CM Sepharose™ Fast Flow
DEAE Sepharose Fast Flow
Q Sepharose Fast Flow
SP Sepharose Fast Flow

CM, DEAE, Q and SP Sepharose Fast Flow ion exchangers are part of the BioProcess™ media product portfolio. These chromatography media (resins) reflects the important role they play in protein purification today. The reliability and well documented performance of these media, have made them a common choice for capture and intermediate purification of proteins in both research and industry. Sepharose Fast Flow ion exchangers offer many practical advantages:

- 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

Table of Contents

Please read these instructions carefully before using the products.

Safety

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

1 BioProcess chromatography media

BioProcess chromatography media are developed and supported for production scale chromatography. All BioProcess chromatography media are produced with validated methods and are tested to meet manufacturing requirements. Secure ordering and delivery routines give a reliable supply of chromatography media for production scale. Regulatory Support Files (RSF) are available to assist process validation and submissions to regulatory authorities. BioProcess media 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. This means that characteristics such as capacity, elution behavior and pressure/ flow rate are unaffected by the solutions commonly used in process chromatography and cleaning procedures, for details see table under each respective ion exchanger. High physical stability gives good flow characteristics and low back pressures. Flow velocities ranging between 300 and 700 cm/h through a bed height of 15 cm at a pressure of 1 bar are typical for these media, see *Figure 1*. Furthermore, the high rigidity of the matrix minimizes volume variations during change of pH or ionic strength.

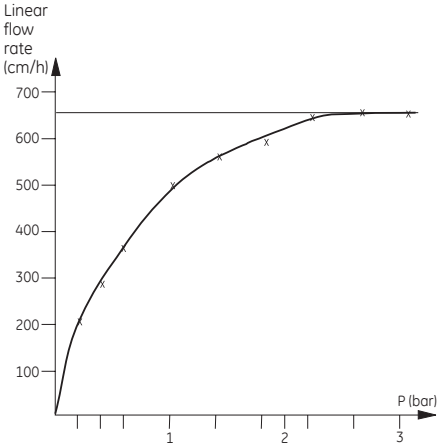

Fig 1. A typical pressure/flow rate curve for Sepharose Fast Flow ion exchangers.

Characteristics of CM Sepharose Fast Flow

CM Sepharose Fast Flow is a weak cation exchanger. The ion exchange group is a carboxy methyl group, see below.

$-O-CH_2COO^-$

Table 1. Characteristics of CM Sepharose Fast Flow.

Property	Description
Ion exchange type	Weak cation
Total ionic capacity	0.09 to 0.13 mmol/ml medium
Matrix	Cross-linked agarose, 6%
Average particle size (d_{50v}) [1]	90 µm
Flow velocity	300 to 600 cm/h (15 cm bed height, 1 bar, 25°C, XK 50/30 column)
Working temperature	4°C to 40°C
pH stability [2]	2 to 14 (Cleaning-in-place) 4 to 13 (Working range)
Chemical stability	All commonly used aqueous buffers 1 M NaOH, 8 M urea, 6 M guanidine hydrochloride, 70% ethanol
Avoid	Oxidizing agents, cationic detergents Long exposures (1 week, 20°C) to pH <4
Storage temperature	4°C to 30°C
Storage buffer [3]	20% ethanol

[1] d_{50v} is the median particle size of the cumulative volume distribution.

[2] Working range: pH interval where the medium can be operated without significant change in function.

Cleaning-in-place: pH stability where the medium can be subjected to cleaning-in-place without significant change in function.

[3] Large pack sizes of CM Sepharose Fast Flow in 2% benzyl alcohol are available on request. Contact your local GE representative for further information.

The titration curve in *Figure 2* shows the pH working range of CM Sepharose Fast Flow, i.e., the pH range in which the CM group is charged.

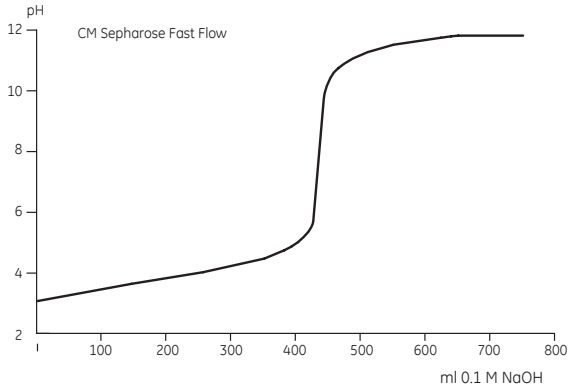

Fig 2. Titration curve of CM Sepharose Fast Flow.

Characteristics of DEAE Sepharose Fast Flow

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

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

Table 2. Characteristics of DEAE Sepharose Fast Flow.

Property	Description
Ion exchange type	Weak anion
Total ionic capacity	0.11 to 0.16 mmol/ml medium
Matrix	Cross-linked agarose, 6%
Average particle size (d_{50v}) [1]	90 µm
Flow velocity	300 to 600 cm/h (15 cm bed height, 1 bar, 25°C, XK 50/30 column)
Working temperature	4°C to 40°C
pH stability [2]	2 to 14 (Cleaning-in-place) 2 to 12 (Working range)
Chemical stability	All commonly used aqueous buffers 1 M NaOH, 8 M urea, 6 M guanidine hydrochloride, 70% ethanol
Avoid	Oxidizing agents, anionic detergents Long exposures (1 week, 20°C) to pH <4
Storage temperature	4°C to 30°C
Storage buffer	20% ethanol

[1] d_{50v} is the median particle size of the cumulative volume distribution.

[2] Working range: pH interval where the medium can be operated without significant change in function.

Cleaning-in-place: pH stability where the medium can be subjected to cleaning-in-place without significant change in function.

The titration curve in *Figure 3* shows the pH working range of DEAE Sepharose Fast Flow, i.e., the pH range in which the DEAE group is charged.

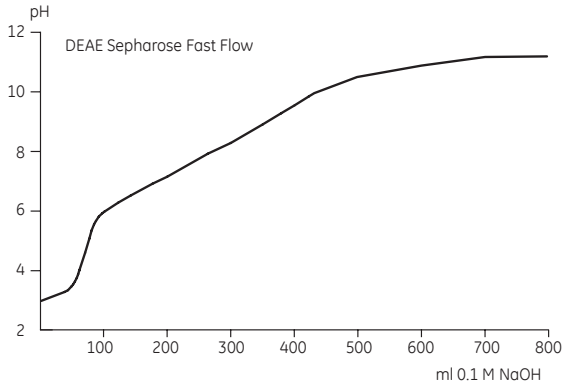

Fig 3. Titration curve of DEAE Sepharose Fast Flow.

Characteristics of Q Sepharose Fast Flow

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

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

Table 3. Characteristics of Q Sepharose Fast Flow.

Property	Description
Ion exchange type	Strong anion
Total ionic capacity	0.18 to 0.25 mmol/ml medium
Matrix	Cross-linked agarose, 6%
Average particle size (d_{50v}) [1]	90 µm
Flow velocity	400 to 700 cm/h (15 cm bed height, 1 bar, 25°C, XK 50/30 column)
Working temperature	4°C to 40°C
pH stability [2]	2 to 14 (Cleaning-in-place) 2 to 12 (Working range)
Chemical stability	All commonly used aqueous buffers 1 M NaOH, 8 M urea, 6 M guanidine hydrochloride, 70% ethanol
Avoid	Oxidizing agents, anionic detergents Long exposures (1 week, 20°C) to pH <4
Storage temperature	4°C to 30°C
Storage buffer [3]	20% ethanol

[1] d_{50v} is the median particle size of the cumulative volume distribution.

[2] Working range: pH interval where the medium can be operated without significant change in function.

Cleaning-in-place: pH stability where the medium can be subjected to cleaning-in-place without significant change in function.

[3] Large pack sizes of Q Sepharose Fast Flow in 2% benzyl alcohol are available on request. Contact your local GE representative for further information.

The titration curve in *Figure 4* shows the broad pH working range of Q Sepharose Fast Flow, i.e., the pH range in which the Q group is charged.

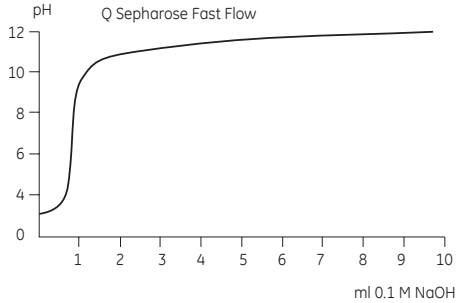

Fig 4. Titration curve of Q Sepharose Fast Flow.

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.

Property	Description
Ion exchange type	Strong cation
Total ionic capacity	0.18 to 0.25 mmol/ml medium
Matrix	Cross-linked agarose, 6%
Average particle size (d_{50v}) [1]	90 µm
Flow velocity	400 to 700 cm/h (15 cm bed height, 1 bar, 25°C, XK 50/30 column)
Working temperature	4°C to 40°C
pH stability [2]	3 to 14 (Cleaning-in-place) 4 to 13 (Working range)
Chemical stability	All commonly used aqueous buffers 1 M NaOH, 8 M urea, 6 M guanidine hydrochloride, 70% ethanol
Avoid	Oxidizing agents, cationic detergents Long exposures (1 week, 20°C) to pH <4
Storage temperature	4°C to 30°C
Storage buffer [3]	20% ethanol, 0.2 M sodium acetate

[1] d_{50v} is the median particle size of the cumulative volume distribution.

[2] Working range: pH interval where the medium can be operated without significant change in function.

Cleaning-in-place: pH stability where the medium can be subjected to cleaning-in-place without significant change in function.

[3] Large pack sizes of Q Sepharose Fast Flow in 2% benzyl alcohol, 0.2 M sodium acetate, are available on request. Contact your local GE representative for further information.

The titration curve in *Figure 5* shows the broad pH working range of SP Sepharose Fast Flow, i.e., the pH range in which the SP group is charged.

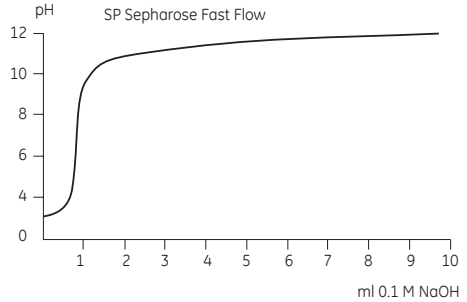

Fig 5. Titration curve of SP Sepharose Fast Flow.

3 Method optimization

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 the shortest possible time with highest possible product recovery and purity. Design the method in laboratory scale.

For certain proteins, dynamic binding capacities increase at increased conductivity and this is pH dependent. Therefore, scouting of both pH and conductivity for optimal dynamic binding conditions on the different IEX Sepharose Fast Flow media is recommended. Flow velocity can also be included in the scouting.

Elution of protein can either be done by use of salt, pH or a combination of both. For optimization of the elution, sample load, flow velocity and gradient volume should be considered. The three factors are interrelated and best results will be obtained using:

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

The use of PreDictor™ plates is preferentially included in the method development. The PreDictor plates are 96-well filter plates pre-filled with chromatography media, which can be used for rapid screening of chromatographic conditions in small scale. The suggested workflow with PreDictor plates is shown in Figure 6, where a large design space can be explored prior to further experiments in packed column formats, such as prepacked HiScreen™ columns.

Fig 6. The recommended workflow is described in the figure. It starts with screening of conditions in high throughput 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 is typically performed by keeping bed height and diameter and volumetric flow rate. However, since optimization is preferentially performed with small column volumes, in order to save sample and buffer, some parameters such as the dynamic binding capacity may be optimized using shorter bed heights than those being used in the final scale. As long as the residence time is kept constant, the binding capacity for the target molecule remains the same.

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

Procedure

Step	Action
1	Select bed volume according to required binding capacity. Keep sample concentration and gradient slope constant.
2	Select column diameter to obtain the bed height (10 to 40 cm) from method optimization. The good rigidity of the high flow base matrix allows for flexibility in choice of bed heights.
3	The larger equipment used when scaling up may cause some deviations from the method optimized at small scale. In such cases, check the buffer delivery and monitoring systems for time delays or volume changes. Different lengths and diameters of outlet tubing can cause zone spreading on larger systems. Check also the compatibility of the hardware and chromatography media pressure limits with expected pressure during packing and operation.

5 Packing columns

Packing HiScale™ and XK columns

Introduction

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 packing HiScale columns, see instructions *HiScale columns (16, 26, 50) and accessories* (28-9674-70).

For more details about packing XK columns, see Instruction 28-9920-23.

For documents describing packing of AxiChrom™, BPG™ and Chromaflow™, see *Packing AxiChrom, BPG and Chromaflow columns, on page 19*.

Materials needed

- CM Sepharose Fast Flow, or
  DEAE Sepharose Fast Flow, or
  Q Sepharose Fast Flow, or
  SP Sepharose Fast Flow
- HiScale column or XK column
- HiScale packing tube
- Plastic spoon or spatula
- Glass filter G4
- Vacuum suction equipment
- Filter flask
- Measuring cylinder
- Distilled water

Equipment

- Chromatography system, such as ÄKTA™ system, or a stand-alone pump such as Pump P-900, depending on the flow rate required, can be used for packing.
- Pressure monitor

Equilibrate all materials to room temperature.

Preparation of the slurry

To measure the slurry concentration, let the medium settle in 20% ethanol at least overnight in a measuring cylinder or use the method for slurry concentration measurement described in application note 28-9259-32. This method can also be used for HiScale and XK columns.

Washing the medium

Mount a glass filter funnel onto a filtering flask. Suspend the medium by shaking and pour into the funnel and wash according to the following instructions:

Step	Action
1	Wash 5 times with 5 ml distilled water/ml medium.
2	Gently stir with a spatula between additions.
3	Move the washed medium from the funnel into a beaker and add distilled water to obtain a 50% slurry concentration.

Packing preparations

Step	Action
1	Mount the packing reservoir at the top of the column and rinse with distilled water.
2	Mount filter and bottom piece on the column.

Step	Action
3	Wet the bottom filter by injecting 20% ethanol through the effluent tubing.
4	Mount the column and packing reservoir vertically on a laboratory stand. Rinse them with distilled water.
5	Apply distilled water 2 cm over the column end piece and put a tubing clamp on the effluent tubing.
6	Pour all the separation media slurry into the column and packing reservoir and top up carefully with distilled water.

Packing procedure

Step	Action
1	Connect the pump outlet to the inlet on the packing reservoir and open the column outlet.
2	Pack the column with distilled water at a constant flow (see Table 3, Step 1) until the medium bed is stable.
3	Adjust the flow rate to 2x the final one (see Table 3, Step 2) and decrease it step-wise until the pressure signal is 180 ± 20 kPa. Pack the column at the flow rate which gives 180 ± 20 kPa for 45 minutes.
4	Dismount the packing reservoir.
5	Carefully fill the rest of the column with distilled water to form an upward meniscus at the top and insert the flow adapter. The adapter should be adjusted down to the bed surface.
6	Continue packing the column at 180 ± 20 kPa for 6 minutes.
7	Mark on the column the position of the bed surface, stop the pump, close the column outlet and adjust the adapter to the bed surface and then push the adapter a further 3 mm.

Table 6. Packing parameters

Column	Sedim.[1] medium (ml)	Slurry (ml)	Height (mm)	Step 1 (ml/min)	Step 2 (kPa)	Final flow rate (ml/min)
HiScale or XK 16/20	25	50	100	2.0	180±20	~10
HiScale or XK 26/20	66	132	100	5.0	180±20	~25

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

Packing AxiChrom, BPG and Chromaflow columns

Refer to these documents:

- *Predictable scale-up through column design and robust packing methodology* (28-9490-52)
- *Constant Flow Packing Method* (29-0017-95)
- *Pack-in-place packing procedure* (29-0017-97)

Also, refer to these data files:

- *AxiChrom columns* (28-9290-41)
- *BPG Columns* (18-1115-23)
- *Chromaflow columns* (18-1138-92)
- *Media Wand Media Handling Unit* (28-9231-01)
- *Slurry tanks* (28-9785-97)

6 Evaluation of column packing

Intervals

Test the column efficiency to check the quality of packing. Testing should be done after packing and at regular intervals during the working life of the column and also when separation performance is seen to deteriorate.

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). These values are easily determined by applying a sample such as 1% acetone solution to the column. Sodium chloride can also be used as a test substance. Use a concentration of 0.8 M NaCl in water as sample and 0.4 M NaCl in water as eluent.

For more information about column efficiency testing, consult the application note *Column efficiency testing* (28-9372-07).

Note: *The calculated plate number will vary according to the test conditions and it should only be used as a reference value. It is important that test conditions and equipment are kept constant so that results are comparable. Changes of solute, solvent, eluent, sample volume, flow velocity, liquid pathway, temperature, etc. will influence the results.*

Sample volume and flow velocity

For optimal results, the sample volume should 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 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

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

V_R = volume eluted from the start of sample application to the peak maximum
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} = mean diameter of the beads (cm)

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

The peak should 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.

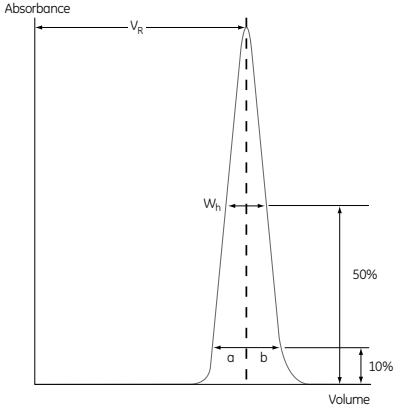

Fig 7. A typical test chromatogram showing the parameters used for HETP and A_s calculations.

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 start buffer by washing with five bed volumes 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 M NaCl in buffer) or by increasing pH. Regenerate the medium 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 also prevents the build-up of these contaminants in the medium bed and helps to maintain the capacity, flow properties and general performance of the medium.

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

Ionically bound proteins	Wash with 0.5 column volumes of filtered 2 M NaCl. Contact time 10 to 15 min. Reversed flow direction.
Precipitated, hydrophobically bound proteins or lipoproteins	Wash with 1 M NaOH at 40 cm/h. Contact time 1 to 2 hours.
Lipids and very hydrophobic proteins	Wash with 2 to 4 column volumes of 0.5% non-ionic detergent (e.g., 1 M acetic acid). Contact time 1 to 2 hours. Reversed flow direction. Alternatively, wash with 2 to 4 column volumes of up to 70% ethanol [1] or 30% isopropanol. Contact time 1 to 2 hours. Reversed flow direction.

[1] Specific regulations may apply when using 70% ethanol since the use of explosion proof areas and equipment may be required.

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. The CIP protocols above will sanitize the medium as well as remove bound contaminants.

Sterilization

Autoclaving is the only recommended sterilization treatment.

Step	Action
1	Equilibrate the medium with 0.5 M NaCl, pH 7.
2	Dismantle the column and autoclave the medium at 120°C for 30 minutes.
3	Sterilize the column parts according to the instructions in the column manual.
4	Re-assemble the column.
5	Pack and test the columns as recommended.

Storage

- CM Sepharose Fast Flow: 20% ethanol at 4°C to 30°C
- DEAE Sepharose Fast Flow: 20% ethanol at 4°C to 30°C
- Q Sepharose Fast Flow: 20% ethanol at 4°C to 30°C
- SP Sepharose Fast Flow: 20% ethanol, 0.2 M sodium acetate at 4°C to 30°C

Unused media can be stored in the container at 4°C to 30°C. Make sure that the screw-top is fully tightened.

After storage, equilibrate with at least five column volumes of start buffer.

Note: *CM Sepharose Fast Flow and Q Sepharose Fast Flow can also be stored in 2% benzyl alcohol.*
SP Sepharose Fast Flow can also be stored in 2% benzyl alcohol, 0.2 M sodium acetate.

8 Ordering information

Product	Quantity	Code No.
CM Sepharose Fast Flow	25 ml	17-0719-10
	500 ml	17-0719-01
	10 l	17-0719-05
	60 l	17-0719-60
DEAE Sepharose Fast Flow	25 ml	17-0709-10
	500 ml	17-0709-01
	10 l	17-0709-05
	60 l	17-0709-60
Q Sepharose Fast Flow	25 ml	17-0510-10
	300 ml	17-0510-01
	5 l	17-0510-04
	10 l	17-0510-05
	60 l	17-0510-60
SP Sepharose Fast Flow	25 ml	17-0729-10
	300 ml	17-0729-01
	5 l	17-0729-04
	10 l	17-0729-05
	60 l	17-0729-60

Note: *5 l, 10 l and 60 l pack sizes of CM Sepharose Fast Flow and Q Sepharose Fast Flow in 2% benzyl alcohol and SP Sepharose Fast Flow in 2% benzyl alcohol and 0.2 M sodium acetate are available on request. Contact your local GE representative for further information.*

Related products

Prepacked 96-weel plates and columns

Product	Quantity	Code No.
HiTrap™ CM FF	5 × 1 ml	17-5056-01
	5 × 5 ml	17-5155-01
HiPrep™ CM FF 16/10	1 × 20 ml	28-9365-42
HiScreen DEAE FF	1 × 4.7 ml	28-9782-45
HiTrap DEAE FF	5 × 1 ml	17-5055-01
	5 × 5 ml	17-5154-01
HiPrep DEAE FF 16/10	1 × 20 ml	28-9365-41
PreDictor Q Sepharose Fast Flow, 6 µl	4 × 96-well plates	28-9432-69
PreDictor Q Sepharose Fast Flow, 20 µl	4 × 96-well plates	28-9432-70
PreDictor Q Sepharose Fast Flow, 50 µl	4 × 96-well plates	28-9432-71
PreDictor RoboColumn™ Q Sepharose Fast Flow, 200 µl	1 × 8-row columns	28-9860-86
PreDictor RoboColumn Q Sepharose Fast Flow, 600 µl	1 × 8-row columns	28-9861-80
HiScreen Q FF	1 × 4.7 ml	28-9505-10
HiTrap Q FF	5 × 1 ml	17-5053-01
	5 × 5 ml	17-5156-01
HiPrep Q FF 16/10	1 × 20 ml	28-9365-43
PreDictor SP Sepharose Fast Flow, 6 µl	4 × 96-well plates	28-9432-72
PreDictor SP Sepharose Fast Flow, 20 µl	4 × 96-well plates	28-9432-73
PreDictor SP Sepharose Fast Flow, 50 µl	4 × 96-well plates	28-9432-74
PreDictor RoboColumn SP Sepharose Fast Flow, 200 µl	1 × 8-row columns	28-9861-04
PreDictor RoboColumn SP Sepharose Fast Flow, 600 µl	1 × 8-row columns	28-9861-81
HiScreen SP FF	1 × 4.7 ml	28-9505-13
HiTrap SP FF	5 × 1 ml	17-5054-01
	5 × 5 ml	17-5157-01
HiPrep SP FF 16/10	1 × 20 ml	28-9365-44

Empty columns

Product	Quantity	Code No.
Tricorn™ 5/100 column	1	28-4064-10
Tricorn 10/100 column	1	28-4064-15
HiScale 16/20	1	28-9644-41
HiScale 16/40	1	28-9644-24
HiScale 26/20	1	28-9645-14
HiScale 26/40	1	28-9645-13
HiScale 50/20	1	28-9644-45
HiScale 50/40	1	28-9644-44
Tricorn Glass Tube 5/100	1	18-1153-06
Tricorn Packing Connector 5-5	1	18-1153-21
Tricorn Packing Equipment 10/100	1	18-1153-25
Packing tube 20 (HiScale 16)	1	28-9868-16
Packing tube 40 (HiScale 16)	1	28-9868-15
Packing tube 20 (HiScale 26)	1	28-9803-83
Packing tube 40 (HiScale 26)	1	28-9645-05
Packing tube 20 (HiScale 50)	1	28-9802-51
Packing tube 40 (HiScale 50)	1	28-9645-06

Literature

Product	Code No.
Data File: Sepharose Fast Flow ion exchange media and prepacked formats	18-1177-22
Handbook: Ion Exchange Chromatography & Chromatofocusing, Principles and Methods	11-0004-21
Handbook: High throughput process development with PreDictor plates	28-9403-58
Instructions: Tricorn Empty High Performance Columns	28-4094-88
Instructions: HiScale columns (16, 26, 50) and accessories	28-9674-70
Application note: Column efficiency testing	28-9372-07

For local office contact information, visit
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