

# Mobius® FlexReady Solution with Smart Flexware® Assemblies for Chromatography and TFF

For Purification of Clinical and  
Process Scale Biologics

The Mobius® FlexReady Solution with Smart Flexware® Assemblies is a flexible solution, allowing end user to have a single, scalable system for chromatography and tangential flow filtration at various scales.

The fully automated system is designed to achieve separation and purification of mAbs, vaccines, plasma and therapeutic proteins.

The Mobius® FlexReady Solution with Smart Flexware® Assemblies delivers optimal operational flexibility in a very simple and fast way. Thanks to our innovative single-use flow paths, contamination is no longer a threat, giving you the confidence you need to tackle any chromatography and TFF challenge.



## Features & Benefits

- **Flexibility**—Standard hardware platform supports multi-unit operation, multi-product and multi-scale production, maximizing the flexibility of high-value investments
- **100% single-use flowpath**—Smart Flexware® single-use assemblies provide ease-of-use, robust reproducibility and elimination of carryover from previous batches
- **Fully Automated**—Enables you to easily and consistently produce clinical- and preclinical-scale quantities of high-value drug products
- **Services**—Comprehensive range of services and support ensures rapid implementation and optimized performance
- **Ease of Use**—The system shares common elements, such as software, design, and maintenance components, with our other systems, making training and validation easier across scales and applications
- Supports **industry-leading resins and devices**, such as Fractogel® resin, Eshmuno® resin, and Pellicon® cassettes

## System Hardware

The Mobius® FlexReady Solution with Smart Flexware® assemblies covers multiple scales and applications, allowing production facilities to maximize the return on their investment.

### Smart Cart

The Smart Cart is the heart of the system, and houses the clamshell and automation software for all applications. Designed for maximum mobility, the system's Smart Cart does not exceed the standard height and width of a door. In addition, the system has been designed to allow a single technician to manage, maintain and switch applications via the use of accessories to lift and store application components.



### Clamshells, Lift and Storage Rack

This unique solution has already been widely adopted.

Valuable space and time are saved with the multiple size of clamshells for TFF and chromatography that can be installed on any Smart Cart.

A single operator can change application and/or scale in a matter of minutes.



## Common Control Platform® (CCP®) Software

The automation software (CCP®), allows central control of all pumps and valves on the Smart Cart and any connected carts. In addition, all application recipes can be edited and stored for different applications, reducing the need for multiple automation systems. Each aspect of your process can be monitored from the home screen, and the report generator quickly creates batch reports.

The software is designed for facilities operating under Good Manufacturing Practices, developed in line with GAMP® 5 recommendations for automation software, and fulfills FDA guideline 21 CFR Part 11 requirements for electronic records and signatures. Our CCP® Software provides one software platform across our portfolio of automated systems for a familiar look and feel at each step of your process, reducing training time for operators.

## Smart Flexware® Assemblies

The USP class VI and Animal-Free or EMA/410/01-compliant Smart Flexware® single-use assemblies deliver equivalent performance to that of traditional stainless steel systems, while maximizing system flexibility. Smart Flexware® assemblies are clearly labeled, significantly reducing the risk of operator error and the challenges typically associated with installing single-use flow paths. Our groundbreaking flow path eliminates moving parts and minimizes dead space, decreasing the risk of contamination to virtually zero.

### Benefits

- Gamma irradiated and ready to use, reducing set-up time
- Highly automated system increases robustness and consistency of production processes
- Reduced number of connections versus traditional single-use, reducing risk of integrity failure
- The main flow paths are 100% Integrity Tested during manufacturing, ensuring robust performance
- Reduced dead-legs maximize product purity and diafiltration efficiency
- No cleaning validation required

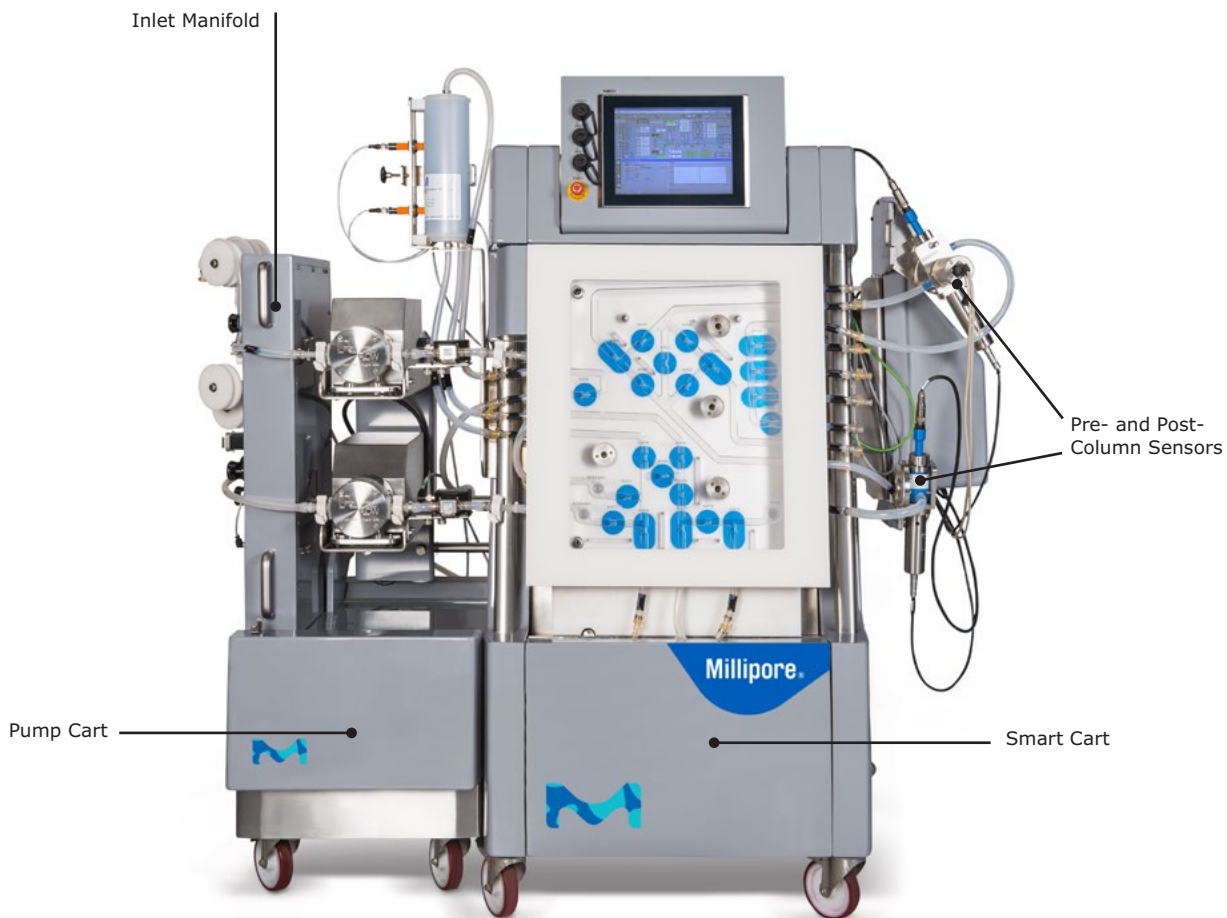
## Sensor Instrumentation

The system gives the option to choose between single- and multi-use sensors, for both pre-/post-column and TFF filtrate, without having to sacrifice performance in favor of reducing cleaning or risk of carryover.

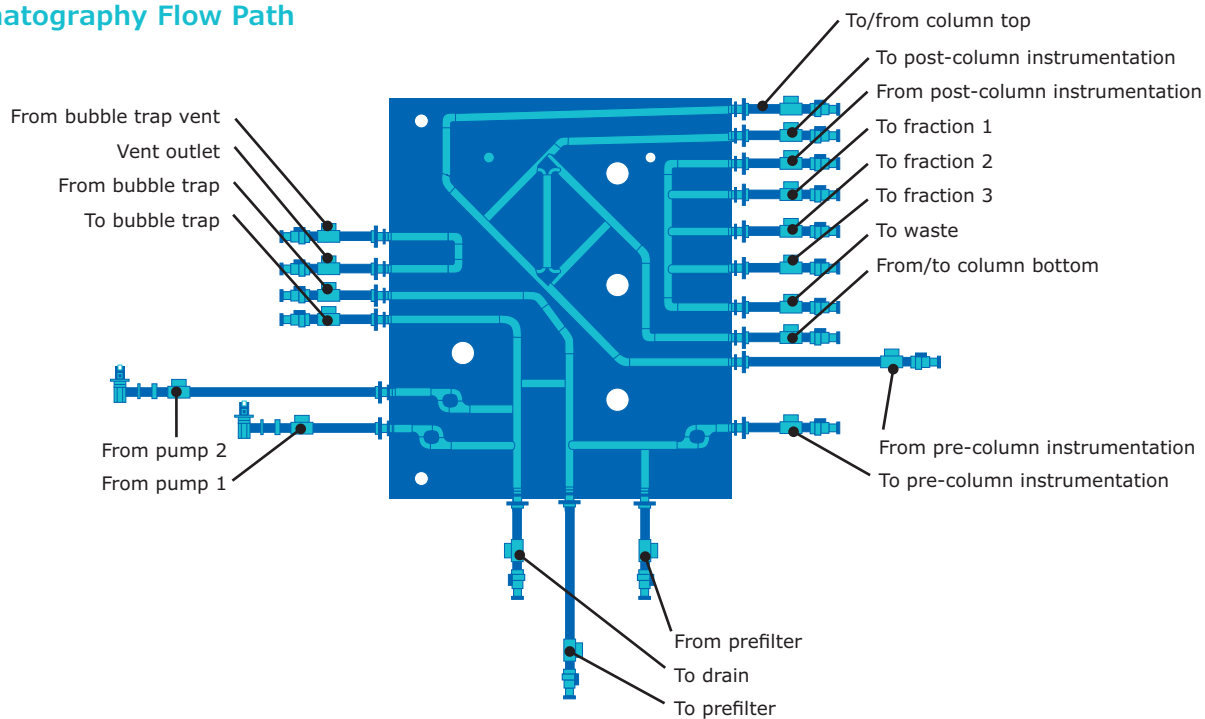
The hardware for receiving and transmitting data is the same regardless of single- or multi-use approach, increasing the flexibility of your facility, balancing economy and scale-up effort.



## Chromatography Configuration



## Chromatography Flow Path



## General Chromatography Specifications

Pressure Rating	Up to 4 bar (58 psi)
Environmental Temperature Range	2–30 °C (TF3S 20–30 °C)
Process Connection Type	Colder CPC and TC connections
Humidity	10–90% (non-condensing)
Utility Requirements	Compressed air: 6 bar minimum (oil-free). Maximum consumption: 4 L/min Power supply: Smart Cart: 220–240 VAC, 50/60 Hz, 1 phase or 100–120 VAC, 50/60 Hz, 1 phase, maximum consumption: 1 kW Electrical cable with CN, EU, JP, NA or UK plugs delivered with the system
Wetted Materials	PureFlex® film, Platinum cured silicone tubing, PE fittings, Polysulfone flow cell (SUC), PP TC connections, Polysulfone connections, SS316 L (flow meters and conductivity pins on SUC), PP pump body, Santoprene® pump diaphragms, EPDM pump non-return valve, quartz UV cell windows, PFA (flow meter body), USP <88> Class VI, Animal Free or EMA/410/01 compliant.
Electrical Compliance	CE (2006/95, 2004/108, 2006/42/EEC)

## Chromatography Specifications XMO1/2 and XMO3

	XMO1/2	XMO3
Flow Rate	0.1–2.2 L/min	1.6–10 L/min
Process Fluid Temperature Range	2–30 °C	
Buffer/Solvent Inlets	2 times 5 inlets	
Column Connectivity	¾ in. TC connection	
Pipe Work Inside Diameter	¼ in.	⅜ in. i.d.
Gradient Capability	10–90% (lowest controllable flow)	
Fraction Ports	3 + 1 waste	
Holdup Volume	Volume between buffer inlet to column inlet (Bubble trap bypass, filter bypass and column bypass) 300 mL for 2.2 L/min system, and 550 mL for 8.0 & 10.0 L/min systems Bubble trap (full): 1.1–1.9 L small-scale and large-scale	
Dimensions	Height: 175 cm (69 in.) Width: 172 cm (68 in.) Depth: 88 cm (34 in.)	
Uncrated Weight	~ 650 kg (1450 lbs) — depends on configuration	

## Chromatography Sensor Performance

Sensor Type	Range	Accuracy
Pressure Sensors	0–4 bar	±0.2 bar
Flow Meter	Multi-Use 2.2 L/min: 1.0–2.2 L/min 0.1–1.0 L/min 8 L/min: 1.6–8.0 L/min Single-Use 10 L/min: 1.6–10.0 L/min	±1% MV ±0.01 L/min ±1% MV ±2% MV
Multi-Use Conductivity Default range	0–200 mS/cm 0–50 mS/cm	±3% MV + 0.4 mS/cm
Single-Use Conductivity Default range	0–150 mS/cm 0–50 mS/cm	±3% MV + 0.4 mS/cm
Pre- and Post-Column Temperature	2–30 °C	±1 °C
pH	1–14	±0.1 (between pH 3–9)
Multi-Use and Single-Use Post-Column UV	0–2 AU (wavelengths 280/300 nm)	±2% FS



## Related Products

### QuikScale® Chromatography Columns

Designed to achieve ultra-high throughput, our robust QuikScale® columns are easily packed to deliver optimal resolution across a wide range of chromatographic applications, accommodating all media types.



### Featuring Industry-Leading Chromatography Resins

#### Eshmuno® Resin

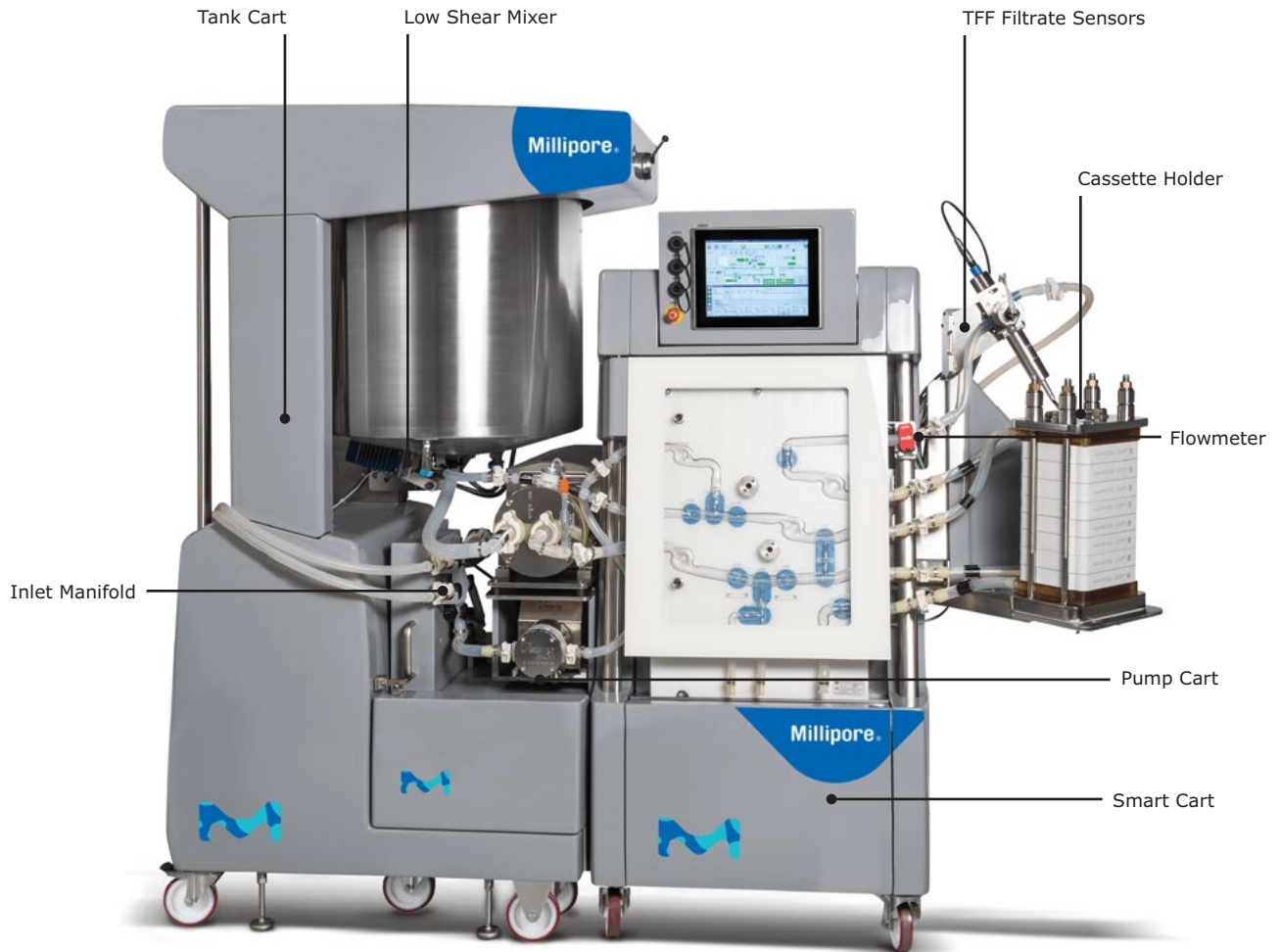
This unique family of ion-exchange resins is specifically designed for highly productive downstream purification.

#### Fractogel® Resin

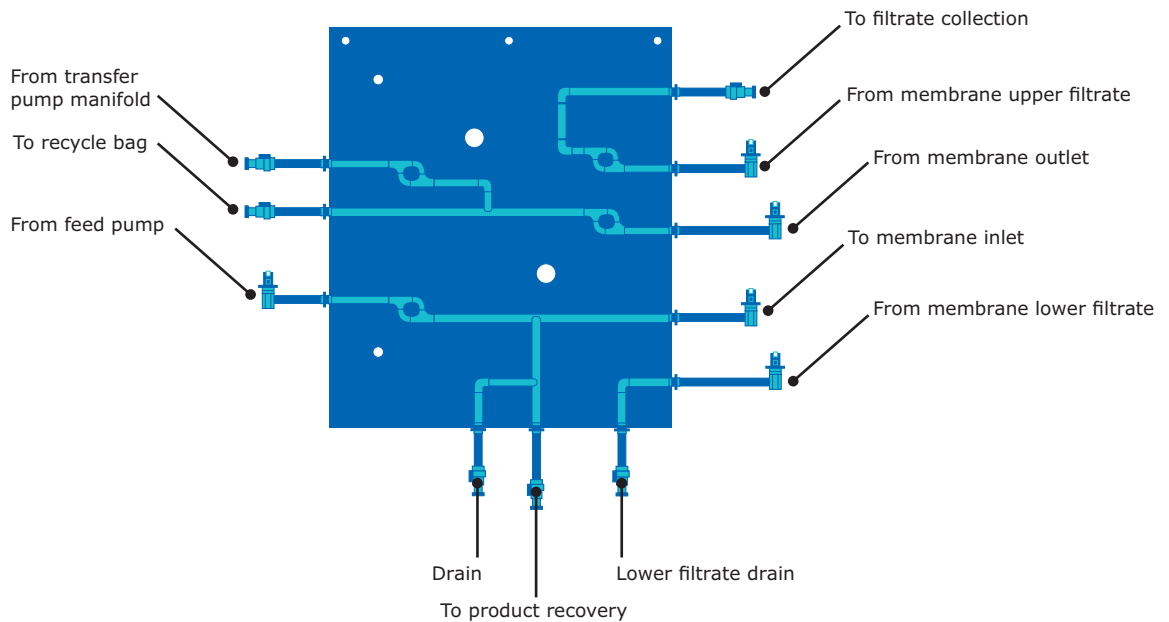
This tentacle-modified synthetic polymer resin is designed for ion exchange, hydrophobic interaction, size exclusion and metal chelate affinity.



# Tangential Flow Filtration (TFF) Configuration



## TFF Flow Path



## General TFF Specifications

Pressure Rating	Up to 4 bar (58 psi)
Environmental Temperature Range	2–30 °C (TF3S 20–30 °C)
Process Connection Type	Colder CPC and TC connections
Humidity	10–90% (non-condensing)
Utility Requirements	Compressed air: 6 bar minimum (oil-free). Maximum consumption: 4 L/min Power supply: Smart Cart: 220–240 VAC, 50/60 Hz, 1 phase or 100–120 VAC, 50/60 Hz, 1 phase, maximum consumption: 1 kW Tank Cart: 220–240 VAC, 50–60 Hz, 1 phase or 100–120VAC, 50/60Hz, 1 phase, maximum consumption: 0.4kW for 100 and 200 L and 0,1 kW for 50 TF3S Pump Cart: 3 x 200–208 VAC, 50/60 Hz, 3 phases + neutral + ground or 3 x 380–400 VAC, 50/60 Hz, 3 phases + neutral + ground, maximum consumption: 3 KW Electrical cable with CN, EU, JP, NA or UK plugs delivered with the system
Wetted Materials	PureFlex® film, Platinum cured silicone tubing, PE fittings and Inline Sampler, Polysulfone flow cell (SUC) and TFF cassette/ Liner, PP TC connections, Polysulfone connections, SS316 L (flow meters and conductivity pins on SUC), PP pump body, Santoprene® pump diaphragms, EPDM pump non-return valve, quartz UV cell windows, USP <88> Class VI, Animal Free or EMA/410/01 compliant.
Electrical Compliance	CE (2006/95, 2004/108, 2006/42/EEC)

## TFF Specifications TF2S/TF3S

	TF2S	TF3S
Membrane Holder Capacity	0.5–5.0 m <sup>2</sup>	2.0–10.0 m <sup>2</sup>
Feed Flow Rate	2.0–20.0 L/min	4.0–40.0 L/min
Feed Flow Measurement	Flow is calculated to an accuracy of ±10% MV with a minimum pressure of 1 bar on the feed line	
Filtrate Flow Measurement	Flow can be calculated to an accuracy of ±5% MV (between 0.5–8.0 LPM) using the optional external 0–600 kg floor weight scale. RC Flow can be measured using an optional non-intrusive flowmeter to an accuracy of ±5% MV above 2 L/min, ±0.12 below 2 L/min.	
Process Fluid Temperature Range	2–45 °C	
Inlets	5 inlets (air plus 4 fluids)	
Pipe Work Inside Diameter	TF2S ¾ in. (Inlet Manifold), 5/8 in. (recirculation loop), ½ in. (Filtrate & Diafiltration lines), 3/8 in. (Product Recovery & Drains) i.d.	TF3S ¾ in. (Inlet Manifold), ¾ in. (recirculation loop), 5/8 in. (Filtrate & Diafiltration lines), ½ in. (Product Recovery & Drains) i.d.
Outlet Ports	1 drain, 1 Recovery, 1 Filtrate	
Tank Size	50 L, 100 L, 200 L	200 L
Minimum Working Volume (Excluding cassette's feed volume, and function of recirculation flow rate)	Down to 0.7 L	Down to 2.2 L
Hold-up Volume	<700 mL (exc filtration device)	<2200 mL (exc filtration device)
Unrecoverable Volume	Virtually zero using a displacement by buffer	
Dimensions	Height: 202 cm Width: 217 cm Depth: 101 cm	Height: 202 cm Width: 233 cm Depth: 119 cm
Uncrated Weight	~ 1000 kg — depends on configuration	

## TFF Sensor Performance

Sensor Type	Range	Accuracy
Pressure Sensors	0–4 bar	±0.2 bar
Optional Filtrate Conductivity	0–150 µS/cm Default range: 0–100 µS/cm	±3% MV + 0.4 µS/cm
Tank Temperature	2–45 °C	±2 °C
Optional Filtrate UV	0–2 AU (wavelengths 280/300 nm)	±2% FS
Tank Weight	0–50 kg; 0–100 kg 0–200 kg	±0.3% FS
Flow Meter	Not-product contact >2.0 L/min 0.2 (0.4 for TF3S) to 2.0 L/min	±5% MV at 20 °C ±0.12 L/min



## Tangential Flow Filtration System Performance

The Mobius® FlexReady Solution with Smart Flexware® assemblies for TFF is optimized and validated for a feed flow capacity up to 40 L/min and a membrane holder that can accommodate from 0.5–10.0 m<sup>2</sup> of Pellicon® devices, making it suitable for a wide range of concentration and diafiltration processes. In addition to the feed pump and retentate valve control loops, the system also includes an automated flow control valve on the filtrate line to enable open UF and MF operations, increasing the overall flexibility for clinical development and manufacturing facilities.

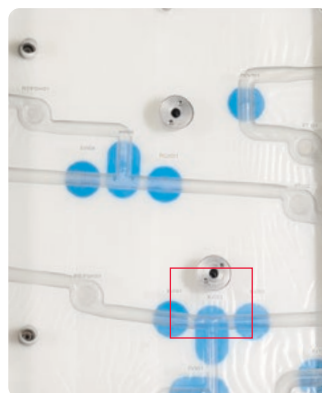
A variety of recycle vessel configurations are available with the Mobius® FlexReady Solution to provide maximum process capability. In addition to different vessel volumes, users can select a plastic carrier or a double-jacketed carrier, depending on whether or not temperature control is required. All recycle vessels come with integrated load cells, mixer and temperature sensor, and have been designed to allow containers to be easily and accurately installed by a single operator. For even greater plant flexibility, the recycle vessel skids have a built-in “stand-alone” setting, where they can be used as a mix container decoupled from the TFF system.

The Mobius® FlexReady Solution with Smart Flexware® assemblies for TFF performance is documented in the system performance guide. Some examples of key performance data are highlighted below.

The system includes several unique design features that make it especially suited to demanding final concentration and buffer exchange applications, where the ability to accommodate elevated protein viscosity, low final volume and high purity requirements is key to process success. Feed pump capability and line pressure drop were tested with solutions up to 35 cP, giving you confidence in your operation as protein concentration increases. The recycle container and flow path were

designed to enable recirculation at process flow rates with a minimum product volume, while maintaining adequate mixing and avoiding vortexing or air entrainment.

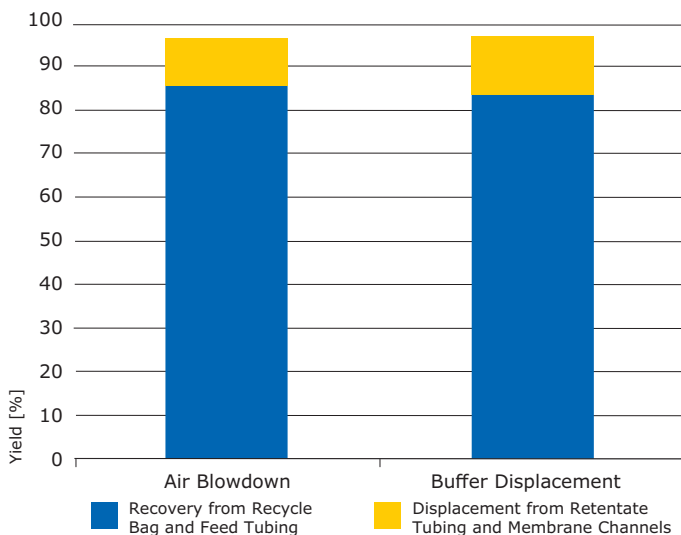
The Smart Flexware® assembly includes innovative valving where the transfer and product recovery lines intersect with the recirculation flow path. By replicating the functionality of traditional stainless steel zerostatic valves, dead-legs are eliminated in the critical product path to maintain product purity and enable highly effective buffer exchange for demanding final UF/DF operations (**Figure 1**).



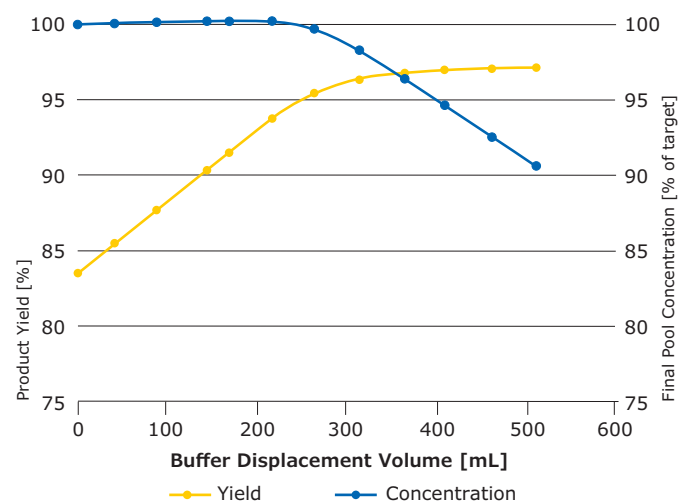
**Figure 1.** Innovative Smart flow path provides zero-dead-leg valving for excellent buffer exchange and purity.

At the end of concentration and diafiltration operations, achieving maximum recovery of product from the system is essential for process success. A straightforward sequence of steps has been developed to maximize product yield during recovery. The method can be carried out using either air or buffer to displace product from the flow path lines and membrane channels (**Figures 2 and 3**). This provides flexibility for users to select a product recovery strategy that is most in line with their specific process objectives, knowing that either choice will result in success.

**Figure 2.** Proven methodology for high product recovery using air or buffer displacement, using TF2S.



**Figure 3.** Product dilution during recovery with buffer can be minimized while achieving high product yield.



## Related Products

### TFF Cassette Holder

The TFF system includes a Pellicon® cassette holder adapted to utilize single-use liner plates, which isolates the process fluid from the holder endplates in order to achieve robust membrane compression, while eliminating cleaning and validation effort.

### Pellicon® Cassettes

These advanced, high-performance cassettes are ideal for today's higher titer therapeutic antibodies, as well as the more demanding filtration processes that require higher operating pressures, temperatures and caustic cleaning regimes.

**Pellicon® 3  
(size 0.57  
and 1.14 m<sup>2</sup>)**



### Pellicon® Capsules

Our innovative Pellicon® Capsules with Ultracel® membrane are ideal TFF devices to process biopharmaceuticals that require single-use capabilities, including enhanced ease-of-use, process flexibility, rapid product turnaround, and reduced operator exposure. First-of-its-kind, the capsule has a holderless, self-contained design and is provided gamma sterilized, offering easy installation and removal, and reduced pre-use steps.



**Pellicon®  
Capsule**

### Cogent® Lab Systems

When developing a TFF step at small scale, using a model that is representative of large-scale performance is essential. It not only allows for the successful transfer from laboratory scale to larger volumes, but also maintains consistent process parameters. Our family of Cogent® Lab systems uses similar design, sensing technologies, and accessories as our manufacturing-scale equipment. With a homogeneous design and flow range from 20 to 6000 mL/min, our Cogent® Lab systems have been specifically created to simplify process development. These systems offer linear performance and a uniform and intuitive software experience, reducing training requirements and ensuring smooth scale-up and scale-down.



## Mobius® FlexReady Solution Services

The pharmaceutical and biotechnology industries are highly regulated and, to help you navigate this challenging environment, we offer a wide range of services. These services help you save time, lower costs, and ensure a validated equipment. For your peace of mind, all our services are performed by our global experts who have an intimate knowledge of our equipment backed by decades of experience.

### Qualification Services

Our qualification services are designed to make the integration of our system into your process as seamless as possible and ensure your equipment is properly installed and functioning per your pre-defined requirements.

- Factory acceptance test (FAT)
- Installation qualification/operational qualification (IQ/OQ)
- Full test package: this service is an alternative to standard IQ/OQ for customers who wish to have tests from FAT performed again at their site
- Performance qualification support (PQ)

### Training Services

Appropriate training for users is not only a cGMP requirement, but it also ensures your staff has the expertise to operate and manage the system as part of your manufacturing process. Our training offering has been designed to make your staff more autonomous in managing your system and your process while saving time and money. Our training services cover system use and programming with interactive hands-on sessions and, depending on the training you select, may also include:

- Installing the Flexware® assemblies
- Interacting with the Human Machine Interface
- Manual and automatic system operation
- Troubleshooting issues
- Creating and managing your own recipes
- Process recommendations

These trainings can be delivered either at your site or in our M Lab™ Collaboration Centers. Please contact your local representative or email [ilearn@merckgroup.com](mailto:ilearn@merckgroup.com) to discuss our training offering.

## System Service Reliance Plans

To help you ensure optimum equipment uptime while mitigating risks, we have developed a wide range of services and support that allow you to select a coverage level that best fits your needs. Our System Service Reliance Plans, a complete range of services for your systems, offer priority access while ensuring your equipment is properly maintained.

For additional details, please refer to the System Service Reliance Plans Data Sheet (MK\_DS7881EN).

## Specialized Services

### CCP® Software Recipe Design

Every process is unique and, to ensure that your system is optimized to deliver the best performance, our biomanufacturing engineers will configure your process into your own CCP® software recipe. This allows your system to run fully automatic, resulting in consistency and reduced operator error.

For catalogue numbers, please refer to the ordering information at the end of the document.

## Repair Services and Spare Parts

### Repair Services

In the event your system experiences a problem, our worldwide engineering organization will provide on-site or repair center technical support to get you back up and running as quickly as possible.

### Spare Parts

Purchasing spare parts directly from us is the only way we can guarantee that you get the right parts every time, with the same level of performance as the original. For details and ordering information, check the illustrated spare parts list (MK\_CA7934EN).

## References

1. FDA Guidance for Industry Process Validation: General Principles and Practices — January 2011
2. Annex 15 to the EU Guide to Good Manufacturing Practice Qualification and Validation — March 2015
3. Performance guide — Mobius® FlexReady Solution with Smart Flexware® assemblies for Tangential Flow Filtration — AN4465EN00
4. Performance guide — Mobius® FlexReady Solution with Smart Flexware® assemblies for Chromatography — TB5222EN00

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