cytiva

CM **Sepharose** Fast Flow
DEAE **Sepharose** Fast Flow
Q **Sepharose** Fast Flow
SP **Sepharose** Fast Flow

Ion exchange resins

Instructions for Use

CM, DEAE, Q and SP Sepharose™ Fast Flow ion exchangers are part of the BioProcess™ resin product portfolio. Sepharose Fast Flow ion exchangers resins are developed for capture and intermediate purification of proteins in both research and industry applications. The following are characteristics of Sepharose FF resins:

- High binding capacity and good flow properties
- High chemical and physical stabilities in combination with predictable scale-up
- Reliable and reproducible performance
- Easy and effective cleaning-in-place (CIP)/sanitization
- Various, convenient prepacked column formats
- Security of supply and comprehensive regulatory support

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Read these instructions carefully before using the products.

Safety

For use and handling of the products in a safe way, refer to the Safety Data Sheets.

1 BioProcess chromatography resins

BioProcess chromatography resins are developed and supported for production-scale chromatography. BioProcess resins are produced with validated methods and are tested to meet the manufacturing requirements. Secure ordering and delivery routines give a reliable supply of resins for production-scale. Regulatory Support Files (RSF) are available to assist the process validation and submissions to regulatory authorities. BioProcess resins cover all purification steps from capture to polishing.

2 Characteristics of Sepharose Fast Flow ion exchangers

Introduction

The base matrix of Sepharose Fast Flow ion exchangers is highly cross-linked agarose which gives the ion exchangers high chemical and physical stability. The characteristics such as capacity, elution behavior and pressure/flow rate are unaffected by the solutions commonly used in process chromatography and the cleaning procedures.

The high physical stability gives good flow characteristics and low back pressures and the high matrix rigidity minimizes volume variations during change of pH or ionic strength. The flow velocities ranging from 300 to 700 cm/h through a bed height of 15 cm at a pressure of 1 bar are typical for these resins, see *Figure 1, on page 4*.

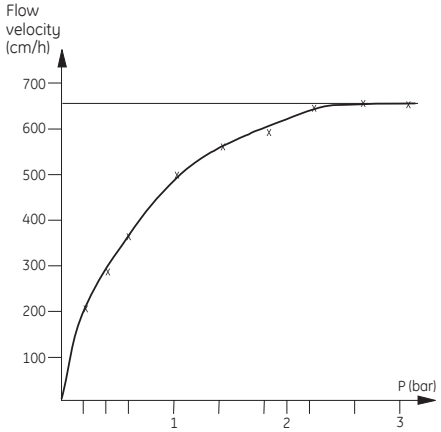

Fig 1. A typical pressure/flow velocity curve for Sepharose Fast Flow ion exchangers.

Characteristics of CM Sepharose Fast Flow

CM Sepharose Fast Flow is a weak cation exchanger. The ion exchange group is a carboxy methyl group ($-O-CH_2COO^-$).

Table 1. Characteristics of CM Sepharose Fast Flow.

Matrix	Cross-linked agarose, 6%, spherical
Ion exchange type	Weak cation
Ionic capacity	0.09 to 0.13 mmol/mL resin
Particle size, d_{50v} [1]	~ 90µm
Pressure/flow characteristics[2]	300 to 600 cm/h at <0.1 MPa in a XK 50/30 column with 5 cm diameter and 15 cm bed height (at 25°C using buffers with the same viscosity as water)
Working temperature	4°C to 40°C

pH stability, operational[3]	4 to 13
pH stability, CIP[4]	2 to 14
pH of the fully charged ligand[5]	Above 6
Chemical stability[6]	Stable to commonly used aqueous buffers
	1.0 M NaOH[7] 8 M urea, 6 M guanidine hydrochloride, 70% ethanol
Storage	20% ethanol, 4°C to 30°C

1 Median particle size of the cumulative volume distribution.

2 The pressure/flow characteristics describes the relationship between pressure and flow under the set circumstances. The pressure given shall not be taken as the maximum pressure of the resin.

3 pH range where resin can be operated without significant change in the function.

4 pH range where resin can be subjected to cleaning- or sanitization-in-place without significant change in the function.

5 pH range where ligand is fully charged; although the ligand is fully charged throughout the range stated, only use the resin within the stated stability ranges.

6 Aviod oxidizing agents, cationic detergents and long exposure to pH <4.

7 1.0 M NaOH should only be used for cleaning purposes

The curve below shows the titration of CM Sepharose Fast Flow using sodium hydroxide and the pH range in which the CM group is charged.

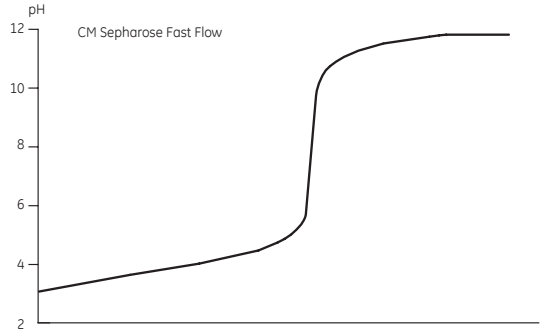

Fig 2. Titration curve of CM Sepharose Fast Flow.

Characteristics of DEAE Sepharose Fast Flow

DEAE Sepharose Fast Flow is a weak anion exchanger. The ion exchange group is a diethylaminoethyl group.

$-O-CH_2CH_2-N^+(C_2H_5)_2H$

Table 2. Characteristics of DEAE Sepharose Fast Flow.

Matrix	Cross-linked agarose, 6%, spherical
Ion exchange type	Weak anion
Ionic capacity	0.11 to 0.16 mmol/mL resin
Particle size, d_{50v} [1]	~ 90µm
Pressure/flow characteristisc[2]	300 to 600 cm/h at < 0.1 MPa in a XK 50/30 column with 5 cm diameter and 15 cm bed height (at 25°C using buffers with the same viscosity as water)
Working temperature	4°C to 40°C
pH stability, operational[3]	2 to 12
pH stability, CIP[4]	2 to 14

pH of the fully charged ligand[5]	Below 9
Chemical stability[6]	Stable to commonly used aqueous buffers 1.0 M NaOH[7] 8 M urea, 6 M guanidine hydrochloride, 70% ethanol
Storage	20% ethanol, 4°C to 30°C

1 Median particle size of the cumulative volume distribution.

2 The pressure/flow characteristics describes the relationship between pressure and flow under the set circumstances. The pressure given shall not be taken as the maximum pressure of the resin.

3 pH range where resin can be operated without significant change in the function.

4 pH range where resin can be subjected to cleaning- or sanitization-in-place without significant change in the function.

5 pH range where ligand is fully charged; although the ligand is fully charged throughout the range stated, only use the resin within the stated stability ranges.

6 Aviod oxidizing agents, anionic detergents and long exposure to pH <4.

7 1.0 M NaOH should only be used for cleaning purposes

The curve below shows the titration of DEAE Sepharose Fast Flow using sodium hydroxide and the pH range in which the DEAE group is charged.

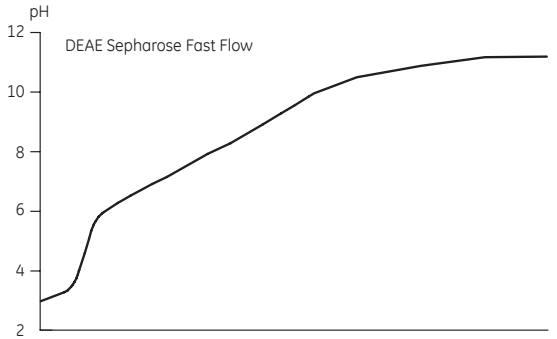

Fig 3. Titration curve of DEAE Sepharose Fast Flow

Characteristics of Q Sepharose Fast Flow

Q Sepharose Fast Flow is a strong anion exchanger. The ion exchange group is a quaternary amine group.

$-O-CH_2CHOHCH_2OCH_2CHOHCH_2N^+(CH_3)_3$

Table 3. Characteristics of Q Sepharose Fast Flow.

Matrix	Cross-linked agarose, 6%, spherical
Ion exchange type	Strong anion
Ionic capacity	0.18 to 0.24 mmol/mL resin
Particle size, d_{50v} [1]	~ 90µm
Pressure/flow characteristisc[2]	400 to 700 cm/h at < 0.1 MPa in a XK 50/30 column with 5 cm diameter and 15 cm bed height (at 25°C using buffers with the same viscosity as water)
Working temperature	4°C to 40°C
pH stability, operational[3]	2 to 12
pH stability, CIP[4]	2 to 14
pH of the fully charged ligand[5]	Entire pH range
Chemical stability[6]	Stable to commonly used aqueous buffers 1.0 M NaOH[7] 8 M urea, 6 M guanidine hydrochloride, 70% ethanol
Storage	20% ethanol, 4°C to 30°C

1 Median particle size of the cumulative volume distribution.

2 The pressure/flow characteristics describes the relationship between pressure and flow under the set circumstances. The pressure given shall not be taken as the maximum pressure of the resin.

3 pH range where resin can be operated without significant change in the function.

4 pH range where resin can be subjected to cleaning- or sanitization-in-place without significant change in the function.

5 pH range where ligand is fully charged; although the ligand is fully charged throughout the range stated, only use the resin within the stated stability ranges.

6 Avoid oxidizing agents, anionic detergents and long exposure to pH < 4.

7 1.0 M NaOH should only be used for cleaning purposes

The curve below shows the titration of Q Sepharose Fast Flow using sodium hydroxide and the broad pH range in which the Q group is charged.

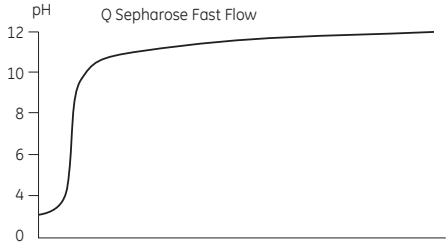

Fig 4. Titration curve of Q Sepharose Fast Flow

Characteristics of SP Sepharose Fast Flow

SP Sepharose Fast Flow is a strong cation exchanger. The ion exchange group is a sulphopropyl group, see below.

$-O-CH_2CHOHCH_2OCH_2CH_2CH_2SO_3^-$

Table 4. Characteristics of SP Sepharose Fast Flow.

Matrix	Cross-linked agarose, 6%, spherical
Ion exchange type	Strong cation
Ionic capacity	0.18 to 0.25 mmol/mL resin
Particle size, d_{50v} [1]	~90µm
Pressure/flow characteristics[2]	400 to 700 cm/h at <0.1 MPa in a XK 50/30 column with 5 cm diameter and 15 cm bed height (at 25°C using buffers with the same viscosity as water)
Working temperature	4°C to 40°C
pH stability, operational[3]	4 to 13
pH stability, CIP[4]	3 to 14
pH of the fully charged ligand[5]	Entire pH range
Chemical stability[6]	Stable to commonly used aqueous buffers 1.0 M NaOH[7] 8 M urea, 6 M guanidine hydrochloride, 70% ethanol

Storage	20% ethanol, 0.2 M sodium acetate, 4°C to 30°C

[1] Median particle size of the cumulative volume distribution.

[2] The pressure/flow characteristics describes the relationship between pressure and flow under the set circumstances. The pressure given shall not be taken as the maximum pressure of the resin.

[3] pH range where resin can be operated without significant change in the function.

[4] pH range where resin can be subjected to cleaning- or sanitization-in-place without significant change in the function.

[5] pH range where ligand is fully charged; although the ligand is fully charged throughout the range stated, only use the resin within the stated stability ranges.

[6] Aviod oxidizing agents, cationic detergents and long exposure to pH <4.

[7] 1.0 M NaOH should only be used for cleaning purposes

The curve below shows the titration of SP Sepharose Fast Flow using sodium hydroxide and the broad pH range in which the SP group is charged.

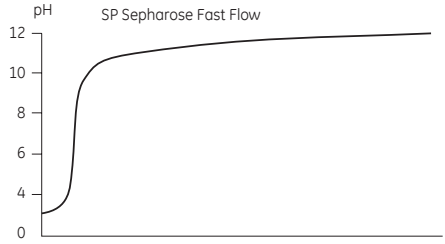

Fig 5. Titration curve of SP Sepharose Fast Flow.

3 Method optimization

Method optimization is performed at laboratory-scale. The aim of designing and optimizing an ion exchange separation process is to identify conditions that promote binding of the highest amount of target molecule, in shortest possible time and with the highest possible recovery and purity.

For certain proteins, depending on the pH, dynamic binding capacity (DBC) increases with increased conductivity. Therefore, scouting of both pH and conductivity for optimal binding conditions on the different IEX Sepharose Fast Flow resins is recommended. Flow velocity can also be included in the scouting.

Elution of the bound proteins can either be done by use of salt, pH, or a combination of both in the elution buffer. For optimization of the elution, sample load, flow velocity and gradient volume should be considered.

The best result is obtained using:

- Maximized sample load with respect to the dynamic binding capacity.
- Maximized flow velocity with respect to the system constraints and resin rigidity.
- The gradient elution volume that provides the best resolution with maximized sample load and maximized flow velocity.

Workflow using PreDictor™ plates

PreDictor™ plates are preferentially used in the method development. The PreDictor plates are 96-well filter plates pre-filled with chromatography resin, which can be used for rapid screening of chromatographic conditions in small scale, prior to further experiments in packed column formats, for example, prepacked HiScreen™ columns.

Fig 6. The workflow starts with screening of conditions in high throughput multiwell formats, followed by optimization, preferably by applying Design of Experiments (DoE), in small columns and finally scale-up to large columns.

Table 5. The experimental conditions to consider when designing and optimizing the process.

Phases	Activity	Conditions to consider
1. Equilibration of column and sample preparation	Equilibration of column and adjustment of sample	• pH • Conductivity • Column volume • Column bed height • Particle content • Temperature
2. Sample application	Manual or automatic application onto the column	• Flow rate • Sample pH • Sample conductivity • Upward/downward flow

Phases	Activity	Conditions to consider
3. Wash	Wash out unbound material with clean binding buffer	• Flow rate • Upward/downward flow • Buffer choice (normally same as column equilibration buffer)
4. Elution	Elute the material from the column either with salt or by change in pH	• Sample load • pH • Conductivity • Flow rate • Upward/downward flow

4 Scale-up

After optimizing the method at laboratory scale, the process can be scaled up. Scale-up to larger columns is typically performed by keeping the bed height and flow velocity (cm/h) constant while increasing the bed diameter and the flow rate.

If the residence time is kept constant, the binding capacity for the target molecule remains the same as in the method optimaization.

The residence time is approximated as the bed height (cm) divided by the linear flow velocity (cm/h) applied during sample loading.

Other factors, such as clearance of critical impurities, may change when column bed height is modified and should be validated using the final bed height.

Scale-up procedure

Step	Action
1	Choose the bed volume according to the required binding capacity. Keep sample concentration and gradient slope constant.
2	Choose the column diameter to obtain the bed height (10 to 40 cm) from the method optimization. The good rigidity of the high flow base matrix allows for flexibility in choice of bed heights.
3	Check the buffer delivery and monitoring systems for time delays or volume changes. ***Note:*** *The use of larger systems may cause some deviations from the optimized method at the small scale. The different lengths and diameters of outlet tubing can cause zone spreading on larger systems.*
4	Check the hardware compatibility and the resin pressure limits, to the expected pressure during the packing and operation.

5 Packing columns

Packing HiScale™ and XK columns

The following instructions are for packing HiScale 16/20, HiScale 26/20, XK 16/20 and XK 26/20 with 10 cm bed height.

For more details about the packing:

- HiScale columns, see *HiScale columns (16, 26, 50) and accessories* Instructions Product code: 28967470.
- XK columns, see Instruction, Product code: 28992023.
- AxiChrom™, BPG and Chromaflow™, see *Packing AxiChrom, BPG and Chromaflow columns, on page 19*.

Materials needed

Material / equipment needed	Description
Resin	CM Sepharose Fast Flow, or DEAE Sepharose Fast Flow, or Q Sepharose Fast Flow, or SP Sepharose Fast Flow.
Column	HiScale column or XK column and HiScale packing tube.
Equipment	• Chromatography system, such as ÄKTA™ system, or a stand-alone pump such as Pump P-900, depending on the required flow rate. • Pressure monitor • Vacuum suction equipment
Other materials	• Measuring cylinder • Filter flask • Distilled water • Glass filter G4 • Plastic spoon or spatula

Preparation of the slurry

To measure the slurry concentration, follow the instructions below (steps 1-2) or use the method for slurry concentration measurement described in *Application note*, Product code: 28925932.

This method can also be used for HiScale and XK columns.

Step	Action
1	Let the resin settle in 20% ethanol at least overnight in a measuring cylinder.
2	Measure the sedimented resin in the cylinder.
3	Calculate the slurry concentration.
4	Attach a glass filter funnel onto a filtering flask
5	Suspend the resin to a homogenous slurry by shaking.
6	Pour the resin into the funnel.
7	Wash 5 times with 5 mL distilled water/mL resin. ***Note:*** *Gently stir with a spatula at each wash step.*
8	Move the washed resin from the funnel into a beaker.
9	Add enough distilled water to obtain a 50% slurry concentration.

Packing preparations

Step	Action
1	Attach the packing tube to the top of the column and rinse with distilled water.
2	Attach the filter and the bottom piece on the column.
3	Wet the bottom filter by injecting 20% ethanol through the effluent tubing.

Step	Action
4	Assemble the column and the packing tube vertically on a laboratory stand and rinse them with distilled water.
5	Add distilled water, up to 2 cm over the column end piece and put a tubing clamp on the effluent tubing.
6	Pour all the slurry into the column and packing tube.
7	Top up the column with distilled water.

Packing procedure

Step	Action
1	Connect the pump outlet to the inlet on the packing tube and open the column outlet.
2	Pack the column with distilled water at a constant flow (see Table 6, first packing step) until the resin bed is stable.
3	Adjust the flow rate to 2x the final one (see Table 6, Second packing step) and decrease the flow rate step-wise until the pressure signal is 180 ± 20 kPa.
4	Pack the column at the flow rate which gives 180 ± 20 kPa for 45 minutes.
5	Disconnect the packing tube.

Step	Action
6	Carefully fill the rest of the column with distilled water to form an upward meniscus at the top and insert the flow adapter. ***Note:*** *The adapter should be adjusted down to the bed surface.*
7	Continue packing the column at 180 ± 20 kPa for 6 minutes.
8	Mark the position of the bed surface, on the column and stop the pump.
9	Close the column outlet and adjust the adapter to the bed surface.
10	Push the adapter a further 3 mm.

Table 6. Packing parameters

Parameters	HiScale or XK 16/20	HiScale or XK 26/20
Sedimented resin (mL)[1]	25	66
Slurry (mL)	50	132
Bed height (mm)	100	100
Flow rate (mL/min)[2]	2.0	5.0
Pressure (kPa)[3]	180±20	180±20
Final flow rate (mL/min)	~10	~25

[1] Sedimented resin volume = 1.25 × Packed resin volume.

[2] Recommended flow rate at first packing step.

[3] Pressure limit at second packing step.

Packing AxiChrom, BPG and Chromaflow columns

Refer to these documents:

- *Predictable scale-up through column design and robust packing methodology* (Product code: 28949052)
- *Constant Flow Packing Method* (Product code: 29001795)
- *Pack-in-place packing procedure* (Product code: 29001797)

Also, refer to data files:

- *AxiChrom columns* (Product code: 28929041)
- *BPG Columns* (Product code: 18111523)
- *Chromaflow columns* (Product code: 18113892)
- *Media Wand Media Handling Unit* (Product code: 28923101)
- *Slurry tanks* (Product code: 28978597)

6 Evaluation of packed column

Introduction

The packing quality needs to be checked by column efficiency testing. The test must be done after the packing, and at regular intervals during the working life of the column, and also when the separation performance is deteriorated.

Column efficiency testing

The best method of expressing the efficiency of a packed column is in terms of the height equivalent to a theoretical plate (HETP) and the asymmetry factor (A_s). The values are easily determined by applying a test sample such as 1% acetone solution or sodium chloride to the column.

Note: *Use a concentration of 0.8 M NaCl in water as sample and 0.4 M NaCl in water as eluent.*

The calculated plate number is depended on the test conditions and must only be used as a reference value. It is important that the test conditions and the equipment are the same so that the results are comparable.

Note: *Changing the solute, solvent, eluent, sample volume, flow velocity, liquid pathway, temperature, chromatography system, etc., influence the results.*

For more information about column efficiency testing, consult the application note *Column efficiency testing* (Product code: 28937207).

Sample volume and flow velocity

For optimal column efficiency results, the sample volume must be approximately 1% of the column volume and the flow velocity 30 cm/h. If an acceptance limit is defined in relation to column performance, the column plate number can be used as one of the acceptance criteria for the column use.

Method for measuring HETP and A_S

Calculate HETP and A_S from the UV curve (or conductivity curve) as follows:

$$HETP = \frac{L}{N}$$

L = bed height (cm)

N = number of theoretical plates

V_R = volume eluted from the start of sample application to the peak maximum.

$$N = 5.54 \times \left(\frac{V_R}{W_h}\right)^2$$

W_h = peak width measured as the width of the recorded peak at half of the peak height.

V_R and W_h are in the same units.

The concept of reduced plate height is often used for comparing column performance.

The reduced plate height, h, is calculated as follows:

$$h = \frac{HETP}{d_{50v}}$$

d_{50V} = Median particle size of the cumulative volume distribution (cm)

As a guideline, a value of < 3 is very good.

The peak must be symmetrical, and the asymmetry factor as close to 1 as possible. A typical acceptable range could be $0.8 < A_S < 1.8$.

A change in the shape of the peak is usually the first indication of bed deterioration due to excessive use.

Peak asymmetry factor calculation:

$$A_s = \frac{b}{a}$$

a = ascending part of the peak width at 10% of peak height

b = descending part of the peak width at 10% of peak height

The Figure below shows a UV trace for acetone in a typical test chromatogram from which the HETP and A_S values are calculated.

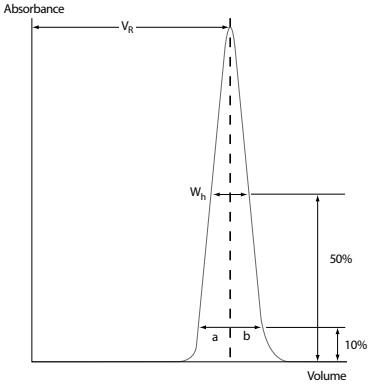

Fig 7. A typical test chromatogram showing the parameters used for HETP and A_S calculations.

7 Maintenance

For best performance of Sepharose Fast Flow ion exchangers over a long working life, follow the procedures described below.

Equilibration

After packing, and before a chromatographic run, equilibrate with 5 column volumes (CV) of start buffer or until the column effluent shows stable conductivity and pH values.

The equilibration step can be shortened by first washing with a high concentration buffer to obtain approximately the desired pH value and then washing with start buffer until the conductivity and pH values are stable.

Regeneration

After each separation, elute any reversibly bound material either with a high ionic strength solution (e.g., 1.0 M NaCl in buffer) or by increasing pH.

Regenerate the resin by washing with at least 5 bed volumes of buffer, or until the column effluent shows stable conductivity and pH values.

Cleaning-in-place (CIP)

Cleaning-in-place is a cleaning procedure that removes contaminants such as lipids, precipitates, or denatured proteins that may remain in the packed column after regeneration. Such contamination is especially likely when working with crude materials. Regular CIP prevents the build-up of these contaminants in the resin bed and helps to maintain the capacity, flow properties and general performance of the resin.

A specific CIP protocol should be designed for each process according to the type of contaminants present. The frequency of CIP depends of the nature and the condition of the starting material, but one CIP cycle is generally recommended every 1 to 5 separation cycles.

CIP protocols

When	Then
Ionically bound proteins	Wash with 0.5 CV filtered 2 M NaCl solution. Contact time 10 to 15 minutes. Reversed flow direction.
Precipitated, hydrophobically bound proteins or lipoproteins	Wash with 1.0 M NaOH at 40 cm/h. Contact time 1 to 2 hours.
Lipids and very hydrophobic proteins	Wash with 2 to 4 CV 0.5% non-ionic detergent (for example, 1 M acetic acid). Contact time 1 to 2 hours. Reversed flow direction. or, wash with 2 to 4 column volumes of up to 70% ethanol or 30% isopropanol. Contact time 1 to 2 hours. Reversed flow direction.

CAUTION
70% ethanol can require the use of explosion-proof areas and equipment.

Sanitization

To reduce microbial contamination in the packed column, sanitization using 0.5 to 1.0 M NaOH with a contact time of 1 hour is recommended.

For sanitization and removal of bound contaminants from the resin, see *Cleaning-in-place (CIP), on page 23*.

Storage

Product	Storage condition
CM Sepharose Fast Flow [1]	20% ethanol at 4°C to 30°C
DEAE Sepharose Fast Flow	20% ethanol at 4°C to 30°C
Q Sepharose Fast Flow [1]	20% ethanol at 4°C to 30°C
SP Sepharose Fast Flow [2]	20% ethanol, 0.2 M sodium acetate at 4°C to 30°C

[1] The resin can also be stored in 2% benzyl alcohol.

[2] SP Sepharose Fast Flow can also be stored in 2% benzyl alcohol, 0.2 M sodium acetate.

The unused resins are stored in container with the screw-top, fully tightened at 4°C to 30°C.

Note: *Before the use, equilibrate with at least five column volumes of the start buffer.*

8 Ordering information

Product	Quantity	Product code
CM Sepharose Fast Flow[1]	25 mL	17071910
	500 mL	17071901
	10 L	17071905
	60 L[2]	17071960
DEAE Sepharose Fast Flow	25 mL	17070910
	500 mL	17070901
	10 L	17070905
	60 L[2]	17070960
Q Sepharose Fast Flow[1]	25 mL	17051010
	300 mL	17051001
	5 L	17051004
	10 L	17051005
	60 L[2]	17051060

Product	Quantity	Product code
SP Sepharose Fast Flow[3]	25 mL	17072910
	300 mL	17072901
	5 L	17072904
	10 L	17072905
	60 L[2]	17072960

1 5 L, 10 L and 60 L, pack sizes in 2% benzyl alcohol, are available on request.

2 60 L pack size is available on request.

3 5 L, 10 L and 60 L, pack sizes in 2% benzyl alcohol and 0.2 M sodium acetate, are available on request. Contact your local Cytiva representative for further information.

Related products

Columns	Quantity	Product code
HiTrap™ CM FF	5 × 1 mL	17505601
	5 × 5 mL	17515501
HiPrep™ CM FF 16/10	1 × 20 mL	28936542
HiScreen DEAE FF	1 × 4.7 mL	28978245
HiTrap DEAE FF	5 × 1 mL	17505501
	5 × 5 mL	17515401
HiPrep DEAE FF 16/10	1 × 20 mL	28936541
HiScreen Q FF	1 × 4.7 mL	28950510
HiTrap Q FF	5 × 1 mL	17505301
	5 × 5 mL	17515601
HiPrep Q FF 16/10	1 × 20 mL	28936543
HiScreen SP FF	1 × 4.7 mL	28950513
HiTrap SP FF	5 × 1 mL	17505401
	5 × 5 mL	17515701
HiPrep SP FF 16/10	1 × 20 mL	28936544

Prepacked well plates and columns	Quantity	Product code
PreDictor Q Sepharose Fast Flow, 6 µL	4 × 96-well plates	28943269
PreDictor Q Sepharose Fast Flow, 20 µL	4 × 96-well plates	28943270
PreDictor Q Sepharose Fast Flow, 50 µL	4 × 96-well plates	28943271
PreDictor RoboColumn™ Q Sepharose Fast Flow, 200 µL	1 × 8-row columns	28986086
PreDictor RoboColumn Q Sepharose Fast Flow, 600 µL	1 × 8-row columns	28986180
PreDictor SP Sepharose Fast Flow, 6 µL	4 × 96-well plates	28943272
PreDictor SP Sepharose Fast Flow, 20 µL	4 × 96-well plates	28943273
PreDictor SP Sepharose Fast Flow, 50 µL	4 × 96-well plates	28943274
PreDictor RoboColumn SP Sepharose Fast Flow, 200 µL	1 × 8-row columns	28986104
PreDictor RoboColumn SP Sepharose Fast Flow, 600 µL	1 × 8-row columns	28986181

Empty column	Quantity	Code No.
Tricorn™ 5/100	1	28406410
Tricorn 10/100	1	28406415
HiScale 16/20	1	28964441
HiScale 16/40	1	28964424
HiScale 26/20	1	28964514
HiScale 26/40	1	28964513
HiScale 50/20	1	28964445
HiScale 50/40	1	28964444
Tricorn Glass Tube 5/100	1	18115306
Tricorn Packing Connector 5-5	1	18115321
Tricorn Packing Equipment 10/100	1	18115325
Packing tube 20 (HiScale 16)	1	28986816
Packing tube 40 (HiScale 16)	1	28986815
Packing tube 20 (HiScale 26)	1	28980383
Packing tube 40 (HiScale 26)	1	28964505
Packing tube 20 (HiScale 50)	1	28980251
Packing tube 40 (HiScale 50)	1	289645-06

Literature	Product code
Data File: Sepharose Fast Flow ion exchange media and prepacked formats	18117722
Handbook: Ion Exchange Chromatography, Principles and Methods	11000421
Handbook: High throughput process development with PreDictor plates	28940358
Instructions: Tricorn Empty High Performance Columns	28409488

Literature	Product code
Instructions: HiScale columns (16, 26, 50) and accessories	28967470
Application note: Column efficiency testing	28937207

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71500964 AH V:5 06/2020