Filtration hardware

UniFlux™ system

The UniFlux series is a line of systems for cross flow filtration (CFF), also known as tangential flow filtration, that utilizes UNICORN™ control software for full automation with data logging capabilities over the entire cross flow process. The systems are intended for use in pilot- to full-scale manufacturing in a good manufacturing practices (GMP) environment. UniFlux systems are available in four sizes and are capable of processing batches of 1 to 10 000 liters of feed material. The systems are configured to operate hollow fiber cartridges suited for microfiltration applications such as cell clarification/harvesting, or cassettes/hollow fibers for ultrafiltration applications, such as protein concentration and diafiltration in downstream unit operations (Fig 1).

Key features of UniFlux systems include:

- Compatible with both hollow fiber and cross flow cassettes

- A broad range of applications, covering both ultrafiltration and microfiltration

- Single, familiar UNICORN interface for both upstream and downstream unit operations

- Minimized manual handling

- Extensive real-time data logging and reporting function

Validatable control with UNICORN software

UNICORN software is a single, familiar interface for both upstream and downstream unit operations that provides efficient process control, flexible method programming, extensive data evaluation, and powerful reporting functionality. Cost-effective process security is provided as standard. The system control unit allows process operation even if communication between the system computer and UNICORN software is lost.

UNICORN software has undergone an independent audit and is designed as a validatable control package for use in a FDA 21 CFR part 11 and GMP compliant manner. The electronic

Fig 1. UniFlux 10 system configured for cassettes and with 10 L tank.

signature and record system uses a dual password confirmation, document locking scheme, and traceable audit log. For integration purposes, UNICORN software communicates with control systems via object linking and embedding (OLE) for open platform communication (OPC).

OPC supports data access for real-time values and security control to protect sensitive information.

Regardless of filter surface conditions, the UNICORN software provides powerful filtration monitoring and control functionality, including maintaining constant transmembrane pressure, regulating feed flow to maintain constant differential pressure across the membrane, and regulating cross flow to maximize flux and thereby process efficiency.

UNICORN software for cross flow filtration

- Automation of fed batch operations

- Control logic for level control of recirculation tank allows complete control of product concentration and/or diafiltration/buffer exchange from the UNICORN software

- Flux can be monitored for percentage decrease from a reference point, and the system can be programmed to automatically react accordingly at user-defined value

- Concentration steps can be programmed using volume set-points or using the automatic concentration factor calculation

- Diafiltration steps can be programmed using volume set-points or using the automatic diafiltration exchange factor calculation

- Performance of air flow and pressure hold integrity tests

- Permeate flow control for increased filter efficiency with larger pore filters

Typical applications

- Cell harvesting/clarification

- Recombinant protein concentration

- Vaccine concentration/purification

- Monoclonal antibody clarification/concentration

- Plasma purification/concentration

System design

UniFlux systems are designed to allow linear scalability for both hollow fiber and cassette filters, and for system sizes varying from lab to manufacturing scale. Zero dead-leg drain valves eliminate dead spaces during processing and cleaning. Low working/hold-up volumes enable high concentration factors along with maximized product recovery. In addition, over-pressure monitoring protects membranes and hardware during operation.

The standardized UniFlux design allows for short delivery lead times as well as simple and rapid upgrade possibilities.

System components

UniFlux systems offer flexible, configurable design. A typical system configuration is outlined in Figure 2. System components include:

- Positive displacement type pump for low shear, negligible heat generation, and reliable operation. For the UniFlux 10 system, a diaphragm pump is supplied; for larger systems, a rotary lobe pump is provided.

- Automatic, sanitary diaphragm valves with position switches

- Pressure sensors on feed, retentate, and permeate

- Temperature sensor on retentate

- Magnetic flowmeter on feed

- Mass flowmeter on permeate line for UniFlux 30 and 120 systems. Magnetic flowmeter on permeate line of the UniFlux 10 system.

- Hydraulic unit to compress cassette for UniFlux 30 and 120 systems. For enhanced safety, the hydraulic pressure and generated force are monitored in the UNICORN software.

- Zero dead-leg piping in 316L stainless steel

- Wetted surface finish average roughness (Ra):
  system   < 0.6 μm
  cassette holder < 0.8 μm

The systems can be configured for cassettes or hollow fibers and a number of options can be fitted to the systems:

- pH sensor on permeate

- Conductivity sensor on permeate

- UV sensor on permeate

- Transfer pump

- Quadruple inlet valve kit

- Permeate flow control pump

- Built-in computer for UniFlux 30 and 120*

- Hollow fiber/cassette conversion kits

* For UniFlux 10, a stand-alone computer is used. For UniFlux 30 and 120 systems, the built-in computer or a stand-alone computer is used.
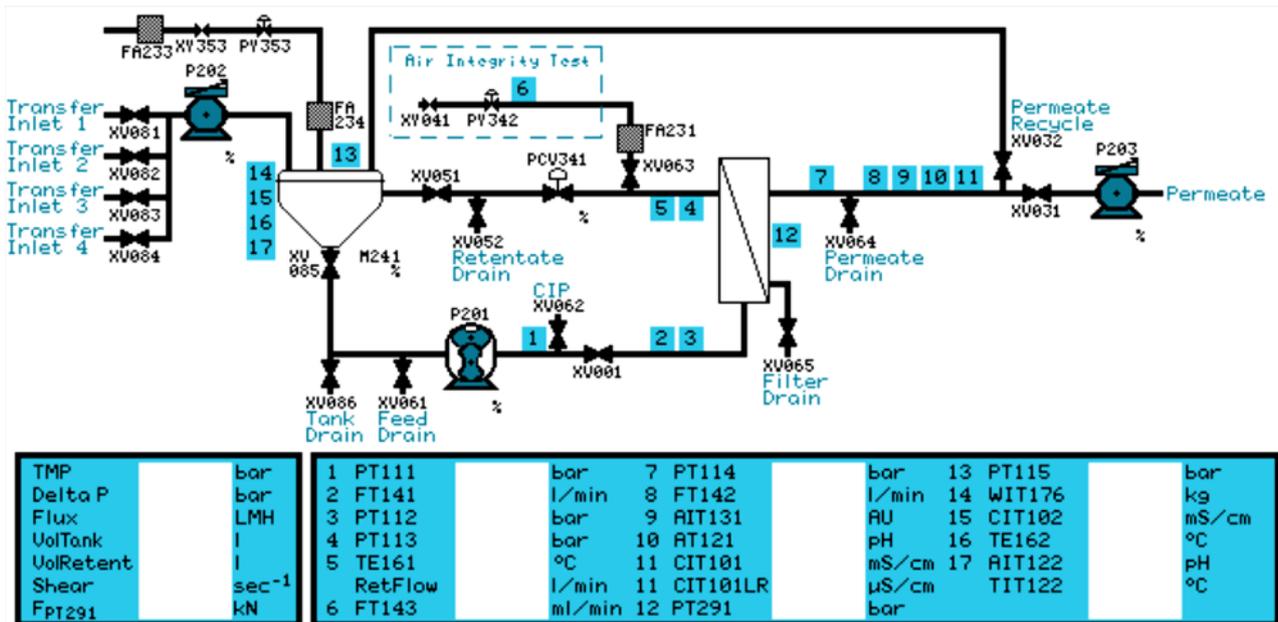
TMP	bar	1	PT111	bar	7	PT114	bar	13	PT115	bar
Delta P	bar	2	FT141	l/min	8	FT142	l/min	14	WIT176	kg
Flux	LMH	3	PT112	bar	9	AIT131	AU	15	CIT102	mS/cm
VolTank	l	4	PT113	bar	10	AT121	°C	16	TE162	°C
VolRetent	l	5	TE161	°C	11	CIT101	mS/cm	17	AIT122	pH
Shear	sec^{-1}		RetFlow	l/min	11	CIT101LR	μS/cm		TIT122	°C
F$_{PT291}$	kN	6	FT143	ml/min	12	PT291	bar			

Fig 2. Example of a UniFlux flow scheme picture in the UNICORN software.

Integrated stainless steel tanks

CFF processes require a tank to feed the filter and to collect retentate. The tank is normally an integral part of the system and plays a major role in mixing, measurements, and minimizing recirculation volume (Fig 3). When running automated CFF, a tank needs to communicate with the system control unit to enable a fully automated process. GE Healthcare offers a series of tanks that communicate with the UNICORN software, allowing fully automated control of the tank sensors and mixer. Weight and volume in the tank are also monitored via the UNICORN software, allowing for control of concentration or diafiltration.

The tanks are developed to work seamlessly with UniFlux systems for a total CFF process. Different tank volumes can be chosen for specific systems, depending on the desired process volumes. A large range of options is available, including sensors, valves, mixer, pressurized tank, cooling jacket, and hoses. For requirements outside the standard options, spare ports are also available for sensors and the sampling valve. The tanks are available in volumes from 5 to 600 L.

Fig 3. Integrated UniFlux 30 system and 100 L tank allow fully automated CFF via UNICORN system control software.

Designed for easy sanitization

Stainless steel tanks (surface finish Ra 0.5 µm) are mounted on a skid with castors, allowing for easy movement for storage or for cleaning of floor space (Fig 4). The 5 and the 10 L tanks for UniFlux 10 are mounted on the system skid.

Fig 4. UniFlux 100 L tank.

Options available for tanks

Standard components included with 50, 100, 250, and 600 L tanks are listed in Table 1.

Table 1. Standard components included with 50, 100, 250, and 600 L tanks

Component	Function
Sight glass with lamp	Watch the process fluid in the tank
Vent filter	Ensure inlet and exhaust air are filtered
Manhole	Cleaning and inspection of tank
Pressure safety valve	Safety
Spray balls	For cleaning (powered by system pump)
Load cells	Determine weight of tank contents

Additional options available for the 5 and 10 L tanks for UniFlux 10 include:

- Mixer

Additional options available for the 50, 100, 250, and 600 L tanks for UniFlux 30 and 120 include:

- Tank jacket to enable heating/cooling, including insulation and cladding

- Pressure equipment directive (PED) for pressurized processes - includes pressure sensor

- ASME pressure directive for pressurized processes - includes pressure sensor

- Bottom-mounted tank mixer

- Manual product sampling valve

- Automatic valve to drain tank

- Combined pH and temperature sensor

- Temperature sensor

- Conductivity sensor

- Spare ports for sampling valve, pH/temp sensor, conductivity sensor

- Flexible hose kit for connection between system and tank

Note: tank accessories need to be purchased with the tank.

Single-use mixing systems

As alternatives to stainless steel tanks, Xcellerex™ XDM S UF single-use mixing systems can also be used as tanks for the UniFlux 30 and 120 systems. Single-use mixing systems offer the benefit of reduced need for cleaning and cleaning validation, improving flexibility in filtration operations. Recommended mixing systems for the UniFlux systems are listed in Table 2. Specifications for XDM S UF mixing systems are listed in Table 3.

Table 2. XDM mixing systems recommended for UniFlux systems

Mixing system	Recommended UniFlux system
XDM S UF, 50 L	UniFlux 30
XDM S UF, 100 L	UniFlux 30 and UniFlux 120
XDM S UF, 200 L	UniFlux 120

Table 3. Specifications for XDM S UF mixing systems

	XDM S UF, 50 L		XDM S UF, 100 L		XDM S UF, 200 L	
Power supply	110 V	220 V	110 V	220 V	110 V	220 V
Product code	29169017	29169018	29169019	29169020	29169021	29169022
Dimensions (W × L × H)	625 × 847 × 1063 mm (24 5/8 × 33 5/16 × 41 13/16 in)		721 × 969 × 1065 mm (28 3/8 × 38 3/16 × 41 15/16 in)		848 × 1095 × 1073 mm (33 3/8 × 43 1/8 × 42 1/4 in)	
Lid (H)	35 mm (1 3/8 in)		35 mm (1 3/8 in)		35 mm (1 3/8 in)	
Weight	71 kg (156 lbs)		85 kg (187 lbs)		143 kg (316 lbs)	
Nominal working volume	50 L		100 L		200 L	
Minimum working volume (with stirring)	20 L		50 L		77 L	
Minimum working volume (without stirring)	10 L		16 L		26 L	
Applicable codes and standards	Electrical design Mechanical design Ingress protection, electrical control cabinet EMC UL508A / EN 60204-1:2006 EN ISO 12100:2010 IP45 EN 61326-1:2013					
Material of construction	Frame, vessel, cabinet and supports SS ASTM 304L Stainless steel finish, vessel Ra ≤ 35 μ in, ≤ 1.0 μm Stainless steel finish, cabinet Ra ≤ 35 μ in, ≤ 1.0 μm Casters 4, polyurethane					
pH/conductivity monitoring	Yes					
pH control	No					
Temperature monitoring	Yes					
Weight monitoring	Yes					

Note: XDM S UF mixing systems can be ordered through GE Healthcare's configurator. For assistance in placing your order, please contact your local GE Healthcare representative.

Validation documentation

An optional installation qualification and operational qualification (IQ/OQ) package offers proven test procedures, verifying that the equipment has been installed in accordance with system drawings and specifications. The IQ/OQ also assures that the system operates as specified in the design, satisfying all functional requirements. The IQ/OQ protocols enable quality assurance and regulatory reviewers to verify that all functional testing of the quality-critical equipment and components, including the requirements of 21 CFR Part 11, has been performed and documented.

System specifications

UniFlux system specifications are listed in Table 4.

Table 4. System specifications

	UniFlux 10	UniFlux 30	UniFlux 120
Max recirculation flow rate	10 L/min at 4 bar	60 L/min at 4 bar	120 L/min at 4 bar
Min recirculation flow rate	0.5 L/min at 4 bar	3 L/min at 4 bar	12 L/min at 4 bar
Feed connection (TC size)	1/2 in (TC25)	1 in (TC50)	1 1/2 in (TC50)
Retentate connection (TC size)	1/2 in (TC25)	1 in (TC50)	1 1/2 in (TC50)
Permeate connection (TC size)	3/8 in (TC25)	1/2 in (TC25)	3/4 in (TC25)
Feed tank capacity (L)	5 or 10	50 or 100	100, 250, and 600
System hold up volume (L)	0.2*	1	3
System dimensions (W × L × H mm)	750 × 860 × 2010	1000 × 2000 × 1790	1000 × 2070 × 1850
Cassette cart dimensions (W × L × H mm)	N/A	N/A	N/A
Hollow fiber cart dimensions (W × L × H mm)	N/A	N/A	N/A

* The tank is included in the system hold up volume as tank is mounted on the UniFlux 10 system skid

Stainless steel tank specifications	50	100	250
Working volume (L)	50	100	250
Total volume (L)	66	127	378
Tank skid dimensions (W × L × H mm)	780 × 1190 × 1470	850 × 1270 × 1650	850 × 1380 × 1990
System compatibility	UniFlux 30	UniFlux 30 or 120	UniFlux 120
Minimum working volume tank* (L)	5.5	5.5	10

* For total minimum working volume add the hold-up volume for the UniFlux system.

Utility requirements

Compressed air	6 to 10 Barg (87 to 145 psig). Dry particle free, non-condensing

Power requirements

Control system hardware		1-Phase; 110/230 VAC; 50/60 Hz; 16 A
Pump	UniFlux 10	1-Phase; 110/230 VAC; 50/60 Hz; 16/10 A
Pump, hydraulic unit	UniFlux 30, 120	3-Phase, 400/480 VAC; 50/60 Hz; 10 to 30 A

Note: power to the tanks is supplied from the UniFlux system

Filter specifications

Hollow fiber filters

Specifications for hollow fiber filters are listed in Table 5.

Table 5. Specifications for hollow fiber filters

	UniFlux 10	UniFlux 30	UniFlux 120
No. of cartridges	1	1	2
Min./max. area			
ft^2	1.3/5.2	9.9/65	19.8/130
m^2	0.12/0.48	0.92/6	1.8/12
Cartridge size	5 or 6	35, 55, or 75	35, 55, or 75
Lumen diameter	For more information, see Selection handbook, Hollow fiber cartridges and systems for membrane separations (18116529)		

Cassette filters

UniFlux systems support the use of flat sheet cassettes. The surface area limit/max number of cassettes supported by each UniFlux system can be estimated by using the maximum flow capabilities of the system and the maximum physical opening of the cassette holder, based on flow rate or physical dimension provided by vendor of the cassette that will be used with UniFlux system.

Please contact your GE Healthcare representative for information about Kvick Lab™ and Kvick Flow™ cassettes.

Ordering information

UniFlux systems, tanks, and accessories can be ordered through GE Healthcare's configurator. For assistance in placing your order, please contact your local GE Healthcare representative.