ÄKTA flux™ filtration system

FILTRATION HARDWARE

ÄKTA flux™ is a versatile cross flow filtration system for sample concentration and diafiltration (buffer exchange) as well as cell harvest and clarification (Fig 1). The system allows easy filtrations using cassettes, hollow fiber filter cartridges, and membrane adsorbers. The ÄKTA flux system is available in two versions: ÄKTA flux s for research, filter screenings and small-scale production, and ÄKTA flux 6 for process development and small-scale production. Semiautomated features enable end-point control, constant retentate volume (CRV), and data logging. These features liberate time for other tasks in the lab. Process information and control are conveniently monitored and handled from an easy-to-use touchscreen. The system can handle low working volumes to support a wide range of concentration factors. The ÄKTA flux filtration system is well-suited for use in protein purification and clarification as a complement to the ÄKTA™ chromatography systems.

ÄKTA flux offers the following benefits:

- Low working volumes support a wide range of concentration factors
- Automated end-point control and data logging liberate time for other tasks in the lab
- Flexible handling allows use of both hollow fiber cartridges and cassettes
- Versatile design enables use in both ultra- and microfiltration applications
- Easy-to-use operator interface simplifies system handling
- ÄKTA flux 6 is suitable for use in a GxP regulated environment enabling support for 21 CFR Part 11 requirements

Fig 1. ÄKTA flux cross flow filtration system is available in two versions: ÄKTA flux s for research and filter screenings, and ÄKTA flux 6 for process development and small-scale production.

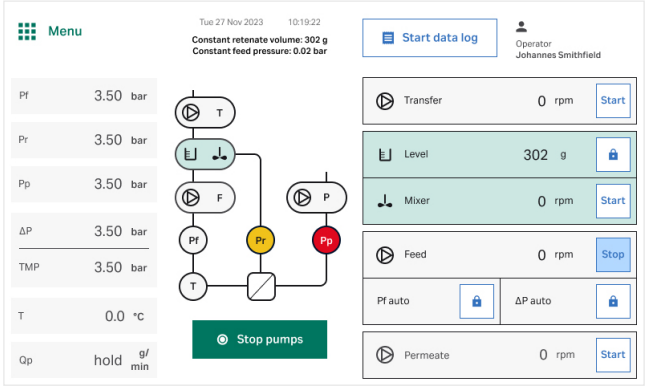

Fig 2. Monitoring and control of the ÄKTA flux system are managed through the user-friendly interface.

System characteristics

Easy-to-use operator interface

ÄKTA flux comprises a built-in computer, which starts automatically when the system power is turned on. From the touchscreen, pump control can easily be managed and process information, such as flow, temperature, and pressures, can be conveniently monitored (Fig 2). Indicators of system status, warnings, and alarms can be viewed, and commands be entered through the control panel.

To minimize start-up time and need for training, the operator interface is consistent between both versions of ÄKTA flux.

Warnings and alarms

The ÄKTA flux warning and alarm management system can be configured for pressures, reservoir level, and other process parameters. The user is notified of issued warnings and alarms through a displayed message and sound. Several warnings can appear simultaneously. In case of an alarm, the system pumps will stop, while the reservoir stirrer remains active. The alarm management system can also be used for end-point control.

End-point control

The alarm function can be used for end-point control against set parameters such as reservoir level and transmembrane pressure (TMP). The end-point control enables reliable, unattended operation of the system. When the end point is reached, the pumps, and thus processing, will stop and the user can take appropriate actions.

Automated data logging

The ÄKTA flux system supports the automatic logging of run data, enabling seamless data collection throughout the operation.

- **Data transfer via ethernet interface**
  The system allows the transfer of run data through an ethernet connection, facilitating easy integration with a network
- **File formats**
  The system generates data files in either CSV (comma-separated values) or PDF format
- **Local storage**
  - Data files are stored locally on the instrument. These files are named uniquely, making them easily identifiable
  - Backup files for the database are also stored locally
- **File backup notifications**
  - The system will notify the user when it is nearing its memory limit
  - Users are encouraged to back up their files to a pre-configured network drive to prevent data loss

Transmembrane pressure

Filtration processes are normally optimized for minimal process time by maximizing the flux (permeate flow/filter area). For a stable flow during sample concentration and diafiltration, the TMP is controlled through the opening and closing function of the manual retentate pressure control valve (Fig 3). The retentate pressure control valve has been specially developed to fit cross flow filtration applications and to enable sufficient control over the entire TMP range. TMP is displayed on the touchscreen and can also be captured in the data logging function.

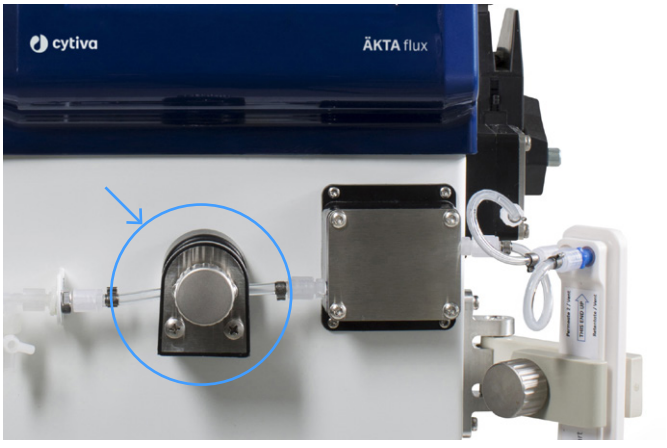

Fig 3. Retentate pressure control valve.

Constant retentate volume (CRV) control

For an efficient buffer exchange during continuous diafiltration, the reservoir volume should remain constant. CRV control, enabled by the optional transfer pump, can be used for automatically maintaining the retentate volume. The transfer pump will add fluid to the reservoir to compensate for the liquid reduced by the permeate outflow, and thereby maintains the set retentate volume.

Permeate flow control

To avoid premature fouling of the filter and to achieve a stable flow when working with microfiltration, the permeate flow can be kept constant at a set point using a permeate control pump. For monitoring of the permeate pressure, a permeate pressure sensor can be installed as an optional component.

When using permeate flow control, the permeate flow rate is controlled at a lower initial level than would be possible with an uncontrolled permeate stream. The required permeate flow is dependent of the nature of the starting feed stream. If the target molecule is very large or if the particulates are variable in size or sticky and fouling, lower flow rates are recommended. A typical monoclonal antibody clarification from a hybridoma cell culture containing intact cells may be controlled at a flux of approximately 30–50 L/m^2/h. However, clarification of enzyme from bacterial lysate is almost always controlled at 10–25 L/m^2/h, depending on process. Permeate flow control results in a more stable flow, higher protein yield, and often a shorter process time compared with an uncontrolled permeate flow.

Manual permeate flow control can be done with the permeate control valve included in the system.

Cassettes

Filter cassettes are suitable for use in product concentration and diafiltration applications. Filter cassettes consist of many layers of filter membranes. The pore size determines the filtration characteristics of the cassette, that is, the cut-off size for particles that will either be retained or filtered out with the permeate. Please contact your Cytiva representative for information on the Centramate™ cassettes product range.

Table 1. Centramate cassettes compatibility with ÄKTA flux system cassette holders

Holder type	Cassette type and filtration area	Number of cassettes	
		ÄKTA flux s	ÄKTA flux 6
Kvick Lab™ packet holder	Centramate 0.01 m^2 (T01)	1–3	Not applicable
Kvick Lab holder II	Centramate 0.1 m^2 (T12)	Not applicable	1–5

Hollow fiber cartridges

Because of their open channel structure, hollow fiber filter cartridges are suitable for microfiltration applications. Hollow fiber cartridges are also available in the ultrafiltration range for concentration and diafiltration.

Cytiva's cartridges are available in a broad spectrum of pore sizes (Table 2).

Table 2. Membrane pore size availability for hollow fiber cartridges

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

Workflows

The ÄKTA flux filtration system is designed to be part of purification protocols including different unit operations such as chromatography performed on ÄKTA chromatography systems, or clarification from upstream harvest, such as microbial fermentation or cell culture from ReadyToProcess WAVE™ 25 rocker. Cytiva's application specialists can support with knowledge on how to design your process.

System overview

Flow path

The ÄKTA flux filtration system is designed for operations at low working volumes to enable high concentration of the final product. The flow path of the system consists of tubing. In ÄKTA flux s the flow path can easily be exchanged during maintenance or when working with sample-specific flow paths. A recommended cleaning procedure is available. In ÄKTA flux 6, the flow path is designed and verified for sanitization and a recommended procedure can be provided.

System pumps

The recirculation loop consists of the feed line and the retentate line. In the feed line, liquid is transferred from the reservoir to the filter by the feed pump. Particles or molecules too large to pass through the filter pores (i.e., the retentate) are transported back to the reservoir via the retentate line.

The ÄKTA flux filtration system is equipped with a feed pump. Optionally, transfer and permeate control pumps can also be used with the system.

Feed pump

The feed pump creates a cross flow over the membrane. The feed pump of ÄKTA flux s is a peristaltic pump that supports three different tubing sizes to deliver a wide range of flow rates. ÄKTA flux 6 uses a diaphragm feed pump. The feed pump speed is either set in rpm or controlled against flow rate (L/min), share rate (s^{-1}), feed pressure (bar), or pressure differential over the filter, delta P (bar).

Transfer pump

The use of a transfer pump with the ÄKTA flux system facilitates addition of fluid to the recirculation reservoir. The transfer pump can maintain CRV against a set point by replacing the volume leaving the system as permeate with a corresponding amount of fluid from an external source. The transfer pump can also be used for addition of sample, condition buffers, cleaning solutions, and more.

The peristaltic transfer pump is optional and can easily be installed by the user.

Permeate control pump

The use of a permeate control pump enables a stable flow and prevents early fouling of the filter. The optional peristaltic permeate control pump can be installed by the user.

Pressure sensors

Feed pressure sensor

A feed pressure sensor is used in the recirculation system to monitor the pressure before the filter. The feed pressure sensor helps to ensure that the system pressure is kept within limits. The system supports automated feedback control of the feed pump to maintain the feed pressure at a user-defined set point.

A temperature sensor, integrated with the feed pressure sensor, continuously reports the temperature of the liquid fed into the filter.

Retentate pressure sensor

Retentate pressure is monitored with a pressure sensor in the retentate line.

The feed and retentate pressure data are used to calculate delta P and TMP. The system supports automated feedback control of the feed pump to maintain delta P at a user-defined set point.

Permeate pressure sensor

For monitoring of the permeate pressure, the permeate outlet line can be equipped with a pressure sensor, easily installed by the user. The pressure sensor is needed when controlling the permeate flow. The permeate flow can be controlled either through the permeate valve or by using the optional permeate control pump.

The feed, retentate, and permeate pressure data are used to calculate TMP for monitoring of the filtration run.

Valves

The system is equipped with an easy-to-regulate, manual retentate pressure control valve for smooth control of the filtration run. The pressure control valve has been specially developed and tested for cross flow filtration applications. The same type of valve is used on the permeate outlet. To raise the pressure upstream, the retentate pressure control valve used in the retentate line enables manual throttling of the liquid flow. The entire retentate line can be shut off by closing the retentate pressure control valve.

ÄKTA flux s is equipped with manual, three-way valves for recovery and waste handling, whereas, in ÄKTA flux 6, manual three-way diaphragm valves are used for these procedures.

Reservoir

The reservoir contains the sample and collects the retentate returned from the filter. The reservoir is equipped with a feed outlet as well as transfer and retentate inlets by means of flexible tubing. A magnetic stirrer in the bottom of the reservoir allows uniform mixing of any liquid in the reservoir. The reservoir volume of ÄKTA flux s is 0.5 L and 8 L for ÄKTA flux 6.

Reservoir volume is monitored by weight feedback from the load cell integrated in the reservoir. For end-point control, the alarm is set to a desired end-point volume. The alarm is automatically triggered when end-point is reached.

Designed for low minimum working volume

The system's minimum working volume represents the minimum volume of fluid in the recirculation line required to operate the system at the desired crossflow rate. The minimum working volume is determined by the design of the system reservoir, feed and retentate tubing. When designing a filtration process, minimum working volume needs to be considered to ensure that the target recirculation volume is not less than the system's minimum working volume. For ÄKTA flux s, the minimum working volume at different feed flow rates for a BSA solution of 5 g/L for each tubing size is displayed in Figure 4. Similarly, for ÄKTA flux 6, the minimum working volume at different feed flow rates for a BSA solution of 5 g/L is displayed in Figure 5. For both systems, the minimum working volume depends on the flow rate (Figs 4 and 5).

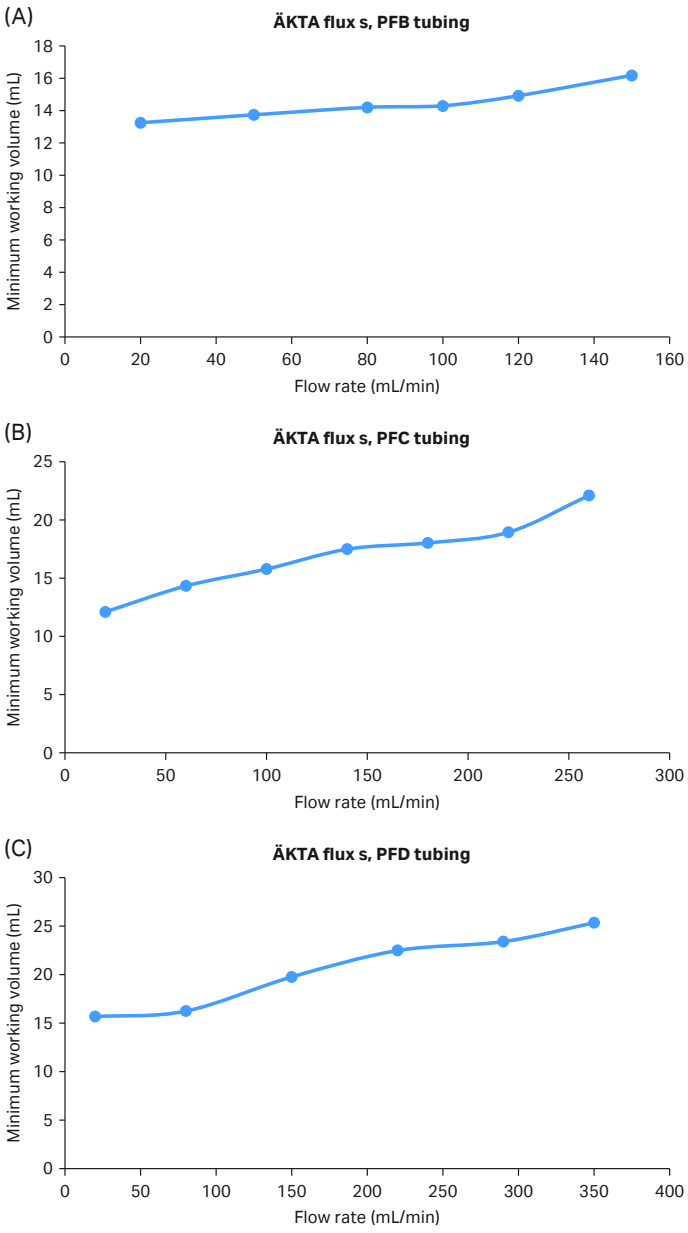

Fig 4. Minimum working volume (recirculation line excl. filter) at different feed flow rates with (A) PFB tubing, (B) PFC tubing, and (C) PFD tubing. Here, a BSA solution of 5 g/L was used.

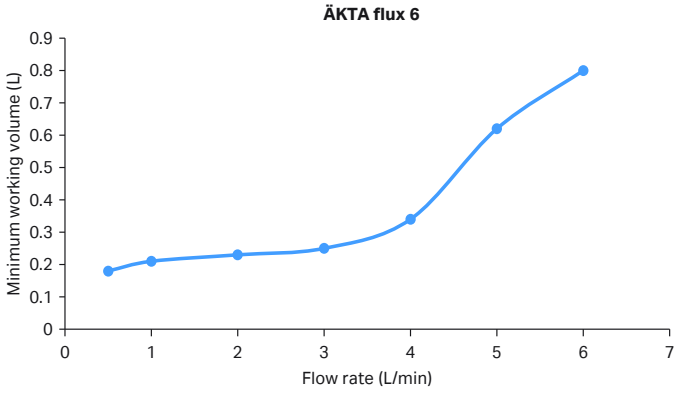

Fig 5. Minimum working volume (recirculation line excl. filter) at different feed flow rates for ÄKTA flux 6. Here, a BSA solution of 5 g/L was used.

System specifications

System specifications are listed in Table 3.

Table 3. ÄKTA flux system specifications

General specifications		**ÄKTA flux s**	**ÄKTA flux 6**
Dimensions (W × L × H)		460 × 400 × 570 mm	640 × 470 × 720 mm
Weight, approximate		28 kg	53 kg
Reservoir volume		0.5 L	8 L
Voltage		100–120/220–240 VAC, ± 10%	100–120/220–240 VAC, ± 10%
Phases		Single	Single
Frequency		50 to 60 Hz	50 to 60 Hz
Max power		300 VA	400 VA
Operating ranges			
Feed pump pressure		Max. 4 bar	Max. 4 bar
Transfer pump:	Outlet pressure	Max. 1 bar	Max. 1 bar
Permeate pump:	Inlet pressure	Max. 1 bar	Max. 1 bar
	Outlet pressure	Max. 1 bar*	Max. 1 bar*
Ambient temperature		2°C to 35°C	2°C to 35°C
Liquid temperature:	Process temperature	2°C to 40°C	2°C to 40°C
	Cleaning in place	Max. 50°C	Max. 50°C
Fluid line:	Components and piping	-0.4 to 4.0 bar†	-0.4 to 4.0 bar
	Reservoir	-0.1 to 0.05 bar	-0.1 to 0.05 bar

System capacity	**ÄKTA flux s**			**ÄKTA flux 6**
	Pump tubing PFB	**Pump tubing PFC**	**Pump tubing PFD**	
Pump tubing dimensions	3.2 mm i.d. × 6.4 mm o.d.	4.8 mm i.d × 8 mm o.d.	6.4 mm i.d. × 9.6 mm o.d.	7.9 mm i.d. × 12.9 mm o.d.‡
Feed flow range	20 to 150 mL/min at 4 bar	20 to 260 mL/min at 2.75 bar	20 to 350 mL/min at 1.5 bar	100 to 6000 mL/min
Transfer flow range	1 to 50 mL/min	1 to 50 mL/min	1 to 50 mL/min	20 to 1000 mL/min
Permeate flow range	1 to 50 mL/min	1 to 50 mL/min	1 to 50 mL/min	20 to 1000 mL/min
TMP range produced	0.3 to 4.0 bar§	0.3 to 4 bar§	0.3 to 2.5 bar	0.3 to 4 bar
Hold-up volume	10 mL	13 mL	17 mL	80 mL

* The fluid line and pump tube allow a maximum pressure of 4 bar, the maximum pressure of the permeate pump is specified to 1 bar.
† Pump tubing PFD is limited to 2.5 bar.
‡ Refers to permeate and transfer pump tubing.
§ Maximum pressure rating for pump tubing.

Applications

ÄKTA flux enables easy cross flow filtration operations in a variety of applications.

ÄKTA flux covers three main filtration techniques:

- Ultrafiltration of proteins and peptides
- Diafiltration of proteins and peptides
- Microfiltration of cell and lysate solutions
- Filtration of liposomes, exosomes and virus.

Recommended pore sizes for a variety of applications are listed in Table 4.

Regulatory support for 21 CFR Part 11

ÄKTA flux 6 features a system audit trail, user management, data management and electronic records. Individual user access permissions can be set, and individual users are password protected. The ability to lock the system according to a defined time schedule with user passwords provides a high level of security. This means that you can lock active processes for unattended operation without the risk of unauthorized interference. All your records are maintained and stored in a single, unalterable database, including results and extended run documentation. You can access additional validation support documentation including 21 CFR Part 11 requirements on request.

Validation documentation and services

ÄKTA flux 6 can be used in process development and small-scale production. Regulatory authorities expect companies that produce therapeutic or diagnostic products to qualify equipment before use in production or analysis. Fast Trak Validation™ is Cytiva's specialist service providing validation documentation on request after delivery of the system.

Installation and operational qualifications (IQ/OQ) of production and analysis equipment are part of the formal qualification required by good manufacturing practice (GMP). As such, the IQ/OQ documentation is subject to inspection by regulatory authorities. Fast Trak™ IQ/OQ packages consist of professionally developed templates that will facilitate equipment qualification. The templates have help texts and are easy to complete. If assistance is required, our specially trained and certified engineers perform onsite IQ/OQ and change control protocols in accordance with GMP, and provide onsite training for your personnel.

Cytiva services

Cytiva has over 50 years of experience in providing service solutions, with the understanding that maintaining instruments in prime condition is a science in itself. To enable excellent lifelong performance, serviceability is built into our equipment. Our global network of service engineers is available for your local support.

Table 4. Recommended pore sizes for a selection of 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	

*Nominal molecular weight cutoff

Ordering information

Product	Quantity	Product code
ÄKTA flux s system	1	29038437
ÄKTA flux 6 system	1	29038438

Accessories for ÄKTA flux s	Quantity	Product code
Pump tubing PA size 14	1	29060946
Pump tubing PB size 16	1	29060944
Pump tubing PFB size 16	1	29093045
Pump tubing PFC Size 25	1	29060947
Pump tubing PFD size 17	1	29060948
Kvick Lab packet holder	1	11000670
Clamp for Kvick Lab packet holder	1	29089893
Torque wrench	1	56411284
Transfer pump	1	29060942
Permeate control pump	1	29060943
Pressure sensor	1	29065213
Tubing kit	1	29060952
Drain valve	10	29093703
Reservoir assembly	1	29060951
Stirrer	1	29060949
Air filter	1	29060950
0.5 IN TC x male luer Kit-AF-S	1	29403653

Accessories for ÄKTA flux 6	Quantity	Product code
Transfer pump	1	29094019
Permeate control pump	1	29094675
Pump tubing	1	29136668
Stirrer	1	29094677
Air filter	1	29094678
Check valve	1	29094679
Tank assembly	1	29094680
Line tubing kit	1	29094681
Kvick Lab holder II	1	29094674
Pressure sensor	1	29095152
Torque wrench 6	1	56411284
Drain valve kit	10	29097955
Connector 25 mm TC-UNF 5/16” male (short)	2	18117008

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For local office contact information, visit cytiva.com/contact

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