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

Ion exchange chromatography resins

Instructions for Use

The CM, DEAE, Q, and SP Sepharose™ Fast Flow (FF) ion exchange chromatography resins are part of the BioProcess™ resin product portfolio. Sepharose Fast Flow ion exchangers 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

Table of Contents

1 BioProcess chromatography resins 3
2 Resin properties 3
3 Method optimization 12
4 Scale-up 15
5 Packing columns 16
6 Evaluation of packed column 22
7 Maintenance 25
8 Ordering information 29

Important

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. All 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 Resin properties

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 *Fig. 1, on page 4*.

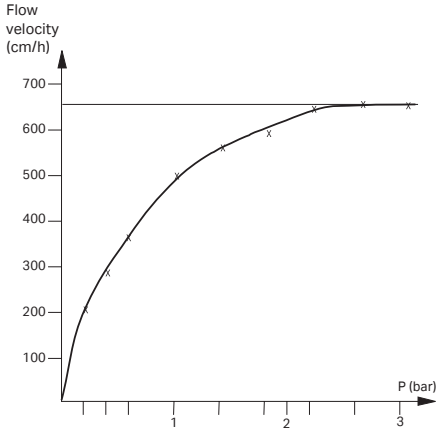

Fig 1. A typical pressure-flow curve for Sepharose Fast Flow ion exchangers.

Characteristics of CM Sepharose Fast Flow

CM Sepharose Fast Flow is a weak cation exchanger. The ion exchange group is a carboxymethyl 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	0.10 to 0.12 mmol H^+/mL resin
Particle size, d_{50v}[1]	~ 90 µm
Pressure-flow characteristics[2]	300 to 600 cm/h at < 0.1 MPa in an 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 in commonly used aqueous buffers: 1.0 M NaOH[7], 8 M urea, 6 M guanidine hydrochloride, 70% ethanol[8]
Storage	20% ethanol, 4°C to 30°C

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

[2] The pressure-flow characteristics describe 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 function.

[4] pH range where resin can be subjected to cleaning- or sanitization-in-place without significant change in 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, cationic detergents and long exposure to pH < 4.

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

[8] Consult local safety regulations to verify if safety precautions are required for the use of 70% ethanol.

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.

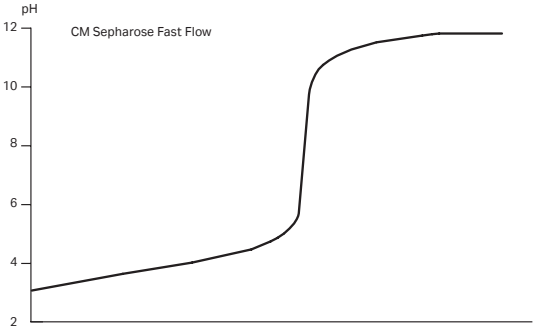

Fig 2. Titration curve of CM Sepharose Fast Flow.

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	0.12 to 0.15 mmol Cl^-/mL resin
Particle size, d_{50v}[1]	~ 90 µm
Pressure-flow characteristics[2]	300 to 600 cm/h at < 0.1 MPa in an 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 in commonly used aqueous buffers: 1.0 M NaOH[7], 8 M urea, 6 M guanidine hydrochloride, 70% ethanol[8]
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 function.

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

[8] Consult local safety regulations to verify if safety precautions are required for the use of 70% ethanol.

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.

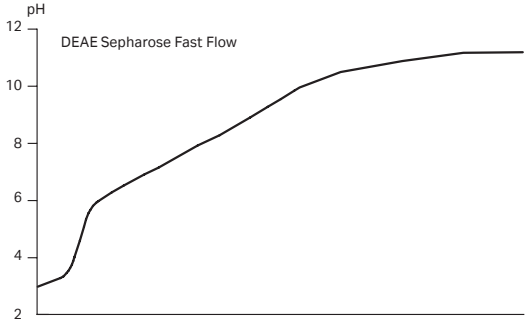

Fig 3. Titration curve of DEAE Sepharose Fast Flow.

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 Cl^-/mL resin
Particle size, d_{50v}[1]	~ 90 µm
Pressure-flow characteristics[2]	400 to 700 cm/h at < 0.1 MPa in an 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 in commonly used aqueous buffers: 1.0 M NaOH[7], 8 M urea, 6 M guanidine hydrochloride, 70% ethanol[8]
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 function.

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

[8] Consult local safety regulations to verify if safety precautions are required for the use of 70% ethanol.

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.

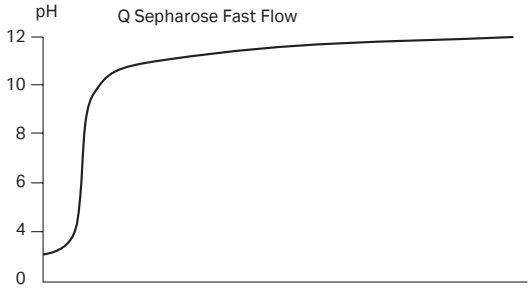

Fig 4. Titration curve of Q Sepharose Fast Flow

Characteristics of SP Sepharose Fast Flow

SP Sepharose Fast Flow is a strong cation exchanger. The ion exchange group is a sulfopropyl group: $-O-CH_2CHOHCH_2OCH_2CH_2CH_2SO_3^-$

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 H^+/mL resin
Particle size, d_{50v}[1]	~ 90 µm
Pressure-flow characteristics[2]	400 to 700 cm/h at < 0.1 MPa in an 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 in commonly used aqueous buffers: 1.0 M NaOH[7], 8 M urea, 6 M guanidine hydrochloride, 70% ethanol[8]
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 function.

4 pH range where resin can be subjected to cleaning- or sanitization-in-place without significant change in 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, cationic detergents and long exposure to pH < 4.

7 1.0 M NaOH should only be used for cleaning purposes

8 Consult local safety regulations to verify if safety precautions are required for the use of 70% ethanol.

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.

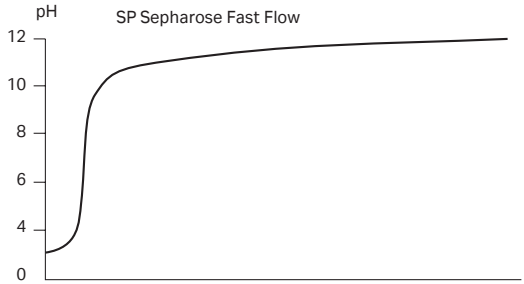

Fig 5. Titration curve of SP Sepharose Fast Flow.

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 providing the best resolution with maximized sample load and maximized flow velocity

Workflow using PreDictor plates

PreDictor™ plates are preferably 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 at small scale, prior to further experiments in packed column formats, for example, prepacked HiScreen™ columns.

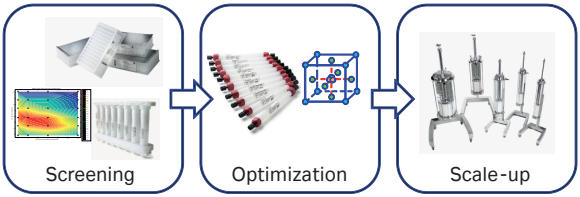

Fig 6. The workflow starts with screening of conditions in high throughput multiwell formats, followed by optimization, preferably by applying Design of Experiments (DoE), in small columns and finally scale-up to large columns.

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 • Upflow/downflow
3. Wash	Wash out unbound material with clean binding buffer	• Flow rate • Upflow/downflow • 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 • Upflow/downflow

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 optimization.

The residence time is calculated as the bed volume (mL) divided by the volumetric flow rate (mL/min) applied during sample loading.

Other factors, such as clearance of critical impurities, might change when column bed height is modified and need to 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.

Step	Action
3	Check the buffer delivery and monitoring systems for time delays or volume changes. ***Note:*** *The use of larger systems might cause some deviations from the optimized method at 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 packing and operation.

5 Packing columns

Packing HiScale and XK columns

The following instructions are for packing HiScale™ 10/40, 16/20, HiScale 26/20, XK 16/20, and XK 26/20 with 10 cm bed height.

For more details about packing:

- HiScale columns, refer to the Instructions *HiScale columns (10, 16, 26, 50) and accessories (28967470)*;
- XK columns, refer to the Instructions *XK 16, 26, 50 columns, RK 16/26, RK 50 packing reservoirs (28992023)*;
- AxiChrom™, BPG, and Chromaflow™ columns, see *Packing AxiChrom, BPG, and Chromaflow columns, on page 21*.

Materials needed

Material / equipment needed	Description
Resin	CM Sepharose Fast Flow, DEAE Sepharose Fast Flow, Q Sepharose Fast Flow, or SP Sepharose Fast Flow
Column	HiScale column or XK column
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 first three steps of the instructions below or use the method for slurry concentration measurement described in *Application note (CY13253)*. The 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.

Step	Action
2	Measure the sedimented resin in the measuring cylinder.
3	Calculate the slurry concentration.
4	Attach a glass filter funnel onto a filter flask
5	Shake the resin to suspend it into a homogenous slurry.
6	Pour the resin into the glass filter funnel.
7	Wash the slurry five times with 1 to 2 mL distilled water/mL resin. ***Note:*** *Gently stir with a spatula between each wash step.*
8	Transfer the washed slurry from the glass filter 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 to the column.

Step	Action
3	Wet the bottom filter by injecting 20% ethanol through the effluent tubing.
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 endpiece and attach a tubing clamp to 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, on page 21*, first packing step) until the resin bed is stable.
3	Adjust the flow rate to twice the final flow rate (see *Table 6, on page 21*) and decrease the flow rate step-wise until the pressure signal is 0.18 ± 0.02 MPa.
4	Pack the column at the flow rate which gives 0.18 ± 0.02 MPa for 45 minutes.

Step	Action
5	Disconnect the packing tube.
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:*** *Lower the adapter down to the bed surface.*
7	Continue packing the column at 0.18 ± 0.02 MPa for 6 minutes.
8	Mark the position of the bed surface on the column and stop the pump.
9	Close the column outlet and lower the adapter down to the bed surface.
10	Lower the adapter a further 3 mm into the resin bed.

Note: *It is recommended to perform CIP after packing, as column packing involves open handling of the resin.*

Table 6. Packing parameters

Parameters	Column inner diameter		
	10 mm[1]	**16 mm**	**26 mm**
Sedimented resin (mL)[2]	9.2	23	61
Slurry (mL)	18.4	46	122
Bed height (mm)	100	100	100
Flow rate (mL/min)[3]	0.8	2.0	5.0
Pressure (MPa)[4]	0.18 ± 0.02	0.18 ± 0.02	0.18 ± 0.02
Final flow rate (mL/min)	~ 4	~ 10	~ 25

[1] Only applies to HiScale.

[2] Sedimented resin volume = 1.15 × packed resin volume.

[3] Recommended flow rate at first packing step.

[4] Pressure limit at second packing step.

Packing AxiChrom, BPG, and Chromaflow columns

Refer to the following application notes:

- *Predictable scale-up through column design and robust packing methodology (CY13211)*

Also, refer to the following data files:

- *AxiChrom columns (CY10003)*
- *BPG columns (CY978)*
- *Chromaflow columns (CY13377)*
- *Media Wand Media Handling Unit (CY13577)*
- *Slurry tanks (CY14429)*

6 Evaluation of packed column

Introduction

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

For more information about column efficiency testing, refer to the application note *Column efficiency testing (CY13149)*.

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 column use.

Method for measuring HETP and A_S

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

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

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

L = bed height (cm)

N = number of theoretical plates

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} = median particle size of the cumulative volume distribution (cm)

As a guideline, an acceptance value of < 3 for (h) can be used.

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.

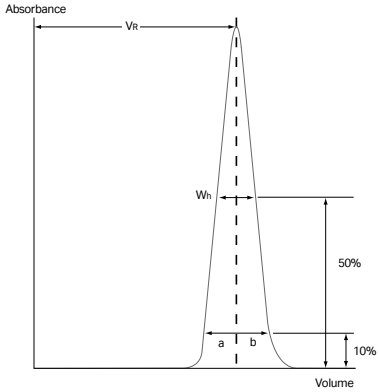

Fig 7. A typical test chromatogram showing the parameters used for HETP and A_S calculations.

Troubleshooting

If experiencing	Then
Low efficiency (i.e., N < 3000 plates per meter)	Repeat the packing procedure and retest the column.
Severe peak tailing (i.e., A_S > 1.3)	Repeat the compression phase and retest the column.
Severe peak fronting (i.e., A_S < 0.7)	Repeat the packing procedure and retest the column.

7 Maintenance

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

Equilibration

After packing and CIP, and before a chromatographic run, equilibrate with start buffer by washing with at least five column 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 target 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 changing the pH.

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

CIP

Regular CIP prevents the buildup of impurities or contaminants in the packed bed and helps to maintain capacity, flow properties, and general performance. A specific CIP protocol must be designed for each process according to the type of impurities or contaminants present.

It is recommended to perform a CIP:

- before first-time use – especially after packing the column – or after long-term storage
- between cycles
- when an increase in back pressure or a reduction in column performance is observed
- to prevent potential cross-contamination or carry-over, when the same column is used for purification of different proteins or protein lots and batches

Recommended protocols for removing specific contaminants or impurities are described below.

When	Then
Precipitated, hydrophobically bound proteins or lipoproteins	Wash with at least 3 CV of 1.0 M NaOH at 40 cm/h with reversed flow direction. Contact time 1 to 2 hours.
Ionically bound proteins	Wash with 0.5 CV of 2 M NaCl with reversed flow direction. Contact time 1 to 2 h.
Lipids and very hydrophobic proteins	Wash with 2 to 4 CV of 0.5% non-ionic detergent in e.g., 1 M acetic acid, with reversed flow direction. Contact time 1 to 2 h. Alternatively, wash with 2 to 4 CV of up to 70% ethanol or 30% isopropanol with reversed flow direction[1]. Contact time 1 to 2 h.

[1] Consult local safety regulations to verify if safety precautions are required for the use of 70% ethanol or 30% isopropanol.

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 *CIP, on page 26*. For more information about the use of NaOH for sanitization, refer to *Application note (CY13951)*.

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%, 0.2 M sodium acetate at 4°C to 30°C

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

[2] The resin can also be stored in 2% benzyl alcohol, 0.2 M sodium acetate.

Store unused resin in its container at 4°C to 30°C with the screw top fully tightened.

Note: *Before use, equilibrate with at least five CV of start buffer.*

8 Ordering information

Product	Pack size	Product code
CM Sepharose Fast Flow[1]	25 mL	17071910
	500 mL	17071901
	10 L[2]	17071905
	60 L[2]	17071960
DEAE Sepharose Fast Flow	25 mL	17070910
	500 mL	17070901
	10 L[2]	17070905
	60 L[2]	17070960
Q Sepharose Fast Flow[1]	25 mL	17051010
	300 mL	17051001
	5 L[2]	17051004
	10 L[2]	17051005
	60 L[2]	17051060
SP Sepharose Fast Flow[3]	25 mL	17072910
	300 mL	17072901
	5 L[2]	17072904
	10 L[2]	17072905
	60 L[2]	17072960

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

[2] 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

Prepacked columns	Pack size	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 PreDictor units	Pack size	Product code
96-well plates		
PreDictor Q Sepharose FF, 6 µL	4 × 96-well plates	28943269
PreDictor Q Sepharose FF, 20 µL	4 × 96-well plates	28943270
PreDictor Q Sepharose FF, 50 µL	4 × 96-well plates	28943271
PreDictor SP Sepharose FF, 6 µL	4 × 96-well plates	28943272
PreDictor SP Sepharose FF, 20 µL	4 × 96-well plates	28943273
PreDictor SP Sepharose FF, 50 µL	4 × 96-well plates	28943274
RoboColumn units		
PreDictor RoboColumn Q Sepharose FF, 200 µL	1 × 8-row columns	28986086
PreDictor RoboColumn Q Sepharose FF, 600 µL	1 × 8-row columns	28986180
PreDictor RoboColumn SP Sepharose FF, 200 µL	1 × 8-row columns	28986104
PreDictor RoboColumn SP Sepharose FF, 600 µL	1 × 8-row columns	28986181

Empty column	Pack size	Product code
Tricorn™ 5/100	1	28406410
Tricorn 10/100	1	28406415
HiScale 10/40	1	29360550
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 10	1	29360551
Packing tube 20, HiScale 16	1	28986816
Packing tube 20, HiScale 26	1	28980383
Packing tube 20, HiScale 50	1	28980251
Packing tube 40, HiScale 16	1	28986815
Packing tube 40, HiScale 26	1	28964505
Packing tube 40, HiScale 50	1	28964506

Related literature	Reference
Application notes	
Column efficiency testing	CY13149
Use of sodium hydroxide for cleaning and sanitization of chromatography resins and systems	CY13951
Data File	
Sepharose Fast Flow ion exchange resins and prepacked column formats	CY13444
Handbooks	
High-throughput process development with PreDictor plates, Principles and Methods	CY16051
Ion Exchange Chromatography, Principles and Methods	CY13983
Instructions	
HiScale columns (10, 16, 26, 50) and accessories	28967470
Tricorn Empty High Performance Columns	28409488

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