid

A generally undesirable open space in the substructure of a membrane filter that is appreciably larger than the average pore size. Macrovoids can lead to pinhole defects resulting in unwanted passage that directly affects final product yield. Macrovoids can also affect the overall membrane strength and thus the device’s ability to maintain integrity under pressure.

Media exchange

A filtration step used to exchange one type of media for an alternative type of media during an aseptic cell culture separation.

Membrane

A thin layer of a highly engineered material with controlled pore size used to separate particulates, biological matter, and molecules from a solution.

Membrane recovery

The degree to which the original performance of a membrane can be restored by cleaning.

Microfiltration

The process of removing particles from a liquid by passing it through a porous membrane under pressure. Microfiltration usually refers to removing submicron-size particles.

Micron (micrometer, μm)

One one-millionth of one meter. The average human eye can discern particles down to ~ 40 μm.

Microporous membrane

A thin, porous film or hollow fiber having pores ranging from 0.1 to 10 μm. Cross flow microfilters typically range from 0.1 to 1 μm.

Minimum process volume

The least amount of fluid able to be handled effectively by a filtration system.

Molecular weight

Mass of one molecule of a nonionic substance in atomic mass units.

Molecular weight cutoff, (MWCO)

The size designation in Daltons (Da) for ultrafiltration membranes. Typically measured as the molecular weight of a globular protein that is 90% retained by the membrane. No industry standard exists; hence the MWCO ratings of different manufacturers are not always comparable.

Nanofiltration

Separations processes targeted for solutes having molecular weights from 500 to 1000 Da. See Molecular weight cut off (MWCO).

Nominal filter rating

A rating that indicates the percentage of particles of a specific size or molecules of a specific molecular weight that will be removed by a filter. No industry standard exists; hence the ratings from manufacturer to manufacturer are not always comparable.

Nominal molecular weight cutoff, (NMWC)

In ultrafiltration, the molecular weight size of a protein or other solute (in Daltons) that will be retained to 90% by the membrane. See Molecular weight cutoff.

Normal flow filtration

Also called **dead-ended filtration**. In normal flow filtration, liquid flows perpendicular to the filter media, and all of the feed passes through.

Normalized water permeability, (NWP)

The water flux temperature corrected to a standardized temperature.

Oleophobic

Membranes that repel nonpolar fluids, such as oil and lubricants.

Particle size distribution

The dispersion of particle sizes (number or weight fraction) in a fluid.

Permeate

Also called **filtrate**. The portion of a process fluid that passes through a membrane.

pH

Negative logarithm of the hydronium ion (H₃O⁺) concentration in an aqueous solution. Indicates the acidity or alkalinity of a substance.

Pleating

Folding flat sheet filter media to increase the surface area that can be fitted into a given separations device generally used in dead-ended filtration.

Pore size distribution

The range of pore sizes in a membrane. The tighter the pore size distribution, the better control one has over the filtration process.

Porosity

A measurement of the open space in a membrane. The higher the membrane porosity, the more pores there are, hence, a higher flow rate is anticipated.

Pressure drop

The difference in pressure between two points.

Protein passage

The channel of protein into the permeate stream. This could be the result of using too “open” a membrane pore structure; a mechanical failure in the cartridge; or degradation of the membrane over time due to chemical incompatibility.

Pyrogen

A substance that produces a fever within a warm-blooded animal when injected into the bloodstream. Filtration materials of construction that come in contact with injectable liquids must meet pyrogenicity standards and be non-pyrogenic.

Recovery

Percentage of the target substance that can be collected in the retentate or permeate solution after processing.

Retentate

The portion of the feed solution that does not pass through a cross flow membrane filter.

Retention

The ability of a separations device to retain an entity of a given size.

Reverse osmosis

Type of cross flow filtration used for removal of very small solutes (< 1000 Daltons) and salts. It uses a semipermeable membrane under high pressure to separate water from ionic materials. High pressure is necessary to overcome the natural osmotic pressure created by the concentration gradient across the membrane.

Sanitization

A cleaning process that destroys most living microorganisms.

Separation

Dividing a liquid or gas feed stream into separate components.

Shear rate

A ratio of velocity and distance expressed in units of sec⁻¹. The shear rate for a hollow fiber cartridge is based on the flow rate through the fiber lumen and can be calculated as follows:

$$r = (4 \cdot q) / \pi \cdot R^3$$

where:

r = shear rate, sec⁻¹
q = flow rate through the fiber lumen, cm³/sec
R = fiber radius, cm

Sieving

Removal of particulates from a feed stream as a result of entrapment within the depth of the membrane pore structure.

Size exclusion

Mechanism for removing particulates from a feed stream based strictly on the size of the particles. Retained particulates are held back because they are larger than the pore opening.

Solute

An ionic or organic compound dissolved in a solvent; for example, the sugar in a cup of coffee is a solute.

Starling flow

A portion of filtrate (permeate) that is driven back through the membrane in the reverse direction near the outlet of the cartridge, due to the high permeability of these membranes in the presence of permeate pressure. This phenomenon is most often associated with the operation of microfiltration membranes using permeate flow control.

Steam-in-place, (SIP)

The process of sterilizing a device, such as a hollow fiber cartridge, with steam, without removing the device from the separations system.

Sterilization

A process that removes/destroys all microorganisms from a solution or a filtration system. see Autoclave, Ethylene oxide (EtO) sterilization, Gamma sterilization.

Surface filter

A filter in which particles larger than the pores are retained on the surface of the filter.

Tangential flow filtration

See **cross flow filtration**. In tangential flow filtration, the feed solution flows parallel to the surface of the membrane. Driven by pressure, some of the feed solution passes through the membrane filter. Most of the solution is circulated back to the feed tank. The movement of the feed solution across the face of the membrane surface helps to remove the buildup of materials on the surface. In direct (normal) flow filters, the liquid flows perpendicular to the filter surface, and all the feed passes through the filter. Particles and solutes rejected in direct flow filtration are trapped in or on the pore structure of the filter.

Thermal stability

The ability of a membrane and filtering device to maintain its performance during and after exposure to excursions of temperature, such as the elevated temperatures experienced during autoclaving or steam sterilization.

Throughput

(1) The volume of solution that will pass through a separations device before the filtrate output drops to an unacceptable level.

(2) The rate at which a separations system will generate filtrate. In a business sense, throughput can be a constraint on the rate at which product is made available for sale.

Titer reduction

The measurement of a filter’s ability to remove microbes or virus from a fluid.

Transmembrane pressure, (TMP)

The force that drives liquid through a cross flow membrane. During filtration, the feed side of the membrane is under higher pressure than the permeate side.

$$TMP = \frac{P_{in} - P_{out}}{2} - P_{perm}$$

where:

TMP = transmembrane pressure
P_{in} = membrane inlet pressure
P_{out} = membrane outlet pressure
P_{perm} = membrane permeate pressure

Tubule

Tube-like structure (larger i.d. fibers than hollow fibers) made from ultrafiltration or microfiltration membrane and sealed inside a cross flow cartridge. When in use, the feed stream flows into one end of the tubule and the retentate (the material that does not permeate through the walls of the tubule) flows out the other end. The material that does flow through the membrane (walls of the tubule) is called the permeate.

Turbidity

A measure of relative liquid clarity. Measurements are based on the amount of light transmitted in straight lines through a sample. The more light that is scattered by fine solids or colloids, the less clear (and more turbid) the solution. Often reported in nephelometric turbidity unit (NTU).

Ultrafiltration

The separation of macrosolutes based on their molecular weight or size.

Upstream

The feed side of a separations process.

Upstream processing

Cellular separations including: cell lysates, cell harvesting, clarification, and cell culture perfusion.

Viral clearance

The removal of viral contamination using specialized membranes or chromatography. To ensure that therapeutic drugs derived from certain sources are fully rid of any viral contamination, these protein solutions undergo viral clearance to inactivate or remove viral materials.

Viscosity

A measurement of a fluid's resistance to shear. A slow-flowing liquid such as gear oil, has a higher viscosity than a free-flowing liquid such as water. In a given separations process, higher-viscosity fluids are operated at a lower flow rate through a cartridge than lower viscosity fluids.

Void volume

The combined volume of all filter pores, interstices, passages, and the like. Indicates, in general, the solids or contaminant holding capacity of filter cartridges.

Water flux

Measurement of the amount of water that flows through a cartridge. Clean water flux refers to the flux measurement made under standardized conditions on a new (and cleaned) membrane cartridge. See Flux.

Yield

The amount of particulates or molecules of interest (product) that can be recovered from the cross flow filtration process; also referred to as **recovery**.

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