

Single-Pass Tangential Flow Filtration with Pellicon® Cassettes and Capsules

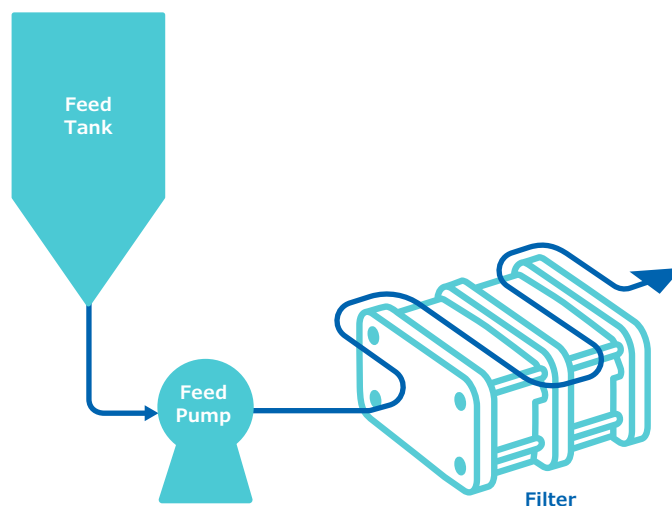
In-line concentration technology for process intensification

Single-pass tangential flow filtration (SPTFF) is an advanced mode of ultrafiltration that provides significant advantages for molecule concentration within biomanufacturing processes. Unlike traditional tangential flow filtration (TFF), where feed material circulates through the filtration devices multiple times, SPTFF operates by circulating the feed material through TFF devices arranged in series at much longer residence times. The feed material reaches the target concentration after a single pass through the devices, eliminating the recirculation loop, and reducing system hold-up volumes.

By integrating Pellicon® cassettes or capsules into systems specifically designed for SPTFF, optimal performance is achieved with higher final concentrations, enhanced product recovery and reduced intermediate step volumes. This proven technology enables intensified or continuous processing.

Benefits

- Facilitates process intensification by integrating in-line concentration steps into continuous processes.
- Ensures reliable performance with Pellicon® cassettes and capsules, offering various membrane options to best match your process requirements.
- Minimizes the potential for product degradation and improves product recovery.
- Reduces the overall system footprint and associated costs.



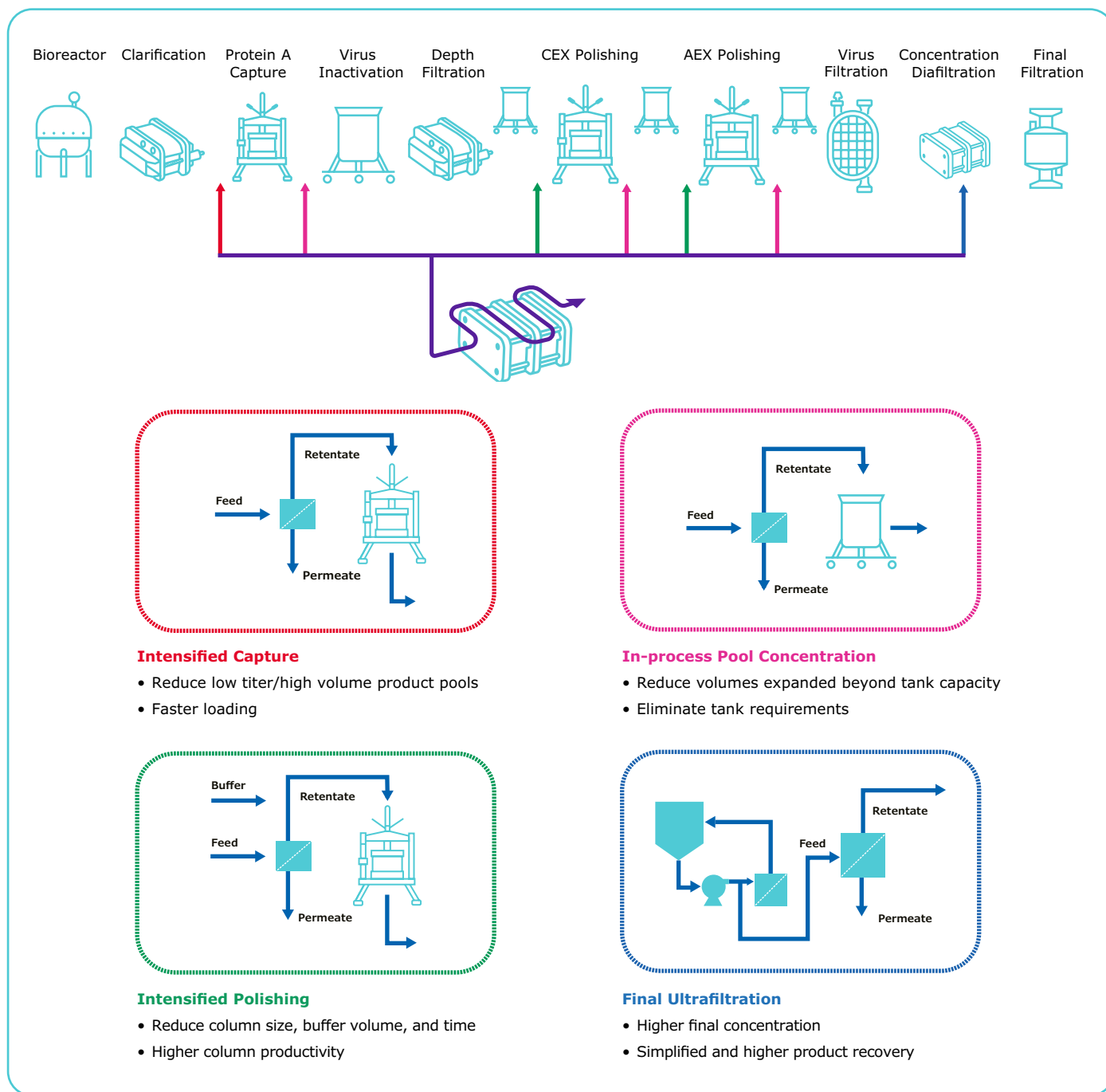
Ideal for ...

- Achieving high concentrations and high yields in a single step (e.g. final concentration step).
- In-line concentration and volume reduction for improved facility fit.
- Sensitive products that require gentle processing to minimize the risk of degradation during concentration.
- Seamless integration of concentration steps in intensified and continuous processes.

Versatile applicability for process intensification

SPTFF with Pellicon® capsules or cassettes is a convenient way to reduce fluid volumes, eliminate tank bottlenecks, minimize the footprint of purification columns, concentrate with in-line buffer addition for desalting, and enable high final product concentration with greatly improved recovery.

The small footprint of SPTFF facilitates the integration of in-line concentration steps anywhere within a biomanufacturing process where volume reduction is needed, including before or after column chromatography or at final concentration and formulation.



Reliable performance

Pellicon® Cassettes

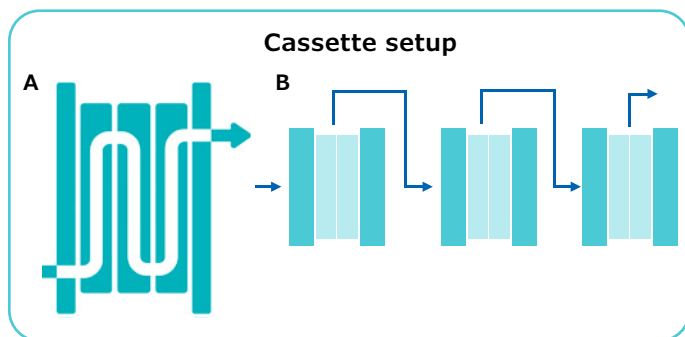
Our high performance Pellicon® 2 and 3 cassettes deliver high protein yield and consistent product purity and quality from run to run at every scale and for a variety of drug products. Pellicon® cassettes are designed for use in research, process scale-up/down, applications development, and commercial manufacturing. The materials of construction are compatible with a broad range of cleaning agents required for proper membrane regeneration with no product carryover after multiple cycles of reuse.

Pellicon® Capsules

Pellicon® Capsules are the ideal single-use TFF device and provide ease-of-use, process flexibility, rapid batch turnaround, reduced risks and easier validation. Our innovative capsules have a holderless design and are provided gamma sterilized and wetted with purified water for easy installation and reduced pre-use steps, making them especially suitable for SPTFF. The self-contained format of capsules makes it easier and safer to remove the entire flow path to reduce risks of operator exposure and product cross-contamination.

Easy installation and operation

SPTFF with Pellicon® cassettes and capsules operates at constant feed flow rates and retentate pressures for simpler operation and smaller pump requirements compared to batch TFF. The straight-through flow path lowers working volumes that limit concentration factors and reduces footprint for improved facility fit. Existing Pellicon® filters and accessories can easily be installed for single-pass operations. Pellicon® cassettes can be configured in single-pass mode by using same-sized diverter plates (A) or connecting standard holders in series (B). Pellicon® Capsules are easily connected from port to port, simplifying installation even further.



Fast, reliable scale-up/down from lab to production

Pellicon® 2 and 3 cassettes, available in several sizes, are designed to offer consistent performance at every scale for predictable and reliable scale-up. Furthermore, Pellicon® Capsules provide the same high performance and linear scalability as Pellicon® cassettes, making it easy to transition between either filter format. Small-scale experiments are simple to execute and analyze. With one simple trial, fast evaluation of optimum feed flow rate and number of sections over a wide range of conversion targets is possible. To scale up SPTFF, the feed flow rate and number of sections in series are simply maintained at values determined at bench scale.

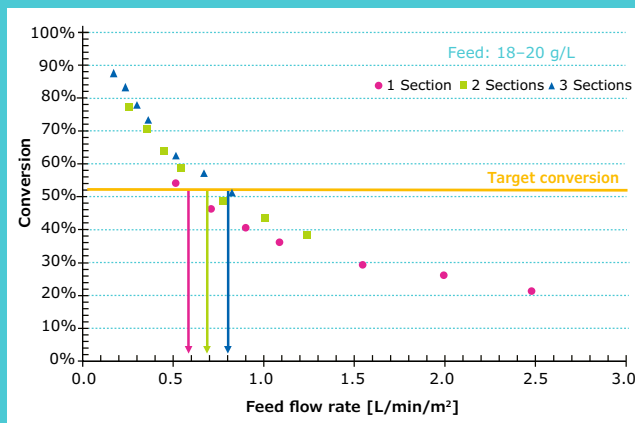
Small-scale evaluation and sizing

Small-scale experiments for SPTFF are performed with three identical Pellicon® 3 cassettes assembled in a Pellicon® mini holder with mini diverter plates (Pellicon® SPTFF mini kit).

The specially designed diverter plates enable the retentate from one cassette to serve as the feed for the next, generating a serial feed flow path through the filter assembly. This assembly allows the operator to simultaneously evaluate the conversion performance of one-, two-, and three-section processes in 4–6 hours of run time using 1–2 liters of feed material.

One user-configurable assembly for any conversion target

- Fast evaluation of optimum feed flow rate
- Precise selection of number of sections
- Easy scale-up, from lab to production



The required feed flow rate for a conversion target of 52% (—) is 0.6 L/min/m² for a one-section assembly (●), 0.7 L/min/m² for a two-section assembly (■), and 0.8 L/min/m² for a three-section assembly (▲).

Comprehensive choice of Pellicon® membranes to best match your process requirements

Our Pellicon® family of ultrafiltration products features devices with Ultracel® or Biomax® membranes in a wide range of surface areas and molecular weight cut-offs, and with several options of feed channel screens for optimal performance to suit different process challenges.

Our broad selection of tangential flow filters enables bench-to-process scale single-pass filtration of mAbs, recombinant proteins, plasma, albumin, hormones, growth factors, vaccines, and viruses.

Biomax® membranes

The high flux and high retention properties of Biomax® membranes result in faster processing with high yields. Composed of modified polyethersulfone (PES), Biomax® membranes are designed to reduce non-specific protein binding compared to conventional PES membranes. They are resistant to harsh chemicals used in cleaning, biological decontamination, and sanitization with no degradation of processing performance over multiple cleaning cycles.

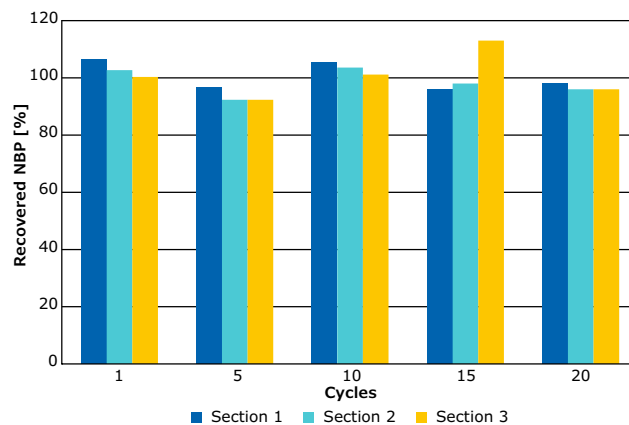
Ultracel® membranes

Ultracel® membranes are constructed of regenerated cellulose cast on a microporous substrate that creates a uniform structure with superior robustness compared to conventional membranes. Ultracel® membranes are used for processes that require low fouling and ultra-low protein binding capabilities and offer resistance to organic solvents together with excellent product retention, recovery, and yields.

Excellent cleanability

Pellicon® cassettes offer excellent cleanability, regardless of the cleaning strategy. Static cleaning, which does not require a recirculation loop, can be performed using typical cleaning agents and has been shown to maintain consistent cleaning efficiency across all membrane sections, even after multiple process runs and cleaning cycles (see below). For large-scale, multi-use applications, dynamic cleaning methods can also be employed to ensure thorough cleaning and optimal cassette performance.

Normalized buffer permeability (NBP) over 20 reuse cycles and static cleaning.



Pellicon® 3 cassettes with Ultracel® 30 kDa membrane

Setup components

To run SPTFF, longer residence times need to be achieved. The feed path length is thus increased and the feed flux to the modules is reduced. Pellicon® cassettes, in a traditional TFF holder, can be run in SPTFF mode simply by diverting the flow path in a serial configuration through sections of equal membrane area. This can be achieved by either serializing the feed flow through multiple holders or by installing diverter plates between each cassette in a holder to divert the feed path through the membranes.

This setup, combined with processing at a low flow rate under pressure, results in higher retentate concentration after one pass. For most applications, a 3-section (3 cassettes) assembly is sufficient and allows for easy evaluation of a range of concentration targets and quick optimization. The Pellicon® SPTFF mini kit is ideally suited for start-up trials with cassettes. Larger diverter plates are available for scale-up. For single-use applications, Pellicon® Capsules are connected from port to port using off-the-shelf components.

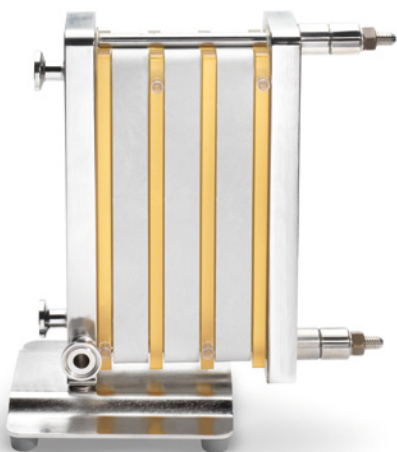


Pellicon® SPTFF mini diverter plate



Pellicon® SPTFF cassette diverter plate

Pellicon® SPTFF cassette retentate collection plate



Cassette lab-scale SPTFF setup



Cassette pilot-scale SPTFF setup

Using single-use technology for SPTFF

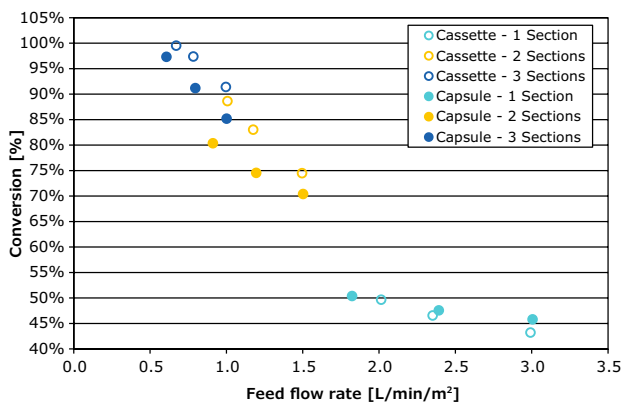
As more bioprocessing operations transition towards single-use implementation, there is a growing need for compatible purification technologies.

Pellicon® Capsules are ideally suited for SPTFF as no holder or diverter plates are required. The single-pass flow path is configured by simply connecting the capsules in series, typically using the “N” configuration where capsules are connected directly from port to port, retentate to feed.

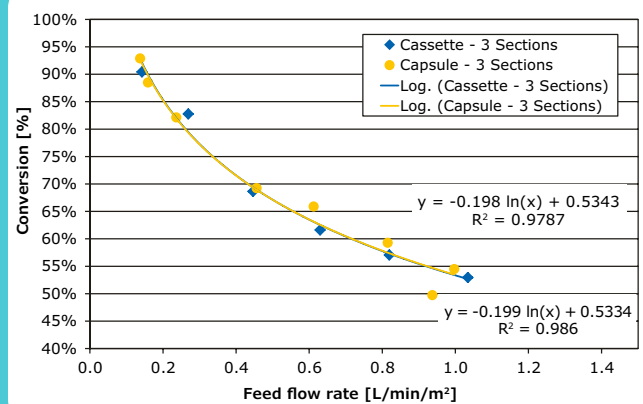
Pellicon® Capsules perform comparably to Pellicon® 3 cassettes, offering high conversions at both low and high feed concentrations.



Comparison of Pellicon® Capsule and Pellicon® 3 Cassette with Ultracel® membrane and C screen



Feed flux excursions, 1 g/L BgG.



Feed flux excursions, 25 g/L BgG (shown for 3 sections).

Systems for SPTFF

Our portfolio provides a comprehensive solution for both development and manufacturing scales of SPTFF operations. Together, Cogent® Lab Systems and Process Scale SPTFF Systems ensure optimal efficiency across all stages of your bioprocessing.

Cogent® Lab Systems

Efficient SPTFF process development and seamless scale-up are crucial for high productivity and cost-effectiveness. The Cogent® Lab System family mirrors manufacturing-scale equipment in design, sensing technologies, and accessories, ensuring a smooth transition from small- to large-scale production. Paired with Pellicon® cassettes and Capsules, these systems simplify SPTFF process development, with linear performance and intuitive software that reduces training needs. The Cogent® Lab 150, 800, and 6000 systems offer high product recovery, drainability, and precise conversion rate evaluation using weight scales in SPTFF mode. Their modular design supports diverse process needs while minimizing capital expenditure.



Process Scale SPTFF Systems

Our configurable process-scale SPTFF systems are designed for GMP environments, enabling intensified and continuous processing, reduced batch sizes, and enhanced productivity. Featuring TFF holders in series with isolation valves, they ensure optimized flow, pressure distribution, and single-pass processing without recirculation – ideal for continuous operations. The systems support filtration areas from 1.5 to 68.4 m² using Pellicon® cassettes and provide efficient cleaning with dynamic parallel membrane operation. Fully automated software ensures precise monitoring and adaptability. With optimized flow paths, slopes, and regulation valves, these systems maximize product recovery and simplify processes. Tailored solutions with dual pumps ensure efficient operation at low flow rates during production while supporting high flow rates for effective cleaning, making them robust for large scale SPTFF.



Global services and support

Application Support

Our skilled and experienced engineers provide comprehensive support to ensure optimized performance and rapid implementation of Pellicon® SPTFF anywhere in your process. With careful consideration of your specific process needs, our technical experts can help achieve the operational results you need throughout process development, scale-up, and production implementation.

System Services

To help you implement SPTFF in your process we offer a wide range of services to save you time, reduce costs, and comply with regulations. For your peace of mind, all our services are performed by our global experts, who possess a unique and intimate knowledge of our equipment, backed by decades of experience.

- Qualification Services
- Training Services
- System Service Reliance Plans
- Repair Services and Spare Parts

Single-use and Filter Validation Services

Our Validation Services help you manage process risks and align with global regulations to ensure patient safety. We offer deep expertise, proven methods, and robust scale-down models tested under worst-case conditions. Our dedicated team provides comprehensive project management and consultative support for Chemical Compatibility Studies, Extractables & Leachables assessments, and expert consultancy. Partner with us to implement reliable and compliant validation strategies.

Ordering Information

SPTFF Cassette Accessory	Cassette Size	Cat. No.
Pellicon® Single-Pass TFF Mini Kit (includes 4 diverter plates and 2 gaskets)	Pellicon® 3 88 cm ² and 0.11 m ² ; Pellicon® 2 0.1 m ²	XXSPTFF01
Pellicon® Single-Pass TFF Cassette Diverter Plate	Pellicon® 3 0.57 m ² and 1.14 m ² ; Pellicon® 2 0.5 m ²	XXSPTFF02
Pellicon® Single-Pass TFF Cassette Retentate Collection Plate	Pellicon® 3 0.57 m ² and 1.14 m ² ; Pellicon® 2 0.5 m ²	XXSPTFF03

Note: For large-scale installations, both XXSPTFF02 and XXSPTFF03 are used.

Cassette holders and adapter plates	Cassette Size	Cat. No.
Pellicon® MiniX holder	Pellicon® 3 88 cm ² and 0.11 m ² ; Pellicon® 2 0.1 m ²	XX42PMINIX
Pellicon® stainless steel holder	Pellicon® 3 0.57 m ² and 1.14 m ² ; Pellicon® 2 0.5 m ² and 2.5 m ²	XX42P0080
Pellicon® stainless steel holder and assembly	Pellicon® 3 0.57 m ² and 1.14 m ² ; Pellicon® 2 0.5 m ² and 2.5 m ²	XX42P0K80
Pellicon® 3 manifold adapter plate	Pellicon® 3 0.57 m ² and 1.14 m ²	XXPEL3MAP
Process scale holder	Pellicon® 3 0.57 m ² and 1.14 m ² ; Pellicon® 2 0.5 m ² and 2.5 m ²	On Request
Hydraulic process scale holder	Pellicon® 3 0.57 m ² and 1.14 m ² ; Pellicon® 2 0.5 m ² and 2.5 m ²	On Request

Capsule Accessory	Capsule Size	Cat. No.
Pellicon® Capsule Stand	Pellicon® Capsule 0.1 m ² and 0.5 m ²	PCX001

Systems	Flow range	Cat. No.
Cogent® Lab 150	20–150 mL/min	See datasheet DS8631 for recommended configurations for SPTFF
Cogent® Lab 800	100–800 mL/min	
Cogent® Lab 6000	400–6000 mL/min	
Multi-Use Process Scale SPTFF Systems	From 1.5 to 60 m ² using Pellicon® 2 cassettes and up to 68.4 m ² with Pellicon® 3 cassettes	On Request

Filters

All Pellicon® tangential flow filters must be purchased separately. See datasheets DS1324EN00, DS1209EN00 (Pellicon® 3), DS1210EN00 (Pellicon® 2), DS1285EN (Pellicon® Capsules) available at sigmaaldrich.com for ordering information.

Single-Pass TFF Accessories Specifications

Materials			
Accessory	Single-Pass TFF Mini Kit	Cassette Diverter Plate	Retentate Collection Plate
Materials of Construction	Mini diverter plate: Polysulfone	316 L stainless steel	316 L stainless steel
	Gasket: Silicone		
Maximum Operating Conditions			
Maximum Operating Pressure	40 psi (2.7 bar) at 50 °C, 80 psi (5.5 bar) at 40 °C		
Maximum Caustic Exposure	1.0N NaOH up to 50 hours		
Operating pH Range	2–13		
Regulatory Information			
Component Material Toxicity	Mini diverter plate component materials meet the criteria for Biological Reactivity Testing. These tests can be any or a combination of the following test methods: USP<88> Class VI (<i>in vivo</i>), USP<87> (<i>in vitro</i>), ISO 10993-5 (<i>in vitro</i>).		
FDA 21 CFR 177-1655	Mini diverter plate polysulfone component materials are aligned with 21 CFR 177-1655 specified conditions under which polysulfone resins may be safely used as articles or components of articles intended for use in contact with food.		

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For additional information, please visit SigmaAldrich.com/TFF-devices

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