

Shodex™

Capture the Essence



2022 HPLC Columns

Shodex™

We provide a wide range of products to meet your analytical needs, from pretreatment and separation columns to calibration standards for size exclusion chromatography. Please visit the Shodex website to see detailed information about our products and their uses with abundant application data.

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[Caution]

1. Please read the operating manual packaged with the product carefully before the use.
2. For improvement purposes, some specifications are subject to change without notice.
3. Figures and descriptions in this catalogue are provided to help you select appropriate columns. However they do not guarantee nor warrant the suitability for your applications.
4. It is essential to take normal precautions when handling reagents and other chemical products even if the safety information is not included in the operating manual.
5. Products described in this brochure are not intended for medical use or medical applications including medical diagnosis.

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Types of Columns, Base Materials, Functional Groups and Ligands

| Separation Type | | Product Name | Base Material | Functional Group, Ligand | Page |
|--|-------------------------------|---|----------------------------------|---------------------------|-----------|
| Reversed Phase & HILIC (Polymer-based) | | ODP2 HP | Polyhydroxymethacrylate | — | 12 |
| | Asahipak | ODP-50, ODP-90 20F | Polyvinyl alcohol | Octadecyl | 14 |
| | Asahipak | C4P-50 4D | Polyvinyl alcohol | Butyl | 14 |
| | RSpak | DS-613, DS-413 | Styrene divinylbenzene copolymer | — | 16 |
| | RSpak | DE-613, DE-413, DE-213 | Polymethacrylate | — | 16 |
| | RSpak | DM-614 | Polyhydroxymethacrylate | — | 16 |
| | RSpak | NN-814 | Polyhydroxymethacrylate | Sulfo | 16 |
| | RSpak | JJ-50 2D | Polyvinyl alcohol | Quaternary ammonium | 16 |
| | HILICpak | VG-50 | Polyvinyl alcohol | Amino | 18 |
| | HILICpak | VT-50 2D | Polyvinyl alcohol | Quaternary ammonium | 18 |
| | HILICpak | VC-50 2D | Polyvinyl alcohol | Carboxyl | 18 |
| | HILICpak | VN-50 | Polyvinyl alcohol | Diol | 18 |
| | Asahipak | NH2P-40, NH2P-50, NH2P-90 20F | Polyvinyl alcohol | Amino | 22 |
| | Reversed Phase (Silica-based) | | C18 | Silica | Octadecyl |
| Silica | | C18M | Silica | Octadecyl | 24 |
| | | C18U | Organic/inorganic hybrid silica | Octadecyl | 24 |
| Ligand Exchange | SUGAR | SC1011, SC1211 | Styrene divinylbenzene copolymer | Sulfo (Ca ²⁺) | 26 |
| | SUGAR | SP0810 | Styrene divinylbenzene copolymer | Sulfo (Pb ²⁺) | 26 |
| | SUGAR | KS-800 | Styrene divinylbenzene copolymer | Sulfo (Na ⁺) | 26 |
| | RSpak | DC-613 | Styrene divinylbenzene copolymer | Sulfo (Na ⁺) | 26 |
| | SUGAR | SZ5532 | Styrene divinylbenzene copolymer | Sulfo (Zn ²⁺) | 26 |
| | EP | SC1011-7F | Styrene divinylbenzene copolymer | Sulfo (Ca ²⁺) | 27 |
| | USPpak | MN-431 | Styrene divinylbenzene copolymer | Sulfo (Ca ²⁺) | 27 |
| Ion Exclusion | SUGAR | SH1011, SH1821 | Styrene divinylbenzene copolymer | Sulfo | 30 |
| | RSpak | KC-811 | Styrene divinylbenzene copolymer | Sulfo | 30 |
| Ion Chromatography | IC | NI-424, I-524A | Polyhydroxymethacrylate | Quaternary ammonium | 32 |
| | IC | SI-90, SI-50, SI-52, SI-35, SI-36 | Polyvinyl alcohol | Quaternary ammonium | 32, 33 |
| | IC | YS-50 | Polyvinyl alcohol | Carboxyl | 33 |
| | IC | YK-421 | Silica | Carboxyl | 33 |
| Aqueous SEC (GFC) | PROTEIN | KW-800 | Silica | Hydrophilic polymer | 36 |
| | | KW400 | Silica | Hydrophilic polymer | 36 |
| | PROTEIN | LW-803, LW-403 4D | Silica | Hydrophilic polymer | 37 |
| | OHpak | SB-800 HQ | Polyhydroxymethacrylate | — | 40 |
| | OHpak | SB-2000 | Polyhydroxymethacrylate | — | 40 |
| | OHpak | LB-800 | Polyhydroxymethacrylate | — | 41 |
| Multimode SEC | Asahipak | GS-220 HQ, GS-320 HQ, GS-220 20G, GS-320 20G | Polyvinyl alcohol | — | 44 |
| Aqueous-Organic SEC | Asahipak | GF-210 HQ, GF-310 HQ, GF-510 HQ, GF-7M HQ, GS-310 20G, GS-510 20G | Polyvinyl alcohol | — | 46 |
| | MSPak | GF-310 4D | | | |
| Organic SEC (GPC) | GPC | KF-800, KD-800, KF-400HQ, HK-400, LF, FP-2002, KF-2000, K-2000, H-2000, KF-5000, K-5000 | Styrene divinylbenzene copolymer | — | 48 - 59 |
| Ion Exchange | IEC | QA-825 | Polyhydroxymethacrylate | Quaternary ammonium | 62 |
| | IEC | DEAE-825 | Polyhydroxymethacrylate | Diethylaminoethyl | 62 |
| | Asahipak | ES-502N 7C | Polyvinyl alcohol | Diethylaminoethyl | 62 |
| | IEC | SP-825 | Polyhydroxymethacrylate | Sulfopropyl | 62 |
| | IEC | SP-FT 4A | Polyhydroxymethacrylate | Sulfopropyl | 62 |
| | IEC | CM-825 | Polyhydroxymethacrylate | Carboxymethyl | 62 |
| | Asahipak | ES-502C 7C | Polyvinyl alcohol | Carboxymethyl | 62 |
| | CXpak | P-421S | Styrene divinylbenzene copolymer | Sulfo (Na ⁺) | 62 |
| Chiral Separation | ORpak | CDBS-453 | Silica | β-Cyclodextrin derivative | 64 |
| Column Switching Pretreatment | MSPak | GF-4A | Polyvinyl alcohol | — | 64 |
| GPC Clean-up | CLNpak | EV | Styrene divinylbenzene copolymer | — | 64 |

HPLC Separation Modes

Liquid chromatography (LC) uses liquid as mobile phase (eluent). It is an analytical method that separates a mixture of compounds based on their physical and chemical differences. High performance liquid chromatography (HPLC) is a method that introduces the mobile phase under high-pressure conditions resulting in rapid and high-performance separations. The various interactions between the analyte, stationary phase (packing material), and mobile phase are the key factors for the separation. A wide variety of separation modes can be achieved by using particular combinations of stationary and mobile phases.

| Separation mode | Characteristics |
|--|--|
| Reversed Phase Chromatography (RP) | <ul style="list-style-type: none"> Separation is based on the partition equilibrium between stationary phase and mobile phase. The polarity of the stationary phase is lower than that of the mobile phase. Typically the mobile phase contains a mixture of organic solvents (methanol, acetonitrile, or THF) and aqueous solvents (water or buffer). Use of lower polarity mobile phases fasten the elution. |
| Hydrophilic Interaction Chromatography (HILIC) | <ul style="list-style-type: none"> Separation is based on hydrophilic interaction. A high polarity stationary phase is used. Typically the mobile phase contains a mixture of organic solvents such as acetonitrile and aqueous solvents (water or buffer). Using the higher polarity mobile phase causes a faster elution. Applicable for the analysis of high polar substances. |
| Ligand Exchange Chromatography (LEX) | <ul style="list-style-type: none"> Separation is based on differences in analytes' coordination complex. Stationary phase modified with metal sulfonate complex ion. Works in combination with size exclusion or HILIC modes. |
| Ion Exclusion Chromatography (IEX) | <ul style="list-style-type: none"> Separation is based on electrostatic interaction (repulsion) between the ion exchanger and ionic solutes. Dissociated ionic molecules elute faster than non-dissociated forms. Used mainly for the analysis of organic acids. |
| Ion Chromatography (IC) | <ul style="list-style-type: none"> Separation is based on electrostatic interaction (bonding) between the ion exchanger and ionic solutes. Electrical conductivity detector can be used with a mobile phase with low-salt concentration. Used mainly for the analysis of inorganic compounds. |
| Size Exclusion Chromatography (SEC) | <ul style="list-style-type: none"> Network or pores on the surface of the packing material works as molecular sieve to separate molecules based on their sizes. To separate molecules solely based on their sizes, it requires an analytical condition without any compounds and packing gel interaction. The bigger the molecule size, the faster the elution sequence. Used for molecular weight or molecular distribution determination of macromolecules and qualification of oligomers. |
| Ion Exchange Chromatography (IEC) | <ul style="list-style-type: none"> Separation is based on electrostatic interactions between the ion exchanger and ionic solutes. The mobile phase of choice should have a sufficient buffering capacity at the pH that produces the largest charge differences between the analyte of interest. The elution position is optimized by varying the pH, salt concentration, and/or ionic strength of the mobile phase. |
| Chiral Separation Chromatography (CS) | <ul style="list-style-type: none"> Separation of optical isomers using chiral selectors. Highly selective. |
| Multimode Chromatography | <ul style="list-style-type: none"> Separation is based on the combination of different modes. |

Column Selection (Proteins, Peptides, and Amino Acids)

| | Separation mode | Figure | Column | Page |
|----------------------|-----------------|-----------|----------------------|------|
| Proteins Peptides | SEC | | KW-802.5, KW402.5-4F | 36 |
| | | | LW-803, LW-403 4D | 37 |
| | | | KW-803, KW403-4F | 36 |
| | | | KW-804, KW404-4F | 36 |
| | | | KW405-4F | 36 |
| | Reversed phase | | DE series | 16 |
| | | | ODP-50 series | 14 |
| | | | C4P-50 4D | 14 |
| | HILIC | | VC-50 2D | 18 |
| | | | NH2P series | 22 |
| | Ion exchange | | QA-825 | 62 |
| | | | DEAE-825 | 62 |
| | | | ES-502N 7C | 62 |
| | | | SP-825, SP-FT 4A | 62 |
| | | | CM-825 | 62 |
| ES-502C 7C | | | 62 | |
| Multimode | | GS-220 HQ | 44 | |
| | | GS-320 HQ | 44 | |
| Amino acids | Ion exchange | | NN-814 | 16 |
| | | | YS-50 | 33 |
| | | | P-421S | 62 |
| | Reversed phase | | ODP-50 series | 14 |
| | | | VC-50 2D | 18 |
| | HILIC | | VG-50 series | 18 |
| | | | NH2P series | 22 |

Column Selection (Nucleic Acids)

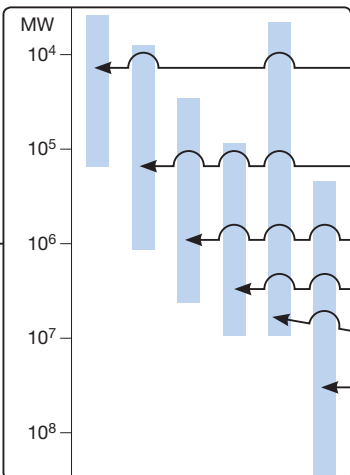
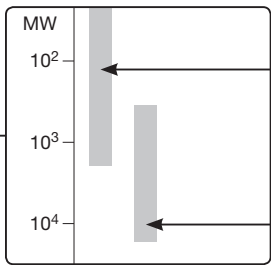
| | | Separation mode | Column | Page |
|---------------------|---|-----------------|-------------------|--------|
| Nucleic acids | Nucleobases Nucleosides Nucleotides | Multimode | GS-320 HQ | 44 |
| | | | NN-814 | 16 |
| | | Reversed phase | DE series | 16 |
| | Oligonucleic acids | HILIC | VN-50 series | 18 |
| | | Multimode | GS-320 HQ | 44 |
| | DNA RNA | Ion exchange | DEAE-825 | 62 |
| | | | SB-804 HQ, LB-804 | 40, 41 |
| | | SEC | GF-510 HQ | 46 |
| | | | SB-805 HQ, LB-805 | 40, 41 |
| | | | GF-7M HQ | 46 |
| SB-806 HQ, LB-806 | | | 40, 41 | |
| SB-806M HQ, LB-806M | 40, 41 | | | |

Column Selection (Organic Acids)

| | | Separation mode | Column | Page |
|---------------|-------------------------------------|-----------------|----------------|------|
| Organic acids | Ion exclusion (+ Reversed phase) | | KC-811 | 30 |
| | | | SH1011, SH1821 | 30 |
| | | | NN-814 | 16 |
| | Reversed phase | | DE series | 16 |
| | Ion exchange | | NI-424 | 32 |
| | | | SI series | 32 |
| | HILIC | | VG-50 series | 18 |

Column Selection (Saccharides)

| | Separation mode | Column | Page |
|---|-------------------------|---|--------|
| Mono-, di-saccharides, and sugar alcohols Saccharides and sugar alcohols | Ligand exchange + SEC | SP0810 (Pb ²⁺) | 26 |
| | | SC1011 (Ca ²⁺) | 26 |
| | | KS-801 (Na ⁺) | 26 |
| | Ligand exchange + HILIC | SZ5532 (Zn ²⁺) | 26 |
| | | DC-613 (Na ⁺) | 26 |
| | HILIC | VG-50 series | 18 |
| | | NH2P series | 22 |
| Sugar alcohols | Ligand exchange + HILIC | SC1211 (Ca ²⁺) | 26 |
| Oligosaccharides and sugar alcohols | Ligand exchange + SEC | KS-801 (Na ⁺) + KS-802 (Na ⁺) | 26 |
| Amino sugars | HILIC | VG-50 series | 18 |
| | | NH2P series | 22 |
| | Ion exchange | SC1011 (Ca ²⁺) | 26 |
| Acidic sugars | Ion exclusion | SH1011 (H ⁺) | 30 |
| | | KC-811 | 30 |
| | Ion exchange | VT-50 2D | 18 |
| | | NH2P series | 22 |
| Saccharides and organic acids | Ion exclusion + SEC | SH1011 (H ⁺), SH1821 (H ⁺) | 30 |
| Oligosaccharides | SEC | KS-801 (Na ⁺) | 26 |
| | | SB-802 HQ | 40 |
| | | GS-220 HQ | 44 |
| | | KS-802 (Na ⁺) | 26 |
| | | SB-802.5 HQ, LB-802.5 | 40, 41 |
| | HILIC | GS-320 HQ | 44 |
| | | VN-50 series | 18 |
| | | NH2P series | 22 |
| | | KS-803 (Na ⁺) | 26 |
| | | SB-803 HQ, LB-803 | 40, 41 |
| Polysaccharides | SEC | KS-804 (Na ⁺) | 26 |
| | | SB-804 HQ, LB-804 | 40, 41 |
| | | SB-805 HQ, LB-805 | 40, 41 |
| | | SB-806 HQ, LB-806 | 40, 41 |
| | | SB-806M HQ, LB-806M | 40, 41 |
| | | SB-807 HQ | 40 |



Column Selection (Drugs, Metabolites and Chiral Compounds)

| | Separation mode | Column | Page | |
|----------------------|------------------|--------------------------|-----------|----|
| Drugs Metabolites | Reversed phase | ODP2 HP | 12 | |
| | | ODP-50 series, C4P-50 4D | 14 | |
| | | DS-413, DS-613 | 16 | |
| | | DE series | 16 | |
| | | C18M, C18U | 24 | |
| | HILIC | VC-50 2D | 18 | |
| | | VT-50 2D | 18 | |
| | | NH2P series | 22 | |
| | Ion exchange | I-524A | 32 | |
| | | NI-424 | 32 | |
| | | YK-421 | 33 | |
| | | ES-502C 7C | 62 | |
| | | Multimode | GS-320 HQ | 44 |
| | Chiral compounds | Chiral separation | CDBS-453 | 64 |

Column Selection (Vitamins, Hormones / Neurotransmitters and Lipids)

| | Separation mode | Column | Page |
|------------------------------|-----------------|--------------------------|---------------|
| Water-soluble vitamins | Reversed phase | ODP-50 series | 14 |
| | | DE series | 16 |
| | | DM-614 | 16 |
| | | C18M, C18U | 24 |
| | HILIC | VG-50 series | 18 |
| | | VT-50 2D | 18 |
| | | NH2P series | 22 |
| Multimode | NN-814 | 16 | |
| Fat-soluble vitamins | Reversed phase | ODP-50 series | 14 |
| | | C18M, C18U | 24 |
| | SEC | KF-801, KF-401HQ | 48, 52 |
| Hormones / Neurotransmitters | Reversed phase | ODP-50 series | 14 |
| | | DE series | 16 |
| | | C18M, C18U | 24 |
| | | SB-802.5 HQ, LB-802.5 | 40, 41 |
| | HILIC | VC-50 2D | 18 |
| | | VT-50 2D | 18 |
| | | NH2P series | 22 |
| | Ion exchange | ES-502N 7C | 62 |
| | | ES-502C 7C | 62 |
| | Lipids | Reversed phase | ODP-50 series |
| DS-413, DS-613 | | | 16 |
| DE series | | | 16 |
| SEC | | GF-310 HQ | 46 |
| | | KF-801, KF-802, KF-802.5 | 48 |
| | | KF-402HQ | 52 |

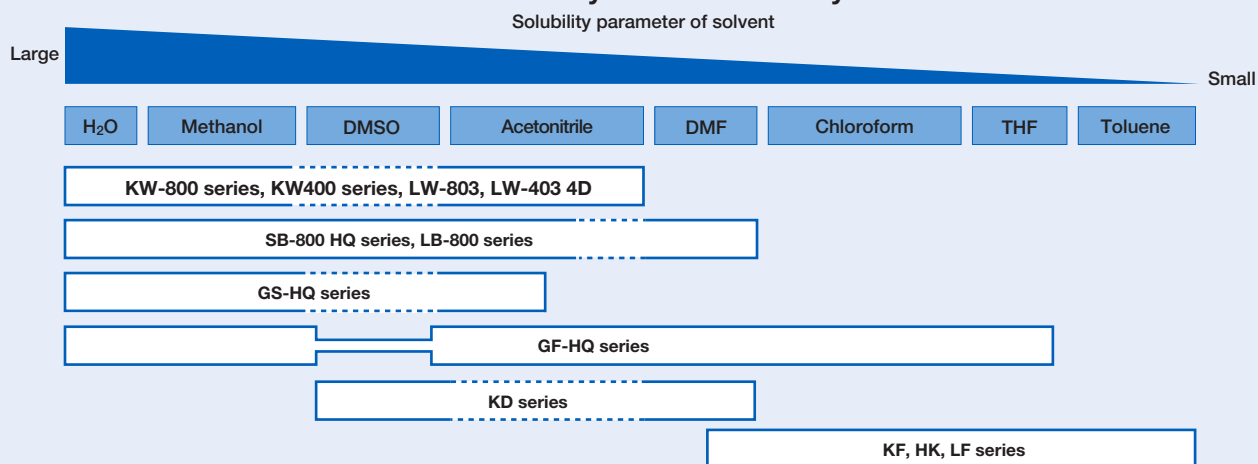
Column Selection (Anions and Cations)

| Separation mode | | Column | Page | |
|-----------------|--|--|-----------|----|
| Anions | Ion exchange | Inorganic anions analysis (Suppressor method: Sodium carbonate eluent) | SI-90 4E | 32 |
| | | | SI-35 2B | 33 |
| | | Inorganic anions and organic acids analysis (Suppressor method: Sodium carbonate eluent) | SI-50 4E | 32 |
| | | Inorganic anions and oxyhalides analysis (Suppressor method: Sodium carbonate eluent) | SI-52 4E | 32 |
| | | | SI-35 4D | 32 |
| | Inorganic anions analysis (Suppressor method: Potassium hydroxide eluent) | SI-36 4D | 33 | |
| | Inorganic anions analysis (Non-suppressor method) | NI-424 | 32 | |
| | | I-524A | 32 | |
| | HILIC | Oxyhalides analysis (LC/MS) | JJ-50 2D | 16 |
| | Ion exclusion | Cyanide ions and cyanogen chloride analysis (Post column method) | KC-811 6E | 30 |
| Cations | Ion exchange | Simultaneous analysis of monovalent and divalent cations (Non-suppressor / Suppressor method) Analysis of alkylamines and/or transition metals | YS-50 | 33 |
| | | Simultaneous analysis of monovalent and divalent cations (Non-suppressor method) Analysis of ethanolamines and/or alkylamines | YK-421 | 33 |
| | | Transition metal ion analysis (LC/ICP-MS) | VC-50 2D | 18 |

Column Selection (Polymers)

| | Application | Eluent | Column | Page | |
|--|---|---|------------------|---------------|----|
| Aqueous SEC (GFC) | Biological macromolecules (Proteins, Peptides, Nucleic acids, etc.) | Buffer etc. | KW-800 series | 36 | |
| | | | KW400 series | 36 | |
| | | | LW-803 | 37 | |
| | | | LW-403 4D | 37 | |
| | Biological macromolecules (High MW range) | Buffer etc. | SB-800 HQ series | 40 | |
| | | | LB-800 series | 41 | |
| | Water-soluble polymers (Polyacrylamide, etc.) | Water, buffer and aqueous salt solution, etc. | SB-800 HQ series | 40 | |
| | | | LB-800 series | 41 | |
| | Organic SEC (GPC) | General polymers | THF | KF-800 series | 48 |
| KF-400HQ series | | | | 52 | |
| HK-400 series | | | | 54 | |
| Chloroform | | | LF series | 56 | |
| | | | KF-800 series | 48 | |
| | | | HK-400 series | 54 | |
| Polar polymers (Polyimides etc.) | | DMF | LF series | 56 | |
| | | | SB-800 HQ series | 40 | |
| | | | LB-800 series | 41 | |
| Engineering plastics (Polyamides etc.) | | HFIP | KD-800 series | 50 | |
| | | | HK-400 series | 54 | |
| | | | LF series | 56 | |
| Aqueous-Organic SEC | | | | GF-HQ series | 46 |

Guideline for SEC column selection by solvent usability



See page 60 for the solvent replaceability of organic solvent SEC (GPC) packed columns.

Precautions for Polar Polymer Analysis

Unexpected interactions in the column can affect the size exclusion chromatography analysis of polar polymers. These interactions may change elution patterns and results in an invalid molecular weight calculation. It is important to reduce these interfering interactions in order to obtain the accurate molecular weight distribution.

~ Interfering interactions likely to be observed ~

Interactions between the analyte and the packing materials

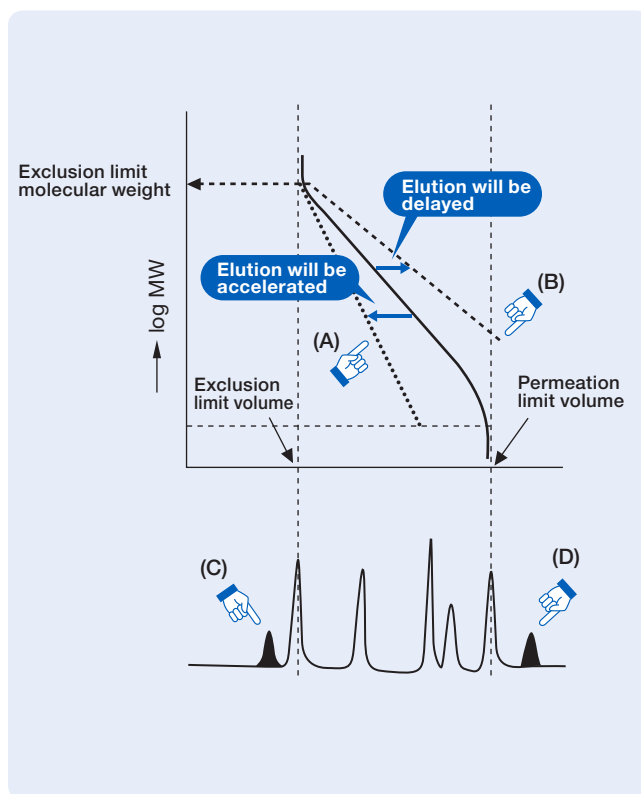
- ◆ Hydrophobic interaction
 - The analyte is adsorbed on the packing material.
 - This delays the analyte elution and results in under estimating the analyte's molecular weight. See (B) and (D).
- ◆ Ionic interaction
 - (1) Ion Exclusion
 - The analyte is repelled from the packing material.
 - This accelerates the analyte elution and results in over estimating the analyte's molecular weight. See (A) and (C).
 - (2) Ion Exchange
 - The analyte is adsorbed onto the packing material.
 - This delays the analyte elution and results in under estimating the analyte's molecular weight. See (B) and (D).

Interaction within and between the analyte

- ◆ Ionic repulsion effects observed within the multivalent macromolecules causes structure expansion
 - This accelerates the analyte elution and results in over estimating the analyte's molecular weight. See (A).
- ◆ Association between the molecules
 - This accelerates the analyte elution and results in over estimating the analyte's molecular weight. See (A).

Interactions between the analyte and the solvent

- ◆ The multivalent ion in the solvent works as a bridge to bind ionic molecules (analyte).



Methods to reduce interactions

Aqueous SEC (GFC)

Ionic interaction

- ◆ Add salt into the eluent

Hydrophobic interaction

- ◆ Increase the analyte dissociation
 - Cationic polymer → Lower the eluent pH
 - Anionic polymer → Higher the eluent pH
- ◆ Lower the eluent polarity
 - e.g. Add acetonitrile or methanol

Organic SEC (GPC)

Ionic interaction

- ◆ Add salt into the eluent
 - e.g. Add LiBr to DMF
 - Add CF_3COONa to HFIP

Hydrophobic interaction

- ◆ Lower the eluent polarity
 - e.g. Change the eluent from DMF to THF

Hydrophilic interaction

- ◆ Increase the eluent polarity
 - e.g. Change the eluent from THF to DMF

Polymer-based Reversed Phase Chromatography Columns (ODP2 HP)

Features

ODP2 HP

- Provides a large theoretical plate number nearly twice as much as generally available polymer-based reversed phase columns do
- Offers enhanced retention of high polar substances compared to ODS columns
- Suitable for the analysis of small molecules such as pharmaceuticals in the presence of protein matrix
- Ideal for LC/MS analysis of high polar compounds
- Fulfills USP-NF L39 requirements

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7622001 | ODP2 HP-4B | ≥ 3,500 | — | 5 | 40 | 4.6 x 50 | H ₂ O/CH ₃ CN = 55/45 |
| F7622002 | ODP2 HP-4D | ≥ 10,000 | — | 5 | 40 | 4.6 x 150 | H ₂ O/CH ₃ CN = 55/45 |
| F7622003 | ODP2 HP-4E | ≥ 17,000 | — | 5 | 40 | 4.6 x 250 | H ₂ O/CH ₃ CN = 55/45 |
| F6714010 | ODP2 HPG-4A | (guard column) | — | 5 | — | 4.6 x 10 | H ₂ O/CH ₃ CN = 55/45 |

Base Material: Polyhydroxymethacrylate

Semi-micro columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7622004 | ODP2 HP-2B | ≥ 3,000 | — | 5 | 40 | 2.0 x 50 | H ₂ O/CH ₃ CN = 55/45 |
| F7622005 | ODP2 HP-2D | ≥ 7,000 | — | 5 | 40 | 2.0 x 150 | H ₂ O/CH ₃ CN = 55/45 |
| F6714011 | ODP2 HPG-2A | (guard column) | — | 5 | — | 2.0 x 10 | H ₂ O/CH ₃ CN = 55/45 |

Base Material: Polyhydroxymethacrylate

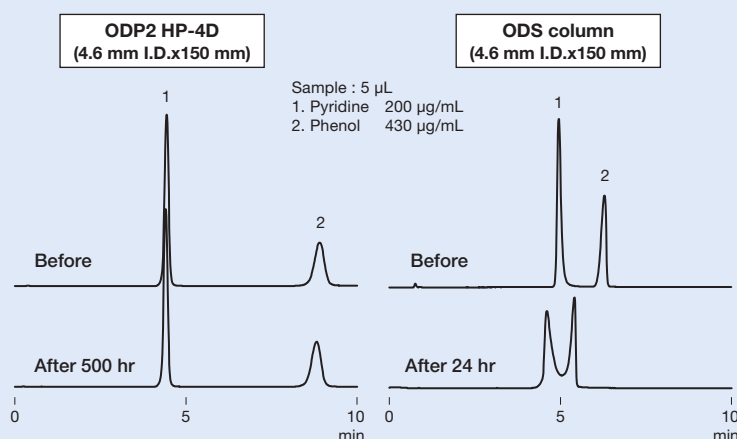
Preparative columns [Preparative columns are made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|--------------------|--------------------------------|---|
| F6822001 | ODP2 HP-10E | ≥ 9,500 | 6 | 10.0 x 250 | H ₂ O/CH ₃ CN = 55/45 |
| F6714015 | ODP2 HPG-7B | (guard column) | 6 | 7.5 x 50 | H ₂ O/CH ₃ CN = 55/45 |

Base Material: Polyhydroxymethacrylate

Comparison between ODP2 HP-4D and an ODS column for their alkaline tolerances

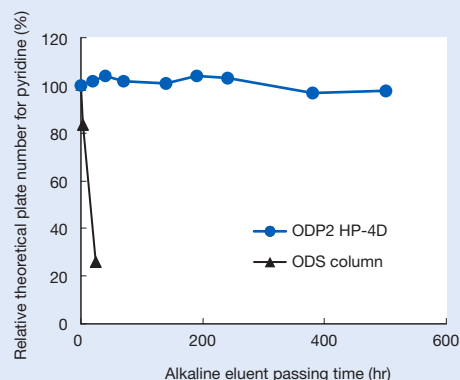
Chromatograms obtained before and after passing alkaline eluent



Analysis condition

Column : Shodex ODP2 HP-4D
 ODS column from other manufacturer
 Eluent : H₂O/CH₃OH = 70/30
 Flow rate : 1.0 mL/min
 Detector : UV (254 nm)
 Column temp. : 40 °C

Correlation between alkaline eluent passing time and relative theoretical plate number



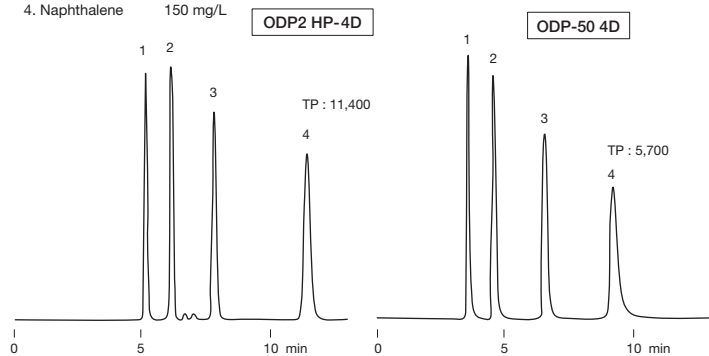
Eluent passing conditions for an alkaline tolerance test

Column : Shodex ODP2 HP-4D
 ODS column from other manufacturer
 Eluent : 10 mM Sodium phosphate buffer (pH12)
 /CH₃CN = 45/55
 Flow rate : 0.6 mL/min
 Column temp. : 30 °C

Comparison between ODP2 HP and ODP-50

 Sample : 5 μ L

1. Phenol 300 mg/L
2. Methyl benzoate 350 mg/L
3. Toluene 1000 mg/L
4. Naphthalene 150 mg/L



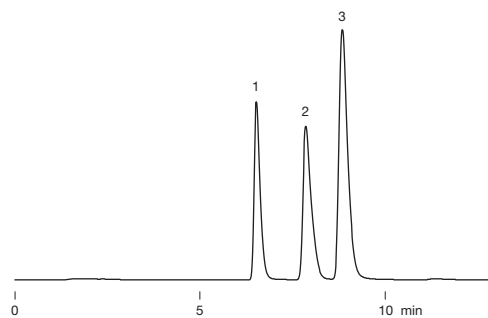
Column : Shodex ODP2 HP-4D
Eluent : H₂O/CH₃CN = 55/45
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 40 °C

Column : Shodex Asahipak ODP-50 4D
Eluent : H₂O/CH₃CN = 35/65
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 40 °C

Imidazoles

 Sample : 0.1 % each, 10 μ L

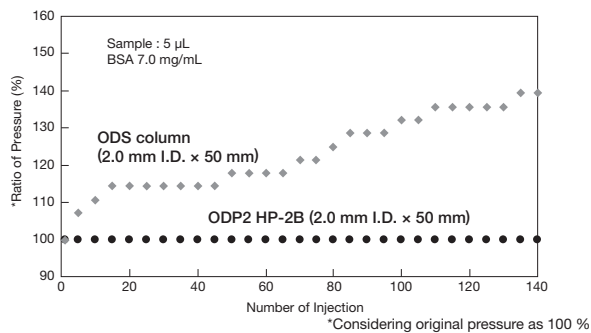
1. Imidazole
2. 2-Methylimidazole
3. 4-Methylimidazole



Column : Shodex ODP2 HP-4E
Eluent : 10 mM Na₂HPO₄ aq./CH₃CN = 90/10
Flow rate : 0.8 mL/min
Detector : UV (220 nm)
Column temp. : 40 °C

Influence of repeated protein injection on column pressure

ODP2 HP columns are packed with gels with increased surface polarity and smaller pore size which prevent the adsorption of proteins. BSA was injected multiple times to both ODS and ODP2 HP columns. A significant column pressure increase was observed for the ODS column, while no considerable change was observed for the ODP2 HP column even after 140 injections.

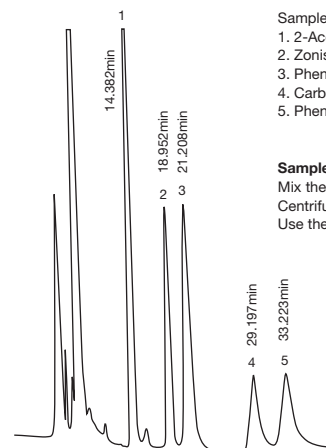


Column : Shodex ODP2 HP-2B
ODS column from other manufacturer
Eluent : 1 mM CH₃COONH₄ aq./CH₃CN = 90/10
Flow rate : 0.2 mL/min
Detector : UV (220 nm)
Column temp. : 30 °C

Anticonvulsant in serum

 Sample : 20 μ L

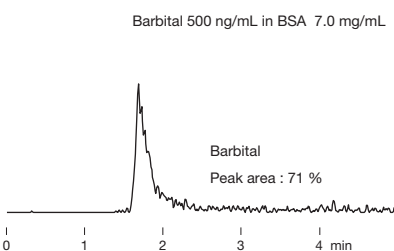
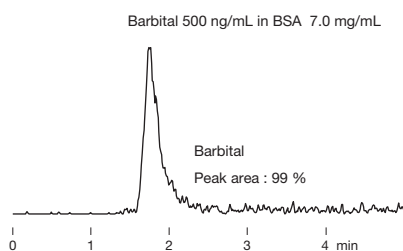
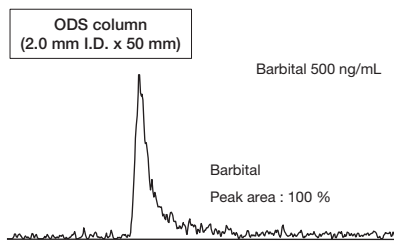
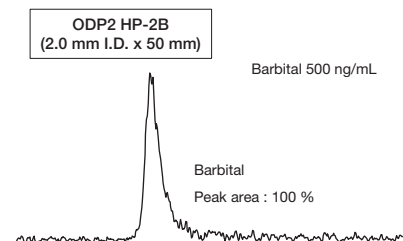
1. 2-Acetaminophen (I.S.) 10 μ g/mL
2. Zonisamide 13.0 μ g/mL
3. Phenobarbital 19.0 μ g/mL
4. Carbamazepine 4.5 μ g/mL
5. Phenytoin 9.0 μ g/mL



Sample pretreatment:
 Mix the same volumes of serum and acetonitrile. Centrifuge the mixture at 6000 x g for 5 minutes. Use the supernatant as sample.

Data provided by Katsuko Hara.MT
 Yutaka Komiya .Ph.D.,
 Department of Clinical Sciences
 and Laboratory Medicine,
 Kansai Medical University.

Column : Shodex ODP2 HP-4E
Eluent : 25 mM Sodium phosphate buffer (pH5.2)/CH₃CN = 680/320
Flow rate : 0.35 mL/min
Detector : UV (210 nm)
Column temp. : 40 °C

Comparison of barbital recovery rate using ODP2 HP-2B and ODS in the presence of BSA


LC/MS analysis of drugs in biological samples is often interfered by ion suppression caused by presence of protein when using general ODS columns. However, ODP2 HP does not retain proteins and elutes them at the void volume. Thus, elution of barbital is not affected when using the ODP2 HP and provides better recovery rate than that of an ODS column.

Column : Shodex ODP2 HP-2B
ODS column from other manufacturer
Eluent : 10 mM CH₃COONH₄ aq./CH₃CN = 70/30
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM Negative: m/z 183)
Column temp. : 30 °C
Injection vol. : 10 μ L

Polymer-based Reversed Phase Chromatography Columns (Asahipak)

Features

ODP-50 C4P-50 4D

- Relatively large pore size is suitable for the analysis of amino acids, peptides, and proteins
- Usable in a wide pH range from pH 2 to 13
- Usable in 100 % water and buffer solution
- Best used for the analysis of basic substances
- ODP-50 fulfills USP-NF L67 requirements

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7620002 | Asahipak ODP-50 6D | ≥ 9,000 | Octadecyl | 5 | 250 | 6.0 x 150 | H ₂ O/CH ₃ CN = 35/65 |
| F7620001 | Asahipak ODP-50 6E | ≥ 14,000 | Octadecyl | 5 | 250 | 6.0 x 250 | H ₂ O/CH ₃ CN = 35/65 |
| F6710001 | Asahipak ODP-50G 6A | (guard column) | Octadecyl | 5 | — | 6.0 x 10 | H ₂ O/CH ₃ CN = 35/65 |
| F6710023 | Asahipak ODP-50 4B | ≥ 2,500 | Octadecyl | 5 | 250 | 4.6 x 50 | H ₂ O/CH ₃ CN = 35/65 |
| F7620004 | Asahipak ODP-50 4D | ≥ 9,000 | Octadecyl | 5 | 250 | 4.6 x 150 | H ₂ O/CH ₃ CN = 35/65 |
| F7620003 | Asahipak ODP-50 4E | ≥ 14,000 | Octadecyl | 5 | 250 | 4.6 x 250 | H ₂ O/CH ₃ CN = 35/65 |
| F6710022 | Asahipak ODP-50G 4A | (guard column) | Octadecyl | 5 | — | 4.6 x 10 | H ₂ O/CH ₃ CN = 35/65 |
| F7620008 | Asahipak C4P-50 4D | ≥ 6,000 | Butyl | 5 | 250 | 4.6 x 150 | H ₂ O/CH ₃ CN = 35/65 |
| F6710003 | Asahipak C4P-50G 4A | (guard column) | Butyl | 5 | — | 4.6 x 10 | H ₂ O/CH ₃ CN = 35/65 |

Base Material: Polyvinyl alcohol

• Semi-micro columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7620009 | Asahipak ODP-50 2D | ≥ 5,000 | Octadecyl | 5 | 250 | 2.0 x 150 | H ₂ O/CH ₃ CN = 35/65 |
| F6713001 | Asahipak ODP-50G 2A | (guard column) | Octadecyl | 5 | — | 2.0 x 10 | H ₂ O/CH ₃ CN = 35/65 |

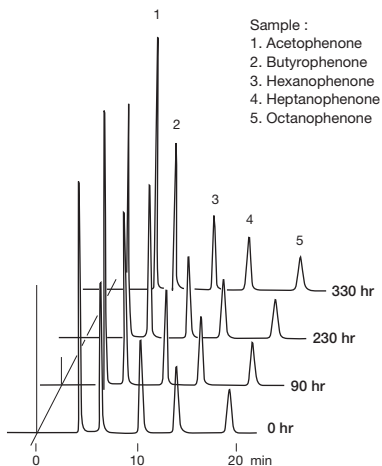
Base Material: Polyvinyl alcohol

• Preparative columns [Preparative columns are made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-----------------------------|--------------------------|------------------|--------------------|--------------------------------|---|
| F6820001 | Asahipak ODP-50 10E | ≥ 10,000 | Octadecyl | 5 | 10.0 x 250 | H ₂ O/CH ₃ CN = 35/65 |
| F6820035 | Asahipak ODP-90 20F | ≥ 9,000 | Octadecyl | 9 | 20.0 x 300 | H ₂ O/CH ₃ CN = 35/65 |
| F6710004 | Asahipak ODP-130G 7B | (guard column) | Octadecyl | 13 | 7.5 x 50 | H ₂ O/CH ₃ CN = 35/65 |

Base Material: Polyvinyl alcohol

Alkaline tolerance of ODP-50

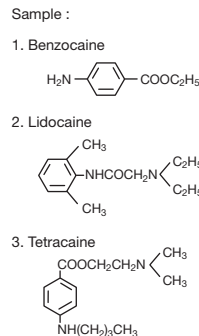
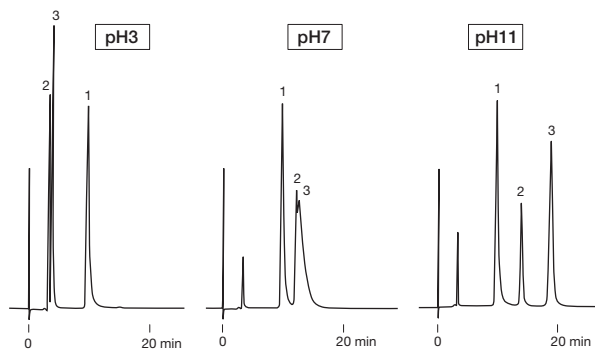


Sample :
 1. Acetophenone
 2. Butyrophenone
 3. Hexanophenone
 4. Heptanophenone
 5. Octanophenone

Column : Shodex Asahipak ODP-50 4D
 Eluent : 10 mM NaOH aq. (pH12.0)/CH₃CN = 35/65
 Flow rate : 0.6 mL/min
 Detector : UV (254 nm)
 Column temp. : 30 °C

Local anesthetics

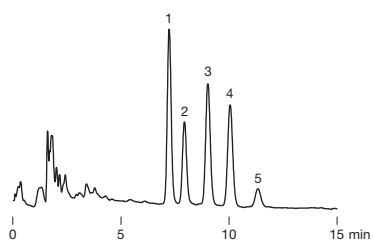
Dissociation of tertiary amino groups in basic drugs can be suppressed by making pH of the eluent higher than pKa of the amino groups. This increases the relative hydrophobicity of the basic drugs, thereby allowing the column to retain the drugs stronger and provide baseline separation of them.



Column : Shodex Asahipak ODP-50 4D
 Eluent : 25 mM Phosphate buffer/CH₃CN = 60/40
 Flow rate : 0.6 mL/min
 Detector : UV (254 nm)
 Column temp. : 30 °C

Unsaturated fatty acids

Sample : 0.002 % each (in Ethanol), 5 µL
 1. EPA (Eicosapentaenoic acid)
 2. α-Linolenic acid
 3. DHA (Docosahexaenoic acid)
 4. Arachidonic acid
 5. Linoleic acid

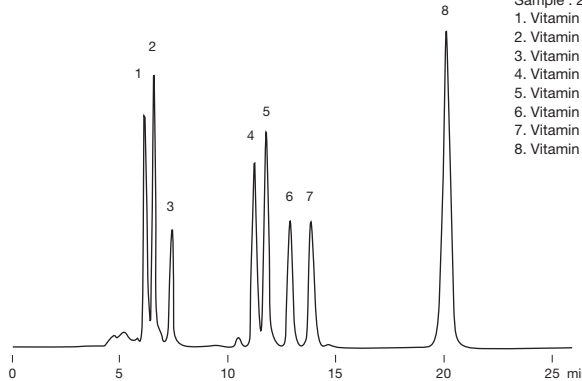


Column : Shodex Asahipak ODP-50 4D
 Eluent : 0.1 % H₃PO₄ in (H₂O/CH₃CN = 30/70)
 Flow rate : 1.0 mL/min
 Detector : UV (215 nm)
 Column temp. : 40 °C

Fat-soluble vitamins

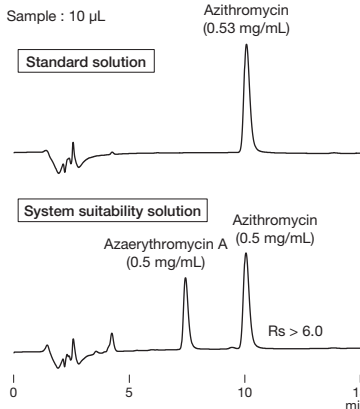
Sample : 20 µL

| | |
|---------------------------|-----------|
| 1. Vitamin K ₃ | 1.5 µg/mL |
| 2. Vitamin A | 0.3 µg/mL |
| 3. Vitamin A acetate | 1.9 µg/mL |
| 4. Vitamin D ₂ | 0.3 µg/mL |
| 5. Vitamin D ₃ | 0.3 µg/mL |
| 6. Vitamin E acetate | 2.4 µg/mL |
| 7. Vitamin E | 2.5 µg/mL |
| 8. Vitamin K ₁ | 2.4 µg/mL |



Column : Shodex Asahipak ODP-50 4E
 Eluent : CH₃CN/CH₃OH = 50/50
 Flow rate : 0.6 mL/min
 Detector : UV (280 nm)
 Column temp. : 30 °C

Analysis of azithromycin according to USP-NF method



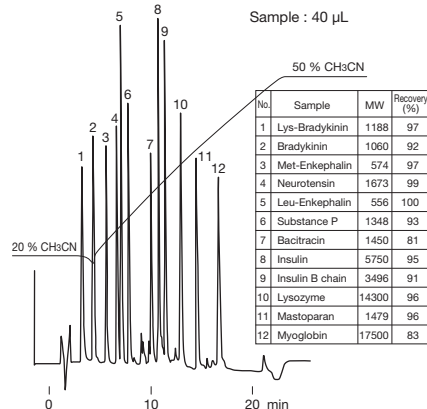
Sample : 10 µL
 Azithromycin (0.53 mg/mL)

Standard solution

System suitability solution
 Azaerythromycin A (0.5 mg/mL)
 Azithromycin (0.5 mg/mL)
 Rs > 6.0

Column : Shodex Asahipak ODP-50 4E
 Eluent : 6.7 g/L Dibasic potassium phosphate aq. (pH11.0 adjusted with 10 M KOH) /CH₃CN = 40/60
 Flow rate : 1.0 mL/min
 Detector : UV (210 nm)
 Column temp. : 40 °C

Gradient analysis of proteins and peptides



Sample : 40 µL

Column : Shodex Asahipak ODP-50 6D
 Eluent : (A); 0.05 % TFA aq./CH₃CN = 80/20 (B); 0.05 % TFA aq./CH₃CN = 50/50
 Linear gradient; (A) to (B), 20 min
 Flow rate : 1.0 mL/min
 Detector : UV (220 nm)
 Column temp. : 30 °C

Polymer-based Reversed Phase Chromatography Columns (RSpak)

Features

- DS-613**
 - Suitable for reversed phase analysis of highly hydrophilic substances that are not well retained by ODS columns
- DS-413**
 - Fulfill USP-NF L21 requirements
- DE-613**
 - General purpose polymer-based column having similar polarity as ODS columns
- DE-413**
 - Wide working pH range (from pH 2 to 12), usable in 100 % water and buffer solutions
- DE-213**
 - Fulfill USP-NF L71 requirements
- DM-614**
 - Suitable for the analysis of amino acids and water-soluble vitamins
 - Fulfills USP-NF L39 requirements
- NN-814**
 - The packing material modified with sulfo groups supports multimode (reversed phase and cation exchange) analysis
 - Ideal for the analysis of complex samples containing neutral and ionic substances
- JJ-50 2D**
 - The packing material is modified with trace amounts of quaternary ammonium groups, and supports multimode (reversed phase and anion exchange) analysis
 - Ideal for analysis of complex samples containing neutral and ionic substances

DS

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|--|
| F7001001 | RSpak DS-613 | ≥ 6,500 | — | 6 | 200 | 6.0 x 150 | H ₂ O/CH ₃ CN/THF = 30/40/30 |
| F6700140 | RSpak DS-G | (guard column) | — | 10 | — | 4.6 x 10 | H ₂ O/CH ₃ CN/THF = 30/40/30 |
| F7001012 | RSpak DS-413 | ≥ 11,000 | — | 3.5 | 200 | 4.6 x 150 | H ₂ O/CH ₃ CN/THF = 40/30/30 |

Base Material: Styrene divinylbenzene copolymer

DE

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7001004 | RSpak DE-613 | ≥ 7,000 | — | 6 | 25 | 6.0 x 150 | H ₂ O |
| F7001005 | RSpak DE-413 | ≥ 11,000 | — | 4 | 25 | 4.6 x 150 | H ₂ O/CH ₃ CN = 50/50 |
| F6700150 | RSpak DE-G 4A | (guard column) | — | 10 | — | 4.6 x 10 | H ₂ O |

Base Material: Polymethacrylate

• Semi-micro columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7001007 | RSpak DE-213 | ≥ 8,000 | — | 4 | 25 | 2.0 x 150 | H ₂ O/CH ₃ CN = 50/50 |
| F6700151 | RSpak DE-G 2A | (guard column) | — | 6 | — | 2.0 x 10 | H ₂ O/CH ₃ CN = 50/50 |

Base Material: Polymethacrylate

DM

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7001002 | RSpak DM-614 | ≥ 4,500 | — | 10 | 200 | 6.0 x 150 | 5 mM H ₃ PO ₄ aq. |
| F6700160 | RSpak DM-G 4A | (guard column) | — | 12 | — | 4.6 x 10 | 5 mM H ₃ PO ₄ aq. |

Base Material: Polyhydroxymethacrylate

NN

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---------------------------------------|
| F7008140 | RSpak NN-814 | ≥ 9,000 | Sulfo | 10 | 200 | 8.0 x 250 | 0.1 M Sodium phosphate buffer (pH3.0) |
| F6700510 | RSpak NN-G | (guard column) | Sulfo | 10 | — | 6.0 x 50 | 0.1 M Sodium phosphate buffer (pH3.0) |

Base Material: Polyhydroxymethacrylate

JJ

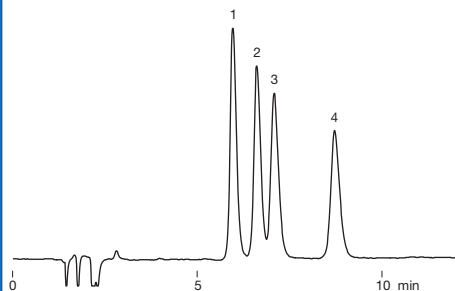
• Semi-micro columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-----------------------|--------------------------|---------------------|--------------------|---------------|--------------------------------|---|
| F7008220 | RSpak JJ-50 2D | ≥ 3,500 | Quaternary ammonium | 5 | 100 | 2.0 x 150 | H ₂ O/CH ₃ CN = 40/60 |

Base Material: Polyvinyl alcohol

Fatty acid methyl esters

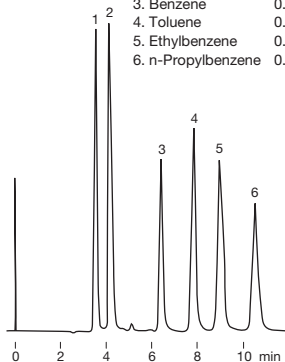
Sample : 0.2 % each, 20 μ L
 1. Methyl linoleate
 2. Methyl palmitate
 3. Methyl oleate
 4. Methyl stearate



Column : Shodex RSpak DS-413
 Eluent : H₂O/CH₃CN/THF = 25/45/30
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

Alkylbenzenes

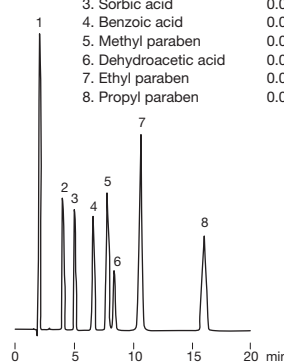
Sample : 5 μ L
 1. m-Cresol 0.1 %
 2. 2,4-Xylenol 0.1 %
 3. Benzene 0.5 %
 4. Toluene 0.5 %
 5. Ethylbenzene 0.5 %
 6. n-Propylbenzene 0.5 %



Column : Shodex RSpak DS-613
 Eluent : H₂O/CH₃CN/THF = 30/40/30
 Flow rate : 1.0 mL/min
 Detector : UV (254 nm)
 Column temp. : 40 °C

Food additives (Preservatives)

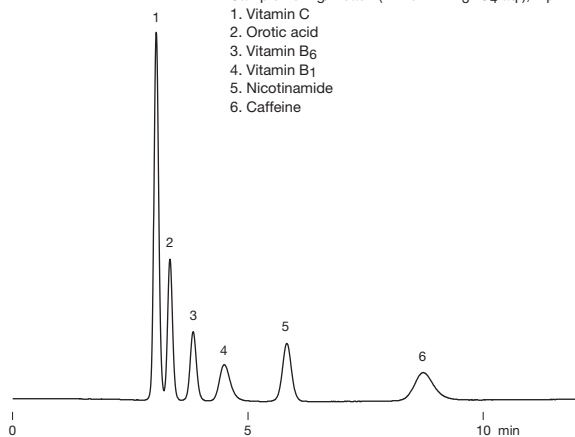
Sample : 10 μ L
 1. Saccharin sodium 0.005 %
 2. p-Hydroxybenzoic acid 0.005 %
 3. Sorbic acid 0.02 %
 4. Benzoic acid 0.02 %
 5. Methyl paraben 0.01 %
 6. Dehydroacetic acid 0.01 %
 7. Ethyl paraben 0.02 %
 8. Propyl paraben 0.02 %



Column : Shodex RSpak DE-413
 Eluent : 50 mM KH₂PO₄ + 0.1 % H₃PO₄ aq./CH₃CN = 65/35
 Flow rate : 1.0 mL/min
 Detector : UV (210 nm)
 Column temp. : 40 °C

Vitamins

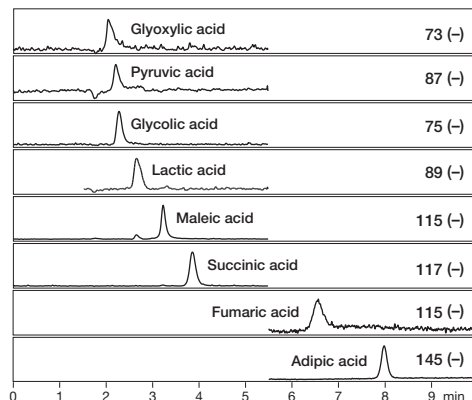
Sample : 5 mg/L each (in 2.5 mM H₃PO₄ aq.), 4 μ L
 1. Vitamin C
 2. Orotic acid
 3. Vitamin B₆
 4. Vitamin B₁
 5. Nicotinamide
 6. Caffeine



Column : Shodex RSpak DM-614
 Eluent : 0.055 M Na₂HPO₄ + 0.045 M KH₂PO₄ aq.
 Flow rate : 1.0 mL/min
 Detector : UV (254 nm)
 Column temp. : 30 °C

LC/MS analysis of organic acids

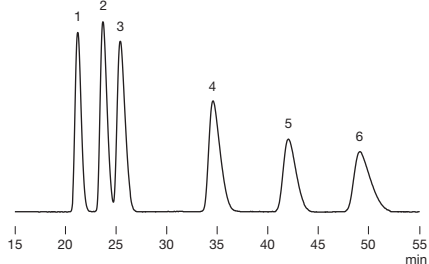
Sample : 50 ng/mL each, 10 μ L



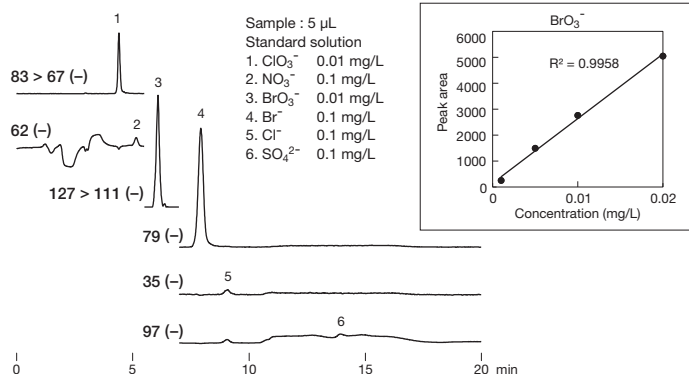
Column : Shodex RSpak DE-213
 Eluent : (A); 0.1 % (v/v) Formic acid aq./ (B); CH₃CN
 Linear gradient; 5 B % (0 to 2 min),
 5 B % to 15 B % (2 to 2.5 min), 15 B % (2.5 to 10 min)
 Flow rate : 0.2 mL/min
 Detector : ESI-MS (SIM)
 Column temp. : 30 °C

Amino acids

Sample : 0.1 % each, 20 μ L
 1. Aspartic acid
 2. Glycine
 3. Alanine
 4. Valine
 5. Methionine
 6. Isoleucine



Column : Shodex RSpak NN-814
 Eluent : 40 mM H₃PO₄ aq.
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

High sensitive analysis of bromate by LC/MS/MS


Column : Shodex RSpak JJ-50 2D
 Eluent : (A); 200 mM HCOONH₄ aq./ (B); CH₃CN
 Linear gradient (High pressure);
 85 B % (0 to 8 min), 85 B % to 50 B % (8 to 9 min), 50 B % (9 to 14 min),
 50 B % to 85 B % (14 to 15 min), 85 B % (15 to 20 min)
 Flow rate : 0.3 mL/min
 Detector : ESI-MS/MS (MRM) for ClO₃⁻, BrO₃⁻
 ESI-MS (SIM) for NO₃⁻, Br⁻, Cl⁻, SO₄²⁻
 Column temp. : 50 °C

Polymer-based Hydrophilic Interaction Chromatography (HILIC) Columns (HILICpak)

Features

- VG-50**
 - Suitable for saccharide analysis using HILIC mode
 - Recovers reducing saccharides with high ratio
 - Polymer-based packing material provides excellent chemical stability and minimum deterioration over an extended time period
 - Easily regenerated by washing in an alkaline solution
 - Appropriate for evaporative light scattering detector, corona charged aerosol detector, and LC/MS
- VT-50 2D**
 - Suitable for anionic substances (especially phosphate compounds) analysis using HILIC mode
 - Use of some eluents add ion exchange mode
 - Polymer-based packing material provides excellent chemical stability and minimum deterioration over an extended time period
 - Suitable for LC/MS analysis
- VC-50 2D**
 - Modified carboxyl group is suitable for cationic substance analysis including amines
 - The dominant separation mode is RP or IEX rather than HILIC mode
- VN-50**
 - The modified diol groups on the packing material create the HILIC mode
 - Suitable for oligosaccharide and oligonucleotide separation which is not possible by SEC column or conventional HILIC columns

VG-50

- Standard columns (Housing Material: SUS)

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7630200 | HILICpak VG-50 4D | ≥ 5,500 | Amino | 5 | 100 | 4.6 x 150 | H ₂ O/CH ₃ CN = 20/80 |
| F7630100 | HILICpak VG-50 4E | ≥ 7,500 | Amino | 5 | 100 | 4.6 x 250 | H ₂ O/CH ₃ CN = 20/80 |
| F6711100 | HILICpak VG-50G 4A | (guard column) | Amino | 5 | 100 | 4.6 x 10 | H ₂ O/CH ₃ CN = 20/80 |

Base Material: Polyvinyl alcohol

- Semi-micro columns (Housing Material: PEEK)

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7630300 | HILICpak VG-50 2D | ≥ 3,500 | Amino | 5 | 100 | 2.0 x 150 | H ₂ O/CH ₃ CN = 15/85 |
| F6711200 | HILICpak VG-50G 2A | (guard column) | Amino | 5 | 100 | 2.0 x 10 | H ₂ O/CH ₃ CN = 15/85 |

Base Material: Polyvinyl alcohol

VT-50

- Semi-micro columns (Housing Material: PEEK)

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|---------------------|--------------------|---------------|--------------------------------|---|
| F7630400 | HILICpak VT-50 2D | ≥ 4,500 | Quaternary ammonium | 5 | 100 | 2.0 x 150 | 25 mM HCOONH ₄ aq./ CH ₃ CN = 15/85 |
| F6711300 | HILICpak VT-50G 2A | (guard column) | Quaternary ammonium | 5 | 100 | 2.0 x 10 | 25 mM HCOONH ₄ aq./ CH ₃ CN = 15/85 |

Base Material: Polyvinyl alcohol

VC-50

- Semi-micro columns (Housing Material: PEEK)

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|------------------|
| F7630700 | HILICpak VC-50 2D | ≥ 3,500 | Carboxyl | 5 | 100 | 2.0 x 150 | H ₂ O |
| F6711600 | HILICpak VC-50G 2A | (guard column) | Carboxyl | 5 | 100 | 2.0 x 10 | H ₂ O |

Base Material: Polyvinyl alcohol

VN-50

- Standard columns (Housing Material: PEEK)

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7630500 | HILICpak VN-50 4D | ≥ 10,000 | Diol | 5 | 100 | 4.6 x 150 | H ₂ O/CH ₃ CN = 25/75 |
| F6711400 | HILICpak VN-50G 4A | (guard column) | Diol | 5 | 100 | 4.6 x 10 | H ₂ O/CH ₃ CN = 25/75 |

Base Material: Polyvinyl alcohol

- Semi-micro columns (Housing Material: PEEK)

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|---|
| F7630600 | HILICpak VN-50 2D | ≥ 3,500 | Diol | 5 | 100 | 2.0 x 150 | H ₂ O/CH ₃ CN = 25/75 |
| F6711500 | HILICpak VN-50G 2A | (guard column) | Diol | 5 | 100 | 2.0 x 10 | H ₂ O/CH ₃ CN = 25/75 |

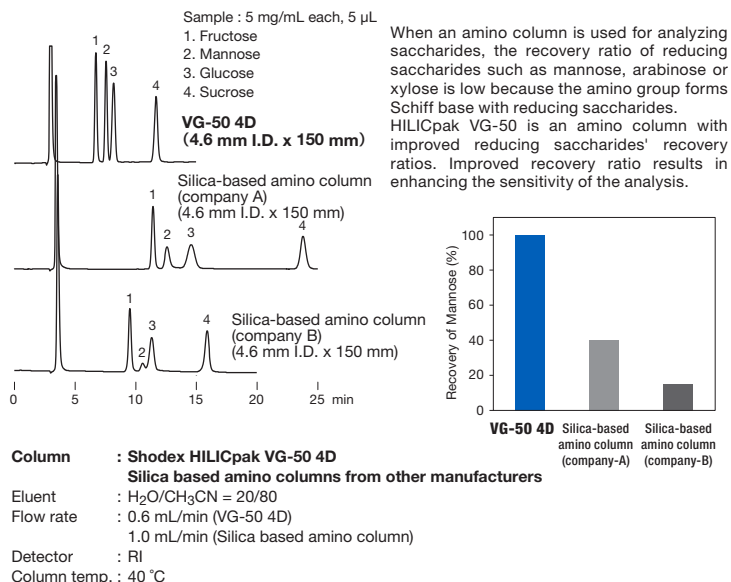
Base Material: Polyvinyl alcohol

- Preparative columns (Housing Material: SUS) [Preparative columns are made to order.]

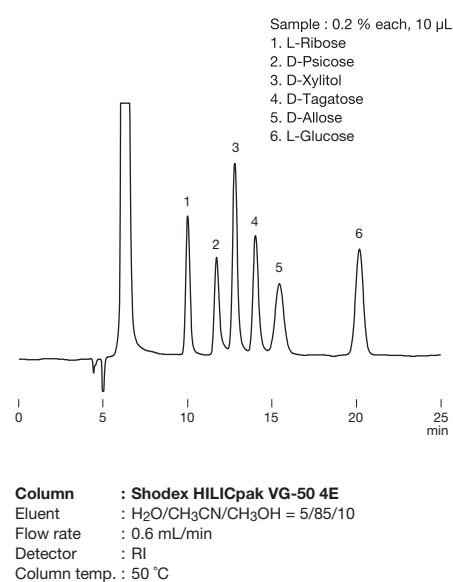
| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|------------------|--------------------|--------------------------------|---|
| F6830100 | HILICpak VN-50 10E | ≥ 11,000 | Diol | 5 | 10.0 x 250 | H ₂ O/CH ₃ CN = 25/75 |
| F6711400 | HILICpak VN-50G 4A | (guard column) | Diol | 5 | 4.6 x 10 | H ₂ O/CH ₃ CN = 25/75 |

Base Material: Polyvinyl alcohol

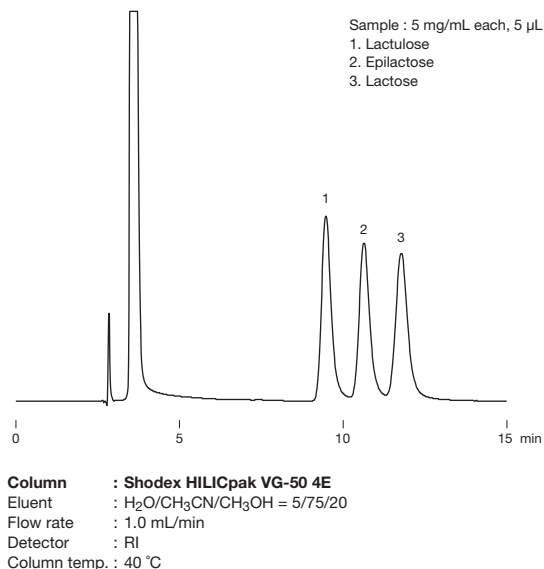
Recovery of reducing sugar



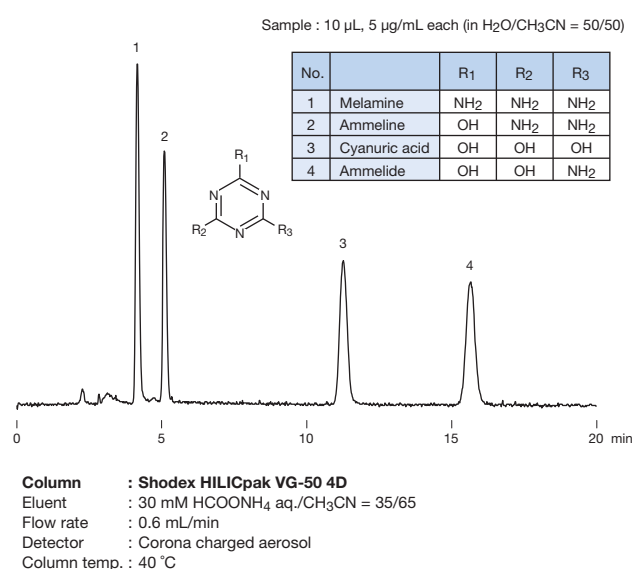
Rare sugar



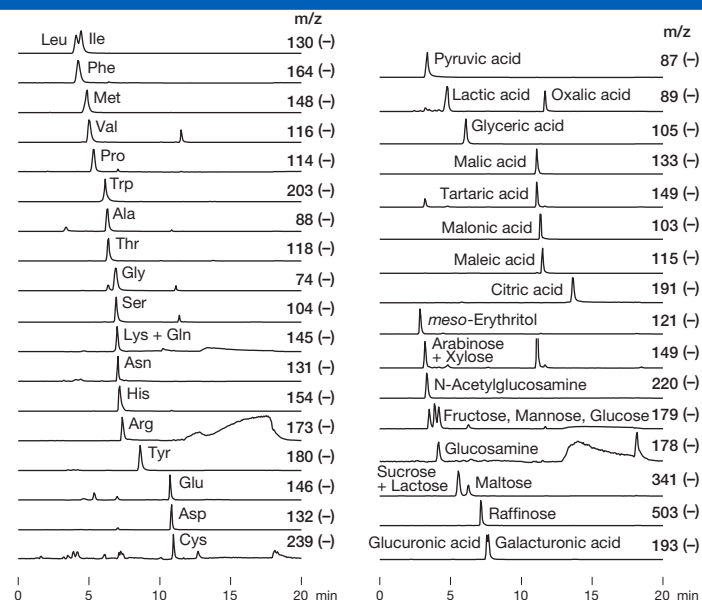
Lactose, epilactose, and lactulose



Melamine and related substances



Simultaneous analysis of saccharides, organic acids and amino acids with LC/MS



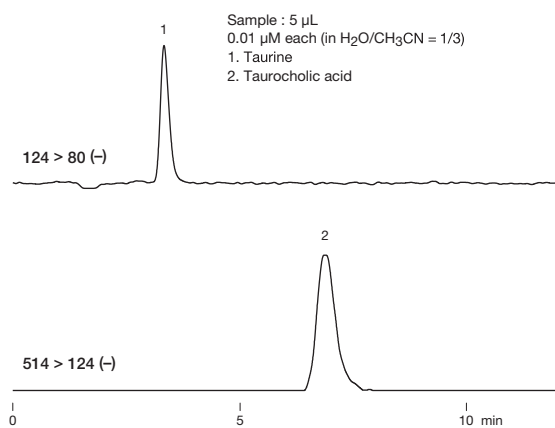
Sample : 1 μ g/mL each (in H₂O/CH₃CN = 1/4), 5 μ L

VG-50 2D allows simultaneous analysis of saccharides, organic acids and amino acids with LC/MS detection under alkaline conditions. High anionic substances elute under alkaline conditions. Furthermore, alkaline conditions promote the deprotonation of hydroxyl groups at the time of ionization. Therefore, alkaline conditions are suitable for high sensitive detection of substances with hydroxyl groups such as saccharides under the negative mode.

Column : **Shodex HILICpak VG-50 2D**
Eluent : (A); 0.5 % NH₃ aq./ (B); CH₃CN
Linear gradient (High pressure);
80 B % (0 to 2 min), 80 B % to 10 B % (2 to 12 min),
10 B % (12 to 15 min), 80 B % (15 to 20 min)

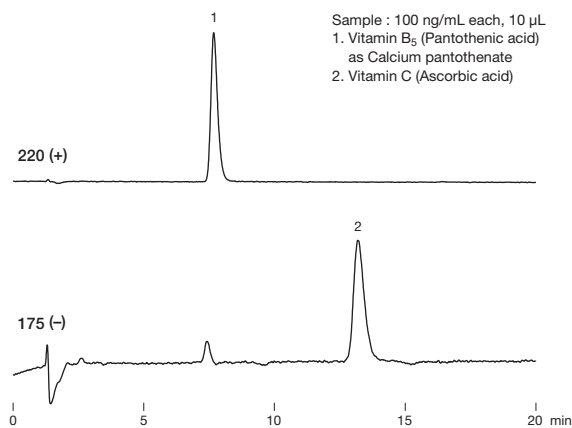
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM)
Column temp. : 40 °C

LC/MS/MS analysis of organic sulfonic acids



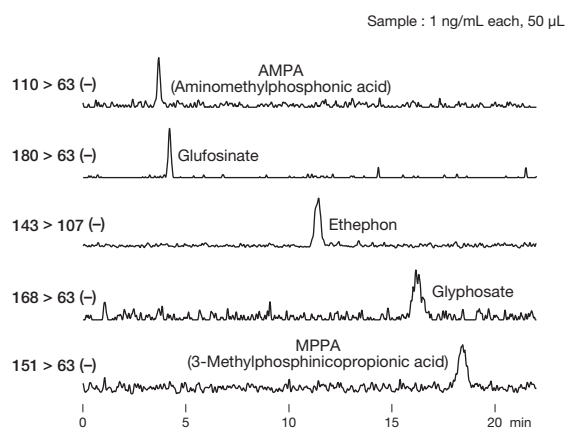
Column : Shodex HILICpak VT-50 2D
Eluent : 50 mM HCOONH₄ aq./CH₃CN = 20/80
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 30 °C

LC/MS analysis of pantothenic acid and vitamin C



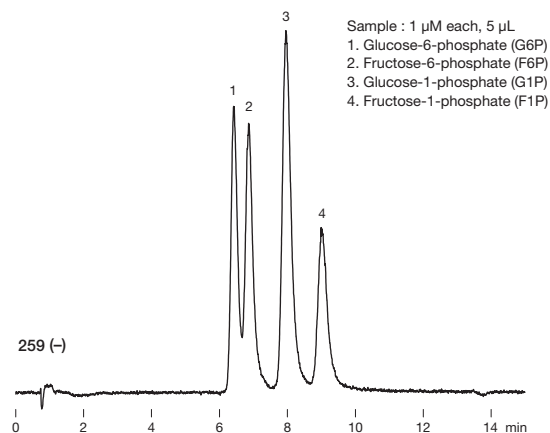
Column : Shodex HILICpak VT-50 2D
Eluent : 50 mM HCOONH₄ aq./CH₃CN = 30/70
Flow rate : 0.2 mL/min
Detector : ESI-MS (SIM)
Column temp. : 30 °C

LC/MS/MS analysis of glyphosate and glufosinate



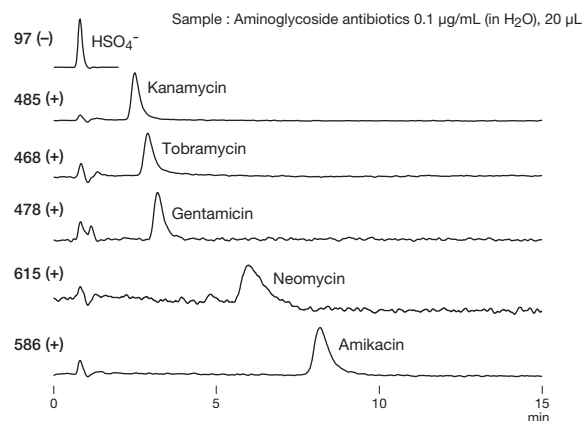
Column : Shodex HILICpak VT-50 2D
Eluent : 50 mM NH₄HCO₃ aq./CH₃CN = 50/50
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 °C

LC/MS analysis of phosphorylated saccharides



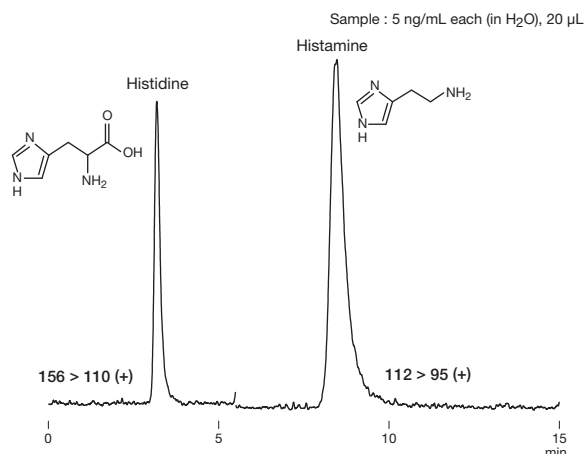
Column : Shodex HILICpak VT-50 2D
Eluent : 25 mM HCOONH₄ aq./CH₃CN = 80/20
Flow rate : 0.3 mL/min
Detector : ESI-MS (SIM)
Column temp. : 60 °C

LC/MS analysis of aminoglycoside antibiotics

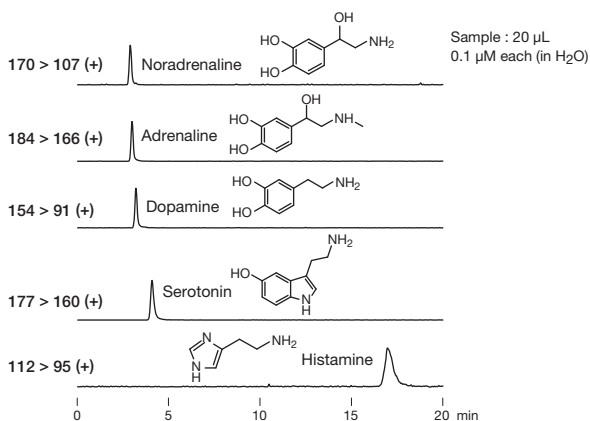


Column : Shodex HILICpak VC-50 2D
Eluent : (A): 1.5 % NH₃ aq./ (B): CH₃CN
 Linear gradient (High pressure);
 30 B % to 10 B % (0 to 5 min), 10 B % (5 to 15 min)
Flow rate : 0.3 mL/min
Detector : ESI-MS (SIM)
Column temp. : 40 °C

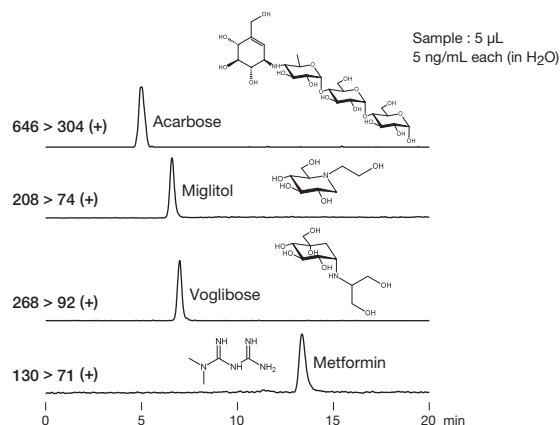
LC/MS/MS analysis of histamine and histidine



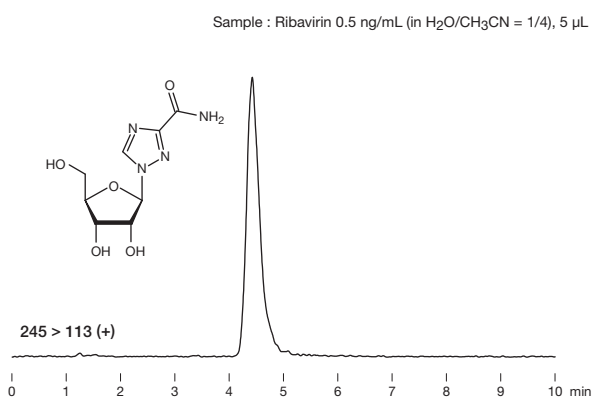
Column : Shodex HILICpak VC-50 2D
Eluent : 250 mM HCOOH aq./CH₃CN = 70/30
Flow rate : 0.3 mL/min
Detector : ESI-MS/MS (MRM)
Column temp. : 40 °C

LC/MS/MS analysis of monoamine neurotransmitters


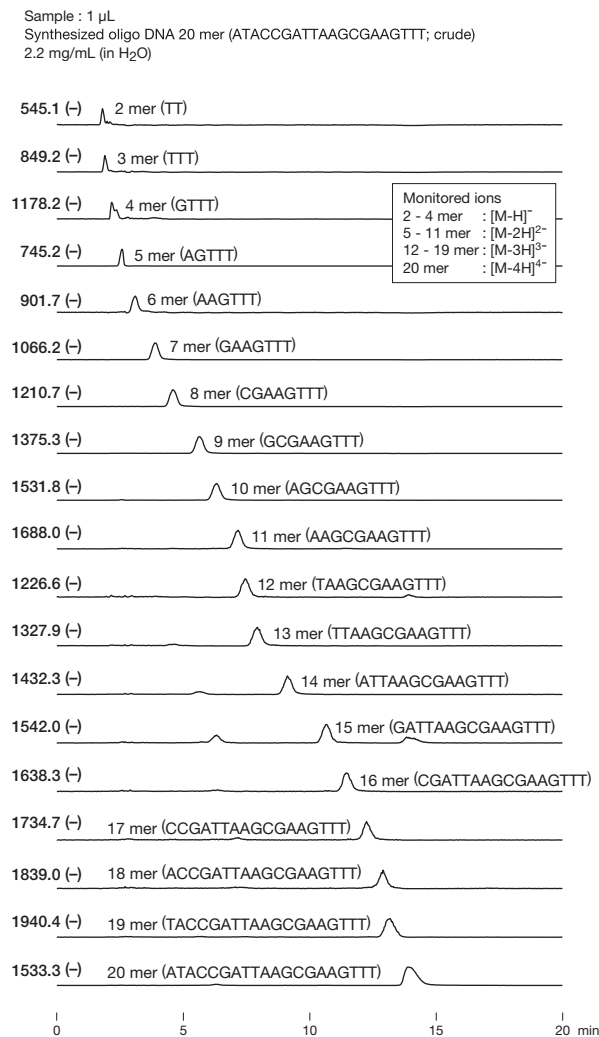
Column : Shodex HILICpak VC-50 2D
 Eluent : (A); 200 mM HCOOH aq./ (B); CH₃CN
 Linear gradient (High pressure);
 60 B % (0 to 5 min), 60 B % to 10 B % (5 to 6 min), 10 B % (6 to 20 min)
 Flow rate : 0.3 mL/min
 Detector : ESI-MS/MS (MRM)
 Column temp. : 40 °C

LC/MS/MS analysis of oral anti-diabetes drugs


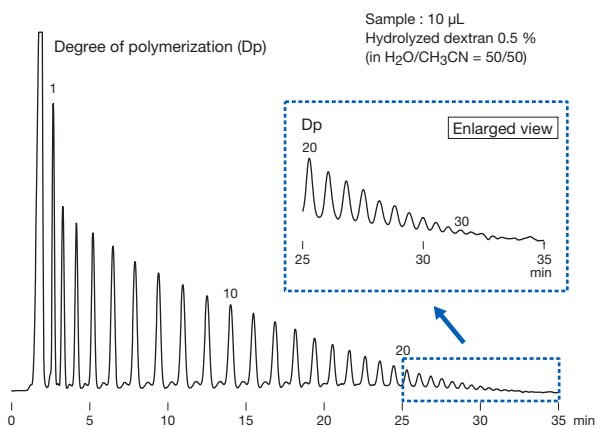
Column : Shodex HILICpak VC-50 2D
 Eluent : (A); 200 mM HCOOH aq./ (B); CH₃CN
 Linear gradient (High pressure);
 60 B % (0 to 5 min), 60 B % to 20 B % (5 to 6 min), 20 B % (6 to 20 min)
 Flow rate : 0.3 mL/min
 Detector : ESI-MS/MS (MRM)
 Column temp. : 40 °C

LC/MS/MS analysis of ribavirin


Column : Shodex HILICpak VC-50 2D
 Eluent : 50 mM HCOOH aq./CH₃CN = 10/90
 Flow rate : 0.25 mL/min
 Detector : ESI-MS/MS (MRM)
 Column temp. : 40 °C

LC/MS analysis of oligo DNA


Column : Shodex HILICpak VN-50 2D
 Eluent : (A); 50 mM HCOONH₄ aq./ (B); CH₃CN
 Linear gradient;
 60 B % (0 to 10 min), 60 B % to 55 B % (10 to 15 min),
 60 B % (15 to 20 min)
 Flow rate : 0.2 mL/min
 Detector : ESI-MS (SIM)
 Column temp. : 40 °C

Hydrolyzed dextran


Column : Shodex HILICpak VN-50 4D
 Eluent : (A); H₂O/ (B); CH₃CN
 Linear gradient; 70 B % to 50 B % (0 to 40 min)
 Flow rate : 1.0 mL/min
 Detector : Corona charged aerosol
 Column temp. : 40 °C

Polymer-based Hydrophilic Interaction Chromatography (HILIC) Columns (Asahipak)

Features

- Suitable for saccharides analysis using HILIC mode
 - Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
 - Easily regenerated by washing in an alkaline solution
 - Appropriate for evaporative light scattering detector, corona charged aerosol detector, and LC/MS
 - Fulfills USP-NF L82 requirements
- NH2P-50**
- NH2P-40** • Provides higher theoretical plate number than NH2P-50 series

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-----------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|--------------------|
| F7630005 | Asahipak NH2P-50 4B | ≥ 1,500 | Amino | 5 | 100 | 4.6 x 50 | CH ₃ CN |
| F7630002 | Asahipak NH2P-50 4D | ≥ 5,500 | Amino | 5 | 100 | 4.6 x 150 | CH ₃ CN |
| F7630001 | Asahipak NH2P-50 4E | ≥ 7,500 | Amino | 5 | 100 | 4.6 x 250 | CH ₃ CN |
| F6710016 | Asahipak NH2P-50G 4A | (guard column) | Amino | 5 | — | 4.6 x 10 | CH ₃ CN |
| F7630007 | Asahipak NH2P-40 3E | ≥ 8,500 | Amino | 4 | 100 | 3.0 x 250 | CH ₃ CN |
| F6710030 | Asahipak NH2P-50G 3A | (guard column) | Amino | 5 | — | 3.0 x 10 | CH ₃ CN |

Base Material: Polyvinyl alcohol

Semi-micro columns

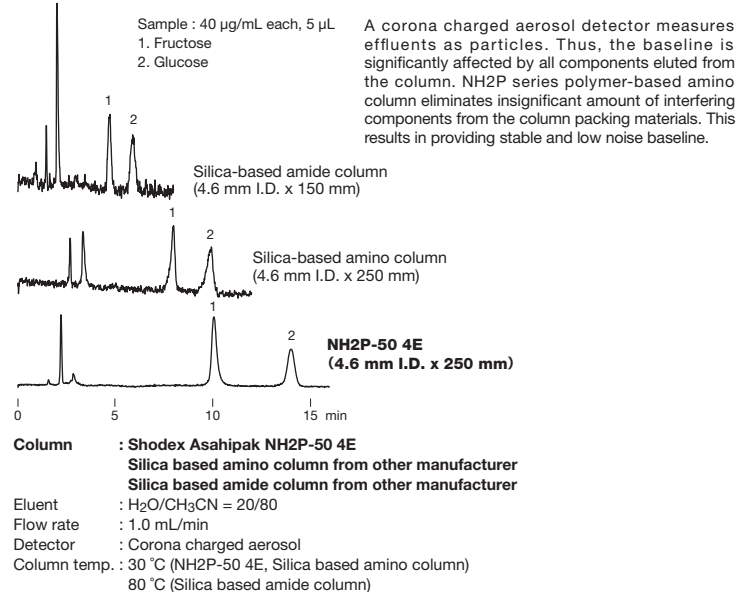
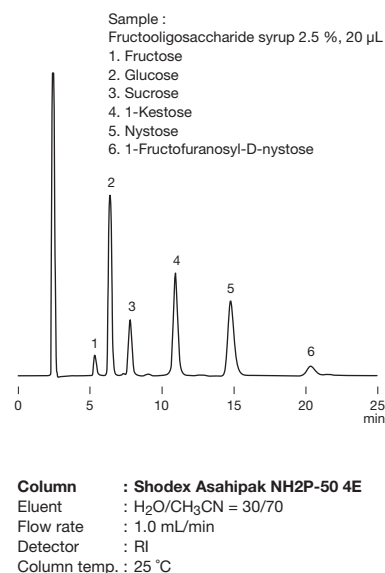
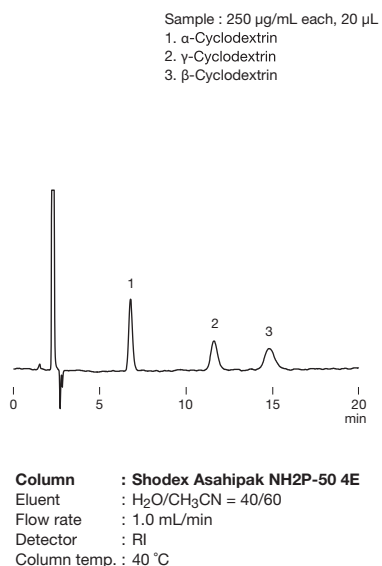
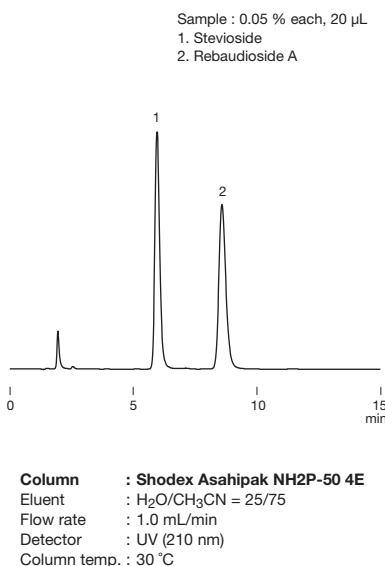
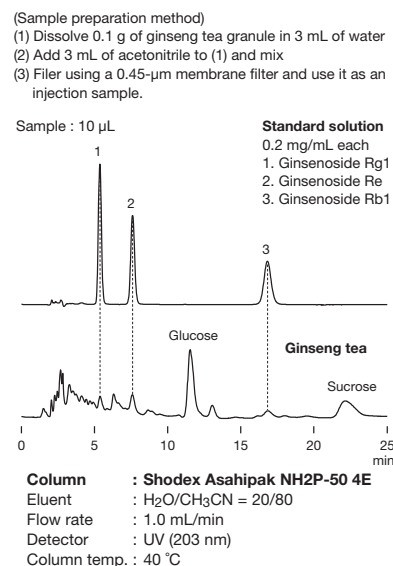
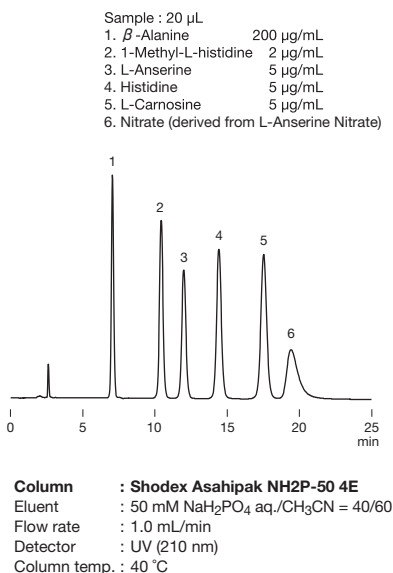
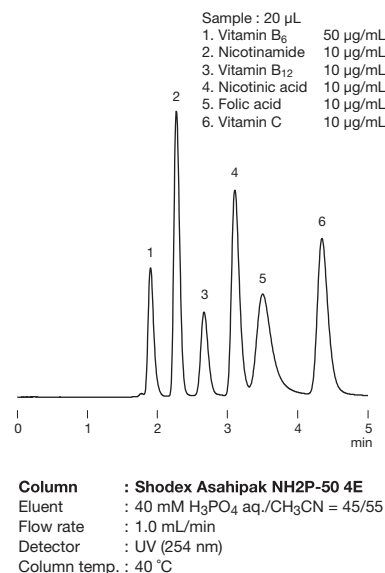
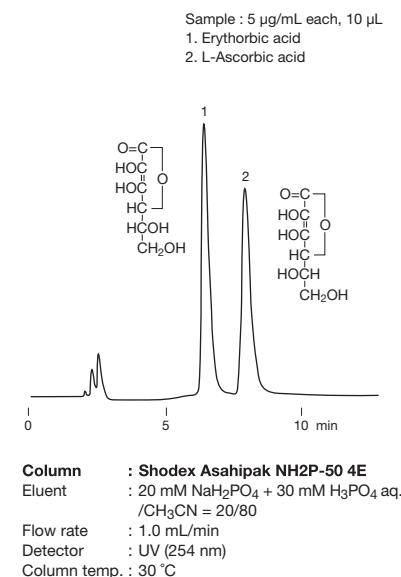
| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-----------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|--------------------|
| F7630006 | Asahipak NH2P-50 2D | ≥ 3,500 | Amino | 5 | 100 | 2.0 x 150 | CH ₃ CN |
| F6713000 | Asahipak NH2P-50G 2A | (guard column) | Amino | 5 | — | 2.0 x 10 | CH ₃ CN |
| F7630010 | Asahipak NH2P-40 2E | ≥ 7,000 | Amino | 4 | 100 | 2.0 x 250 | CH ₃ CN |

Base Material: Polyvinyl alcohol

Preparative columns [Preparative columns are made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------------------|--------------------------|------------------|--------------------|--------------------------------|--------------------|
| F6830001 | Asahipak NH2P-50 10E | ≥ 10,000 | Amino | 5 | 10.0 x 250 | CH ₃ CN |
| F6710016 | Asahipak NH2P-50G 4A | (guard column) | Amino | 5 | 4.6 x 10 | CH ₃ CN |
| F6830031 | Asahipak NH2P-90 20F | ≥ 10,000 | Amino | 9 | 20.0 x 300 | CH ₃ CN |
| F6710017 | Asahipak NH2P-130G 7B | (guard column) | Amino | 13 | 7.5 x 50 | CH ₃ CN |

Base Material: Polyvinyl alcohol

Comparison of saccharide analysis using corona charged aerosol detector

Fructooligosaccharide syrup

Cyclodextrins

Stevioside and rebaudioside A

Ginsenosides in ginseng tea

Imidazole dipeptides

Simultaneous analysis of water-soluble vitamins

Ascorbic acid and erythorbic acid


Silica-based Reversed Phase Chromatography Columns (ODS Columns)

Features

C18

- Fully end capped ODS column available at very reasonable price
- Fulfills USP-NF L1 requirements

C18M

- Monomeric type ODS column, fully end capped high purity silica (99.99 % or higher)
- Fulfills USP-NF L1 requirements

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Carbon Load (%) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-----------------------|--------------------------|------------------|--------------------|-----------------|---------------|--------------------------------|---|
| F6651010 | C18-4D | ≥ 13,000 | Octadecyl | 5 | 17 | 120 | 4.6 x 150 | H ₂ O/CH ₃ OH = 25/75 |
| F6651011 | C18-4E | ≥ 21,000 | Octadecyl | 5 | 17 | 120 | 4.6 x 250 | H ₂ O/CH ₃ OH = 25/75 |
| F6650040 | Silica C18M 4D | ≥ 10,000 | Octadecyl | 5 | 16 | 100 | 4.6 x 150 | H ₂ O/CH ₃ OH = 30/70 |
| F6650041 | Silica C18M 4E | ≥ 16,000 | Octadecyl | 5 | 16 | 100 | 4.6 x 250 | H ₂ O/CH ₃ OH = 30/70 |

Base Material: Silica

Silica-based Reversed Phase Chromatography Columns (ODS Columns for UHPLC)

Features

C18U

- ODS columns for UHPLC (Maximum pressure: 100 MPa)
- Achieves high performance analysis with sub-2 µm particles
- Organic/inorganic silica hybrid particles provide excellent resolution and mechanical stability and improved alkali durability (from pH 1 to 12)
- Usable in 100 % water and buffer solution
- Fulfills USP-NF L1 requirements

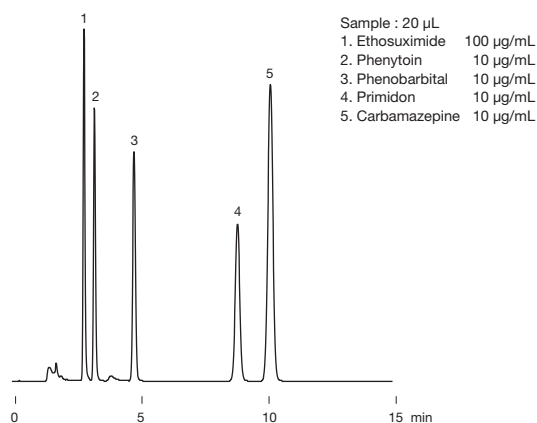
Semi-micro columns

| Product Code | Product Name | Functional Group | Particle Size (µm) | *Carbon Load (%) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------|------------------|--------------------|------------------|---------------|--------------------------------|--------------------|
| F6654011 | C18U 2B | Octadecyl | 1.9 | 20 | 120 | 2.0 x 50 | CH ₃ CN |
| F6654012 | C18U 2D | Octadecyl | 1.9 | 20 | 120 | 2.0 x 150 | CH ₃ CN |

* Includes carbon in hybrid silica base material (8 %).

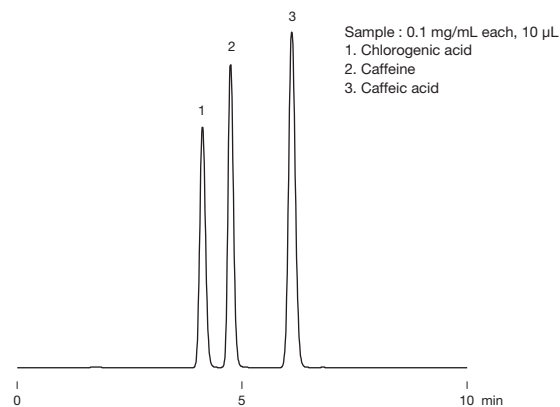
Base Material: Organic/inorganic hybrid silica

Anticonvulsant



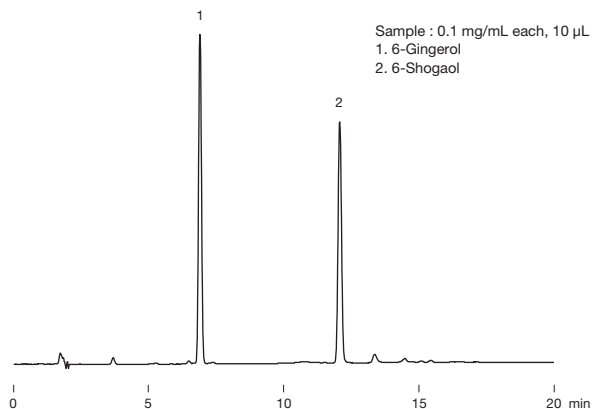
Column : Shodex C18-4D
 Eluent : 100 mM Phosphate buffer (pH2.1)
 /CH₃OH/CH₃CN = 4/2/1
 Flow rate : 1.0 mL/min
 Detector : UV (210 nm)
 Column temp. : 40 °C

Chlorogenic acid



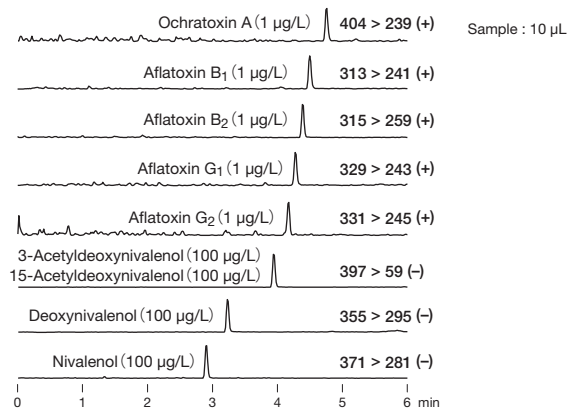
Column : Shodex Silica C18M 4D
 Eluent : 20 mM H₃PO₄ aq. /CH₃OH = 70/30
 Flow rate : 1.0 mL/min
 Detector : UV (280 nm)
 Column temp. : 30 °C

Gingerol and shogaol



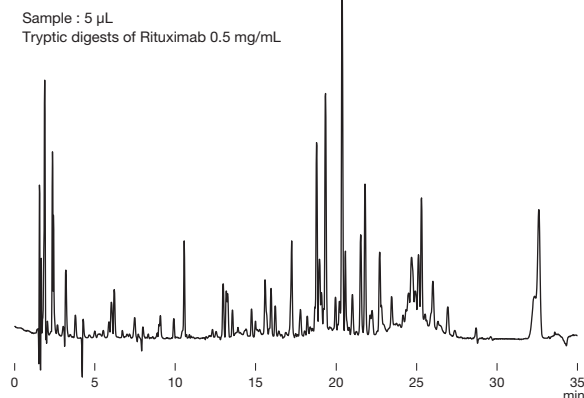
Column : Shodex Silica C18M 4D
 Eluent : (A); H₂O/(B); CH₃CN
 Linear gradient; 40 B % to 70 B % (15 min)
 Flow rate : 1.0 mL/min
 Detector : UV (280 nm)
 Column temp. : 40 °C

LC/MS/MS simultaneous analysis of aflatoxins



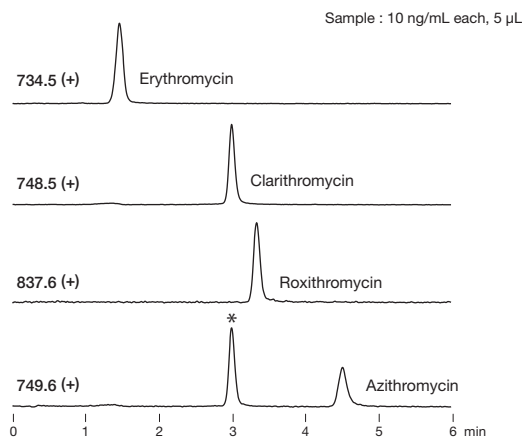
Column : Shodex C18U 2B
 Eluent : (A); 10 mM CH₃COONH₄ aq. / (B); CH₃OH
 Gradient;
 0 to 90 B % (0 to 5 min), 90 B % (5 to 7 min), 0 B % (7.01 min),
 0 B % (7.01 to 10 min)
 Flow rate : 0.4 mL/min
 Detector : ESI-MS/MS (MRM)
 Column temp. : 40 °C

Tryptic digests of rituximab



Column : Shodex C18U 2D
 Eluent : (A); 0.1 % TFA in H₂O/(B); 0.1 % TFA in CH₃CN
 Linear gradient;
 10 to 40 B % (0 to 25 min), 40 B % (25 to 30 min),
 90 B % (30 to 35 min)
 Flow rate : 0.2 mL/min
 Detector : UV (220 nm)
 Column temp. : 40 °C

LC/MS simultaneous analysis of macrolide antibiotics



Column : Shodex C18U 2B
 Eluent : 0.05 % NH₃ aq./CH₃CN = 40/60
 Flow rate : 0.4 mL/min
 Detector : ESI-MS (SIM)
 Column temp. : 40 °C

*: Clarithromycin containing one ¹³C isotope

Ligand Exchange Chromatography Columns

* Please check our website for elution-volume summary lists of various saccharides using Shodex columns.

Features

SC1011

SP0810

KS-801

KS-802

- Separates saccharides by combination of ligand exchange and size exclusion modes
- Three types of counter ions are available: Ca²⁺, Pb²⁺ and Na⁺
- Only water is required for the analysis of neutral sugars
- SC1011 fulfills USP-NF L19 and L22 requirements
- SP0810 fulfills USP-NF L22 and L34 requirements
- KS-801 and KS-802 fulfill USP-NF L22 and L58 requirements

KS-803

KS-804

- Suitable for separation of polysaccharides by size exclusion mode
- Can be used in combination with other columns e.g., KS-801 and/or KS-802
- Only water is required for the analysis of neutral sugars
- Fulfill USP-NF L22 and L58 requirements

DC-613

SZ5532

SC1211

- Separates elements by combination of ligand exchange and HILIC modes
- DC-613 can analyze sugars without removing sodium salts in the sample
- SZ5532 is recommended for the separation of disaccharides or trisaccharides
- SC1211 is suitable for separating sugar alcohols
- DC-613 fulfills USP-NF L22 and L58 requirements
- SZ5532 fulfills USP-NF L22 requirements
- SC1211 fulfills USP-NF L19 and L22 requirements

SC1011-7F

MN-431

- Pharmacopoeia method relevant columns
- Ca²⁺ modified ligand exchange chromatography column
- Only water is required for the analysis of neutral sugars
- Fulfill USP-NF L19 and L22 requirements

Ligand exchange and size exclusion

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group (Counter Ion) | Exclusion Limit (Pullulan) | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------------|--------------------------|--------------------------------|----------------------------|--------------------|--------------------------------|------------------|
| F6378102 | SUGAR SC1011 | ≥ 13,000 | Sulfo (Ca ²⁺) | 1,000 | 6 | 8.0 x 300 | H ₂ O |
| F6700090 | SUGAR SC-G 6B | (guard column) | Sulfo (Ca ²⁺) | — | 10 | 6.0 x 50 | H ₂ O |
| F6378105 | SUGAR SP0810 | ≥ 11,000 | Sulfo (Pb ²⁺) | 1,000 | 7 | 8.0 x 300 | H ₂ O |
| F6700081 | SUGAR SP-G 6B | (guard column) | Sulfo (Pb ²⁺) | — | 10 | 6.0 x 50 | H ₂ O |
| F6378106 | SUGAR SP0810 8C | ≥ 3,000 | Sulfo (Pb ²⁺) | 1,000 | 7 | 8.0 x 100 | H ₂ O |
| F6378010 | SUGAR KS-801 | ≥ 17,000 | Sulfo (Na ⁺) | 1,000 | 6 | 8.0 x 300 | H ₂ O |
| F6378020 | SUGAR KS-802 | ≥ 17,000 | Sulfo (Na ⁺) | 10,000 | 6 | 8.0 x 300 | H ₂ O |
| F6378025 | SUGAR KS-803 | ≥ 17,000 | Sulfo (Na ⁺) | 50,000 | 6 | 8.0 x 300 | H ₂ O |
| F6378035 | SUGAR KS-804 | ≥ 17,000 | Sulfo (Na ⁺) | 400,000 | 7 | 8.0 x 300 | H ₂ O |
| F6700020 | SUGAR KS-G 6B | (guard column) | Sulfo (Na ⁺) | — | 10 | 6.0 x 50 | H ₂ O |

Base Material: Styrene divinylbenzene copolymer

Ligand exchange and HILIC

| Product Code | Product Name | Plate Number (TP/column) | Functional Group (Counter Ion) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-------------------------|--------------------------|--------------------------------|--------------------|---------------|--------------------------------|---|
| F7001003 | RSpak DC-613 | ≥ 5,500 | Sulfo (Na ⁺) | 6 | 100 | 6.0 x 150 | H ₂ O/CH ₃ CN = 30/70 |
| F6700170 | RSpak DC-G 4A | (guard column) | Sulfo (Na ⁺) | 10 | — | 4.6 x 10 | H ₂ O/CH ₃ CN = 30/70 |
| F7001300 | SUGAR SZ5532 | ≥ 5,500 | Sulfo (Zn ²⁺) | 6 | — | 6.0 x 150 | H ₂ O/CH ₃ CN = 30/70 |
| F6700110 | SUGAR SZ-G | (guard column) | Sulfo (Zn ²⁺) | 6 | — | 4.6 x 10 | H ₂ O/CH ₃ CN = 30/70 |
| F7001400 | SUGAR SC1211 | ≥ 5,500 | Sulfo (Ca ²⁺) | 6 | 50 | 6.0 x 250 | H ₂ O/CH ₃ CN = 75/25 |
| F6700120 | SUGAR SC1211G 4A | (guard column) | Sulfo (Ca ²⁺) | 10 | — | 4.6 x 10 | H ₂ O/CH ₃ CN = 75/25 |

Base Material: Styrene divinylbenzene copolymer

Pharmacopoeia Method Relevant Columns

● Standard columns

| Product Code | Product Name | Functional Group (Counter Ion) | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-------------------------------------|--------------------------------|--------------------|--------------------------------|------------------|
| F6379300 | EP SC1011-7F | Sulfo (Ca ²⁺) | 8 | 7.8 x 300 | H ₂ O |
| F6700090 | SUGAR SC-G 6B (guard column) | Sulfo (Ca ²⁺) | 10 | 6.0 x 50 | H ₂ O |
| F6379230 | USPpak MN-431 | Sulfo (Ca ²⁺) | 8 | 4.0 x 250 | H ₂ O |

See page 70 for USP-NF Column List.

Base Material: Styrene divinylbenzene copolymer

Elution volumes of saccharides analyzed by Shodex columns

[Partial list only; refer to our website for complete list]

| Substances | Elution volume (mL) | | | | | |
|-------------------------|---------------------|---------|--------|---------|------------|---------|
| | SP0810 | SC1011 | KS-801 | SZ5532 | NH2P-50 4E | SC1211 |
| Arabinose | 10.42 | 8.91 | 8.21 | 5.11 | 6.18 | 5.56 |
| D-Arabitol | 15.86 | 11.33 | 7.63 | 7.27 | 6.29 | 8.16 |
| Dulcitol | 20.18 | 12.76 | 7.40 | 9.46 | 7.45 | 11.28 |
| <i>meso</i> -Erythritol | 12.70 | 10.09 | 7.86 | 5.73 | 5.43 | 6.27 |
| D(-)-Fructose | 11.05 | 8.85 | 7.71 | 5.37 | 6.75 | 5.90 |
| D(+)-Fucose | 10.48 | 8.84 | 8.09 | 4.50 | 5.43 | 4.96 |
| D(+)-Galactose | 9.74 | 7.98 | 7.58 | 6.46 | 8.10 | 4.98 |
| Gentiobiose | 7.22 | 6.08 | 5.75 | 10.50 | 16.36 | * |
| Glucose | 8.63 | 7.30 | 7.17 | 5.87 | 8.61 | 4.76 |
| <i>myo</i> -Inositol | 12.77 | 8.86 | 7.99 | 12.63 | 9.96 | 7.87 |
| Isomaltose | 7.68 | 6.26 | 5.95 | 10.57 | 15.18 | * |
| Isomaltotriose | 7.09 | 5.75 | 5.34 | 21.17 | 27.55 | * |
| 1-Kestose | 6.79 | 5.75 | 5.26 | 13.09 | 20.11 | * |
| Kojibiose | 7.56 | 6.21 | 5.88 | 9.65 | 14.82 | * |
| Lactitol | 13.27 | 8.09 | 6.13 | 16.35 | 11.82 | 6.67 |
| Lactose | 8.05 | 6.51 | 5.99 | 10.12 | 13.27 | 4.07 |
| Lactulose | 9.13 | 6.99 | 6.19 | 9.16 | 10.72 | 4.65 |
| Maltitol | 12.23 | 8.26 | 6.03 | 13.04 | 11.82 | 6.77 |
| Maltose | 7.85 | 6.34 | 5.94 | 8.67 | 14.24 | * |
| Maltotriose | 7.48 | 5.89 | 5.38 | 13.79 | 24.96 | * |
| Mannitol | 15.80 | 11.10 | 7.23 | 8.75 | 7.39 | 9.03 |
| D-Mannose | 10.72 | 8.17 | 7.64 | 5.83 | 7.84 | 5.01 |
| Melibiose | 8.16 | 6.45 | 5.98 | 11.69 | 14.70 | 4.23 |
| Nystose | 6.38 | 5.45 | 4.93 | 20.05 | 31.90 | * |
| Palatinin | 2 peaks | 2 peaks | 5.90 | 2 peaks | 12.73 | 2 peaks |
| Palatinose | 7.84 | 6.45 | 5.89 | 8.08 | 12.12 | 3.99 |
| Panose | 7.14 | 5.78 | 5.32 | 16.87 | 25.60 | * |
| D(+)-Raffinose | 7.14 | 5.78 | 5.29 | 16.36 | 20.25 | * |
| Rhamnose | 9.77 | 8.23 | 7.37 | 3.93 | 5.52 | 4.43 |
| D(-)-Ribose | 19.35 | 13.66 | 9.04 | 4.82 | 5.45 | 8.64 |
| D(-)-Sorbitol | 21.61 | 13.31 | 7.42 | 9.79 | 7.09 | 11.88 |
| Sorbose | 9.67 | 8.03 | 7.38 | 5.12 | 7.35 | 4.92 |
| Stachyose | 6.82 | 5.57 | 4.97 | — | 36.22 | * |
| Sucrose | 7.54 | 6.29 | 5.87 | 7.91 | 11.87 | * |
| α-D-Talose | 21.33 | 12.59 | 8.76 | 5.69 | 6.47 | 8.51 |
| Trehalose | 7.62 | 6.27 | 5.78 | 10.85 | 13.25 | * |
| Trehalulose | 8.92 | 6.95 | 6.10 | 9.54 | 11.68 | 4.78 |
| Xylitol | 19.87 | 13.14 | 7.94 | 7.77 | 6.10 | 10.16 |
| Xylobiose | 8.16 | 6.68 | 6.40 | 5.65 | 9.05 | * |
| D(+)-Xylose | 9.21 | 7.90 | 7.71 | 4.55 | 6.58 | 4.48 |
| D-Xylulose | 10.64 | 9.02 | 8.04 | 4.06 | 5.41 | 5.07 |

(—) Not detected (*) Overlap with solvent peak

Column : SUGAR SP0810,
SC1011, KS-801
Eluent : H₂O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 80 °C

Column : SUGAR SC1211
Eluent : H₂O/CH₃CN = 65/35
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 70 °C

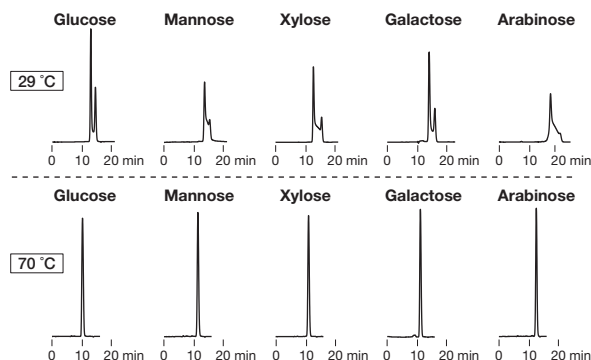
Column : SUGAR SZ5532
Eluent : H₂O/CH₃CN = 25/75
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 60 °C

Column : Asahipak NH2P-50 4E
Eluent : H₂O/CH₃CN = 25/75
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 °C

Saccharides anomer separation

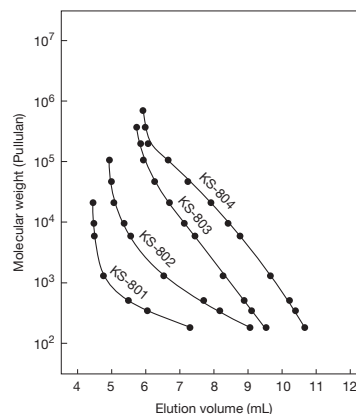
Saccharides may present their anomers at lower temperatures. By setting the SUGAR series columns at higher temperatures will prevent the anomer separation and this results in providing better chromatograms of each saccharide.

Sample : 0.5 % each, 10 μ L



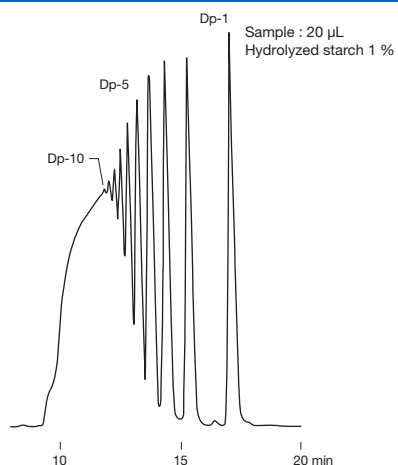
Column : Shodex SUGAR SC1011
 Eluent : H₂O
 Flow rate : 0.7 mL/min
 Detector : RI
 Column temp. : 29 °C, 70 °C

Calibration curves for KS-800 series using pullulan



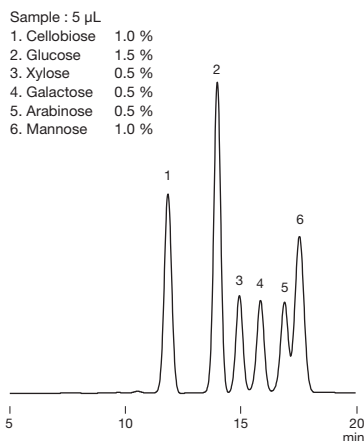
Column : Shodex SUGAR KS-800 series
 Eluent : H₂O
 Detector : RI
 Column temp. : 80 °C

Hydrolyzed starch



Column : Shodex SUGAR KS-802 x 2
 Eluent : H₂O
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 80 °C

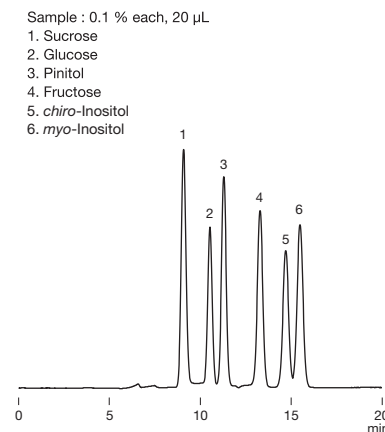
Biomass sugars



Sample : 5 μ L
 1. Cellobiose 1.0 %
 2. Glucose 1.5 %
 3. Xylose 0.5 %
 4. Galactose 0.5 %
 5. Arabinose 0.5 %
 6. Mannose 1.0 %

Column : Shodex SUGAR SP0810
 Eluent : H₂O
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 85 °C

Pinitol

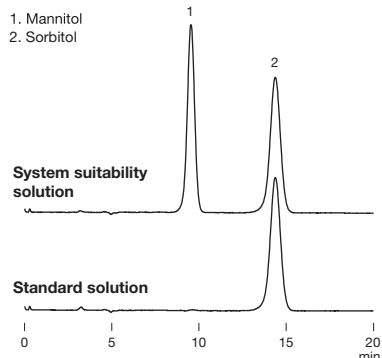


Sample : 0.1 % each, 20 μ L
 1. Sucrose
 2. Glucose
 3. Pinitol
 4. Fructose
 5. *chiro*-Inositol
 6. *myo*-Inositol

Column : Shodex SUGAR SP0810
 Eluent : H₂O
 Flow rate : 0.8 mL/min
 Detector : RI
 Column temp. : 85 °C

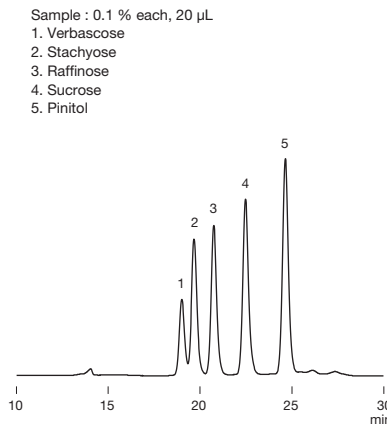
Analysis of sorbitol according to USP-NF method

Sample : 10 μ L
 (System suitability solution) Mannitol, Sorbitol 4.8 mg/g each
 (Standard solution) Sorbitol 4.8 mg/g



Column : Shodex SUGAR SP0810 8C
 Eluent : H₂O
 Flow rate : 0.7 mL/min
 Detector : RI (35 °C)
 Column temp. : 50 °C

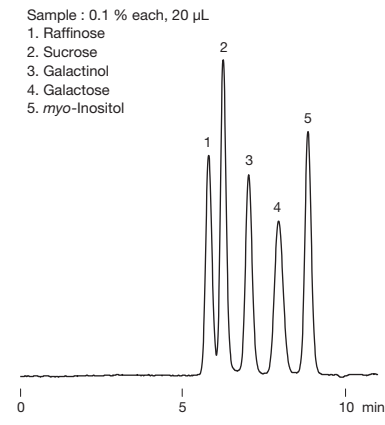
Oligosaccharides in soybean



Sample : 0.1 % each, 20 μ L
 1. Verbascose
 2. Stachyose
 3. Raffinose
 4. Sucrose
 5. Pinitol

Column : Shodex SUGAR KS-802 + KS-801
 Eluent : H₂O
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 85 °C

Saccharides related to raffinose biosynthesis

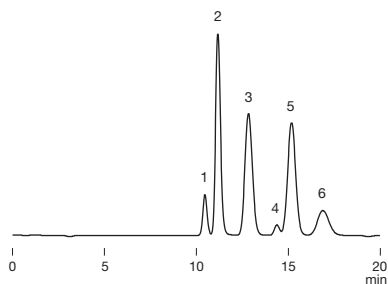


Sample : 0.1 % each, 20 μ L
 1. Raffinose
 2. Sucrose
 3. Galactinol
 4. Galactose
 5. *myo*-Inositol

Column : Shodex SUGAR SC1011
 Eluent : H₂O
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 80 °C

Acesulfame K and sucralose

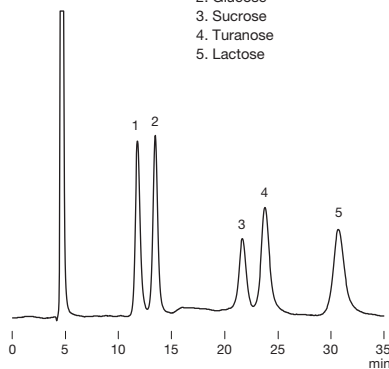
Sample : 20 μ L
 1. Acesulfame K 0.1 %
 2. Sucrose 0.5 %
 3. Glucose 0.5 %
 4. Unknown from Acesulfame K
 5. Fructose 0.5 %
 6. Sucralose 0.1 %



Column : Shodex SUGAR SC1011
 Eluent : 10 mM CaSO₄ aq.
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 80 °C

Sucrose and turanose

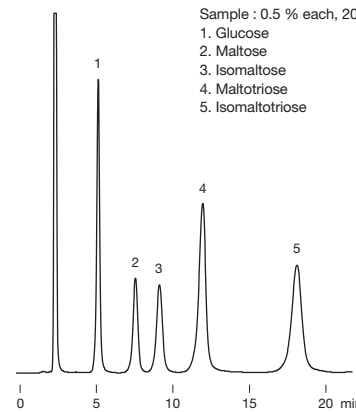
Sample : 0.5 % each, 10 μ L
 1. Fructose
 2. Glucose
 3. Sucrose
 4. Turanose
 5. Lactose



Column : Shodex SUGAR SZ5532
 Eluent : H₂O/CH₃CN = 20/80
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 60 °C

Maltose and isomaltose

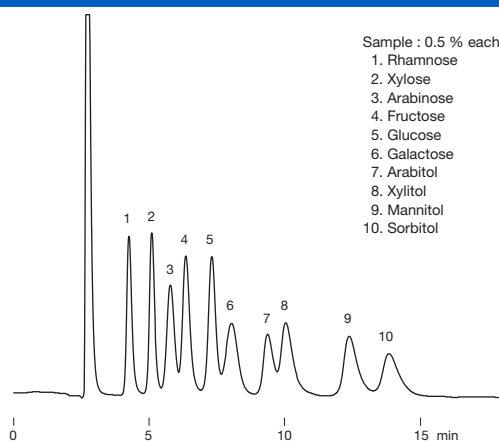
Sample : 0.5 % each, 20 μ L
 1. Glucose
 2. Maltose
 3. Isomaltose
 4. Maltotriose
 5. Isomaltotriose



Column : Shodex SUGAR SZ5532
 Eluent : H₂O/CH₃CN = 25/75
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 60 °C

Saccharides and sugar alcohols

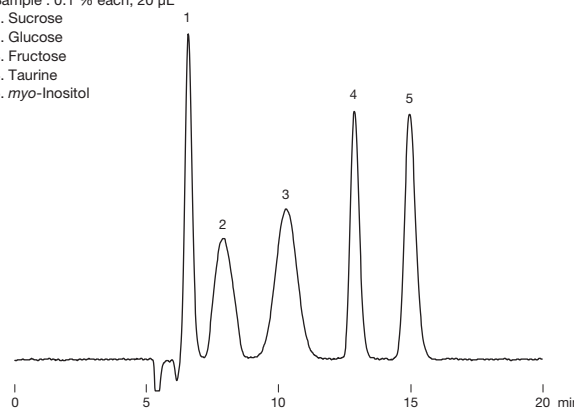
Sample : 0.5 % each, 20 μ L
 1. Rhamnose
 2. Xylose
 3. Arabinose
 4. Fructose
 5. Glucose
 6. Galactose
 7. Arabitol
 8. Xylitol
 9. Mannitol
 10. Sorbitol



Column : Shodex SUGAR SZ5532
 Eluent : H₂O/CH₃CN = 20/80
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 65 °C

Saccharides and taurine

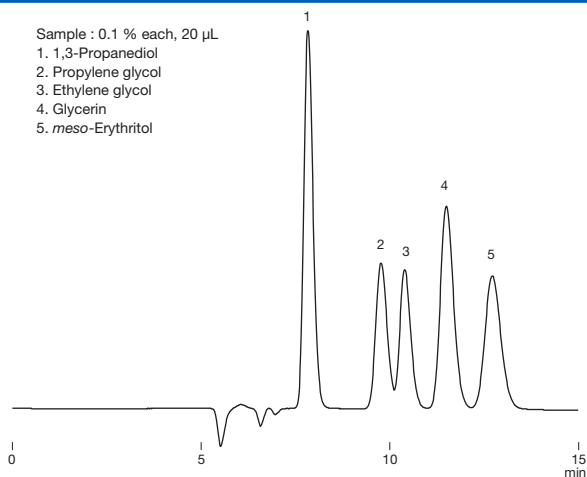
Sample : 0.1 % each, 20 μ L
 1. Sucrose
 2. Glucose
 3. Fructose
 4. Taurine
 5. *myo*-Inositol



Column : Shodex SUGAR SC1211
 Eluent : H₂O/CH₃CN = 60/40
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 70 °C

Moisturizing components

Sample : 0.1 % each, 20 μ L
 1. 1,3-Propanediol
 2. Propylene glycol
 3. Ethylene glycol
 4. Glycerin
 5. *meso*-Erythritol

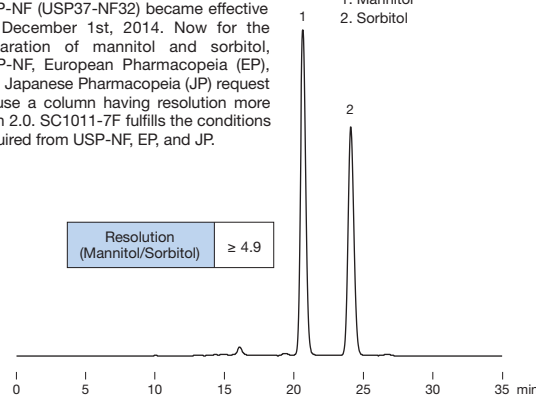


Column : Shodex SUGAR SC1211
 Eluent : H₂O/CH₃CN = 60/40
 Flow rate : 0.6 mL/min
 Detector : RI
 Column temp. : 40 °C

Mannitol and sorbitol

Partial modifications on the analytical conditions of mannitol stated in the USP-NF (USP37-NF32) became effective on December 1st, 2014. Now for the separation of mannitol and sorbitol, USP-NF, European Pharmacopeia (EP), and Japanese Pharmacopeia (JP) request to use a column having resolution more than 2.0. SC1011-7F fulfills the conditions required from USP-NF, EP, and JP.

Sample : 25 mg/mL each, 20 μ L
 1. Mannitol
 2. Sorbitol



Column : Shodex EP SC1011-7F
 Eluent : H₂O
 Flow rate : 0.5 mL/min
 Detector : RI
 Column temp. : 85 °C

Ion Exclusion Chromatography Columns

Features

SH1011 SH1821

- Columns for simultaneous analysis of saccharides and organic acids
- Separates neutral sugars by size exclusion mode and organic acids by ion exclusion mode
- Suitable for the analysis of uronic and aldonic acids
- Fulfill USP-NF L17 and L22 requirements

KC-811

- Columns suitable for the analysis of organic acids
- Separates compounds by ion exclusion mode and reversed phase mode
- Highly selective when used with post column method
- KC-811 6E is suitable for the analysis of cyanide ions and cyanogen chloride in accordance with the Japanese Water Supply Act
- Fulfills USP-NF L17 and L22 requirements

For simultaneous analysis of saccharides and organic acids

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Exclusion Limit (Pullulan) | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------------|--------------------------|------------------|----------------------------|--------------------|--------------------------------|------------------|
| F6378100 | SUGAR SH1011 | ≥ 17,000 | Sulfo | 1,000 | 6 | 8.0 x 300 | H ₂ O |
| F6378101 | SUGAR SH1821 | ≥ 17,000 | Sulfo | 10,000 | 6 | 8.0 x 300 | H ₂ O |
| F6700080 | SUGAR SH-G | (guard column) | Sulfo | — | 10 | 6.0 x 50 | H ₂ O |
| F6378104 | SUGAR SH1011 8C | ≥ 5,000 | Sulfo | 1,000 | 6 | 8.0 x 100 | H ₂ O |

Base Material: Styrene divinylbenzene copolymer

For organic acids, cyanide ions and cyanogen chloride

• Standard columns

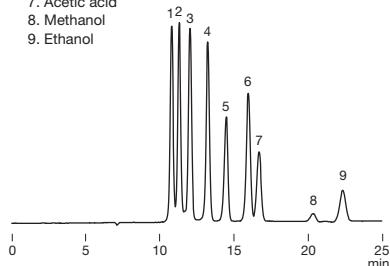
| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------------|--------------------------|------------------|--------------------|--------------------------------|--|
| F6378030 | RSpak KC-811 | ≥ 17,000 | Sulfo | 6 | 8.0 x 300 | 0.1 % H ₃ PO ₄ aq. |
| F6378033 | RSpak KC-811 6E | ≥ 13,000 | Sulfo | 6 | 6.0 x 250 | 0.1 % H ₃ PO ₄ aq. |
| F6700030 | RSpak KC-G 6B | (guard column) | Sulfo | 10 | 6.0 x 50 | 0.1 % H ₃ PO ₄ aq. |
| F6700010 | RSpak KC-G 8B | (guard column) | Sulfo | 13 | 8.0 x 50 | 0.1 % H ₃ PO ₄ aq. |

Use KC-G 8B for samples with relatively high impurities and KC-G 6B for samples with relatively low impurities. Base Material: Styrene divinylbenzene copolymer

Maltooligosaccharides, organic acids and ethanol

 Sample : 0.05 % each, 20 μ L

1. Maltotetraose
2. Maltotriose
3. Maltose
4. Glucose
5. Lactic acid
6. Glycerin
7. Acetic acid
8. Methanol
9. Ethanol

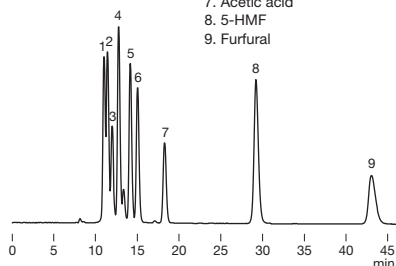


Column : Shodex SUGAR SH1821
Eluent : 0.5 mM H₂SO₄ aq.
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 75 °C

Cello-oligosaccharides and furfurals

 Sample : 0.1 % each, 10 μ L

1. Cellopentaose
2. Cellotetraose
3. Cellotriose
4. Cellobiose
5. Glucose
6. Glyceric acid
7. Acetic acid
8. 5-HMF
9. Furfural

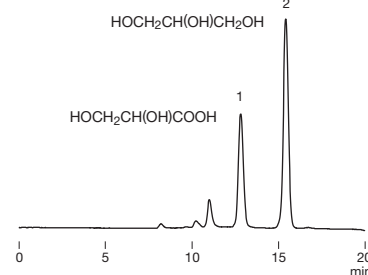


Column : Shodex SUGAR SH1821
Eluent : 2 mM H₂SO₄ aq.
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 60 °C

Glycerin and glyceric acid

 Sample : 0.1 % each, 10 μ L

1. Glyceric acid
2. Glycerin

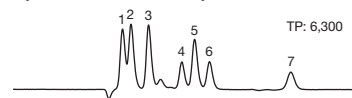
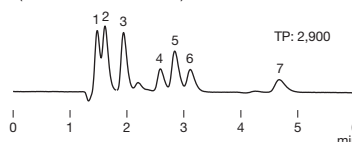


Column : Shodex SUGAR SH1011
Eluent : 2 mM H₂SO₄ aq.
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 60 °C

Rapid analysis of maltooligosaccharides, organic acids and ethanol

 Sample : 0.1 % each, 5 μ L

1. Maltotriose
2. Maltose
3. Glucose
4. Lactic acid
5. Acetic acid
6. Glycerin
7. Ethanol

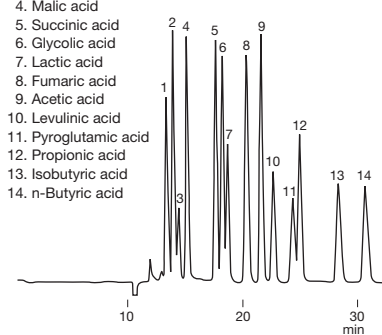
(1) Shodex SUGAR SH1011 8C (8.0 mm I.D. x 100 mm)

(2) Ion exclusion column from other manufacturer (7.8 mm I.D. x 100 mm)


Column : (1) Shodex SUGAR SH1011 8C
 (2) Ion exclusion column from other manufacturer
Eluent : 1 mM H₂SO₄ aq.
Flow rate : (1) 1.0 mL/min
 (2) 0.95 mL/min
Detector : RI
Column temp. : 65 °C

Common organic acids

Sample :

1. Citric acid
2. Tartaric acid
3. Pyruvic acid
4. Malic acid
5. Succinic acid
6. Glycolic acid
7. Lactic acid
8. Fumaric acid
9. Acetic acid
10. Levulinic acid
11. Pyroglutamic acid
12. Propionic acid
13. Isobutyric acid
14. n-Butyric acid

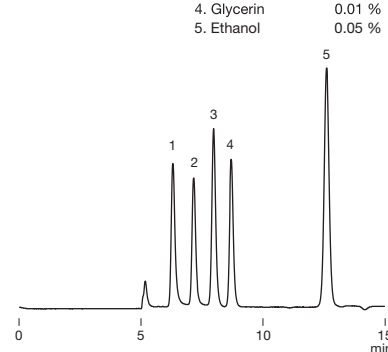


Column : Shodex RSpak KC-811 x 2
Eluent : 6 mM HClO₄ aq.
Flow rate : 1.0 mL/min
Detector : VIS (430 nm)
 post column method
Column temp. : 50 °C

Glucronolactone and organic acids

 Sample : 20 μ L

- | | |
|--------------------|--------|
| 1. Citric acid | 0.01 % |
| 2. Malic acid | 0.01 % |
| 3. Glucronolactone | 0.01 % |
| 4. Glycerin | 0.01 % |
| 5. Ethanol | 0.05 % |

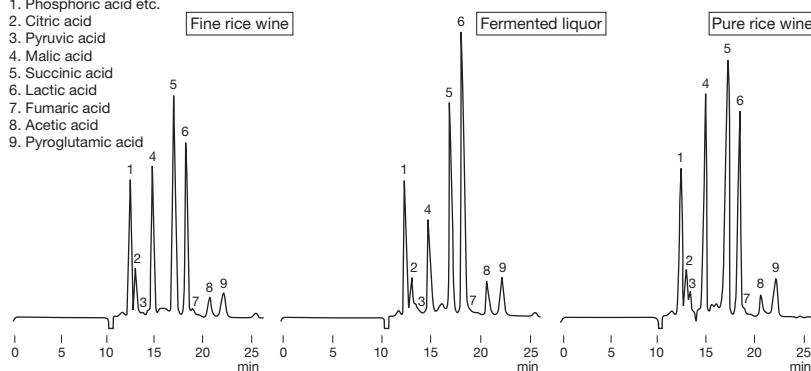


Column : Shodex RSpak KC-811
Eluent : 3 mM HClO₄ aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Organic acids in sake

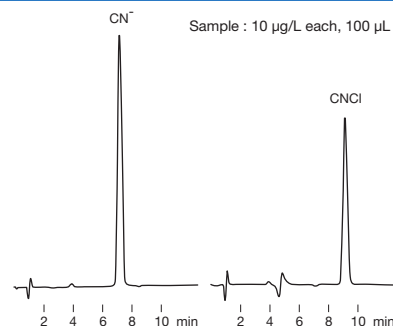
 Sample : 100 μ L

1. Phosphoric acid etc.
2. Citric acid
3. Pyruvic acid
4. Malic acid
5. Succinic acid
6. Lactic acid
7. Fumaric acid
8. Acetic acid
9. Pyroglutamic acid



Column : Shodex RSpak KC-G 8B + KC-811 x 2
Eluent : 4.8 mM HClO₄ aq.
Flow rate : 1.0 mL/min
Detector : VIS (430 nm)
 post column method
Column temp. : 63 °C

Analysis of cyanide ion and cyanogen chloride with post column method

 Sample : 10 μ g/L each, 100 μ L


Column : Shodex RSpak KC-811 6E
Eluent : 1 mM H₂SO₄ aq.
Reagent A : Chloramine T solution
Reagent B : 4-Pyridinecarboxylic acid-Pyrazolone solution
Flow rate : (Eluent) 1.0 mL/min
 (Reagent) 0.5 mL/min each
Detector : VIS (638 nm)
Column temp. : 40 °C
Reaction temp. : (Reagent A) 40 °C
 (Reagent B) 80 °C

Ion Chromatography Columns (Anion Analysis)

Features

- NI-424**
 - Ideal for anion non-suppressor methods
 - NI-424 provides simultaneous analysis of fluoride and phosphate ions
- I-524A**
 - I-524A fulfills USP-NF L23 requirements
- SI-90 4E**
 - Suitable for anion suppressor methods with sodium carbonate eluent
- SI-50 4E**
 - Suitable for the quantitative analysis of fluoride ion
- SI-52 4E**
 - SI-50 4E separates target inorganic anions from organic acids
 - SI-52 4E provides simultaneous analysis of oxyhalides and general inorganic ions
 - Carbonate peak does not interfere with analysis
- SI-35**
 - Rapid-analysis type columns used with suppressor and sodium carbonate eluent
 - SI-35 4D provides rapid analysis of oxyhalides and general inorganic ions
 - SI-35 2B provides rapid analysis of general inorganic ions
- SI-36 4D**
 - Suitable for anion suppressor methods with potassium hydroxide
 - Good separation of sulfite and sulfate ions
 - Analysis of seven general inorganic anions within 30 minutes under isocratic conditions

For non-suppressor method

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------|--------------------------|---------------------|--------------------|--------------------------------|---|
| F6995243 | IC NI-424 | ≥ 5,000 | Quaternary ammonium | 5 | 4.6 x 100 | 8 mM 4-Hydroxybenzoic acid + 2.8 mM Bis-Tris + 2 mM Phenylboronic acid + 0.005 mM CyDTA aq. |
| F6709616 | IC NI-G | (guard column) | Quaternary ammonium | 5 | 4.6 x 10 | 8 mM 4-Hydroxybenzoic acid + 2.8 mM Bis-Tris + 2 mM Phenylboronic acid + 0.005 mM CyDTA aq. |
| F6995240 | IC I-524A | ≥ 2,000 | Quaternary ammonium | 12 | 4.6 x 100 | 2.5 mM Phthalic acid aq. |
| F6700400 | IC IA-G | (guard column) | Quaternary ammonium | 12 | 4.6 x 10 | 2.5 mM Phthalic acid aq. |

Base Material: Polyhydroxymethacrylate
Housing Material: SUS

For suppressor method (Sodium carbonate eluent)

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|---------------------|--------------------|--------------------------------|--|
| F6995244 | IC SI-90 4E | ≥ 5,000 | Quaternary ammonium | 9 | 4.0 x 250 | 1.8 mM Na ₂ CO ₃ + 1.7 mM NaHCO ₃ aq. |
| F6709620 | IC SI-90G | (guard column) | Quaternary ammonium | 9 | 4.6 x 10 | 1.8 mM Na ₂ CO ₃ + 1.7 mM NaHCO ₃ aq. |
| F6995245 | IC SI-50 4E | ≥ 10,000 | Quaternary ammonium | 5 | 4.0 x 250 | 3.2 mM Na ₂ CO ₃ + 1.0 mM NaHCO ₃ aq. |
| F6709625 | IC SI-50G | (guard column) | Quaternary ammonium | 5 | 4.6 x 10 | 3.2 mM Na ₂ CO ₃ + 1.0 mM NaHCO ₃ aq. |

Base Material: Polyvinyl alcohol
Housing Material: PEEK

<For oxyhalides analysis>

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|---------------------|--------------------|--------------------------------|--|
| F6995260 | IC SI-52 4E | ≥ 14,000 | Quaternary ammonium | 5 | 4.0 x 250 | 3.6 mM Na ₂ CO ₃ aq. |
| F6709626 | IC SI-92G | (guard column) | Quaternary ammonium | 9 | 4.6 x 10 | 3.6 mM Na ₂ CO ₃ aq. |

Base Material: Polyvinyl alcohol
Housing Material: PEEK

<For oxyhalides rapid analysis>

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|---------------------|--------------------|--------------------------------|--|
| F6995290 | IC SI-35 4D | ≥ 13,000 | Quaternary ammonium | 3.5 | 4.0 x 150 | 3.6 mM Na ₂ CO ₃ aq. |
| F6709627 | IC SI-95G | (guard column) | Quaternary ammonium | 9 | 4.6 x 10 | 3.6 mM Na ₂ CO ₃ aq. |

Base Material: Polyvinyl alcohol
Housing Material: PEEK

• Semi-micro columns

<For rapid analysis>

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|---------------------|--------------------|--------------------------------|--|
| F6995291 | IC SI-35 2B | ≥ 4,000 | Quaternary ammonium | 3.5 | 2.0 x 50 | 1.0 mM Na ₂ CO ₃ + 2.0 mM NaHCO ₃ aq. |

Base Material: Polyvinyl alcohol
Housing Material: PEEK

• Guard filter for IC SI-35 2B

| Product Code | Product Name | Contents |
|--------------|-------------------------|---------------------------|
| F6709720 | IC SI-2GF | One holder and one filter |
| F6709730 | IC SI-2GF filter | 3 filters |

Removes sample-origin insoluble components.

For anion suppressor method (Potassium hydroxide eluent)

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------------|---------------------|--------------------|--------------------------------|--|
| F6999361 | IC SI-36 4D | ≥ 8,500 | Quaternary ammonium | 3.5 | 4.0 x 150 | 10 mM Na ₂ SO ₄ aq. |
| F6709620 | IC SI-90G | (guard column) | Quaternary ammonium | 9 | 4.6 x 10 | 1.8 mM Na ₂ CO ₃ + 1.7 mM NaHCO ₃ aq. |

Base Material: Polyvinyl alcohol
Housing Material: PEEK

Ion Chromatography Columns (Cation Analysis)

Features

YS-50

- High performance type of YK-421
- Applicable to both suppressor and non-suppressor methods
- Provides sharp peaks; more significant for divalent cation analysis
- Supports the analysis of alkylamines and transition metals

YK-421

- Column for cation analysis with non-suppressor method
- Simultaneous analysis of monovalent and divalent cations
- Suitable separating of alkylamines
- Fulfills USP-NF L76 requirements

For non-suppressor method/suppressor method

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-----------------|--------------------------|------------------|--------------------|--------------------------------|---|
| F7122000 | IC YS-50 | ≥ 5,500 | Carboxyl | 5 | 4.6 x 125 | 10 mM Na ₂ SO ₄ aq. |
| F6700530 | IC YS-G | (guard column) | Carboxyl | 5 | 4.6 x 10 | 10 mM Na ₂ SO ₄ aq. |

Base Material: Polyvinyl alcohol
Housing Material: SUS

For non-suppressor method

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------|--------------------------|------------------|--------------------|--------------------------------|---|
| F7120012 | IC YK-421 | ≥ 2,800 | Carboxyl | 5 | 4.6 x 125 | 5 mM Tartaric acid + 1 mM Dipicolinic acid + 24 mM Boric acid aq. |
| F6709608 | IC YK-G | (guard column) | Carboxyl | 5 | 4.6 x 10 | 5 mM Tartaric acid + 1 mM Dipicolinic acid + 24 mM Boric acid aq. |

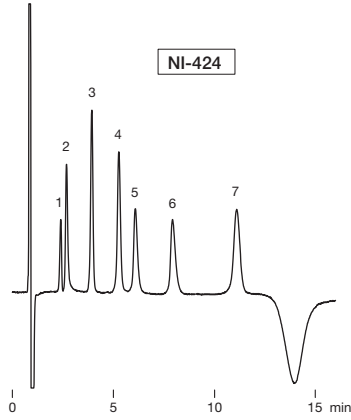
Base Material: Silica
Housing Material: SUS

• Line filters for IC columns (Suitable either for anion or cation analyses)

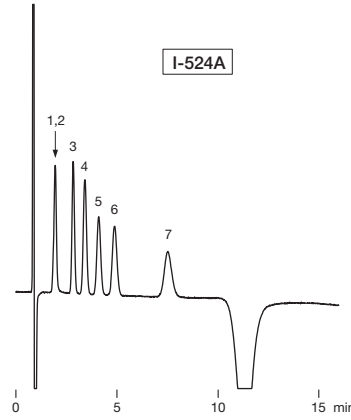
| Product Code | Product Name | Contents |
|--------------|-----------------------|---------------------------|
| F8500630 | IC FL-1 | One holder and one filter |
| F8500640 | IC FL-1 filter | 5 filters |

Install in upstream of the injector. Removes eluent-origin insoluble components.

Anion analysis using NI-424 and I-524A (non-suppressor methods)



Sample : 20 µL
 1. H₂PO₄⁻ 10 mg/L
 2. F⁻ 1 mg/L
 3. Cl⁻ 1 mg/L
 4. NO₂⁻ 5 mg/L
 5. Br⁻ 5 mg/L
 6. NO₃⁻ 5 mg/L
 7. SO₄²⁻ 5 mg/L



With twice increased theoretical plate number, NI-424 provides a higher performance compared to I-524A.

<Features of NI-424>

- (1) Enables the separation of H₂PO₄⁻ and F⁻ which were difficult to separate with I-524A.
- (2) Provides sharper peaks, and resolution between all peaks are well defined. Especially, the separation of Cl⁻ and NO₂⁻ is improved.

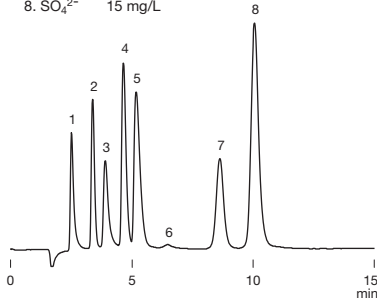
Column : Shodex IC NI-424
Eluent : 8 mM 4-Hydroxybenzoic acid + 2.8 mM Bis-Tris + 2 mM Phenylboronic acid + 0.005 mM *CyDTA aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 °C

Column : Shodex IC I-524A
Eluent : 2.5 mM Phthalic acid + 2.3 mM Tris(hydroxymethyl)aminomethane aq.
Flow rate : 1.2 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 °C

*CyDTA : trans-1,2-Diaminocyclohexane-N,N,N',N'-tetra acetic acid

Anion analysis using SI-90 4E (suppressor method)

Sample : 20 µL
 1. F⁻ 2 mg/L
 2. Cl⁻ 3 mg/L
 3. NO₂⁻ 5 mg/L
 4. Br⁻ 10 mg/L
 5. NO₃⁻ 10 mg/L
 6. HCO₃⁻ 300 mg/L
 7. HPO₄²⁻ 15 mg/L
 8. SO₄²⁻ 15 mg/L

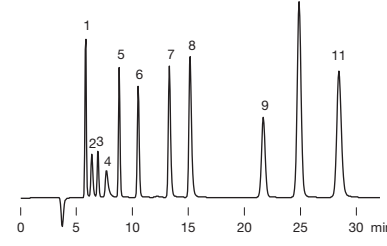


Column : Shodex IC SI-90 4E
Eluent : 1.8 mM Na₂CO₃ + 1.7 mM NaHCO₃ aq.
Flow rate : 1.5 mL/min
Detector : Suppressed conductivity
Column temp. : Room temp. (25 °C)

Anion analysis using SI-50 4E (suppressor method)

SI-50 4E is a high performance type of SI-90 4E. Acetic acid, formic acid, and methacrylic acid elute between F⁻ and Cl⁻. The carbonate system peak appears between NO₂⁻ and Br⁻ peaks.

Sample : 20 µL
 1. F⁻ 2 mg/L
 2. Acetic acid 10 mg/L
 3. Formic acid 2 mg/L
 4. Methacrylic acid 10 mg/L
 5. Cl⁻ 3 mg/L
 6. NO₂⁻ 5 mg/L
 7. Br⁻ 10 mg/L
 8. NO₃⁻ 10 mg/L
 9. HPO₄²⁻ 15 mg/L
 10. SO₄²⁻ 15 mg/L
 11. Oxalic acid 15 mg/L

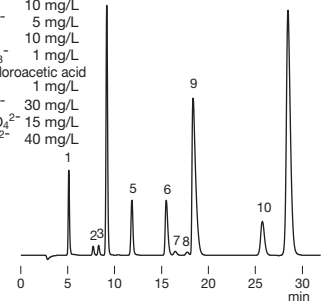


Column : Shodex IC SI-50 4E
Eluent : 3.2 mM Na₂CO₃ + 1.0 mM NaHCO₃ aq.
Flow rate : 0.7 mL/min
Detector : Suppressed conductivity
Column temp. : 25 °C

Oxyhalides and anions analysis using SI-52 4E (suppressor method)

SI-52 4E is a high resolution column offering 14,000 or higher theoretical plate number. It supports simultaneous analysis of oxyhalides and inorganic anions. It is recommended to set the column temperature at 45 °C.

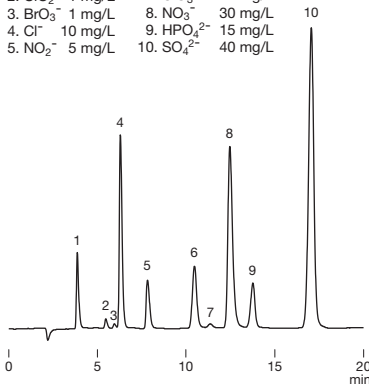
Sample : 50 µL
 1. F⁻ 2 mg/L
 2. ClO₂⁻ 1 mg/L
 3. BrO₃⁻ 1 mg/L
 4. Cl⁻ 10 mg/L
 5. NO₂⁻ 5 mg/L
 6. Br⁻ 10 mg/L
 7. ClO₃⁻ 1 mg/L
 8. Dichloroacetic acid 1 mg/L
 9. NO₃⁻ 30 mg/L
 10. HPO₄²⁻ 15 mg/L
 11. SO₄²⁻ 40 mg/L



Column : Shodex IC SI-52 4E
Eluent : 3.6 mM Na₂CO₃ aq.
Flow rate : 0.8 mL/min
Detector : Suppressed conductivity
Column temp. : 45 °C

Rapid analysis of oxyhalides and anions using SI-35 4D (suppressor method)

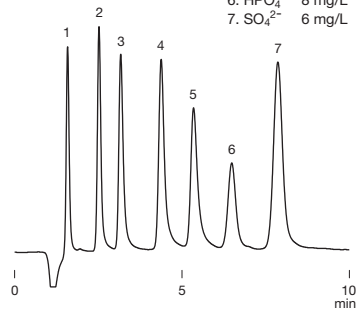
Sample : 20 µL
 1. F⁻ 2 mg/L
 2. ClO₂⁻ 1 mg/L
 3. BrO₃⁻ 1 mg/L
 4. Cl⁻ 10 mg/L
 5. NO₂⁻ 5 mg/L
 6. Br⁻ 10 mg/L
 7. ClO₃⁻ 1 mg/L
 8. NO₃⁻ 30 mg/L
 9. HPO₄²⁻ 15 mg/L
 10. SO₄²⁻ 40 mg/L



Column : Shodex IC SI-35 4D
Eluent : 2.0 mM Na₂CO₃ + 4.5 mM NaHCO₃ aq.
Flow rate : 0.6 mL/min
Detector : Suppressed conductivity
Column temp. : 45 °C

Rapid analysis of anions using SI-35 2B (suppressor method)

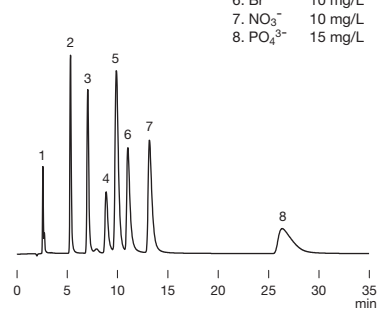
Sample : 2 µL
 1. F⁻ 1 mg/L
 2. Cl⁻ 2 mg/L
 3. NO₂⁻ 3 mg/L
 4. Br⁻ 5 mg/L
 5. NO₃⁻ 5 mg/L
 6. HPO₄²⁻ 8 mg/L
 7. SO₄²⁻ 6 mg/L



Column : Shodex IC SI-35 2B
Eluent : 1.0 mM Na₂CO₃ + 2.0 mM NaHCO₃ aq.
Flow rate : 0.2 mL/min
Detector : Suppressed conductivity
Column temp. : 30 °C

Anions and sulfite ion analysis using SI-36 4D (suppressor method)

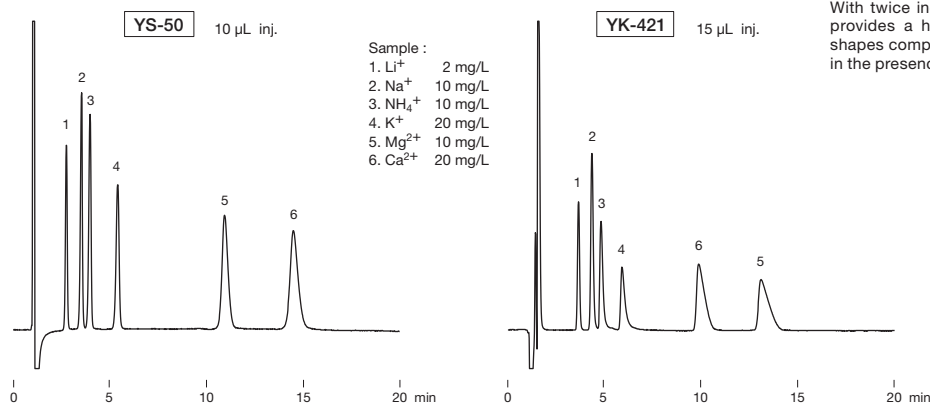
Sample : 25 µL
 1. F⁻ 0.5 mg/L
 2. Cl⁻ 3 mg/L
 3. NO₂⁻ 5 mg/L
 4. SO₃²⁻ 5 mg/L
 5. SO₄²⁻ 10 mg/L
 6. Br⁻ 10 mg/L
 7. NO₃⁻ 10 mg/L
 8. PO₄³⁻ 15 mg/L



Column : Shodex IC SI-36 4D
Eluent : 25 mM KOH aq.
Flow rate : 0.7 mL/min
Detector : Suppressed conductivity
Column temp. : 30 °C

Eluent source : Dionex™ EGC 500 KOH

Cation analysis using YS-50 and YK-421



With twice increased theoretical plate number, YS-50 provides a higher performance with improved peak shapes compared to YK-421. The quantitation of NH_4^+ in the presence of high Na^+ content is also improved.

| TP | YS-50 | YK-421 |
|------------------|-------|--------|
| Mg^{2+} | 6,900 | 3,000 |
| Ca^{2+} | 6,600 | 3,000 |

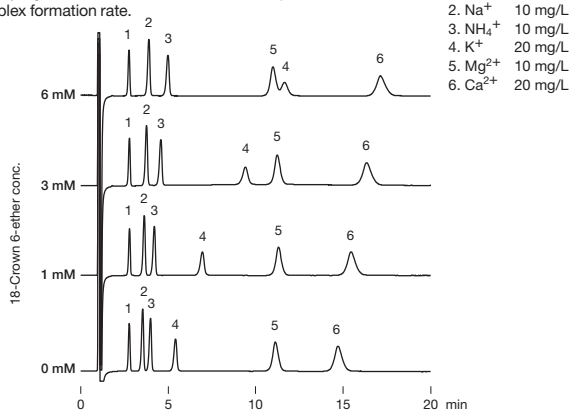
| Resolution ($\text{Na}^+ / \text{NH}_4^+$) | YS-50 | YK-421 |
|---|-------|--------|
| | 2.5 | 2.1 |

Column : Shodex IC YS-50
Eluent : 4 mM Methanesulfonic acid aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 °C

Column : Shodex IC YK-421
Eluent : 5 mM Tartaric acid + 1 mM Dipicolinic acid + 24 mM Boric acid aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 °C

Effects of added crown ether in the eluent

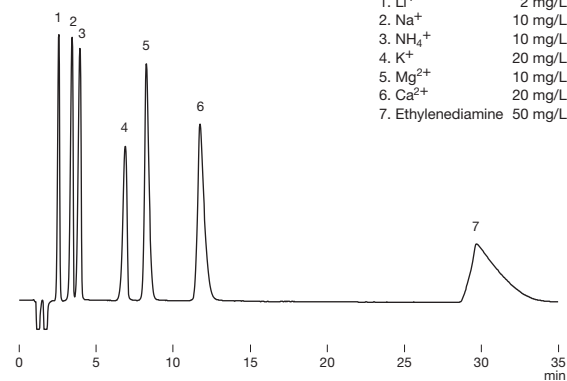
The elution of cations (particularly K^+) can be well controlled by modifying the eluent concentration, as it provides different complex formation rate.



Column : Shodex IC YS-50
Eluent : 4 mM Methanesulfonic acid + 18-Crown 6-ether aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 °C

Sample : 10 μL
 1. Li^+ 2 mg/L
 2. Na^+ 10 mg/L
 3. NH_4^+ 10 mg/L
 4. K^+ 20 mg/L
 5. Mg^{2+} 10 mg/L
 6. Ca^{2+} 20 mg/L

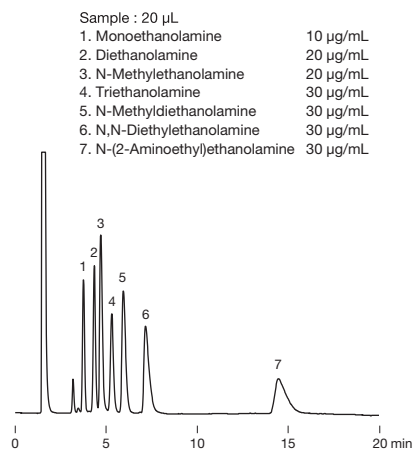
Simultaneous analysis of cations and ethylenediamine



Column : Shodex IC YS-50
Eluent : 4 mM Nitric acid + 1.5 mM 18-Crown 6-ether aq. / CH_3CN = 90/10
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 °C

Sample : 50 μL
 1. Li^+ 2 mg/L
 2. Na^+ 10 mg/L
 3. NH_4^+ 10 mg/L
 4. K^+ 20 mg/L
 5. Mg^{2+} 10 mg/L
 6. Ca^{2+} 20 mg/L
 7. Ethylenediamine 50 mg/L

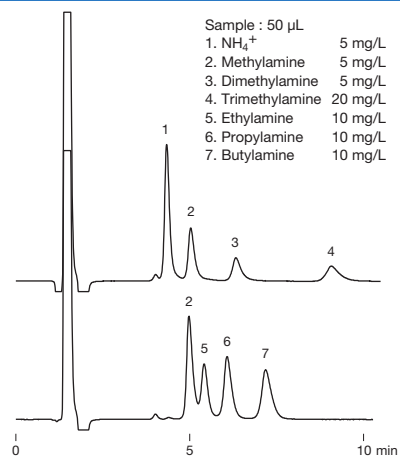
Amino alcohols



Column : Shodex IC YK-421
Eluent : 4 mM Nitric acid aq.
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 40 °C

Sample : 20 μL
 1. Monoethanolamine 10 $\mu\text{g}/\text{mL}$
 2. Diethanolamine 20 $\mu\text{g}/\text{mL}$
 3. N-Methylethanolamine 20 $\mu\text{g}/\text{mL}$
 4. Triethanolamine 30 $\mu\text{g}/\text{mL}$
 5. N-Methyldiethanolamine 30 $\mu\text{g}/\text{mL}$
 6. N,N-Diethylethanolamine 30 $\mu\text{g}/\text{mL}$
 7. N-(2-Aminoethyl)ethanolamine 30 $\mu\text{g}/\text{mL}$

Alkylamines



Column : Shodex IC YK-421
Eluent : 4 mM H_3PO_4 aq. / CH_3CN = 90/10
Flow rate : 1.0 mL/min
Detector : Non-suppressed conductivity
Column temp. : 25 °C

Sample : 50 μL
 1. NH_4^+ 5 mg/L
 2. Methylamine 5 mg/L
 3. Dimethylamine 5 mg/L
 4. Trimethylamine 20 mg/L
 5. Ethylamine 10 mg/L
 6. Propylamine 10 mg/L
 7. Butylamine 10 mg/L

Aqueous SEC (GFC) Columns: Silica-based

Features

| | |
|------------------|--|
| KW-800 | <ul style="list-style-type: none"> • Silica-based packed columns for aqueous SEC (GFC) analysis • Suitable for the analysis of proteins and enzymes • Fulfills USP-NF L20, L33, and L59 requirements |
| KW400 | <ul style="list-style-type: none"> • Reduced packing material particle size enhances column performance • Three to four-fold higher sensitivity than KW-800 series • KW405-4F is applicable analyzing samples with molecular weight above 1,000,000 • Fulfills USP-NF L20, L33, and L59 requirements |
| LW-803 | <ul style="list-style-type: none"> • Pore size specifically controlled for analyzing proteins with a molecular weight of several hundred of thousand • High performance analysis of antibody drugs and various proteins • High lot-to-lot reproducibility • Fulfills USP-NF L20, L33, and L59 requirements |
| LW-403 4D | <ul style="list-style-type: none"> • Rapid analysis column of LW-803 • Achieves approximately halved analysis time compared with standard column • Fulfills USP-NF L20, L33, and L59 requirements |

• Standard columns

| Product Code | Product Name | * Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-------------------------|----------------------------|--------------------|---------------|--------------------------------|------------------|
| F6989000 | PROTEIN KW-802.5 | ≥ 21,000 | 5 | 400 | 8.0 x 300 | H ₂ O |
| F6989103 | PROTEIN KW-803 | ≥ 21,000 | 5 | 1,000 | 8.0 x 300 | H ₂ O |
| F6989104 | PROTEIN KW-804 | ≥ 16,000 | 7 | 1,500 | 8.0 x 300 | H ₂ O |
| F6700131 | PROTEIN KW-G 6B | (guard column) | 7 | — | 6.0 x 50 | H ₂ O |

* Measured with ethylene glycol

Base Material: Silica
Usable pH Range: pH3.0 - 7.5

• High performance semi-micro columns

* KW400 series is recommended to be used with semi-micro type devices.

| Product Code | Product Name | * Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-------------------|----------------------------|--------------------|---------------|--------------------------------|------------------|
| F6989201 | KW402.5-4F | ≥ 35,000 | 3 | 400 | 4.6 x 300 | H ₂ O |
| F6989202 | KW403-4F | ≥ 35,000 | 3 | 800 | 4.6 x 300 | H ₂ O |
| F6989203 | KW404-4F | ≥ 25,000 | 5 | 1,500 | 4.6 x 300 | H ₂ O |
| F6989204 | KW405-4F | ≥ 25,000 | 5 | 2,000 | 4.6 x 300 | H ₂ O |
| F6700132 | KW400G-4A | (guard column) | 5 | — | 4.6 x 10 | H ₂ O |

* Measured with uridine

Base Material: Silica
Usable pH Range: pH3.0 - 7.5

For antibody drugs analysis

● Standard columns

| Product Code | Product Name | * Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------------|----------------------------|--------------------|---------------|--------------------------------|------------------|
| F6989303 | PROTEIN LW-803 | ≥ 12,000 | 3 | 1,000 | 8.0 x 300 | H ₂ O |
| F6700133 | PROTEIN LW-G 6B | (guard column) | 3 | — | 6.0 x 50 | H ₂ O |

* Measured with bovine serum albumin

Base Material: Silica
Usable pH Range: pH3.0 - 7.5

● Semi-micro columns

* LW-403 4D is recommended to be used with semi-micro type devices.

| Product Code | Product Name | * Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------------|----------------------------|--------------------|---------------|--------------------------------|------------------|
| F6989403 | PROTEIN LW-403 4D | ≥ 11,000 | 1.9 | 1,000 | 4.6 x 150 | H ₂ O |
| F6700134 | PROTEIN LS-G 4J | (guard column) | 1.9 | — | 4.6 x 20 | H ₂ O |

* Measured with bovine serum albumin

Base Material: Silica
Usable pH Range: pH3.0 - 7.5

Usable solvents

| Product Name | Solvent | | | |
|---------------------------------|--------------|----------|---------|------------------|
| | Acetonitrile | Methanol | Ethanol | 2-Propanol (IPA) |
| KW-802.5, KW-803, KW-804 | ○ | ○ | ○ | ○ |
| KW402.5-4F | ○ | ○ | ○ | △ |
| KW403-4F | ○ | ○ | ○ | × |
| KW404-4F, KW405-4F | ○ | ○ | ○ | ○ |
| LW-803 | ○ | ○ | ○ | ○ |
| LW-403 4D | ○ | ○ | ○ | × |

○: Solvent replacement possible △: Solvent replacement possible up to 50 % ×: Solvent replacement not possible

Target molecular weight range and exclusion limit

● Measured with protein (eluent: phosphate buffer)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------------------|-------------------------------|-----------------|
| KW-802.5 | 5,000 - 100,000 | 150,000 |
| KW-803 | 10,000 - 700,000 | * (1,000,000) |
| KW-804 | 30,000 - * (4,000,000) | * (4,000,000) |
| KW402.5-4F | 5,000 - 70,000 | 150,000 |
| KW403-4F | 10,000 - 500,000 | 600,000 |
| KW404-4F | 30,000 - * (4,000,000) | * (4,000,000) |
| KW405-4F | 200,000 - * (20,000,000) | * (20,000,000) |
| LW-803, LW-403 4D | 10,000 - 700,000 | * (1,000,000) |

Please use the above table for reference purposes only when selecting columns.

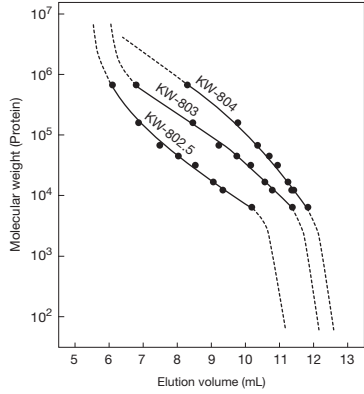
* () Estimated value

● Measured with pullulan (eluent: ultrapure water)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|-------------------|-------------------------------|-----------------|
| KW-802.5 | 2,000 - 50,000 | 60,000 |
| KW-803 | 5,000 - 100,000 | 170,000 |
| KW-804 | 20,000 - 300,000 | 500,000 |
| KW402.5-4F | 2,000 - 40,000 | 60,000 |
| KW403-4F | 3,000 - 50,000 | 80,000 |
| KW404-4F | 20,000 - 300,000 | 400,000 |
| KW405-4F | 100,000 - 700,000 | 1,300,000 |

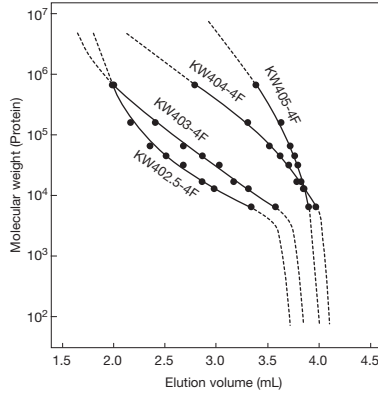
Please use the above table for reference purposes only when selecting columns.

Calibration curves for KW-800 series using protein



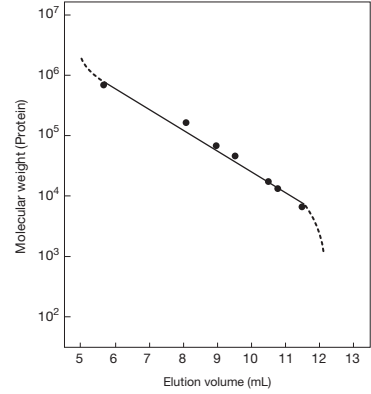
Column : Shodex PROTEIN KW-800 series
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 °C

Calibration curves for KW400 series using protein



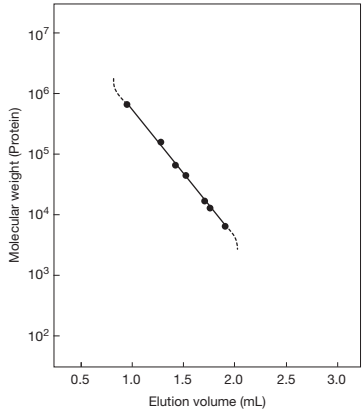
Column : Shodex KW400-4F series
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.33 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 30 °C

Calibration curve for LW-803 using protein



Column : Shodex PROTEIN LW-803
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

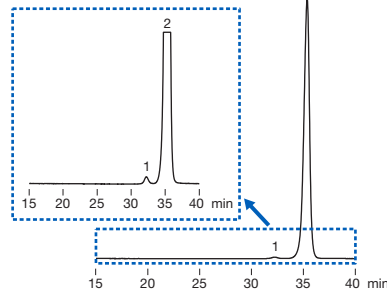
Calibration curve for LW-403 4D using protein



Column : Shodex PROTEIN LW-403 4D
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.35 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 30 °C

Analysis of impurities (high molecular weight proteins) in insulin glargine according to USP-NF method

Sample : 100 µL
System suitability solution (prepared following USP-NF method)
 1. High molecular weight proteins
 2. Insulin glargine



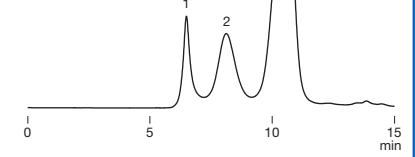
Column : Shodex PROTEIN KW-802.5 x 2
Eluent : CH₃COOH/CH₃CN/H₂O=20/30/50 (pH to 3.0 adjusted with 25 % NH₃ aq.)
Flow rate : 0.5 mL/min
Detector : UV (276 nm)
Column temp. : Ambient

Lipoproteins in serum

Sample : 40 µL
 Whole lipoproteins from serum of a healthy person 1.0 mg/mL
 1. VLDL 2. LDL 3. HDL

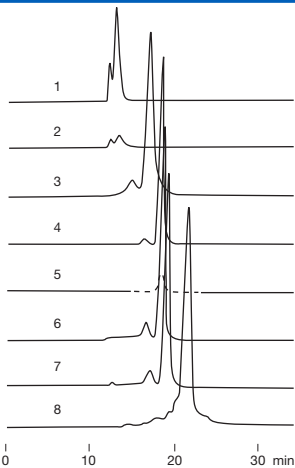
(Sample preparation method)

1. Use potassium bromide to adjust the specific gravity of serum from a healthy person to 1.210 g/mL. Ultracentrifuge for 24 hours.
2. Dialyze the supernatant and then substitute the solvent with PBS*.
3. Measure protein concentration by Lowry method and dilute the sample with PBS* to 1.0 mg/mL.



Column : Shodex PROTEIN KW-G + KW-804
Eluent : 10-fold diluted x 10 PBS* with H₂O
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 30 °C
 x10 PBS* : 80 g NaCl + 29 g Na₂HPO₄ · 12H₂O + 2 g KCl + 2 g KH₂PO₄ in 1000 mL of H₂O
 Data provided by Ohkawa Ryunosuke, Graduate School of Health Care Sciences, Analytical Laboratory Chemistry, Tokyo Medical and Dental University

Proteins in human blood serum

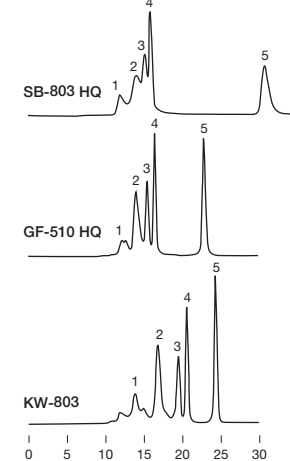


Sample : 0.1 % each
 1. Fibrinogen 50 µL
 2. α₂-Macroglobulin 50 µL
 3. IgG 50 µL
 4. Transferrin 50 µL
 5. Plasminogen 50 µL
 6. Albumin 100 µL
 7. Antitrypsin 100 µL
 8. Hemoglobin 100 µL

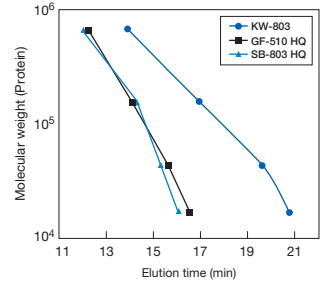
Column : Shodex PROTEIN KW-803
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Comparing three GFC columns for the separation of common proteins

Sample :
 1. Thyroglobulin (bovine)
 2. γ-Globulin (bovine)
 3. Ovalbumin (chicken)
 4. Myoglobin (horse)
 5. Cyanocobalamin



Separation performances of three aqueous SEC columns (SB-803 HQ, GF-510 HQ, and KW-803) were compared. KW-803, silica-based column, showed the best separation performance for the analysis of protein standards.



Column : Shodex OHpak SB-803 HQ
 Shodex Asahipak GF-510 HQ
 Shodex PROTEIN KW-803
Eluent : 0.2 M Phosphate buffer (pH6.9)
Flow rate : 0.5 mL/min
Detector : UV (280 nm)
Column temp. : 30 °C

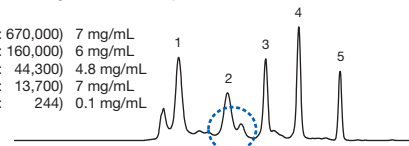
Comparison of LW-803, conventional column, and other manufacturer's column

PROTEIN LW-803 is suitable for analyzing a few-hundred-thousand molecular weight size proteins. When comparing LW-803 to our conventional columns and other manufacturer's columns, LW-803 provides a better separation around 160,000 molecular weight range that is about the size of Globulin. This improved separation efficiency is advantageous for the separation of monomer and dimer of IgG which is a mainstream of antibody drug.

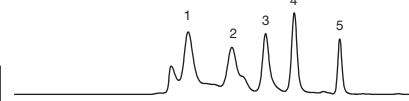
Sample : 5 μ L

1. Thyroglobulin (MW : 670,000) 7 mg/mL
2. γ -Globulin (MW : 160,000) 6 mg/mL
3. Ovalbumin (MW : 44,300) 4.8 mg/mL
4. Ribonuclease A (MW : 13,700) 7 mg/mL
5. Uridine (MW : 244) 0.1 mg/mL

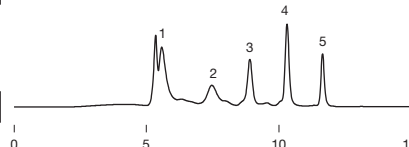
LW-803



KW-803 (conventional type)



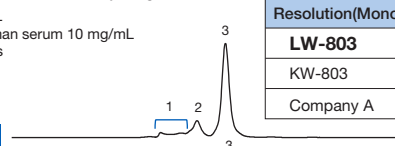
Company A



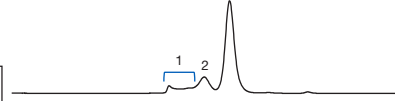
Sample : 5 μ L

- IgG from human serum 10 mg/mL
1. Aggregates
 2. Dimer
 3. Monomer

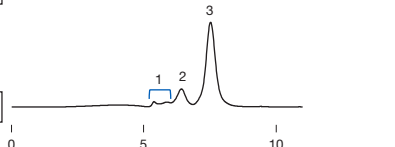
LW-803



KW-803 (conventional type)



Company A



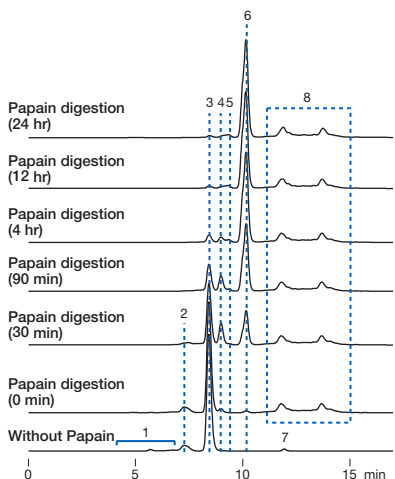
Resolution(Monomer/Dimer)

| Resolution(Monomer/Dimer) | |
|---------------------------|------------|
| LW-803 | 2.2 |
| KW-803 | 1.6 |
| Company A | 1.9 |

Column : Shodex PROTEIN LW-803, Shodex PROTEIN KW-803, Silica-based SEC column from other manufacturer
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Monitoring papain digestion of humanized monoclonal IgG

Papain digestion of humanized monoclonal IgG was monitored using PROTEIN LW-803, an aqueous SEC (GFC) column. During the papain digestion of IgG, Fc and Fab fragments from the IgG and their decomposition intermediates are expected to be observed. LW-803 separates IgG and decomposed fragments and intermediates well from each other, thus it is suitable for the monitoring of papain digestion of IgG.



Sample : 10 μ L

- Humanized monoclonal IgG
1. Aggregates of IgG
 2. Dimer of IgG
 3. Monomer of IgG
 - 4 - 6. Fragments of IgG from papain digestion
 7. Citric acid
 8. Papain

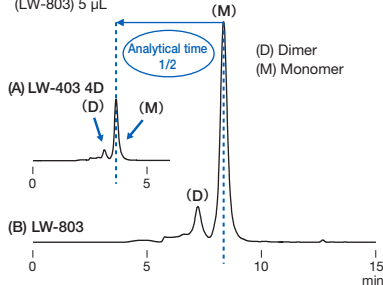
(Procedures for digestion monitoring)

- (1) Dissolve 3 mg of humanized monoclonal IgG in 500 μ L of the eluent. (6 mg/mL conc.)
- (2) Dissolve 1 mg of papain in 500 μ L of the eluent. (1 mg/mL conc.)
- (3) Filter (1) and (2) using 0.2- μ m membrane filters
- (4) Mix two solutions in 1:1 ratio.
- (5) Keep the mixture at 25 $^{\circ}$ C.
- (6) Take samples at set timings and analyze them by HPLC.

Column : Shodex PROTEIN LW-803
Eluent : 0.1 M Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 25 $^{\circ}$ C

Efficiencies of LW-403 4D over LW-803 for IgG separation

Sample : IgG from human serum 10 mg/mL
 (LW-403 4D) 0.5 μ L
 (LW-803) 5 μ L



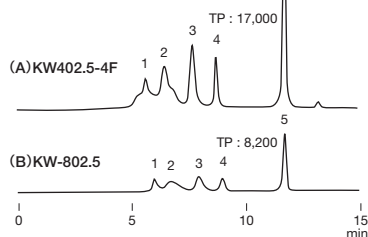
Column : (A) Shodex PROTEIN LW-403 4D
 (B) Shodex PROTEIN LW-803
Eluent : 50mM Sodium phosphate buffer (pH7.0) + 0.3M NaCl
Flow rate : (A) 0.35 mL/min
 (B) 1.0 mL/min
Detector : (A) UV (280 nm) (small cell volume)
 (B) UV (280 nm) (conventional type)
Column temp. : Room temp.

Comparison of KW402.5-4F and KW-802.5

KW400 series is a high performance type semi-micro columns. It offers approximately 1.5 times larger theoretical plate number and 3 to 4 times higher detection sensitivity (peak height) than KW-800 series columns do.

Sample : 10 μ L

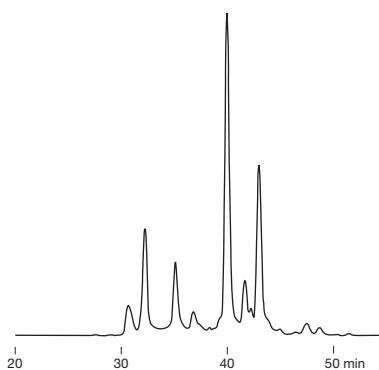
1. Blue dextran 2000 0.2 mg/mL
2. γ -Globulin 0.8 mg/mL
3. Ovalbumin 0.8 mg/mL
4. Myoglobin 0.56 mg/mL
5. Uridine 0.04 mg/mL



Column : (A) Shodex KW402.5-4F
 (B) Shodex PROTEIN KW-802.5
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : (A) 0.33 mL/min, (B) 1.0 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 25 $^{\circ}$ C

Whey in yogurt

Sample : Whey, 5 μ L

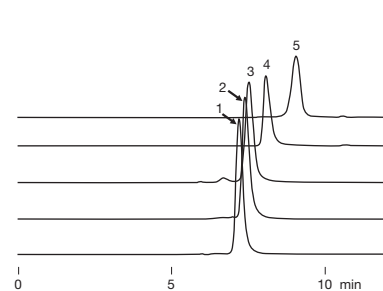


Column : Shodex KW403-4F + KW402.5-4F
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.20 mL/min
Detector : UV (280 nm) (small cell volume)
Column temp. : 30 $^{\circ}$ C

Lectins

Sample : 5 μ L

1. Lectin from soybean 0.6 mg/mL
2. Lectin from arachis hypogaea 1.1 mg/mL
3. Lectin from canavalia ensiformis (Con A) 0.9 mg/mL
4. Lectin from lens culinaris (LCA) 0.7 mg/mL
5. Lectin from triticum vulgaris (WGA) 0.8 mg/mL



Column : Shodex KW402.5-4F
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 0.3 M NaCl
Flow rate : 0.33 mL/min
Detector : UV (220 nm) (small cell volume)
Column temp. : 30 $^{\circ}$ C

Aqueous SEC (GFC) Columns: Polymer-based

Features

SB-800 HQ

- Polymer-based packed columns for aqueous SEC (GFC) analysis
- Supports a wide range of molecular weight sample analysis
- The eluent can be replaced with DMF (except SB-802 HQ and SB-807 HQ), enabling the analysis of polar polymers
- Method using SB-804 HQ or SB-805 HQ for gelatin's mean molecular weight determination is comparable with PAGI method (Ver. 10, Japan)
- Fulfills USP-NF L38 and L39 requirements
- SB-802 HQ fulfills USP-NF L25 requirements
- SB-802.5 HQ fulfills USP-NF L25 and L89 requirements
- SB-803 HQ fulfills USP-NF L37 requirements

SB-807 HQ

- Column for the analysis of water-soluble ultra high molecular weight polymers
- Large particle-size gel prevents shear degradation of polymers
- Fulfills USP-NF L38 and L39 requirements

LB-800

- Polymer-based packed columns for aqueous SEC (GFC) analysis
- Low column bleeding allows its use with light scattering detectors
- The eluent can be replaced with DMF enabling the analysis of polar polymers
- LB-802.5 (exclusion limit: about 10,000) newly added to the series
- Fulfills USP-NF L38 and L39 requirements
- LB-802.5 fulfills USP-NF L25 and L89 requirements
- LB-803 fulfills USP-NF L37 requirements

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------------|--------------------------|--------------------|---------------|--------------------------------|-----------------------------|
| F6429100 | OHpak SB-802 HQ | ≥ 12,000 | 8 | 100 | 8.0 x 300 | 0.02 % NaN ₃ aq. |
| F6429101 | OHpak SB-802.5 HQ | ≥ 16,000 | 6 | 200 | 8.0 x 300 | 0.02 % NaN ₃ aq. |
| F6429102 | OHpak SB-803 HQ | ≥ 16,000 | 6 | 800 | 8.0 x 300 | 0.02 % NaN ₃ aq. |
| F6429103 | OHpak SB-804 HQ | ≥ 16,000 | 10 | 2,000 | 8.0 x 300 | 0.02 % NaN ₃ aq. |
| F6429104 | OHpak SB-805 HQ | ≥ 12,000 | 13 | 7,000 | 8.0 x 300 | 0.02 % NaN ₃ aq. |
| F6429105 | OHpak SB-806 HQ | ≥ 12,000 | 13 | 15,000 | 8.0 x 300 | 0.02 % NaN ₃ aq. |
| F6429106 | OHpak SB-806M HQ | ≥ 12,000 | 13 | 15,000 | 8.0 x 300 | 0.02 % NaN ₃ aq. |
| F6709430 | OHpak SB-G 6B | (guard column) | 10 | — | 6.0 x 50 | 0.02 % NaN ₃ aq. |

SB-806M HQ is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Polyhydroxymethacrylate
Usable pH Range: pH3 - 10

Aqueous high molecular weight analysis column

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|------------------------|--------------------------|--------------------|---------------|--------------------------------|------------------|
| F6429108 | OHpak SB-807 HQ | ≥ 1,500 | 35 | 30,000 | 8.0 x 300 | H ₂ O |
| F6709431 | OHpak SB-807G | (guard column) | 35 | — | 8.0 x 50 | H ₂ O |

Base Material: Polyhydroxymethacrylate
Usable pH Range: pH3 - 10

Preparative columns [Preparative columns are made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent | Standard Column |
|--------------|------------------------|--------------------------|--------------------|--------------------------------|-----------------------------|-----------------|
| F6516011 | OHpak SB-2002 | ≥ 9,000 | 15 | 20.0 x 300 | 0.02 % NaN ₃ aq. | SB-802 HQ |
| F6516012 | OHpak SB-2002.5 | ≥ 12,000 | 10 | 20.0 x 300 | 0.02 % NaN ₃ aq. | SB-802.5 HQ |
| F6516013 | OHpak SB-2003 | ≥ 12,000 | 10 | 20.0 x 300 | 0.02 % NaN ₃ aq. | SB-803 HQ |
| F6516014 | OHpak SB-2004 | ≥ 12,000 | 18 | 20.0 x 300 | 0.02 % NaN ₃ aq. | SB-804 HQ |
| F6516015 | OHpak SB-2005 | ≥ 12,000 | 20 | 20.0 x 300 | 0.02 % NaN ₃ aq. | SB-805 HQ |
| F6516016 | OHpak SB-2006 | ≥ 12,000 | 20 | 20.0 x 300 | 0.02 % NaN ₃ aq. | SB-806 HQ |
| F6516017 | OHpak SB-2006M | ≥ 12,000 | 20 | 20.0 x 300 | 0.02 % NaN ₃ aq. | SB-806M HQ |
| F6709555 | OHpak SB-G 8B | (guard column) | 18 | 8.0 x 50 | 0.02 % NaN ₃ aq. | (guard column) |

Base Material: Polyhydroxymethacrylate

GFC columns to be used with light scattering detector

● Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--|--------------------------|--------------------|---------------|--------------------------------|------------------|
| F6429206 | OHpak LB-802.5 New | ≥ 16,000 | 6 | 200 | 8.0 x 300 | H ₂ O |
| F6429201 | OHpak LB-803 | ≥ 16,000 | 6 | 800 | 8.0 x 300 | H ₂ O |
| F6429204 | OHpak LB-804 | ≥ 16,000 | 10 | 2,000 | 8.0 x 300 | H ₂ O |
| F6429203 | OHpak LB-805 | ≥ 12,000 | 13 | 7,000 | 8.0 x 300 | H ₂ O |
| F6429205 | OHpak LB-806 | ≥ 12,000 | 13 | 15,000 | 8.0 x 300 | H ₂ O |
| F6429202 | OHpak LB-806M | ≥ 12,000 | 13 | 15,000 | 8.0 x 300 | H ₂ O |
| F6709434 | OHpak LB-G 6B | (guard column) | 13 | — | 6.0 x 50 | H ₂ O |

LB-806M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Polyhydroxymethacrylate
Usable pH Range: pH3 - 10

Usable solvents

| Product Name | Maximum Usable Concentration (%) | | |
|------------------------------------|----------------------------------|--------------|-----------------------------|
| | Methanol | Acetonitrile | N,N-Dimethylformamide (DMF) |
| SB-802 HQ | 0 | 0 | 0 |
| SB-802.5 HQ, SB-803 HQ | 100 | 75 | 100 |
| SB-804 HQ - SB-806M HQ | 75 | 75 | 100 |
| SB-G 6B | 75 | 75 | 100 |
| SB-807 HQ, SB-807G | 30 | 30 | 0 |
| LB-802.5 - LB-806M, LB-G 6B | 100 | 100 | 100 |

(Note)

The maximum solvent tolerance of SB-2000 series, preparative columns of SB-800 HQ series, is 50 % methanol, acetonitrile, or DMF. (SB-2002 is not tolerant to organic solvents)

Target molecular weight range and exclusion limit

● Measured with pullulan (eluent: ultrapure water)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------------|-------------------------------|-----------------|
| SB-802 HQ | 200 - 1,000 | 1,000 |
| SB-802.5 HQ | 500 - 10,000 | 10,000 |
| SB-803 HQ | 1,000 - 100,000 | 100,000 |
| SB-804 HQ | 5,000 - 400,000 | 1,000,000 |
| SB-805 HQ | 100,000 - 1,000,000 | * (4,000,000) |
| SB-806 HQ | 100,000 - * (20,000,000) | * (20,000,000) |
| SB-806M HQ | 500 - * (20,000,000) | * (20,000,000) |
| SB-807 HQ | 500,000 - * (500,000,000) | * (500,000,000) |
| LB-802.5 | 500 - 10,000 | 10,000 |
| LB-803 | 1,000 - 100,000 | 100,000 |
| LB-804 | 5,000 - 400,000 | 1,000,000 |
| LB-805 | 100,000 - 1,000,000 | * (4,000,000) |
| LB-806 | 100,000 - * (20,000,000) | * (20,000,000) |
| LB-806M | 500 - * (20,000,000) | * (20,000,000) |

Please use the above table for reference purposes only when selecting columns.

* () Estimated value

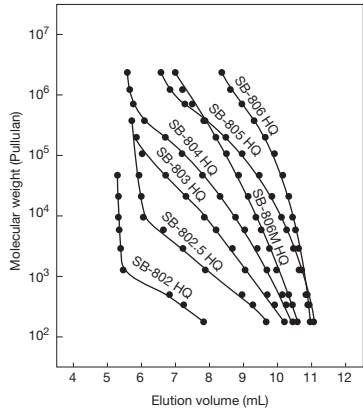
● Measured with *PEG/PEO (eluent: DMF)

| Product Name | Target Molecular Weight Range |
|--------------------|-------------------------------|
| SB-802.5 HQ | 100 - 2,000 |
| SB-803 HQ | 200 - 40,000 |
| SB-804 HQ | 500 - 300,000 |
| SB-805 HQ | 50,000 - 700,000 |
| SB-806 HQ | 70,000 - ** (20,000,000) |
| SB-806M HQ | 200 - ** (20,000,000) |
| LB-802.5 | 100 - 5,000 |
| LB-803 | 500 - 50,000 |
| LB-804 | 500 - 300,000 |
| LB-805 | 50,000 - 700,000 |
| LB-806 | 70,000 - ** (20,000,000) |
| LB-806M | 200 - ** (20,000,000) |

Please use the above table for reference purposes only when selecting columns.

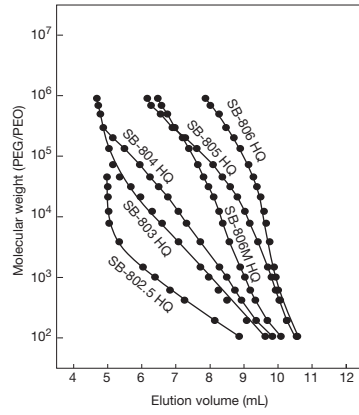
*PEG : polyethylene glycol
*PEO : polyethylene oxide
** () Estimated value

Calibration curves for SB-800 HQ series using pullulan (eluent: H₂O)



Column : Shodex OHpak SB-800 HQ series
Eluent : H₂O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 °C

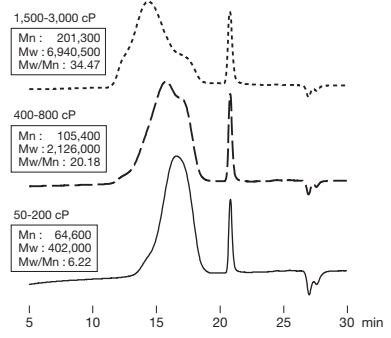
Calibration curves for SB-800 HQ series using PEG/PEO (eluent: DMF)



Column : Shodex OHpak SB-800 HQ series
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Carboxymethylcellulose

Sample : Carboxymethylcellulose 0.1 % each, 50 µL



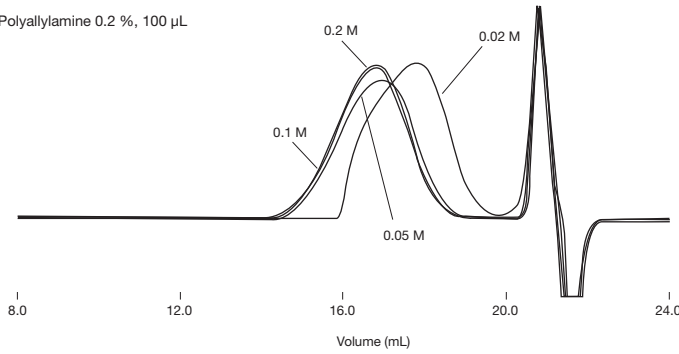
Molecular weight was determined from the calibration curve of pullulan.

Column : Shodex OHpak SB-806M HQ x 2
Eluent : 0.1 M NaCl aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Effects of sodium nitrate in eluent on the analysis of polyallylamine

For the analysis of cationic polymers, such as polyallylamine, the polymer is observed to adsorb on the column or delayed in elution when low sodium nitrate eluent was used. These phenomena can be suppressed by increasing the concentration of sodium nitrate in the eluent. In the case of polyallylamine, a good shape chromatogram is obtained when sodium nitrate concentration is 0.1 M or higher.

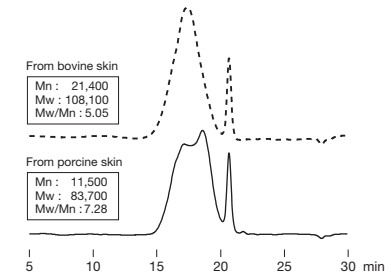
Sample : Polyallylamine 0.2 %, 100 µL



Column : Shodex OHpak SB-806M HQ x 2
Eluent : 0.5 M CH₃COOH + NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Gelatin

Sample : 0.1 % each, 100 µL
 Gelatin from bovine skin (Acid treatment, Gel strength : 225 g)
 Gelatin from porcine skin (Alkali treatment, Gel strength : 90-100 g)

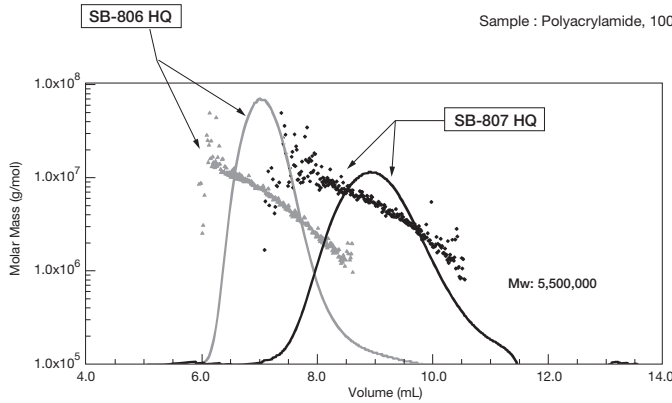


*Molecular weight was determined from the calibration curve of pullulan.

Column : Shodex OHpak SB-806M HQ x 2
Eluent : 0.1 M KH₂PO₄ aq./ 0.1 M Na₂HPO₄ aq. = 50/50
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Polyacrylamide

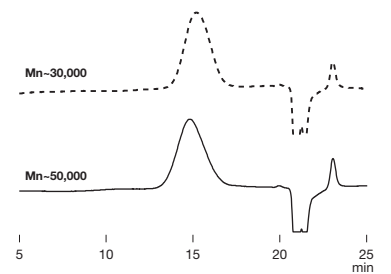
Sample : Polyacrylamide, 100 µL



Column : Shodex OHpak SB-807 HQ, SB-806 HQ
Eluent : 0.2 M NaCl aq.
Flow rate : 0.5 mL/min
Detector : RI
 MALS (Multi angle light scattering)
Column temp. : 30 °C

Cellulose acetate

Sample : Cellulose acetate 0.1 % each, 100 µL



Column : Shodex OHpak SB-806M HQ x 2
Eluent : 20 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Copovidones

Sample : 100 μ L
Poly(1-vinylpyrrolidone-co-vinyl acetate) 0.1 % each

Copolymer 7:3

Mn : 2,000
Mw : 14,400
Mw/Mn : 7.40

Copolymer 3:7

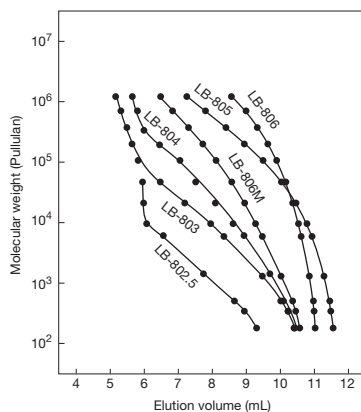
Mn : 6,400
Mw : 28,900
Mw/Mn : 4.53



Molecular weight was determined from the calibration curve of PEG/P EO.

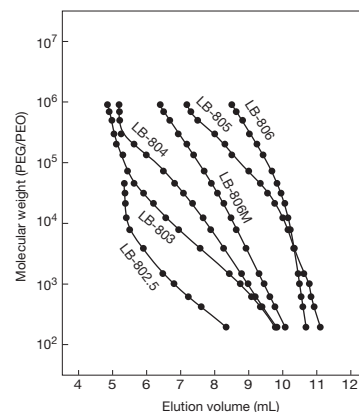
Column : Shodex OHpak SB-806M HQ x 2
Eluent : 20 mM LiBr in DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 $^{\circ}$ C

Calibration curves for LB-800 series using pullulan (eluent: H₂O)



Column : Shodex OHpak LB-800 series
Eluent : H₂O
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 $^{\circ}$ C

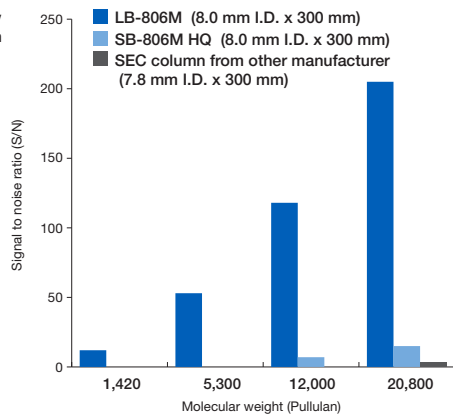
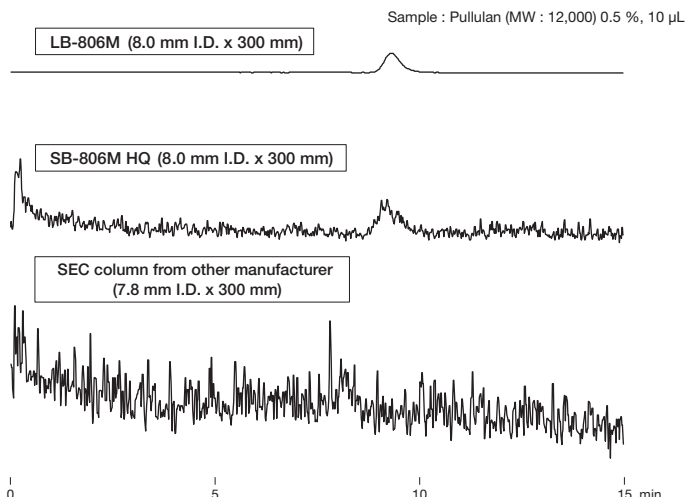
Calibration curves for LB-800 series using PEG/P EO (eluent: DMF)



Column : Shodex OHpak LB-800 series
Eluent : DMF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 $^{\circ}$ C

Comparison of pullulan detection using multi angle light scattering detector

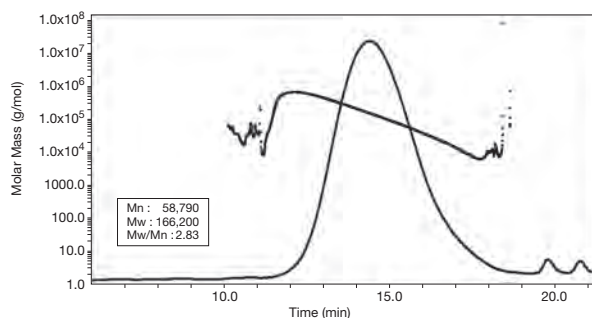
The OHpak LB-800 series is able to detect low molecular weight substances owing to its improved low baseline noise level while using it with a multiangle light scattering detector. This cannot be achieved with other manufacturer's SEC column.



Column : Shodex OHpak LB-806M
Shodex OHpak SB-806M HQ
SEC column from other manufacturer
Eluent : 0.1 M NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : MALS (Multi angle light scattering) (90 $^{\circ}$)
Column temp. : 30 $^{\circ}$ C

Sodium alginate

Sample : Sodium alginate 0.1 % , 100 μ L

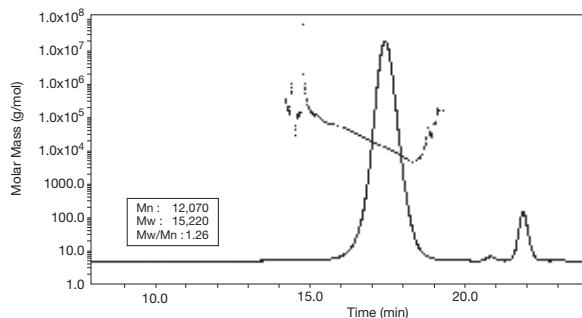


Mn : 58,790
Mw : 166,200
Mw/Mn : 2.83

Column : Shodex OHpak LB-806M x 2
Eluent : 0.1 M NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : RI
MALS (Multi angle light scattering)
Column temp. : 30 $^{\circ}$ C

Sodium heparin

Sample : Sodium heparin 0.1 % , 100 μ L



Mn : 12,070
Mw : 15,220
Mw/Mn : 1.26

Column : Shodex OHpak LB-806M x 2
Eluent : 0.1 M NaNO₃ aq.
Flow rate : 1.0 mL/min
Detector : RI
MALS (Multi angle light scattering)
Column temp. : 30 $^{\circ}$ C

Multimode Columns

Features

GS-HQ

- SEC is the main separation mode
- With the choice of eluent, the column provides multimode features of reversed phase, HILIC, and ion exchange modes to SEC
- Suitable for the separation of peptides or nucleic acids with similar molecular weights
- Suitable for desalting samples or substituting buffer in protein analysis

Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|--------------------|---------------|--------------------------------|---|
| F7600005 | Asahipak GS-220 HQ | ≥ 19,000 | 6 | 150 | 7.5 x 300 | H ₂ O/CH ₃ OH = 70/30 |
| F7600006 | Asahipak GS-320 HQ | ≥ 19,000 | 6 | 400 | 7.5 x 300 | H ₂ O/CH ₃ OH = 70/30 |
| F6710019 | Asahipak GS-2G 7B | (guard column) | 9 | — | 7.5 x 50 | H ₂ O/CH ₃ OH = 70/30 |

Base Material: Polyvinyl alcohol
Usable pH Range: pH2 - 9 (GS-220 HQ)
pH2 - 12 (GS-320 HQ)

Preparative columns [Preparative columns are made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent | Standard Column |
|--------------|----------------------------|--------------------------|--------------------|--------------------------------|---|-----------------|
| F6810034 | Asahipak GS-220 20G | ≥ 14,000 | 13 | 20.0 x 500 | H ₂ O/CH ₃ OH = 70/30 | GS-220 HQ |
| F6810035 | Asahipak GS-320 20G | ≥ 14,000 | 13 | 20.0 x 500 | H ₂ O/CH ₃ OH = 70/30 | GS-320 HQ |
| F6710021 | Asahipak GS-20G 7B | (guard column) | 20 | 7.5 x 50 | H ₂ O/CH ₃ OH = 70/30 | (guard column) |

Base Material: Polyvinyl alcohol

Usable solvents

| Product Name | Maximum Usable Concentration (%) | |
|------------------|----------------------------------|--------------|
| | Methanol | Acetonitrile |
| GS-220 HQ | 30 | 50 |
| GS-320 HQ | 100 | 50 |

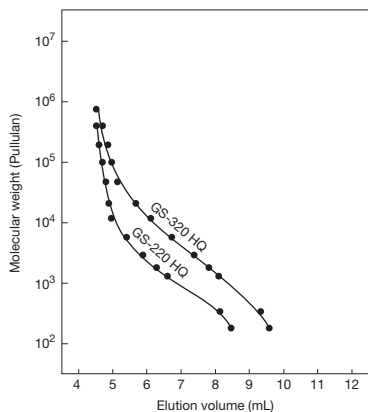
Target molecular weight range and exclusion limit

Measured with pullulan (eluent: ultrapure water)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|------------------|-------------------------------|-----------------|
| GS-220 HQ | 300 - 3,000 | 7,000 |
| GS-320 HQ | 300 - 20,000 | 40,000 |

Please use the above table for reference purposes only when selecting columns.

Calibration curves for GS-HQ series using pullulan



Column : Shodex Asahipak GS-HQ series
Eluent : H₂O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 30 °C

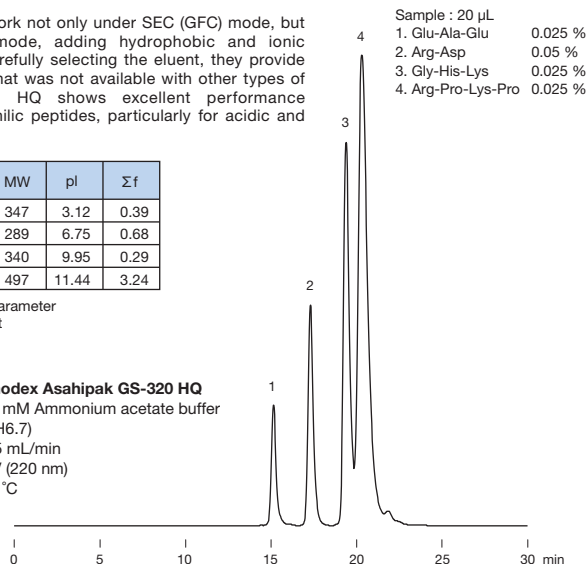
Peptides

GS-HQ columns work not only under SEC (GFC) mode, but also under multimode, adding hydrophobic and ionic interactions. By carefully selecting the eluent, they provide separation mode that was not available with other types of columns. GS-320 HQ shows excellent performance separating hydrophilic peptides, particularly for acidic and basic peptides.

| | MW | pI | Σ f |
|-----------------|-----|-------|------|
| Glu-Ala-Glu | 347 | 3.12 | 0.39 |
| Arg-Asp | 289 | 6.75 | 0.68 |
| Gly-His-Lys | 340 | 9.95 | 0.29 |
| Arg-Pro-Lys-Pro | 497 | 11.44 | 3.24 |

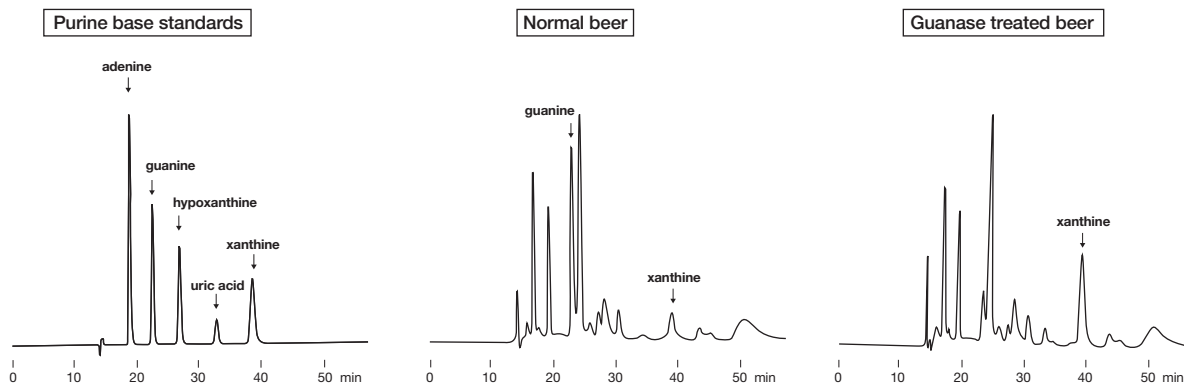
Σ f : Hydrophobic parameter
 pI : Isoelectric point

Column : Shodex Asahipak GS-320 HQ
Eluent : 30 mM Ammonium acetate buffer (pH6.7)
Flow rate : 0.5 mL/min
Detector : UV (220 nm)
Column temp. : 30 °C



Purine bases in beer

Purine in food is analyzed as purine base after steps of sample preparation; homogenization, freeze drying, hydrolyzation with 70 % perchloric acid, and neutralization. Example below shows the analysis of purine in regular beer and beer treated with guanase (an enzyme that degrades guanine to xanthine). The following data indicate that guanine was decreased and xanthine was increased by guanase.

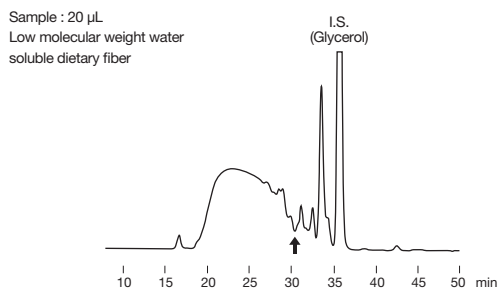


Column : Shodex Asahipak GS-320 HQ
Eluent : 150 mM Sodium phosphate buffer (pH2.5)
Flow rate : 0.6 mL/min
Detector : UV (260 nm)
Column temp. : 35 °C

Data provided by Kiyoko Kaneko Ph.D.,
 Faculty of Pharmaceutical Sciences, Teikyo University

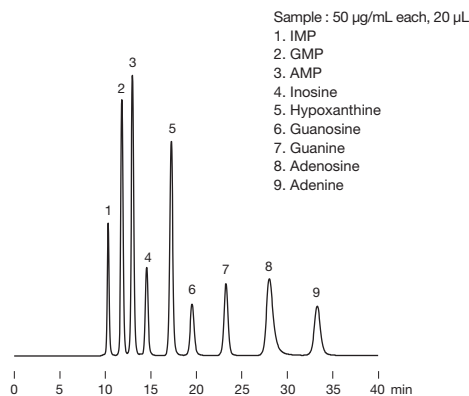
Low molecular weight water-soluble dietary fiber

GS-220 HQ allows to elute monosaccharides, disaccharides, and sugar alcohols after the indigestible component fraction (indicated by an arrow on the chromatogram). This separation makes the method preferable for the quantification of low molecular weight water-soluble dietary fiber.



Column : Shodex Asahipak GS-220 HQ x 2
Eluent : H₂O
Flow rate : 0.5 mL/min
Detector : RI
Column temp. : 60 °C

“Umami”



Column : Shodex Asahipak GS-320 HQ
Eluent : 10 mM NaH₂PO₄ aq./10 mM Na₂HPO₄ aq. = 1000/31
Flow rate : 1.0 mL/min
Detector : UV (260 nm)
Column temp. : 40 °C

Aqueous-Organic SEC Columns

Features

GF-HQ

- Polymer-based SEC columns with high solvent durability
- Works well with both aqueous and organic solvents

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------------|--------------------------|--------------------|---------------|--------------------------------|---|
| F7600000 | Asahipak GF-210 HQ | ≥ 19,000 | 5 | 180 | 7.5 x 300 | H ₂ O |
| F7600001 | Asahipak GF-310 HQ | ≥ 19,000 | 5 | 400 | 7.5 x 300 | H ₂ O/CH ₃ OH = 70/30 |
| F7600002 | Asahipak GF-510 HQ | ≥ 19,000 | 5 | 2,000 | 7.5 x 300 | H ₂ O/CH ₃ OH = 70/30 |
| F7600004 | Asahipak GF-7M HQ | ≥ 13,000 | 9 | 10,000 | 7.5 x 300 | H ₂ O/CH ₃ OH = 70/30 |
| F6710018 | Asahipak GF-1G 7B | (guard column) | 9 | — | 7.5 x 50 | H ₂ O/CH ₃ OH = 70/30 |
| F7600110 | MSPak GF-310 4D | ≥ 10,000 | 5 | 400 | 4.6 x 150 | H ₂ O |

GF-7M HQ is a mixed-gel column capable of analyzing samples over a wide range of molecular weight.

Base Material: Polyvinyl alcohol
Usable pH range: pH2 - 9

• Preparative columns [Preparative columns are made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent | Standard Column |
|--------------|----------------------------|--------------------------|--------------------|--------------------------------|---|-----------------|
| F6810038 | Asahipak GS-310 20G | ≥ 14,000 | 13 | 20.0 x 500 | H ₂ O/CH ₃ OH = 70/30 | GF-310 HQ |
| F6810039 | Asahipak GS-510 20G | ≥ 14,000 | 13 | 20.0 x 500 | H ₂ O/CH ₃ OH = 70/30 | GF-510 HQ |
| F6710020 | Asahipak GS-10G 7B | (guard column) | 20 | 7.5 x 50 | H ₂ O/CH ₃ OH = 70/30 | (guard column) |

Base Material: Polyvinyl alcohol

Usable solvents

| Solvent | Product Name | | Solvent | Product Name | |
|--------------------------------------|--------------|------------------------------------|-----------------------------|--------------|------------------------------------|
| | GF-210 HQ | GF-310 HQ GF-510 HQ GF-7M HQ | | GF-210 HQ | GF-310 HQ GF-510 HQ GF-7M HQ |
| Water (0 - 0.5 M salt concentration) | ○ | ○ | N,N-Dimethylformamide (DMF) | ○ | ○ |
| Methanol | ○ | ○ | Acetone | ○ | ○ |
| Ethanol | ○ | ○ | Chloroform | ○ | ○ |
| Acetonitrile | ○ | ○ | Ethylacetate | ○ | ○ |
| Tetrahydrofuran (THF) | ○ | ○ | Dimethyl sulfoxide (DMSO) | ○ | △ |

○: Solvent replacement possible △: Solvent replacement possible up to 50 %

Target molecular weight range and exclusion limit

• Measured with pullulan (eluent: ultrapure water)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|------------------|-------------------------------|-----------------|
| GF-210 HQ | 300 - 4,000 | 9,000 |
| GF-310 HQ | 300 - 30,000 | 40,000 |
| GF-510 HQ | 5,000 - 200,000 | 300,000 |
| GF-7M HQ | 300 - * (10,000,000) | * (10,000,000) |

Please use the above table for reference purposes only when selecting columns.

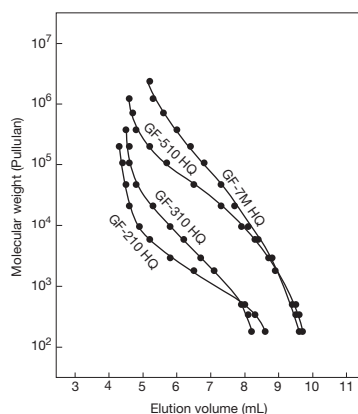
* () Estimated value

• Measured with *PEG/PEO (eluent: DMF)

| Product Name | Target Molecular Weight Range |
|------------------|-------------------------------|
| GF-210 HQ | 100 - 2,000 |
| GF-310 HQ | 200 - 4,000 |
| GF-510 HQ | 2,000 - 200,000 |
| GF-7M HQ | 200 - ** (10,000,000) |

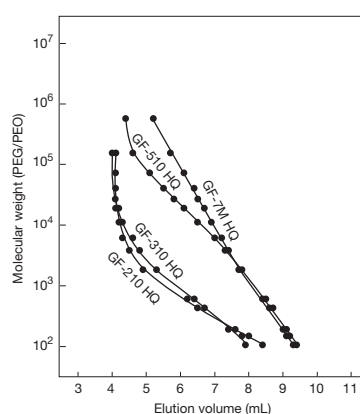
Please use the above table for reference purposes only when selecting columns.

*PEG: polyethylene glycol
*PEO: polyethylene oxide
** () Estimated value

Calibration curves for GF-HQ series using pullulan (eluent: H₂O)

Column : Shodex Asahipak GF-HQ series
Eluent : H₂O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 30 °C

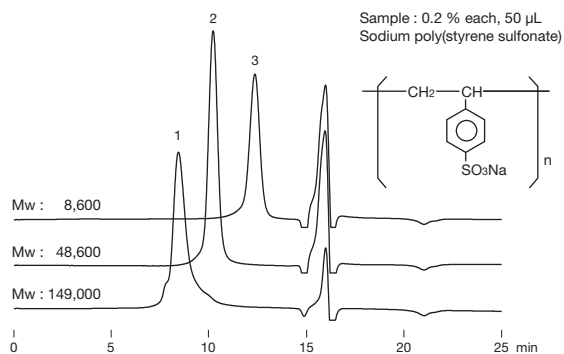
Calibration curves for GF-HQ series using PEG/PEO (eluent: DMF)



Column : Shodex Asahipak GF-HQ series
Eluent : DMF
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 40 °C

Sodium polystyrene sulfonates

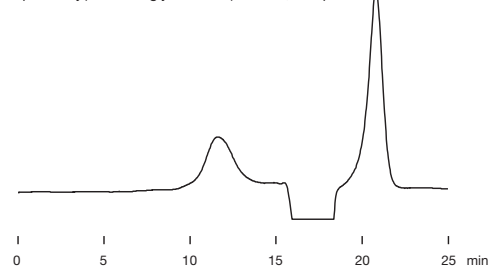
Polymers having both hydrophobic and hydrophilic functional groups may exhibit hydrophobic interactions with packing materials. When analyzing such polymers, addition of organic solvents to the eluent can suppress the hydrophobic interaction.



Column : Shodex Asahipak GF-510 HQ
Eluent : 50 mM LiCl aq./CH₃CN = 60/40
Flow rate : 0.6 mL/min
Detector : UV (254 nm)
Column temp. : 30 °C

Biodegradable Polymer

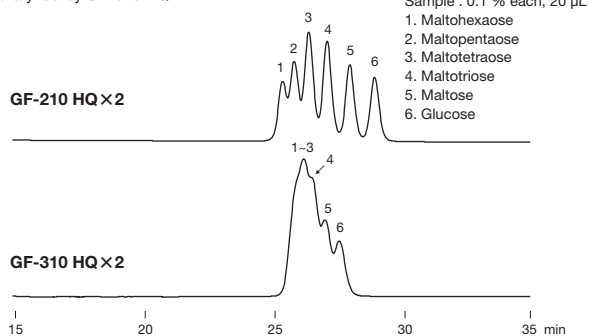
Sample : Poly(lactic-co-glycolic acid) 0.02 %, 200 μ L



Column : Shodex Asahipak GF-7M HQ
Eluent : CH₃CN
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 40 °C

Comparison of two GF column performances for the separation of maltoligosaccharides

GF-210 HQ demonstrates an improved separation of low molecular substances. The chromatograms below show that the peaks obtained by GF-210 HQ are separated with deeper notches compared to peaks obtained by GF-310 HQ. GF-210 HQ is capable of separating oligosaccharides (trisaccharides to hexasaccharides) while those oligosaccharides were eluted all together when analyzed by GF-310 HQ.

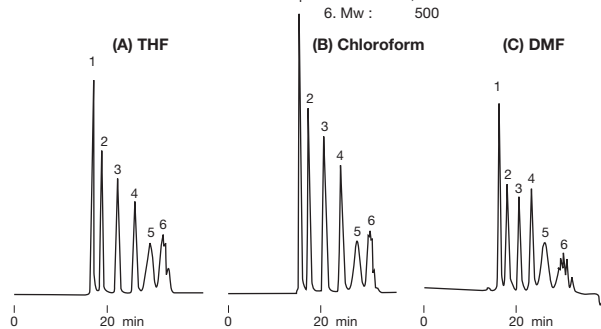


Column : Shodex Asahipak GF-210 HQ x 2
 Shodex Asahipak GF-310 HQ x 2
Eluent : H₂O
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 50 °C

Comparison of polystyrene separation under three different solvent conditions

Sample : Polystyrene 1 mg/mL each, 50 μ L

- Mw : 1,090,000
- Mw : 190,000
- Mw : 37,900
- Mw : 9,100
- Mw : 2,980
- Mw : 500



Column : Shodex Asahipak GF-510 HQ + GF-310 HQ
Eluent : (A); THF, (B); Chloroform, (C); DMF
Flow rate : 0.5 mL/min
Detector : (A),(B) UV (254 nm), (C) UV (270 nm)
Column temp. : 30 °C

Organic SEC (GPC) Columns: General Analysis (THF)

Features

- **KF-800**
 - Standard organic solvent SEC (GPC) column
 - Supports a wide range of applications from low to high molecular weight compounds
 - Fulfills USP-NF L21 requirements

• Standard columns

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|---------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6028010 | GPC KF-801 | ≥ 18,000 | 6 | 50 | 8.0 x 300 |
| F6028020 | GPC KF-802 | ≥ 18,000 | 6 | 150 | 8.0 x 300 |
| F6028025 | GPC KF-802.5 | ≥ 18,000 | 6 | 300 | 8.0 x 300 |
| F6028030 | GPC KF-803 | ≥ 18,000 | 6 | 500 | 8.0 x 300 |
| F6027030 | GPC KF-803L | ≥ 18,000 | 6 | 500 | 8.0 x 300 |
| F6028040 | GPC KF-804 | ≥ 18,000 | 7 | 1,500 | 8.0 x 300 |
| F6027040 | GPC KF-804L | ≥ 18,000 | 7 | 1,500 | 8.0 x 300 |
| F6028050 | GPC KF-805 | ≥ 11,000 | 10 | 5,000 | 8.0 x 300 |
| F6027050 | GPC KF-805L | ≥ 11,000 | 10 | 5,000 | 8.0 x 300 |
| F6028090 | GPC KF-806M | ≥ 13,000 | 10 | 10,000 | 8.0 x 300 |
| F6027060 | GPC KF-806L | ≥ 11,000 | 10 | 10,000 | 8.0 x 300 |
| F6027070 | GPC KF-807L | ≥ 6,000 | 18 | 20,000 | 8.0 x 300 |
| F6700300 | GPC KF-G 4A | (guard column) | 8 | — | 4.6 x 10 |

The columns with 'L' or 'M' at the end of column names are mixed-gel columns capable of analyzing samples over a wide range of molecular weight distribution. See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

Target molecular weight range and exclusion limit

• Measured with polystyrene (eluent: THF)

| Product Name | Target Molecular Weight Range | Exclusion Limit | Product Name | Target Molecular Weight Range | Exclusion Limit |
|-----------------|-------------------------------|-----------------|----------------|-------------------------------|-----------------|
| KF-801 | 100 - 700 | 1,500 | KF-804L | 100 - 300,000 | 400,000 |
| KF-802 | 300 - 3,000 | 5,000 | KF-805 | 50,000 - 2,000,000 | 4,000,000 |
| KF-802.5 | 300 - 8,000 | 20,000 | KF-805L | 300 - 2,000,000 | 4,000,000 |
| KF-803 | 1,000 - 50,000 | 70,000 | KF-806M | 1,000 - * (20,000,000) | * (20,000,000) |
| KF-803L | 100 - 50,000 | 70,000 | KF-806L | 300 - * (20,000,000) | * (20,000,000) |
| KF-804 | 7,000 - 300,000 | 400,000 | KF-807L | 300 - * (200,000,000) | * (200,000,000) |

Please use the above tables for reference purposes only when selecting columns.

* () Estimated value

Organic SEC (GPC) Columns: Solvent-Peak Separation

Features

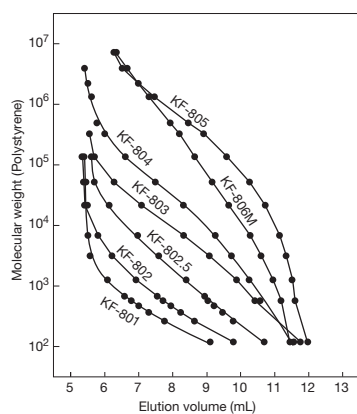
- **KF-800D**
 - Use this column in combination with a linear column
 - Accurate molecular weight distribution of polymers and oligomers are achieved by shifting the elutions of monomers, polymer additives, and solvent-peak in the lower molecular region

• Solvent-peak separation column

| Product Code | Product Name | Column Combination | Particle Size (µm) | Column Size (mm) I.D. x Length |
|--------------|--------------------|---------------------------|--------------------|--------------------------------|
| F6709350 | GPC KF-800D | KF-805L, 806L, 806M, 807L | 10 | 8.0 x 100 |

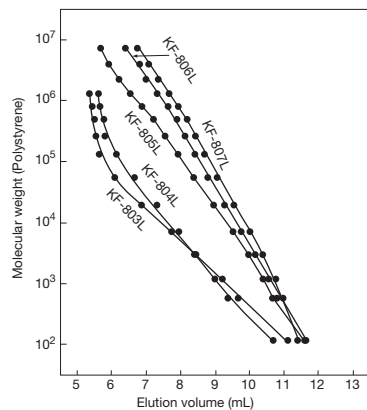
Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

Calibration curves for KF-800 series using polystyrene



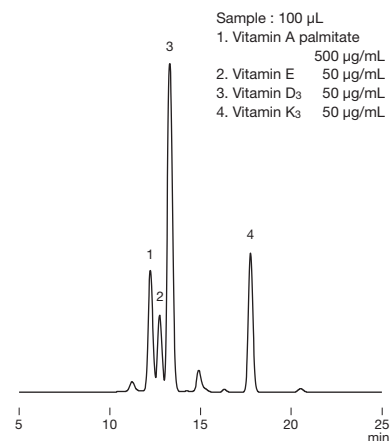
Column : Shodex GPC KF-800 series
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Calibration curves for KF-800L (linear type) series using polystyrene



Column : Shodex GPC KF-800L series
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

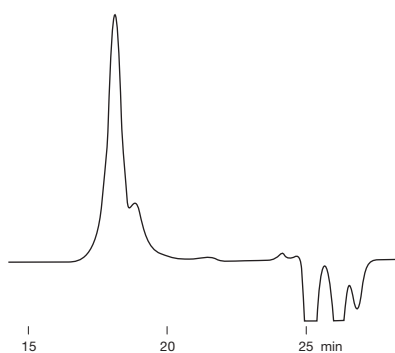
Fat-soluble vitamins



Column : Shodex GPC KF-801 x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 40 °C

Styrene isoprene ABA block copolymer

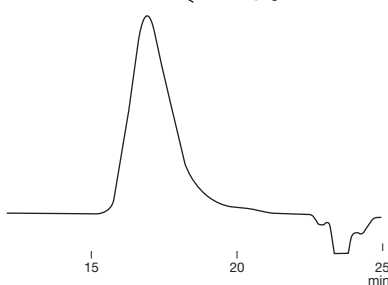
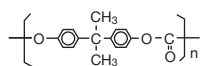
Sample : Styrene isoprene ABA block copolymer



Column : Shodex GPC KF-806M x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 °C

Polycarbonate resin

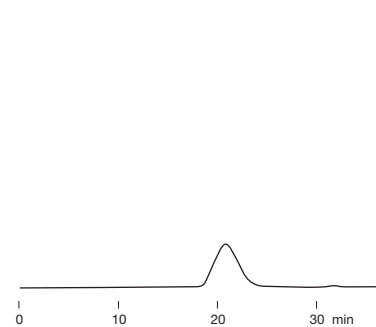
Sample : Polycarbonate resin 0.1 %, 100 μ L



Column : Shodex GPC KF-806L x 2
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Raw rubber

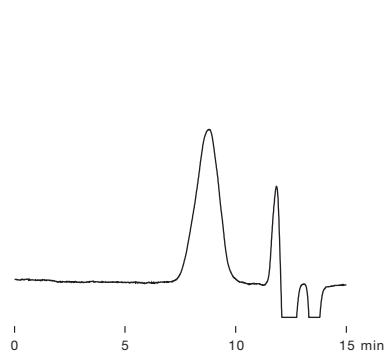
Sample : Rubber 0.1 %, 300 μ L



Column : Shodex GPC KF-806M x 2
 + KF-802
Eluent : Toluene
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : Room temp.

Polylactic Acid

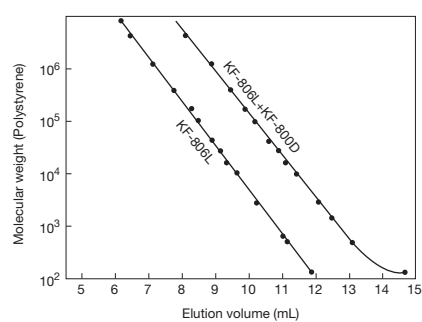
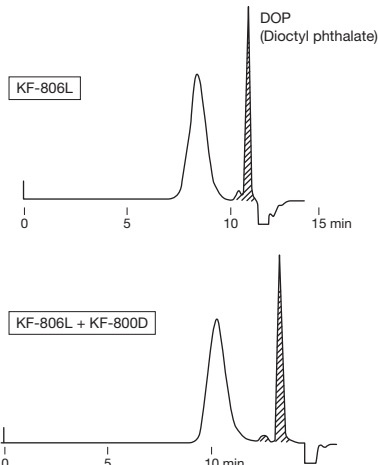
Sample : Polylactic acid 0.2 %, 50 μ L



Column : Shodex GPC KF-806M
Eluent : Chloroform
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 30 °C

Effects of solvent-peak separation column

Sample : Poly(vinyl chloride)



Column : Shodex GPC KF-806L
 Shodex GPC KF-806L + KF-800D
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI

Organic SEC (GPC) Columns: General Analysis (DMF)

Features

- **KD-800**
 - Standard organic solvent SEC (GPC) column
 - Supports a wide range of applications from low to high molecular weight compounds
 - Fulfills USP-NF L21 requirements

• Standard columns [KD-800 series is made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|---------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6028210 | GPC KD-801 | ≥ 17,000 | 6 | 50 | 8.0 x 300 |
| F6028220 | GPC KD-802 | ≥ 17,000 | 6 | 150 | 8.0 x 300 |
| F6028225 | GPC KD-802.5 | ≥ 17,000 | 6 | 300 | 8.0 x 300 |
| F6028230 | GPC KD-803 | ≥ 17,000 | 6 | 500 | 8.0 x 300 |
| F6028240 | GPC KD-804 | ≥ 17,000 | 7 | 1,500 | 8.0 x 300 |
| F6028250 | GPC KD-805 | ≥ 11,000 | 10 | 5,000 | 8.0 x 300 |
| F6028260 | GPC KD-806 | ≥ 11,000 | 10 | 10,000 | 8.0 x 300 |
| F6028290 | GPC KD-806M | ≥ 13,000 | 10 | 10,000 | 8.0 x 300 |
| F6028270 | GPC KD-807 | ≥ 6,000 | 18 | 20,000 | 8.0 x 300 |
| F6700411 | GPC KD-G 4A | (guard column) | 8 | — | 4.6 x 10 |

KD-806M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution. See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: N,N-Dimethylformamide (DMF)

Target molecular weight range and exclusion limit

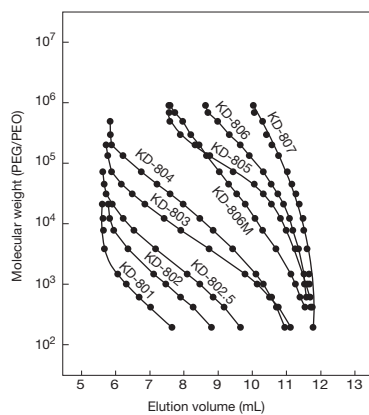
• Measured with *PEG/PEO (eluent: DMF)

| Product Name | Target Molecular Weight Range | Exclusion Limit | Product Name | Target Molecular Weight Range | Exclusion Limit |
|-----------------|-------------------------------|-----------------|----------------|-------------------------------|------------------|
| KD-801 | 100 - 1,500 | 2,500 | KD-805 | 30,000 - ** (4,000,000) | ** (4,000,000) |
| KD-802 | 200 - 4,000 | 7,000 | KD-806 | 30,000 - ** (40,000,000) | ** (40,000,000) |
| KD-802.5 | 400 - 10,000 | 20,000 | KD-806M | 1,000 - ** (40,000,000) | ** (40,000,000) |
| KD-803 | 1,000 - 50,000 | 70,000 | KD-807 | 50,000 - ** (200,000,000) | ** (200,000,000) |
| KD-804 | 4,000 - 200,000 | 200,000 | | | |

Please use the above tables for reference purposes only when selecting columns.

*PEG: polyethylene glycol
*PEO: polyethylene oxide
** () Estimated value

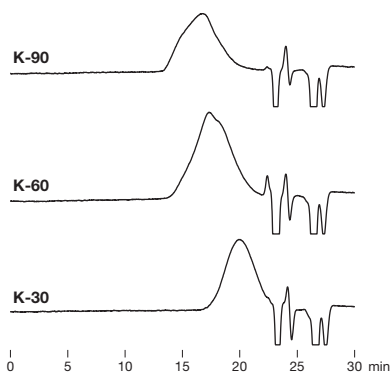
Calibration curves for KD-800 series using PEG/PEO



Column : Shodex GPC KD-800 series
 Eluent : DMF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 40 °C

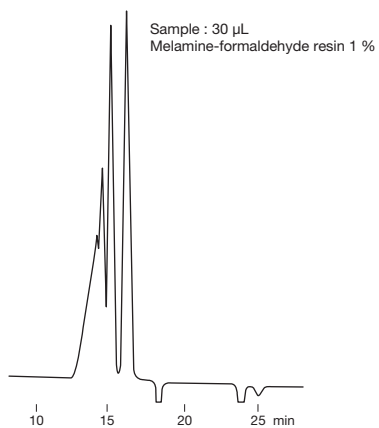
Polyvinylpyrrolidones

Sample : Polyvinylpyrrolidone 0.1 % each, 100 μ L



Column : Shodex GPC KD-806M x 2
 Eluent : 10 mM LiBr in DMF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 50 °C

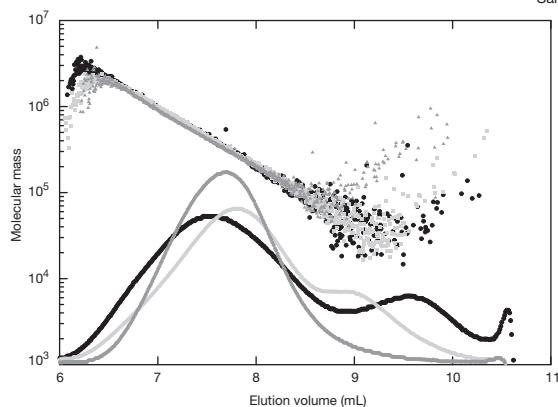
Melamine formaldehyde resin



Column : Shodex GPC KD-802 x 2
 Eluent : 10 mM LiBr in DMF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 50 °C

Celluloses

Sample : Cellulose ca. 0.05 % each, 100 μ L



Cellulose is difficult to dissolve and repeated solvent replacement is required to prepare the cellulose solution. The time required to completely dissolve cellulose depends on the solvent type, crystallinity and molecular weight of the cellulose. This can be 1 to 60 days.

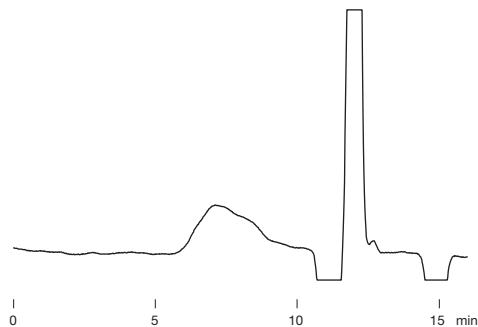
Column : Shodex GPC KD-806M
 Eluent : 1 % LiCl in *DMI
 Flow rate : 0.5 mL/min
 Detector : RI, MALS (Multi angle light scattering)
 Column temp. : 60 °C

Data provided by Dr. Masahiko Yanagisawa,
 Isogai group, Graduate School of Agricultural and
 Life Sciences, The University of Tokyo

*DMI: 1,3-dimethyl-2-imidazolidinone

Potato starch

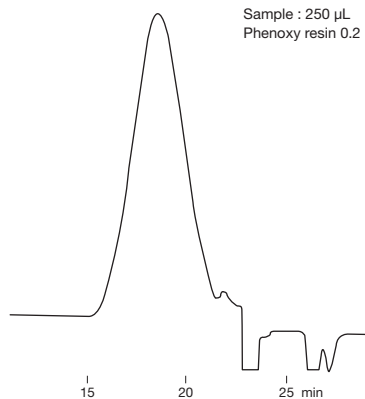
Sample : 100 μ L
 Potato starch in DMSO 0.1 %
 (dissolved at 80 °C)



Column : Shodex GPC KD-806M
 Eluent : 10 mM LiBr in DMSO/DMF = 75/25
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 50 °C

Phenoxy resin

Sample : 250 μ L
 Phenoxy resin 0.2 %



Column : Shodex GPC KD-806M x 2
 Eluent : 10 mM in DMF
 Flow rate : 1.0 mL/min
 Detector : RI
 Column temp. : 50 °C

Organic SEC (GPC) Columns: High Performance Analysis

Features

KF-400HQ

- About 1.5 times better separation performance than standard columns, obtains higher resolution
- About 4 times better sensitivity than that of standard columns, supports high sensitivity analysis
- The amount of solvent used is reduced to about a third
- Improved applicability of solvent replacement
- Fulfills USP-NF L21 requirements

• High performance semi-micro columns

* KF-400HQ series is recommended to be used with semi-micro type devices.

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|----------------|--------------------------|--------------------|---------------|--------------------------------|
| F6028111 | GPC KF-401HQ | ≥ 25,000 | 3 | 50 | 4.6 x 250 |
| F6028112 | GPC KF-402HQ | ≥ 25,000 | 3 | 150 | 4.6 x 250 |
| F6028114 | GPC KF-402.5HQ | ≥ 25,000 | 3 | 300 | 4.6 x 250 |
| F6028116 | GPC KF-403HQ | ≥ 25,000 | 3 | 500 | 4.6 x 250 |
| F6700300 | GPC KF-G 4A | (guard column) | 8 | — | 4.6 x 10 |

See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

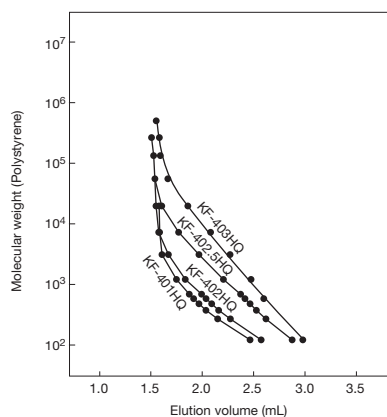
Target molecular weight range and exclusion limit

• Measured with polystyrene (eluent: THF)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------|-------------------------------|-----------------|
| KF-401HQ | 100 - 700 | 1,500 |
| KF-402HQ | 200 - 1,500 | 4,000 |
| KF-402.5HQ | 300 - 10,000 | 20,000 |
| KF-403HQ | 600 - 50,000 | 70,000 |

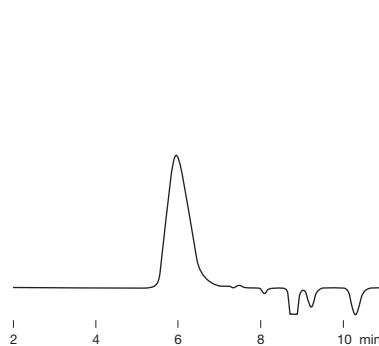
Please use the above tables for reference purposes only when selecting columns.

Calibration curves for KF-400HQ series using polystyrene



Column : Shodex GPC KF-400HQ series
Eluent : THF
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Liquid paraffin

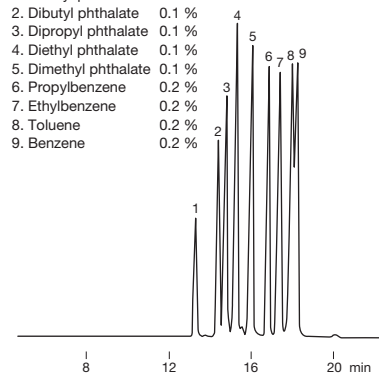
Sample : Liquid paraffin 1 %, 5 μ L

Column : Shodex GPC KF-401HQ
Eluent : Chloroform
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Phthalates

Sample : 10 μ L

1. Dioctyl phthalate 0.1 %
2. Dibutyl phthalate 0.1 %
3. Dipropyl phthalate 0.1 %
4. Diethyl phthalate 0.1 %
5. Dimethyl phthalate 0.1 %
6. Propylbenzene 0.2 %
7. Ethylbenzene 0.2 %
8. Toluene 0.2 %
9. Benzene 0.2 %

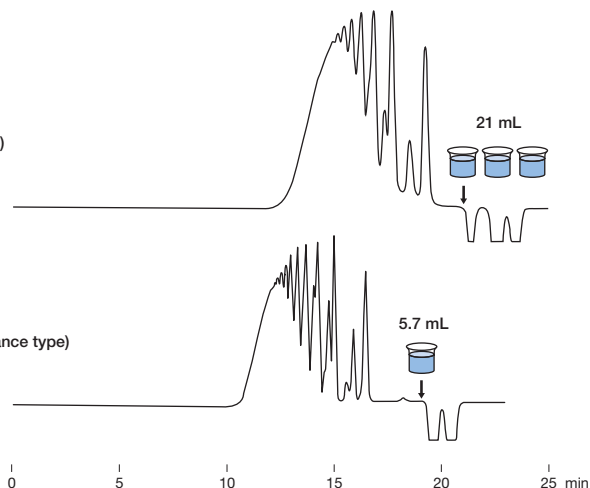


Column : Shodex GPC KF-401HQ x 2
Eluent : THF
Flow rate : 0.3 mL/min
Detector : UV (254 nm) (small cell volume)
Column temp. : 40 °C

Comparison of standard and high performance type columns

(Standard type)
 KF-802.5 x 2
 50 μ L injection

(High performance type)
 KF-402.5HQ x 2
 10 μ L injection



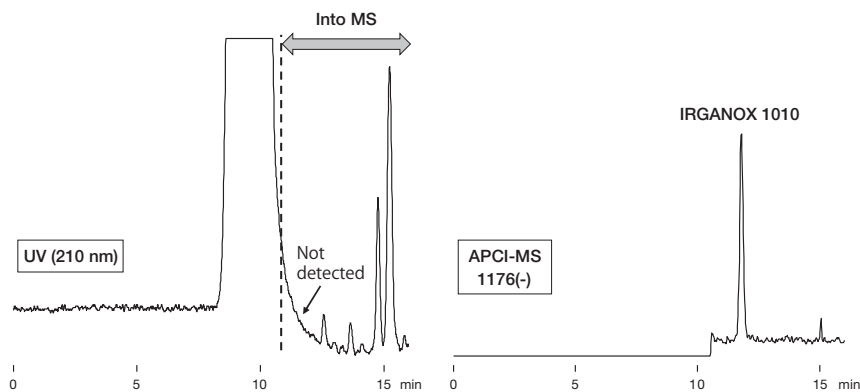
Sample : EPON1001 0.2 %

Having 1.5 times more theoretical plate number than standard column, KF-402.5HQ provides improved resolution especially for the separation of small to medium molecular weight substances. High performance type columns use less than one third of solvent per analysis compared to standard type columns do.

Column : Shodex GPC KF-802.5 x 2
 Shodex GPC KF-402.5HQ x 2
Eluent : THF
Flow rate : 1.0 mL/min (KF-802.5)
 0.3 mL/min (KF-402.5HQ)
Detector : RI (conventional type) (KF-802.5)
 RI (small cell volume) (KF-402.5HQ)
Column temp. : 40 °C

LC/MS analysis of antioxidant (IRGANOX 1010) in a cup of instant noodles (styrene foam)

Generally, pretreatment is required for additives analysis in polymers. By using a size exclusion chromatography column, it separates the additives from polymers, and only the low molecular weight region containing the additive is introduced into a mass spectrometer (MS). Therefore, sample pretreatment is not required, and thus a simple and rapid detection can be expected.



Sample : 5 μ L
 Cup of instant noodles (styrene foam) 1000 mg/L

Column : Shodex GPC KF-402HQ x 2
Eluent : THF
Flow rate : 0.3 mL/min
Detector : UV (210 nm), APCI-MS (SIM)
Column temp. : 40 °C

Organic SEC (GPC) Columns: Ultra-Rapid Analysis

Features

HK-400

- Newly developed styrene divinylbenzene copolymer monodisperse particles
- Analysis time is reduced to about a sixth of conventional column's analysis time
- Low column pressure even under high flow rate does not require a UHPLC system
- The amount of solvent used is reduced to about a sixth
- HK-402 (exclusion limit: 20,000) and HK-406 (exclusion limit: 10,000,000) newly added to the series
- Fulfills USP-NF L21 requirements

• Ultra-Rapid analysis semi-micro columns

* HK-400 series is recommended to be used with semi-micro type devices.

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-----------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6025010 | GPC HK-401 | ≥ 9,000 | 3 | 50 | 4.6 x 150 |
| F6025020 | GPC HK-402 New | ≥ 12,000 | 3 | 300 | 4.6 x 150 |
| F6025030 | GPC HK-403 | ≥ 9,000 | 3.5 | 550 | 4.6 x 150 |
| F6026040 | GPC HK-404L | ≥ 9,000 | 3.5 | 2,000 | 4.6 x 150 |
| F6025050 | GPC HK-405 | ≥ 7,000 | 3 | 5,000 | 4.6 x 150 |
| F6025060 | GPC HK-406 New | ≥ 5,000 | 6.5 | 10,000 | 4.6 x 150 |

HK-404L is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

• Guard filter for HK series

| Product Code | Product Name | Contents |
|--------------|-----------------|---------------------------|
| F6700200 | GPC HK-G | One holder and one filter |
| F6700100 | GPC HK-G filter | 3 filters |

Removes sample-origin insoluble components.



Attach directly to the analytical column

Usable solvents

| Solvent | Product Name | |
|------------------------------|---|--------|
| | HK-401 HK-403 HK-404L HK-405 HK-406 | HK-402 |
| Chloroform | ○ | ○ |
| N,N-Dimethylformamide (DMF) | ○ | ○ |
| Toluene | ○ | ○ |
| Hexafluoroisopropanol (HFIP) | ○ | × |
| 30 % HFIP/Chloroform | ○ | ○ |

○: Solvent replacement possible ×: Solvent replacement not possible

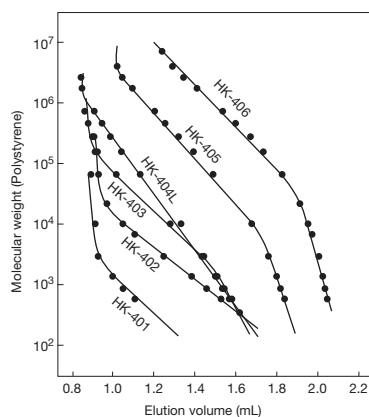
Target molecular weight range and exclusion limit

• Measured with polystyrene (eluent: THF)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------|-------------------------------|-----------------|
| HK-401 | 100 - 1,500 | 2,000 |
| HK-402 | 200 - 10,000 | 20,000 |
| HK-403 | 2,000 - 70,000 | 100,000 |
| HK-404L | 100 - 1,000,000 | 1,000,000 |
| HK-405 | 10,000 - 2,500,000 | 4,000,000 |
| HK-406 | 30,000 - 8,000,000 | 10,000,000 |

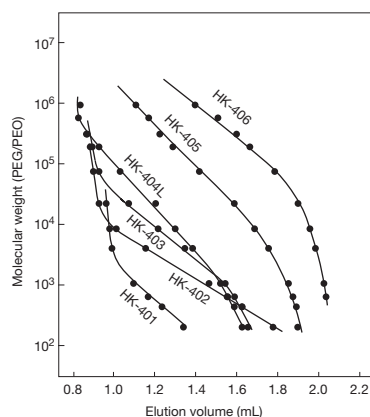
Please use the above table for reference purposes only when selecting columns.

Calibration curves for HK-400 series using polystyrene (eluent : THF)



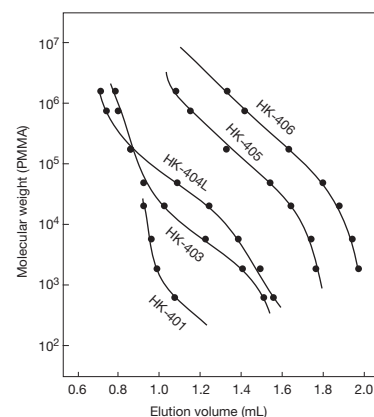
Column : Shodex GPC HK-400 series
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Calibration curves for HK-400 series using PEG/PEO (eluent : DMF)



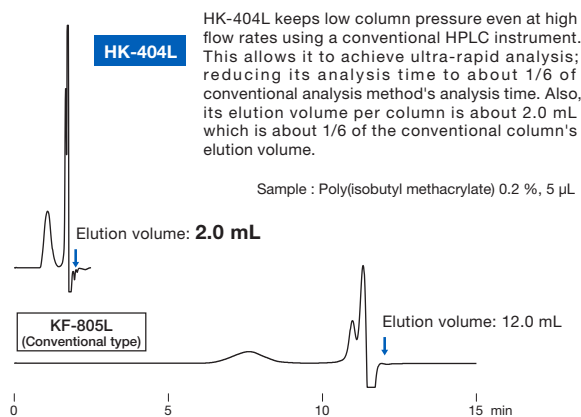
Column : Shodex GPC HK-400 series
 Eluent : DMF
 Flow rate : 1.0 mL/min (HK-402: 0.8 mL/min)
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Calibration curve for HK-400 series using PMMA (eluent : HFIP)



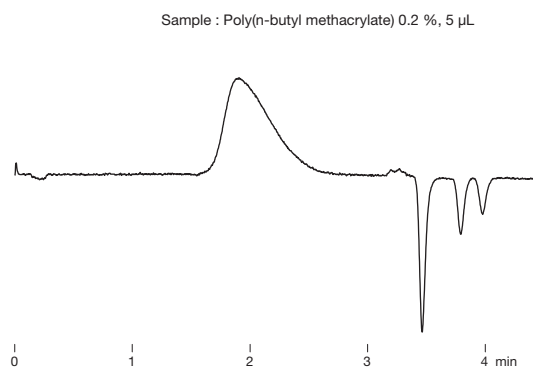
Column : Shodex GPC HK-400 series
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Comparison of HK-404L and conventional column (KF-805L)



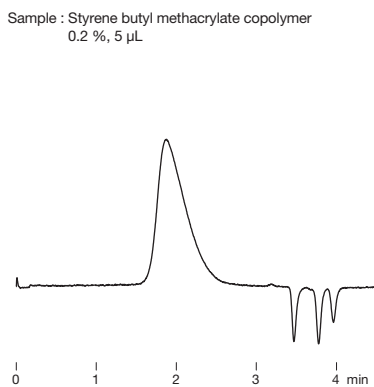
Column : Shodex GPC HK-404L, KF-805L
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Poly (butyl methacrylate)



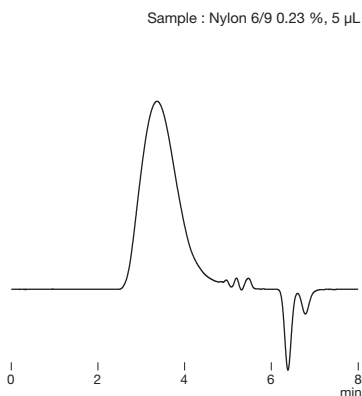
Column : Shodex GPC HK-404L x 2
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Styrene butyl methacrylate copolymer



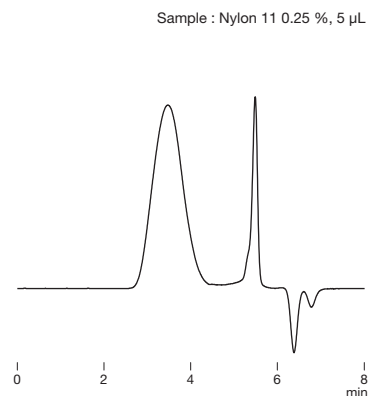
Column : Shodex GPC HK-404L x 2
 Eluent : THF
 Flow rate : 1.0 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Polyamide (Nylon 6/9)



Column : Shodex GPC HK-404L
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Polyamide (Nylon 11)



Column : Shodex GPC HK-404L
 Eluent : 5 mM CF₃COONa in HFIP
 Flow rate : 0.3 mL/min
 Detector : RI (small cell volume)
 Column temp. : 40 °C

Organic SEC (GPC) Columns: Linear Calibration Type

Features

LF

- Packed with unique multi-pore gels with a wide pore-size distribution
- Highly linear calibration curve without inflection points
- Achieves highly precise molecular weight distribution determination
- Enables analysis over a wide molecular weight range
- Rapid analysis column (LF-604) and high performance analysis column (LF-404) are also available
- LF-604 and LF-404 reduce solvent use
- Fulfills USP-NF L21 requirements

• Standard column

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6021041 | GPC LF-804 | ≥ 17,000 | 6 | 3,000 | 8.0 x 300 |
| F6709621 | GPC LF-G | (guard column) | 6 | — | 4.6 x 10 |

See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

• Rapid analysis downsized column

* LF-604 is recommended to be used with semi-micro type devices.

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6021042 | GPC LF-604 | ≥ 9,000 | 6 | 3,000 | 6.0 x 150 |
| F6709621 | GPC LF-G | (guard column) | 6 | — | 4.6 x 10 |

See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

• High performance semi-micro column

* LF-404 is recommended to be used with semi-micro type devices.

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6021043 | GPC LF-404 | ≥ 14,000 | 6 | 3,000 | 4.6 x 250 |
| F6709621 | GPC LF-G | (guard column) | 6 | — | 4.6 x 10 |

See page 60 for solvent replacement applicability of Organic SEC (GPC) columns.

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Tetrahydrofuran (THF)

Target molecular weight range and exclusion limit

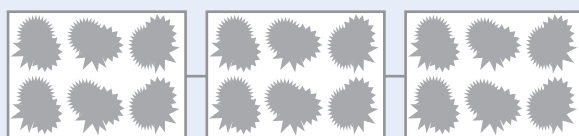
• Measured with polystyrene (eluent: THF)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|---------------|-------------------------------|-----------------|
| LF-804 | 300 - 2,000,000 | 2,000,000 |
| LF-604 | 300 - 2,000,000 | 2,000,000 |
| LF-404 | 300 - 2,000,000 | 2,000,000 |

Please use the above table for reference purposes only when selecting columns.

Schematic diagram of linear calibration type packing

Connecting linear calibration type columns (LF series)



The linear calibration type column covers a broad range of molecular weights with only one kind of packing material.

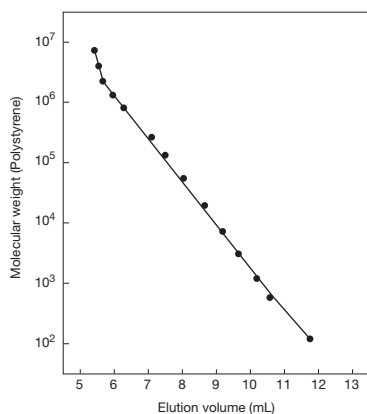
Connecting mixed-gel columns (KF-804L, etc.)



Connecting different single pore-size columns (KF-804 + KF-803 + KF-802, etc.)

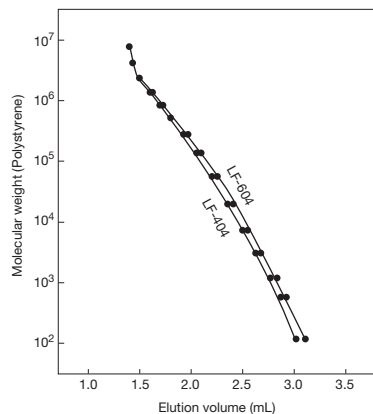


Calibration curve for LF-804 using polystyrene



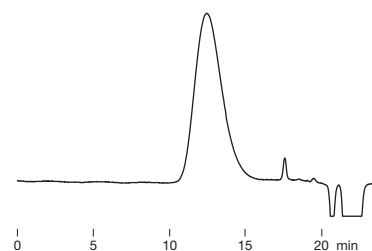
Column : Shodex GPC LF-804
Eluent : THF
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Calibration curves for LF-604 and LF-404 using polystyrene



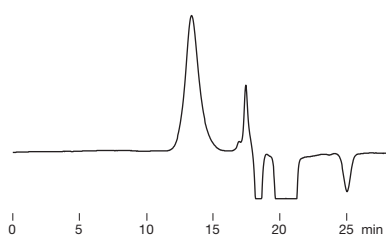
Column : Shodex GPC LF-604, LF-404
Eluent : THF
Flow rate : 0.5 mL/min (LF-604)
 0.3 mL/min (LF-404)
Detector : RI (small cell volume)
Column temp. : 40 °C

Polyurethane

Sample : Polyurethane 0.1 %, 20 μ L

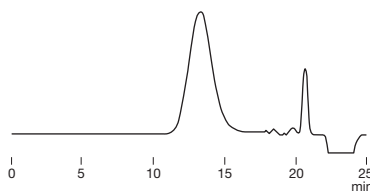
Column : Shodex GPC LF-404 x 2
Eluent : THF
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Xylan

Sample : Xylan 0.1 %, 100 μ L

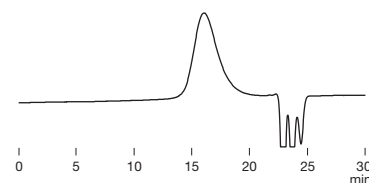
Column : Shodex GPC LF-804
Eluent : 20 mM H₃PO₄ + 20 mM LiBr
 in DMSO/DMF = 80/20
Flow rate : 0.6 mL/min
Detector : RI
Column temp. : 50 °C

Polyamide (Nylon 6/6)

Sample : Nylon 6/6 0.1 %, 20 μ L

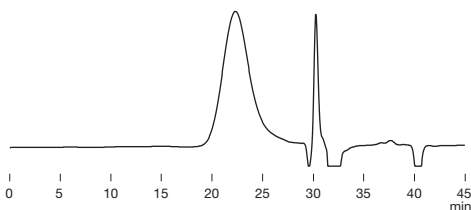
Column : Shodex GPC LF-404
Eluent : 5 mM CF₃COONa in HFIP
Flow rate : 0.15 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Polymethyl methacrylate

Sample : Polymethyl methacrylate, 100 μ L

Column : Shodex GPC LF-804 x 2
Eluent : Methyl ethyl ketone
Flow rate : 1.0 mL/min
Detector : RI
Column temp. : 40 °C

Polyamic acid

Sample : Poly(pyromellitic dianhydride-co-4,4'-oxydianiline), 100 μ L

Column : Shodex GPC LF-804 x 2
Eluent : 30 mM LiBr + 30 mM H₃PO₄ in NMP
Flow rate : 0.7 mL/min
Detector : RI
Column temp. : 50 °C

Effects of using multiple LF-404 columns for the separation of polystyrenes



Sample : 10 μ L
 1. Polystyrene (Mw : 1,030,000)
 2. Polystyrene (Mw : 152,000)
 3. Polystyrene (Mw : 66,000)
 4. Polystyrene (Mw : 22,000)
 5. Polystyrene (Mw : 5,050)
 6. Polystyrene (Mw : 580)
 7. Ethylbenzene

Column : Shodex GPC LF-404 x n
Eluent : THF
Flow rate : 0.3 mL/min
Detector : RI (small cell volume)
Column temp. : 40 °C

Organic SEC (GPC) Column: Rapid Preparation

Features

- Newly developed styrene divinylbenzene copolymer monodisperse particles
- Can deliver at four times higher flow rate (10 mL/min or more) compared with conventional products
- Achieves rapid recycling separation
- Suitable for the separation of samples in a wide molecular weight range due to its wide linear range and large pore volume
- Usable with various organic solvents such as THF, toluene, dichloroethane, ethyl acetate, DMF, and acetone used in GPC analysis in addition to chloroform

FP-2002

- Preparative columns [Preparative columns are made to order.]

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (μm) | Column Size (mm) I.D. x Length |
|--------------|--------------|--------------------------|--------------------|--------------------------------|
| F6102520 | GPC FP-2002 | ≥ 30,000 | 8 | 20.0 x 600 |
| F6700340 | GPC FP-G 8B | (guard column) | 8 | 8.0 x 50 |

Base Material: Styrene divinylbenzene copolymer
Shipping Solvent: Chloroform

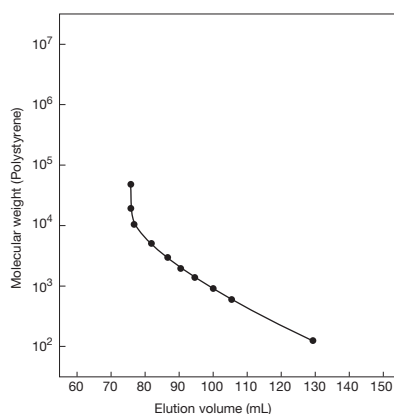
Target molecular weight range and exclusion limit

- Measured with polystyrene (eluent: chloroform)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------|-------------------------------|-----------------|
| FP-2002 | 100 - 5,000 | 8,000 |

Please use the above tables for reference purposes only when selecting columns.

Calibration curve for FP-2002 using polystyrene

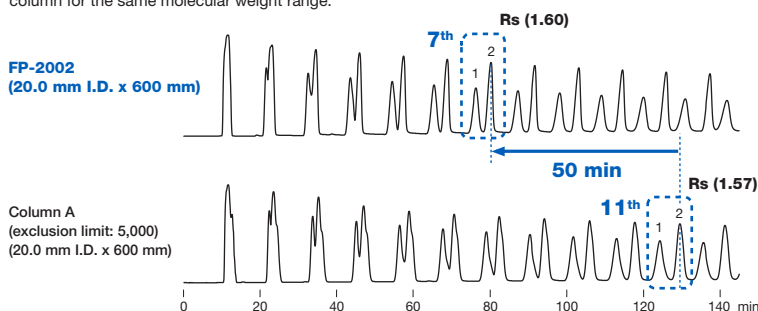


Column : Shodex GPC FP-2002
Eluent : Chloroform
Flow rate : 10 mL/min
Detector : UV (254 nm)
(preparative type)
Column temp. : 30 °C

Comparison of recycling separation

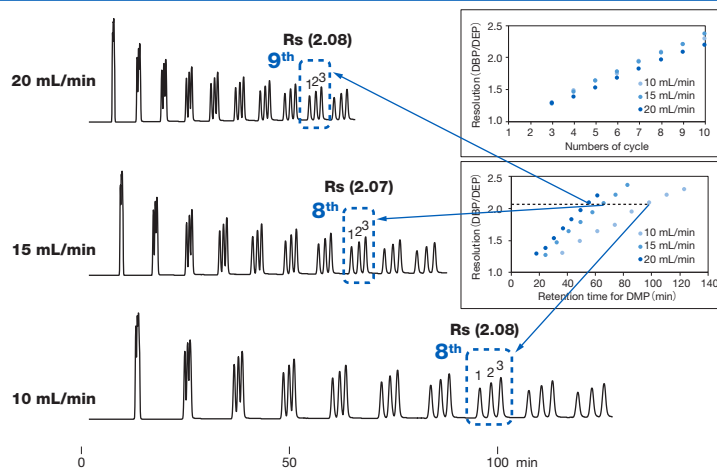
GPC FP-2002 is a column suitable for rapid organic solvent SEC(GPC) separation. Phthalate esters were used to compare recycled separations with other manufacturer's rapid preparative column (exclusion limit: 5,000). The recycling separation using FP-2002 can be made faster than other column for the same molecular weight range.

Sample : 10 % each, 2 mL
1. Ditridecyl Phthalate (MW: 530)
2. Bis(*trans*-3,3,5-trimethylcyclohexyl) phthalate (MW: 414)



Column : Shodex GPC FP-2002
Column A from other manufacturer
Eluent : Chloroform
Flow rate : 10 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 30 °C

Effects of flow rate for recycling separation



The standard flow rate of the packed column GPC FP-2002 for organic solvent-based SEC (GPC) is 10 mL/min. We have investigated the flow rate dependency of phthalate esters recycling separation. Even at the maximum usable flow rate of 20 mL/min, there is no extreme drop in column efficiency and further speeding up is possible.

(Note) In the case of a polymer sample, shear degradation of the polymer tends to occur as the molecular weight increases. It is recommended to lower the flow rate, if there is a possibility that shear degradation occurred.

Sample : 3 % each, 1 mL
1. Dibutyl phthalate (DBP) (MW: 278)
2. Diethyl phthalate (DEP) (MW: 222)
3. Dimethyl phthalate (DMP) (MW: 194)

Column : Shodex GPC FP-2002
Eluent : Chloroform
Detector : UV (254 nm) (preparative type)
Column temp. : 30 °C

Organic SEC (GPC) Columns: Preparative

- **Preparative columns** [Preparative columns are made to order.]

GPC KF-2000 series Shipping Solvent: Tetrahydrofuran (THF)

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|----------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6102401 | GPC KF-2001 | ≥ 18,000 | 6 | 20.0 x 300 | KF-801 |
| F6102402 | GPC KF-2002 | ≥ 18,000 | 6 | 20.0 x 300 | KF-802 |
| F6102425 | GPC KF-2002.5 | ≥ 18,000 | 6 | 20.0 x 300 | KF-802.5 |
| F6102403 | GPC KF-2003 | ≥ 18,000 | 6 | 20.0 x 300 | KF-803 |
| F6102404 | GPC KF-2004 | ≥ 14,000 | 7 | 20.0 x 300 | KF-804 |
| F6102405 | GPC KF-2005 | ≥ 10,000 | 10 | 20.0 x 300 | KF-805 |
| F6102406 | GPC KF-2006 | ≥ 10,000 | 10 | 20.0 x 300 | KF-806 |
| F6102409 | GPC KF-2006M | ≥ 10,000 | 10 | 20.0 x 300 | KF-806M |
| F6700406 | GPC KF-G 8B | (guard column) | 15 | 8.0 x 50 | (guard column) |

KF-2006M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution. Base Material: Styrene divinylbenzene copolymer

GPC K-2000 series Shipping Solvent: Chloroform

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|---------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6102301 | GPC K-2001 | ≥ 18,000 | 6 | 20.0 x 300 | KF-801 |
| F6102312 | GPC K-2002 | ≥ 18,000 | 6 | 20.0 x 300 | KF-802 |
| F6102315 | GPC K-2002.5 | ≥ 18,000 | 6 | 20.0 x 300 | KF-802.5 |
| F6102303 | GPC K-2003 | ≥ 18,000 | 6 | 20.0 x 300 | KF-803 |
| F6102304 | GPC K-2004 | ≥ 14,000 | 7 | 20.0 x 300 | KF-804 |
| F6102305 | GPC K-2005 | ≥ 10,000 | 10 | 20.0 x 300 | KF-805 |
| F6102306 | GPC K-2006 | ≥ 10,000 | 10 | 20.0 x 300 | KF-806 |
| F6102309 | GPC K-2006M | ≥ 10,000 | 10 | 20.0 x 300 | KF-806M |
| F6700407 | GPC K-G 8B | (guard column) | 15 | 8.0 x 50 | (guard column) |

K-2006M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution. Base Material: Styrene divinylbenzene copolymer

[Customized columns]

GPC H-2000 series Shipping Solvent: Chloroform

| Product Code | Product Name | Plate Number (TP/column) | Particle Size (µm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|---------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6102001 | GPC H-2001 | ≥ 13,000 | 15 | 20.0 x 500 | KF-801 |
| F6102002 | GPC H-2002 | ≥ 13,000 | 15 | 20.0 x 500 | KF-802 |
| F6102025 | GPC H-2002.5 | ≥ 13,000 | 15 | 20.0 x 500 | KF-802.5 |
| F6102003 | GPC H-2003 | ≥ 13,000 | 15 | 20.0 x 500 | KF-803 |
| F6102004 | GPC H-2004 | ≥ 13,000 | 15 | 20.0 x 500 | KF-804 |
| F6102005 | GPC H-2005 | ≥ 13,000 | 15 | 20.0 x 500 | KF-805 |
| F6102006 | GPC H-2006 | ≥ 13,000 | 15 | 20.0 x 500 | KF-806 |
| F6102009 | GPC H-2006M | ≥ 12,000 | 15 | 20.0 x 500 | KF-806M |
| F6700310 | GPC H-G 8B | (guard column) | 15 | 8.0 x 50 | (guard column) |

H-2006M is a mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution. Base Material: Styrene divinylbenzene copolymer

GPC KF-5000 series Shipping Solvent: Tetrahydrofuran (THF)

| Product Code | Product Name | Particle Size (µm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|----------------------|--------------------|--------------------------------|-----------------|
| F6108010 | GPC KF-5001 | 15 | 50.0 x 300 | KF-801 |
| F6108020 | GPC KF-5002 | 15 | 50.0 x 300 | KF-802 |
| F6108025 | GPC KF-5002.5 | 15 | 50.0 x 300 | KF-802.5 |
| F6108030 | GPC KF-5003 | 15 | 50.0 x 300 | KF-803 |
| F6108040 | GPC KF-5004 | 15 | 50.0 x 300 | KF-804 |
| F6700408 | GPC KF-G 20C | 15 | 20.0 x 100 | (guard column) |

Base Material: Styrene divinylbenzene copolymer

GPC K-5000 series Shipping Solvent: Chloroform

| Product Code | Product Name | Particle Size (µm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|---------------------|--------------------|--------------------------------|-----------------|
| F6109010 | GPC K-5001 | 15 | 50.0 x 300 | KF-801 |
| F6109020 | GPC K-5002 | 15 | 50.0 x 300 | KF-802 |
| F6109025 | GPC K-5002.5 | 15 | 50.0 x 300 | KF-802.5 |
| F6109030 | GPC K-5003 | 15 | 50.0 x 300 | KF-803 |
| F6109040 | GPC K-5004 | 15 | 50.0 x 300 | KF-804 |
| F6700409 | GPC K-G 20C | 15 | 20.0 x 100 | (guard column) |

Base Material: Styrene divinylbenzene copolymer

Solvent Replacement Applicability of Organic SEC (GPC) Columns

| Solvent | Product Name | | | | | | | | | |
|--------------------------------|------------------------|--|--------|--|------------------------------------|----------|----------------------------|------------------------------|--------|---|
| | Shipping Solvent : THF | | | | | | Shipping Solvent : DMF | | | |
| | KF-801 | KF-802 KF-802.5 KF-803L KF-804L | KF-803 | KF-804 KF-805 KF-805L KF-806M KF-806L KF-807L | KF-401HQ KF-402HQ KF-402.5HQ | KF-403HQ | LF-804 LF-604 LF-404 | KD-801 KD-802 KD-802.5 | KD-803 | KD-804 KD-805 KD-806 KD-807 KD-806M |
| Tetrahydrofuran (THF) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | × | × | ○ |
| Chloroform | ○ | ○ | ○ | ○ | ○ | ○ | ○ | × | × | ○ |
| Carbon tetrachloride | × | ○ | ○ | ○ | | | ○ | × | × | ○ |
| Benzene | ○ | ○ | ○ | ○ | ○ | ○ | | × | ○ | ○ |
| Toluene | ○ | ○ | ○ | ○ | ○ | ○ | ○ | × | ○ | ○ |
| p-Xylene | × | ○ | ○ | ○ | ○ | ○ | | × | ○ | ○ |
| o-Dichlorobenzene (ODCB) | × | × | ○ | ○ | ○ | ○ | | × | ○ | ○ |
| 1,2,4-Trichlorobenzene (TCB) | × | × | ○ | ○ | ○ | ○ | | × | ○ | ○ |
| Dioxane | × | ○ | ○ | ○ | | | | × | ○ | ○ |
| Diethyl ether | × | × | ○ | ○ | | | | × | ○ | ○ |
| Ethyl acetate | × | × | ○ | ○ | | | | × | × | ○ |
| Acetone | × | × | ○ | ○ | ○ | ○ | | × | ○ | ○ |
| Methyl ethyl ketone | × | × | ○ | ○ | ○ | ○ | ○ | × | ○ | ○ |
| N,N-Dimethylformamide (DMF) | × | × | ○ | ○ | ○* | ○* | ○* | ○ | ○ | ○ |
| N,N-Dimethylacetamide (DMAc) | × | × | ○ | ○ | ○* | ○* | ○* | × | ○ | ○ |
| Hexafluoroisopropanol (HFIP) | × | × | × | ○ | × | △* | ○* | × | ○ | ○ |
| m-Cresol | × | × | ○ | ○ | | | | × | ○ | ○ |
| o-Chlorophenol | × | × | ○ | ○ | | | | × | ○ | ○ |
| Quinoline | × | × | ○ | ○ | | | | × | ○ | ○ |
| N-Methyl-2-pyrrolidone (NMP) | × | × | ○ | ○ | ○* | ○* | ○* | × | ○ | ○ |
| Dimethyl sulfoxide (DMSO) | × | × | × | × | △* | ○* | ○* | × | × | ○ |
| 30 % m-Cresol/Chloroform | × | ○ | ○ | ○ | | | ○ | × | ○ | ○ |
| 30 % o-Chlorophenol/Chloroform | × | ○ | ○ | ○ | | | ○ | × | ○ | ○ |
| 30 % HFIP/Chloroform | × | ○ | ○ | ○ | | | | × | ○ | ○ |
| Hexane | × | × | × | × | × | × | × | × | × | × |
| Acetonitrile | × | × | × | × | × | × | × | × | × | × |
| Methanol | × | × | × | × | × | × | × | × | × | × |
| Water | × | × | × | × | × | × | × | × | × | × |

○ : Solvent replacement possible

△ : Solvent replacement possible, but this may cause column performance to deteriorate slightly

* : Usable at 40 °C or higher

× : Solvent replacement not possible

Calibration Standards for SEC

Polystyrene (PS)

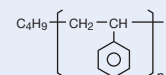
Features

- SL-105**
 - For organic solvent SEC (GPC)
- SM-105**
 - Less branched polystyrene with anionic polymerization
- SH-75**
 - Easily soluble in tetrahydrofuran (THF), chloroform, toluene, and o-dichlorobenzene (ODCB)

Standard kit

| Product Code | Product Name | Contents | Molecular Weights (Mp) Range |
|--------------|------------------------|-------------------------|------------------------------|
| F8601105 | STANDARD SL-105 | 0.5 g x 10 kinds | 580 - 22,800 |
| F8602105 | STANDARD SM-105 | 0.5 g x 10 kinds | 1,210 - 2,330,000 |
| F8603075 | STANDARD SH-75 | 0.5 g x 7 kinds | 662,000 - 6,550,000 |

Structural formula of S series



◆ SL-105

| Std.No. | Mp | Mw/Mn |
|---------|--------|-------|
| S-23 | 22,800 | 1.02 |
| S-13 | 13,000 | 1.02 |
| S-10 | 10,300 | 1.03 |
| S-6.5 | 6,540 | 1.03 |
| S-4.9 | 4,880 | 1.03 |
| S-2.9 | 2,880 | 1.04 |
| S-2.0 | 1,990 | 1.05 |
| S-1.2 | 1,210 | 1.07 |
| S-1.1 | 1,120 | 1.07 |
| S-0.6 | 580 | 1.11 |

◆ SM-105

| Std.No. | Mp | Mw/Mn |
|---------|-----------|-------|
| S-2330 | 2,330,000 | 1.03 |
| S-1700 | 1,700,000 | 1.04 |
| S-740 | 740,000 | 1.06 |
| S-321 | 321,000 | 1.03 |
| S-129 | 129,000 | 1.06 |
| S-57 | 56,600 | 1.03 |
| S-23 | 22,800 | 1.02 |
| S-6.5 | 6,540 | 1.03 |
| S-2.9 | 2,880 | 1.04 |
| S-1.2 | 1,210 | 1.07 |

◆ SH-75

| Std.No. | Mp | Mw/Mn |
|---------|-----------|-------|
| S-6550 | 6,550,000 | 1.07 |
| S-3550 | 3,550,000 | 1.05 |
| S-3020 | 3,020,000 | 1.03 |
| S-2330 | 2,330,000 | 1.03 |
| S-1860 | 1,860,000 | 1.04 |
| S-885 | 885,000 | 1.05 |
| S-662 | 662,000 | 1.04 |

(Note)
Molecular weights (Mp, Mw/Mn) of each standard kit may vary depending on production lot.

Polymethylmethacrylate (PMMA)

Features

- M-75**
 - For organic solvent SEC (GPC)
 - Narrow molecular weight distribution range
 - Easily soluble in hexafluoroisopropanol (HFIP) and dimethylformamide (DMF)

Standard kit

| Product Code | Product Name | Contents | Molecular Weights (Mp) Range |
|--------------|----------------------|------------------------|------------------------------|
| F8604075 | STANDARD M-75 | 0.5 g x 7 kinds | 3,040 - 1,020,000 |

(Note)
Molecular weights (Mp, Mw/Mn) of a standard kit may vary depending on production lot.

◆ M-75

| Std.No. | Mp | Mw/Mn |
|---------|-----------|-------|
| M-1020 | 1,020,000 | 1.04 |
| M-539 | 539,000 | 1.02 |
| M-224 | 224,000 | 1.02 |
| M-72 | 72,000 | 1.02 |
| M-20 | 20,100 | 1.03 |
| M-7.3 | 7,290 | 1.11 |
| M-3.0 | 3,040 | 1.08 |

Pullulan

Features

- P-82**
 - For aqueous SEC (GFC)
 - Unbranched pullulan standard
 - High solubility in water eliminates the possibility of recrystallization
- P**

Standard kit

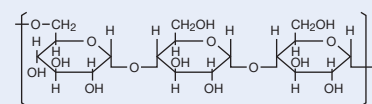
| Product Code | Product Name | Contents | Molecular Weights (Mp) Range |
|--------------|----------------------|------------------------|------------------------------|
| F8400000 | STANDARD P-82 | 0.2 g x 8 kinds | 6,300 - 739,000 |

Single type

| Product Code | Product Name | Contents | Mp | Mw/Mn |
|--------------|------------------|--------------|---------|-------|
| F8400800 | STD P-800 | 0.5 g | 739,000 | 1.24 |
| F8400400 | STD P-400 | 0.5 g | 334,000 | 1.30 |
| F8400200 | STD P-200 | 0.5 g | 216,000 | 1.22 |
| F8400100 | STD P-100 | 0.5 g | 107,000 | 1.12 |
| F8400050 | STD P-50 | 0.5 g | 49,700 | 1.09 |
| F8400020 | STD P-20 | 0.5 g | 22,000 | 1.08 |
| F8400010 | STD P-10 | 0.5 g | 9,800 | 1.07 |
| F8400005 | STD P-5 | 0.5 g | 6,300 | 1.09 |

(Note)
Molecular weights (Mp, Mw/Mn) of a standard kit or each single type may vary depending on production lot.

Structural formula of P series



◆ P-82

| Std.No. | Mp | Mw/Mn |
|---------|---------|-------|
| P-800 | 739,000 | 1.24 |
| P-400 | 334,000 | 1.30 |
| P-200 | 216,000 | 1.22 |
| P-100 | 107,000 | 1.12 |
| P-50 | 49,700 | 1.09 |
| P-20 | 22,000 | 1.08 |
| P-10 | 9,800 | 1.07 |
| P-5 | 6,300 | 1.09 |

Anion Exchange Chromatography Columns

Features

QA-825

DEAE-825

- Suitable for analyzing relatively high molecular weight compounds: proteins, peptides, DNA, and RNA
- Usable in a wide pH range from pH 2 to 12
- QA-825 fulfills USP-NF L23 requirements

ES-502N 7C

- Compared to IEC series columns, polyvinyl alcohol is used as base material and this offers different separation pattern
- Low hydrophobic interaction of proteins allows analysis under mild conditions

Strong anion exchange resin [Functional Group: Quaternary ammonium]

• Standard column

| Product Code | Product Name | Ion Exchange Capacity (meq/g) | Base Material | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-------------------|-------------------------------|-------------------------|--------------------|---------------|--------------------------------|---|
| F6110011 | IEC QA-825 | 0.45 | Polyhydroxymethacrylate | 12 | 5,000 | 8.0 x 75 | 50 mM Na ₂ SO ₄ aq. |

Weak anion exchange resin [Functional Group: Diethylaminoethyl]

• Standard column

| Product Code | Product Name | Ion Exchange Capacity (meq/g) | Base Material | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------------|-------------------------------|-------------------------|--------------------|---------------|--------------------------------|--|
| F6118255 | IEC DEAE-825 | 0.6 | Polyhydroxymethacrylate | 8 | 5,000 | 8.0 x 75 | 50 mM Na ₂ SO ₄ aq. |
| F7640002 | Asahipak ES-502N 7C | 0.55 | Polyvinyl alcohol | 9 | 2,000 | 7.5 x 100 | 50 mM 1,3-Diaminopropane + 50 mM NaCl (pH10.0) |

Cation Exchange Chromatography Columns

Features

SP-825

CM-825

- Suitable for analyzing relatively high molecular weight compounds: proteins, peptides, DNA, and RNA
- Usable in a wide pH range from pH 2 to 12

SP-FT 4A

- Non-porous base material
- Provides ultra-rapid analysis using conventional devices

ES-502C 7C

- Compared to IEC series columns, polyvinyl alcohol is used as base material offering different separation pattern
- Low hydrophobic interaction with proteins allows analysis under mild conditions

P-421S

- Column for amino acids analysis by cation exchange mode
- Provides simultaneous analysis of different amino acids
- Fulfills USP-NF L22 and L58 requirements

Strong cation exchange resin [Functional Group: Sulfoethyl]

• Standard column

| Product Code | Product Name | Ion Exchange Capacity (meq/g) | Base Material | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------|-------------------------------|-------------------------|--------------------|---------------|--------------------------------|---|
| F6118250 | IEC SP-825 | 0.4 | Polyhydroxymethacrylate | 8 | 5,000 | 8.0 x 75 | 50 mM Na ₂ SO ₄ aq. |
| F6113100 | IEC SP-FT 4A | 0.2 | Polyhydroxymethacrylate | 2.7 | — | 4.6 x 10 | 20 mM MES buffer (pH5.6) |

Housing Material of SP-FT 4A: PEEK
*MES: 2-(N-Morpholino)ethanesulfonic acid

Weak cation exchange resin [Functional Group: Carboxymethyl]

• Standard column

| Product Code | Product Name | Ion Exchange Capacity (meq/g) | Base Material | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------------|-------------------------------|-------------------------|--------------------|---------------|--------------------------------|---|
| F6110002 | IEC CM-825 | 0.4 | Polyhydroxymethacrylate | 8 | 5,000 | 8.0 x 75 | 50 mM Na ₂ SO ₄ aq. |
| F7640001 | Asahipak ES-502C 7C | 0.55 | Polyvinyl alcohol | 9 | 2,000 | 7.5 x 100 | 0.1 M Sodium phosphate buffer (pH4.4) |

Amino acid analysis column [Functional Group: Sulfo (Na⁺)]

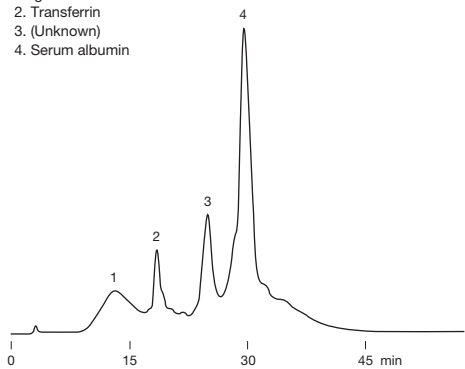
• Standard column

| Product Code | Product Name | Plate Number (TP/column) | Base Material | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------|--------------------------|----------------------------------|--------------------|--------------------------------|------------------|
| F6354211 | CXpak P-421S | ≥ 3,500 | Styrene divinylbenzene copolymer | 6 | 4.6 x 150 | H ₂ O |
| F6700210 | CXpak P-G | (guard column) | Styrene divinylbenzene copolymer | 6 | 4.6 x 10 | H ₂ O |

Proteins in human serum

Sample : Human serum 0.5 %, 200 μ L

1. IgG
2. Transferrin
3. (Unknown)
4. Serum albumin

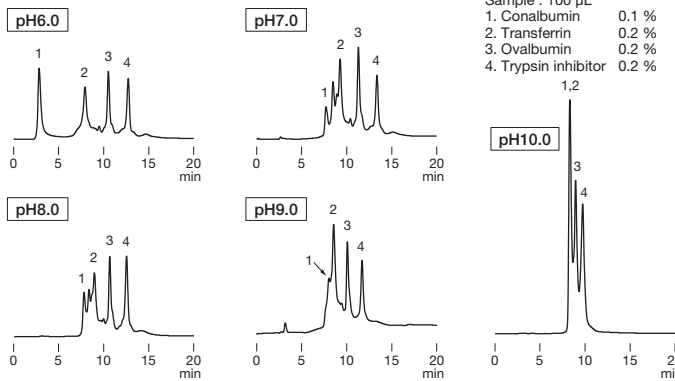


Column : Shodex IEC QA-825
Eluent : (A); 20 mM Tris-HCl buffer (pH8.6)
 (B); (A) + 0.5 M NaCl
 Linear gradient; 100 % (A) to 50 % (B), 60 min
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Effects of eluent pH on DEAE-825 analysis

Sample : 100 μ L

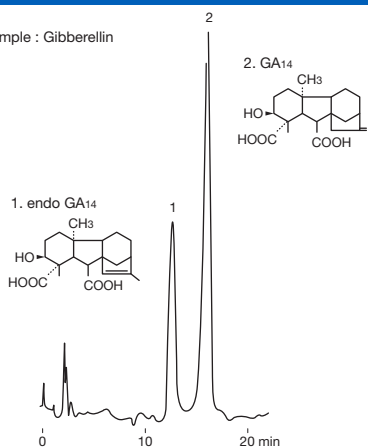
1. Conalbumin 0.1 %
2. Transferrin 0.2 %
3. Ovalbumin 0.2 %
4. Trypsin inhibitor 0.2 %



Column : Shodex IEC DEAE-825
Eluent : (A); 20 mM Piperazine-HCl buffer (pH6.0), 20 mM Bis-Tris-HCl buffer (pH7.0)
 20 mM Tris-HCl buffer (pH8.0), 20 mM Ethanolamine-HCl buffer (pH9.0)
 20 mM 1,3-Diaminopropane-HCl buffer (pH10.0)
 (B); (A) + 0.5 M NaCl
 Linear gradient; (A) to (B), 20 min
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : 25 $^{\circ}$ C

Gibberellin isomers

Sample : Gibberellin



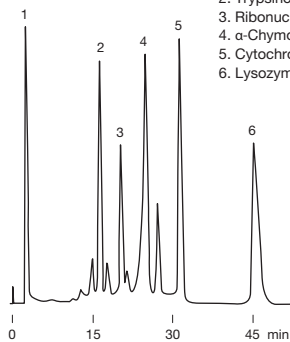
Column : Shodex Asahipak ES-502N 7C
Eluent : CH₃COOH/H₂O/CH₃OH = 0.1/0.4/99.5
Flow rate : 1.5 mL/min
Detector : UV (210 nm)
Column temp. : 50 $^{\circ}$ C

Data provided by Prof. Yamaguchi,
 Faculty of Agriculture, University of Tokyo.

Protein separation using cation exchange columns

Sample : 90 μ L

1. Myoglobin
2. Trypsinogen
3. Ribonuclease A
4. α -Chymotrypsinogen A
5. Cytochrome c
6. Lysozyme

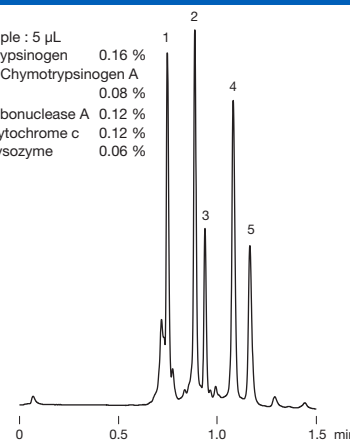


Column : Shodex IEC CM-825
Eluent : (A); 20 mM Sodium phosphate buffer (pH7.0)
 (B); (A) + 0.5 M NaCl
 Linear gradient; (A) to (B), 60 min
Flow rate : 1.0 mL/min
Detector : UV (280 nm)
Column temp. : Room temp.

Ultra-rapid analysis of hemoglobins

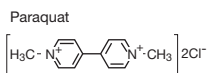
Sample : 5 μ L

1. Trypsinogen 0.16 %
2. α -Chymotrypsinogen A 0.08 %
3. Ribonuclease A 0.12 %
4. Cytochrome c 0.12 %
5. Lysozyme 0.06 %

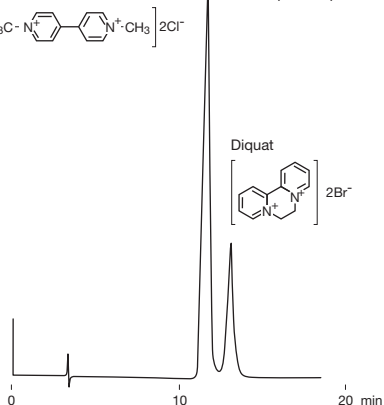


Column : Shodex IEC SP-FT 4A
Eluent : (A); 20 mM MES buffer (pH5.6)
 (B); (A) + 0.5 M Na₂SO₄
 Linear gradient; (A) to (B), 2 min
Flow rate : 1.7 mL/min
Detector : UV (280 nm)
Column temp. : 30 $^{\circ}$ C

Paraquat and diquat



Sample : 20 μ L

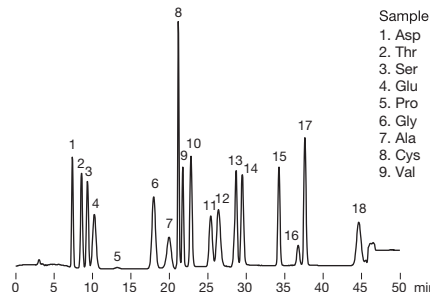


Column : Shodex Asahipak ES-502C 7C
Eluent : 50 mM Sodium phosphate buffer (pH7.0) + 150 mM NaCl
Flow rate : 1.0 mL/min
Detector : UV (288 nm)
Column temp. : 30 $^{\circ}$ C

Standard amino acids

Sample : 0.1 μ M each, 100 μ L

1. Asp
2. Thr
3. Ser
4. Glu
5. Pro
6. Gly
7. Ala
8. Cys
9. Val
10. Met
11. Ile
12. Leu
13. Tyr
14. Phe
15. Lys
16. NH₃
17. His
18. Arg



Column : Shodex CXPak P-421S
Eluent : MCI Buffer L-8500-PH Kit (Mitsubishi Chemical Corporation)
 Low pressure gradient;
 PH-1 (0 min), PH-2 (0.2 min), PH-3 (12.5 min), PH-4 (22.7 min), PH-RG (40.0 min)
Reagent : Ninhydrin Coloring Solution Kit for HITACHI
 (Wako Pure Chemical Industries, Ltd.)
 R1:R2 = 50:50
Flow rate : (Eluent) 0.5 mL/min
 (Reagent) 0.35 mL/min
Detector : VIS (570 nm)
Column Temp. : 63 $^{\circ}$ C
Reaction Temp. : 120 $^{\circ}$ C

Chiral Separation Columns

Features

CDBS-453

- Separates optical isomers by using their conformational compatibility differences
- Versatile column for chiral separation
- Fulfills USP-NF L45 requirements

• Standard column

| Product Code | Product Name | Functional Group | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-----------------------|---------------------------|--------------------|-----------------------------------|--|
| F7146003 | ORpak CDBS-453 | β-Cyclodextrin derivative | 3 | 4.6 x 150 | 0.05 % CH ₃ COOH + 0.2 M NaCl aq./ CH ₃ CN = 95/5 |

Base Material: Silica

Pretreatment Column for Column Switching Method

Features

GF-4A

- High protein removal rate
- Removes surfactants well but is not suitable for trapping hydrophilic substances

• Column for column switching method

| Product Code | Product Name | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------|---------------|-----------------------------------|------------------|
| F8700015 | MSpak GF-4A | 9 | 400 | 4.6 x 10 | H ₂ O |

Base Material: Polyvinyl alcohol

GPC Clean-up Columns

Features

EV

- Suitable for fractionation of residual pesticides in foods
- EV-2000 AC is used in Shoku-An No. 0124001 (January 24th, 2005, Japan) of the Pharmaceutical and Food Safety Bureau, MHLW, Section 2 "Simultaneous GC/MS (LC/MS) Analyses of Agricultural Chemicals in Livestock and Marine Products".
- EV2000AC-12F is used in Shoku-An No. 0226 (February 26th, 2015, Japan) of the Pharmaceutical and Food Safety Bureau, MHLW, Section 2 "LC/MS Analyses of Agricultural Chemicals in Livestock and Marine Products".

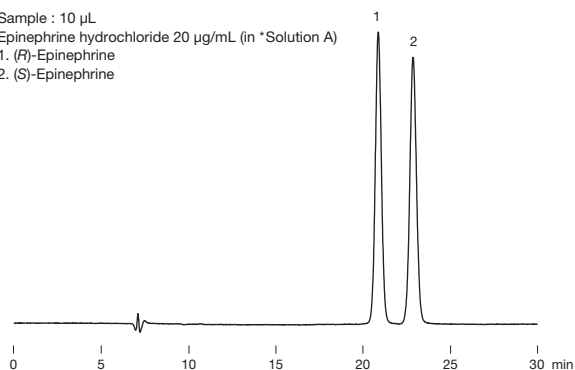
• GPC clean-up columns for residual pesticides in foods, etc.

| Product Code | Product Name | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------------|--------------------|----------------|-----------------------------------|--------------------------------|
| F6090006 | CLNpak EV2000AC-12F | 16 | 30 | 12.0 x 300 | Acetone/Cyclohexane = 3/7 |
| F6090007 | CLNpak EV-G AC12C | 16 | (guard column) | 12.0 x 100 | Acetone/Cyclohexane = 3/7 |
| F6090003 | CLNpak EV-2000 AC | 16 | 30 | 20.0 x 300 | Acetone/Cyclohexane = 3/7 |
| F6090004 | CLNpak EV-G AC | 16 | (guard column) | 20.0 x 100 | Acetone/Cyclohexane = 3/7 |
| F6090001 | CLNpak EV-2000 | 16 | 30 | 20.0 x 300 | Ethylacetate/Cyclohexane = 3/7 |
| F6090002 | CLNpak EV-G | 16 | (guard column) | 20.0 x 100 | Ethylacetate/Cyclohexane = 3/7 |
| F6090005 | CLNpak EV-200 | 16 | 30 | 2.0 x 150 | Ethylacetate/Cyclohexane = 3/7 |

Base Material: Styrene divinylbenzene copolymer

Analysis of epinephrine injection proposed in USP-NF pharmacopeial forum

Sample : 10 μ L
 Epinephrine hydrochloride 20 μ g/mL (in *Solution A)
 1. (R)-Epinephrine
 2. (S)-Epinephrine

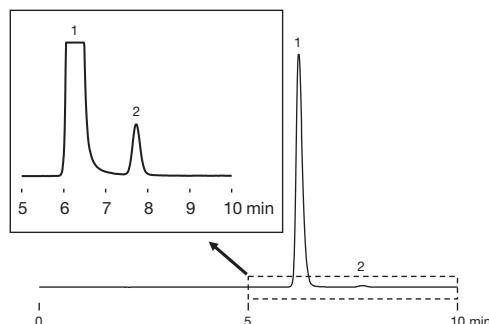


Column : Shodex ORpak CDBS-453
Eluent : *Solution A/CH₃CN = 99/1
Flow rate : 0.3 mL/min
Detector : UV (280 nm)
Column temp. : 25 °C

*Solution A : 0.75 g/L Ammonium acetate aqueous solution adjusted to pH4.0 with Glacial acetic acid

Impurity analysis of lamivudine according to USP-NF method

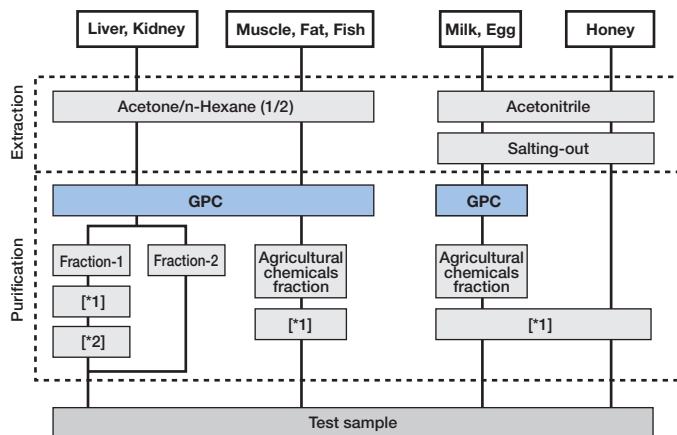
Sample : 10 μ L (System suitability solution)
 0.25 mg/mL USP Lamivudine resolution mixture A RS in water
 1. Lamivudine
 2. Lamivudine enantiomer



Column : Shodex ORpak CDBS-453
Eluent : Methanol and *Buffer (5 : 95)
 *Buffer: 7.7 g/L of Ammonium acetate in water
Flow rate : 1.0 mL/min
Detector : UV (270 nm)
Column temp. : 25 °C

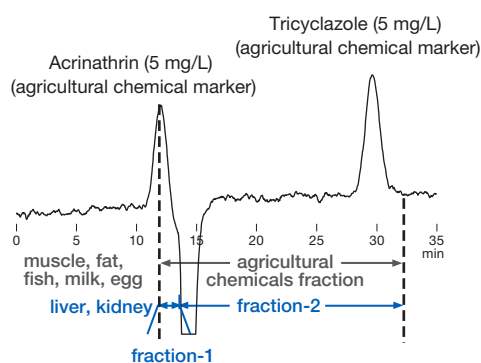
Sample preparation outline for simultaneous GC/MS and LC/MS analysis of agricultural chemicals in livestock and marine products (part 1)

[Outline]



GPC column : Shodex CLNpak EV-2000 AC + EV-G AC
 *1 Purification with ethylenediamine-N-propylsilyled silica gel mini-column
 *2 Purification with silica gel mini-column

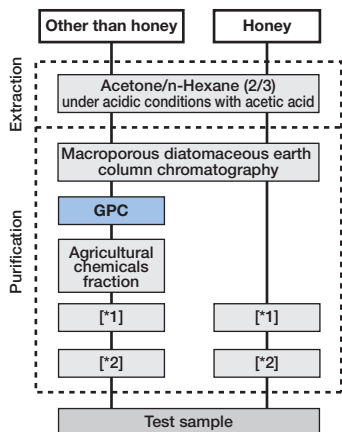
Fractionation of agricultural chemicals using EV-2000 AC



Column : Shodex CLNpak EV-G AC + EV-2000 AC
Eluent : Acetone/Cyclohexane = 1/4
Flow rate : 5.0 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 40 °C
Injection vol. : 5 mL

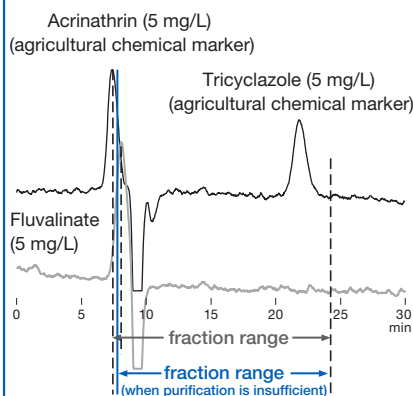
Sample preparation outline for simultaneous LC/MS analysis of agricultural chemicals in livestock and marine products (part 2)

[Outline]



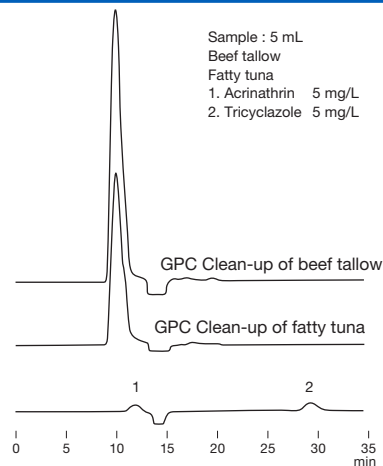
GPC column : Shodex CLNpak EV2000AC-12F + EV-G AC12C
 *1 Purification with trimethyl aminopropylsilyled silica gel mini-column
 *2 Purification with ethylenediamine-N-propylsilyled silica gel mini-column

Fractionation of agricultural chemicals using EV2000AC-12F



Column : Shodex CLNpak EV-G AC12C + EV2000AC-12F
Eluent : Acetone/Cyclohexane = 3/17
Flow rate : 3.0 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 45 °C
Injection vol. : 2 mL

GPC clean-up of fatty tuna and beef tallow



Column : Shodex CLNpak EV-G AC + EV-2000 AC
Eluent : Acetone/Cyclohexane = 1/4
Flow rate : 5.0 mL/min
Detector : UV (254 nm) (preparative type)
Column temp. : 40 °C
Injection vol. : 5 mL

Column Cleaning

Problems in peak shapes and elution timing changes or elevated column pressure etc. are often caused by insoluble or adsorbing components present in the eluent and reagents being deposited inside the column. These problems may be resolved by cleaning the column.

This section describes general signs of column deterioration and column cleaning procedures.

Please also read column-specific detailed cleaning procedures included in the product operation manual.

■ Typical signs of column deterioration

1. Elevated column pressure
2. Abnormal peak shapes (broadening, leading, tailing, and split peaks)
3. Change in retention time
4. Unstable baseline

■ Standard cleaning procedures

1. Insoluble components

Insoluble components that block the column inlet may be removed by reversing the flow direction, i.e., introducing the eluent from the column outlet, with flow rate at less than half of the recommended flow rate.

2. Adsorbing components

For an efficient cleaning, reverse the flow direction and reduce the flow rate at half of the recommended flow rate.

■ Cleaning solvent selection guide

Solvents capable of dissolving the adsorbed substances

Solvents with high eluting power (depends on separation mode)

***use only the solvents allowed in the operation manual**

Methods

| | |
|--|--|
| Reversed phase chromatography columns | Use a solvent with higher organic solvent concentration such as methanol, acetonitrile, or THF. (When using a mixture of buffer solution and organic solvent, make sure there is no precipitation of salt.) |
| Sugar analysis columns | [Ligand exchange columns (SUGAR series)] To regenerate the detached counter ions. - Flush or inject aqueous salt solvent which contains the modified counter ion. [Polymer-based amino columns (NH2P series and VG-50 series)] Adsorption of acidic substances on the amino functional group. - Flush with solvents in the following sequence; water, 0.1 M NaOH (aq.), water, and the eluent. |
| Aqueous SEC (GFC) chromatography columns | Adsorption of ionic substances. - Use a solvent with higher salt concentration or solvent with different pH from the eluent. Adsorption of hydrophobic substances. - Use a solvent containing organic solvent. (When using a mixture of buffer solution and organic solvent, make sure there is no precipitation of salt.) |
| Ion exchange chromatography columns | Adsorption of ionic substances. - Use a solvent with higher salt concentration or solvent with different pH from the eluent. Adsorption of hydrophobic substances. - Use a solvent containing organic solvent. (When using a mixture of buffer solution and organic solvent, make sure there is no precipitation of salt.) Adsorption of protein. - Inject 1 - 2 mL of 0.1 M NaOH (aq.) or 30 % acetic acid (aq.) several times. |

*Recommended solvent volume to introduce is 5 to 10 times the column volume.

*Pay attention to the column pressure elevation during column cleaning.

*Column cleaning is limited and does not guarantee full recovery of the column to its original condition.

General Precautions for Column Handling

For the best performance of the column, please follow the instructions given below.

HPLC System Preparation

- Wash entire LC system prior to the column installation, including all flow-lines and sample loop by switching the valve, and then replace the washing solution with the eluent to be used.
- If desired new eluent has low miscibility/solubility to the eluent of previous analysis, first use the eluent that is miscible/soluble to both eluents, and then replace it with the desired eluent.

*If the eluent left in the system is not compatible with the column to be used, it may damage the column.

*A drastic change in the eluent compositions may remove substances adsorbed on the system and they may enter and deteriorate the column.

Column Installation

- Connect the column to LC system by following the "flow direction arrow" (➔) indicated on the column name tag. If guard column is used, position the guard column in front (before the inlet) of the analytical column.
- Make sure to insert the tubing all the way to the end fitting and secure it with the male nut. It is important that there is no extra space between the tubing and the column side of the end fitting. Presence of an extra space will let the sample to spread out and may result in wide peaks.
- Set the initial flow rate at less than half of the recommended flow rate and start the system. If using the column at an elevated temperature, keep a low flow rate until the temperature of the column reaches to the set temperature, and then gradually increase the flow rate to the desired.
 - *Verify that there is no solvent leak. It may cause electronic leakage, rust, and/or chemical injury.
 - *Make sure not to let air bubbles enter the column while installing the column. The air bubbles may damage the column.
 - *When restarting the system after column installation or after holding the eluent flow, start the system at less than half of the recommended flow rate. A rapid increase in pressure can damage the column.
 - *If the column was used at an elevated temperature, lower the flow rate to less than half of the recommended flow rate at the end of analysis. Then, turn off the column oven, and let the column temperature return to room temperature before stopping the pump. If the pump was stopped while the eluent inside the column was still hot, as the eluent temperature decreases, its volume also decreases. This may result in creating an empty space in the column and deteriorates the column.

*It is recommended to set the pump limiter to avoid exceeding the maximum pressure.

Solvent Exchange

- When replacing the solvent, start the system at less than half of the recommended flow rate. Recommended solvent volume to introduce at each step is 3 to 5 times of the column volume.
- Check miscibility/solubility of the desired new solvent and the solvent currently filled in the column.
- When replacing the current solvent with a solvent with low miscibility/solubility to the current solvent, first use a solvent that is miscible/soluble to both eluents, and then replace it with the new solvent.
- When using a gradient method, changes in the eluent compositions may increase the column backpressure. Adjust the flow rate and column temperature so that the column backpressure remains below the usable maximum pressure.

Column Storage

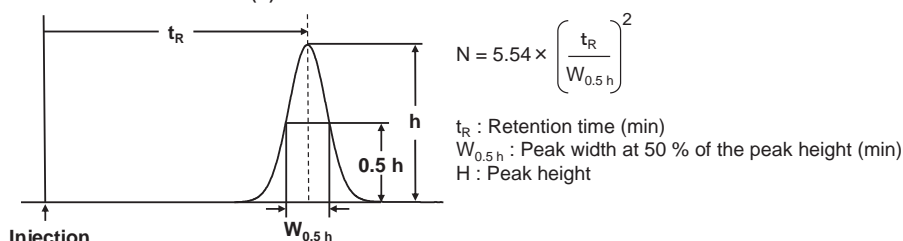
- Remove the column from the system after replacing the in-column solvent with the shipping solvent. Securely tighten the end caps and store the column at a location with stable temperature (a cool and dark space is recommended).
 - *Never allow inside of the column to dry. It can damage the column.

Column Inspection

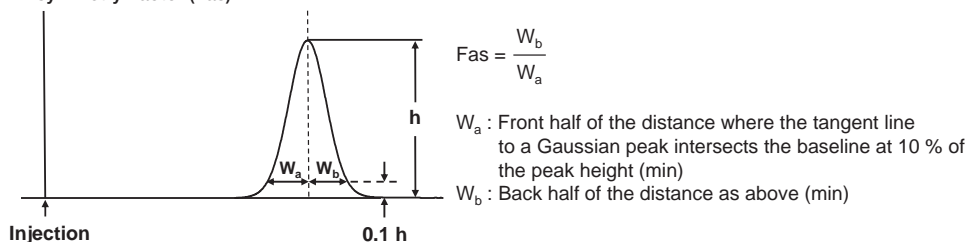
Inspection method is described in the Certificate of Analysis (CoA).

Theoretical Plate Number (N) and Asymmetry Factor (Fas) were calculated using the below equations.

Theoretical Plate Number (N)



Asymmetry Factor (Fas)



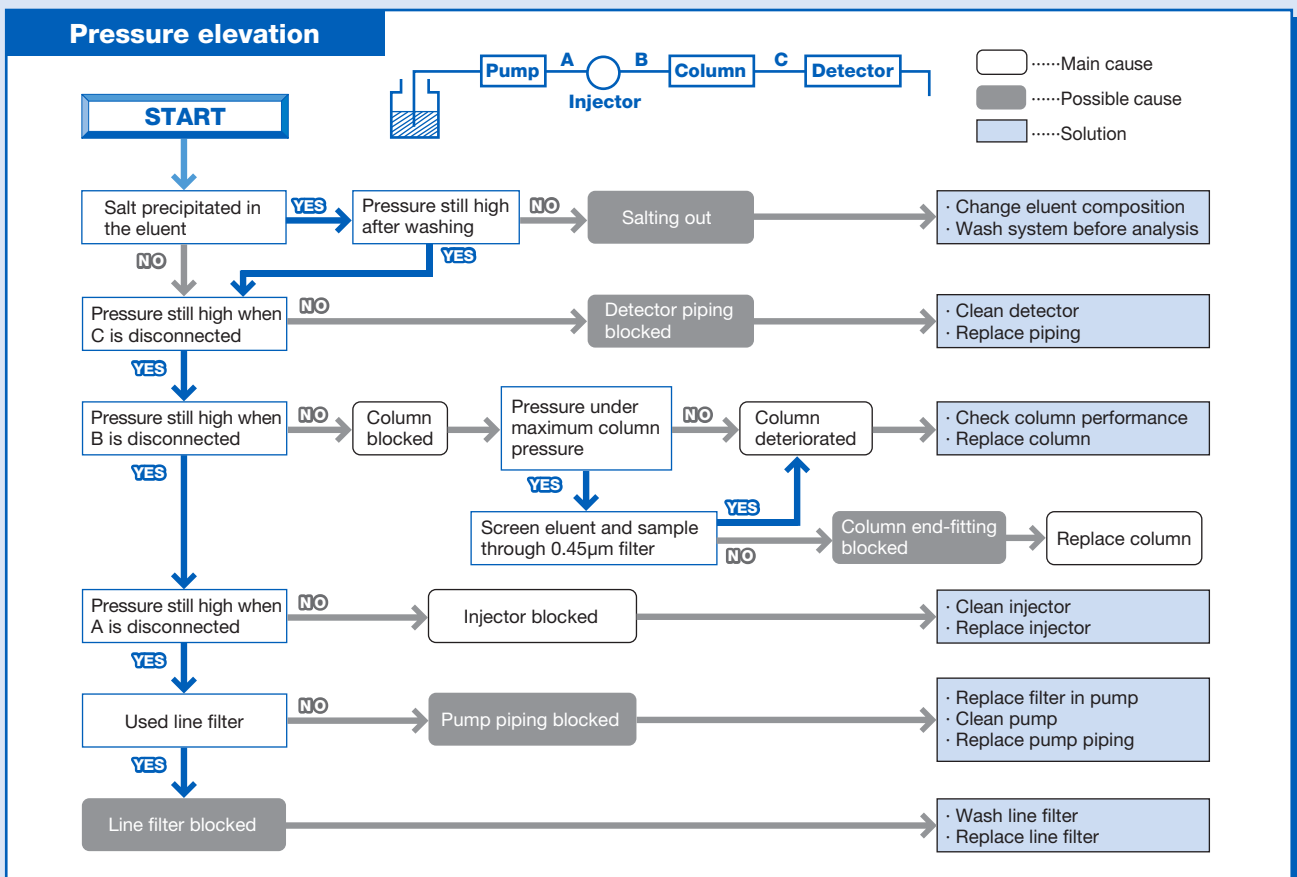
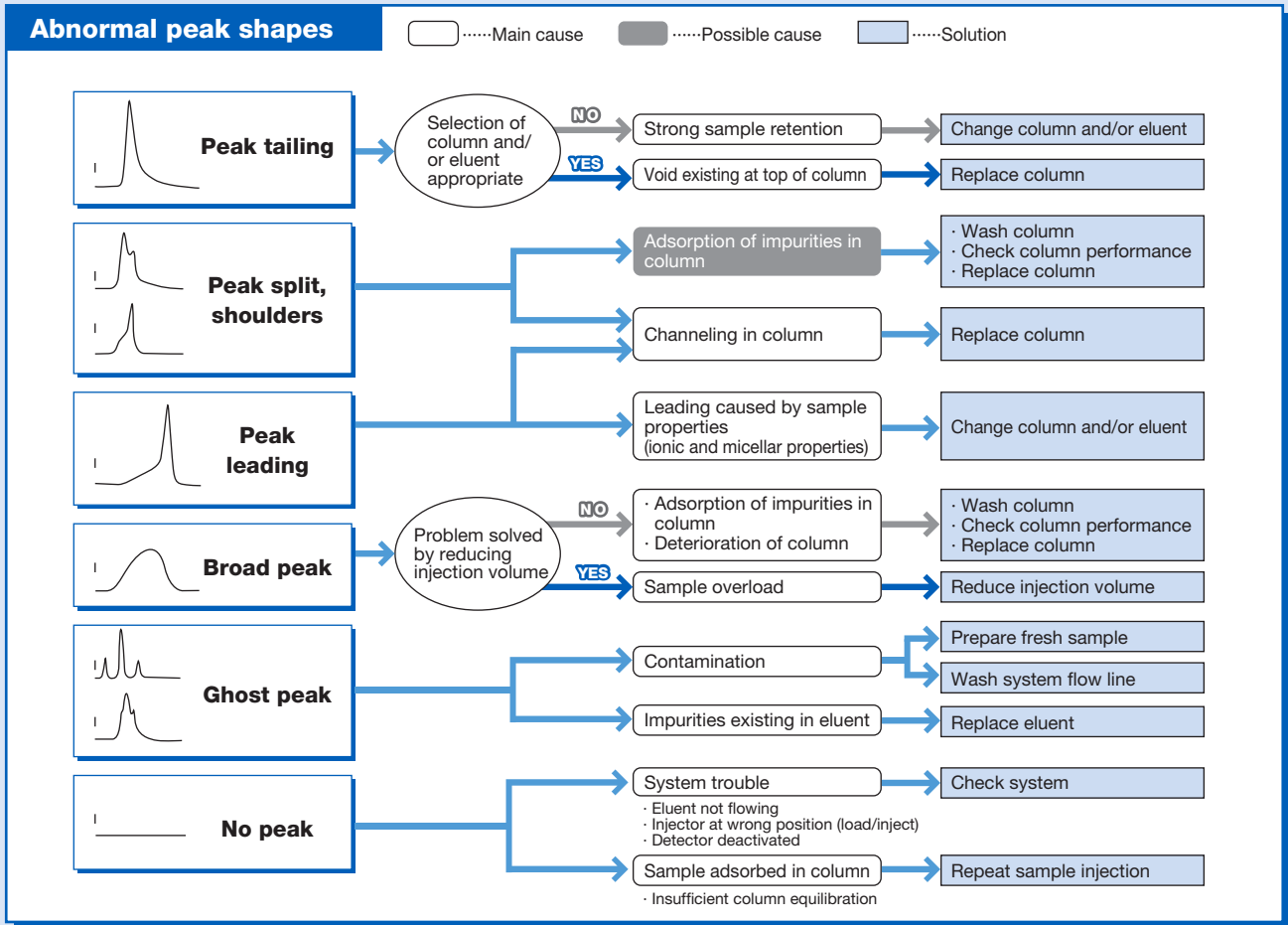
Additional Warnings

- Do not remove end fittings.
- Do not make a strong impact on the column. Do not drop or hit the column on a hard surface.

*Read the operation manual before using the column.

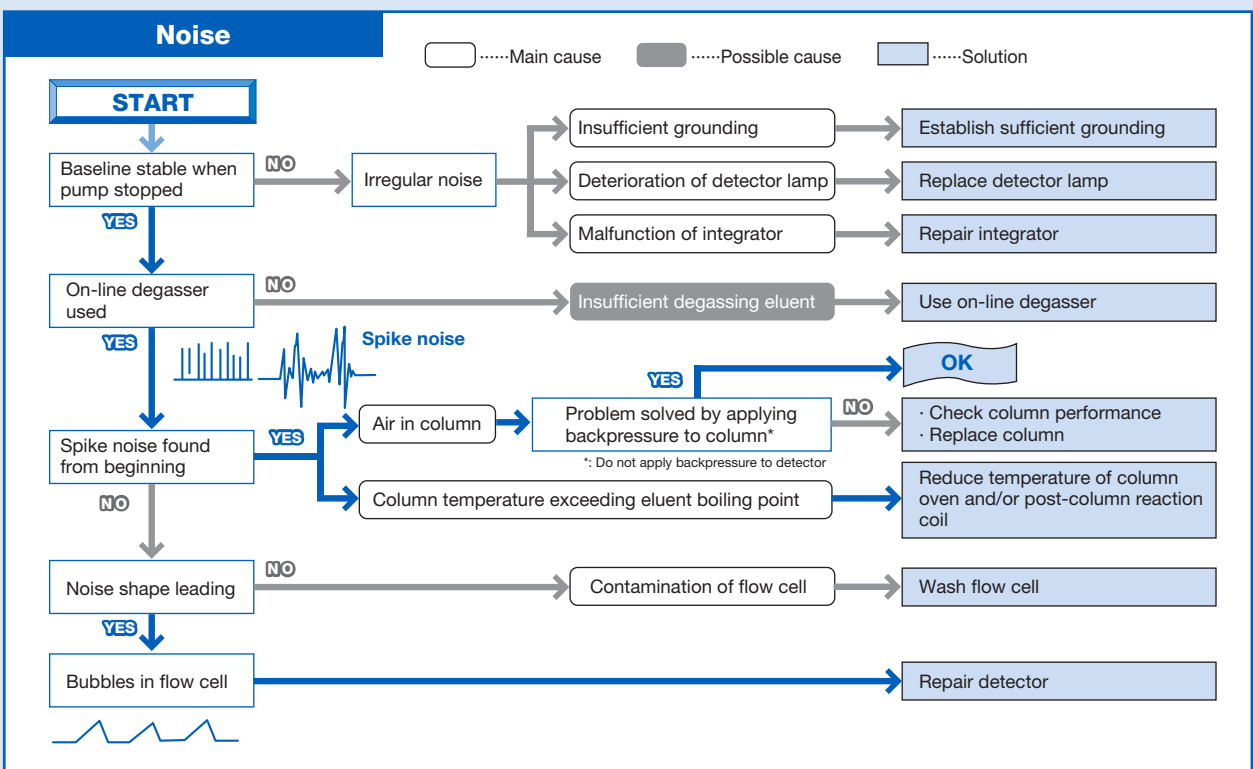
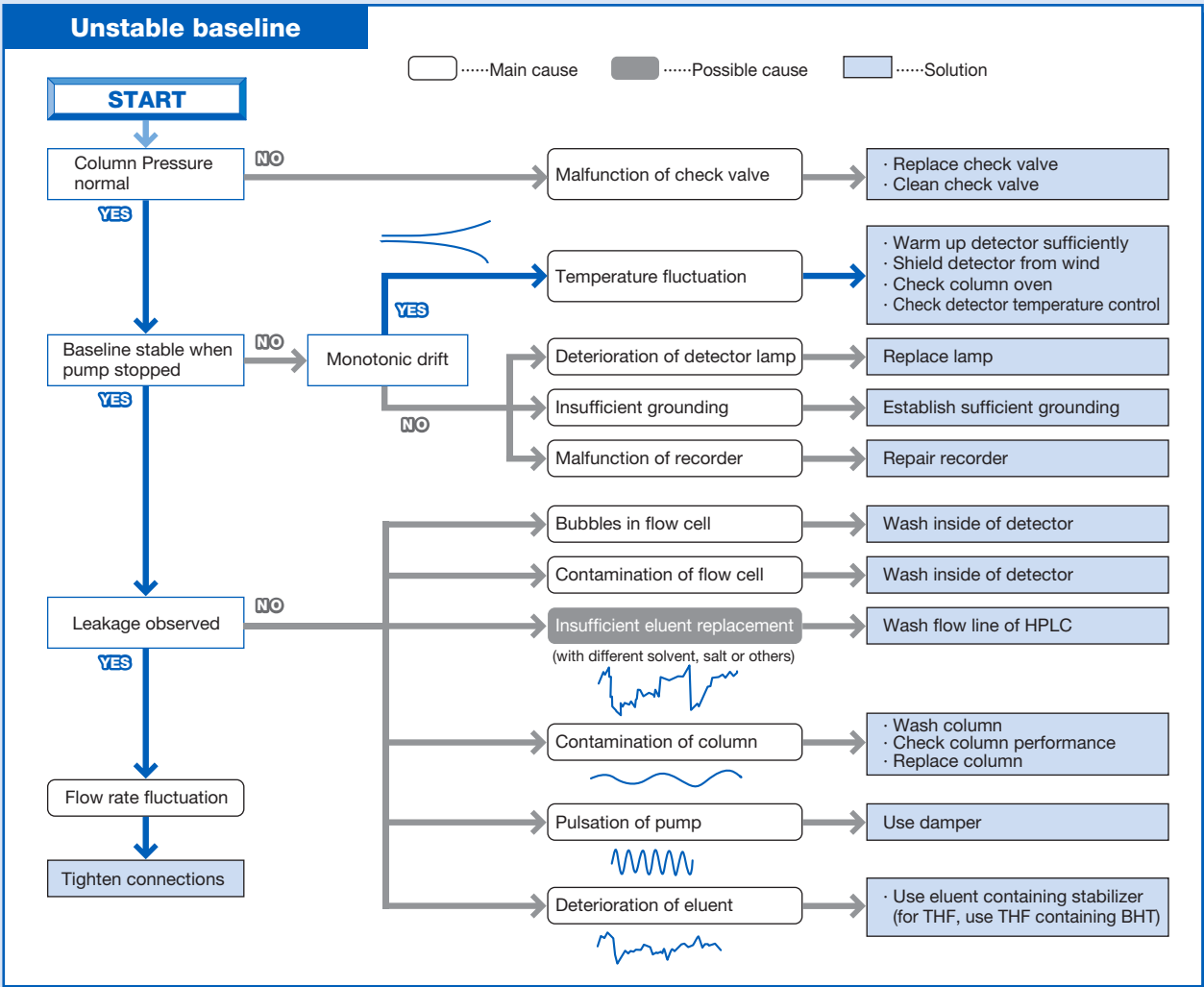
Column Trouble Shooting

Common causes for abnormal chromatograms



HPLC System Trouble Shooting

Common causes for abnormal chromatograms



USP44-NF39 Column List

| No. | Packing Material | Recommended Column | Page |
|--------------|---|---------------------------|--------------------|
| L1 | Octadecyl silane chemically bonded to porous or nonporous silica or ceramic microparticles, 1.5 to 10 µm in diameter, or a monolithic rod. | C18 | 24 |
| | | Silica C18M | 24 |
| | | C18U | 24 |
| L17 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the hydrogen form, 6 to 12 µm in diameter. | SUGAR SH1011 | 30 |
| | | SUGAR SH1821 | 30 |
| | | RSpak KC-811 | 30 |
| L19 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the calcium form, 5-15 µm in diameter. | SUGAR SC1011 | 26 |
| | | SUGAR SC1211 | 26 |
| | | EP SC1011-7F | 27 |
| | | USPpak MN-431 | 27 |
| L20 | Dihydroxypropane groups chemically bonded to porous silica or hybrid particles, 1.5-10 µm in diameter, or a monolithic silica rod. | PROTEIN KW-800 series | 36 |
| | | KW400 series | 36 |
| | | PROTEIN LW-803 | 37 |
| | | PROTEIN LW-403 4D | 37 |
| L21 | A rigid, spherical styrene-divinylbenzene copolymer, 3 to 30 µm in diameter. | RSpak DS-613 | 16 |
| | | RSpak DS-413 | 16 |
| | | GPC KF, KD, HK, LF series | 48, 50, 52, 54, 56 |
| L22 | A cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, 5-15 µm in diameter. | SUGAR SC1011 | 26 |
| | | SUGAR SP0810 | 26 |
| | | SUGAR KS-800 series | 26 |
| | | RSpak DC-613 | 26 |
| | | SUGAR SZ5532 | 26 |
| | | SUGAR SC1211 | 26 |
| | | EP SC1011-7F | 27 |
| | | USPpak MN-431 | 27 |
| | | SUGAR SH1011 | 30 |
| | | SUGAR SH1821 | 30 |
| | | RSpak KC-811 | 30 |
| CXpak P-421S | 62 | | |
| L23 | An anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, 7-12 µm in size. | IC I-524A | 32 |
| | | IEC QA-825 | 62 |
| L25 | Packing having the capacity to separate compounds with a molecular weight range from 100-5000 (as determined by polyethylene oxide), applied to neutral, anionic, and cationic water-soluble polymers. A polymethacrylate resin base, cross-linked with polyhydroxylated ether (surface contained some residual carboxyl functional groups) was found suitable. | OHpak SB-802 HQ | 40 |
| | | OHpak SB-802.5 HQ | 40 |
| | | OHpak LB-802.5 | 41 |
| L33 | Packing having the capacity to separate dextrans by molecular size over a range of 4,000 to 500,000 Da. It is spherical, silica-based, and processed to provide pH stability. | PROTEIN KW-800 series | 36 |
| | | KW400 series | 36 |
| | | PROTEIN LW-803 | 37 |
| | | PROTEIN LW-403 4D | 37 |
| L34 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the lead form, 7 to 9 µm in diameter. | SUGAR SP0810 | 26 |
| L37 | Packing having the capacity to separate proteins by molecular size over a range of 2,000 to 40,000 Da. It is a polymethacrylate gel. | OHpak SB-803 HQ | 40 |
| | | OHpak LB-803 | 41 |
| L38 | A methacrylate-based size-exclusion packing for water-soluble samples. | OHpak SB-800 HQ series | 40 |
| | | OHpak LB-800 series | 41 |
| L39 | A hydrophilic polyhydroxymethacrylate gel of totally porous spherical resin. | ODP2 HP | 12 |
| | | RSpak DM-614 | 16 |
| | | OHpak SB-800 HQ series | 40 |
| | | OHpak LB-800 series | 41 |
| L45 | Beta cyclodextrin, <i>R,S</i> -hydroxypropyl ether derivative, bonded to porous silica particles, 3-10 µm in diameter. | ORpak CDBS-453 | 64 |
| L58 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the sodium form, about 6 to 30 µm in diameter. | SUGAR KS-800 series | 26 |
| | | RSpak DC-613 | 26 |
| | | CXpak P-421S | 62 |
| L59 | Packing for the size-exclusion separations of proteins (separation by molecular weight) over the range of 5 to 7000 kDa. The packing is a spherical 1.5- to 10-µm, silica or hybrid packing with a hydrophilic coating. | PROTEIN KW-800 series | 36 |
| | | KW400 series | 36 |
| | | PROTEIN LW-803 | 37 |
| | | PROTEIN LW-403 4D | 37 |
| L67 | Porous vinyl alcohol copolymer with a C18 alkyl group attached to the hydroxyl group of the polymer, 2 to 10 µm in diameter. | Asahipak ODP-50 | 14 |
| L71 | A rigid, spherical polymethacrylate, 4 to 6 µm in diameter. | RSpak DE-613 | 16 |
| | | RSpak DE-413 | 16 |
| | | RSpak DE-213 | 16 |
| L76 | Silica based, weak cation-exchange material, 5 µm in diameter. Substrate is surface polymerized polybutadiene-maleic acid to provide carboxylic acid functionalities. Capacity not less than 29 µEq/column. | IC YK-421 | 33 |
| L82 | Polyamine chemically bonded to cross-linked polyvinyl alcohol polymer, 5 µm in diameter. | Asahipak NH2P-50 | 22 |
| L89 | Packing having the capacity to separate compounds with a molecular weight range from 100 to 3000 (as determined by polyethylene oxide), applied to neutral and anionic water-soluble polymers. A polymethacrylate resin base, cross-linked with polyhydroxylated ether (surface contains some residual cationic functional groups). | OHpak SB-802.5 HQ | 40 |
| | | OHpak LB-802.5 | 41 |

Index by Product Name

Columns are listed in alphabetical order without their series names.

[Series name]

| Asahipak | CLNpak | CXpak | EP | GPC | HILICpak | IC | IEC | MSPak |
|----------|--------|---------|-------|--------|----------|-----|-------|--------|
| OHpak | ORpak | PROTEIN | RSpak | Silica | STANDARD | STD | SUGAR | USPpak |

C

| | |
|------------------|----|
| C18 | 24 |
| C18M 4D, C18M 4E | 24 |
| C18U 2B, C18U 2D | 24 |
| C4P-50 4D | 14 |
| CDBS-453 | 64 |
| CM-825 | 62 |

D

| | |
|------------------------|----|
| DC-613 | 26 |
| DE-213, DE-413, DE-613 | 16 |
| DEAE-825 | 62 |
| DM-614 | 16 |
| DS-413, DS-613 | 16 |

E

| | |
|------------|----|
| ES-502C 7C | 62 |
| ES-502N 7C | 62 |
| EV-200 | 64 |
| EV-2000 | 64 |

F

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