Operating Instructions

Strong cation exchange Chromatography Media
Cellufine™ MAX GS

Description
Cellufine MAX is the new name of 2nd generation Cellufine chromatography media. Cellufine MAX GS strong cation exchanger is highly cross-linked media with stable at high flow velocities and with optimized ligand density. These high performances offer significant opportunity for increasing downstream purification throughput, especially aggregate removal from therapeutic Mabs.

Characteristics of Cellufine MAX GS

Type	
Ion exchange type	Strong cation (graft polymer type)
Matrix	Highly cross-linked cellulose
Particle size	ca. 40 – 130 μm （Average 90）
Ion exchange capacity	0.09～0.15 m mol /ml
Flow velocity	600 cm/h(0.3 MPa) I.D.30 cm-L 20 cm, pure water at 24 °C
Adsorption capacity	≧100 mg / ml (Lysozyme)
Dynamic binding capacity	≧70 mg /ml (Polyclonal IgG 10 % DBC)
pH stability (20°C, 1week)	2 – 13
Chemical stability	Stable all commonly used aqueous buffers, 0.5 M NaOH
Storage	20 % ethanol

Packing to the column
1. Calculate volume required for the desired bed dimension.
   (a) Packed bed volume = column cross sectional area (cm^2) x bed height (cm)
   (b) Required sedimented gel volume = Packed bed volume x 1.1
   (c) The slurry concentration in the bottle of Cellufine MAX GS is approximately 50% in 20% ethanol.
2. Wash the gel with water or the appropriate buffer.
3. Prepare a 40 – 60 % (v/v) slurry with water, 0.1 M NaCl solution or the appropriate buffer. Equilibrate at ambient temperature for one hour.
4. Gently stir. If required place under vacuum to degas.
5. Column
   (a) A column is prepared according to the instructions from the column supplier.
   (b) The bed support should be wetted in a packing solution or 20% ethanol before use to remove air.
   (c) Pour the packing solution into the column tube and it check that solution flows out from the column exit. Shut the exit valve when approximately 0.5 to 1cm height of the solution remains.
6. Carefully pour the slurry into the column without creating air bubbles. Depending on the volume, a filler tube may be necessary.
7. Mount the top adapter on the top of column. (Be careful to not entrain air)
8. Open the column outlet and begin pumping elution buffer for 10 min at 1000cm/h or 0.3 MPa. Caution: do not excess the operation pressure limit for the selected column.

9. Mark the gel bed height. Stop the pump and shut the column outlet valve.
10. Disconnect the top adapter line from the pump. Loosen the adaptor seal and move the top adapter down to mark the gel bed reached at packing.
11. After the bed stabilizes, lock the adapter and reconnect the line from the pump. Equilibrate with 10 column volumes of adsorption buffer before sample loading.

Packing to the fixed length column

1. Calculate volume required of the desired bed dimension.
   (a) Packed bed volume= column cross sectional area (cm^2) x bed height (cm)
   (b) Required sedimented gel volume=Packed bed volume x 1.1
   (c) Note: When using a packing connector, the amount of excess gel corresponds to the required sedimentary gel volume.
   (d) The slurry concentration in the bottle of Cellufine MAX GS is approximately 50 % in 20 % ethanol.
2. Wash the gel with water or the appropriate buffer.
3. Prepare 40– 60 % (v/v) slurry with water or the appropriate buffer (high salt). Equilibrate at ambient temperature for one hour.
4. Gently stir. If required place under vacuum to degas.
5. Column
   (a) A column is prepared according to the instructions from the column supplier.
   (b) The bed support wetted in a packing solution or 20 % ethanol before use to remove air.
   (c) Pour the packing solution into the column tube and it check that solution flows out from the column exit. Shut the exit valve when approximately 0.5 to 1cm high of the solution remains.
6. Carefully pour the slurry into the column and packing connector without creating air bubbles. Depending on the volume, a filler tube may be necessary.
7. Mount the top adapter on the top of packing connector.
8. Open the column outlet and begin pumping elution buffer for 10 min at 1000cm/h or 0.3Mpa. Caution: do not excess the operation pressure limit for the selected column.
9. Stop the pump and shut the column outlet valve.
10. Disconnect the top adapter line from the pump. Remove the packing connector. Before remove excess medium from the packing connector, if necessary.
11. Mount the top adapter, lock the adapter and reconnect the line from the pump. Equilibrate with 10 column volumes of adsorption buffer before sample loading.

Evaluation of packing

See appendix 1

Operating Guidelines

General Operation

Typically, adsorption to Cellufine MAX Cation Exchange medium occurs in relatively low ionic strength (e.g., below 0.1 M NaCl) in the pH range from 4.0- 9.0 below the *pI* of the target protein.

The binding capacity is strongly affected by pH and conductivity. Under these conditions, proteins with neutral or net negative charge will bind. Bound components are then resolved by stepwise elution with buffers containing progressively higher salt concentration or by elution with a linear salt gradient.

Sample Preparation and Load

Prepare sample by centrifugation or microfiltration to remove insoluble material. Samples should be prepared to a concentration of 1 – 20 mg/ml, in binding buffer or at comparable

conditions of ionic strength and pH. If necessary, exchange sample buffer using dialysis, diafiltration or desalting chromatography.

Recommended Buffers
Adsorption buffer: 0.01–0.05 M sodium acetate (pH 4 to 6) or 0.01-0.05 M phosphate or Tris-HCl (pH 6 to 9)
Elution buffer: 0.1 – 2.0 M sodium chloride in adsorption buffer.
Other common buffer systems may be used. For additional information on chromatographic methods of protein purification, see References.

Regeneration and equilibration
After separation, wash the binding material with over 5-bed volumes of high ionic strength solution (1-2 M NaCl). After washing the column, pump an additional 5-bed volume of adsorption buffer, or until the column eluate will be stable pH and conductivity values.

Depyrogenation
Wash the column with 5-bed volumes of 0.2 M NaOH, let stand for 16 hours, and then wash with endotoxin-free water or equilibration buffer.
• 0.2 M NaOH-20% EtOH is effective for endotoxin removal. Moreover 0.2 M NaOH-90% EtOH can rapidly decrease LPS, with contact for at least 2 hours.

Chemical and Physical Stability
Stable in:
Most salts (NaCl, $(NH_4)_2SO_4$, etc.), Alcohol (30 % (v/v) IPA, 70 % (v/v) EtOH), Urea (6 M) and Guanidine-HCl (6 M)
pH 2-13 at 20 °C,1 week

Cleaning-in-place (CIP)
Cellufine MAX GS performance remains constant for at least 100 CIP operating cycles employing 0.5 M NaOH by 10 CV washing.

Flow Rate
Cellufine MAX GS is based on highly cross-linked cellulose gel, and are stable at high flow velocities.
1,000 cm/h in a 2.2 cm diameter column with 20cm bed height at < 0.3 MPa.
Over 500 cm/h 30 cm diameter column with 20 cm bed height at < .3 MPa.

Storage
Store unopened container at ambient temperature. Do not freeze.
Short-term storage for bulk and column (2 weeks or less) can be at a room temperature with pH 2 to pH 13. It is possible to store under alkaline condition at less than 20 °C as recommendation.
0.5 M NaOH ; for less than 2 weeks, at 20 ℃
Longer storage should be in neutral buffer containing 20 % ethanol, at 2 – 25 °C. Do not freeze.

Shelf Lifetime
5 years from date of manufacture

References
1. Harris, E.L.V. and Angal, S., *Protein Purification Methods: A practical Approach*. New York: Oxford University Press, 1989.
2. Janson, J.-C. and Ryden, L., *Protein Purification: Principles, High Resolution Methods, and Applications.* 2nd ed. New York: John Wiley & Sons, Inc., 1998

Product Ordering Information (Catalogue No.)

Media type	Pack Size					
	MC* 1mL x 5	MC 5mL x 5	100 mL	500 mL	5 L	10 L
Cellufine™ MAX GS	21300-51	21300-55	21300	21301	21302	21303

MC = Mini-Column

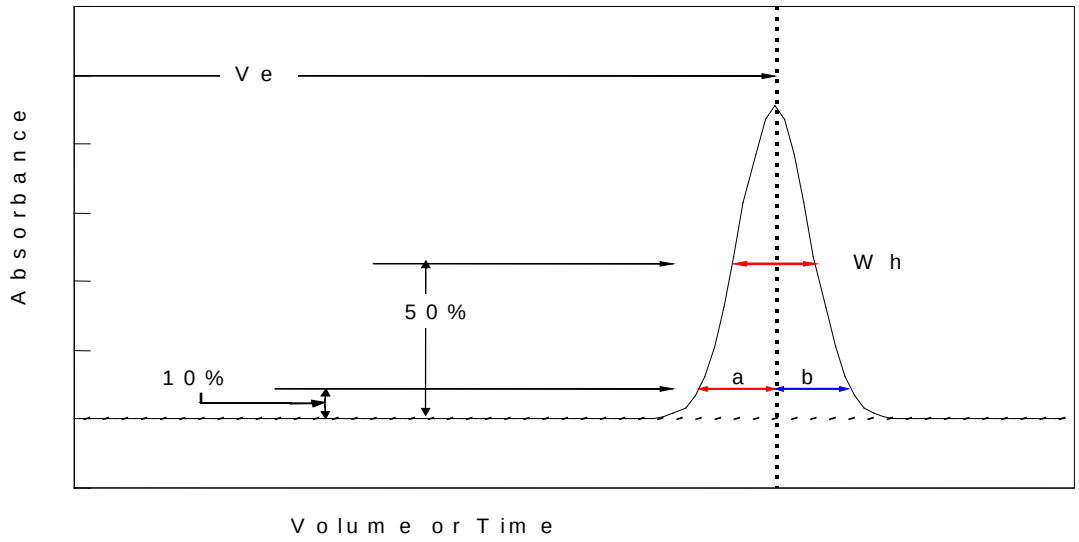
JNC CORPORATION
Life Chemicals Launch Office

2-1, Otemachi 2-Chome, Chiyoda-ku, Tokyo 100-8105, Japan
Phone +81-3-3243-6150, Fax+81-3-3234-6219
E-mail: cellufine@jnc-corp.co.jp
http://www.jnc-corp.co.jp/fine/en/cellufine

Appendix 1: Evaluation of column packing of Cellufine

Evaluation methods for the packing status of a column can employ indices, such as the number of (theoretical) plates (N), the height equivalents to a theoretical plate (HETP), and a symmetry factor (As).
The selected evaluation indices are affected by the measurement condition. For example, they vary with changes in the difference between the diameter/height of a column, the difference in piping, solvent sample volume, the flow velocity, temperature, etc.
Therefore, it is necessary to use the same measurement conditions each time.

Conditions	
Sample volume	1 %（MAX 2.5%）of column bed volume
Sample concentration	1-2 %(V/V)acetone or 1 M NaCl
Flow rate	~30 cm/h (X mL/hr/column cross section)
Detector	UV, conductivity



Formula
HETP = L/N
N = 5.54 x (Ve/Wh)^2
As = b/a

L	Column length [cm or m]
Ve	Elution time or volume
Wh	Half of width of peak
a,b	Peak width of 10% peak hight (a)front, (b)rear
Note	Ve,Wh and a, b should have same dimensional units

(Note)
Generally, a larger value of N is good. (Likewise a smaller value of HETP is good.)
The asymmetry factor value (As) should be close to 1. Generally, acceptable symmetry values range from 0.8-1.6.

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