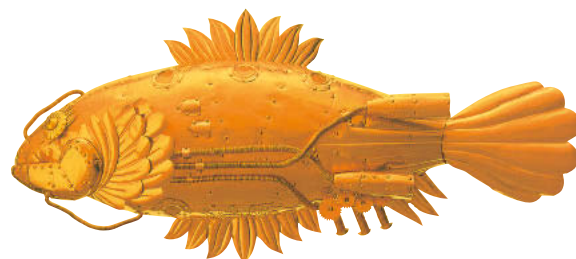


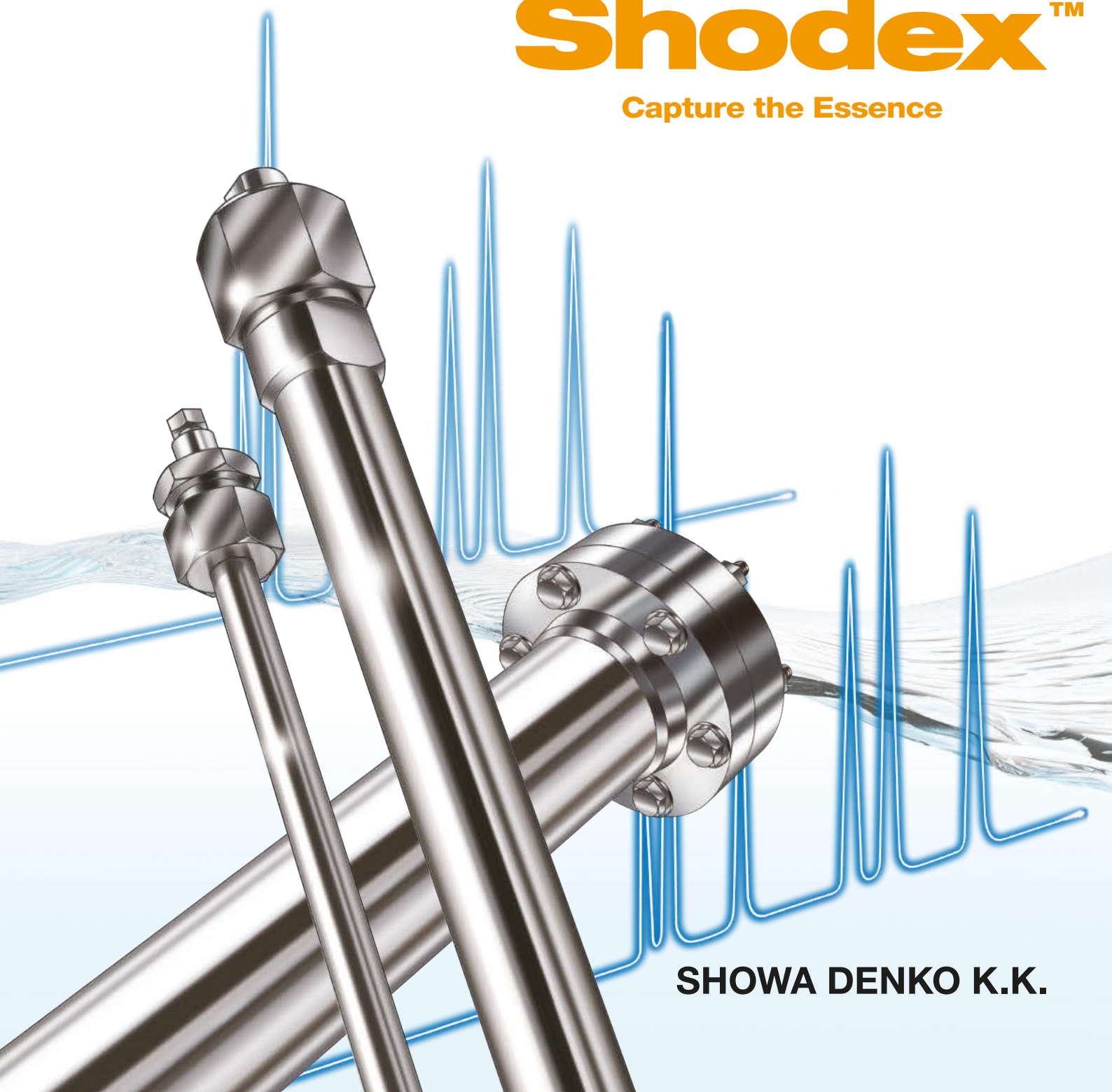
**HPLC Columns**

**2016–2017**



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**SHOWA DENKO K.K.**



# Shodex™



## HPLC Columns

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# Contents

|                                                                                |                                                                                     |    |
|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----|
| <b>Column selection</b>                                                        | Types of Columns, Base Materials, Functional Groups and Ligands                     | 2  |
|                                                                                | HPLC Separation Modes                                                               | 3  |
|                                                                                | Column Selection by Sample Character and Separation Mode                            | 3  |
|                                                                                | Column Selection (Application)                                                      | 4  |
| <b>Analysis and preparative columns</b>                                        | Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns  | 6  |
|                                                                                | Columns for Polymer-based Reversed Phase Chromatography (ODP2 HP)                   | 8  |
|                                                                                | Columns for Polymer-based Reversed Phase Chromatography (Asahipak)                  | 10 |
|                                                                                | Columns for Polymer-based Reversed Phase Chromatography (RSpak)                     | 12 |
| <b>Reversed Phase, Hydrophilic Interaction and Normal Phase Chromatography</b> | Columns for Silica-based Reversed Phase Chromatography (ODS Columns)                | 16 |
|                                                                                | Columns for Silica-based Reversed Phase Chromatography (Other Columns)              | 17 |
|                                                                                | Columns for Silica-based HILIC and Normal Phase Chromatography                      | 17 |
|                                                                                | Columns for Polymer-based Hydrophilic Interaction Chromatography (HILIC) (HILICpak) | 20 |
|                                                                                | Columns for Polymer-based Hydrophilic Interaction Chromatography (HILIC) (Asahipak) | 22 |
| <b>Ligand Exchange Chromatography</b>                                          | Columns for Ligand Exchange Chromatography                                          | 24 |
| <b>Ion Exclusion Chromatography</b>                                            | Columns for Ion Exclusion Chromatography                                            | 28 |
| <b>Ion Chromatography</b>                                                      | Columns for Ion Chromatography (Anion Analysis)                                     | 30 |
|                                                                                | Columns for Ion Chromatography (Cation Analysis)                                    | 32 |
|                                                                                | Column Selection for Size Exclusion Chromatography (SEC)                            | 34 |
|                                                                                | Precautions for Polar Polymer Analysis                                              | 35 |
|                                                                                | Aqueous SEC (GFC) Columns : Silica-based                                            | 36 |
|                                                                                | Aqueous SEC (GFC) Columns : Polymer-based                                           | 38 |
|                                                                                | Multimode Columns                                                                   | 42 |
|                                                                                | Aqueous/Organic SEC Columns                                                         | 44 |
|                                                                                | Organic SEC (GPC) Columns (General Analysis) : THF                                  | 46 |
|                                                                                | Organic SEC (GPC) Columns (General Analysis) : Chloroform                           | 48 |
| <b>Size Exclusion Chromatography</b>                                           | Organic SEC (GPC) Columns (General Analysis) : DMF                                  | 50 |
|                                                                                | Solvent-peak Separation Columns for Organic SEC (GPC)                               | 50 |
|                                                                                | Organic SEC (GPC) Columns : Rapid Analysis                                          | 52 |
|                                                                                | Organic SEC (GPC) Columns : High Performance Analysis                               | 52 |
|                                                                                | Organic SEC (GPC) Columns : For Preparative                                         | 54 |
|                                                                                | Organic SEC (GPC) Columns : Linear Calibration Type                                 | 56 |
|                                                                                | Organic SEC (GPC) Columns : High Temperature/Ultra High Temperature Analysis        | 58 |
|                                                                                | Organic SEC (GPC) Columns : HFIP                                                    | 60 |
|                                                                                | Applicability of SEC (GPC) Columns to Solvent Replacement                           | 62 |
| <b>Calibration Standards for SEC</b>                                           | Calibration Standards for SEC                                                       | 63 |
| <b>Ion Exchange Chromatography</b>                                             | Columns for Anion Exchange Chromatography                                           | 64 |
|                                                                                | Columns for Cation Exchange Chromatography                                          | 66 |
| <b>Columns for Special Separation Modes</b>                                    | Column for Hydrophobic Interaction Chromatography                                   | 68 |
|                                                                                | Columns for Affinity Chromatography                                                 | 68 |
|                                                                                | Columns for Chiral Separation                                                       | 68 |
|                                                                                | Column for High Temperature Reversed Phase Chromatography                           | 68 |
| <b>Sample pretreatment columns</b>                                             | Columns for GPC Clean-up                                                            | 70 |
|                                                                                | Pretreatment Columns for Column Switching Method                                    | 72 |
| <b>Notice of change of product name</b>                                        | Notice of Product Name Changes                                                      | 74 |
| <b>Information</b>                                                             | USP (Ver.38) Column List                                                            | 75 |
|                                                                                | Column Cleaning Procedures                                                          | 76 |
|                                                                                | General Precautions for Column Handling                                             | 77 |
|                                                                                | Column Trouble Shooting                                                             | 78 |
|                                                                                | HPLC System Trouble Shooting                                                        | 79 |
| <b>Index</b>                                                                   | Index by Product Name                                                               | 80 |
|                                                                                | Index by Product Code                                                               | 81 |

# 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                             | —                         | 8                          |
|                                                      | Asahipak | ODP-50, ODP-40                                                                           | Polyvinyl alcohol                                   | Octadecyl                 | 10                         |
|                                                      | Asahipak | C8P-50                                                                                   | Polyvinyl alcohol                                   | Octyl                     | 10                         |
|                                                      | Asahipak | C4P-50                                                                                   | Polyvinyl alcohol                                   | Butyl                     | 10                         |
|                                                      | RSpak    | RP18-415, DS                                                                             | Styrene divinylbenzene copolymer                    | —                         | 12                         |
|                                                      | RSpak    | DE                                                                                       | Polymethacrylate                                    | —                         | 12                         |
|                                                      | RSpak    | DM-614                                                                                   | Polyhydroxymethacrylate                             | —                         | 12                         |
|                                                      | RSpak    | NN                                                                                       | Polyhydroxymethacrylate                             | Sulfo                     | 12                         |
|                                                      | RSpak    | JJ-50                                                                                    | Polyvinyl alcohol                                   | Quaternary ammonium       | 12                         |
|                                                      | HILICpak | VG-50                                                                                    | Polyvinyl alcohol                                   | Amino                     | 20                         |
|                                                      | HILICpak | VT-50                                                                                    | Polyvinyl alcohol                                   | Quaternary ammonium       | 20                         |
|                                                      | Asahipak | NH2P                                                                                     | Polyvinyl alcohol                                   | Amino                     | 22                         |
| Reversed Phase & HILIC & Normal Phase (Silica-based) |          | ET-RP1                                                                                   | Polyvinyl alcohol                                   | Octadecyl                 | 68                         |
|                                                      | Silica   | C18M, C18P                                                                               | Silica                                              | Octadecyl                 | 16                         |
|                                                      | Silica   | 5C8                                                                                      | Silica                                              | Octyl                     | 17                         |
|                                                      | Silica   | 5C4                                                                                      | Silica                                              | Butyl                     | 17                         |
|                                                      | Silica   | 5CN                                                                                      | Silica                                              | Cyanopropyl               | 17                         |
|                                                      | Silica   | 5NPE                                                                                     | Silica                                              | Nitrophenylethyl          | 17                         |
|                                                      | Silica   | 5PYE                                                                                     | Silica                                              | Pyrenylethyl              | 17                         |
|                                                      | Silica   | 5SIL                                                                                     | Silica                                              | —                         | 17                         |
| Ligand Exchange                                      | Silica   | 5NH                                                                                      | Silica                                              | Aminopropyl               | 17                         |
|                                                      | SUGAR    | SC                                                                                       | Styrene divinylbenzene copolymer                    | Sulfo(Ca <sup>2+</sup> )  | 24                         |
|                                                      | SUGAR    | SP0810                                                                                   | Styrene divinylbenzene copolymer                    | Sulfo(Pb <sup>2+</sup> )  | 24                         |
|                                                      | SUGAR    | KS-800                                                                                   | Styrene divinylbenzene copolymer                    | Sulfo(Na <sup>+</sup> )   | 24                         |
|                                                      | RSpak    | DC-613                                                                                   | Styrene divinylbenzene copolymer                    | Sulfo(Na <sup>+</sup> )   | 24                         |
|                                                      | SUGAR    | SZ5532                                                                                   | Styrene divinylbenzene copolymer                    | Sulfo(Zn <sup>2+</sup> )  | 24                         |
|                                                      | EP       | SC1011-7F                                                                                | Styrene divinylbenzene copolymer                    | Sulfo(Ca <sup>2+</sup> )  | 25                         |
| Ion Exclusion                                        | USPpak   | MN-431                                                                                   | Styrene divinylbenzene copolymer                    | Sulfo(Ca <sup>2+</sup> )  | 25                         |
|                                                      | SUGAR    | SH                                                                                       | Styrene divinylbenzene copolymer                    | Sulfo                     | 28                         |
|                                                      | RSpak    | KC-811                                                                                   | Styrene divinylbenzene copolymer                    | Sulfo                     | 28                         |
| Ion Chromatography                                   | IC       | NI-424, I-524A                                                                           | Polyhydroxymethacrylate                             | Quaternary ammonium       | 30                         |
|                                                      | IC       | SI                                                                                       | Polyvinyl alcohol                                   | Quaternary ammonium       | 30                         |
|                                                      | IC       | YS-50                                                                                    | Polyvinyl alcohol                                   | Carboxyl                  | 32                         |
|                                                      | IC       | YK-421                                                                                   | Silica                                              | Carboxyl                  | 32                         |
|                                                      | IC       | Y-521, T-521                                                                             | Styrene divinylbenzene copolymer                    | Sulfo                     | 32                         |
| Aqueous SEC (GFC)                                    | PROTEIN  | KW-800                                                                                   | Silica                                              | Hydrophilic polymer       | 36                         |
|                                                      |          | KW400                                                                                    | Silica                                              | Hydrophilic polymer       | 36                         |
|                                                      | OHpak    | SB-800 HQ                                                                                | Polyhydroxymethacrylate                             | —                         | 38                         |
|                                                      | OHpak    | LB-800                                                                                   | Polyhydroxymethacrylate                             | —                         | 38                         |
| Multimode                                            | Asahipak | GS-HQ                                                                                    | Polyvinyl alcohol                                   | —                         | 42                         |
| Aqueous/Organic SEC                                  | Asahipak | GF-HQ                                                                                    | Polyvinyl alcohol                                   | —                         | 44                         |
|                                                      | MSPak    | GF-310                                                                                   | Polyvinyl alcohol                                   | —                         | 44                         |
| Organic SEC (GPC)                                    |          | KF-800, K-800, KD-800, KF-600, KF-400HQ, LF, HT-800, UT-800, AT-806MS HFIP-800, HFIP-600 | Styrene divinylbenzene copolymer                    | —                         | 46, 48, 50, 52, 56, 58, 60 |
| Ion Exchange                                         | IEC      | QA-825                                                                                   | Polyhydroxymethacrylate                             | Quaternary ammonium       | 64                         |
|                                                      | IEC      | DEAE-825                                                                                 | Polyhydroxymethacrylate                             | Diethylaminoethyl         | 64                         |
|                                                      | IEC      | DEAE3N                                                                                   | Polyhydroxymethacrylate                             | Diethylaminoethyl         | 64                         |
|                                                      | PIKESS   | DEAE-2B                                                                                  | Polyhydroxymethacrylate                             | Diethylaminoethyl         | 64                         |
|                                                      | Asahipak | ES-502N                                                                                  | Polyvinyl alcohol                                   | Diethylaminoethyl         | 64                         |
|                                                      | AXpak    | WA-624                                                                                   | Polyhydroxymethacrylate                             | Diethylaminoethyl         | 64                         |
|                                                      | IEC      | SP-825                                                                                   | Polyhydroxymethacrylate                             | Sulfopropyl               | 66                         |
|                                                      | IEC      | SP-420N                                                                                  | Polyhydroxymethacrylate                             | Sulfopropyl               | 66                         |
|                                                      | PIKESS   | SP-2B                                                                                    | Polyhydroxymethacrylate                             | Sulfopropyl               | 66                         |
|                                                      | IEC      | CM-825                                                                                   | Polyhydroxymethacrylate                             | Carboxymethyl             | 66                         |
|                                                      | Asahipak | ES-502C                                                                                  | Polyvinyl alcohol                                   | Carboxymethyl             | 66                         |
|                                                      | CXpak    | P-421S                                                                                   | Styrene divinylbenzene copolymer                    | Sulfo(Na <sup>+</sup> )   | 66                         |
| Hydrophobic Interaction                              | HIC      | PH-814                                                                                   | Polyhydroxymethacrylate                             | Phenyl                    | 68                         |
| Affinity                                             | AFpak    | Various                                                                                  | Polyhydroxymethacrylate                             | Various ligand            | 68                         |
| Chiral Separation                                    | ORpak    | CDBS-453                                                                                 | Silica                                              | β-Cyclodextrin derivative | 68                         |
|                                                      | ORpak    | CRX-853                                                                                  | Polyhydroxymethacrylate                             | L-Amino acid derivative   | 68                         |
| GPC Clean-up                                         | CLNpak   | EV                                                                                       | Styrene divinylbenzene copolymer                    | —                         | 70                         |
|                                                      | CLNpak   | PAE                                                                                      | Polyvinyl alcohol                                   | —                         | 70                         |
| Column Switching Pretreatment                        | MSPak    | PK                                                                                       | Hydrophilic copolymers containing N-vinyl acetamide | —                         | 72                         |
|                                                      | MSPak    | GF-4A                                                                                    | Polyvinyl alcohol                                   | —                         | 72                         |

# 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Reversed Phase Chromatography (RPC)</b>            | <ul style="list-style-type: none"> <li>Separation is based on the partition equilibrium between stationary phase and mobile phase.</li> <li>The polarity of the stationary phase is lower than that of the mobile phase.</li> <li>Typically the mobile phase contains a mixture of organic solvents (methanol, acetonitrile, or THF) and aqueous solvents (water or buffer).</li> <li>Using the lower polarity mobile phase causes a faster elution.</li> </ul>                                                                      |
| <b>Hydrophilic Interaction Chromatography (HILIC)</b> | <ul style="list-style-type: none"> <li>Separation is based on hydrophilic interaction.</li> <li>A high polarity stationary phase is used.</li> <li>Typically the mobile phase contains a mixture of organic solvents such as acetonitrile and aqueous solvents (water or buffer).</li> <li>Using the higher polarity mobile phase causes a faster elution.</li> <li>Applicable for the analysis of high polar substances.</li> </ul>                                                                                                 |
| <b>Normal Phase Chromatography (NPC)</b>              | <ul style="list-style-type: none"> <li>Separation is based on the partition equilibrium between the stationary phase and the mobile phase.</li> <li>The polarity of the stationary phase is higher than that of the mobile phase.</li> <li>Typically the mobile phase contains a mixture of organic solvents with different polarities such as hexane and isopropanol.</li> <li>Using the higher polarity mobile phase causes a faster elution.</li> </ul>                                                                           |
| <b>Ligand Exchange Chromatography (LEX)</b>           | <ul style="list-style-type: none"> <li>Separation is based on differences in analytes' coordination complex.</li> <li>Stationary phase modified with metal sulfonate complex ion.</li> <li>Works in combination with size exclusion or HILIC modes.</li> </ul>                                                                                                                                                                                                                                                                       |
| <b>Ion Exclusion Chromatography (IEX)</b>             | <ul style="list-style-type: none"> <li>Separation is based on electrostatic interaction (repulsion) between the ion exchanger and ionic solutes.</li> <li>Dissociated ionic molecules elute faster than non-dissociated forms.</li> <li>Used mainly for the analysis of organic acids.</li> </ul>                                                                                                                                                                                                                                    |
| <b>Ion Chromatography (IC)</b>                        | <ul style="list-style-type: none"> <li>Separation is based on electrostatic interaction (bonding) between the ion exchanger and ionic solutes.</li> <li>Has a relatively small ion exchange capacity.</li> <li>Electrical conductivity detector can be used with low-salt concentration mobile phase.</li> <li>Used mainly for the analysis of inorganic compounds.</li> </ul>                                                                                                                                                       |
| <b>Size Exclusion Chromatography (SEC)</b>            | <ul style="list-style-type: none"> <li>Network or pores on the surface of the packing material works as molecular sieve to separate molecules based on their sizes.</li> <li>To separate molecules solely based on their sizes, it requires an analytical condition without any analyte and packing gel interaction.</li> <li>The bigger the molecule size, the faster the elution sequence.</li> <li>Used for molecular weight or molecular distribution determination of macromolecules and qualification of oligomers.</li> </ul> |
| <b>Ion Exchange Chromatography (IEC)</b>              | <ul style="list-style-type: none"> <li>Separation is based on electrostatic interactions between the ion exchanger and ionic solutes.</li> <li>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.</li> <li>The elution position is optimized by varying the pH, salt concentration, and/or ionic strength of the mobile phase.</li> </ul>                                                                                |
| <b>Hydrophobic Interaction Chromatography (HIC)</b>   | <ul style="list-style-type: none"> <li>Separation is based on hydrophobic interaction.</li> <li>Hydrophobic functional group is modified on the stationary phase.</li> <li>Adsorption of analytes generally occurs at a high salt concentration and they are released by lowering the salt concentration.</li> <li>Used mainly for the analysis of proteins.</li> </ul>                                                                                                                                                              |
| <b>Affinity Chromatography (AFC)</b>                  | <ul style="list-style-type: none"> <li>Separation is based on adsorption of the analyte to the specific biologically derived ligand pair.</li> <li>Highly selective.</li> <li>A buffer solution with the appropriate pH and ionic strength is selected based on the type of ligand, analytes, and their interaction.</li> <li>Used mainly for the purification and concentration of biological active substances.</li> </ul>                                                                                                         |
| <b>Chiral Separation Chromatography (CS)</b>          | <ul style="list-style-type: none"> <li>Separation of optical isomers using chiral selectors.</li> <li>Highly selective.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Multimode Chromatography</b>                       | <ul style="list-style-type: none"> <li>Separation is based on the combination of different modes.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                         |

## Column Selection by Sample Character and Separation Mode

| Sample Solubility | Sample MW | Separation Mode | Sample Solubility | Sample MW | Separation Mode |
|-------------------|-----------|-----------------|-------------------|-----------|-----------------|
| Aqueous soluble   | ≥ 2,000   | RPC             | Organic soluble   | ≥ 2,000   | SEC             |
|                   |           | LEX             |                   |           |                 |
|                   |           | IEX             |                   |           |                 |
|                   |           | SEC             |                   |           |                 |
|                   |           | IEC             |                   |           |                 |
|                   |           | HIC             |                   |           |                 |
|                   | ≤ 2,000   | AFC             |                   | ≤ 2,000   | RPC             |
|                   |           | RPC             |                   |           |                 |
|                   |           | HILIC           |                   |           |                 |
|                   |           | LEX             |                   |           |                 |
|                   |           | IEX             |                   |           | NPC             |
|                   |           | IC              |                   |           |                 |
|                   |           | SEC             |                   |           |                 |
|                   |           | IEC             |                   |           |                 |
|                   |           | AFC             |                   |           | SEC             |
|                   |           | CS              |                   |           |                 |

RPC : Reversed Phase Chromatography  
HILIC : Hydrophilic Interaction Chromatography  
NPC : Normal Phase Chromatography  
LEX : Ligand Exchange Chromatography  
IEX : Ion Exclusion Chromatography  
IC : Ion Chromatography  
SEC : Size Exclusion Chromatography  
IEC : Ion Exchange Chromatography  
HIC : Hydrophobic Interaction Chromatography  
AFC : Affinity Chromatography  
CS : Chiral Separation Chromatography

# Column Selection (Application)

## Pharmaceuticals, Cosmetics

|                                             |                                              | Separation Mode | Page              |
|---------------------------------------------|----------------------------------------------|-----------------|-------------------|
| Pharmaceuticals<br>Metabolites<br>Additives | Hydrophobic substances                       | RPC             | 8, 10, 12, 16, 17 |
|                                             | Hydrophilic substances                       | HILIC           | 20, 22            |
|                                             |                                              | IEC+RPC         | 12                |
|                                             |                                              | LEX+SEC         | 24, 25            |
|                                             | Substances in bio-fluid (serum-plasma-urine) | RPC             | 8                 |
|                                             |                                              | SEC+RPC         | 42, 44, 72        |
|                                             | Polymer                                      | SEC             | 38, 44, 50, 56    |
| Moisturizers                                | Polyalcohols                                 | RPC             | 12                |
|                                             |                                              | LEX+SEC         | 24                |
|                                             |                                              | LEX+HILIC       | 24                |
|                                             |                                              | SEC             | 38, 44            |
|                                             | Protein hydrolysates                         | RPC             | 10, 12            |
|                                             |                                              | SEC             | 36                |
|                                             | Mucopolysaccharides                          | SEC             | 38                |
| Emulsifiers                                 | Surfactants                                  | SEC+RPC         | 44                |
|                                             |                                              | SEC             | 46, 52            |
| Preservatives                               | Paraben<br>Dehydroacetic acid                | RPC             | 10, 12, 16, 17    |
| Optical active materials                    |                                              | CS              | 68                |

## Foods

|                         |                                                    | Separation Mode          | Page               |
|-------------------------|----------------------------------------------------|--------------------------|--------------------|
| Nutritional ingredients | Monosaccharides<br>Disaccharides<br>Sugar alcohols | HILIC                    | 20, 22             |
|                         |                                                    | LEX+SEC                  | 24                 |
|                         |                                                    | LEX+HILIC                | 24                 |
|                         | Oligosaccharides                                   | HILIC                    | 20, 22             |
|                         |                                                    | LEX+HILIC                | 24                 |
|                         |                                                    | SEC                      | 24, 38, 42         |
|                         | Low molecular water-soluble dietary fiber          | SEC                      | 42                 |
|                         | Polysaccharides                                    | SEC                      | 24, 38             |
|                         | Organic acids                                      | RPC                      | 8, 12              |
|                         |                                                    | IEC+RPC                  | 28                 |
|                         |                                                    | IC                       | 30                 |
|                         | Water-soluble vitamins                             | RPC                      | 8, 10, 12          |
|                         |                                                    | IEC+RPC                  | 12                 |
|                         |                                                    | HILIC                    | 20, 22             |
|                         | Fat-soluble vitamins                               | RPC                      | 10                 |
|                         |                                                    | NPC                      | 17                 |
|                         |                                                    | SEC                      | 46, 52             |
|                         | Fatty acids                                        | RPC                      | 12, 16, 17         |
|                         |                                                    | SEC                      | 44, 46, 48, 52     |
|                         | Nucleic acids (umami)                              | IEC+SEC                  | 42                 |
| Food safety             | Food additives                                     | RPC                      | 10, 12, 68         |
|                         |                                                    | HILIC                    | 20, 22             |
|                         | Pesticides                                         | RPC                      | 12                 |
|                         |                                                    | IEC+RPC                  | 12                 |
|                         |                                                    | HILIC                    | 20                 |
|                         |                                                    | IC                       | 30                 |
|                         | Mycotoxin                                          | RPC                      | 16                 |
|                         | Pretreatment of residual pesticides                | SEC<br>GPC<br>(Clean-up) | 70                 |
|                         | Synthetic polymers                                 | SEC                      | 44, 46, 48, 52, 56 |
|                         |                                                    |                          | 38, 44, 50, 52, 56 |
|                         |                                                    |                          | 58                 |
|                         |                                                    |                          | 36, 38, 42, 44     |
| Additives<br>Oligomers  |                                                    | RPC                      | 10, 12, 16, 17     |
|                         | Organic solvent soluble                            | SEC                      | 44, 46, 48, 52     |
|                         | Polar organic solvent soluble                      |                          | 38, 44, 50, 52     |
|                         | Water-soluble                                      |                          | 36, 38, 42, 44     |

### Separation Mode (Page 4 and Page 5)

RPC : Reversed Phase Chromatography  
 HILIC : Hydrophilic Interaction Chromatography  
 NPC : Normal Phase Chromatography  
 LEX : Ligand Exchange Chromatography  
 IEX : Ion Exclusion Chromatography  
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 SEC : Size Exclusion Chromatography  
 IEC : Ion Exchange Chromatography  
 HIC : Hydrophobic Interaction Chromatography  
 AFC : Affinity Chromatography  
 CS : Chiral Separation Chromatography

## New Materials

|                        |                                          | Separation Mode | Page               |
|------------------------|------------------------------------------|-----------------|--------------------|
| Synthetic polymers     | Organic solvent soluble                  | SEC             | 44, 46, 48, 52, 56 |
|                        | Polar organic solvent soluble            |                 | 38, 44, 50, 52, 56 |
|                        | High temperature/ Ultra high temperature |                 | 58                 |
|                        | Water-soluble                            |                 | 36, 38, 42, 44     |
| Additives<br>Oligomers |                                          | RPC             | 10, 12, 16, 17     |
|                        | Organic solvent soluble                  | SEC             | 44, 46, 48, 52     |
|                        | Polar organic solvent soluble            |                 | 38, 44, 50, 52     |
|                        | Water-soluble                            |                 | 36, 38, 42, 44     |

## Biotechnology

|            |                                               | Separation Mode | Page           |
|------------|-----------------------------------------------|-----------------|----------------|
| Genomics   | Nucleobases<br>Nucleotides<br>Nucleosides     | RPC             | 12             |
|            |                                               | IEC+SEC         | 12, 42         |
|            |                                               | IEC             | 64             |
|            | Oligo nucleic acids                           | RPC             | 12             |
|            |                                               | IEC+SEC         | 42             |
|            |                                               | IEC             | 64             |
|            | DNA/RNA                                       | SEC             | 38, 44         |
| Proteomics | Amino acids                                   | RPC             | 10             |
|            |                                               | IEC+IEX+RPC     | 12             |
|            |                                               | IEC             | 66             |
|            |                                               | IEC+SEC         | 42             |
|            | Peptides<br>Proteins                          | RPC             | 10, 12         |
|            |                                               | SEC             | 36, 38, 42, 44 |
|            |                                               | IEC             | 64, 66         |
|            |                                               | HIC             | 68             |
| Glycomics  | Glycoproteins                                 | RPC             | 10, 12         |
|            |                                               | SEC             | 36, 38, 42, 44 |
|            |                                               | IEC             | 64, 66         |
|            |                                               | HIC             | 68             |
|            |                                               | AFC             | 68             |
|            | Sugar chains                                  | HILIC           | 20, 22         |
|            |                                               | AFC             | 68             |
|            | Monosaccharides                               | HILIC           | 20, 22         |
|            |                                               | LEX+SEC         | 24             |
|            |                                               | LEX+HILIC       | 24             |
|            | Sialic acids<br>Uronic acids<br>Aldonic acids | IEX+RPC         | 28             |
| Hormones   | Amines                                        | RPC             | 8, 10, 12      |
|            |                                               | IEC             | 66             |
|            | Steroids                                      | RPC             | 10             |
|            |                                               | HILIC           | 20, 22         |
|            |                                               | SEC             | 38, 44         |
| Lipids     | Phospholipids                                 | NPC             | 17             |
|            |                                               | SEC             | 44, 46, 52     |
|            | Lipoproteins                                  | SEC             | 38             |
|            |                                               | AFC             | 68             |

## Environment

|                          |                                                        | Separation Mode          | Page       |
|--------------------------|--------------------------------------------------------|--------------------------|------------|
| Water quality            | Anions                                                 | IC                       | 30         |
|                          | Oxyhalides                                             | IC                       | 30         |
|                          |                                                        | IEC+HILIC                | 20         |
|                          | Cyanide<br>Cyanogen chloride                           | IEX                      | 28         |
|                          | Cations                                                | IC                       | 32         |
|                          | Surfactants                                            | RPC                      | 10, 16     |
|                          |                                                        | SEC+RPC                  | 44         |
|                          | Perchloric acids                                       | IC                       | 30         |
|                          |                                                        | IEC+HILIC                | 20         |
|                          | Pesticides                                             | RPC                      | 12, 16, 17 |
|                          |                                                        | IEC+RPC                  | 12         |
|                          |                                                        | HILIC                    | 20         |
|                          |                                                        | IC                       | 30         |
| Soil                     | Anions                                                 | IC                       | 30         |
|                          | Heavy metals                                           | IC                       | 32         |
|                          | Humic substances                                       | SEC                      | 38         |
|                          | Organic arsenic                                        | IEX+RPC                  | 12         |
|                          | Pesticides                                             | RPC                      | 12, 16, 17 |
|                          |                                                        | IEC+RPC                  | 12         |
|                          |                                                        | HILIC                    | 20         |
|                          |                                                        | IC                       | 30         |
| Environmental hormones   | Pretreatment of Phthalates<br>PCBs<br>Benzo [a] pyrene | SEC<br>GPC<br>(Clean-up) | 70         |
| Bioethanols              | Monosaccharides<br>Oligosaccharides                    | HILIC                    | 20, 22     |
|                          |                                                        | LEX+SEC                  | 24         |
|                          | Oligosaccharides<br>Alcohols<br>Furfural               | LEX+SEC                  | 24         |
|                          | Saccharides<br>Organic acids<br>Alcohols<br>Furfural   | IEX+RPC+SEC              | 28         |
|                          | Hemicelluloses<br>Celluloses                           | SEC                      | 50, 56     |
|                          | Biodiesels                                             | Cations                  | IC         |
| Fatty acid glycerides    |                                                        | SEC                      | 44         |
| Fatty acid methyl esters |                                                        | RPC                      | 12         |
| Organic acids            |                                                        | IC                       | 30         |

# Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns

ODS columns are the most popular reversed phase columns that are packed with silica-based octadecyl group. Shodex provides not only ODS columns but also polymer-based reversed phase columns with different functional groups. You can choose a suitable column for your application based on the features listed below.

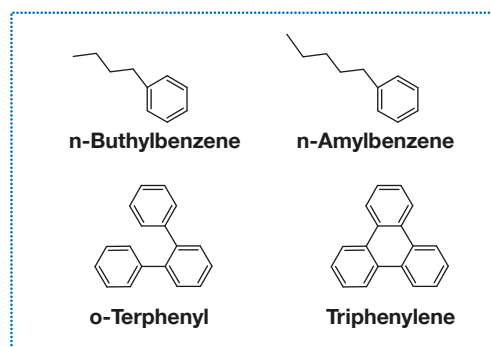
## Features

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ODP2 HP</b>  | <ul style="list-style-type: none"> <li>Provides a large theoretical plate number nearly twice as much as generally available polymer-based reversed phase columns</li> <li>Offers enhanced retention of high polar substances compared to ODS columns</li> <li>Suitable for the analysis of small molecules such as pharmaceuticals in the presence of protein matrix</li> <li>Ideal for LC/MS analysis of high polar compounds</li> <li>Corresponds to USP L39</li> </ul> |
| <b>ODP-50</b>   | <ul style="list-style-type: none"> <li>Relatively large pore size is suitable for the analysis of amino acids, peptides, and proteins</li> </ul>                                                                                                                                                                                                                                                                                                                           |
| <b>C8P-50</b>   | <ul style="list-style-type: none"> <li>Usable in a wide pH range from pH 2 to 13</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                |
| <b>C4P-50</b>   | <ul style="list-style-type: none"> <li>Usable in 100% water or buffer solution</li> <li>Best used for the analysis of basic substances</li> <li>ODP-50 corresponds to USP L67</li> </ul>                                                                                                                                                                                                                                                                                   |
| <b>ODP-40</b>   | <ul style="list-style-type: none"> <li>Higher performance type of ODP-50 series</li> <li>Corresponds to USP L67</li> </ul>                                                                                                                                                                                                                                                                                                                                                 |
| <b>RP18-415</b> | <ul style="list-style-type: none"> <li>Large pore size is suitable for the analysis of proteins and peptides</li> <li>Corresponds to USP L21</li> </ul>                                                                                                                                                                                                                                                                                                                    |
| <b>DS-613</b>   | <ul style="list-style-type: none"> <li>Suitable for reversed phase analysis of highly hydrophilic substances, that are not well retained by ODS columns</li> </ul>                                                                                                                                                                                                                                                                                                         |
| <b>DS-413</b>   | <ul style="list-style-type: none"> <li>Corresponds to USP L21</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>DE</b>       | <ul style="list-style-type: none"> <li>Polymer-based columns, with similar polarity to that of ODS columns, can be used in general purposes</li> <li>Wide working pH range (from pH 2 to 12), usable in 100% water and buffer solutions</li> <li>Corresponds to USP L71</li> </ul>                                                                                                                                                                                         |
| <b>DM-614</b>   | <ul style="list-style-type: none"> <li>Suitable for the analysis of amino acids and water-soluble vitamins</li> <li>Corresponds to USP L39</li> </ul>                                                                                                                                                                                                                                                                                                                      |
| <b>NN</b>       | <ul style="list-style-type: none"> <li>The packing material contains sulfo groups, and supports multimode (reversed phase and cation exchange) analysis</li> <li>Ideal for the analysis of complex samples containing neutral and ionic substances</li> </ul>                                                                                                                                                                                                              |
| <b>JJ-50</b>    | <ul style="list-style-type: none"> <li>The packing material contains trace amounts of quaternary ammonium groups, and supports multimode (reversed phase and anion exchange) analysis</li> <li>Ideal for analysis of complex samples containing neutral and ionic substances</li> </ul>                                                                                                                                                                                    |
| <b>C18M</b>     | <ul style="list-style-type: none"> <li>Monomeric type ODS column, fully end capped high purity silica (99.99% or higher)</li> <li>Corresponds to USP L1</li> </ul>                                                                                                                                                                                                                                                                                                         |
| <b>C18P</b>     | <ul style="list-style-type: none"> <li>Polymeric type ODS column, fully end capped high purity silica (99.99% or higher)</li> <li>Excellent acid tolerance</li> <li>Advantageous for separating planar and nonplanar compounds from each other</li> <li>Corresponds to USP L1</li> </ul>                                                                                                                                                                                   |
| <b>5C8</b>      | <ul style="list-style-type: none"> <li>Use when the retention capacity of C18 is too strong or that of C4 is too weak</li> <li>Applicable to ion pair chromatography, because of its rapid mass transfer and equilibrium</li> <li>Corresponds to USP L7</li> </ul>                                                                                                                                                                                                         |
| <b>5C4</b>      | <ul style="list-style-type: none"> <li>Use when the retention capacity of C18 or C8 is too strong</li> <li>Corresponds to USP L26</li> </ul>                                                                                                                                                                                                                                                                                                                               |
| <b>5CN</b>      | <ul style="list-style-type: none"> <li>Utilizes reversed phase interaction and <math>\pi</math>-electron interaction to separate regioisomers, which typically cannot be separated with ODS, C8, or C4 columns</li> <li>Corresponds to USP L10</li> </ul>                                                                                                                                                                                                                  |
| <b>5NPE</b>     | <ul style="list-style-type: none"> <li>Utilizes several types of interactions based on <math>\pi</math>-electrons to separate structural isomers</li> </ul>                                                                                                                                                                                                                                                                                                                |
| <b>5PYE</b>     | <ul style="list-style-type: none"> <li>5NPE corresponds to USP L67</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                              |

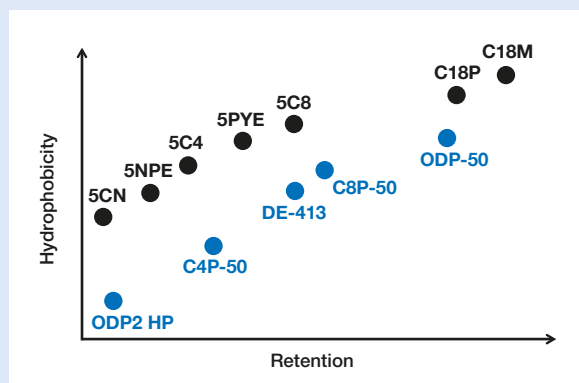
The interrelation between hydrophobicity and retention, and the interrelation between steric selectivity and retention were compared among Shodex columns for reversed phase chromatography.

The retention factor ( $k'$ ) of amylbenzene was used as the retention, the separation factor ( $\alpha$ ) between n-butylbenzene and n-amylbenzene was used as the hydrophobicity. The separation factor between o-terphenil and triphenylene was used as the steric recognition.

Larger separation factor means higher hydrophobicity and higher steric selectivity.

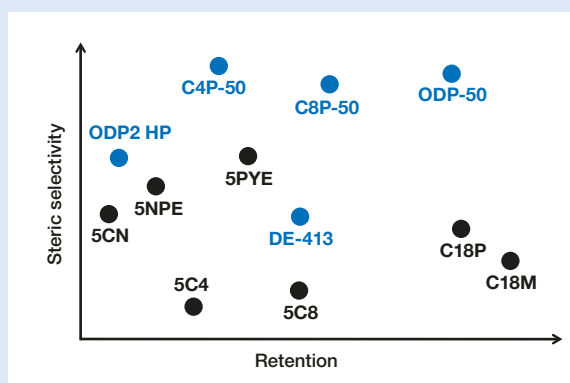


### Interrelation between hydrophobicity and retention



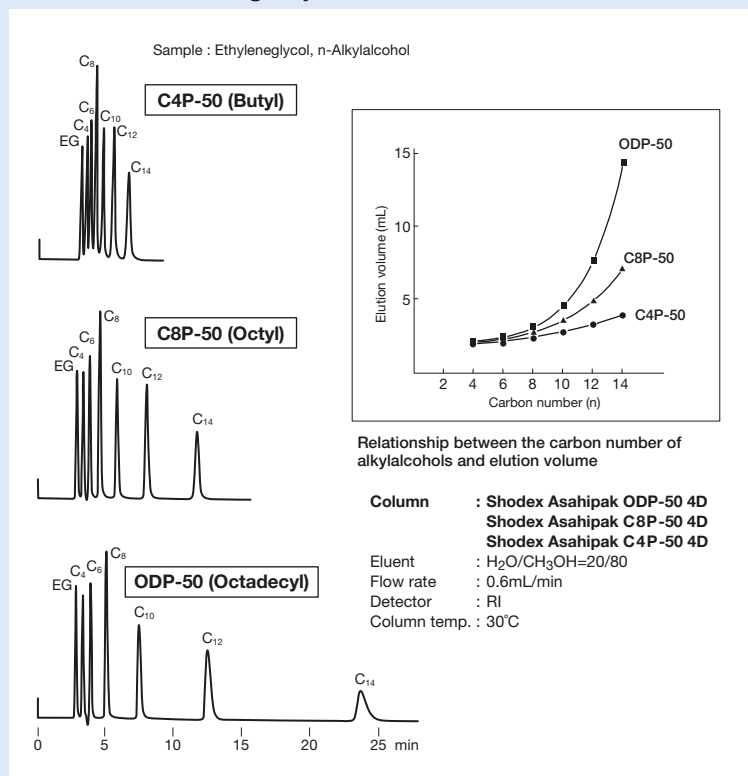
Column size : 4.6mm I.D. x 150mm each  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=20/80  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

### Interrelation between steric selectivity and retention

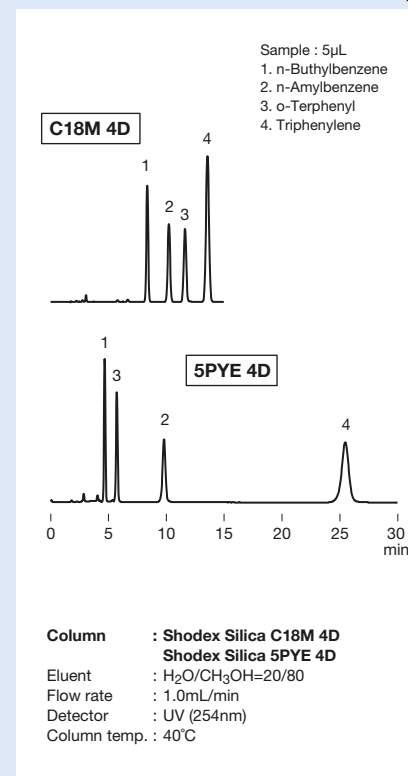


Column size : 4.6mm I.D. x 150mm each  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=20/80  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

### Comparison of separation of alkylalcohol due to different functional groups



### Comparison of separation due to the difference in steric selectivity



# Columns for Polymer-based Reversed Phase Chromatography (ODP2 HP)

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” on page 6 and 7 for features.

## 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     | <b>ODP2 HP-4B</b>  | ≥ 3,500                  | –                | 5                  | 40            | <b>4.6 × 50</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=55/45 |
| F7622002     | <b>ODP2 HP-4D</b>  | ≥ 13,000                 | –                | 5                  | 40            | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=55/45 |
| F7622003     | <b>ODP2 HP-4E</b>  | ≥ 17,000                 | –                | 5                  | 40            | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=55/45 |
| F6714010     | <b>ODP2 HPG-4A</b> | (guard column)           | –                | 5                  | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=55/45 |
| F7622004     | <b>ODP2 HP-2B</b>  | ≥ 3,000                  | –                | 5                  | 40            | <b>2.0 × 50</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=55/45 |
| F7622005     | <b>ODP2 HP-2D</b>  | ≥ 7,000                  | –                | 5                  | 40            | <b>2.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=55/45 |
| F6714011     | <b>ODP2 HPG-2A</b> | (guard column)           | –                | 5                  | –             | <b>2.0 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=55/45 |

Base Material : Polyhydroxymethacrylate

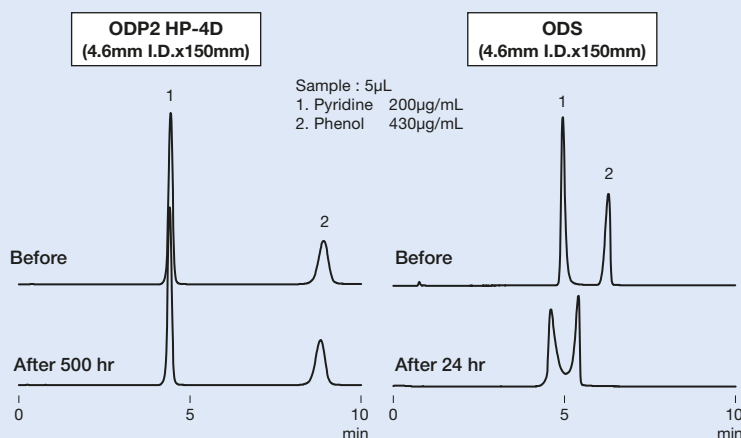
## 3mm I.D columns [Customized columns]

| Product Code | Product Name                      | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-----------------------------------|------------------|--------------------|---------------|--------------------------------|
| F7622006     | <b>ODP2 HP-3B</b>                 | –                | 5                  | 40            | <b>3.0 × 50</b>                |
| F7622007     | <b>ODP2 HP-3D</b>                 | –                | 5                  | 40            | <b>3.0 × 150</b>               |
| F6714014     | <b>ODP2 HPG-3A (guard column)</b> | –                | 5                  | –             | <b>3.0 × 10</b>                |

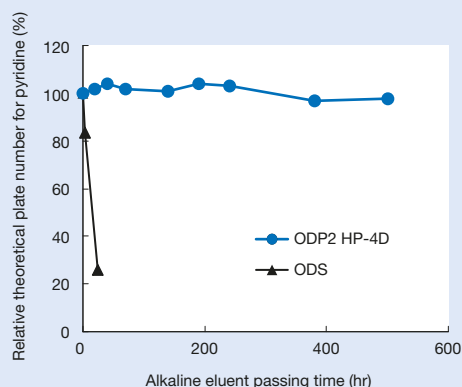
Base Material : Polyhydroxymethacrylate

## Tolerance of ODP2 HP for alkaline condition

### Comparison between the chromatograms obtained before and after passing alkaline eluent



### Correlation between alkaline eluent passing time and relative theoretical plate number



#### Analysis condition

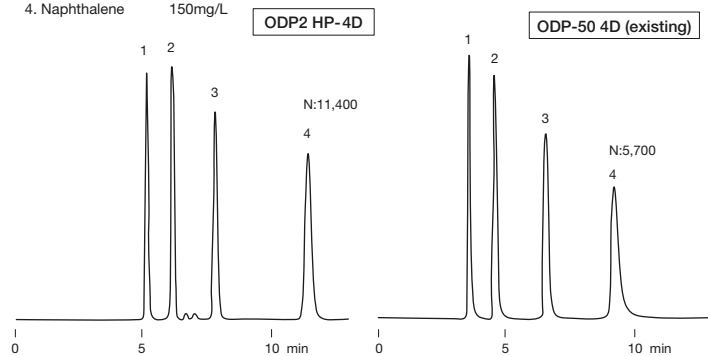
**Column** : Shodex ODP2 HP-4D  
 ODS from other manufacturer  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>OH=70/30  
**Flow rate** : 1.0mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

#### Eluent passing conditions for alkali tolerance test

**Column** : Shodex ODP2 HP-4D  
 ODS from other manufacturer  
**Eluent** : 10mM Sodium phosphate buffer (pH12)  
 /CH<sub>3</sub>CN=45/55  
**Flow rate** : 0.6mL/min  
**Column temp.** : 30°C

## Comparison between ODP2 HP and ODP-50 (existing)

Sample : 5 $\mu$ L  
 1. Phenol 300mg/L  
 2. Methyl benzoate 350mg/L  
 3. Toluene 1000mg/L  
 4. Naphthalene 150mg/L

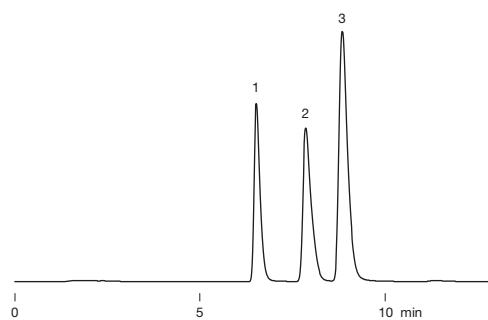


**Column** : Shodex ODP2 HP-4D  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN=55/45  
**Flow rate** : 0.6mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

**Column** : Shodex Asahipak ODP-50 4D  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN=35/65  
**Flow rate** : 0.6mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

## Imidazoles

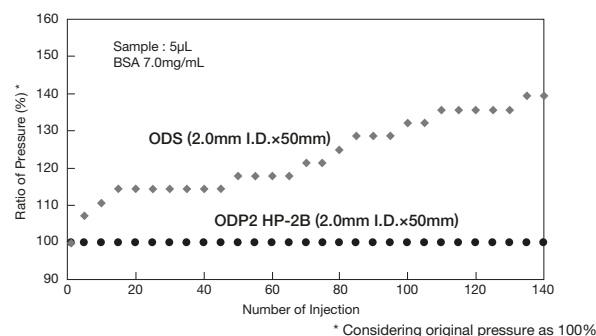
Sample : 0.1% each, 10 $\mu$ L  
 1. Imidazole  
 2. 2-Methylimidazole  
 3. 4-Methylimidazole



**Column** : Shodex ODP2 HP-4E  
**Eluent** : 10mM Na<sub>2</sub>HPO<sub>4</sub> aq./CH<sub>3</sub>CN=90/10  
**Flow rate** : 0.8mL/min  
**Detector** : UV (220nm)  
**Column temp.** : 40°C

## Influence of repeated protein injection on column pressure

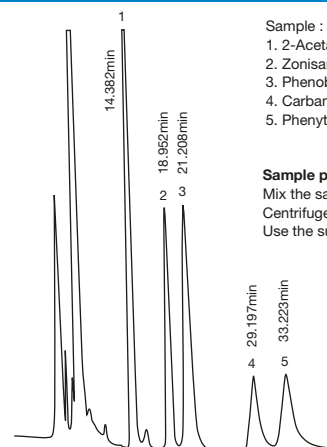
ODP2 HP columns are packed with gels with increased surface polarity and smaller pore size which prevent the adsorption of proteins. BSA was injected multiple times to both ODS and ODP2 HP columns. A significant column pressure increase was observed for the ODS column, while no considerable change was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



**Column** : Shodex ODP2 HP-2B  
**ODS from other manufacturer**  
**Eluent** : 1mM Ammonium acetate aq./CH<sub>3</sub>CN=90/10  
**Flow rate** : 0.2mL/min  
**Detector** : UV (220nm)  
**Column temp.** : 30°C

\* Considering original pressure as 100%

## Anticonvulsant in serum



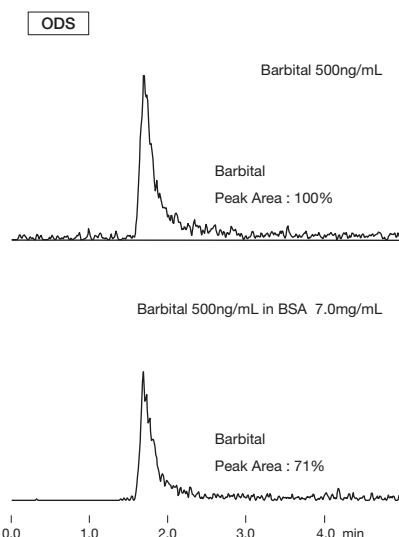
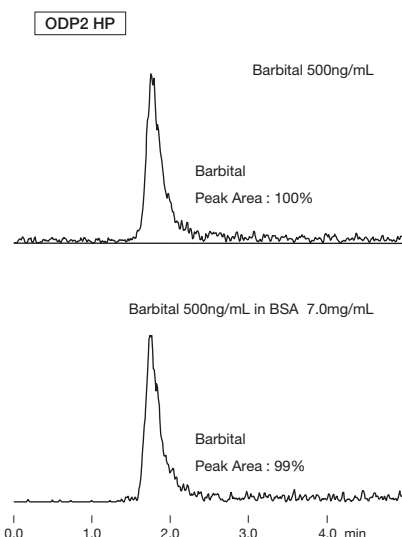
Sample : 20 $\mu$ L  
 1. 2-Acetaminophenol (I.S.) 10 $\mu$ g/mL  
 2. Zonisamide 13.0 $\mu$ g/mL  
 3. Phenobarbital 19.0 $\mu$ g/mL  
 4. Carbamazepine 4.5 $\mu$ g/mL  
 5. Phenytoin 9.0 $\mu$ g/mL

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

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

**Column** : Shodex ODP2 HP-4E  
**Eluent** : 25mM Sodium phosphate buffer (pH5.2)/CH<sub>3</sub>CN=680/320  
**Flow rate** : 0.35mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 40°C

## Barbital recovery rate comparison of ODP2 HP-2B and ODS in the presence of BSA



For the analysis of drugs in samples containing proteins in matrix using LC/MS, ODP2 HP columns show less matrix effects (ion suppression in this case) compared to ODS columns due to fact that proteins can not be retained on ODP2 HP columns and are eluted as a void.

**Column** : Shodex ODP2 HP-2B  
**ODS from other manufacturer**  
**Eluent** : 10mM Ammonium acetate aq. /CH<sub>3</sub>CN=70/30  
**Flow rate** : 0.2mL/min  
**Detector** : ESI-MS (SIM Negative : m/z 183)  
**Column temp.** : 30°C  
**Injection vol.** : 10 $\mu$ L

# Columns for Polymer-based Reversed Phase Chromatography (Asahipak)

Please refer to "Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns" on page 6 and 7 for features.

## 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                          |
|--------------|----------------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|-------------------------------------------|
| F7621001     | <b>Asahipak ODP-40 4D</b>  | ≥ 11,000                 | Octadecyl        | 4                  | 250           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7621002     | <b>Asahipak ODP-40 4E</b>  | ≥ 17,000                 | Octadecyl        | 4                  | 250           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620002     | <b>Asahipak ODP-50 6D</b>  | ≥ 9,000                  | Octadecyl        | 5                  | 250           | <b>6.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620001     | <b>Asahipak ODP-50 6E</b>  | ≥ 14,000                 | Octadecyl        | 5                  | 250           | <b>6.0 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F6710001     | <b>Asahipak ODP-50G 6A</b> | (guard column)           | Octadecyl        | 5                  | –             | <b>6.0 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F6710023     | <b>Asahipak ODP-50 4B</b>  | ≥ 2,500                  | Octadecyl        | 5                  | 250           | <b>4.6 × 50</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620004     | <b>Asahipak ODP-50 4D</b>  | ≥ 9,000                  | Octadecyl        | 5                  | 250           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620003     | <b>Asahipak ODP-50 4E</b>  | ≥ 14,000                 | Octadecyl        | 5                  | 250           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F6710022     | <b>Asahipak ODP-50G 4A</b> | (guard column)           | Octadecyl        | 5                  | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620009     | <b>Asahipak ODP-50 2D</b>  | ≥ 5,000                  | Octadecyl        | 5                  | 250           | <b>2.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F6713001     | <b>Asahipak ODP-50G 2A</b> | (guard column)           | Octadecyl        | 5                  | –             | <b>2.0 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620006     | <b>Asahipak C8P-50 4D</b>  | ≥ 7,000                  | Octyl            | 5                  | 250           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620005     | <b>Asahipak C8P-50 4E</b>  | ≥ 11,000                 | Octyl            | 5                  | 250           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F6710002     | <b>Asahipak C8P-50G 4A</b> | (guard column)           | Octyl            | 5                  | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620008     | <b>Asahipak C4P-50 4D</b>  | ≥ 6,000                  | Butyl            | 5                  | 250           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F7620007     | <b>Asahipak C4P-50 4E</b>  | ≥ 9,000                  | Butyl            | 5                  | 250           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |
| F6710003     | <b>Asahipak C4P-50G 4A</b> | (guard column)           | Butyl            | 5                  | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |

Base Material : Polyvinyl alcohol

## 3mm I.D columns [Customized columns]

| Product Code | Product Name                              | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-------------------------------------------|------------------|--------------------|---------------|--------------------------------|
| F7621101     | <b>Asahipak ODP-40 3B</b>                 | Octadecyl        | 4                  | 250           | <b>3.0 × 50</b>                |
| F7621102     | <b>Asahipak ODP-40 3D</b>                 | Octadecyl        | 4                  | 250           | <b>3.0 × 150</b>               |
| F6714013     | <b>Asahipak ODP-40G 3A (guard column)</b> | Octadecyl        | 4                  | 250           | <b>3.0 × 10</b>                |

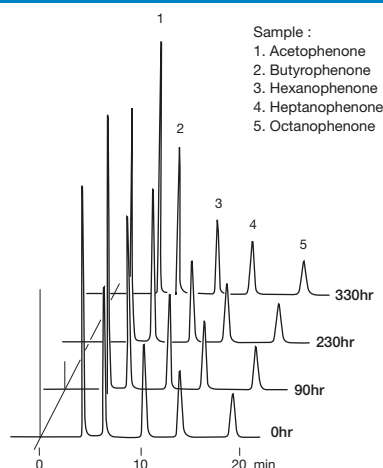
## Semi-micro columns \* The following semi-micro columns are made to order.

| Product Code | Product Name    | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-----------------|------------------|--------------------|---------------|--------------------------------|
| F7838023     | <b>ODP40-2B</b> | Octadecyl        | 4                  | 250           | <b>2.0 × 50</b>                |
| F7838022     | <b>ODP40-2D</b> | Octadecyl        | 4                  | 250           | <b>2.0 × 150</b>               |

## 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 | Standard Column |
|--------------|-----------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6820001     | <b>Asahipak ODP-50 10E</b>  | ≥ 10,000                 | 5                  | <b>10.0 × 250</b>              | ODP-40, ODP-50  |
| F6820035     | <b>Asahipak ODP-90 20F</b>  | ≥ 9,000                  | 9                  | <b>20.0 × 300</b>              | ODP-40, ODP-50  |
| F6710004     | <b>Asahipak ODP-130G 7B</b> | (guard column)           | 13                 | <b>7.5 × 50</b>                | (guard column)  |
| F6820003     | <b>Asahipak C8P-50 10E</b>  | ≥ 8,000                  | 5                  | <b>10.0 × 250</b>              | C8P-50          |
| F6714004     | <b>Asahipak C8P-50G 7B</b>  | (guard column)           | 5                  | <b>7.5 × 50</b>                | (guard column)  |
| F6820005     | <b>Asahipak C4P-50 10E</b>  | ≥ 7,000                  | 5                  | <b>10.0 × 250</b>              | C4P-50          |
| F6714005     | <b>Asahipak C4P-50G 7B</b>  | (guard column)           | 5                  | <b>7.5 × 50</b>                | (guard column)  |

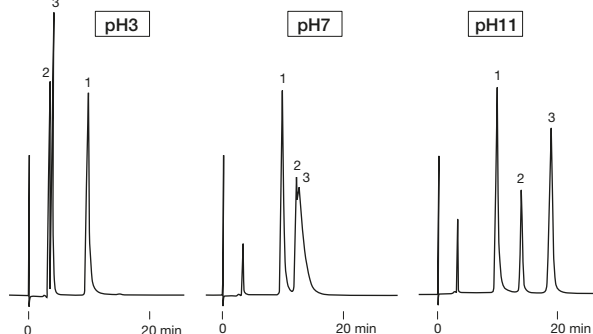
## Tolerance of ODP-50 for alkaline condition



Column : Shodex Asahipak ODP-50 4D  
 Eluent : 10mM NaOH aq. (pH12.0)/CH<sub>3</sub>CN=35/65  
 Flow rate : 0.6mL/min  
 Detector : UV (254nm)  
 Column temp. : 30°C

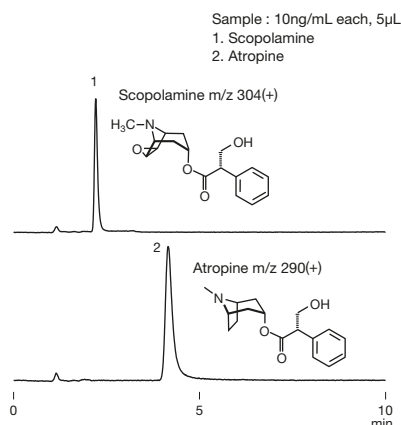
## Local anesthetics

Dissociation of tertiary amino groups in basic drugs can be suppressed by making pH of the eluent higher than pK<sub>a</sub> 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.



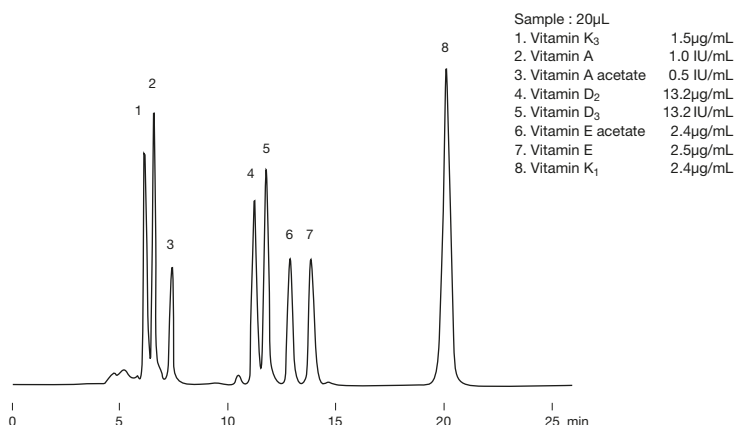
Column : Shodex Asahipak ODP-50 4D  
 Eluent : 25mM Phosphate buffer/CH<sub>3</sub>CN=60/40  
 Flow rate : 0.6mL/min  
 Detector : UV (254nm)  
 Column temp. : 30°C

## LC/MS analysis of basic drugs



Column : Shodex ODP-40 2D  
 Eluent : 0.05% Ammonia aq./CH<sub>3</sub>CN=50/50  
 Flow rate : 0.2mL/min  
 Detector : ESI-MS (SIM Positive)  
 Column temp. : 30°C

## Fat-soluble vitamins

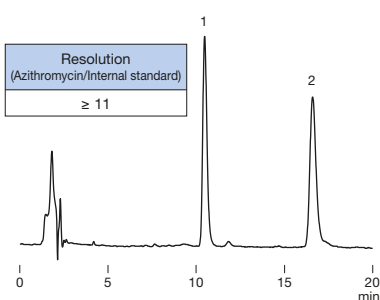


Column : Shodex Asahipak ODP-50 4E  
 Eluent : CH<sub>3</sub>CN/CH<sub>3</sub>OH=50/50  
 Flow rate : 0.6mL/min  
 Detector : UV (280nm)  
 Column temp. : 30°C

## Analysis of azithromycin according to JP method

Sample : 5μL

1. Azithromycin 1mg/mL
2. 4,4'-Bis(diethylamino)benzophenone 30μg/mL

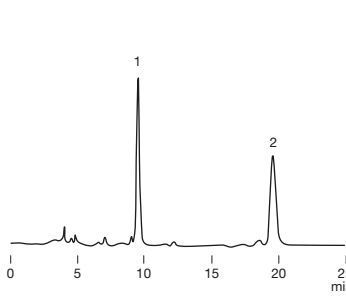


Column : Shodex Asahipak ODP-50 4E  
 Eluent : 40mM K<sub>2</sub>HPO<sub>4</sub> aq. (pH11.0 adjusted with potassium hydroxide aq.)/CH<sub>3</sub>CN=40/60  
 Flow rate : 1.0mL/min  
 Detector : UV (215nm)  
 Column temp. : 40°C

## Macrolide antibiotics

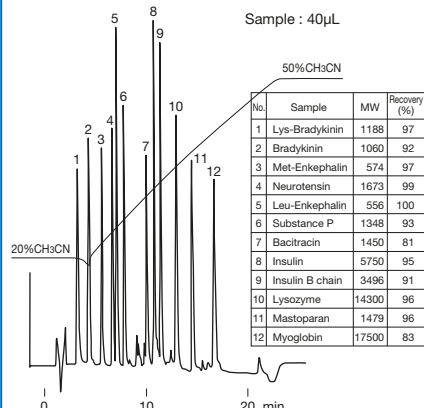
Sample : 0.1% each, 10μL

1. Erythromycin
2. Azithromycin



Column : Shodex Asahipak ODP-40 4E  
 Eluent : 40mM Potassium phosphate buffer (pH11.0)/CH<sub>3</sub>CN=40/60  
 Flow rate : 0.5mL/min  
 Detector : UV (223nm)  
 Column temp. : 40°C

## Gradient analysis of proteins and peptides



Column : Shodex Asahipak ODP-50 6D  
 Eluent : (A); 0.05% TFA aq./CH<sub>3</sub>CN=80/20  
 (B); 0.05% TFA aq./CH<sub>3</sub>CN=50/50  
 Linear gradient; (A) to (B), 20min  
 Flow rate : 1.0mL/min  
 Detector : UV (220nm)  
 Column temp. : 30°C

# Columns for Polymer-based Reversed Phase Chromatography (RSpak)

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” on page 6 and 7 for features.

## Standard columns

| Product Code | Product Name                       | Plate Number (TP/column) | Functional Group    | Base Material                    | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent                                 |
|--------------|------------------------------------|--------------------------|---------------------|----------------------------------|--------------------|---------------|--------------------------------|--------------------------------------------------|
| F7009000     | <b>RSpak RP18-415</b>              | ≥ 5,000                  | –                   | Styrene divinylbenzene copolymer | 6                  | 450           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=5/95         |
| F6709558     | <b>RSpak RP18-G</b>                | (guard column)           | –                   | Styrene divinylbenzene copolymer | 6                  | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN/THF=40/30/30 |
| F7001001     | <b>RSpak DS-613</b>                | ≥ 6,500                  | –                   | Styrene divinylbenzene copolymer | 6                  | 200           | <b>6.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN/THF=30/40/30 |
| F7001012     | <b>RSpak DS-413</b>                | ≥ 11,000                 | –                   | Styrene divinylbenzene copolymer | 3.5                | 200           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN/THF=40/30/30 |
| F6700140     | <b>RSpak DS-G</b>                  | (guard column)           | –                   | Styrene divinylbenzene copolymer | 10                 | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN/THF=30/40/30 |
| F7001004     | <b>RSpak DE-613</b>                | ≥ 7,000                  | –                   | Polymethacrylate                 | 6                  | 25            | <b>6.0 × 150</b>               | H <sub>2</sub> O                                 |
| F7001005     | <b>RSpak DE-413</b>                | ≥ 11,000                 | –                   | Polymethacrylate                 | 4                  | 25            | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=50/50        |
| F7009030     | <b>RSpak DE-413L</b>               | ≥ 17,000                 | –                   | Polymethacrylate                 | 4                  | 25            | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=50/50        |
| F6700150     | <b>RSpak DE-G 4A (RSpak DE-G)</b>  | (guard column)           | –                   | Polymethacrylate                 | 10                 | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O                                 |
| F7001007     | <b>RSpak DE-213</b>                | ≥ 8,000                  | –                   | Polymethacrylate                 | 4                  | 25            | <b>2.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=50/50        |
| F6700151     | <b>RSpak DE-G 2A (RSpak DE-SG)</b> | (guard column)           | –                   | Polymethacrylate                 | 6                  | –             | <b>2.0 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=50/50        |
| F7001002     | <b>RSpak DM-614</b>                | ≥ 4,500                  | –                   | Polyhydroxymethacrylate          | 10                 | 200           | <b>6.0 × 150</b>               | 5mM H <sub>3</sub> PO <sub>4</sub> aq.           |
| F6700160     | <b>RSpak DM-G 4A (RSpak DM-G)</b>  | (guard column)           | –                   | Polyhydroxymethacrylate          | 12                 | –             | <b>4.6 × 10</b>                | 5mM H <sub>3</sub> PO <sub>4</sub> aq.           |
| F7008140     | <b>RSpak NN-814</b>                | ≥ 9,000                  | Sulfo               | Polyhydroxymethacrylate          | 10                 | 200           | <b>8.0 × 250</b>               | 0.1M Sodium phosphate buffer (pH3.0)             |
| F7008150     | <b>RSpak NN-614</b>                | ≥ 4,000                  | Sulfo               | Polyhydroxymethacrylate          | 10                 | 200           | <b>6.0 × 150</b>               | 0.1M Sodium phosphate buffer (pH3.0)             |
| F6700510     | <b>RSpak NN-G</b>                  | (guard column)           | Sulfo               | Polyhydroxymethacrylate          | 10                 | –             | <b>6.0 × 50</b>                | 0.1M Sodium phosphate buffer (pH3.0)             |
| F7008160     | <b>RSpak NN-414</b>                | ≥ 6,000                  | Sulfo               | Polyhydroxymethacrylate          | 10                 | 200           | <b>4.6 × 150</b>               | 0.1M Sodium phosphate buffer (pH3.0)             |
| F7008240     | <b>RSpak JJ-50 4D</b>              | ≥ 4,500                  | Quaternary ammonium | Polyvinyl alcohol                | 5                  | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=40/60        |
| F7008220     | <b>RSpak JJ-50 2D</b>              | ≥ 3,500                  | Quaternary ammonium | Polyvinyl alcohol                | 5                  | 100           | <b>2.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=40/60        |

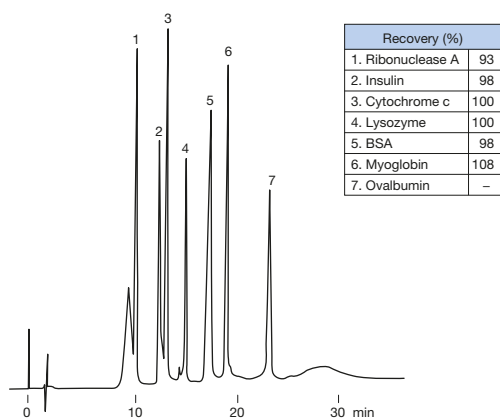
**Semi-micro columns** \* The following semi-micro columns are made to order.

| Product Code | Product Name    | Functional Group | Base Material           | Particle Size (μm) | Pore Size (Å) | Column Size (mm)<br>I.D. x Length |
|--------------|-----------------|------------------|-------------------------|--------------------|---------------|-----------------------------------|
| F7840123     | <b>DE413-2B</b> | –                | Polymethacrylate        | 4                  | 25            | <b>2.0 × 50</b>                   |
| F7840121     | <b>DE413-2E</b> | –                | Polymethacrylate        | 4                  | 25            | <b>2.0 × 250</b>                  |
| F7860122     | <b>NN414-2D</b> | Sulfo            | Polyhydroxymethacrylate | 10                 | 200           | <b>2.0 × 150</b>                  |

**Preparative columns** \* Preparative columns are made to order.

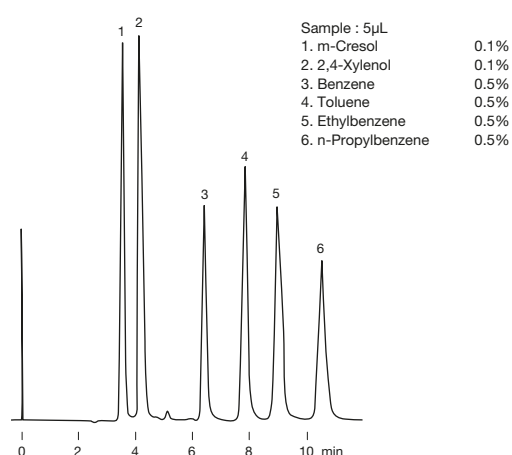
| Product Code | Product Name                             | Plate Number<br>(TP/column) | Particle Size (μm) | Column Size (mm)<br>I.D. x Length | Standard Column |
|--------------|------------------------------------------|-----------------------------|--------------------|-----------------------------------|-----------------|
| F6513013     | <b>RSpak DE-2013</b>                     | ≥ 10,000                    | 12                 | <b>20.0 × 300</b>                 | DE-413, DE-613  |
| F6700190     | <b>RSpak DE-G 8B<br/>(RSpak DE-LG)</b>   | (guard column)              | 12                 | <b>8.0 × 50</b>                   | DE-413, DE-613  |
| F6513015     | <b>RSpak DE-5013</b>                     | –                           | 12                 | <b>50.0 × 300</b>                 | DE-413, DE-613  |
| F6700191     | <b>RSpak DE-G 20C<br/>(RSpak DE-LLG)</b> | (guard column)              | 12                 | <b>20.0 × 100</b>                 | (guard column)  |
| F6514014     | <b>RSpak DM-2014</b>                     | ≥ 5,000                     | 12                 | <b>20.0 × 300</b>                 | DM-614          |
| F6700404     | <b>RSpak DM-G 8B<br/>(RSpak DM-LG)</b>   | (guard column)              | 12                 | <b>8.0 × 50</b>                   | (guard column)  |
| F6514022     | <b>RSpak DM-5014</b>                     | –                           | 12                 | <b>50.0 × 300</b>                 | DM-614          |
| F6700162     | <b>RSpak DM-G 20C<br/>(RSpak DM-LLG)</b> | (guard column)              | 12                 | <b>20.0 × 100</b>                 | (guard column)  |

## Separation and recovery rate of standard proteins



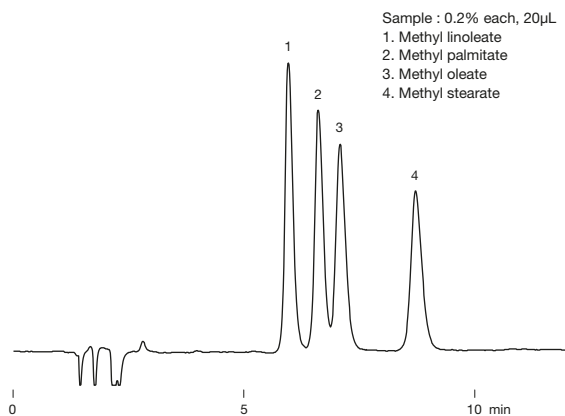
**Column** : Shodex RSpak RP18-415  
**Eluent** : (A); 0.1% TFA aq./CH<sub>3</sub>CN=99/1  
 (B); 0.1% TFA aq./CH<sub>3</sub>CN=5/95  
 Linear gradient; (B%) 20% to 60%, 20min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (220nm)  
**Column temp.** : Room temp.

## Alkylbenzenes



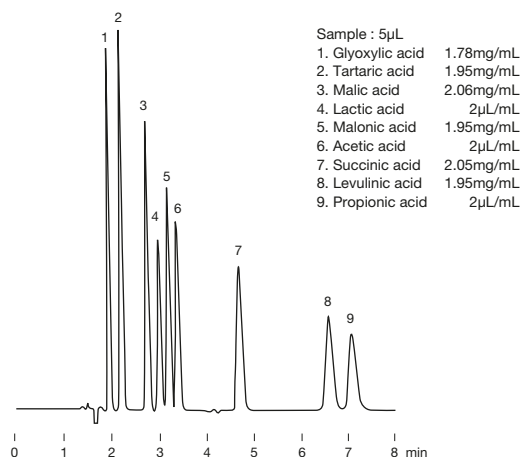
**Column** : Shodex RSpak DS-613  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN/THF=30/40/30  
**Flow rate** : 1.0mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

## Fatty acid methyl esters



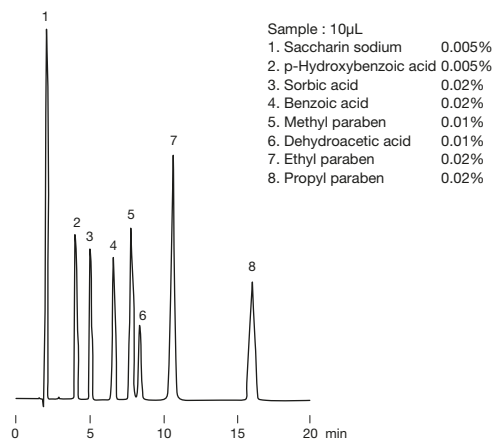
**Column** : Shodex RSpak DS-413  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN/THF=25/45/30  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

## Organic acids



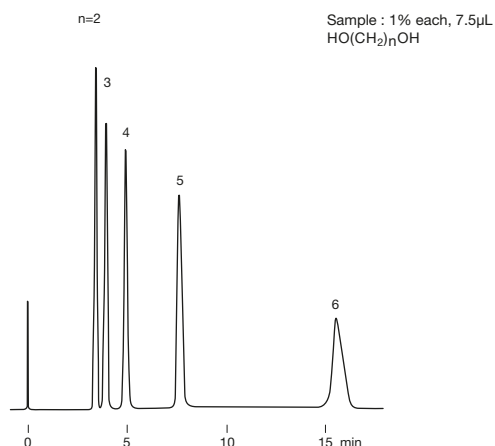
**Column** : Shodex RSpak DE-413  
**Eluent** : 10mM H<sub>3</sub>PO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 50°C

## Food additives (Preservatives)



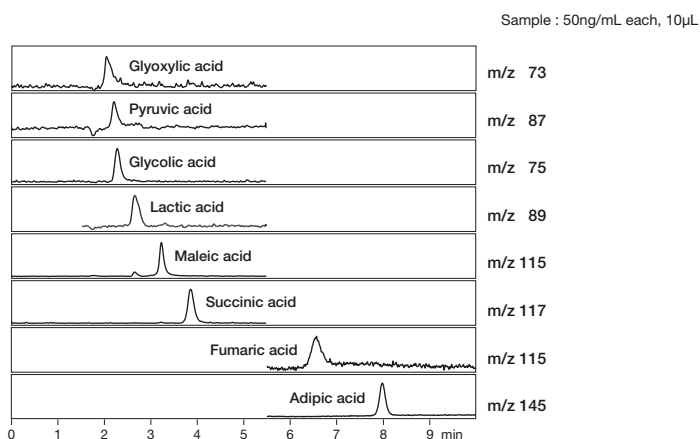
**Column** : Shodex RSpak DE-413  
**Eluent** : 50mM KH<sub>2</sub>PO<sub>4</sub> + 0.1% H<sub>3</sub>PO<sub>4</sub> aq.  
 /CH<sub>3</sub>CN=65/35  
**Flow rate** : 1.0mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 40°C

## Diols



**Column** : Shodex RSpak DE-613  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 60°C

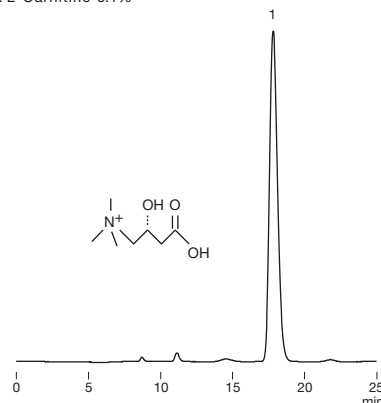
## LC/MS analysis of organic acids



**Column** : Shodex RSpak DE-213  
**Eluent** : (A); 0.1% (v/v) Formic acid aq. (B); CH<sub>3</sub>CN  
Linear gradient; B%; 5% (0min)→5% (2min)→15% (2.5min)→15% (10min)  
**Flow rate** : 0.2mL/min  
**Detector** : ESI-MS (SIM Negative)  
**Column temp.** : 30°C

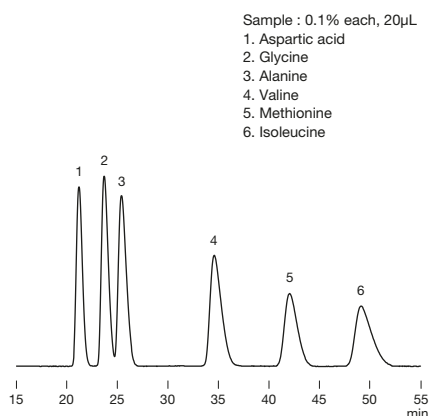
## Carnitine

Sample : 20 $\mu$ L  
1. L-Carnitine 0.1%



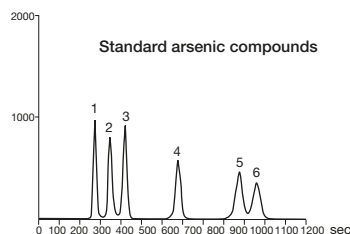
**Column** : Shodex RSpak NN-814  
**Eluent** : 0.1M H<sub>3</sub>PO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 25°C

## Amino acids

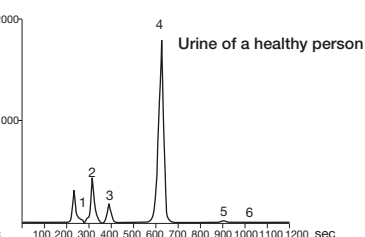
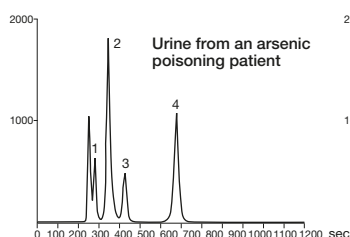


**Column** : Shodex RSpak NN-814  
**Eluent** : 40mM H<sub>3</sub>PO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

## Speciation of arsenic



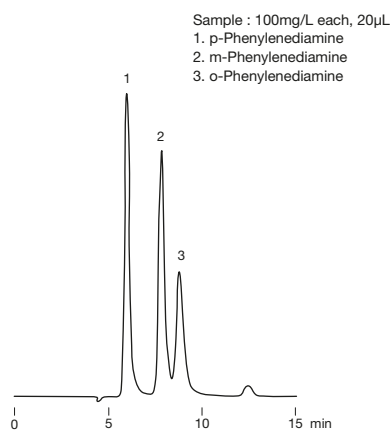
Sample : Arsenic compounds, 50 $\mu$ L  
1. Monomethylarsonic acid  
2. Arsinic acid  
3. Dimethylarsinic acid  
4. Arsenobetaine  
5. Tetramethylarsonium  
6. Trimethylarsine oxide



**Column** : Shodex RSpak NN-614  
**Eluent** : 5mM HNO<sub>3</sub>/8mM NH<sub>4</sub>NO<sub>3</sub> aq.  
**Flow rate** : 0.8mL/min  
**Detector** : ICP-MS (SIM m/z 75)

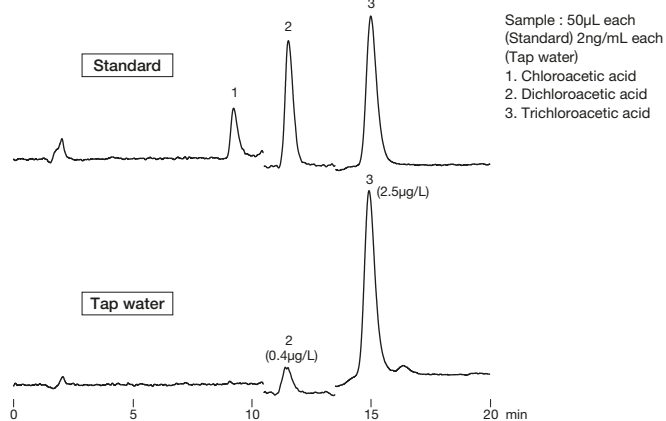
**Source** :  
Noriko Tsunoda,  
Pharmacia. 1998, vol.34, No.12, p.1237-1241

## Phenylenediamine isomers



**Column** : Shodex RSpak JJ-50 4D  
**Eluent** : 25mM Ammonium acetate buffer  
(pH9.2)/CH<sub>3</sub>CN=70/30  
**Flow rate** : 0.4mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 30°C

## LC/MS analysis of haloacetic acids



Sample : 50 $\mu$ L each  
(Standard) 2ng/mL each  
(Tap water)  
1. Chloroacetic acid  
2. Dichloroacetic acid  
3. Trichloroacetic acid

**Column** : Shodex RSpak JJ-50 2D  
**Eluent** : 25mM Ammonium acetate aq. (pH9.2)/CH<sub>3</sub>CN=50/50  
**Flow rate** : 0.2mL/min  
**Detector** : Chloroacetic acid : ESI-MS (SIM Negative : m/z 93)  
Dichloroacetic acid : ESI-MS/MS (MRM Negative : m/z 127→83)  
Trichloroacetic acid : ESI-MS (SIM Negative : m/z 161)  
**Column temp.** : 40°C

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

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” on page 6 and 7 for features.

## 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                          |
|--------------|-----------------------|--------------------------|------------------|--------------------|-----------------|---------------|--------------------------------|-------------------------------------------|
| F6650040     | <b>Silica C18M 4D</b> | ≥ 10,000                 | Octadecyl        | 5                  | 16              | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=30/70 |
| F6650041     | <b>Silica C18M 4E</b> | ≥ 16,000                 | Octadecyl        | 5                  | 16              | 100           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=30/70 |
| F6650042     | <b>Silica C18M 2D</b> | ≥ 9,000                  | Octadecyl        | 5                  | 16              | 100           | <b>2.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=40/60 |
| F6650045     | <b>Silica C18P 4D</b> | ≥ 10,000                 | Octadecyl        | 5                  | 17              | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=30/70 |
| F6650046     | <b>Silica C18P 4E</b> | ≥ 16,000                 | Octadecyl        | 5                  | 17              | 100           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=30/70 |
| F6650047     | <b>Silica C18P 2D</b> | ≥ 9,000                  | Octadecyl        | 5                  | 17              | 100           | <b>2.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=40/60 |

Base Material : Silica

## 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 | Standard Column |
|--------------|------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F7560040     | <b>Silica C18M 10E</b> | ≥ 16,000                 | 5                  | <b>10.0 × 250</b>              | C18M            |
| F7560041     | <b>Silica C18M 20E</b> | ≥ 16,000                 | 5                  | <b>20.0 × 250</b>              | C18M            |

# Columns for Silica-based Reversed Phase Chromatography (Other Columns)

Please refer to “Comparison of the Features Among Shodex Reverse Phase Chromatography (RPC) Columns” on page 6 and 7 for features.

## 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                          |
|--------------|-----------------------|--------------------------|------------------|--------------------|-----------------|---------------|--------------------------------|-------------------------------------------|
| F6650052     | <b>Silica 5C8 4D</b>  | ≥ 9,000                  | Octyl            | 5                  | 10              | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=34/66 |
| F6650053     | <b>Silica 5C8 4E</b>  | ≥ 15,000                 | Octyl            | 5                  | 10              | 100           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=34/66 |
| F6650054     | <b>Silica 5C4 4D</b>  | ≥ 9,000                  | Butyl            | 5                  | 7               | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=45/55 |
| F6650055     | <b>Silica 5C4 4E</b>  | ≥ 15,000                 | Butyl            | 5                  | 7               | 100           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=45/55 |
| F6650058     | <b>Silica 5CN 4D</b>  | ≥ 7,000                  | Cyanopropyl      | 5                  | –               | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=60/40 |
| F6650059     | <b>Silica 5CN 4E</b>  | ≥ 12,000                 | Cyanopropyl      | 5                  | –               | 100           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=60/40 |
| F6650062     | <b>Silica 5NPE 4D</b> | ≥ 8,000                  | Nitrophenylethyl | 5                  | –               | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=45/55 |
| F6650063     | <b>Silica 5PYE 4D</b> | ≥ 7,000                  | Pyrenylethyl     | 5                  | –               | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=30/70 |

Base Material : Silica

## 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 | Standard Column |
|--------------|-----------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F7560062     | <b>Silica 5C8 10E</b> | ≥ 15,000                 | 5                  | <b>10.0 × 250</b>              | 5C8             |
| F7560063     | <b>Silica 5C8 20E</b> | ≥ 15,000                 | 5                  | <b>20.0 × 250</b>              | 5C8             |
| F7560054     | <b>Silica 5C4 10E</b> | ≥ 15,000                 | 5                  | <b>10.0 × 250</b>              | 5C4             |
| F7560055     | <b>Silica 5C4 20E</b> | ≥ 15,000                 | 5                  | <b>20.0 × 250</b>              | 5C4             |

# Columns for Silica-based HILIC and Normal Phase Chromatography

## Features

- 5SIL**
- Uses high purity silica (99.99% or higher)
  - Suitable for normal phase analysis using a nonpolar organic solvent
  - Corresponds to USP L3

- 5NH**
- Suitable for saccharides analysis by hydrophilic interaction chromatography (HILIC)
  - Corresponds to USP L8

## 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                                                      |
|--------------|-----------------------|--------------------------|------------------|--------------------|-----------------|---------------|--------------------------------|-----------------------------------------------------------------------|
| F6650050     | <b>Silica 5SIL 4D</b> | ≥ 9,000                  | –                | 5                  | –               | 100           | <b>4.6 × 150</b>               | C <sub>6</sub> H <sub>14</sub> /C <sub>2</sub> H <sub>5</sub> OH=95/5 |
| F6650051     | <b>Silica 5SIL 4E</b> | ≥ 15,000                 | –                | 5                  | –               | 100           | <b>4.6 × 250</b>               | C <sub>6</sub> H <sub>14</sub> /C <sub>2</sub> H <sub>5</sub> OH=95/5 |
| F6650060     | <b>Silica 5NH 4D</b>  | ≥ 5,000                  | Aminopropyl      | 5                  | –               | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=5/95                              |
| F6650061     | <b>Silica 5NH 4E</b>  | ≥ 8,000                  | Aminopropyl      | 5                  | –               | 100           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=5/95                              |

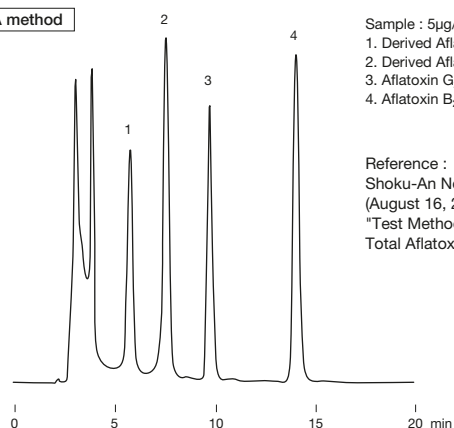
Base Material : Silica

## 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 | Standard Column |
|--------------|------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F7560050     | <b>Silica 5SIL 10E</b> | ≥ 15,000                 | 5                  | <b>10.0 × 250</b>              | 5SIL            |
| F7560051     | <b>Silica 5SIL 20E</b> | ≥ 15,000                 | 5                  | <b>20.0 × 250</b>              | 5SIL            |
| F7560060     | <b>Silica 5NH 10E</b>  | ≥ 8,000                  | 5                  | <b>10.0 × 250</b>              | 5NH             |
| F7560061     | <b>Silica 5NH 20E</b>  | ≥ 8,000                  | 5                  | <b>20.0 × 250</b>              | 5NH             |

## Aflatoxins

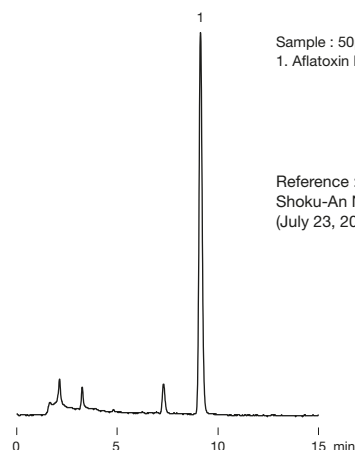
### TFA method



Sample : 5µg/L each, 20µL  
 1. Derived Aflatoxin G<sub>1</sub>  
 2. Derived Aflatoxin B<sub>1</sub>  
 3. Aflatoxin G<sub>2</sub>  
 4. Aflatoxin B<sub>2</sub>

Reference :  
 Shoku-An No. 0816-1  
 (August 16, 2011, Japan)  
 "Test Methods Related to  
 Total Aflatoxin" in Notice

Column : Shodex Silica C18M 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=60/10/30  
 Flow rate : 1.0mL/min  
 Detector : Fluorescence (Ex. : 365nm, Em. : 450nm)  
 Column temp. : 40°C

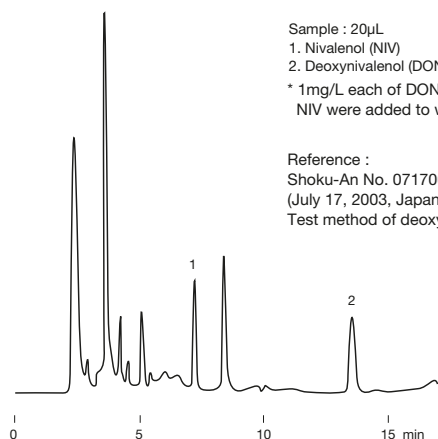


Sample : 50µL  
 1. Aflatoxin M<sub>1</sub> 1µg/L

Reference :  
 Shoku-An No. 0723-5  
 (July 23, 2015, Japan)

Column : Shodex Silica C18M 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=75/25  
 Flow rate : 1.0mL/min  
 Detector : Fluorescence (Ex. : 365nm, Em. : 435nm)  
 Column temp. : 40°C

## Trichothecene mycotoxins

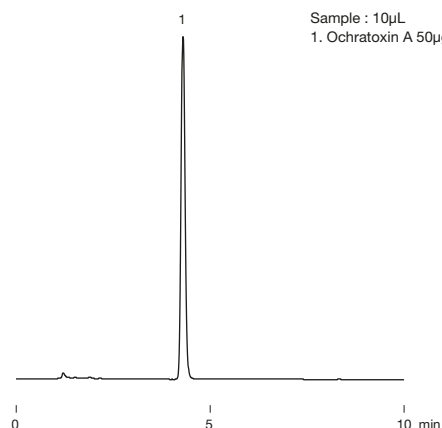


Sample : 20µL  
 1. Nivalenol (NIV)  
 2. Deoxynivalenol (DON)  
 \* 1mg/L each of DON and  
 NIV were added to wheat sample

Reference :  
 Shoku-An No. 0717001  
 (July 17, 2003, Japan)  
 Test method of deoxynivalenol

Column : Shodex Silica C18M 4E  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=90/5/5  
 Flow rate : 1.0mL/min  
 Detector : UV (220nm)  
 Column temp. : 40°C

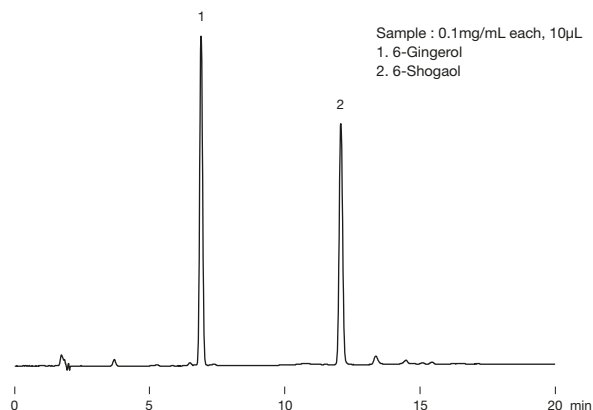
## Ochratoxin



Sample : 10µL  
 1. Ochratoxin A 50µg/L

Column : Shodex Silica C18M 4D  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>COOH/CH<sub>3</sub>CN=43/2/55  
 Flow rate : 1.0mL/min  
 Detector : Fluorescence (Ex. : 333nm, Em. : 460nm)  
 Column temp. : 40°C

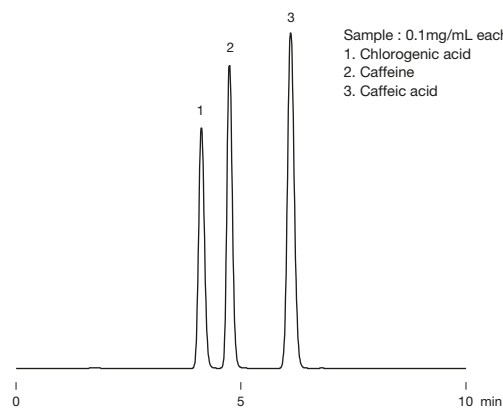
## Gingerol and shogaol



Sample : 0.1mg/mL each, 10µL  
 1. 6-Gingerol  
 2. 6-Shogaol

Column : Shodex Silica C18M 4D  
 Eluent : (A) : H<sub>2</sub>O (B) : CH<sub>3</sub>CN  
 Linear gradient : (B%) 40% to 70% (15min)  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 40°C

## Chlorogenic acid



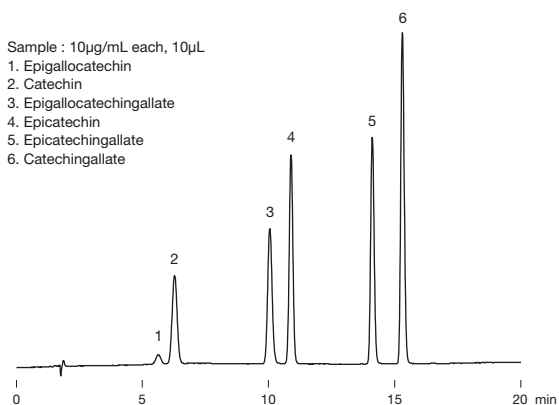
Sample : 0.1mg/mL each, 10µL  
 1. Chlorogenic acid  
 2. Caffeine  
 3. Caffeic acid

Column : Shodex Silica C18M 4D  
 Eluent : 20mM H<sub>3</sub>PO<sub>4</sub> aq. /CH<sub>3</sub>OH=70/30  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 30°C

## Catechins

Sample : 10µg/mL each, 10µL

1. Epigallocatechin
2. Catechin
3. Epigallocatechingallate
4. Epicatechin
5. Epicatechingallate
6. Catechingallate



Column : Shodex Silica C18P 4D

Eluent : (A) : 20mM H<sub>3</sub>PO<sub>4</sub> aq. (B) : CH<sub>3</sub>CNLinear gradient:  
(B%) 20% (0 to 5min), 20 to 40% (5 to 15min),  
40% (15 to 20min)

Flow rate : 1.0mL/min

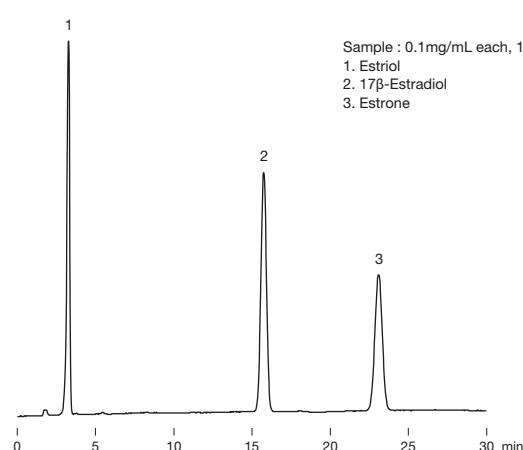
Detector : UV (280nm)

Column temp. : 30°C

## Estradiols

Sample : 0.1mg/mL each, 10µL

1. Estriol
2. 17β-Estradiol
3. Estrone



Column : Shodex Silica C18P 4D

Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=65/35

Flow rate : 1.0mL/min

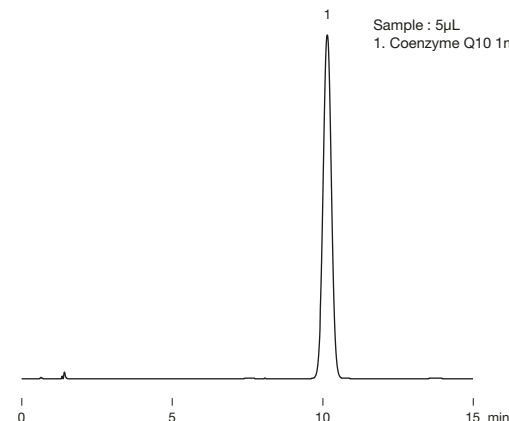
Detector : UV (280nm)

Column temp. : 30°C

## Coenzyme Q10

Sample : 5µL

1. Coenzyme Q10 1mg/mL



Column : Shodex Silica C18P 4D

Eluent : CH<sub>3</sub>OH/C<sub>2</sub>H<sub>5</sub>OH=13/7

Flow rate : 1.2mL/min

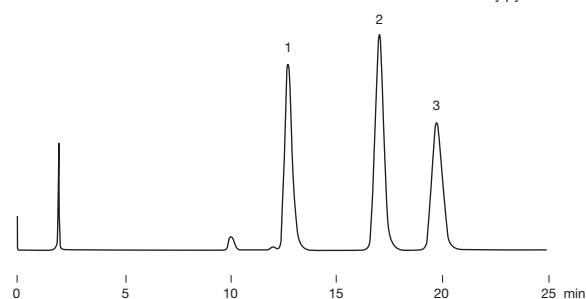
Detector : UV (275nm)

Column temp. : 35°C

## Benzylpyridine isomers

Sample :

1. 2-Benzylpyridine
2. 3-Benzylpyridine
3. 4-Benzylpyridine



Column : Shodex Silica 5PYE 4D

Eluent : 20mM KH<sub>2</sub>PO<sub>4</sub> aq./CH<sub>3</sub>OH=40/60

Flow rate : 1.0mL/min

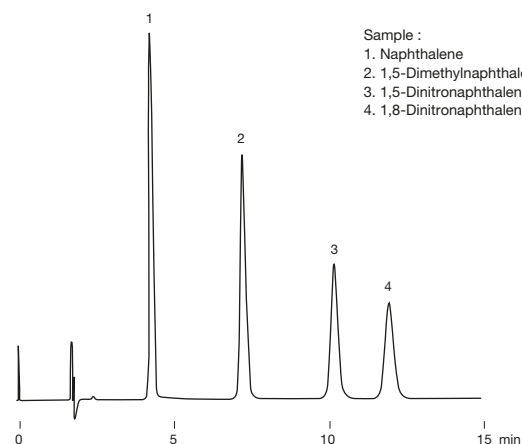
Detector : UV (254nm)

Column temp. : 30°C

## Dinitronaphthalene isomers

Sample :

1. Naphthalene
2. 1,5-Dimethylnaphthalene
3. 1,5-Dinitronaphthalene
4. 1,8-Dinitronaphthalene



Column : Shodex Silica 5NPE 4D

Eluent : H<sub>2</sub>O/CH<sub>3</sub>OH=30/70

Flow rate : 1.0mL/min

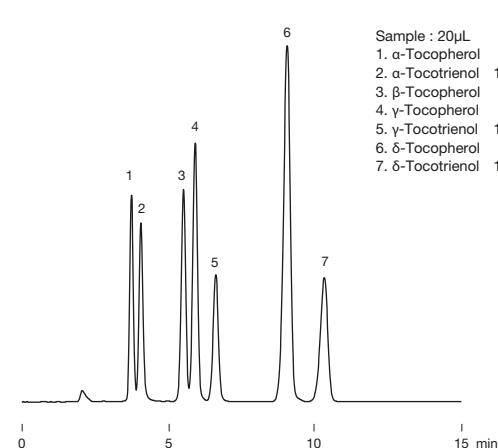
Detector : UV (254nm)

Column temp. : 30°C

## Simultaneous analysis of vitamin E homologs

Sample : 20µL

1. α-Tocopherol 5µg/mL
2. α-Tocotrienol 10µg/mL
3. β-Tocopherol 5µg/mL
4. γ-Tocopherol 5µg/mL
5. γ-Tocotrienol 10µg/mL
6. δ-Tocopherol 5µg/mL
7. δ-Tocotrienol 10µg/mL



Column : Shodex Silica 5SIL 4D

Eluent : n-Hexane/Isopropanol/Acetic acid=1000/6/5

Flow rate : 1.0mL/min

Detector : Fluorescence (Ex. : 298nm, Em. : 325nm)

Column temp. : 30°C

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

## Features

- New VG-50**
- Suitable for saccharides analysis by hydrophilic interaction chromatography (HILIC)
  - High recovery ratio of reducing saccharides
  - Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
  - Easily regenerated by washing in a alkaline solution
  - Also suitable for evaporative light scattering detector, corona charged aerosol detector, and LC/MS
- 
- New VT-50**
- Suitable for anionic substances analysis by hydrophilic interaction chromatography (HILIC)
  - Depends on the eluent selected, the column adds ion exchange mode
  - Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
  - Suitable for LC/MS

## Standard columns

### ● VG-50

(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     | <b>New</b> HILICpak VG-50 4D  | ≥ 5,500                  | Amino            | 5                  | 100           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=20/80 |
| F7630100     | <b>New</b> HILICpak VG-50 4E  | ≥ 7,500                  | Amino            | 5                  | 100           | <b>4.6 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=20/80 |
| F6711100     | <b>New</b> HILICpak VG-50G 4A | (guard column)           | Amino            | 5                  | 100           | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=20/80 |

Base Material : Polyvinyl alcohol

(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     | <b>New</b> HILICpak VG-50 2D  | ≥ 3,500                  | Amino            | 5                  | 100           | <b>2.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=15/85 |
| F6711200     | <b>New</b> HILICpak VG-50G 2A | (guard column)           | Amino            | 5                  | 100           | <b>2.0 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=15/85 |

Base Material : Polyvinyl alcohol

### ● VT-50

(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     | <b>New</b> HILICpak VT-50 2D  | ≥ 4,500                  | Quaternary ammonium | 5                  | 100           | <b>2.0 × 150</b>               | 25mM HCOONH <sub>4</sub> aq. /CH <sub>3</sub> CN=15/85 |
| F6711300     | <b>New</b> HILICpak VT-50G 2A | (guard column)           | Quaternary ammonium | 5                  | 100           | <b>2.0 × 10</b>                | 25mM HCOONH <sub>4</sub> aq. /CH <sub>3</sub> CN=15/85 |

Base Material : Polyvinyl alcohol

## Recovery of reducing sugar

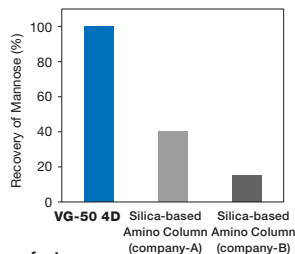
Sample : 5mg/mL each, 5 $\mu$ L  
 1. Fructose  
 2. Mannose  
 3. Glucose  
 4. Sucrose

**VG-50 4D**  
 (4.6mm I.D. x 150mm)

Silica-based amino column  
 (company-A)  
 (4.6mm I.D. x 150mm)

Silica-based amino column  
 (company-B)  
 (4.6mm I.D. x 150mm)

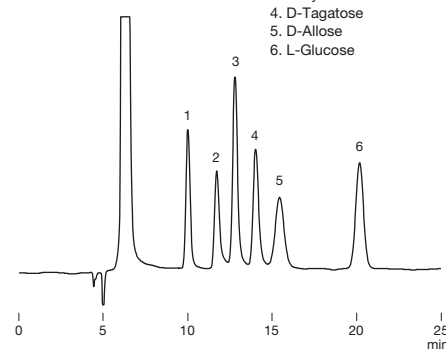
When an amino column is used for analyzing saccharides, the recovery ratio of reducing saccharides such as mannose, arabinose or xylose is low because the amino group forms Schiff base with reducing saccharides. HILICpak VG-50 is the amino column that the recovery ratio of reducing saccharides is improved. By the improvement of the recovery ratio, the sensitivity of the analysis gets higher.



**Column** : Shodex HILICpak VG-50 4D  
**Silica based amino columns from other manufacturers**  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80  
**Flow rate** : 0.6mL/min (VG-50 4D)  
 1.0mL/min (Silica based amino column)  
**Detector** : RI  
**Column temp.** : 40°C

## Rare sugar

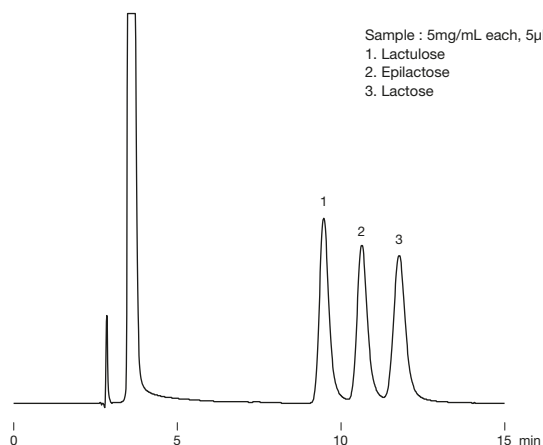
Sample : 0.2% each, 10 $\mu$ L  
 1. L-Ribose  
 2. D-Psicose  
 3. D-Xylitol  
 4. D-Tagatose  
 5. D-Allose  
 6. L-Glucose



**Column** : Shodex HILICpak VG-50 4E  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=5/85/10  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 50°C

## Lactose, epilactose, and aactulose

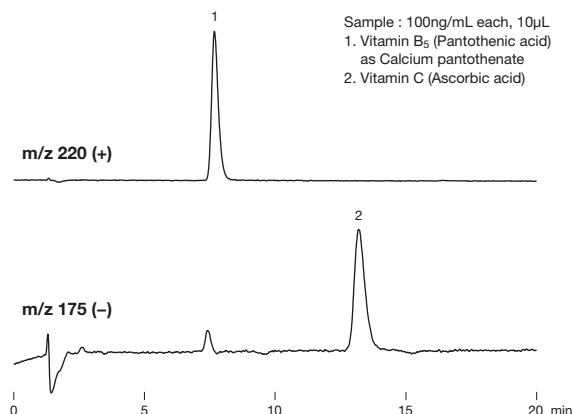
Sample : 5mg/mL each, 5 $\mu$ L  
 1. Lactulose  
 2. Epilactose  
 3. Lactose



**Column** : Shodex HILICpak VG-50 4E  
**Eluent** : H<sub>2</sub>O/CH<sub>3</sub>CN/CH<sub>3</sub>OH=5/75/20  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

## LC/MS analysis of pantothenic acid and vitamin C

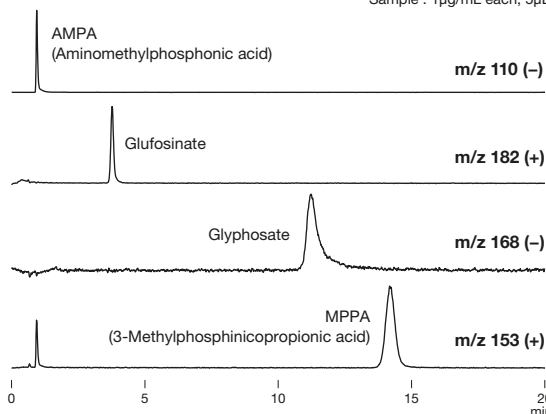
Sample : 100ng/mL each, 10 $\mu$ L  
 1. Vitamin B<sub>5</sub> (Pantothenic acid)  
 as Calcium pantothenate  
 2. Vitamin C (Ascorbic acid)



**Column** : Shodex HILICpak VT-50 2D  
**Eluent** : 50mM HCOONH<sub>4</sub> aq./CH<sub>3</sub>CN=30/70  
**Flow rate** : 0.2mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 30°C

## LC/MS analysis of glyphosate and glufosinate

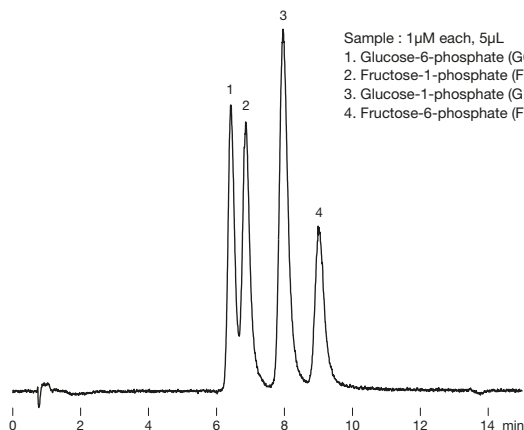
Sample : 1 $\mu$ g/mL each, 5 $\mu$ L



**Column** : Shodex HILICpak VT-50 2D  
**Eluent** : H<sub>2</sub>O/1% HCOOH aq./CH<sub>3</sub>CN=70/20/10  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS (SIM)  
**Column temp.** : 40°C

## LC/MS analysis of phosphorylated saccharides

Sample : 1 $\mu$ M each, 5 $\mu$ L  
 1. Glucose-6-phosphate (G6P)  
 2. Fructose-1-phosphate (F6P)  
 3. Glucose-1-phosphate (G1P)  
 4. Fructose-6-phosphate (F1P)



**Column** : Shodex HILICpak VT-50 2D  
**Eluent** : 25mM HCOONH<sub>4</sub> aq./CH<sub>3</sub>CN=80/20  
**Flow rate** : 0.3mL/min  
**Detector** : ESI-MS (SIM Negative : m/z 259)  
**Column temp.** : 60°C

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

## Features

- NH2P**
- Suitable for saccharides analysis by hydrophilic interaction chromatography (HILIC)
  - Polymer-based packing material provides excellent chemical stability and minimum deterioration over extended time period
  - Easily regenerated by washing in a alkaline solution
  - Also suitable for evaporative light scattering detector, corona charged aerosol detector, and LC/MS
  - Corresponds to USP L82

- NH2P-40**
- Provides higher theoretical plate number compared to NH2P-50 series
  - Corresponds to USP L82

## 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     | <b>Asahipak NH2P-50 4B</b>  | ≥ 1,500                  | Amino            | 5                  | 100           | <b>4.6 × 50</b>                | CH <sub>3</sub> CN |
| F7630002     | <b>Asahipak NH2P-50 4D</b>  | ≥ 5,500                  | Amino            | 5                  | 100           | <b>4.6 × 150</b>               | CH <sub>3</sub> CN |
| F7630001     | <b>Asahipak NH2P-50 4E</b>  | ≥ 7,500                  | Amino            | 5                  | 100           | <b>4.6 × 250</b>               | CH <sub>3</sub> CN |
| F6710016     | <b>Asahipak NH2P-50G 4A</b> | (guard column)           | Amino            | 5                  | –             | <b>4.6 × 10</b>                | CH <sub>3</sub> CN |
| F7630006     | <b>Asahipak NH2P-50 2D</b>  | ≥ 3,500                  | Amino            | 5                  | 100           | <b>2.0 × 150</b>               | CH <sub>3</sub> CN |
| F6713000     | <b>Asahipak NH2P-50G 2A</b> | (guard column)           | Amino            | 5                  | –             | <b>2.0 × 10</b>                | CH <sub>3</sub> CN |
| F7630007     | <b>Asahipak NH2P-40 3E</b>  | ≥ 8,500                  | Amino            | 4                  | 100           | <b>3.0 × 250</b>               | CH <sub>3</sub> CN |
| F6710030     | <b>Asahipak NH2P-50G 3A</b> | (guard column)           | Amino            | 5                  | –             | <b>3.0 × 10</b>                | CH <sub>3</sub> CN |
| F7630008     | <b>Asahipak NH2P-40 2B</b>  | ≥ 2,000                  | Amino            | 4                  | 100           | <b>2.0 × 50</b>                | CH <sub>3</sub> CN |
| F7630009     | <b>Asahipak NH2P-40 2D</b>  | ≥ 5,500                  | Amino            | 4                  | 100           | <b>2.0 × 150</b>               | CH <sub>3</sub> CN |
| F7630010     | <b>Asahipak NH2P-40 2E</b>  | ≥ 7,000                  | Amino            | 4                  | 100           | <b>2.0 × 250</b>               | CH <sub>3</sub> CN |
| F6710100     | <b>Asahipak NH2P-LF</b>     | (line filter)            | Amino            | –                  | –             | <b>8.0 × 75</b>                | CH <sub>3</sub> CN |

Base Material : Polyvinyl alcohol

## 3mm I.D columns [Customized columns]

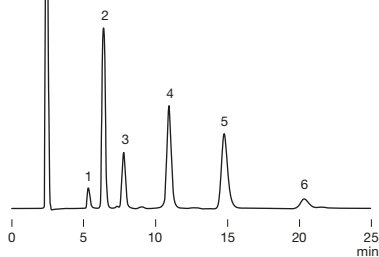
| Product Code | Product Name               | Functional Group | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|----------------------------|------------------|--------------------|---------------|--------------------------------|
| F7630011     | <b>Asahipak NH2P-40 3B</b> | Amino            | 4                  | 100           | <b>3.0 × 50</b>                |
| F7630012     | <b>Asahipak NH2P-40 3D</b> | Amino            | 4                  | 100           | <b>3.0 × 150</b>               |

## 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 | Standard Column |
|--------------|------------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6830001     | <b>Asahipak NH2P-50 10E</b>  | ≥ 10,000                 | 5                  | <b>10.0 × 250</b>              | NH2P-50         |
| F6830031     | <b>Asahipak NH2P-90 20F</b>  | ≥ 10,000                 | 9                  | <b>20.0 × 300</b>              | NH2P-50         |
| F6710017     | <b>Asahipak NH2P-130G 7B</b> | (guard column)           | 13                 | <b>7.5 × 50</b>                | (guard column)  |

## Fructooligosaccharide syrup

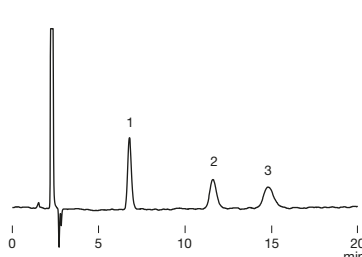
Sample :  
Fructooligosaccharide syrup, 2.5%, 20 $\mu$ L  
1. Fructose  
2. Glucose  
3. Sucrose  
4. 1-Kestose  
5. Nystose  
6. 1-Fructofuranosyl-D-nystose



Column : Shodex Asahipak NH2P-50 4E  
Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=30/70  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 25°C

## Cyclodextrins

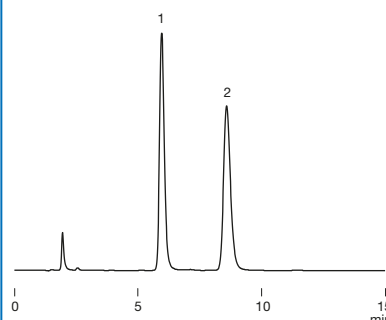
Sample : 250 $\mu$ g/mL each, 20 $\mu$ L  
1.  $\alpha$ -Cyclodextrin  
2.  $\gamma$ -Cyclodextrin  
3.  $\beta$ -Cyclodextrin



Column : Shodex Asahipak NH2P-50 4E  
Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=40/60  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 40°C

## Stevioside and rebaudioside A

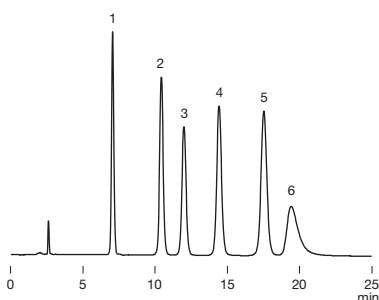
Sample : 0.05% each, 20 $\mu$ L  
1. Stevioside  
2. Rebaudioside A



Column : Shodex Asahipak NH2P-50 4E  
Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
Flow rate : 1.0mL/min  
Detector : UV (210nm)  
Column temp. : 30°C

## Imidazole dipeptides

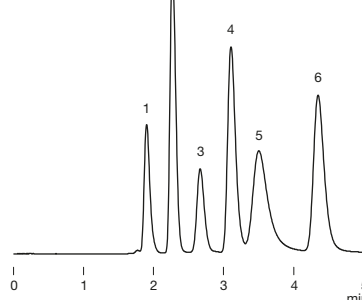
Sample : 20 $\mu$ L  
1.  $\beta$ -Alanine 200 $\mu$ g/mL  
2. 1-Methyl-L-histidine 2 $\mu$ g/mL  
3. L-Anserine 5 $\mu$ g/mL  
4. Histidine 5 $\mu$ g/mL  
5. L-Carnosine 5 $\mu$ g/mL  
6. Nitrate (derived from L-Anserine Nitrate)



Column : Shodex Asahipak NH2P-50 4E  
Eluent : 50mM NaH<sub>2</sub>PO<sub>4</sub> aq./CH<sub>3</sub>CN=40/60  
Flow rate : 1.0mL/min  
Detector : UV (210nm)  
Column temp. : 40°C

## Simultaneous analysis of water-soluble vitamins

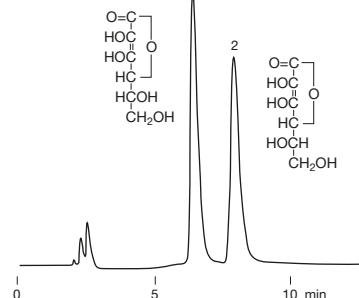
Sample : 20 $\mu$ L  
1. Vitamin B<sub>6</sub> 50 $\mu$ g/mL  
2. Nicotinamide 10 $\mu$ g/mL  
3. Vitamin B<sub>12</sub> 10 $\mu$ g/mL  
4. Nicotinic acid 10 $\mu$ g/mL  
5. Folic acid 10 $\mu$ g/mL  
6. Vitamin C 10 $\mu$ g/mL



Column : Shodex Asahipak NH2P-50 4E  
Eluent : 40mM H<sub>3</sub>PO<sub>4</sub> aq./CH<sub>3</sub>CN=45/55  
Flow rate : 1.0mL/min  
Detector : UV (254nm)  
Column temp. : 40°C

## Ascorbic acid and erythorbic acid

Sample : 5 $\mu$ g/mL each, 10 $\mu$ L  
1. Erythorbic acid  
2. L-Ascorbic acid



Column : Shodex Asahipak NH2P-50 4E  
Eluent : 20mM NaH<sub>2</sub>PO<sub>4</sub> + 30mM H<sub>3</sub>PO<sub>4</sub> aq./CH<sub>3</sub>CN=20/80  
Flow rate : 1.0mL/min  
Detector : UV (254nm)  
Column temp. : 30°C

## Comparison of saccharides analysis using corona charged aerosol detector

Sample : 40 $\mu$ g/mL each, 5 $\mu$ L  
1. Fructose  
2. Glucose

Silica-based amido column  
(4.6mm I.D. x 150mm)

Silica-based amino column  
(4.6mm I.D. x 250mm)

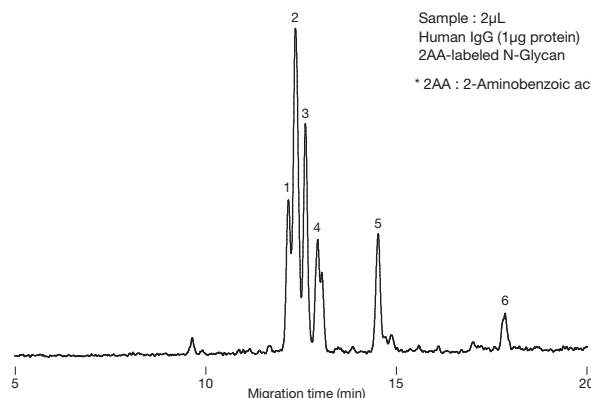
NH2P-50 4E  
(4.6mm I.D. x 250mm)

A corona charged aerosol detector measures effluents as particles. Accordingly, the baseline will be significantly influenced by the components eluted from the column. NH2P series, the polymer based amino columns eliminate the components originated from the column, resulting a stable baseline with lower noise level.

Column : Shodex Asahipak NH2P-50 4E  
Silica based amino column from other manufacturer  
Silica based amide column from other manufacturer  
Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80  
Flow rate : 1.0mL/min  
Detector : Corona charged aerosol  
Column temp : 30°C (NH2P-50 4E, Silica based amino column)  
80°C (Silica based amide column)

## LC/TOF-MS analysis of 2-amino benzoic acid derivatized sugar chains

Sample : 2 $\mu$ L  
Human IgG (1 $\mu$ g protein)  
2AA-labeled N-Glycan  
\* 2AA : 2-Aminobenzoic acid



Column : Shodex Asahipak NH2P-40 2D  
Eluent : (A); 95% CH<sub>3</sub>CN/0.1% Formic acid aq.  
(B); 5% CH<sub>3</sub>CN/0.1% Formic acid aq.  
Linear gradient; (B) 30% (0-2.5min), 30-95% (2.5-20min)  
Flow rate : 0.2mL/min  
Detector : ESI-TOF MS (Polarity : Negative, Full MS range : 2000 )  
Column temp. : 45°C

Data provided by Michihiro Kinoshita Ph.D.,  
Faculty of Pharmacy, Kinki University

# Columns for Ligand Exchange Chromatography

\* A list of elution volume of saccharides for Shodex columns is available.  
Please refer to our website ([www.shodex.de](http://www.shodex.de)) or technical notebook (No.2 and 3).

## Features

- |                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SC1011</b><br><b>SC1821</b><br><b>SP0810</b><br><b>KS-801 to 802</b> | <ul style="list-style-type: none"> <li>• Separates saccharides by the combination of ligand exchange and size exclusion modes</li> <li>• Three types of counter ions are available: Ca<sup>2+</sup>, Pb<sup>2+</sup>, and Na<sup>+</sup></li> <li>• Only water is required for the analysis of neutral sugars</li> <li>• SC1011 and SC1821 correspond to USP L19 and L22</li> <li>• SP0810 corresponds to USP L22 and L34</li> <li>• KS-801 and KS-802 correspond to USP L22 and L58</li> </ul>       |
| <b>KS-803 to 807</b>                                                    | <ul style="list-style-type: none"> <li>• Suitable for separation of polysaccharides by size exclusion mode</li> <li>• Can be used in combination with other columns e.g., KS-802 and KS-801</li> <li>• Only water is required for the analysis of neutral sugars</li> <li>• Corresponds to USP L22 and L58</li> </ul>                                                                                                                                                                                 |
| <b>DC-613</b><br><b>SZ5532</b><br><b>SC1211</b>                         | <ul style="list-style-type: none"> <li>• Separates by the combination of ligand exchange and HILIC modes</li> <li>• DC-613 can analyze sugars without removing sodium salts in the sample</li> <li>• SZ5532 is recommended for the separation of disaccharides or trisaccharides</li> <li>• SC1211 is suitable for separation of sugar alcohols</li> <li>• DC-613 corresponds to USP L22 and L58</li> <li>• SZ5532 corresponds to USP L22</li> <li>• SC1211 corresponds to USP L19 and L22</li> </ul> |
| <b>SC1011-7F</b>                                                        | <ul style="list-style-type: none"> <li>• For the analysis of mannitol under the method of JP, USP and EP</li> <li>• Ca-type ligand exchange chromatography column</li> <li>• Only water is required for the analysis of neutral sugars</li> <li>• Corresponds to USP L19 and L22</li> </ul>                                                                                                                                                                                                           |

## Standard columns

### ● Ligand exchange and size exclusion

| 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     | <b>SUGAR SC1011</b>                | ≥ 13,000                 | Sulfo (Ca <sup>2+</sup> )      | 1,000                      | 6                  | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6378103     | <b>SUGAR SC1821</b>                | ≥ 13,000                 | Sulfo (Ca <sup>2+</sup> )      | 10,000                     | 6                  | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6700090     | <b>SUGAR SC-G 6B (SUGAR SC-LG)</b> | (guard column)           | Sulfo (Ca <sup>2+</sup> )      | –                          | 10                 | <b>6.0 × 50</b>                | H <sub>2</sub> O |
| F6378105     | <b>SUGAR SP0810</b>                | ≥ 11,000                 | Sulfo (Pb <sup>2+</sup> )      | 1,000                      | 7                  | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6700081     | <b>SUGAR SP-G 6B (SUGAR SP-G)</b>  | (guard column)           | Sulfo (Pb <sup>2+</sup> )      | –                          | 10                 | <b>6.0 × 50</b>                | H <sub>2</sub> O |
| F6378010     | <b>SUGAR KS-801</b>                | ≥ 17,000                 | Sulfo (Na <sup>+</sup> )       | 1,000                      | 6                  | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6378020     | <b>SUGAR KS-802</b>                | ≥ 17,000                 | Sulfo (Na <sup>+</sup> )       | 10,000                     | 6                  | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6378025     | <b>SUGAR KS-803</b>                | ≥ 17,000                 | Sulfo (Na <sup>+</sup> )       | 50,000                     | 6                  | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6378035     | <b>SUGAR KS-804</b>                | ≥ 17,000                 | Sulfo (Na <sup>+</sup> )       | 400,000                    | 7                  | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6378050     | <b>SUGAR KS-805</b>                | ≥ 9,000                  | Sulfo (Na <sup>+</sup> )       | 5,000,000                  | 17                 | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6378060     | <b>SUGAR KS-806</b>                | ≥ 9,000                  | Sulfo (Na <sup>+</sup> )       | *(50,000,000)              | 17                 | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6700020     | <b>SUGAR KS-G 6B (SUGAR KS-G)</b>  | (guard column)           | Sulfo (Na <sup>+</sup> )       | –                          | 10                 | <b>6.0 × 50</b>                | H <sub>2</sub> O |
| F6378070     | <b>SUGAR KS-807</b>                | ≥ 4,000                  | Sulfo (Na <sup>+</sup> )       | *(200,000,000)             | 30                 | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6700021     | <b>SUGAR KS-807G</b>               | (guard column)           | Sulfo (Na <sup>+</sup> )       | –                          | 30                 | <b>8.0 × 50</b>                | H <sub>2</sub> O |

\*( ) Estimated value 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     | <b>RSpak DC-613</b>                  | ≥ 5,500                  | Sulfo (Na <sup>+</sup> )       | 6                  | 100           | <b>6.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=30/70 |
| F6700170     | <b>RSpak DC-G 4A (RSpak DC-G)</b>    | (guard column)           | Sulfo (Na <sup>+</sup> )       | 10                 | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=30/70 |
| F7001300     | <b>SUGAR SZ5532</b>                  | ≥ 5,500                  | Sulfo (Zn <sup>2+</sup> )      | 6                  | –             | <b>6.0 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=30/70 |
| F6700110     | <b>SUGAR SZ-G</b>                    | (guard column)           | Sulfo (Zn <sup>2+</sup> )      | 6                  | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=30/70 |
| F7001400     | <b>SUGAR SC1211</b>                  | ≥ 5,500                  | Sulfo (Ca <sup>2+</sup> )      | 6                  | 50            | <b>6.0 × 250</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=75/25 |
| F6700120     | <b>SUGAR SC1211G 4A (SUGAR SC-G)</b> | (guard column)           | Sulfo (Ca <sup>2+</sup> )      | 10                 | –             | <b>4.6 × 10</b>                | H <sub>2</sub> O/CH <sub>3</sub> CN=75/25 |

Base Material : Styrene divinylbenzene copolymer

## For the analysis of mannitol in conformity with JP and USP

| Product Code | Product Name         | Functional Group (Counter Ion) | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|----------------------|--------------------------------|--------------------|--------------------------------|------------------|
| F6379300     | <b>EP SC1011-7F</b>  | Sulfo (Ca <sup>2+</sup> )      | 8                  | <b>7.8 × 300</b>               | H <sub>2</sub> O |
| F6379230     | <b>USPpak MN-431</b> | Sulfo (Ca <sup>2+</sup> )      | 8                  | <b>4.0 × 250</b>               | H <sub>2</sub> O |

See p.75 for USP (Ver.38) Column List.

Base Material : Styrene divinylbenzene copolymer

## Preparative columns \* Preparative columns are made to order.

## ● Ligand exchange and size exclusion

| Product Code | Product Name                       | Plate Number (TP/column) | Particle Size (μm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|------------------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6502007     | <b>SUGAR KS-2001</b>               | ≥ 7,000                  | 13                 | <b>20.0 × 300</b>              | KS-801          |
| F6502008     | <b>SUGAR KS-2002</b>               | ≥ 7,000                  | 13                 | <b>20.0 × 300</b>              | KS-802          |
| F6502009     | <b>SUGAR KS-2003</b>               | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | KS-803          |
| F6502010     | <b>SUGAR KS-2004</b>               | ≥ 6,000                  | 18                 | <b>20.0 × 300</b>              | KS-804          |
| F6502011     | <b>SUGAR KS-2005</b>               | ≥ 6,000                  | 18                 | <b>20.0 × 300</b>              | KS-805          |
| F6502012     | <b>SUGAR KS-2006</b>               | ≥ 6,000                  | 18                 | <b>20.0 × 300</b>              | KS-806          |
| F6700002     | <b>SUGAR KS-G 8B (SUGAR KS-LG)</b> | (guard column)           | 13                 | <b>8.0 × 50</b>                | (guard column)  |

## ● Ligand exchange and HILIC

| Product Code | Product Name                         | Plate Number (TP/column) | Particle Size (μm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|--------------------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6514013     | <b>RSpak DC-2013</b>                 | ≥ 6,000                  | 10                 | <b>20.0 × 300</b>              | DC-613          |
| F6700402     | <b>RSpak DC-G 8B (RSpak DC-LG)</b>   | (guard column)           | 10                 | <b>8.0 × 50</b>                | (guard column)  |
| F6514021     | <b>RSpak DC-5013</b>                 | —                        | 10                 | <b>50.0 × 300</b>              | DC-613          |
| F6700172     | <b>RSpak DC-G 20C (RSpak DC-LLG)</b> | (guard column)           | 10                 | <b>20.0 × 100</b>              | (guard column)  |

## Elution volume of saccharides analysis with various 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  |
| meso-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   |
| myo-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   |

(-)→Not detected (+)→Overlap with solvent peak

| Substances     | Elution Volume (mL) |        |        |        |            |        |
|----------------|---------------------|--------|--------|--------|------------|--------|
|                | SP0810              | SC1011 | KS-801 | SZ5532 | NH2P-50 4E | SC1211 |
| 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      | 2peaks              | 2peaks | 5.90   | 2peaks | 12.73      | 2peaks |
| 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 : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 80°C

Column : SUGAR SC1211  
Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=65/35  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 70°C

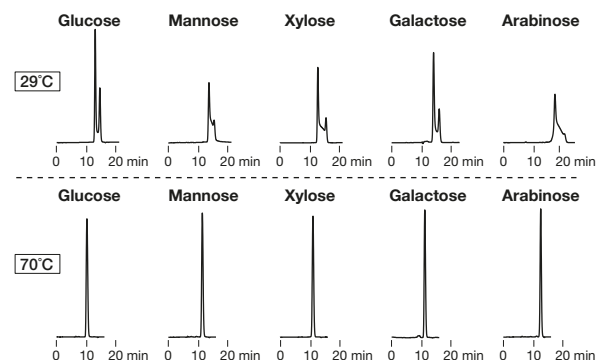
Column : SUGAR SZ5532  
Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 60°C

Column : Asahipak NH2P-50 4E  
Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 30°C

## Anomer separation of saccharides

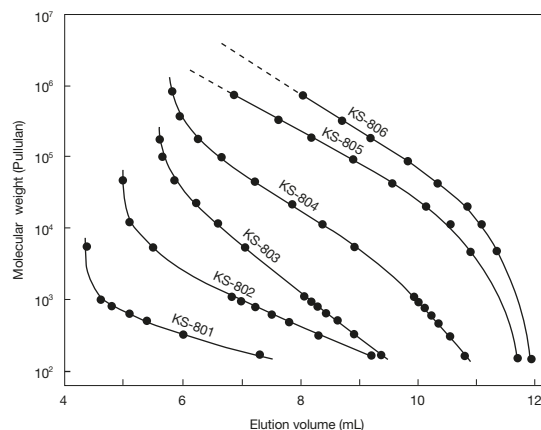
Temperature can affect chromatograms when separating saccharide anomers. When using a SUGAR column to analyze saccharides, the analysis at high temperatures would suppress the influence of anomer separation, resulting in better chromatograms.

Sample :  
0.5% each, 10 $\mu$ L



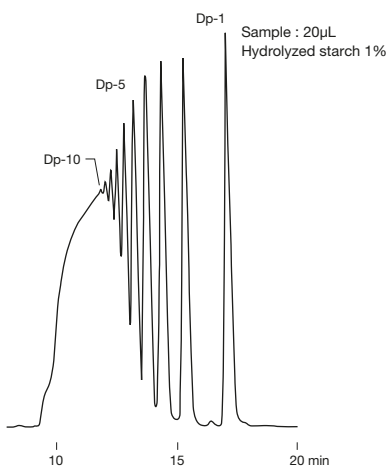
Column : Shodex SUGAR SC1011  
Eluent : H<sub>2</sub>O  
Flow rate : 0.7mL/min  
Detector : RI  
Column temp. : 29°C, 70°C

## Calibration curves for KS-800 series using pullulan



Column : Shodex SUGAR KS-800 series  
Eluent : H<sub>2</sub>O  
Detector : RI  
Column temp. : 80°C

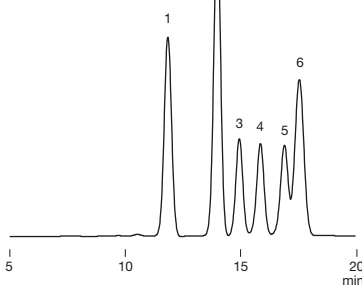
## Hydrolyzed starch



Sample : 20 $\mu$ L  
Hydrolyzed starch 1%  
Column : Shodex SUGAR KS-802 x 2  
Eluent : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 80°C

## Saccharides in wood (model)

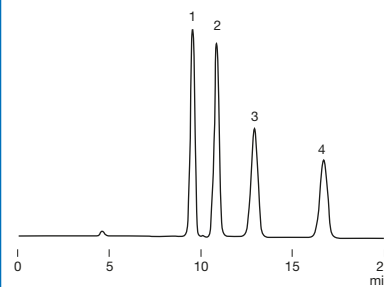
Sample : 5 $\mu$ L  
1. Cellobiose 1.0%  
2. Glucose 1.5%  
3. Xylose 0.5%  
4. Galactose 0.5%  
5. Arabinose 0.5%  
6. Mannose 1.0%



Column : Shodex SUGAR SP0810  
Eluent : H<sub>2</sub>O  
Flow rate : 0.6mL/min  
Detector : RI  
Column temp. : 85°C

## Ketohexoses

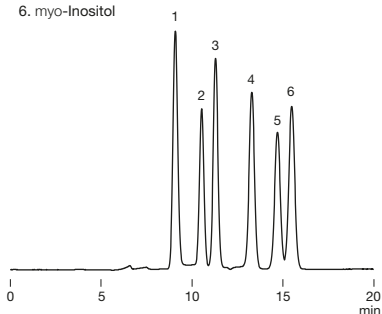
Sample : 0.025% each, 10 $\mu$ L  
1. Sorbose  
2. Fructose  
3. Tagatose  
4. Psicose



Column : Shodex SUGAR SP0810  
Eluent : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 80°C

## Pinitol

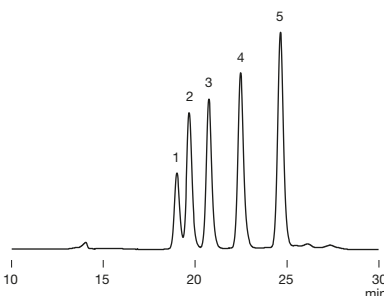
Sample : 0.1% each, 20 $\mu$ L  
1. Sucrose  
2. Glucose  
3. Pinitol  
4. Fructose  
5. chiro-Inositol  
6. myo-Inositol



Column : Shodex SUGAR SP0810  
Eluent : H<sub>2</sub>O  
Flow rate : 0.8mL/min  
Detector : RI  
Column temp. : 85°C

## Oligosaccharides in soybean

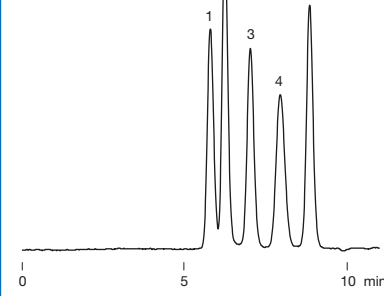
Sample : 0.1% each, 20 $\mu$ L  
1. Verbascose  
2. Stachyose  
3. Raffinose  
4. Sucrose  
5. Pinitol



Column : Shodex SUGAR KS-802 + KS-801  
Eluent : H<sub>2</sub>O  
Flow rate : 0.6mL/min  
Detector : RI  
Column temp. : 85°C

## Saccharides related to raffinose biosynthesis

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

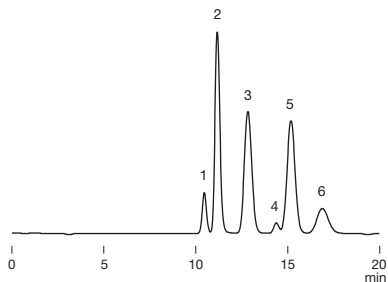


Column : Shodex SUGAR SC1011  
Eluent : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 80°C

## Acesulfame K and sucralose

Sample : 20 $\mu$ 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%

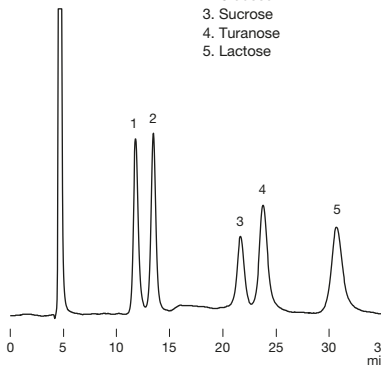


Column : Shodex SUGAR SC1011  
 Eluent : 10mM CaSO<sub>4</sub> aq.  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 80°C

## Sucrose and turanose

Sample : 0.5% each, 10 $\mu$ L

1. Fructose
2. Glucose
3. Sucrose
4. Turanose
5. Lactose

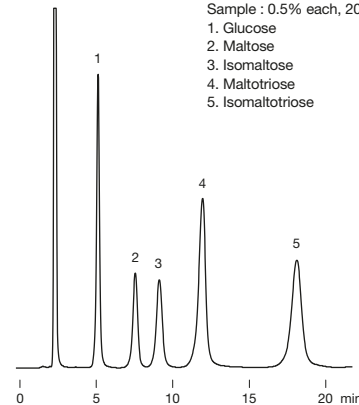


Column : Shodex SUGAR SZ5532  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 60°C

## Maltose and isomaltose

Sample : 0.5% each, 20 $\mu$ L

1. Glucose
2. Maltose
3. Isomaltose
4. Maltotriose
5. Isomaltotriose

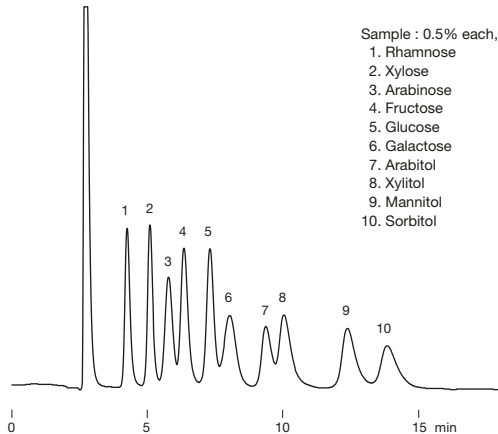


Column : Shodex SUGAR SZ5532  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=25/75  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 60°C

## Saccharides and sugar alcohols

Sample : 0.5% each, 20 $\mu$ L

1. Rhamnose
2. Xylose
3. Arabinose
4. Fructose
5. Glucose
6. Galactose
7. Arabitol
8. Xylitol
9. Mannitol
10. Sorbitol

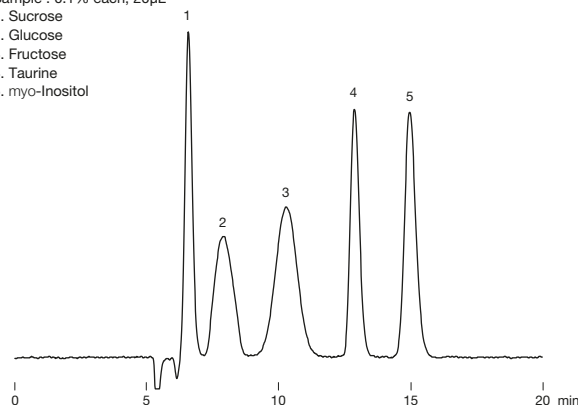


Column : Shodex SUGAR SZ5532  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=20/80  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 65°C

## Saccharides and Amino Acids

Sample : 0.1% each, 20 $\mu$ L

1. Sucrose
2. Glucose
3. Fructose
4. Taurine
5. myo-Inositol

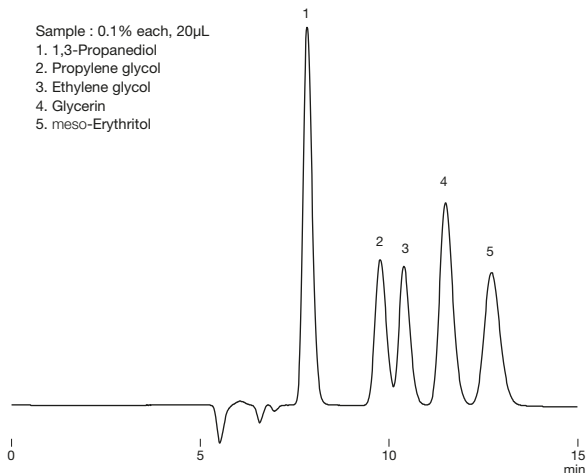


Column : Shodex SUGAR SC1211  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=60/40  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 70°C

## Moisturizing components

Sample : 0.1% each, 20 $\mu$ L

1. 1,3-Propanediol
2. Propylene glycol
3. Ethylene glycol
4. Glycerin
5. meso-Erythritol



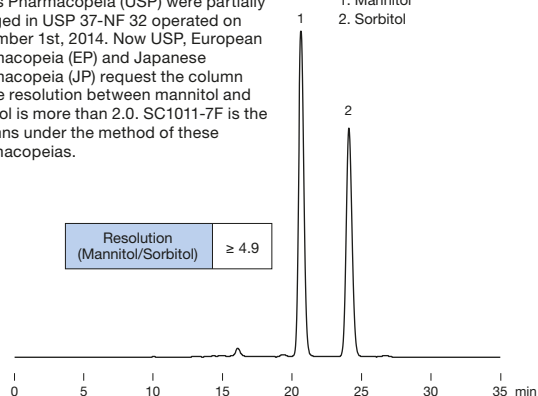
Column : Shodex SUGAR SC1211  
 Eluent : H<sub>2</sub>O/CH<sub>3</sub>CN=60/40  
 Flow rate : 0.6mL/min  
 Detector : RI  
 Column temp. : 40°C

## Mannitol and sorbitol

Analytical conditions of mannitol for United States Pharmacopeia (USP) were partially changed in USP 37-NF 32 operated on December 1st, 2014. Now USP, European Pharmacopeia (EP) and Japanese Pharmacopeia (JP) request the column whose resolution between mannitol and sorbitol is more than 2.0. SC1011-7F is the columns under the method of these pharmacopeias.

Sample : 25mg/mL each, 20 $\mu$ L

1. Mannitol
2. Sorbitol



Column : Shodex EP SC1011-7F  
 Eluent : H<sub>2</sub>O  
 Flow rate : 0.5mL/min  
 Detector : RI  
 Column temp. : 85°C

# Columns for Ion Exclusion Chromatography

## Features

- SH1011** • Columns for simultaneous analysis of saccharides and organic acids
  - SH1821** • Separates neutral sugars in size exclusion mode and organic acids in ion exclusion mode
    - Suitable for the analysis of uronic and aldonic acids
    - Corresponds to USP L17 and L22
- 
- KC-811** • Columns for the analysis of organic acids
    - Ion exclusion mode (+ reversed phase mode)
    - Highly selective detection 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
    - Corresponds to USP L17 and L22

## Standard columns

### ● For simultaneous analysis of saccharides and organic acids

| 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     | <b>SUGAR SH1011</b> | ≥ 17,000                 | Sulfo            | 1,000                      | 6                  | <b>8.0 x 300</b>               | H <sub>2</sub> O |
| F6378101     | <b>SUGAR SH1821</b> | ≥ 17,000                 | Sulfo            | 10,000                     | 6                  | <b>8.0 x 300</b>               | H <sub>2</sub> O |
| F6700080     | <b>SUGAR SH-G</b>   | (guard column)           | Sulfo            | –                          | 10                 | <b>6.0 x 50</b>                | H <sub>2</sub> O |

Base Material : Styrene divinylbenzene copolymer

### ● For organic acids, cyanide ions and cyanogen chloride

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

\* As a guard column, use KC-G 8B for samples with relatively high impurity and KC-G 6B for samples with relatively low impurity.

Base Material : Styrene divinylbenzene copolymer

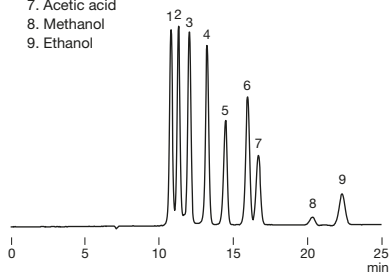
## Preparative columns \* Preparative columns are made to order.

| Product Code | Product Name                       | Plate Number (TP/column) | Particle Size (μm) | Column Size (mm) I.D. x Length | Standard Column |
|--------------|------------------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6505012     | <b>RSpak KC-2011</b>               | ≥ 8,000                  | 13                 | <b>20.0 x 300</b>              | KC-811          |
| F6700010     | <b>RSpak KC-G 8B (RSpak KC-LG)</b> | (guard column)           | 13                 | <b>8.0 x 50</b>                | (guard column)  |

### Maltooligosaccharides, organic acids and ethanol

Sample : 0.05% each, 20 $\mu$ L

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

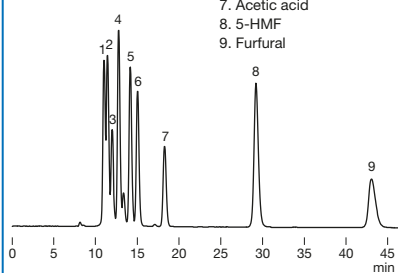


**Column** : Shodex SUGAR SH1821  
**Eluent** : 0.5mM H<sub>2</sub>SO<sub>4</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 75°C

### Cello-oligosaccharides and furfurals

Sample : 0.1% each, 10 $\mu$ L

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

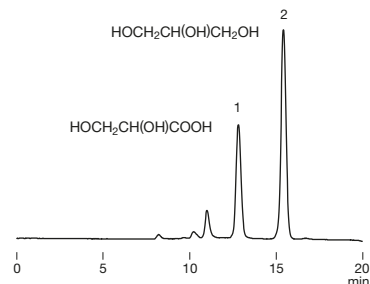


**Column** : Shodex SUGAR SH1821  
**Eluent** : 2mM H<sub>2</sub>SO<sub>4</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 60°C

### Glycerin and glyceric acid

Sample : 0.1% each, 10 $\mu$ L

1. Glyceric acid
2. Glycerin

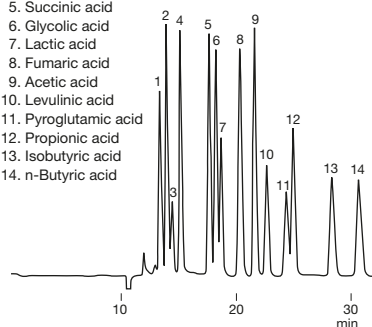


**Column** : Shodex SUGAR SH1011  
**Eluent** : 2mM H<sub>2</sub>SO<sub>4</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 60°C

### General 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

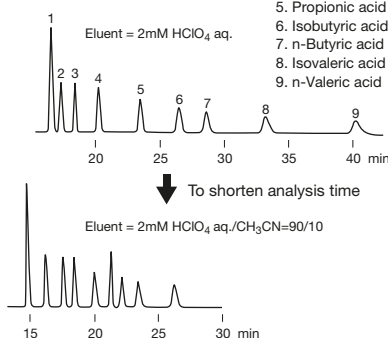


**Column** : Shodex RSPak KC-811 x 2  
**Eluent** : 6mM HClO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : VIS (430nm)  
 post column method  
**Column temp.** : 50°C

### Hydrophobic organic acids

Sample :

1. Succinic acid
2. Lactic acid
3. Formic acid
4. Acetic acid
5. Propionic acid
6. Isobutyric acid
7. n-Butyric acid
8. Isovaleric acid
9. n-Valeric acid

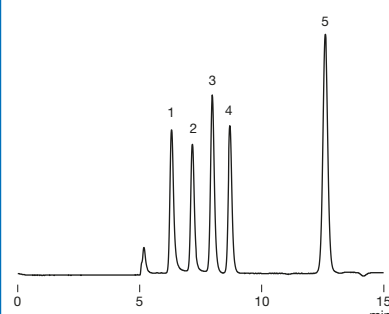


**Column** : Shodex RSPak KC-LG + KC-811 x 2  
**Flow rate** : 1.0mL/min  
**Detector** : VIS (430nm)  
 post column method  
**Column temp.** : 47°C

### Glucronolactone and organic acids

Sample : 20 $\mu$ L

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

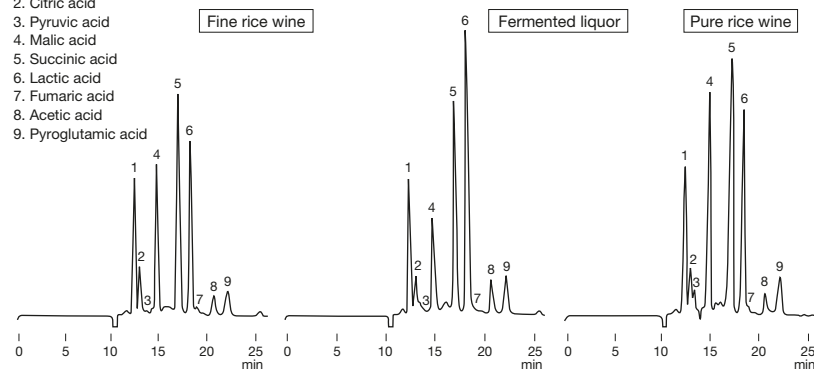


**Column** : Shodex RSPak KC-811  
**Eluent** : 3mM HClO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

### Organic acids in sake

Sample : 100 $\mu$ L

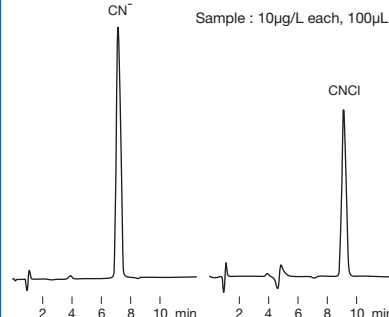
1. Phosphoric acid etc.
2. Citric acid
3. Pyruvic acid
4. Malic acid
5. Succinic acid
6. Lactic acid
7. Fumaric acid
8. Acetic acid
9. Pyroglutamic acid



**Column** : Shodex RSPak KC-LG + KC-811 x 2  
**Eluent** : 4.8mM HClO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : VIS (430nm)  
 post column method  
**Column temp.** : 63°C

### Analysis of Cyanide ion and cyanogen chloride with post column method

Sample : 10 $\mu$ g/L each, 100 $\mu$ L



**Column** : Shodex RSPak KC-811 6E  
**Eluent** : 1.0mM H<sub>2</sub>SO<sub>4</sub> aq.  
**Reagent A** : Chloramine T solution  
**Reagent B** : 4-Pyridinecarboxylic acid-Pyrazolone solution  
**Flow rate** : (Eluent) 1.0mL/min  
 (Reagent) 0.5mL/min each  
**Detector** : VIS (638nm)  
**Column temp.** : 40°C  
**Reaction temp.** : (Reagent A) 40°C  
 (Reagent B) 80°C

# Columns for Ion Chromatography (Anion Analysis)

## Features

- |                 |                                                                                 |
|-----------------|---------------------------------------------------------------------------------|
| <b>NI-424</b>   | • Columns for anion analysis with non-suppressor method                         |
| <b>I-524A</b>   | • NI-424 supports simultaneous analysis of fluoride and phosphate ions          |
| <b>SI-90 4E</b> | • Columns for anion analysis with suppressor method                             |
| <b>SI-50 4E</b> | • Suitable for the quantitative analysis of fluoride ion                        |
|                 | • SI-50 separates target inorganic anions from organic acids                    |
|                 | • Not interfered by the system peak derived from carbonate                      |
| <b>SI-35 4D</b> | • Columns for the analysis of oxyhalides with suppressor method                 |
| <b>SI-52 4E</b> | • SI-35 supports rapid analysis of oxyhalides and general inorganic ions        |
|                 | • SI-52 supports simultaneous analysis of oxyhalides and general inorganic ions |

## Standard columns

### ● For anions (non-suppressor method)

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

Base Material : Polyhydroxymethacrylate  
Housing Material : SUS

### ● For anions (suppressor method)

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

Base Material : Polyvinyl alcohol  
Housing Material : PEEK

### ● For oxyhalides (suppressor method)

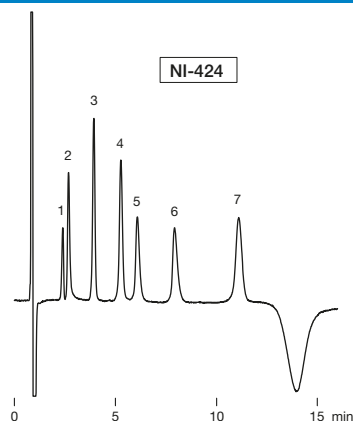
| Product Code | Product Name       | Plate Number (TP/column) | Functional Group    | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent                          |
|--------------|--------------------|--------------------------|---------------------|--------------------|--------------------------------|-------------------------------------------|
| F6995290     | <b>IC SI-35 4D</b> | ≥ 13,000                 | Quaternary ammonium | 3.5                | <b>4.0 × 150</b>               | 3.6mM Na <sub>2</sub> CO <sub>3</sub> aq. |
| F6709627     | <b>IC SI-95G</b>   | (guard column)           | Quaternary ammonium | 9                  | <b>4.6 × 10</b>                | 3.6mM Na <sub>2</sub> CO <sub>3</sub> aq. |
| F6995260     | <b>IC SI-52 4E</b> | ≥ 14,000                 | Quaternary ammonium | 5                  | <b>4.0 × 250</b>               | 3.6mM Na <sub>2</sub> CO <sub>3</sub> aq. |
| F6709626     | <b>IC SI-92G</b>   | (guard column)           | Quaternary ammonium | 9                  | <b>4.6 × 10</b>                | 3.6mM Na <sub>2</sub> CO <sub>3</sub> aq. |

Base Material : Polyvinyl alcohol  
Housing Material : PEEK

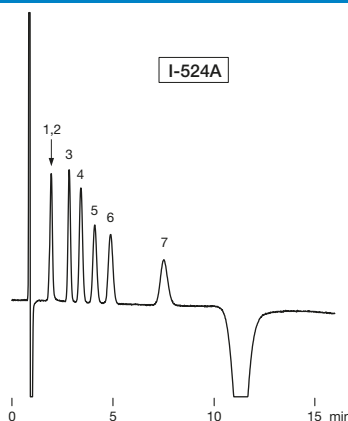
## Line filters for IC

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

## Anions analysis with non-suppressor method (NI-424 and I-524A)



Sample : 20 $\mu$ L  
 1. H<sub>2</sub>PO<sub>4</sub><sup>-</sup> 10mg/L  
 2. F<sup>-</sup> 1mg/L  
 3. Cl<sup>-</sup> 1mg/L  
 4. NO<sub>2</sub><sup>-</sup> 5mg/L  
 5. Br<sup>-</sup> 5mg/L  
 6. NO<sub>3</sub><sup>-</sup> 5mg/L  
 7. SO<sub>4</sub><sup>2-</sup> 5mg/L



NI-424 is a high performance type of column offers an increased theoretical plate number twice as much as I-524A.

## [Features of NI-424]

- (1) Enables the separation of H<sub>2</sub>PO<sub>4</sub><sup>-</sup> and F<sup>-</sup> which were difficult to separate with I-524A.
- (2) The shape of each peak is sharper, and the separation balance is proper. Especially, the separation of Cl<sup>-</sup> and NO<sub>2</sub><sup>-</sup> is improved.

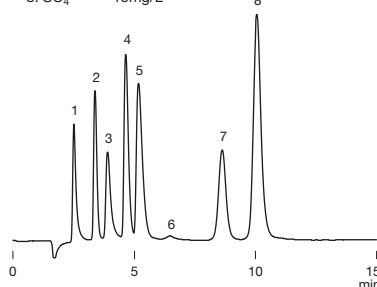
**Column** : Shodex IC NI-424  
**Eluent** : 8mM 4-Hydroxybenzoic acid + 2.8mM Bis-Tris  
 + 2mM Phenylboronic acid + 0.005mM \*CyDTA aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

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

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

## Anions analysis using SI-90 4E (suppressor method)

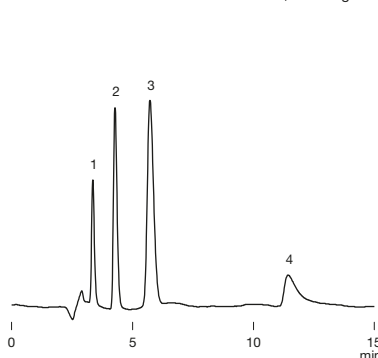
Sample : 20 $\mu$ L  
 1. F<sup>-</sup> 2mg/L  
 2. Cl<sup>-</sup> 3mg/L  
 3. NO<sub>2</sub><sup>-</sup> 5mg/L  
 4. Br<sup>-</sup> 10mg/L  
 5. NO<sub>3</sub><sup>-</sup> 10mg/L  
 6. HCO<sub>3</sub><sup>-</sup> 300mg/L  
 7. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 8. SO<sub>4</sub><sup>2-</sup> 15mg/L



**Column** : Shodex IC SI-90 4E  
**Eluent** : 1.8mM Na<sub>2</sub>CO<sub>3</sub> + 1.7mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 1.5mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : Room temp. (25°C)

## Perchloric acid analysis using SI-90 4E (suppressor method)

Sample : 100 $\mu$ L  
 1. Cl<sup>-</sup> 3mg/L  
 2. NO<sub>3</sub><sup>-</sup> 10mg/L  
 3. SO<sub>4</sub><sup>2-</sup> 15mg/L  
 4. ClO<sub>4</sub><sup>-</sup> 10mg/L

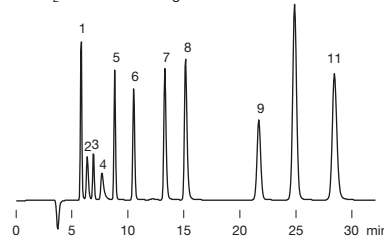


**Column** : Shodex IC SI-90 4E  
**Eluent** : 6mM Na<sub>2</sub>CO<sub>3</sub> aq. + 10% CH<sub>3</sub>CN  
**Flow rate** : 1.0mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 25°C

## Anions 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 eluted between F<sup>-</sup> and Cl<sup>-</sup>. The carbonate system peak appears between NO<sub>2</sub><sup>-</sup> and Br<sup>-</sup> peaks.

Sample : 20 $\mu$ L  
 1. F<sup>-</sup> 2mg/L  
 2. Acetic acid 10mg/L  
 3. Formic acid 2mg/L  
 4. Methacrylic acid 10mg/L  
 5. Cl<sup>-</sup> 3mg/L  
 6. NO<sub>2</sub><sup>-</sup> 5mg/L  
 7. Br<sup>-</sup> 10mg/L  
 8. NO<sub>3</sub><sup>-</sup> 10mg/L  
 9. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 10. SO<sub>4</sub><sup>2-</sup> 15mg/L  
 11. Oxalic acid 15mg/L



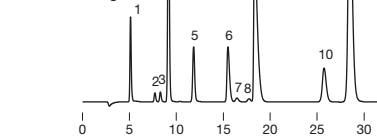
**Column** : Shodex IC SI-50 4E  
**Eluent** : 3.2mM Na<sub>2</sub>CO<sub>3</sub> + 1.0mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 0.7mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 25°C

## 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. The recommended analysis temperature is 45°C.

Sample : 50 $\mu$ L

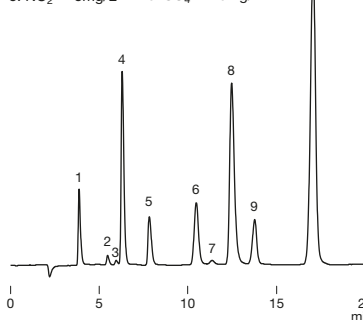
1. F<sup>-</sup> 2mg/L  
 2. ClO<sub>2</sub><sup>-</sup> 1mg/L  
 3. BrO<sub>3</sub><sup>-</sup> 1mg/L  
 4. Cl<sup>-</sup> 10mg/L  
 5. NO<sub>2</sub><sup>-</sup> 5mg/L  
 6. Br<sup>-</sup> 10mg/L  
 7. ClO<sub>3</sub><sup>-</sup> 1mg/L  
 8. Dichloroacetic acid 1mg/L  
 9. NO<sub>3</sub><sup>-</sup> 30mg/L  
 10. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 11. SO<sub>4</sub><sup>2-</sup> 40mg/L



**Column** : Shodex IC SI-52 4E  
**Eluent** : 3.6mM Na<sub>2</sub>CO<sub>3</sub> aq.  
**Flow rate** : 0.8mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 45°C

## Oxyhalides and anions analysis using SI-35 4D (suppressor method)

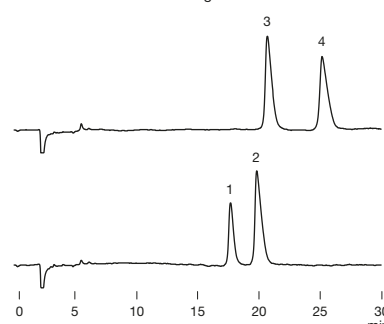
Sample : 20 $\mu$ L  
 1. F<sup>-</sup> 2mg/L  
 2. ClO<sub>2</sub><sup>-</sup> 1mg/L  
 3. BrO<sub>3</sub><sup>-</sup> 1mg/L  
 4. Cl<sup>-</sup> 10mg/L  
 5. NO<sub>2</sub><sup>-</sup> 5mg/L  
 6. Br<sup>-</sup> 10mg/L  
 7. ClO<sub>3</sub><sup>-</sup> 1mg/L  
 8. NO<sub>3</sub><sup>-</sup> 30mg/L  
 9. PO<sub>4</sub><sup>3-</sup> 15mg/L  
 10. SO<sub>4</sub><sup>2-</sup> 40mg/L



**Column** : Shodex IC SI-35 4D  
**Eluent** : 2.0mM Na<sub>2</sub>CO<sub>3</sub> +  
 4.5mM NaHCO<sub>3</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 45°C

## Tricarboxylic acid (suppressor method)

Sample : 20 $\mu$ L  
 1. Citric acid 10mg/L  
 2. Isocitric acid 50mg/L  
 3. trans-Aconitic acid 20mg/L  
 4. cis-Aconitic acid 20mg/L



**Column** : Shodex IC SI-35 4D  
**Eluent** : 9.0mM Na<sub>2</sub>CO<sub>3</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : Suppressed conductivity  
**Column temp.** : 45°C

# Columns for Ion Chromatography (Cation Analysis)

## Features

- |               |                                                                                                                                                                                                                                                                                                         |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>YS-50</b>  | <ul style="list-style-type: none"> <li>• High performance type of YK-421</li> <li>• Applicable to both suppressor and non-suppressor methods</li> <li>• Peak shape is sharper, especially for divalent cation analysis</li> <li>• Supports the analysis of alkylamines and transition metals</li> </ul> |
| <b>YK-421</b> | <ul style="list-style-type: none"> <li>• Column for cation analysis with non-suppressor method</li> <li>• Simultaneous analysis of monovalent and divalent cations</li> <li>• Suitable for separation of alkylamines</li> </ul>                                                                         |
| <b>Y-521</b>  | <ul style="list-style-type: none"> <li>• Column for cation analysis with non-suppressor method</li> <li>• For the separation of monovalent or divalent cations</li> <li>• Corresponds to USP L17 and L22</li> </ul>                                                                                     |
| <b>T-521</b>  | <ul style="list-style-type: none"> <li>• Column for transition metal ion analysis</li> <li>• Highly sensitive analysis is achieved by post column color reaction method</li> </ul>                                                                                                                      |

## Standard columns

### ● For cations

| Product Code | Product Name     | Plate Number (TP/column) | Functional Group | Base Material                    | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent                                                 |
|--------------|------------------|--------------------------|------------------|----------------------------------|--------------------|--------------------------------|------------------------------------------------------------------|
| F7122000     | <b>IC YS-50</b>  | ≥ 5,500                  | Carboxyl         | Polyvinyl alcohol                | 5                  | <b>4.6 × 125</b>               | H <sub>2</sub> O                                                 |
| F6700530     | <b>IC YS-G</b>   | (guard column)           | Carboxyl         | Polyvinyl alcohol                | 5                  | <b>4.6 × 10</b>                | H <sub>2</sub> O                                                 |
| F7120012     | <b>IC YK-421</b> | ≥ 2,800                  | Carboxyl         | Silica                           | 5                  | <b>4.6 × 125</b>               | 5mM Tartaric acid + 1mM Dipicolinic acid + 1.5g/L Boric acid aq. |
| F6709608     | <b>IC YK-G</b>   | (guard column)           | Carboxyl         | Silica                           | 5                  | <b>4.6 × 10</b>                | 5mM Tartaric acid + 1mM Dipicolinic acid + 1.5g/L Boric acid aq. |
| F6995210     | <b>IC Y-521</b>  | ≥ 3,000                  | Sulfo            | Styrene divinylbenzene copolymer | 12                 | <b>4.6 × 150</b>               | 4mM HNO <sub>3</sub> aq.                                         |
| F6700230     | <b>IC Y-G</b>    | (guard column)           | Sulfo            | Styrene divinylbenzene copolymer | 12                 | <b>4.6 × 10</b>                | 4mM HNO <sub>3</sub> aq.                                         |

Housing Material : SUS

### ● For transition metal ions

| Product Code | Product Name    | Plate Number (TP/column) | Functional Group | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent         |
|--------------|-----------------|--------------------------|------------------|--------------------|--------------------------------|--------------------------|
| F6995250     | <b>IC T-521</b> | ≥ 3,000                  | Sulfo            | 12                 | <b>4.6 × 150</b>               | 3mM HNO <sub>3</sub> aq. |
| F6700412     | <b>IC T-G</b>   | (guard column)           | Sulfo            | 12                 | <b>4.6 × 10</b>                | 3mM HNO <sub>3</sub> aq. |

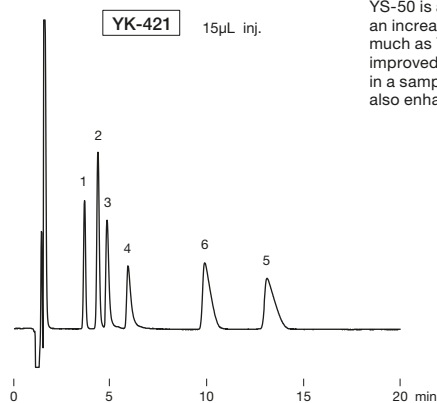
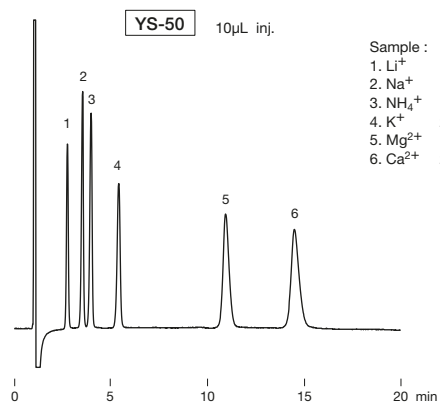
Base Material : Styrene divinylbenzene copolymer

Housing Material : PEEK

## Line filters for IC

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

## Standard cations (YS-50 and YK-421)



YS-50 is a high performance type of column offers an increased theoretical plate number twice as much as YK-421. In particular, the peak shape is improved. The quantitative performance for  $\text{NH}_4^+$  in a sample containing high concentration  $\text{Na}^+$  is also enhanced.

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

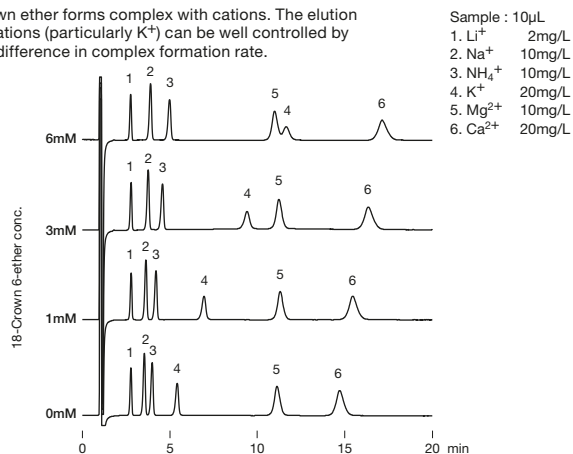
| TP               | YS-50 | YK-421 |
|------------------|-------|--------|
| $\text{Mg}^{2+}$ | 6,900 | 3,000  |
| $\text{Ca}^{2+}$ | 6,600 | 3,000  |

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

**Column** : Shodex IC YK-421  
**Eluent** : 5mM Tartaric acid + 1mM Dipicolinic acid + 1.5g/L Boric acid aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

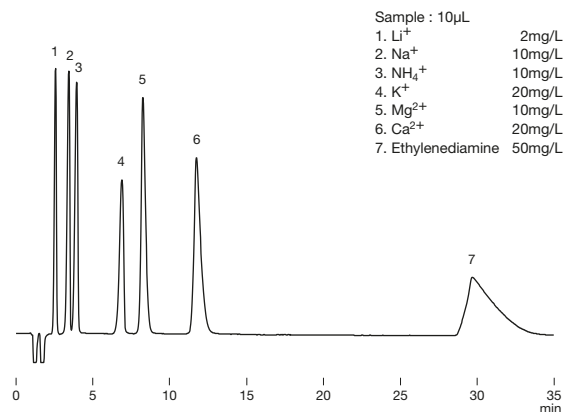
## Effects of crown ether in eluent

Crown ether forms complex with cations. The elution of cations (particularly  $\text{K}^+$ ) can be well controlled by the difference in complex formation rate.



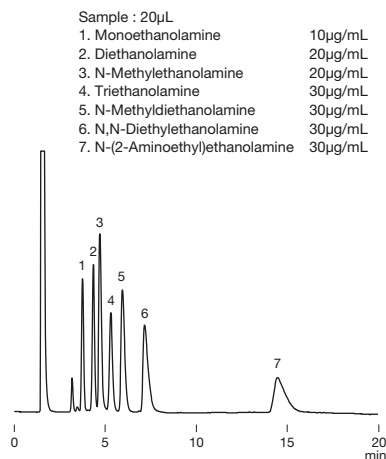
**Column** : Shodex IC YS-50  
**Eluent** : 4mM Methanesulfonic acid + 18-Crown 6-ether aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

## Simultaneous analysis for cations and ethylenediamine



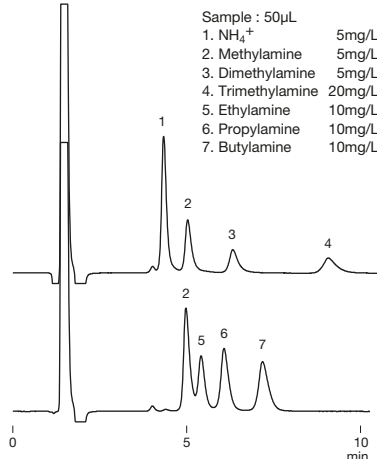
**Column** : Shodex IC YS-50  
**Eluent** : 4mM Nitric acid + 1.5mM 18-Crown 6-ether aq. /  $\text{CH}_3\text{CN}=90/10$   
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

## Amino alcohols



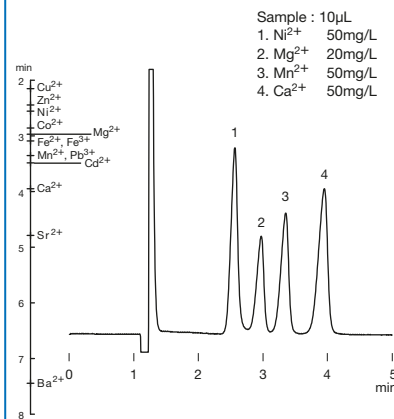
**Column** : Shodex IC YK-421  
**Eluent** : 4mM Nitric acid aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

## Alkylamines



**Column** : Shodex IC YK-421  
**Eluent** : 4mM  $\text{H}_3\text{PO}_4$  aq. /  $\text{CH}_3\text{CN}=90/10$   
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 25°C

## Alkaline earth metal ions

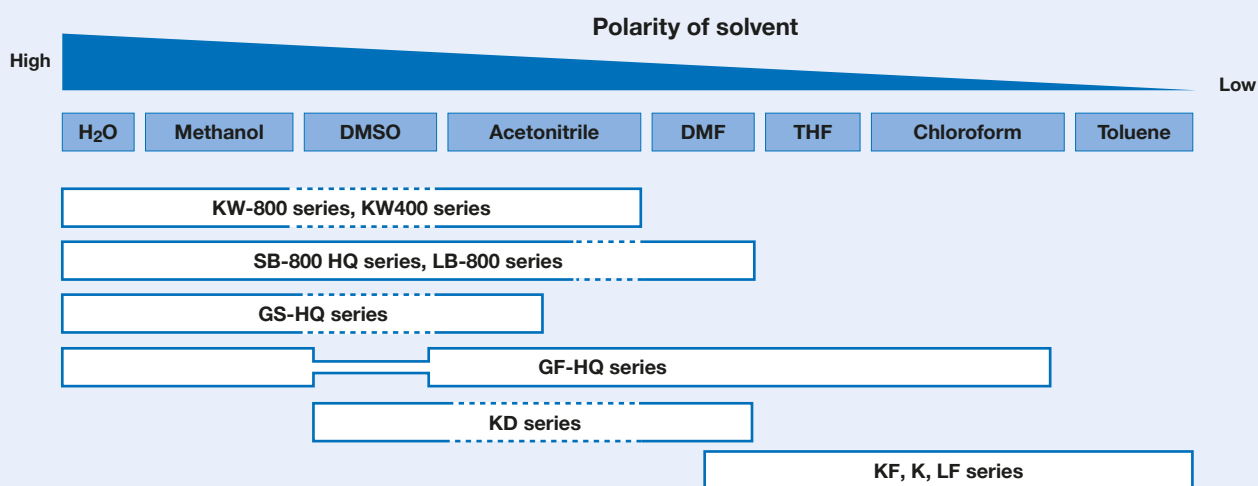


**Column** : Shodex IC Y-521  
**Eluent** : 4mM Tartaric acid + 2mM Ethylenediamine aq.  
**Flow rate** : 1.0mL/min  
**Detector** : Non-suppressed conductivity  
**Column temp.** : 40°C

# Column Selection for Size Exclusion Chromatography (SEC)

|                     | Application                                                                                               | Solvent                                           | Column                                                           | Page |
|---------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------|------------------------------------------------------------------|------|
| Aqueous SEC (GFC)   | Biological macromolecules (proteins, peptides, nucleic acids, etc.)                                       | Buffer etc.                                       | KW-800 series                                                    | 36   |
|                     |                                                                                                           |                                                   | KW400 series <small>High performance (solvent-saving)</small>    | 36   |
|                     | Biological macromolecules (high MW range)                                                                 | Buffer etc.                                       | SB-800 HQ series                                                 | 38   |
|                     |                                                                                                           |                                                   | LB-800 series                                                    | 38   |
|                     | Water-soluble polymers (polyacrylamide, polyethylenimine, etc.)<br>Polysaccharides                        | H <sub>2</sub> O, Buffer<br>Aqueous solution etc. | SB-800 HQ series                                                 | 38   |
|                     |                                                                                                           |                                                   | LB-800 series                                                    | 38   |
|                     | Oligosaccharide, polysaccharides                                                                          | H <sub>2</sub> O,<br>Aqueous solution etc.        | KS-800 series                                                    | 24   |
|                     |                                                                                                           |                                                   | GS-HQ series                                                     | 42   |
| Organic SEC (GPC)   | General polymers                                                                                          | THF                                               | KF-800 series                                                    | 46   |
|                     |                                                                                                           |                                                   | KF-600 series <small>Rapid analysis (solvent-saving)</small>     | 52   |
|                     |                                                                                                           |                                                   | KF-400HQ series <small>High performance (solvent-saving)</small> | 52   |
|                     |                                                                                                           |                                                   | LF series <small>High linearity of calibration curve</small>     | 56   |
|                     | Polar polymers (polyimides, polyvinylpyrrolidones etc.)                                                   | DMF                                               | K-800 series                                                     | 48   |
|                     |                                                                                                           |                                                   | KD-800 series                                                    | 50   |
|                     |                                                                                                           |                                                   | SB-800 HQ series                                                 | 38   |
|                     |                                                                                                           |                                                   | LB-800 series                                                    | 38   |
|                     | Analysis at high temperature (polyethylene, polypropylene etc.)                                           | ODCB etc.                                         | HT-800 series                                                    | 58   |
|                     |                                                                                                           |                                                   | UT-800 series                                                    | 58   |
|                     |                                                                                                           |                                                   | AT-806MS                                                         | 58   |
|                     | Engineering resin analysis at room temperature [polyamide (Nylon), polyethylene terephthalate (PET) etc.] | HFIP                                              | HFIP-800 series                                                  | 60   |
|                     |                                                                                                           |                                                   | HFIP-600 series <small>Rapid analysis (solvent-saving)</small>   | 60   |
|                     |                                                                                                           |                                                   | LF series <small>High linearity of calibration curve</small>     | 56   |
| Aqueous/Organic SEC |                                                                                                           |                                                   | GF-HQ series                                                     | 44   |

## Guideline for column solvent usability



\* See page 62 for the solvent replaceability of organic solvent SEC (GPC) packed columns.

# Precautions for Polar Polymer Analysis

Size exclusion chromatography analysis of polar polymers can be influenced by unexpected interactions in the column. These interactions may change elution patterns and results in an invalid molecular weight calculation. It is important to reduce them in order to obtain the accurate molecular weight distribution.

## Interfering interactions likely to be observed

### Interactions between the analyte and the packing materials

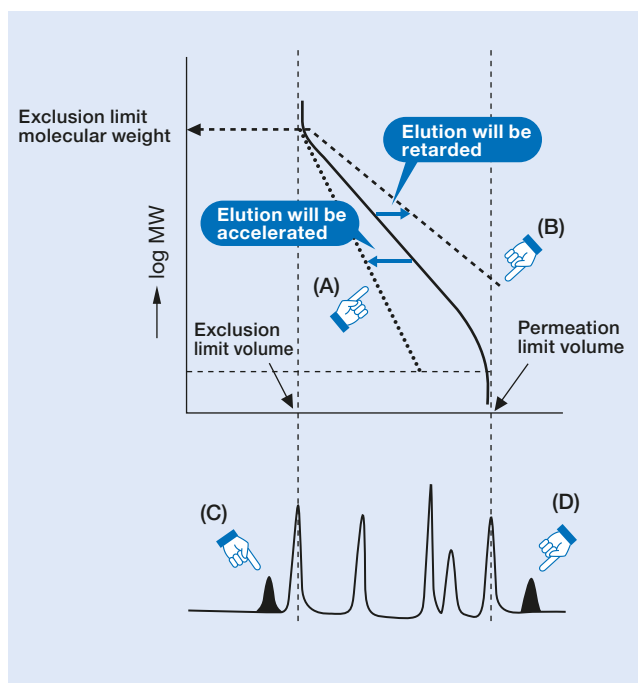
- **Hydrophobic interaction**
  - The analyte is adsorbed into the packing material. This delays the analyte elution, and thus results in under estimation of its molecular weight (Figure B, D).
- **Ionic interaction**
  - (1) Ion Exclusion
    - The analyte is repelled from the packing material. This accelerates the analyte elution, and thus results in over estimation of its molecular weight (Figure A, C).
  - (2) Ion Exchange
    - The analyte is adsorbed onto the packing material. This delays the analyte elution, and thus results in under estimation of its molecular weight (Figure B, D).

### Interaction within and between the analyte

- **Ionic repulsion effects observed within the multivalent macromolecules causes structure expansion**
  - This accelerates the analyte elution, and thus results in over estimation of its molecular weight (Figure A).
- **Association between the molecules**
  - Associated molecule detected as a larger molecule (Figure A).

### Interactions between the analyte and the solvent

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



## Methods to reduce interactions

### Aqueous SEC (GFC)

#### Ionic Interaction

- Add salt

#### Hydrophobic interaction

- Increase dissociation of the analyte
  - Cationic polymer → Lower the pH
  - Anionic polymer → Higher the pH
- Lower the eluent polarity
  - (Example) Add acetonitrile or methanol

### Organic solvent SEC (GPC)

#### Ionic Interaction

- Add salt
  - (Example) Add LiBr to DMF
  - Add  $\text{CF}_3\text{COONa}$  to HFIP

#### Hydrophobic interaction

- Lower the polarity of the eluent
  - (Example) Change the eluent from DMF to THF

#### Hydrophillic interaction

- Increase the polarity of the eluent
  - (Example) Change the eluent from THF to DMF

# Aqueous SEC (GFC) Columns : Silica-based

## Features

- KW-800**
- Silica-based packed columns for aqueous SEC (GFC) analysis
  - Suitable for the analysis of proteins and enzymes
  - Corresponds to USP L20, L33, and L59
- KW400**
- Reducing particle size of the packing material enhances column performance
  - Three- or four-fold higher sensitivity than KW-800 series
  - KW405-4F is applicable to samples with a molecular weight above 1,000,000
  - Corresponds to USP L20, L33, and L59

## 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     | <b>PROTEIN KW-802.5</b>               | ≥ 21,000                 | 5                  | 400           | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6989103     | <b>PROTEIN KW-803</b>                 | ≥ 21,000                 | 5                  | 1,000         | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6989104     | <b>PROTEIN KW-804</b>                 | ≥ 16,000                 | 7                  | 1,500         | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6700131     | <b>PROTEIN KW-G 6B (PROTEIN KW-G)</b> | (guard column)           | 7                  | –             | <b>6.0 × 50</b>                | H <sub>2</sub> O |

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

## High performance semi-micro columns

◎ Use of the KW400 series with semi-micro type devices is recommended.

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

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

## Semi-micro columns

\* The following semi-micro columns are made to order. ◎ Use of the KW400 series with semi-micro type devices is recommended.

| Product Code | Product Name      | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-------------------|--------------------|---------------|--------------------------------|
| F7781213     | <b>KW402.5-4B</b> | 3                  | 400           | <b>4.6 × 50</b>                |
| F7781212     | <b>KW402.5-4D</b> | 3                  | 400           | <b>4.6 × 150</b>               |
| F7781313     | <b>KW403-4B</b>   | 3                  | 800           | <b>4.6 × 50</b>                |
| F7781312     | <b>KW403-4D</b>   | 3                  | 800           | <b>4.6 × 150</b>               |

## 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 | Standard Columns |
|--------------|----------------------------------------|--------------------------|--------------------|--------------------------------|------------------|
| F6505020     | <b>PROTEIN KW-2002.5</b>               | ≥ 17,000                 | 5                  | <b>20.0 × 300</b>              | KW-802.5         |
| F6505021     | <b>PROTEIN KW-2003</b>                 | ≥ 17,000                 | 5                  | <b>20.0 × 300</b>              | KW-803           |
| F6505022     | <b>PROTEIN KW-2004</b>                 | ≥ 14,000                 | 7                  | <b>20.0 × 300</b>              | KW-804           |
| F6709556     | <b>PROTEIN KW-G 8B (PROTEIN KW-LG)</b> | (guard column)           | 7                  | <b>8.0 × 50</b>                | (guard column)   |

## Target molecular weight range and Exclusion limit

### ● With Protein (eluent : phosphate buffer)

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

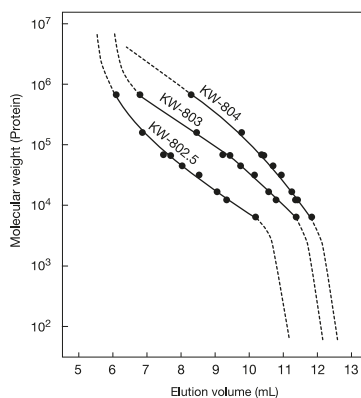
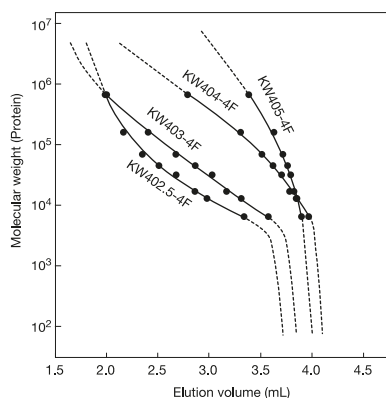
\* Please use the above table as a rough indication for the column selection. \*( ) Estimated value

### ● With Pullulan (eluent : ultrapure water)

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

\* Please use the above table as a rough indication for the column selection.

## Calibration curves for KW400 series and KW-800 series using protein



**Column** : Shodex KW400-4F series, Shodex PROTEIN KW-800 series  
**Eluent** : 50mM Sodium phosphate buffer + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.33mL/min (KW400)  
 1.0mL/min (KW-800)  
**Detector** : UV (280nm) (small cell volume) (KW400)  
 UV (280nm) (conventional type) (KW-800)  
**Column temp.** : 30°C

## Recovery rate of proteins

| Protein              | Recovery (%) |          |
|----------------------|--------------|----------|
|                      | KW402.5-4F   | KW403-4F |
| γ - Globulin         | 98           | 96       |
| Bovine serum albumin | 89           | 96       |
| Ovalbumin            | 89           | 97       |
| Myoglobin            | 90           | 89       |
| Cytochrome c         | 92           | 92       |
| Lysozyme             | 87           | 98       |
| α-Chymotrypsinogen A | 95           | 94       |

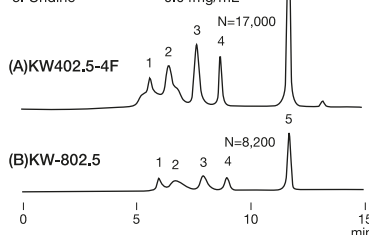
**Column** : Shodex KW402.5-4F  
 Shodex KW403-4F  
**Eluent** : 50mM Sodium phosphate buffer  
 + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.33mL/min  
**Detector** : UV (280nm) (small cell volume)  
**Column temp.** : 25°C

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

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

Sample : 10μL

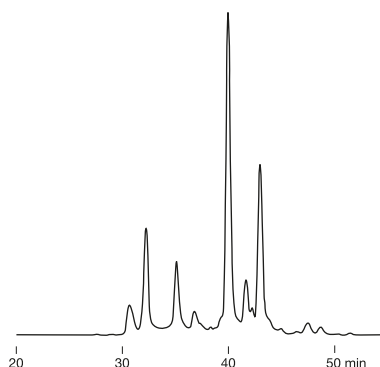
1. Blue dextran 2000 0.2mg/mL
2. γ-Globulin 0.8mg/mL
3. Ovalbumin 0.8mg/mL
4. Myoglobin 0.56mg/mL
5. Uridine 0.04mg/mL



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

## Whey in yogurt

Sample : Whey, 5μL

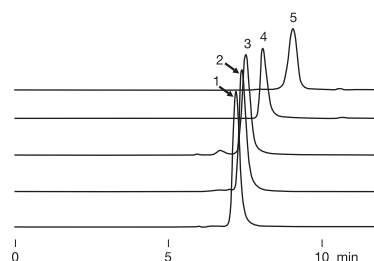


**Column** : Shodex KW402.5-4F + KW403-4F  
**Eluent** : 50mM Sodium phosphate buffer  
 + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.20mL/min  
**Detector** : UV (280nm) (small cell volume)  
**Column temp.** : 30°C

## Lectins

Sample : 5μL

1. Lectin from Soybean 0.6mg/mL
2. Lectin from Arachis hypogaea 1.1mg/mL
3. Lectin from Canavalia ensiformis (Con A) 0.9mg/mL
4. Lectin from Lens culinaris (LCA) 0.7mg/mL
5. Lectin from Triticum vulgaris (WGA) 0.8mg/mL



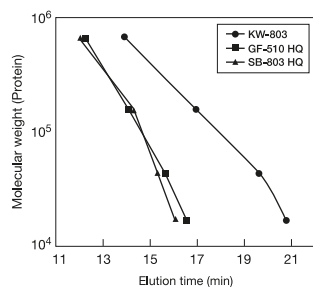
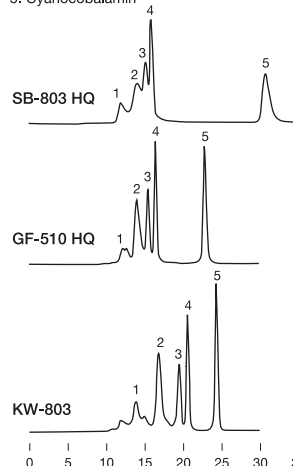
**Column** : Shodex KW402.5-4F  
**Eluent** : 50mM Sodium phosphate buffer  
 + 0.3M NaCl (pH7.0)  
**Flow rate** : 0.33mL/min  
**Detector** : UV (220nm) (small cell volume)  
**Column temp.** : 30°C

## Comparison of various GFC columns for separation of standard proteins

Sample :

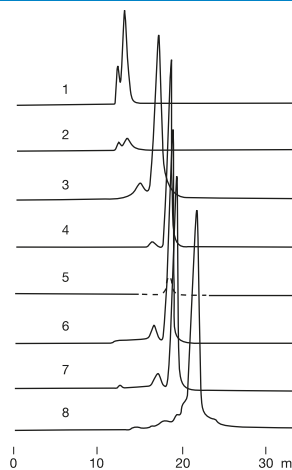
1. Thyroglobulin (bovine)
2. γ-Globulin (bovine)
3. Ovalbumin (chicken)
4. Myoglobin (horse)
5. Cyanocobalamin

Three aqueous SEC columns (SB-803 HQ, GF-510 HQ, and KW-803) were compared for their separation performances. 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** : 0.2M Phosphate buffer (pH6.9)  
**Flow rate** : 0.5mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 30°C

## Proteins in human blood serum



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

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

# 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)
  - Corresponds to USP L38 and L39
  - SB-802 HQ corresponds to USP L25
  - SB-802.5 HQ corresponds to USP L25
  - SB-803 HQ corresponds to USP L37
- 
- SB-807 HQ**
- Column for the analysis of water-soluble ultra high molecular weight polymers
  - Large particle size gel is packed to prevent shear degradation of polymers
  - Corresponds to USP L38 and L39
- 
- New LB-800**
- Suitable for light scattering detector because of the controlled column bleed
  - Polymer-based packed columns for aqueous SEC (GFC) analysis
  - The eluent can be replaced with DMF enabling the analysis of polar polymers
  - Corresponds to USP L38 and L39

## 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     | <b>OHpak SB-802 HQ</b>            | ≥ 12,000                 | 8                  | 100           | <b>8.0 × 300</b>               | 0.02% NaN <sub>3</sub> aq. |
| F6429101     | <b>OHpak SB-802.5 HQ</b>          | ≥ 16,000                 | 6                  | 200           | <b>8.0 × 300</b>               | 0.02% NaN <sub>3</sub> aq. |
| F6429102     | <b>OHpak SB-803 HQ</b>            | ≥ 16,000                 | 6                  | 800           | <b>8.0 × 300</b>               | 0.02% NaN <sub>3</sub> aq. |
| F6429103     | <b>OHpak SB-804 HQ</b>            | ≥ 16,000                 | 10                 | 2,000         | <b>8.0 × 300</b>               | 0.02% NaN <sub>3</sub> aq. |
| F6429104     | <b>OHpak SB-805 HQ</b>            | ≥ 12,000                 | 13                 | 7,000         | <b>8.0 × 300</b>               | 0.02% NaN <sub>3</sub> aq. |
| F6429105     | <b>OHpak SB-806 HQ</b>            | ≥ 12,000                 | 13                 | 15,000        | <b>8.0 × 300</b>               | 0.02% NaN <sub>3</sub> aq. |
| F6429106     | <b>OHpak SB-806M HQ</b>           | ≥ 12,000                 | 13                 | 15,000        | <b>8.0 × 300</b>               | 0.02% NaN <sub>3</sub> aq. |
| F6709430     | <b>OHpak SB-G 6B (OHpak SB-G)</b> | (guard column)           | 10                 | —             | <b>6.0 × 50</b>                | 0.02% NaN <sub>3</sub> 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

## For water-soluble ultra high molecular weight polymers

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

Base Material : Polyhydroxymethacrylate  
Usable pH range : pH3-10

## For light scattering

| Product Code | Product Name             | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------------------|--------------------------|--------------------|---------------|--------------------------------|------------------|
| F6429201     | <b>New OHpak LB-803</b>  | ≥ 16,000                 | 6                  | 800           | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6429202     | <b>New OHpak LB-806M</b> | ≥ 12,000                 | 13                 | 15,000        | <b>8.0 × 300</b>               | H <sub>2</sub> O |
| F6709434     | <b>New OHpak LB-G 6B</b> | (guard column)           | 13                 | —             | <b>6.0 × 50</b>                | H <sub>2</sub> 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 | Standard Column |
|--------------|------------------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6516011     | <b>OHpak SB-2002</b>               | ≥ 9,000                  | 15                 | <b>20.0 × 300</b>              | SB-802 HQ       |
| F6516012     | <b>OHpak SB-2002.5</b>             | ≥ 12,000                 | 10                 | <b>20.0 × 300</b>              | SB-802.5 HQ     |
| F6516013     | <b>OHpak SB-2003</b>               | ≥ 12,000                 | 10                 | <b>20.0 × 300</b>              | SB-803 HQ       |
| F6516014     | <b>OHpak SB-2004</b>               | ≥ 12,000                 | 18                 | <b>20.0 × 300</b>              | SB-804 HQ       |
| F6516015     | <b>OHpak SB-2005</b>               | ≥ 12,000                 | 20                 | <b>20.0 × 300</b>              | SB-805 HQ       |
| F6516016     | <b>OHpak SB-2006</b>               | ≥ 12,000                 | 20                 | <b>20.0 × 300</b>              | SB-806 HQ       |
| F6516017     | <b>OHpak SB-2006M</b>              | ≥ 12,000                 | 20                 | <b>20.0 × 300</b>              | SB-806M HQ      |
| F6709555     | <b>OHpak SB-G 8B (OHpak SB-LG)</b> | (guard column)           | 18                 | <b>8.0 × 50</b>                | (guard column)  |

**Usable concentration of organic solvents**

| Product Code                    | The maximum usable concentration (%) |              |     |
|---------------------------------|--------------------------------------|--------------|-----|
|                                 | Methanol                             | Acetonitrile | DMF |
| <b>SB-802 HQ</b>                | 0                                    | 0            | 0   |
| <b>SB-802.5 HQ, SB-803 HQ</b>   | 100                                  | 75           | 100 |
| <b>SB-804 HQ~SB-806M HQ</b>     | 75                                   | 75           | 100 |
| <b>SB-G 6B</b>                  | 75                                   | 75           | 100 |
| <b>SB-807 HQ, SB-807G</b>       | 30                                   | 30           | 0   |
| <b>LB-803, LB-806M, LB-G 6B</b> | 100                                  | 100          | 100 |

(Note)

The maximum solvent tolerance of preparative type SB-800 HQ, SB-2000 series, is 50% of methanol, acetonitrile, and DMF (SB-2002 is not tolerant of organic solvents, similar to SB-802 HQ).

**Target molecular weight range and Exclusion limit**

## ● With Pullulan (eluent : ultrapure water)

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

\* Please use the above table as a rough indication for the column selection.

\*( ) Estimated value

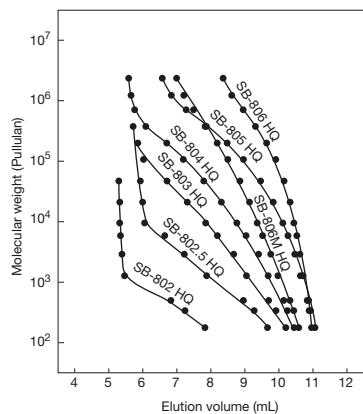
## ● With \*PEG/PEO (eluent : DMF)

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

\* Please use the above table as a rough indication for the column selection.

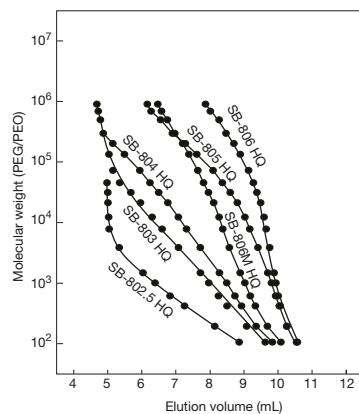
\*PEG : polyethylene glycol  
\*PEO : polyethylene oxide  
\*( ) Estimated value

### Calibration curves for SB-800 HQ series using pullulan (eluent : H<sub>2</sub>O)



**Column** : Shodex OHpak SB-800 HQ series  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 30°C

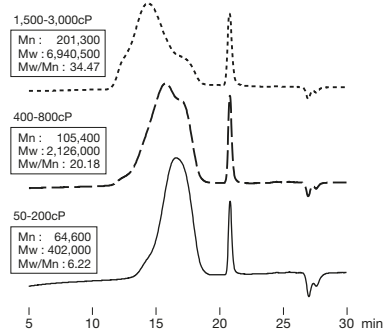
### Calibration curves for SB-800 HQ series using PEG/PEO (eluent : DMF)



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

### Carboxymethylcellulose

Sample : Carboxymethylcellulose 0.1% each, 50μL



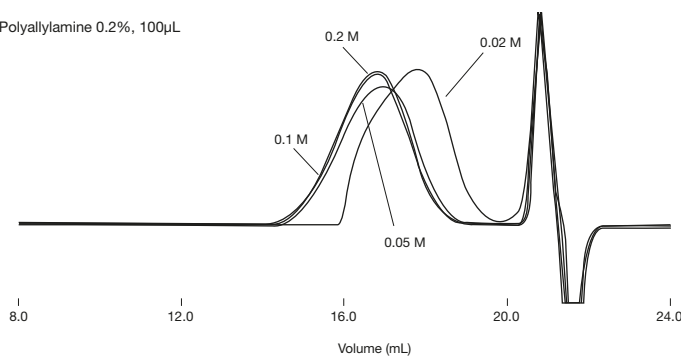
\* Molecular weight was determined from the calibration curve of pullulan.

**Column** : Shodex OHpak SB-806M HQ x 2  
**Eluent** : 0.1M NaCl aq.  
**Flow rate** : 1.0mL/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, undesired adsorption of the polymer is observed when low (0.02M) sodium nitrate eluent was used. By using higher concentration (> 0.1M) salt, it suppresses the sample adsorption and enables to obtain accurate chromatograms.

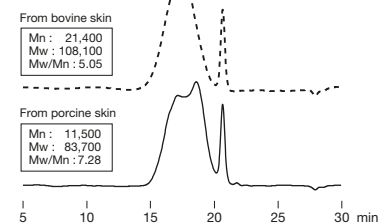
Sample : Polyallylamine 0.2%, 100μL



**Column** : Shodex OHpak SB-806M HQ x 2  
**Eluent** : 0.5M Acetic acid + NaNO<sub>3</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

### Gelatin

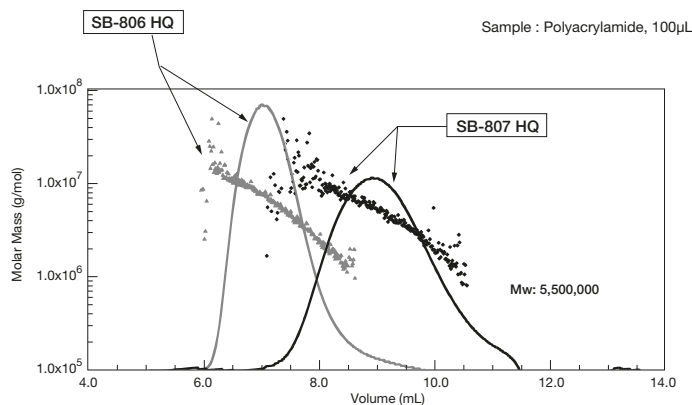
Sample : 0.1% each, 100μL  
 Gelatin from bovine skin  
 (Acid treatment, Gel strength : 225g)  
 Gelatin from porcine skin  
 (Alkali treatment, Gel strength : 90-100g)



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

**Column** : Shodex OHpak SB-806M HQ x 2  
**Eluent** : 0.1M KH<sub>2</sub>PO<sub>4</sub> aq./  
 0.1M Na<sub>2</sub>HPO<sub>4</sub> aq.=50/50  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

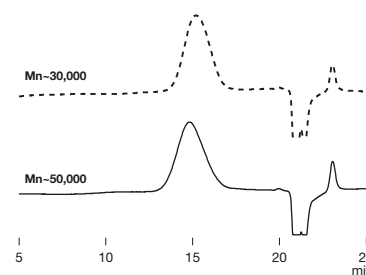
### Polyacrylamide



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

### Cellulose acetate

Sample : Cellulose acetate 0.1% each, 100μL



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

### Copovidones

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

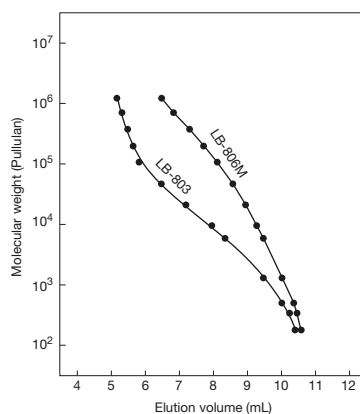
Copolymer 7:3  
Mn : 2,000  
Mw : 14,400  
Mw/Mn : 7.40

Copolymer 3:7  
Mn : 6,400  
Mw : 28,900  
Mw/Mn : 4.53

\* Molecular weight was determined from the calibration curve of PEG/PEO.

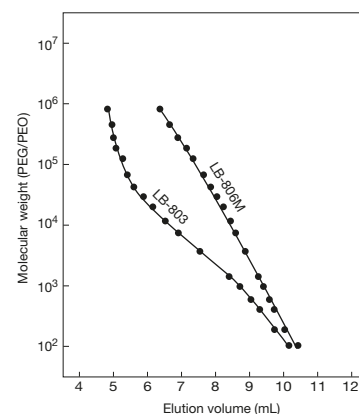
Column : Shodex OHPak SB-806M HQ x 2  
Eluent : 20mM LiBr in DMF  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 40°C

### Calibration curves for LB-800 series using pullulan (eluent : H<sub>2</sub>O)



Column : Shodex OHPak LB-800 series  
Eluent : H<sub>2</sub>O  
Flow rate : 1.0mL/min  
Detector : RI  
Column temp. : 30°C

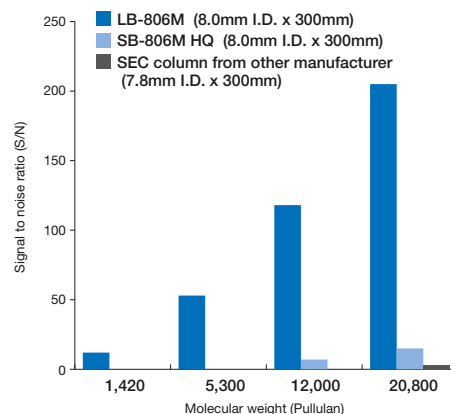
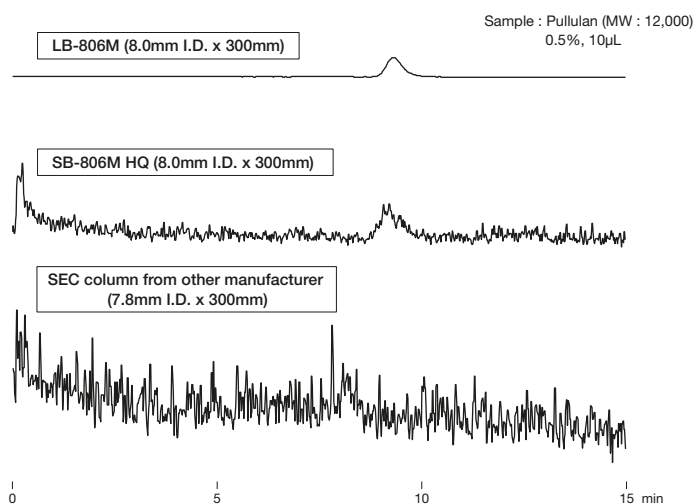
### Calibration curves for LB-800 series using PEG/PEO (eluent : DMF)



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

### Comparison of the detection of pullulan using multiangle light scattering detector

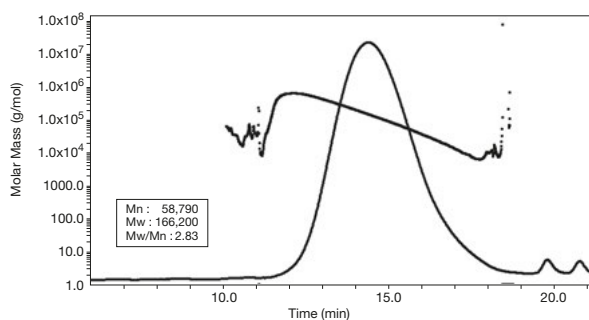
The multiangle light scattering (MALS) signal of low molecular weight substances is low with competitor columns due to the baseline noise. New product OHPak LB-800 series enables the detection by improving the baseline noise level.



Column : Shodex OHPak LB-806M  
Shodex OHPak SB-806M HQ  
SEC column from other manufacturer  
Eluent : 0.1M NaNO<sub>3</sub> aq.  
Flow rate : 1.0mL/min  
Detector : MALS (Multi angle light scattering) (90°)  
Column temp. : 30°C

### Sodium alginate

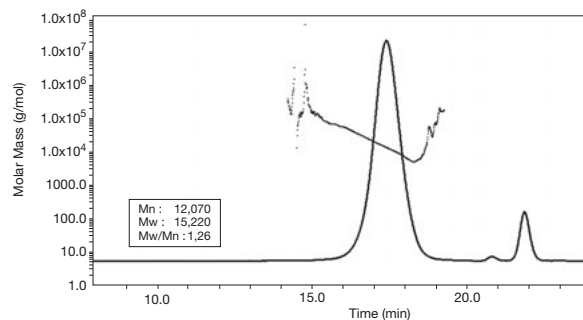
Sample : Sodium alginate 0.1%, 100 $\mu$ L



Column : Shodex OHPak LB-806M x 2  
Eluent : 0.1M NaNO<sub>3</sub> aq.  
Flow rate : 1.0mL/min  
Detector : MALS (Multi angle light scattering)  
Column temp. : 30°C

### Sodium heparin

Sample : Sodium heparin 0.1%, 100 $\mu$ L



Column : Shodex OHPak LB-806M x 2  
Eluent : 0.1M NaNO<sub>3</sub> aq.  
Flow rate : 1.0mL/min  
Detector : MALS (Multi angle light scattering)  
Column temp. : 30°C

# Multimode Columns

## Features

- GS-HQ**
- SEC is the main separation mode
  - Depends on the eluent selected, the column adds 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     | <b>Asahipak GS-220 HQ</b> | ≥ 19,000                 | 6                  | 150           | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F7600006     | <b>Asahipak GS-320 HQ</b> | ≥ 19,000                 | 6                  | 400           | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F7600007     | <b>Asahipak GS-520 HQ</b> | ≥ 18,000                 | 7                  | 2,000         | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F7600008     | <b>Asahipak GS-620 HQ</b> | ≥ 18,000                 | 7                  | 7,000         | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F6710019     | <b>Asahipak GS-2G 7B</b>  | (guard column)           | 9                  | –             | <b>7.5 × 50</b>                | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |

Base Material : Polyvinyl alcohol  
 Usable pH range : pH2-12 (GS-220 HQ : pH2-9)  
 Usable concentration of methanol is up to 100%  
 (GS-220 HQ : up to 30%)  
 Usable concentration of acetonitrile is up to 50%

## Semi-micro columns

\* The following semi-micro columns are made to order.

| Product Code | Product Name     | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|------------------|--------------------|---------------|--------------------------------|
| F7750312     | <b>GS320A-4D</b> | 6                  | 400           | <b>4.6 × 150</b>               |
| F7750311     | <b>GS320A-4E</b> | 6                  | 400           | <b>4.6 × 250</b>               |
| F7750613     | <b>GS620A-4B</b> | 7                  | 7,000         | <b>4.6 × 50</b>                |

## 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 | Standard Column |
|--------------|----------------------------|--------------------------|--------------------|--------------------------------|-----------------|
| F6810017     | <b>Asahipak GS-220 20F</b> | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GS-220 HQ       |
| F6810018     | <b>Asahipak GS-320 20F</b> | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GS-320 HQ       |
| F6810019     | <b>Asahipak GS-520 20F</b> | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GS-520 HQ       |
| F6810020     | <b>Asahipak GS-620 20F</b> | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GS-620 HQ       |
| F6810034     | <b>Asahipak GS-220 20G</b> | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GS-220 HQ       |
| F6810035     | <b>Asahipak GS-320 20G</b> | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GS-320 HQ       |
| F6810036     | <b>Asahipak GS-520 20G</b> | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GS-520 HQ       |
| F6810037     | <b>Asahipak GS-620 20G</b> | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GS-620 HQ       |
| F6710021     | <b>Asahipak GS-20G 7B</b>  | (guard column)           | 20                 | <b>7.5 × 50</b>                | (guard column)  |

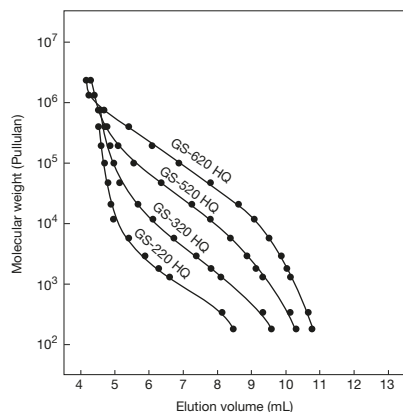
## Target molecular weight range and Exclusion limit

- With Pullulan (eluent : ultrapure water)

| Product Name  | Target Molecular Weight Range | Exclusion Limit |
|---------------|-------------------------------|-----------------|
| <b>GS-220</b> | 300 – 3,000                   | 7,000           |
| <b>GS-320</b> | 300 – 20,000                  | 40,000          |
| <b>GS-520</b> | 5,000 – 200,000               | 300,000         |
| <b>GS-620</b> | 10,000 – 800,000              | 1,000,000       |

\* Please use the above table as a rough indication for the column selection.

### Calibration curves for GS-HQ series using pullulan (eluent : H<sub>2</sub>O)



**Column** : Shodex Asahipak GS-HQ series  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 30°C

### Peptides

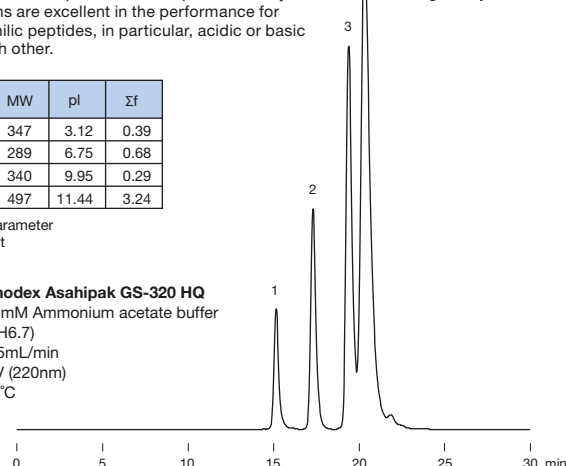
GS-HQ columns can be used not only for SEC (GFC) in an aqueous system, but also for multimodal analysis where hydrophobic interaction and ionic interaction are used together as separation criteria, under certain conditions of the eluent. This results in unprecedented separation analysis. GS-320 HQ columns are excellent in the performance for separating hydrophilic peptides, in particular, acidic or basic peptides, from each other.

|                 | MW  | pI    | Σf   |
|-----------------|-----|-------|------|
| 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 |

Σf : Hydrophobic parameter  
pI : Isoelectric point

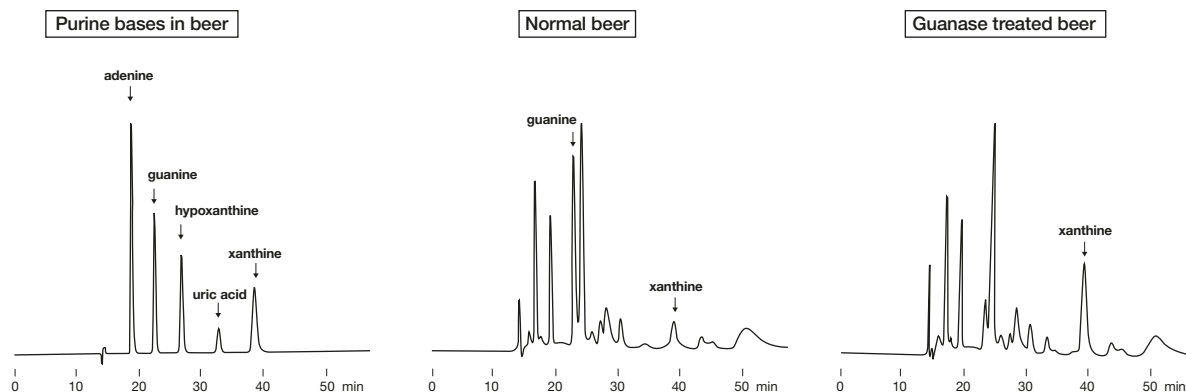
**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 30mM Ammonium acetate buffer (pH6.7)  
**Flow rate** : 0.5mL/min  
**Detector** : UV (220nm)  
**Column temp.** : 30°C

Sample : 20μL  
1. Glu-Ala-Glu 0.025%  
2. Arg-Asp 0.05%  
3. Gly-His-Lys 0.025%  
4. Arg-Pro-Lys-Pro 0.025%



### Analysis of purine bases in beer

Purine in foods is analyzed as purine base after a step of sample preparation; homogenization, freeze drying, hydrolyzation with 70% perchloric acid, and neutralization. Example below shows the analysis of purin 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.

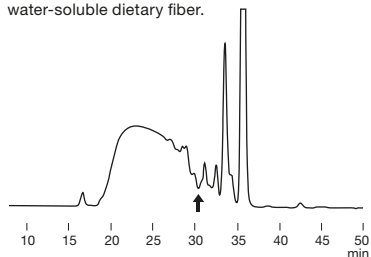


**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 150mM Sodium phosphate buffer (pH2.5)  
**Flow rate** : 0.6mL/min  
**Detector** : UV (260nm)  
**Column temp.** : 35°C

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

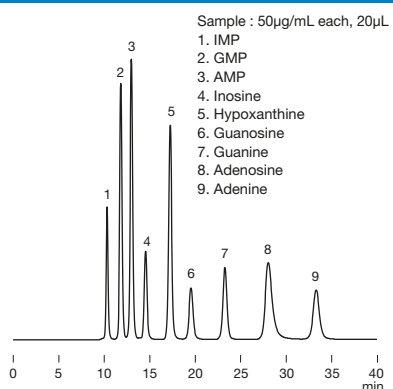
### Low molecular weight water-soluble dietary fiber

By using GS-220 HQ, monosaccharides, disaccharides, and sugar alcohols elute after 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.



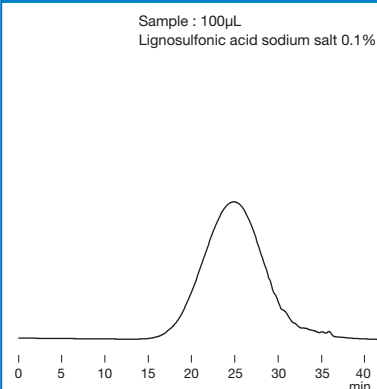
**Column** : Shodex Asahipak GS-220 HQ x 2  
**Eluent** : H<sub>2</sub>O  
**Flow rate** : 0.5mL/min  
**Detector** : RI  
**Column temp.** : 60°C

### "Umami"



**Column** : Shodex Asahipak GS-320 HQ  
**Eluent** : 10mM NaH<sub>2</sub>PO<sub>4</sub> aq./10mM Na<sub>2</sub>HPO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (260nm)  
**Column temp.** : 40°C

### Lignosulfonic acid



**Column** : Shodex Asahipak GS-520 HQ x 2  
**Eluent** : 20mM Na<sub>2</sub>HPO<sub>4</sub> aq.  
**Flow rate** : 0.6mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 40°C

# Aqueous/Organic SEC Columns

## Features

- GF-HQ** • Polymer-based SEC columns exhibit high solvent durability
- Supports 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     | <b>Asahipak GF-210 HQ</b> | ≥ 19,000                 | 5                  | 180           | <b>7.5 × 300</b>               | H <sub>2</sub> O                          |
| F7600001     | <b>Asahipak GF-310 HQ</b> | ≥ 19,000                 | 5                  | 400           | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F7600002     | <b>Asahipak GF-510 HQ</b> | ≥ 19,000                 | 5                  | 2,000         | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F7600003     | <b>Asahipak GF-710 HQ</b> | ≥ 11,000                 | 9                  | 10,000        | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F7600004     | <b>Asahipak GF-7M HQ</b>  | ≥ 13,000                 | 9                  | 10,000        | <b>7.5 × 300</b>               | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F6710018     | <b>Asahipak GF-1G 7B</b>  | (guard column)           | 9                  | –             | <b>7.5 × 50</b>                | H <sub>2</sub> O/CH <sub>3</sub> OH=70/30 |
| F7600100     | <b>MSpak GF-310 4B</b>    | ≥ 3,000                  | 5                  | 400           | <b>4.6 × 50</b>                | H <sub>2</sub> O                          |
| F7600110     | <b>MSpak GF-310 4D</b>    | ≥ 10,000                 | 5                  | 400           | <b>4.6 × 150</b>               | H <sub>2</sub> O                          |
| F7600024     | <b>MSpak GF-310 4E</b>    | ≥ 16,000                 | 5                  | 400           | <b>4.6 × 250</b>               | H <sub>2</sub> O                          |
| F7600120     | <b>MSpak GF-310 2D</b>    | ≥ 5,500                  | 5                  | 400           | <b>2.0 × 150</b>               | H <sub>2</sub> 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

## Semi-micro columns \* The following semi-micro columns are made to order.

| Product Code | Product Name              | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|---------------------------|--------------------|---------------|--------------------------------|
| F7600200     | <b>Asahipak GF-210 4D</b> | 5                  | 180           | <b>4.6 × 150</b>               |
| F7600201     | <b>Asahipak GF-210 4E</b> | 5                  | 180           | <b>4.6 × 250</b>               |
| F7760512     | <b>GF510A-4D</b>          | 5                  | 2,000         | <b>4.6 × 150</b>               |
| F7760511     | <b>GF510A-4E</b>          | 5                  | 2,000         | <b>4.6 × 250</b>               |
| F7760712     | <b>GF710A-4D</b>          | 9                  | 10,000        | <b>4.6 × 150</b>               |

## 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 | Standard Columns |
|--------------|-----------------------------|--------------------------|--------------------|--------------------------------|------------------|
| F6810030     | <b>Asahipak GS-310 20F</b>  | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GF-310 HQ        |
| F6810031     | <b>Asahipak GS-510 20F</b>  | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GF-510 HQ        |
| F6810032     | <b>Asahipak GS-710 20F</b>  | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GF-710 HQ        |
| F6810033     | <b>Asahipak GSM-700 20F</b> | ≥ 8,000                  | 13                 | <b>20.0 × 300</b>              | GF-7M HQ         |
| F6810038     | <b>Asahipak GS-310 20G</b>  | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GF-310 HQ        |
| F6810039     | <b>Asahipak GS-510 20G</b>  | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GF-510 HQ        |
| F6810040     | <b>Asahipak GS-710 20G</b>  | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GF-710 HQ        |
| F6810041     | <b>Asahipak GSM-700 20G</b> | ≥ 14,000                 | 13                 | <b>20.0 × 500</b>              | GF-7M HQ         |
| F6710020     | <b>Asahipak GS-10G 7B</b>   | (guard column)           | 20                 | <b>7.5 × 50</b>                | (guard column)   |

## Target molecular weight range and Exclusion limit

### ● With Pullulan (eluent : ultrapure water)

| Product Name  | Target Molecular Weight Range | Exclusion Limit |
|---------------|-------------------------------|-----------------|
| <b>GF-210</b> | 300 – 4,000                   | 9,000           |
| <b>GF-310</b> | 300 – 30,000                  | 40,000          |
| <b>GF-510</b> | 5,000 – 200,000               | 300,000         |
| <b>GF-710</b> | 100,000 – *(10,000,000)       | *(10,000,000)   |
| <b>GF-7M</b>  | 300 – *(10,000,000)           | *(10,000,000)   |

\* Please use the above table as a rough indication for the column selection.

\*( ) Estimated value

### ● With \*PEG/PEO (eluent : DMF)

| Product Name  | Target Molecular Weight Range |
|---------------|-------------------------------|
| <b>GF-210</b> | 100 – 2,000                   |
| <b>GF-310</b> | 200 – 4,000                   |
| <b>GF-510</b> | 2,000 – 200,000               |
| <b>GF-710</b> | 20,000 – *(10,000,000)        |
| <b>GF-7M</b>  | 200 – *(10,000,000)           |

\* Please use the above table as a rough indication for the column selection.

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

## Usable solvents

| Solvent                                  | GF-210 | GF-310<br>GF-510<br>GF-710<br>GF-7M |
|------------------------------------------|--------|-------------------------------------|
| Water<br>(0 - 0.5M sodium concentration) | ○      | ○                                   |
| Methanol                                 | ○      | ○                                   |
| Ethanol                                  | ○      | ○                                   |
| Acetonitrile                             | ○*     | ○                                   |
| THF                                      | ○      | ○                                   |
| DMF                                      | ○      | ○                                   |
| Acetone                                  | ○      | ○                                   |
| Chloroform                               | ○*     | ○                                   |
| Ethylacetate                             | ○*     | ○                                   |
| DMSO                                     | ○      | 0~50% ○                             |

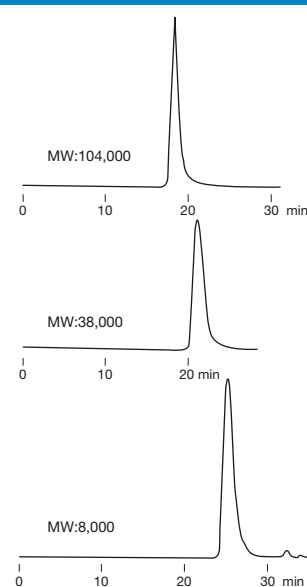
\* When replacing acetonitrile, ethyl acetate or chloroform with water, replace with methanol first and then replace with water.

\* When replacing water with ethyl acetate or chloroform, replace with methanol first and then replace with the required eluent condition.

## (Note)

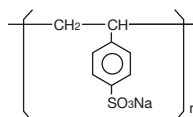
The usable solvents for preparative columns of GF-710 HQ, GS-710 20F and 20G, are water and methanol. GSM-700 20F or 20G is recommended when other solvents are required.

## Sodium polystyrene sulfonates

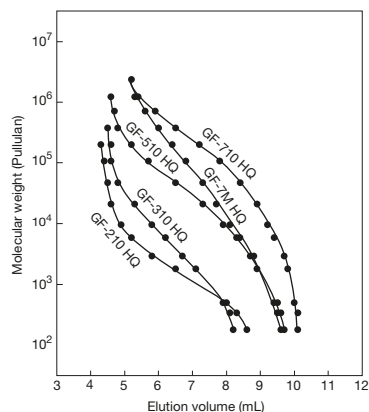


Polymers having both hydrophobic and hydrophilic functional groups may exhibit hydrophobic interactions with packing materials. When analyzing such polymers, the hydrophobic interaction can be suppressed by adding organic solvents to the eluent.

Sample : 1mg/mL each, 50μL  
Sodium polystyrene sulfonate

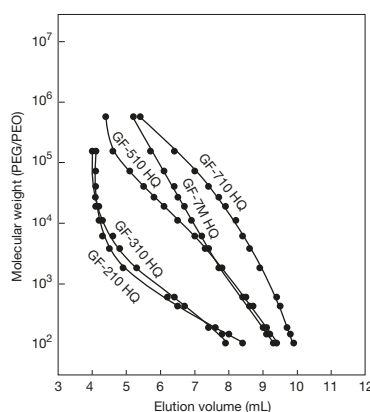


Column : Shodex Asahipak GF-510 HQ  
Eluent : 50mM LiCl aq./CH<sub>3</sub>CN = 60/40  
Flow rate : 0.6mL/min  
Detector : UV (254nm)  
Column temp. : 30°C

Calibration curves for GF-HQ series using pullulan (eluent : H<sub>2</sub>O)

Column : Shodex Asahipak GF-HQ series  
Eluent : H<sub>2</sub>O  
Flow rate : 0.6mL/min  
Detector : RI  
Column temp. : 30°C

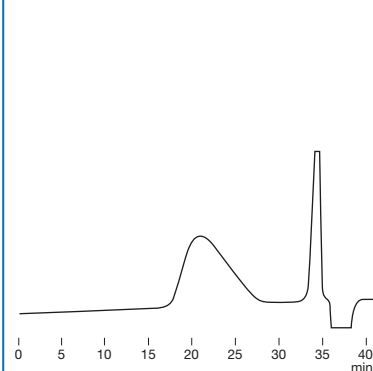
## Calibration curves for GF-HQ series using PEG/PEO (eluent : DMF)



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

## Polyacrylonitrile

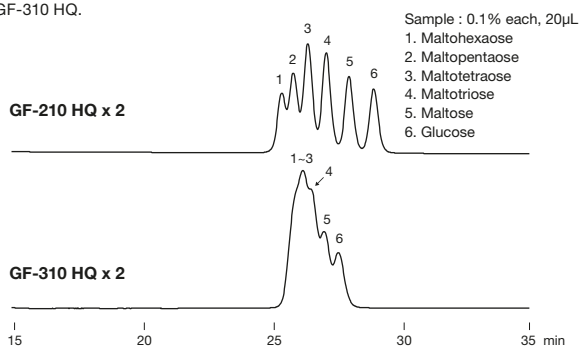
Sample : Polyacrylonitrile 0.1%, 100μL



Column : Shodex Asahipak GF-710 HQ x 2  
Eluent : 20mM LiBr in DMF  
Flow rate : 0.6mL/min  
Detector : RI  
Column temp. : 40°C

## Comparison of two GF columns for the separation performance of maltooligosaccharides

GF-210 HQ demonstrates an improved separation of low molecular substances. The sample below shows 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.

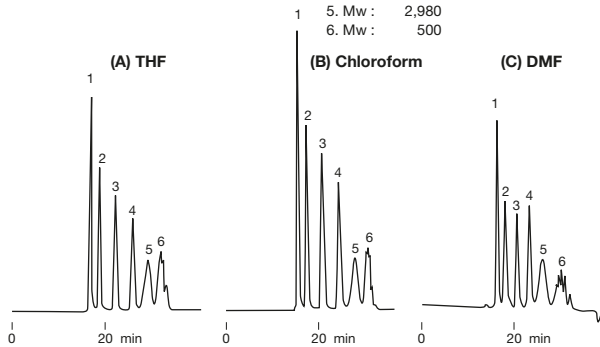


Sample : 0.1% each, 20μL  
1. Maltotetraose  
2. Maltotriose  
3. Maltose  
4. Glucose  
5. Maltose  
6. Glucose

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

## Comparison of polystyrenes separation using various solvents

Sample : Polystyrene 1mg/mL each, 50μL  
1. Mw : 1,090,000  
2. Mw : 190,000  
3. Mw : 37,900  
4. Mw : 9,100  
5. Mw : 2,980  
6. Mw : 500



Column : Shodex Asahipak GF-510 HQ + GF-310 HQ  
Eluent : (A); THF, (B); Chloroform, (C); DMF  
Flow rate : 0.5mL/min  
Detector : (A),(B) UV (254nm), (C) UV (270nm)  
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
  - Corresponds to USP L21

## Standard columns

### ● KF-800 series : Shipping solvent Tetrahydrofuran (THF)

| 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                      |
| F6028060     | GPC KF-806             | ≥ 11,000                           | 10                 | 10,000        | 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                      |
| F6028070     | GPC KF-807             | ≥ 6,000                            | 18                 | 20,000        | 8.0 x 300                      |
| F6027070     | GPC KF-807L            | ≥ 6,000                            | 18                 | 20,000        | 8.0 x 300                      |
| F6700300     | GPC KF-G 4A (GPC KF-G) | (guard column)                     | 8                  | –             | 4.6 x 10                       |
| F6709350     | GPC KF-800D            | ( solvent-peak separation column ) | 10                 | –             | 8.0 x 100                      |

\* The columns with 'L' or 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

\* See page 50 for details of the solvent-peak separation columns.

\* See pages 54 and 55 for details preparative columns.

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

Base Material : Styrene divinylbenzene copolymer

## Target molecular weight range and Exclusion limit

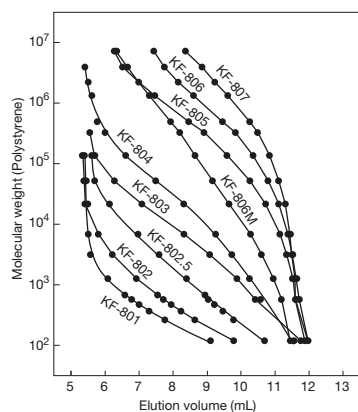
### ● With Polystyrene (eluent : THF)

| Product Name    | Target Molecular Weight Range | Exclusion Limit | Product Name   | Target Molecular Weight Range | Exclusion Limit |
|-----------------|-------------------------------|-----------------|----------------|-------------------------------|-----------------|
| <b>KF-801</b>   | 100 – 700                     | 1,500           | <b>KF-805</b>  | 50,000 – 2,000,000            | 4,000,000       |
| <b>KF-802</b>   | 300 – 3,000                   | 5,000           | <b>KF-805L</b> | 300 – 2,000,000               | 4,000,000       |
| <b>KF-802.5</b> | 300 – 8,000                   | 20,000          | <b>KF-806</b>  | 150,000 – *(20,000,000)       | *(20,000,000)   |
| <b>KF-803</b>   | 1,000 – 50,000                | 70,000          | <b>KF-806M</b> | 1,000 – *(20,000,000)         | *(20,000,000)   |
| <b>KF-803L</b>  | 100 – 50,000                  | 70,000          | <b>KF-806L</b> | 300 – *(20,000,000)           | *(20,000,000)   |
| <b>KF-804</b>   | 7,000 – 300,000               | 400,000         | <b>KF-807</b>  | 300,000 – *(200,000,000)      | *(200,000,000)  |
| <b>KF-804L</b>  | 100 – 300,000                 | 400,000         | <b>KF-807L</b> | 300 – *(200,000,000)          | *(200,000,000)  |

\* Please use the above table as a rough indication for the column selection.

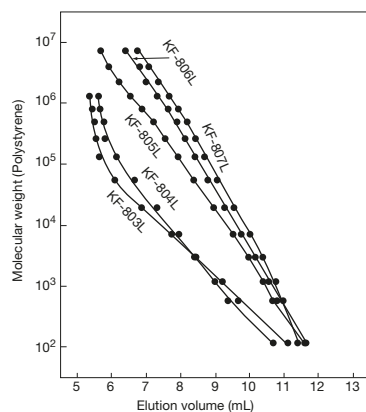
\*( ) Estimated value

## Calibration curves for KF-800 series using polystyrene



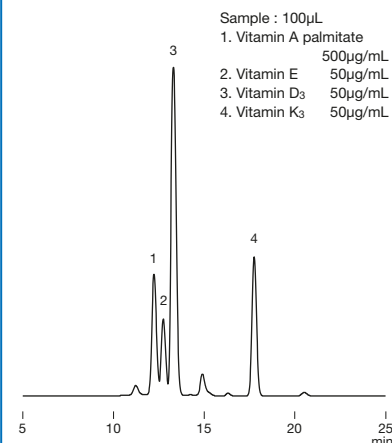
Column : Shodex GPC KF-800 series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

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



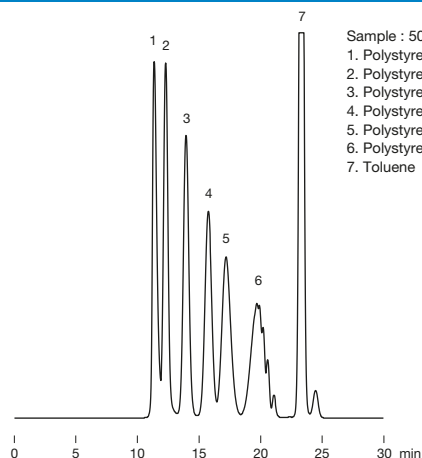
Column : Shodex GPC KF-800L series  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

## Fat-soluble vitamins

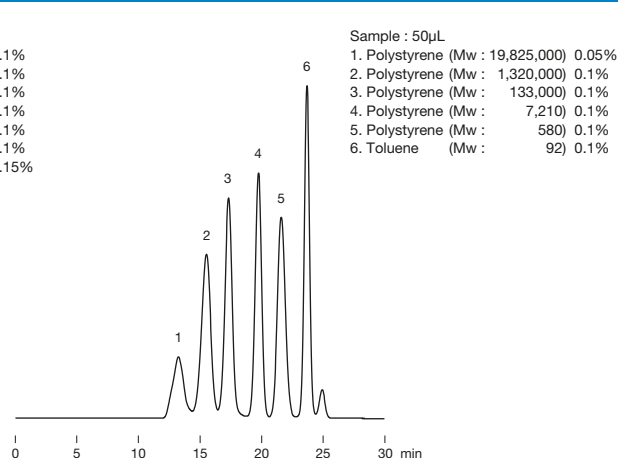


Column : Shodex GPC KF-801 x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : UV (280nm)  
 Column temp. : 40°C

## Standard polystyrenes



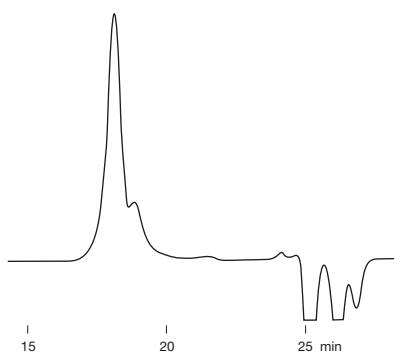
Column : Shodex GPC KF-803L x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C



Column : Shodex GPC KF-807L x 2  
 Eluent : THF  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : 40°C

## Styrene isoprene ABA block copolymer

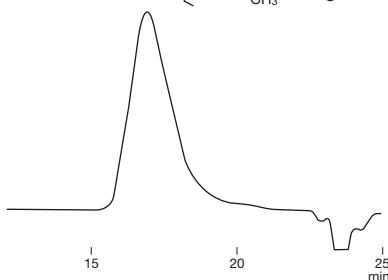
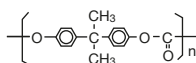
Sample : Styrene isoprene ABA block copolymer



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

## Polycarbonate resin

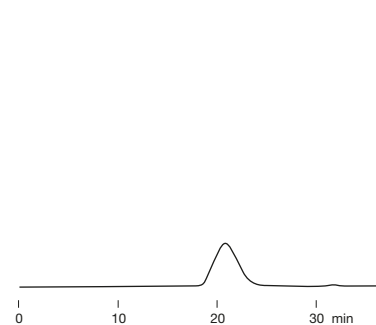
Sample : Polycarbonate resin 0.1%, 100μL



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

## Raw rubber

Sample : Rubber 0.1%, 300μL



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

# Organic SEC (GPC) Columns (General Analysis) : Chloroform

## Features

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

## Standard columns

### ● K-800 series : Shipping solvent Chloroform

| Product Code | Product Name         | Plate Number (TP/column)           | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|----------------------|------------------------------------|--------------------|---------------|--------------------------------|
| F6028110     | GPC K-801            | ≥ 18,000                           | 8                  | 50            | 8.0 × 300                      |
| F6028120     | GPC K-802            | ≥ 18,000                           | 6                  | 150           | 8.0 × 300                      |
| F6028125     | GPC K-802.5          | ≥ 18,000                           | 6                  | 300           | 8.0 × 300                      |
| F6028130     | GPC K-803            | ≥ 18,000                           | 6                  | 500           | 8.0 × 300                      |
| F6028194     | GPC K-803L           | ≥ 18,000                           | 6                  | 500           | 8.0 × 300                      |
| F6028140     | GPC K-804            | ≥ 18,000                           | 7                  | 1,500         | 8.0 × 300                      |
| F6028195     | GPC K-804L           | ≥ 18,000                           | 7                  | 1,500         | 8.0 × 300                      |
| F6028150     | GPC K-805            | ≥ 11,000                           | 10                 | 5,000         | 8.0 × 300                      |
| F6028196     | GPC K-805L           | ≥ 11,000                           | 10                 | 5,000         | 8.0 × 300                      |
| F6028160     | GPC K-806            | ≥ 11,000                           | 10                 | 10,000        | 8.0 × 300                      |
| F6028190     | GPC K-806M           | ≥ 13,000                           | 10                 | 10,000        | 8.0 × 300                      |
| F6028197     | GPC K-806L           | ≥ 11,000                           | 10                 | 10,000        | 8.0 × 300                      |
| F6028170     | GPC K-807            | ≥ 6,000                            | 18                 | 20,000        | 8.0 × 300                      |
| F6028198     | GPC K-807L           | ≥ 6,000                            | 18                 | 20,000        | 8.0 × 300                      |
| F6700401     | GPC K-G 4A (GPC K-G) | (guard column)                     | 8                  | –             | 4.6 × 10                       |
| F6709450     | GPC K-800D           | ( solvent-peak separation column ) | 10                 | –             | 8.0 × 100                      |

\* The columns with 'L' or 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

\* See page 50 for details of the solvent-peak separation columns.

\* See pages 54 and 55 for details preparative columns.

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

Base Material : Styrene divinylbenzene copolymer

## Target molecular weight range and Exclusion limit

### ● With Polystyrene (eluent : Chloroform)

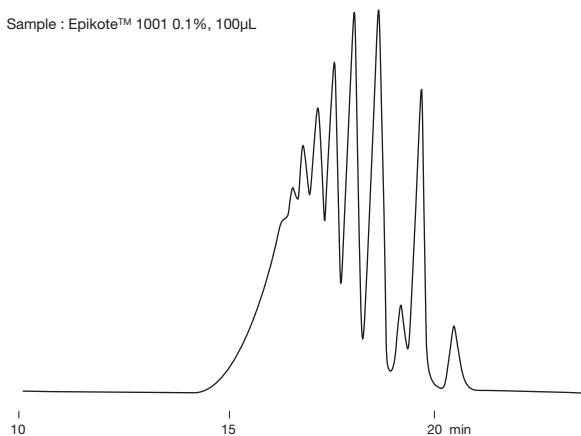
| Product Name | Target Molecular Weight Range | Exclusion Limit | Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------|-------------------------------|-----------------|--------------|-------------------------------|-----------------|
| K-801        | 100 – 700                     | 1,500           | K-805        | 50,000 – 2,000,000            | 4,000,000       |
| K-802        | 300 – 3,000                   | 5,000           | K-805L       | 300 – 2,000,000               | 4,000,000       |
| K-802.5      | 300 – 8,000                   | 20,000          | K-806        | 150,000 – *(20,000,000)       | *(20,000,000)   |
| K-803        | 1,000 – 50,000                | 70,000          | K-806M       | 1,000 – *(20,000,000)         | *(20,000,000)   |
| K-803L       | 100 – 50,000                  | 70,000          | K-806L       | 300 – *(20,000,000)           | *(20,000,000)   |
| K-804        | 7,000 – 300,000               | 400,000         | K-807        | 300,000 – *(200,000,000)      | *(200,000,000)  |
| K-804L       | 100 – 300,000                 | 400,000         | K-807L       | 300 – *(200,000,000)          | *(200,000,000)  |

\* Please use the above table as a rough indication for the column selection.

\*( ) Estimated value

**Epoxy resin**

Sample : Epikote™ 1001 0.1%, 100µL

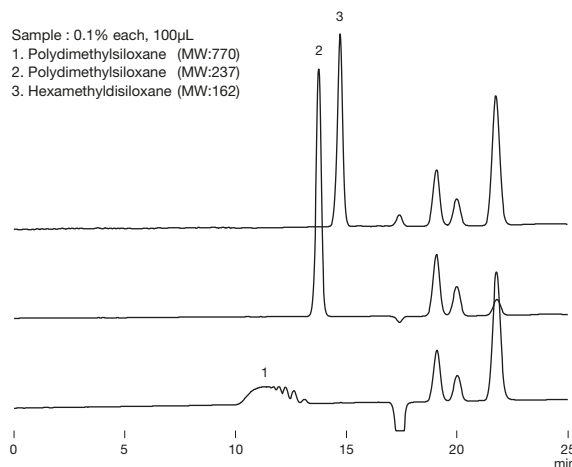


Column : Shodex GPC K-803L x 2  
 Eluent : Chloroform  
 Flow rate : 1.0mL/min  
 Detector : UV (254nm)  
 Column temp. : Room temp.

**Low molecular polydimethylsiloxanes**

Sample : 0.1% each, 100µL

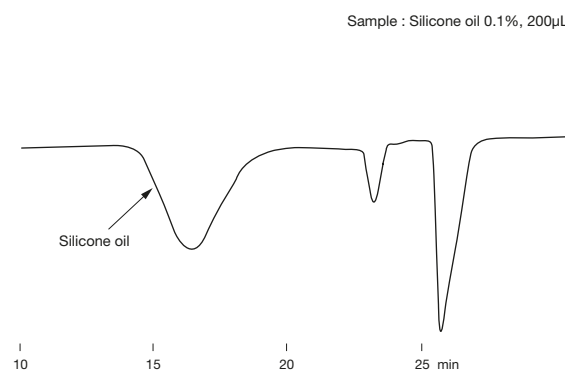
1. Polydimethylsiloxane (MW:770)
2. Polydimethylsiloxane (MW:237)
3. Hexamethyldisiloxane (MW:162)



Column : Shodex GPC K-801 x 2  
 Eluent : Chloroform  
 Flow rate : 1.0mL/min  
 Detector : RI (polarity : -)  
 Column temp. : 40°C

**Silicone oil**

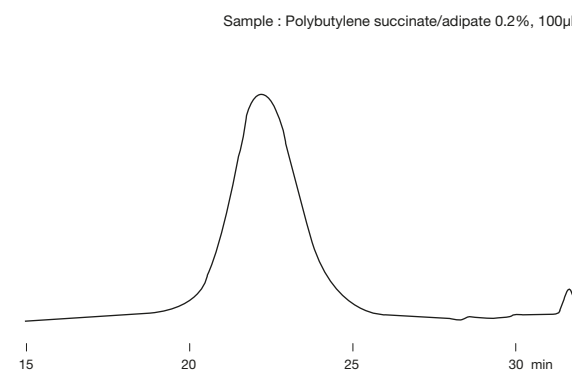
Sample : Silicone oil 0.1%, 200µL



Column : Shodex GPC K-806M x 2  
 Eluent : Toluene  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 45°C

**Bionolle™ (Polybutylene succinate/adipate)**

Sample : Polybutylene succinate/adipate 0.2%, 100µL

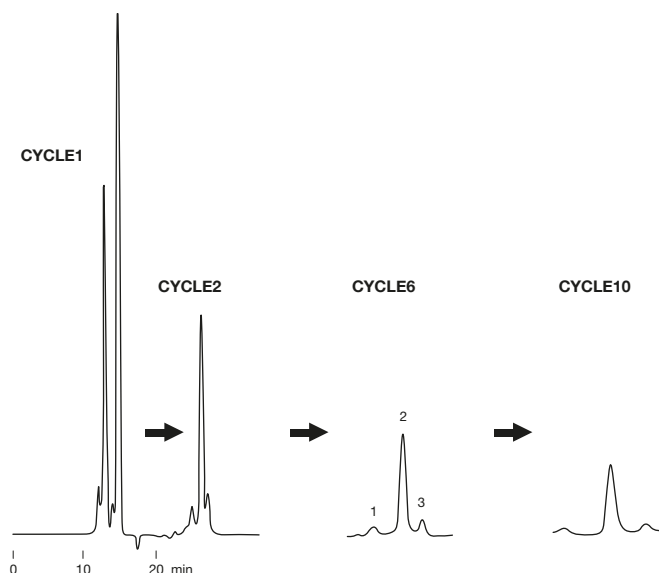


Column : Shodex GPC K-806M x 2 + K-801  
 Eluent : Chloroform  
 Flow rate : 1.0mL/min  
 Detector : RI  
 Column temp. : 40°C

**Recycling fractionation of lauryl stearyl thiodipropionate**

Sample : 5%, 500µL

1. Distearyl stearyl thiodipropionate
2. Lauryl stearyl thiodipropionate
3. Dilauryl thiodipropionate



Column : Shodex GPC K-LG + K-2001  
 Eluent : Chloroform  
 Flow rate : 3.0mL/min  
 Detector : RI (preparative type)  
 Column temp. : 50°C

\* See page 54 for K-2001

# 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
  - Corresponds to USP L21

## Standard columns

### ● KD-800 series : Shipping solvent Dimethylformamide (DMF)

| 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 × 300                      |
| F6028220     | GPC KD-802             | ≥ 17,000                 | 6                  | 150           | 8.0 × 300                      |
| F6028225     | GPC KD-802.5           | ≥ 17,000                 | 6                  | 300           | 8.0 × 300                      |
| F6028230     | GPC KD-803             | ≥ 17,000                 | 6                  | 500           | 8.0 × 300                      |
| F6028240     | GPC KD-804             | ≥ 17,000                 | 7                  | 1,500         | 8.0 × 300                      |
| F6028250     | GPC KD-805             | ≥ 11,000                 | 10                 | 5,000         | 8.0 × 300                      |
| F6028260     | GPC KD-806             | ≥ 11,000                 | 10                 | 10,000        | 8.0 × 300                      |
| F6028290     | GPC KD-806M            | ≥ 13,000                 | 10                 | 10,000        | 8.0 × 300                      |
| F6028270     | GPC KD-807             | ≥ 6,000                  | 18                 | 20,000        | 8.0 × 300                      |
| F6700411     | GPC KD-G 4A (GPC KD-G) | (guard column)           | 8                  | –             | 4.6 × 10                       |

\* The columns with 'L' or 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

Base Material : Styrene divinylbenzene copolymer

## Target molecular weight range and Exclusion limit

### ● With \*PEG/PEO (eluent : DMF)

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

\* Please use the above table as a rough indication for the column selection.

\*PEG : polyethylene glycol

\*PEO : polyethylene oxide

\*( ) Estimated value

# Solvent-peak Separation Columns for Organic SEC (GPC)

## Features

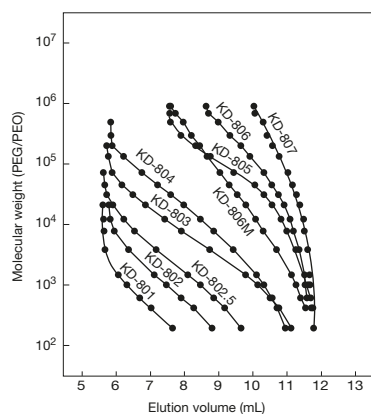
- KF-800D**
  - Use this column in combination with a linear column
- K-800D**
  - By shifting the elution of monomers, polymer additives, and the solvent-peak in low molecular region, it reduces interferences in the calculation of the molecular weight distribution of polymers and oligomers

## Solvent-peak separation columns

| Product Code | Product Name | Column Combination        | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|--------------|---------------------------|--------------------|--------------------------------|------------------|
| F6709350     | GPC KF-800D  | KF-805L, 806L, 806M, 807L | 10                 | 8.0 × 100                      | THF              |
| F6709450     | GPC K-800D   | K-805L, 806L, 806M, 807L  | 10                 | 8.0 × 100                      | Chloroform       |

Base Material : Styrene divinylbenzene copolymer

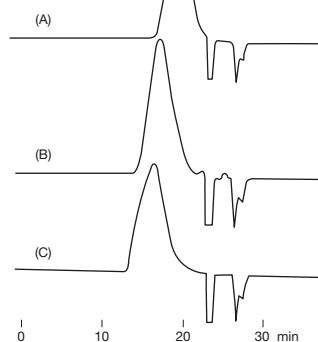
## Calibration curves for KD-800 series using PEG/PEO



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

## Polyvinylpyrrolidones

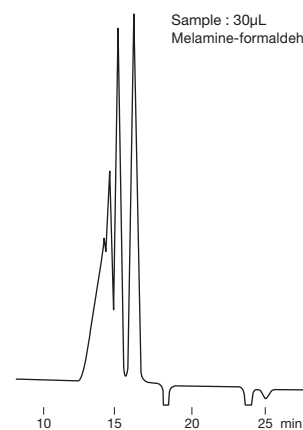
Sample : Polyvinylpyrrolidone 0.2% each  
 (A) K-30 400μL  
 (B) K-60 500μL  
 (C) K-90 500μL



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

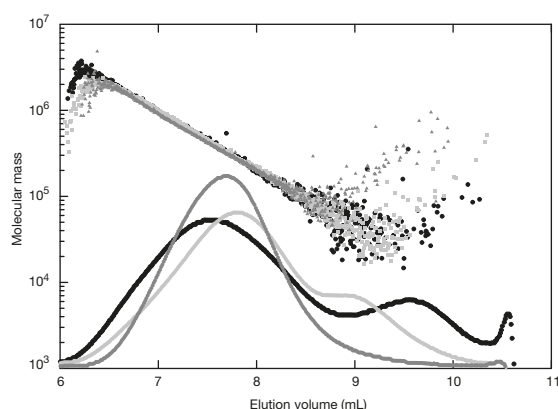
## Melamine formaldehyde resin

Sample : 30μL  
 Melamine-formaldehyde resin 1%



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

## Celluloses



Sample : 100μL  
 Cellulose ca. 0.05% each

Cellulose is known to be difficult to dissolve. A cellulose solution is prepared by repeating solvent replacement. It is reported that it requires a long time to dissolve (1 to 60 days), depending on the solvent type, crystallinity and molecular weight.

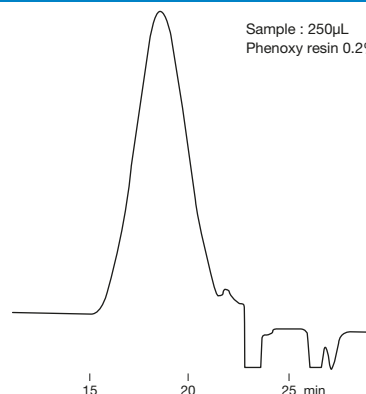
**Column** : Shodex GPC KD-806M  
**Eluent** : 1% LiCl in \*DMI  
**Flow rate** : 0.5mL/min  
**Detector** : RI, MALS (Multi angle light scattering)  
**Column temp.** : 60°C

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

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

## Phenoxy resin

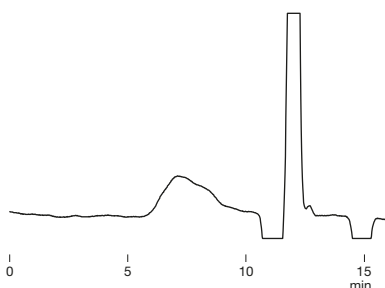
Sample : 250μL  
 Phenoxy resin 0.2%



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

## Potato starch

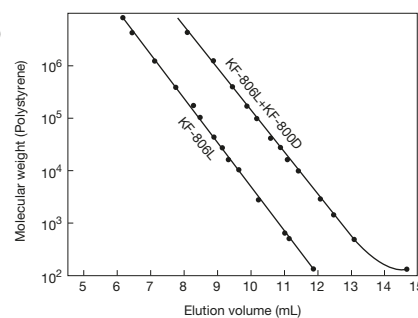
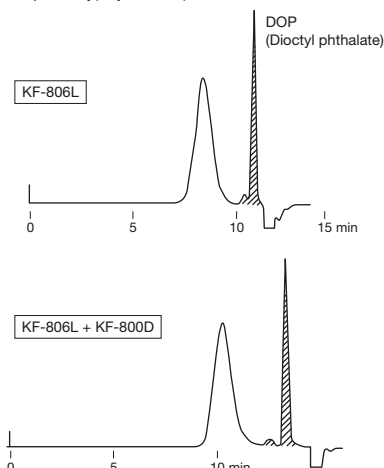
Sample : 100μL  
 Potato starch in DMSO 0.1%  
 \* solved at 80°C



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

# Organic SEC (GPC) Columns : Rapid Analysis, High Performance Analysis

## Features

### KF-600

- Approximately half of the analysis time compared with standard columns
- The amount of solvent used is reduced to about a third
- Improved applicability of solvent replacement
- Corresponds to USP L21

### 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
- Corresponds to USP L21

## Rapid analysis downsized columns

### ● KF-600 series

© Use of the KF-600 series with semi-micro type devices is recommended.

| Product Code | Product Name           | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|------------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6028091     | GPC KF-601             | ≥ 17,000                 | 3                  | 50            | 6.0 x 150                      |
| F6028092     | GPC KF-602             | ≥ 17,000                 | 3                  | 150           | 6.0 x 150                      |
| F6028093     | GPC KF-602.5           | ≥ 17,000                 | 3                  | 300           | 6.0 x 150                      |
| F6028094     | GPC KF-603             | ≥ 17,000                 | 3                  | 500           | 6.0 x 150                      |
| F6028095     | GPC KF-604             | ≥ 16,000                 | 3                  | 1,500         | 6.0 x 150                      |
| F6028096     | GPC KF-605             | ≥ 7,000                  | 10                 | 5,000         | 6.0 x 150                      |
| F6028097     | GPC KF-606             | ≥ 7,000                  | 10                 | 10,000        | 6.0 x 150                      |
| F6028098     | GPC KF-606M            | ≥ 8,000                  | 10                 | 10,000        | 6.0 x 150                      |
| F6028099     | GPC KF-607             | ≥ 5,000                  | 18                 | 20,000        | 6.0 x 150                      |
| F6700300     | GPC KF-G 4A (GPC KF-G) | (guard column)           | 8                  | —             | 4.6 x 10                       |

## High performance semi-micro columns

### ● KF-400HQ series

© Use of the KF-400HQ series with semi-micro type devices is recommended.

| 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                      |
| F6028118     | GPC KF-404HQ           | ≥ 25,000                 | 3                  | 1,500         | 4.6 x 250                      |
| F6028119     | GPC KF-405LHQ          | ≥ 10,000                 | 10                 | 5,000         | 4.6 x 250                      |
| F6028122     | GPC KF-406LHQ          | ≥ 10,000                 | 10                 | 10,000        | 4.6 x 250                      |
| F6700300     | GPC KF-G 4A (GPC KF-G) | (guard column)           | 8                  | —             | 4.6 x 10                       |

#### [KF-600 series and KF-400HQ series]

\* The columns with 'L' or 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

#### [KF-600 series and KF-400HQ series]

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

## Target molecular weight range and Exclusion limit

### ● With Polystyrene (eluent : THF)

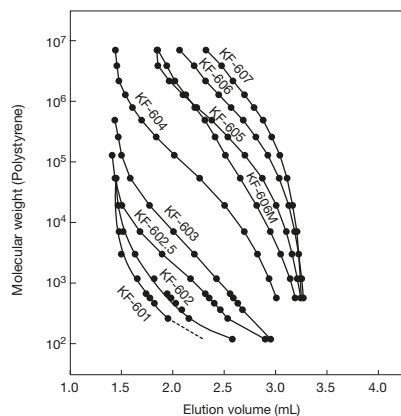
| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------|-------------------------------|-----------------|
| KF-601       | 100 – 700                     | 1,500           |
| KF-602       | 200 – 1,500                   | 4,000           |
| KF-602.5     | 300 – 10,000                  | 20,000          |
| KF-603       | 600 – 50,000                  | 70,000          |
| KF-604       | 7,000 – 500,000               | 1,000,000       |
| KF-605       | 50,000 – 2,000,000            | 4,000,000       |
| KF-606       | 150,000 – *(20,000,000)       | *(20,000,000)   |
| KF-606M      | 1,000 – *(20,000,000)         | *(20,000,000)   |
| KF-607       | 300,000 – *(200,000,000)      | *(200,000,000)  |

| 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          |
| KF-404HQ     | 7,000 – 500,000               | 1,000,000       |
| KF-405LHQ    | 300 – 2,000,000               | 4,000,000       |
| KF-406LHQ    | 300 – *(20,000,000)           | *(20,000,000)   |

\* Please use the above table as a rough indication for the column selection.

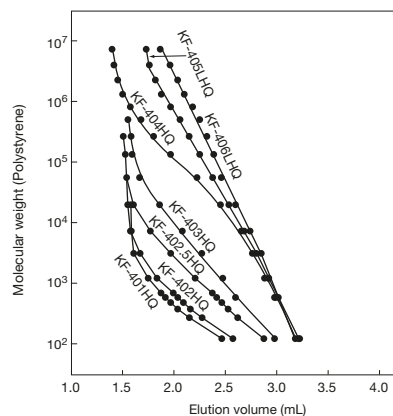
\*( ) Estimated value

## Calibration curves for KF-600 series using polystyrene



Column : Shodex GPC KF-600 series  
 Eluent : THF  
 Flow rate : 0.5mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

## Calibration curves for KF-400HQ series using polystyrene



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

## Comparison of standard, rapid analysis, and high performance type columns

## Standard type

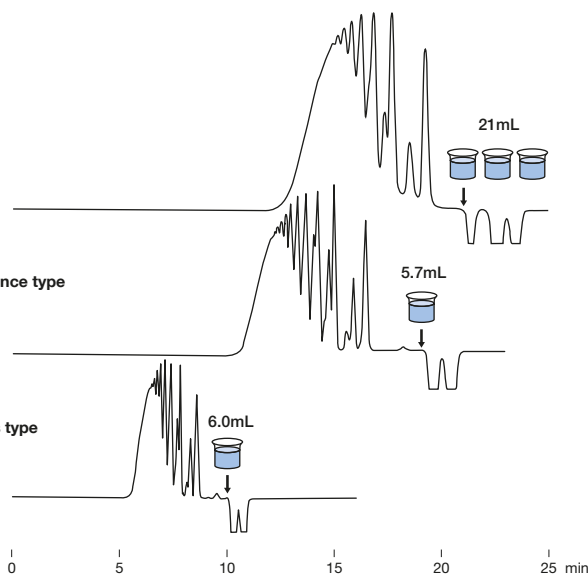
KF-802.5 x 2  
 50μL injection

## High performance type

KF-402.5HQ x 2  
 10μL injection

## Rapid analysis type

KF-602.5 x 2  
 10μL injection



Sample : EPON1001 0.2%

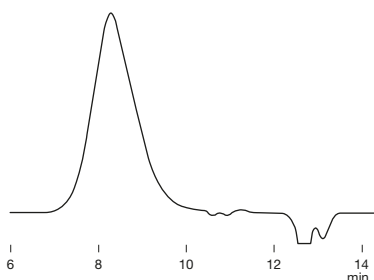
By using KF-602.5, the analysis time is reduced to less than half of that using KF-802.5. Thus KF-600 series enables rapid analysis. On the other hand, KF-402.5HQ has a theoretical plate number 1.5 times more than that of the standard column, thereby improving resolution especially in the analysis of molecules that have a small to medium molecular weight. Rapid analysis and 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  
 Shodex GPC KF-602.5 x 2

Eluent : THF  
 Flow rate : 1.0mL/min (KF-802.5)  
 0.3mL/min (KF-402.5HQ)  
 0.6mL/min (KF-602.5)  
 Detector : RI (conventional type) (KF-802.5)  
 RI (small cell volume) (KF-402.5HQ, KF-602.5)  
 Column temp. : 40°C

## Styrene acrylonitrile copolymer

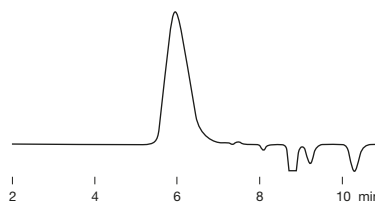
Sample : Styrene-Acrylonitrile (30:70) copolymer



Column : Shodex GPC KF-606M x 2  
 Eluent : 10mM LiBr in DMF  
 Flow rate : 0.5mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

## Liquid paraffin

Sample : Liquid paraffin 1%, 5μL

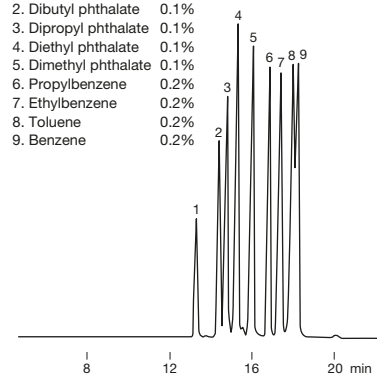


Column : Shodex GPC KF-401HQ  
 Eluent : Chloroform  
 Flow rate : 0.3mL/min  
 Detector : RI (small cell volume)  
 Column temp. : 40°C

## Phthalates

Sample : 10μL

|                       |      |
|-----------------------|------|
| 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 : 0.3mL/min  
 Detector : UV (254nm) (small cell volume)  
 Column temp. : 40°C

# Organic SEC (GPC) Columns : For Preparative

**Preparative columns** \* Preparative columns are made to order.

## ● 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 Columns |
|--------------|--------------------------------|--------------------------|--------------------|--------------------------------|------------------|
| F6102401     | <b>GPC KF-2001</b>             | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | KF-801           |
| F6102402     | <b>GPC KF-2002</b>             | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | KF-802           |
| F6102425     | <b>GPC KF-2002.5</b>           | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | KF-802.5         |
| F6102403     | <b>GPC KF-2003</b>             | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | KF-803           |
| F6102404     | <b>GPC KF-2004</b>             | ≥ 14,000                 | 7                  | <b>20.0 × 300</b>              | KF-804           |
| F6102405     | <b>GPC KF-2005</b>             | ≥ 10,000                 | 10                 | <b>20.0 × 300</b>              | KF-805           |
| F6102406     | <b>GPC KF-2006</b>             | ≥ 10,000                 | 10                 | <b>20.0 × 300</b>              | KF-806           |
| F6102409     | <b>GPC KF-2006M</b>            | ≥ 10,000                 | 10                 | <b>20.0 × 300</b>              | KF-806M          |
| F6700406     | <b>GPC KF-G 8B (GPC KF-LG)</b> | (guard column)           | 15                 | <b>8.0 × 50</b>                | (guard column)   |

\* See page 46 for GPC KF-800 series.

Base Material : Styrene divinylbenzene copolymer

## ● 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 Columns |
|--------------|------------------------------|--------------------------|--------------------|--------------------------------|------------------|
| F6102301     | <b>GPC K-2001</b>            | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | K-801            |
| F6102312     | <b>GPC K-2002</b>            | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | K-802            |
| F6102315     | <b>GPC K-2002.5</b>          | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | K-802.5          |
| F6102303     | <b>GPC K-2003</b>            | ≥ 18,000                 | 6                  | <b>20.0 × 300</b>              | K-803            |
| F6102304     | <b>GPC K-2004</b>            | ≥ 14,000                 | 7                  | <b>20.0 × 300</b>              | K-804            |
| F6102305     | <b>GPC K-2005</b>            | ≥ 10,000                 | 10                 | <b>20.0 × 300</b>              | K-805            |
| F6102306     | <b>GPC K-2006</b>            | ≥ 10,000                 | 10                 | <b>20.0 × 300</b>              | K-806            |
| F6102309     | <b>GPC K-2006M</b>           | ≥ 10,000                 | 10                 | <b>20.0 × 300</b>              | K-806M           |
| F6700407     | <b>GPC K-G 8B (GPC K-LG)</b> | (guard column)           | 15                 | <b>8.0 × 50</b>                | (guard column)   |

\* See page 48 for GPC K-800 series.

Base Material : Styrene divinylbenzene copolymer

**Preparative columns** \* Preparative columns are made to order.

● **H-2000 series : Shipping solvent Chloroform**

| Product Code | Product Name            | Plate Number<br>(TP/column) | Particle Size<br>( $\mu\text{m}$ ) | Column Size (mm)<br>I.D. x Length | Standard Columns |
|--------------|-------------------------|-----------------------------|------------------------------------|-----------------------------------|------------------|
| F6102001     | GPC H-2001              | $\geq 13,000$               | 15                                 | 20.0 x 500                        | K-801            |
| F6102002     | GPC H-2002              | $\geq 13,000$               | 15                                 | 20.0 x 500                        | K-802            |
| F6102025     | GPC H-2002.5            | $\geq 13,000$               | 15                                 | 20.0 x 500                        | K-802.5          |
| F6102003     | GPC H-2003              | $\geq 13,000$               | 15                                 | 20.0 x 500                        | K-803            |
| F6102004     | GPC H-2004              | $\geq 13,000$               | 15                                 | 20.0 x 500                        | K-804            |
| F6102005     | GPC H-2005              | $\geq 13,000$               | 15                                 | 20.0 x 500                        | K-805            |
| F6102006     | GPC H-2006              | $\geq 13,000$               | 15                                 | 20.0 x 500                        | K-806            |
| F6102009     | GPC H-2006M             | $\geq 12,000$               | 15                                 | 20.0 x 500                        | K-806M           |
| F6700310     | GPC H-G 8B<br>(GPC H-G) | (guard column)              | 15                                 | 8.0 x 50                          | (guard column)   |

\* See page 48 for GPC K-800 series.

Base Material : Styrene divinylbenzene copolymer

● **KF-5000 series : Shipping solvent Tetrahydrofuran (THF) [Customized columns]**

| Product Code | Product Name                 | Particle Size<br>( $\mu\text{m}$ ) | Column Size (mm)<br>I.D. x Length | Standard Columns |
|--------------|------------------------------|------------------------------------|-----------------------------------|------------------|
| 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 20B<br>(GPC KF-LLG) | 15                                 | 20.0 x 100                        | (guard column)   |

\* See page 46 for GPC KF-800 series.

Base Material : Styrene divinylbenzene copolymer

● **K-5000 series : Shipping solvent Chloroform [Customized columns]**

| Product Code | Product Name               | Particle Size<br>( $\mu\text{m}$ ) | Column Size (mm)<br>I.D. x Length | Standard Columns |
|--------------|----------------------------|------------------------------------|-----------------------------------|------------------|
| F6109010     | GPC K-5001                 | 15                                 | 50.0 x 300                        | K-801            |
| F6109020     | GPC K-5002                 | 15                                 | 50.0 x 300                        | K-802            |
| F6109025     | GPC K-5002.5               | 15                                 | 50.0 x 300                        | K-802.5          |
| F6109030     | GPC K-5003                 | 15                                 | 50.0 x 300                        | K-803            |
| F6109040     | GPC K-5004                 | 15                                 | 50.0 x 300                        | K-804            |
| F6700409     | GPC K-G 20B<br>(GPC K-LLG) | 15                                 | 20.0 x 100                        | (guard column)   |

\* See page 48 for GPC K-800 series.

Base Material : Styrene divinylbenzene copolymer

# Organic SEC (GPC) Columns : Linear Calibration Type

## Features

- LF**
  - Employs a special packing material with a wide pore size distribution (multi pore type)
  - Highly linear calibration curve without inflection points
  - Molecular weight distribution can be determined with high precision
  - Enables analysis over a broad range of molecular weights
  - Column for rapid analysis (LF-604) and column for high performance analysis (LF-404) enabling reduction in solvent use are also available
  - Corresponds to USP L21

## Standard columns

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

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

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

## Rapid analysis downsized column

◎ Use of the LF-604 with semi-micro type devices is recommended.

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

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

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

## High performance semi-micro column

◎ Use of the LF-404 with semi-micro type devices is recommended.

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

\* See page 62 for applicability of SEC (GPC) columns to solvent replacement.

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

## Target molecular weight range and Exclusion limit

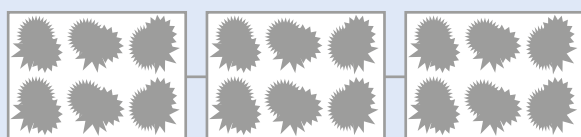
### ● With Polystyrene (eluent : THF)

| Product Name  | Target Molecular Weight Range | Exclusion Limit |
|---------------|-------------------------------|-----------------|
| <b>LF-804</b> | 300 – 2,000,000               | 2,000,000       |
| <b>LF-604</b> | 300 – 2,000,000               | 2,000,000       |
| <b>LF-404</b> | 300 – 2,000,000               | 2,000,000       |

\* Please use the above table as a rough indication for the column selection.

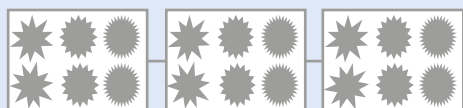
## Schematic diagram of linear calibration type packing

### Connecting linear calibration type columns (LF series)



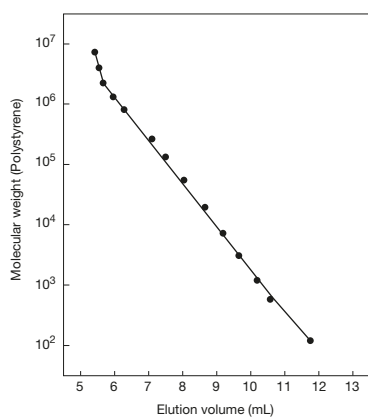
The linear calibration type column covers a broad range of molecular weights with only one kind of packing (column).

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

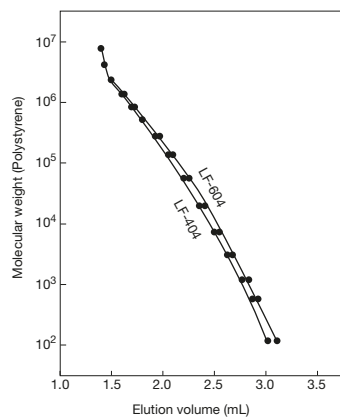


### Connecting different grades columns (KF-804 + KF-803 + KF-802, etc.)



**Calibration curve for LF-804 using polystyrene**

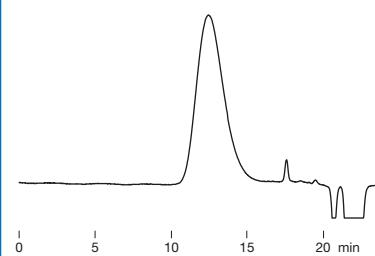
**Column** : Shodex GPC LF-804  
**Eluent** : THF  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

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

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

**Polyurethane**

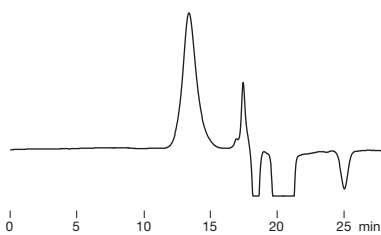
Sample : Polyurethane 0.1%, 20μL



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

**Xylan**

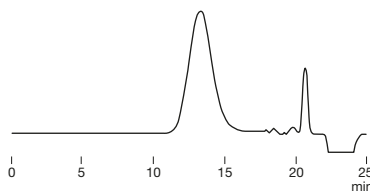
Sample : Xylan 0.1%, 100μL



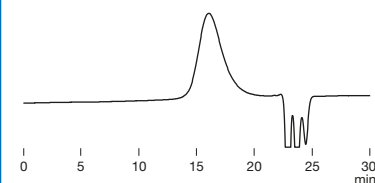
**Column** : Shodex GPC LF-804  
**Eluent** : 20mM H<sub>3</sub>PO<sub>4</sub> + 20mM LiBr in (DMSO/DMF=80/20)  
**Flow rate** : 0.6mL/min  
**Detector** : RI  
**Column temp.** : 50°C

**Polyamide (Nylon6/6)**

Sample : Nylon™ 6/6 0.1%, 20μL



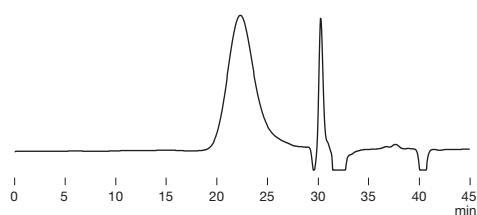
**Column** : Shodex GPC LF-404  
**Eluent** : 5mM CF<sub>3</sub>COONa in HFIP  
**Flow rate** : 0.15mL/min  
**Detector** : RI (small cell volume)  
**Column temp.** : 40°C

**Polymethyl methacrylate**Sample : 100μL  
Polymethyl methacrylate

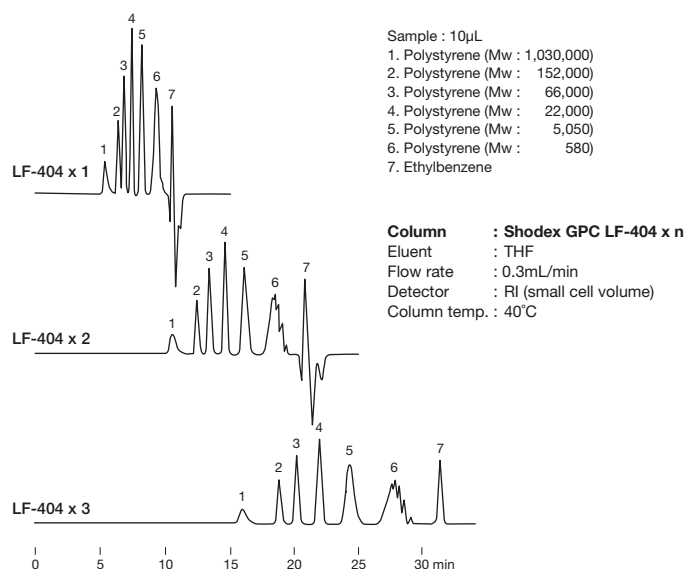
**Column** : Shodex GPC LF-804 x 2  
**Eluent** : Methyl ethyl ketone  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

**Polyamic acid**

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



**Column** : Shodex GPC LF-804 x 2  
**Eluent** : 30mM LiBr + 30mM H<sub>3</sub>PO<sub>4</sub> in NMP  
**Flow rate** : 0.7mL/min  
**Detector** : RI  
**Column temp.** : 50°C

**Comparison of polystyrenes separation with different numbers of LF-404**

# Organic SEC (GPC) Columns : High Temperature/Ultra High Temperature Analysis

## Features

- HT-800**
- Varied product lineup to support a wide range of molecular weights
  - Corresponds to USP L21
- 
- UT-800**
- Dedicated to SEC analysis at high/ultra high temperatures with a maximum usable temperature of 210°C
  - Suitable for the analysis of ultra high molecular weight polymer containing samples
  - Corresponds to USP L21

## Standard columns

| Product Code | Product Name        | Plate Number (TP/column) | Usable Temperature (°C) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|---------------------|--------------------------|-------------------------|--------------------|---------------|--------------------------------|
| F6208700     | <b>GPC HT-803</b>   | ≥ 7,000                  | 100 ~ 150               | 13                 | 500           | <b>8.0 x 300</b>               |
| F6208710     | <b>GPC HT-804</b>   | ≥ 7,000                  | 100 ~ 150               | 13                 | 1,500         | <b>8.0 x 300</b>               |
| F6208720     | <b>GPC HT-805</b>   | ≥ 7,000                  | 100 ~ 150               | 13                 | 5,000         | <b>8.0 x 300</b>               |
| F6208730     | <b>GPC HT-806</b>   | ≥ 7,000                  | 100 ~ 150               | 13                 | 10,000        | <b>8.0 x 300</b>               |
| F6208740     | <b>GPC HT-806M</b>  | ≥ 7,000                  | 100 ~ 150               | 13                 | 10,000        | <b>8.0 x 300</b>               |
| F6208770     | <b>GPC HT-807</b>   | ≥ 4,000                  | 100 ~ 150               | 18                 | 20,000        | <b>8.0 x 300</b>               |
| F6709410     | <b>GPC HT-G</b>     | (guard column)           | 100 ~ 150               | 13                 | –             | <b>8.0 x 50</b>                |
| F6208600     | <b>GPC UT-802.5</b> | ≥ 4,400                  | 100 ~ 210               | 30                 | 300           | <b>8.0 x 300</b>               |
| F6208610     | <b>GPC UT-806M</b>  | ≥ 4,400                  | 100 ~ 210               | 30                 | 10,000        | <b>8.0 x 300</b>               |
| F6208620     | <b>GPC UT-807</b>   | ≥ 3,300                  | 100 ~ 210               | 30                 | 20,000        | <b>8.0 x 300</b>               |
| F6709400     | <b>GPC UT-G</b>     | (guard column)           | 100 ~ 210               | 30                 | –             | <b>8.0 x 50</b>                |
| F6208390     | <b>GPC AT-806MS</b> | ≥ 6,000                  | *Ta ~ 150               | 12                 | 10,000        | <b>8.0 x 250</b>               |
| F6700280     | <b>GPC AT-G</b>     | (guard column)           | *Ta ~ 150               | 15                 | –             | <b>8.0 x 50</b>                |

\* The columns with 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

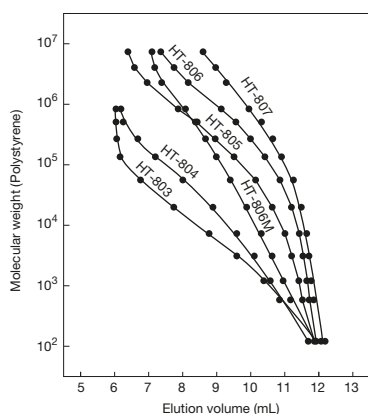
Base Material : Styrene divinylbenzene copolymer  
Shipping Solvent : Toluene  
\*Ta : Ambient temperature

## Target molecular weight range and Exclusion limit

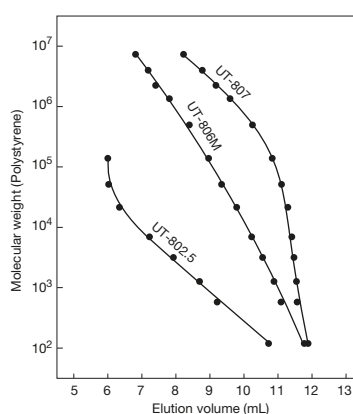
### ● With Polystyrene (eluent : THF)

| Product Name    | Target Molecular Weight Range | Exclusion Limit |
|-----------------|-------------------------------|-----------------|
| <b>HT-803</b>   | 1,000 – 50,000                | 70,000          |
| <b>HT-804</b>   | 7,000 – 300,000               | 400,000         |
| <b>HT-805</b>   | 50,000 – 2,000,000            | 4,000,000       |
| <b>HT-806</b>   | 150,000 – *(20,000,000)       | *(20,000,000)   |
| <b>HT-806M</b>  | 1,000 – *(20,000,000)         | *(20,000,000)   |
| <b>HT-807</b>   | 300,000 – *(200,000,000)      | *(200,000,000)  |
| <b>UT-802.5</b> | 300 – 10,000                  | 20,000          |
| <b>UT-806M</b>  | 1,000 – *(20,000,000)         | *(20,000,000)   |
| <b>UT-807</b>   | 500,000 – *(200,000,000)      | *(200,000,000)  |
| <b>AT-806MS</b> | 1,000 – *(20,000,000)         | *(20,000,000)   |

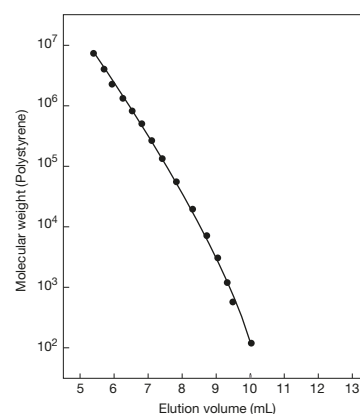
\* Please use the above table as a rough indication for the column selection.      \*( ) Estimated value

**Calibration curves for HT-800 series using polystyrene**

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

**Calibration curves for UT-800 series using polystyrene**

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

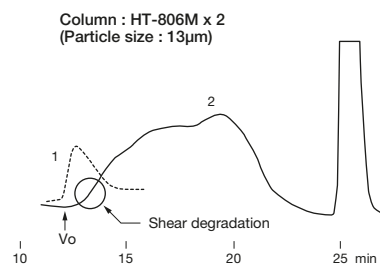
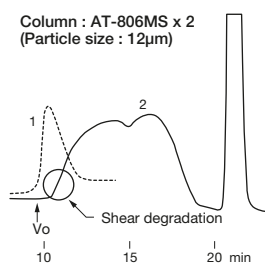
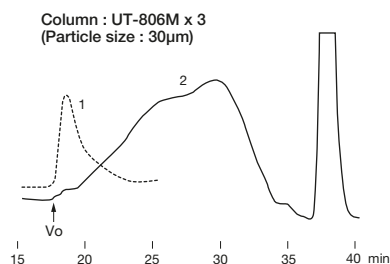
**Calibration curve for AT-806MS using polystyrene**

**Column** : Shodex GPC AT-806MS  
**Eluent** : THF  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

**Effects of gel particle size in high temperature GPC columns**

High temperature SEC columns are suitable for the analysis of high molecular weight polymers that are difficult to be dissolved in ambient temperature solvents; examples of such polymers are polyethylene and polypropylene. The GPC UT-800 series packed with large particle size (30  $\mu$ m) are recommended for the analysis of macromolecules. The large particle size prevents potential molecular shear degradation of the sample.

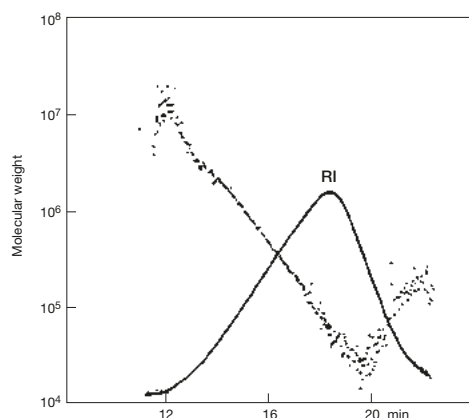
**Sample** :  
 1. Polystyrene (MW : 20,000,000)  
 2. High density polyethylene (HDPE-A)



**Column** : Shodex GPC UT-806M  
 Shodex GPC HT-806M  
 Shodex GPC AT-806MS  
**Eluent** : 0.1% BHT in o-Dichlorobenzene  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 140°C

**High density polyethylene**

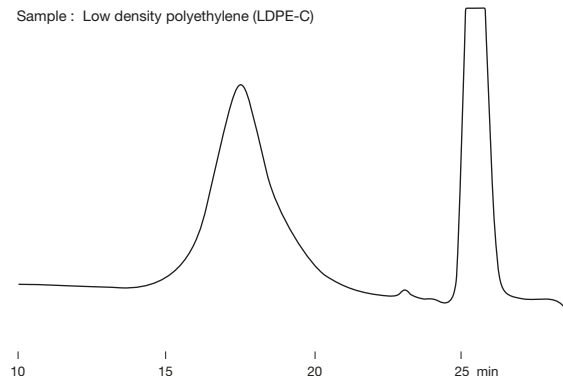
**Sample** : High density polyethylene (HDPE-B)



**Column** : Shodex GPC UT-806M x 2  
**Eluent** : 0.1% BHT in o-Dichlorobenzene  
**Flow rate** : 1.0mL/min  
**Detector** : RI, MALS (Multi angle light scattering)  
**Column temp.** : 145°C

**Low density polyethylene**

**Sample** : Low density polyethylene (LDPE-C)



**Column** : Shodex GPC HT-806M x 2  
**Eluent** : 0.1% BHT in o-Dichlorobenzene  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 140°C

# Organic SEC (GPC) Columns : HFIP

## Features

- HFIP-800**
- Columns exclusively for use with hexafluoroisopropanol (HFIP)
  - Corresponds to USP L21

- HFIP-600**
- Rapid analysis, solvent saving type
  - Corresponds to USP L21

## Standard columns

### ● HFIP-800 series

| Product Code | Product Name                | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|-----------------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6028530     | GPC HFIP-803                | ≥ 12,000                 | 10                 | 500           | 8.0 × 300                      |
| F6028540     | GPC HFIP-804                | ≥ 12,000                 | 7                  | 1,500         | 8.0 × 300                      |
| F6028550     | GPC HFIP-805                | ≥ 10,000                 | 10                 | 5,000         | 8.0 × 300                      |
| F6028560     | GPC HFIP-806                | ≥ 10,000                 | 10                 | 10,000        | 8.0 × 300                      |
| F6028590     | GPC HFIP-806M               | ≥ 10,000                 | 10                 | 10,000        | 8.0 × 300                      |
| F6028570     | GPC HFIP-807                | ≥ 4,000                  | 18                 | 20,000        | 8.0 × 300                      |
| F6700500     | GPC HFIP-G 8B (GPC HFIP-LG) | (guard column)           | 15                 | –             | 8.0 × 50                       |

\* The columns with 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material : Styrene divinylbenzene copolymer  
Shipping Solvent : Hexafluoroisopropanol (HFIP)

## Rapid analysis downsized columns

### ● HFIP-600 series

© Use of the HFIP-600 series with semi-micro type devices is recommended.

| Product Code | Product Name               | Plate Number (TP/column) | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|----------------------------|--------------------------|--------------------|---------------|--------------------------------|
| F6021030     | GPC HFIP-603               | ≥ 12,000                 | 3                  | 500           | 6.0 × 150                      |
| F6021040     | GPC HFIP-604               | ≥ 12,000                 | 3                  | 1,500         | 6.0 × 150                      |
| F6021050     | GPC HFIP-605               | ≥ 5,000                  | 10                 | 5,000         | 6.0 × 150                      |
| F6021060     | GPC HFIP-606               | ≥ 5,000                  | 10                 | 10,000        | 6.0 × 150                      |
| F6021080     | GPC HFIP-606M              | ≥ 6,000                  | 10                 | 10,000        | 6.0 × 150                      |
| F6021070     | GPC HFIP-607               | ≥ 3,000                  | 18                 | 20,000        | 6.0 × 150                      |
| F6700511     | GPC HFIP-G 4A (GPC HFIP-G) | (guard column)           | 8                  | –             | 4.6 × 10                       |

\* The columns with 'M' at the end of column names are mixed-gel column capable of analyzing samples over a wide range of molecular weight distribution.

Base Material : Styrene divinylbenzene copolymer  
Shipping Solvent : Hexafluoroisopropanol (HFIP)

## Target molecular weight range and Exclusion limit

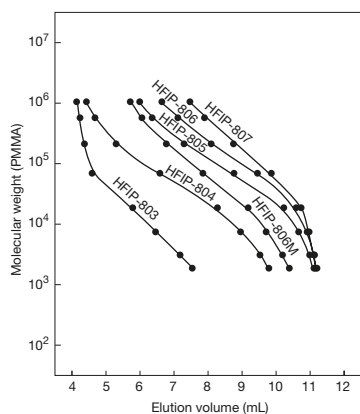
### ● With \*PMMA (eluent : HFIP)

| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------|-------------------------------|-----------------|
| HFIP-803     | 1,000 – 30,000                | 60,000          |
| HFIP-804     | 20,000 – 200,000              | 300,000         |
| HFIP-805     | 20,000 – 600,000              | 1,000,000       |
| HFIP-806     | 70,000 – *(8,000,000)         | *(8,000,000)    |
| HFIP-806M    | 1,000 – *(8,000,000)          | *(8,000,000)    |
| HFIP-807     | 70,000 – *(50,000,000)        | *(50,000,000)   |

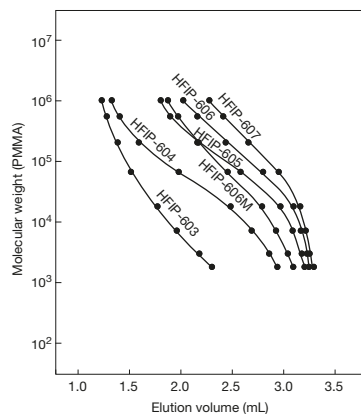
| Product Name | Target Molecular Weight Range | Exclusion Limit |
|--------------|-------------------------------|-----------------|
| HFIP-603     | 1,000 – 30,000                | 60,000          |
| HFIP-604     | 20,000 – 200,000              | 300,000         |
| HFIP-605     | 20,000 – 600,000              | 1,000,000       |
| HFIP-606     | 70,000 – *(8,000,000)         | *(8,000,000)    |
| HFIP-606M    | 1,000 – *(8,000,000)          | *(8,000,000)    |
| HFIP-607     | 70,000 – *(50,000,000)        | *(50,000,000)   |

\* Please use the above table as a rough indication for the column selection.

\*PMMA : Polymethylmethacrylate  
\*( ) Estimated value

**Calibration curves for HFIP-800 series using PMMA**

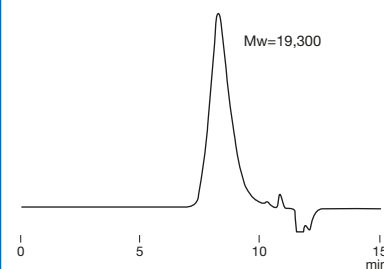
**Column** : Shodex GPC HFIP-800 series  
**Eluent** : HFIP  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

**Calibration curves for HFIP-600 series using PMMA**

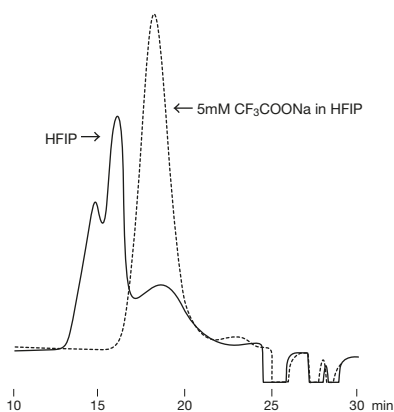
**Column** : Shodex GPC HFIP-600 series  
**Eluent** : HFIP  
**Flow rate** : 0.3mL/min (HFIP-603, 604)  
 0.5mL/min (HFIP-605, 606, 606M, 607)  
**Detector** : RI (small cell volume)  
**Column temp.** : 40°C

**Polyethylene terephthalate (PET)**

Sample : Polyethylene terephthalate 0.2%, 20 $\mu$ L



**Column** : Shodex GPC HFIP-606M x 2  
**Eluent** : 5mM CF<sub>3</sub>COONa in HFIP  
**Flow rate** : 0.6mL/min  
**Detector** : RI (small cell volume)  
**Column temp.** : 40°C

**Polyamide (effects of salt addition)**

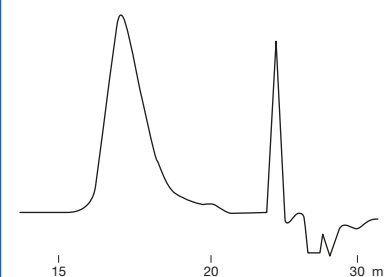
Sample : Polycaprolactum (Nylon® 6)

In SEC analysis using HFIP, some samples may yield abnormal peaks as a result of ionic interaction. In this case, ionic interaction can be suppressed by adding sodium trifluoroacetate to HFIP.

**Column** : Shodex GPC HFIP-806M x 2  
**Eluent** : HFIP (solid line), 5mM CF<sub>3</sub>COONa in HFIP (broken line)  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

**Polybutylene terephthalate (PBT)**

Sample : Polybutylene terephthalate 0.05%, 500 $\mu$ L

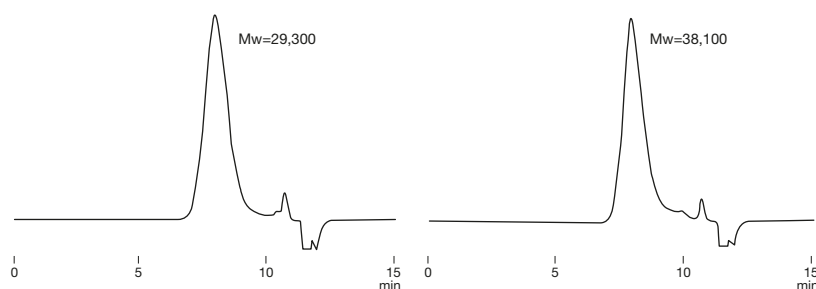


**Column** : Shodex GPC HFIP-805 + HFIP-803  
**Eluent** : 5mM CF<sub>3</sub>COONa in HFIP  
**Flow rate** : 1.0mL/min  
**Detector** : RI  
**Column temp.** : 40°C

**Polyamides (Nylon 610 and Nylon 6)**

Sample : Nylon® 610 0.2%, 20 $\mu$ L

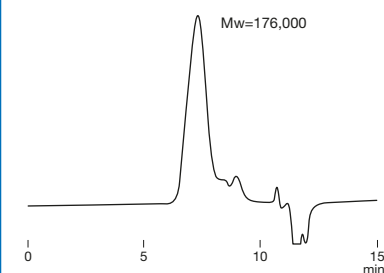
Sample : Nylon® 6 0.2%, 20 $\mu$ L



**Column** : Shodex GPC HFIP-606M x 2  
**Eluent** : 5mM CF<sub>3</sub>COONa in HFIP  
**Flow rate** : 0.6mL/min  
**Detector** : RI (small cell volume)  
**Column temp.** : 40°C

**Polyacetal**

Sample : Polyacetal 0.2%, 20 $\mu$ L



**Column** : Shodex GPC HFIP-606M x 2  
**Eluent** : 5mM CF<sub>3</sub>COONa in HFIP  
**Flow rate** : 0.6mL/min  
**Detector** : RI (small cell volume)  
**Column temp.** : 40°C

# Applicability of SEC (GPC) Columns to Solvent Replacement

| Solvent                       | Product Name                  |                                          |        |                                                                                  |                                    |                                                           |                            |                              |        |                                                 |
|-------------------------------|-------------------------------|------------------------------------------|--------|----------------------------------------------------------------------------------|------------------------------------|-----------------------------------------------------------|----------------------------|------------------------------|--------|-------------------------------------------------|
|                               | Shipping Solvent : THF        |                                          |        |                                                                                  |                                    |                                                           |                            | Shipping Solvent : DMF       |        |                                                 |
|                               | KF-801                        | KF-802<br>KF-802.5<br>KF-803L<br>KF-804L | KF-803 | KF-804<br>KF-805<br>KF-806<br>KF-807<br>KF-806M<br>KF-805L<br>KF-806L<br>KF-807L | KF-601<br>KF-602<br>KF-602.5       | KF-603<br>KF-604<br>KF-605<br>KF-606<br>KF-607<br>KF-606M | LF-804<br>LF-604<br>LF-404 | KD-801<br>KD-802<br>KD-802.5 | KD-803 | KD-804<br>KD-805<br>KD-806<br>KD-807<br>KD-806M |
|                               | Shipping Solvent : Chloroform |                                          |        |                                                                                  | Shipping Solvent : THF             |                                                           |                            |                              |        |                                                 |
|                               | K-801                         | K-802<br>K-802.5<br>K-803L<br>K-804L     | K-803  | K-804<br>K-805<br>K-806<br>K-807<br>K-806M<br>K-805L<br>K-806L<br>K-807L         | KF-401HQ<br>KF-402HQ<br>KF-402.5HQ | KF-403HQ<br>KF-404HQ<br>KF-405LHQ<br>KF-406LHQ            |                            |                              |        |                                                 |
| Tetrahydrofuran (THF)         | ○                             | ○                                        | ○      | ○                                                                                | ○                                  | ○                                                         | ○                          | ×                            | ×      | ○                                               |
| Chloroform                    | ○                             | ○                                        | ○      | ○                                                                                | ○                                  | ○                                                         | ○                          | ×                            | ×      | ○                                               |
| Carbon tetrachloride          | ×                             | ○                                        | ○      | ○                                                                                |                                    |                                                           | ○                          | ×                            | ×      | ○                                               |
| Benzene                       | ○                             | ○                                        | ○      | ○                                                                                | ○                                  | ○                                                         |                            | ×                            | ○      | ○                                               |
| Toluene                       | ○                             | ○                                        | ○      | ○                                                                                | ○                                  | ○                                                         | ○                          | ×                            | ○      | ○                                               |
| p-Xylene                      | ×                             | ○                                        | ○      | ○                                                                                | ○                                  | ○                                                         |                            | ×                            | ○      | ○                                               |
| o-Dichlorobenzene (ODCB)      | ×                             | ×                                        | ○      | ○                                                                                | ○                                  | ○                                                         |                            | ×                            | ○      | ○                                               |
| Trichlorobenzene (TCB)        | ×                             | ×                                        | ○      | ○                                                                                | ○                                  | ○                                                         |                            | ×                            | ○      | ○                                               |
| Dioxane                       | ×                             | ○                                        | ○      | ○                                                                                |                                    |                                                           |                            | ×                            | ○      | ○                                               |
| Diethyl ether                 | ×                             | ×                                        | ○      | ○                                                                                |                                    |                                                           |                            | ×                            | ○      | ○                                               |
| Ethyl acetate                 | ×                             | ×                                        | ○      | ○                                                                                |                                    |                                                           |                            | ×                            | ×      | ○                                               |
| Acetone                       | ×                             | ×                                        | ○      | ○                                                                                | ○                                  | ○                                                         |                            | ×                            | ○      | ○                                               |
| Methyl ethyl ketone           | ×                             | ×                                        | ○      | ○                                                                                | ○                                  | ○                                                         | ○                          | ×                            | ○      | ○                                               |
| Dimethylformamide (DMF)       | ×                             | ×                                        | ○      | ○                                                                                | ○ *                                | ○ *                                                       | ○ *                        | ○                            | ○      | ○                                               |
| Dimethylacetamide (DMAc)      | ×                             | ×                                        | ○      | ○                                                                                | ○ *                                | ○ *                                                       | ○ *                        | ×                            | ○      | ○                                               |
| Hexafluoroisopropanol (HFIP)  | ×                             | ×                                        | ×      | ○                                                                                | ×                                  | △ *                                                       | ○ *                        | ×                            | ○      | ○                                               |
| m-Cresol                      | ×                             | ×                                        | ○      | ○                                                                                |                                    |                                                           |                            | ×                            | ○      | ○                                               |
| o-Chlorophenol                | ×                             | ×                                        | ○      | ○                                                                                |                                    |                                                           |                            | ×                            | ○      | ○                                               |
| Quinolin                      | ×                             | ×                                        | ○      | ○                                                                                |                                    |                                                           |                            | ×                            | ○      | ○                                               |
| N-Methylpyrrolidone (NMP)     | ×                             | ×                                        | ○      | ○                                                                                | ○ *                                | ○ *                                                       | ○ *                        | ×                            | ○      | ○                                               |
| Dimethylsulfoxide (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

×

# Calibration Standards for SEC

## [Polystyrene (PS)]

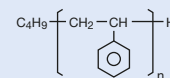
### Features

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

### Kit type

| Product Code | Product Name           | Contents        | MW Range            |
|--------------|------------------------|-----------------|---------------------|
| F8601105     | <b>STANDARD SL-105</b> | 0.5g x 10 kinds | 580 – 19,500        |
| F8602105     | <b>STANDARD SM-105</b> | 0.5g x 10 kinds | 1,220 – 2,700,000   |
| F8603075     | <b>STANDARD SH-75</b>  | 0.5g x 7 kinds  | 591,000 – 6,870,000 |

### Structural formula of S series



### ■ SL-105

| Std. No. | Mp     | Mw/Mn |
|----------|--------|-------|
| S-19     | 19,500 | 1.03  |
| S-13     | 13,300 | 1.02  |
| S-9.9    | 9,970  | 1.03  |
| S-6.9    | 6,940  | 1.03  |
| S-4.8    | 4,830  | 1.04  |
| S-2.7    | 2,780  | 1.04  |
| S-1.8    | 1,860  | 1.04  |
| S-1.3    | 1,390  | 1.05  |
| S-0.8    | 860    | 1.07  |
| S-0.5    | 580    | 1.11  |

### ■ SM-105

| Std. No. | Mp        | Mw/Mn |
|----------|-----------|-------|
| S-2700   | 2,700,000 | 1.07  |
| S-1390   | 1,390,000 | 1.06  |
| S-661    | 661,000   | 1.04  |
| S-326    | 326,000   | 1.02  |
| S-124    | 124,000   | 1.03  |
| S-47     | 47,200    | 1.03  |
| S-18     | 18,300    | 1.03  |
| S-6.9    | 6,940     | 1.03  |
| S-3.0    | 2,980     | 1.04  |
| S-1.2    | 1,220     | 1.06  |

### ■ SH-75

| Std. No. | Mp        | Mw/Mn |
|----------|-----------|-------|
| S-6870   | 6,870,000 | 1.09  |
| S-5190   | 5,190,000 | 1.03  |
| S-3990   | 3,990,000 | 1.05  |
| S-2350   | 2,350,000 | 1.04  |
| S-1820   | 1,820,000 | 1.04  |
| S-991    | 991,000   | 1.05  |
| S-591    | 591,000   | 1.02  |

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

## [Polymethylmethacrylate (PMMA)]

### Features

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

### Kit type

| Product Code | Product Name         | Contents       | MW Range          |
|--------------|----------------------|----------------|-------------------|
| F8604075     | <b>STANDARD M-75</b> | 0.5g x 7 kinds | 2,880 – 1,050,000 |

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

| Std. No. | Mp        | Mw/Mn |
|----------|-----------|-------|
| M-1050   | 1,050,000 | 1.07  |
| M-569    | 569,000   | 1.04  |
| M-211    | 211,000   | 1.02  |
| M-69     | 68,800    | 1.02  |
| M-18     | 17,800    | 1.04  |
| M-6.8    | 6,850     | 1.10  |
| M-2.9    | 2,880     | 1.08  |

## [Pullulan]

### Features

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

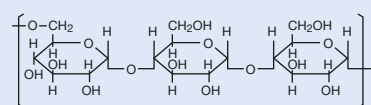
### Kit type

| Product Code | Product Name         | Contents       | MW Range        |
|--------------|----------------------|----------------|-----------------|
| F8400000     | <b>STANDARD P-82</b> | 0.2g x 8 kinds | 6,100 – 642,000 |

### Single type

| Product Code | Product Name     | Contents | Mp      | Mw/Mn |
|--------------|------------------|----------|---------|-------|
| F8400800     | <b>STD P-800</b> | 0.5g     | 642,000 | 1.23  |
| F8400400     | <b>STD P-400</b> | 0.5g     | 337,000 | 1.12  |
| F8400200     | <b>STD P-200</b> | 0.5g     | 194,000 | 1.09  |
| F8400100     | <b>STD P-100</b> | 0.5g     | 107,000 | 1.13  |
| F8400050     | <b>STD P-50</b>  | 0.5g     | 47,100  | 1.07  |
| F8400020     | <b>STD P-20</b>  | 0.5g     | 21,100  | 1.09  |
| F8400010     | <b>STD P-10</b>  | 0.5g     | 9,600   | 1.09  |
| F8400005     | <b>STD P-5</b>   | 0.5g     | 6,100   | 1.05  |

### Structural formula of P series



| Std. No.  | Mp      | Mw/Mn |
|-----------|---------|-------|
| STD P-800 | 642,000 | 1.23  |
| STD P-400 | 337,000 | 1.12  |
| STD P-200 | 194,000 | 1.09  |
| STD P-100 | 107,000 | 1.13  |
| STD P-50  | 47,100  | 1.07  |
| STD P-20  | 21,100  | 1.09  |
| STD P-10  | 9,600   | 1.09  |
| STD P-5   | 6,100   | 1.05  |

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

# Columns for Anion Exchange Chromatography

## Features

|                                  |                                                                                                                                                                                                                                                                  |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>QA-825</b><br><b>DEAE-825</b> | <ul style="list-style-type: none"> <li>Suitable for analysis of relatively high molecular weight compounds: proteins, peptides, DNA, and RNA</li> <li>Usable in a wide pH range from pH 2 to 12</li> <li>QA-825 corresponds to USP L23</li> </ul>                |
| <b>DEAE3N-4T</b>                 | <ul style="list-style-type: none"> <li>Non-porous base material</li> <li>For rapid analysis</li> </ul>                                                                                                                                                           |
| <b>DEAE-2B</b>                   | <ul style="list-style-type: none"> <li>Non-porous base material</li> <li>Supports UHPLC (available under hyperbaric conditions up to 30 MPa)</li> </ul>                                                                                                          |
| <b>ES-502N 7C</b>                | <ul style="list-style-type: none"> <li>Compared to IEC series columns, polyvinyl alcohol is used as base material and this offers different separation pattern</li> <li>Low hydrophobic interaction of proteins allows analysis under mild conditions</li> </ul> |
| <b>WA-624</b>                    | <ul style="list-style-type: none"> <li>Suitable for anion exchange analysis of low molecular weight compounds such as nucleotides</li> </ul>                                                                                                                     |

## Standard columns

### ● Strong anion exchange resin [Functional Group : Quaternary ammonium]

| 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     | <b>IEC QA-825</b> | 0.45                          | Polyhydroxymethacrylate | 12                 | 5,000         | <b>8.0 × 75</b>                | 50mM Na <sub>2</sub> SO <sub>4</sub> aq. |

### ● Weak anion exchange resin [Functional Group : Diethylaminoethyl]

| 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     | <b>IEC DEAE-825</b>        | 0.6                           | Polyhydroxymethacrylate | 8                  | 5,000         | <b>8.0 × 75</b>                | 50mM Na <sub>2</sub> SO <sub>4</sub> aq.                       |
| F6112100     | <b>IEC DEAE3N-4T</b>       | 0.4                           | Polyhydroxymethacrylate | 2.5                | –             | <b>4.6 × 35</b>                | H <sub>2</sub> O                                               |
| F7640002     | <b>Asahipak ES-502N 7C</b> | 0.55                          | Polyvinyl alcohol       | 9                  | 2,000         | <b>7.5 × 100</b>               | 50mM 1,3-Diaminopropane + 50mM NaCl (pH10.0)                   |
| F6356240     | <b>AXpak WA-624</b>        | 1.2                           | Polyhydroxymethacrylate | 10                 | 2,000         | <b>6.0 × 150</b>               | 0.1M Sodium phosphate buffer (pH3.0)/CH <sub>3</sub> CN =80/20 |
| F6700245     | <b>AXpak WA-G</b>          | (guard column)                | Polyhydroxymethacrylate | 10                 | –             | <b>4.6 × 10</b>                | 0.1M Sodium phosphate buffer (pH3.0)/CH <sub>3</sub> CN =80/20 |

### ● Weak anion exchange resin [Functional Group : Diethylaminoethyl] : For UHPLC 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 |
|--------------|-----------------------|-------------------------------|-------------------------|--------------------|---------------|--------------------------------|------------------|
| F6112110     | <b>PIKESS DEAE-2B</b> | 0.4                           | Polyhydroxymethacrylate | 2.5                | –             | <b>2.0 × 50</b>                | H <sub>2</sub> O |

## Semi-micro columns \* The following semi-micro columns are made to order.

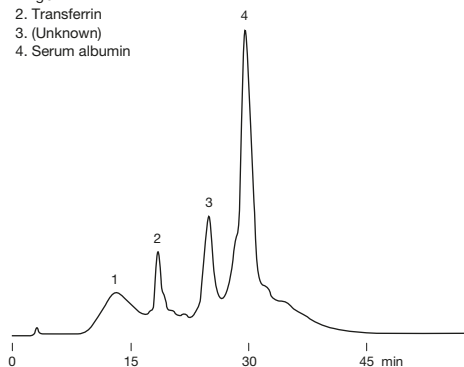
| Product Code | Product Name     | Ion Exchange Capacity (meq/g) | Base Material     | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length |
|--------------|------------------|-------------------------------|-------------------|--------------------|---------------|--------------------------------|
| F7960122     | <b>DEAE9A-2D</b> | 0.55                          | Polyvinyl alcohol | 9                  | 2,000         | <b>2.0 × 150</b>               |

## Preparative columns \* Preparative columns are made to order.

| Product Code | Product Name                | Particle Size (μm) | Column Size (mm) I.D. x Length | Standard columns |
|--------------|-----------------------------|--------------------|--------------------------------|------------------|
| F6548000     | <b>IEC QA-2025</b>          | 20                 | <b>20.0 × 150</b>              | QA-825           |
| F6548050     | <b>IEC QA-5025</b>          | 37                 | <b>50.0 × 300</b>              | QA-825           |
| F6709602     | <b>IEC QA-LG</b>            | 20                 | <b>8.0 × 50</b>                | (guard column)   |
| F6548001     | <b>IEC DEAE-2025</b>        | 20                 | <b>20.0 × 150</b>              | DEAE-825         |
| F6548051     | <b>IEC DEAE-5025</b>        | 37                 | <b>50.0 × 300</b>              | DEAE-825         |
| F6709603     | <b>IEC DEAE-LG</b>          | 20                 | <b>8.0 × 50</b>                | (guard column)   |
| F6840004     | <b>Asahipak ES-502N 20C</b> | 13                 | <b>20.0 × 100</b>              | ES-502N 7C       |
| F6710021     | <b>Asahipak GS-20G 7B</b>   | 20                 | <b>7.5 × 50</b>                | (guard column)   |

## Proteins in human serum

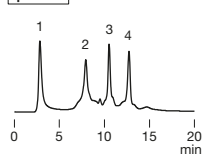
Sample : Human serum 0.5%, 200 $\mu$ L  
 1. IgG  
 2. Transferrin  
 3. (Unknown)  
 4. Serum albumin



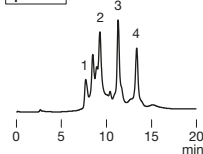
**Column** : Shodex IEC QA-825  
**Eluent** : (A); 20mM Tris-HCl buffer (pH8.6)  
 (B); (A) + 0.5M NaCl  
 Linear gradient; 100% (A) to 50% (B), 60min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

## Effects of eluent pH for DEAE-825

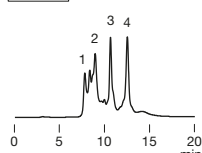
pH6.0



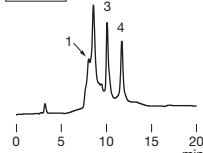
pH7.0



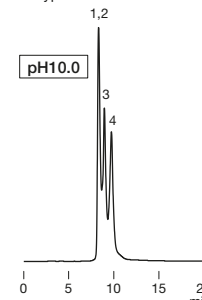
pH8.0



pH9.0



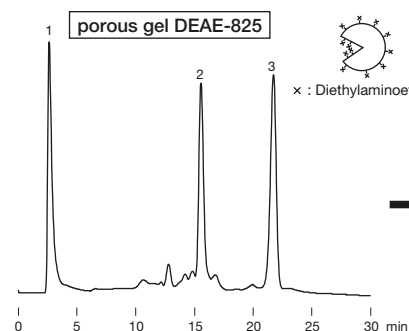
Sample : 100 $\mu$ L  
 1. Conalbumin 0.1%  
 2. Transferrin 0.2%  
 3. Ovalbumin 0.2%  
 4. Trypsin inhibitor 0.2%



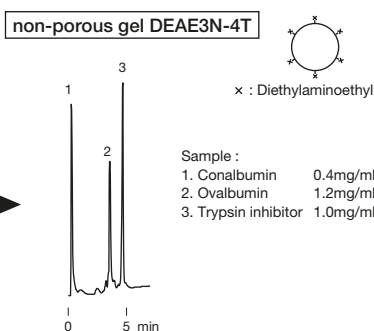
**Column** : Shodex IEC DEAE-825  
**Eluent** : (A); 20mM Piperazine-HCl buffer (pH6.0), 20mM Bis-Tris-HCl buffer (pH7.0)  
 20mM Tris-HCl buffer (pH8.0), 20mM Ethanolamine-HCl buffer (pH9.0)  
 20mM 1,3-Diaminopropane-HCl buffer (pH10.0)  
 (B); (A) + 0.5M NaCl  
 Linear gradient; (A) to (B), 20min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

## Comparison of porous DEAE-825 and non-porous DEAE3N-4T for protein separation

IEC DEAE3N-4T is a weak anion exchange column, having diethylaminoethyl functional group modified on non-porous gel. The non-porous gel enables rapid analysis of proteins and peptides. DEAE3N-4T is also suitable for the analysis of small-volume samples, as it provides sharp peaks even with small injection volume.

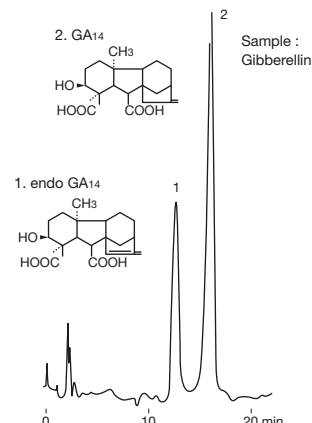


**Column** : Shodex IEC DEAE-825  
**Eluent** : (A); 20mM Piperazine-HCl buffer (pH6.0)  
 (B); (A) + 0.5M NaCl  
 Linear gradient; (A) to (B), 60min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.  
**Injection vol.** : 100 $\mu$ L



**Column** : Shodex IEC DEAE3N-4T  
**Eluent** : (A); 25mM Piperazine-HCl buffer (pH6.0)  
 (B); (A) + 0.5M NaCl  
 Linear gradient; (A) to (B), 10min  
**Flow rate** : 1.5mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.  
**Injection vol.** : 20 $\mu$ L

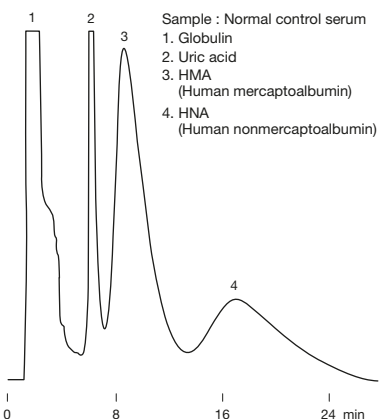
## Gibberellin Isomers



**Column** : Shodex Asahipak ES-502N 7C  
**Eluent** : Acetic acid/H<sub>2</sub>O/CH<sub>3</sub>OH  
 =0.1/0.4/99.5  
**Flow rate** : 1.5mL/min  
**Detector** : UV (210nm)  
**Column temp.** : 50°C

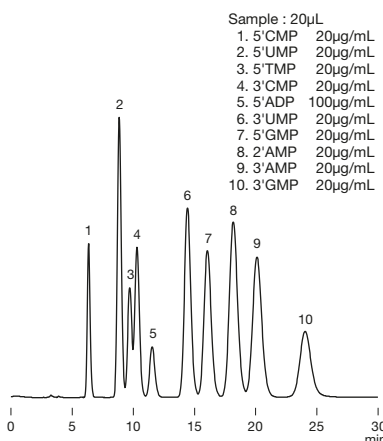
Data was provided by Prof. Yamaguchi,  
 Faculty of Agriculture, University of Tokyo.

## Mercaptoalbumin and non-mercaptoalbumin



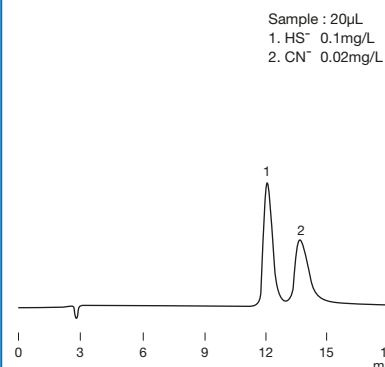
**Column** : Shodex Asahipak ES-502N 7C  
**Eluent** : 50mM N-methylpiperazine-HCl  
 buffer (pH4.8) + 400mM Na<sub>2</sub>SO<sub>4</sub>  
 + 0.3% C<sub>2</sub>H<sub>5</sub>OH  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : 35°C

## Nucleotides



**Column** : Shodex AXPak WA-624  
**Eluent** : 0.35M CH<sub>3</sub>COOH aq.  
 /0.35M CH<sub>3</sub>COONH<sub>4</sub> aq.=240/100  
**Flow rate** : 1.0mL/min  
**Detector** : UV (260nm)  
**Column temp.** : 60°C

## Sulfide ion and cyanide ion



**Column** : Shodex IEC DEAE-825  
**Eluent** : 10mM Na<sub>2</sub>CO<sub>3</sub>  
 + 1mM Ethylenediamine aq.  
 + 10% CH<sub>3</sub>OH  
**Flow rate** : 1.0mL/min  
**Detector** : Electrochemical  
 (Electrode; Silver, 0mV SCE)  
**Column temp.** : 25°C

# Columns for Cation Exchange Chromatography

## Features

|                                |                                                                                                                                                                                                                                                             |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SP-825</b><br><b>CM-825</b> | <ul style="list-style-type: none"> <li>Suitable for analysis of relatively high molecular weight compounds: proteins, peptides, DNA, and RNA</li> <li>Usable in a wide pH range from pH 2 to 12</li> </ul>                                                  |
| <b>SP-420N</b>                 | <ul style="list-style-type: none"> <li>Non-porous base material</li> <li>For rapid analysis</li> </ul>                                                                                                                                                      |
| <b>SP-2B</b>                   | <ul style="list-style-type: none"> <li>Non-porous base material</li> <li>Supports UHPLC (available under hyperbaric conditions for up to 30 MPa)</li> </ul>                                                                                                 |
| <b>ES-502C 7C</b>              | <ul style="list-style-type: none"> <li>Compared to IEC series columns, polyvinyl alcohol is used as base material offering different separation pattern</li> <li>Low hydrophobic interaction with proteins allows analysis under mild conditions</li> </ul> |
| <b>P-421S</b>                  | <ul style="list-style-type: none"> <li>Column for amino acids analysis by cation exchange mode</li> <li>Supports simultaneous analysis of different amino acids</li> <li>Corresponds to USP L22 and L58</li> </ul>                                          |

## Standard columns

### ● Strong cation exchange resin [Functional Group : Sulfopropyl]

| 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     | <b>IEC SP-825</b>  | 0.4                           | Polyhydroxymethacrylate | 8                  | 5,000         | <b>8.0 × 75</b>                | 50mM Na <sub>2</sub> SO <sub>4</sub> aq.                                  |
| F6113000     | <b>IEC SP-420N</b> | 0.3                           | Polyhydroxymethacrylate | 2.5                | –             | <b>4.6 × 35</b>                | 20mM Sodium acetate buffer + 0.5M Na <sub>2</sub> SO <sub>4</sub> (pH5.0) |

### ● Strong cation exchange resin [Functional Group : Sulfopropyl] : For UHPLC 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                                                          |
|--------------|---------------------|-------------------------------|-------------------------|--------------------|---------------|--------------------------------|---------------------------------------------------------------------------|
| F6113110     | <b>PIKESS SP-2B</b> | 0.3                           | Polyhydroxymethacrylate | 2.5                | –             | <b>2.0 × 50</b>                | 20mM Sodium acetate buffer + 0.5M Na <sub>2</sub> SO <sub>4</sub> (pH5.0) |

### ● Weak cation exchange resin [Functional Group : Carboxymethyl]

| 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     | <b>IEC CM-825</b>          | 0.4                           | Polyhydroxymethacrylate | 8                  | 5,000         | <b>8.0 × 75</b>                | 50mM Na <sub>2</sub> SO <sub>4</sub> aq. |
| F7640001     | <b>Asahipak ES-502C 7C</b> | 0.55                          | Polyvinyl alcohol       | 9                  | 2,000         | <b>7.5 × 100</b>               | 0.1M Sodium phosphate buffer (pH4.4)     |

### ● For amino acids [Functional Group : Sulfo (Na<sup>+</sup>)]

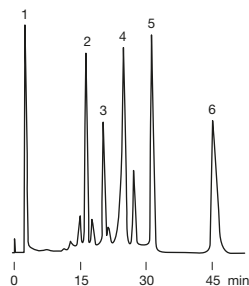
| Product Code | Product Name        | Plate Number (TP/column) | Base Material                    | Particle Size (μm) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|---------------------|--------------------------|----------------------------------|--------------------|--------------------------------|------------------|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

## Preparative columns \* Preparative columns are made to order.

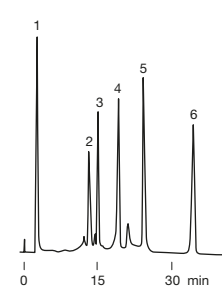
| Product Code | Product Name                   | Particle Size (μm) | Column Size (mm) I.D. x Length | Standard columns |
|--------------|--------------------------------|--------------------|--------------------------------|------------------|
| F6548002     | <b>IEC SP-2025</b>             | 20                 | <b>20.0 × 150</b>              | SP-825           |
| F6548052     | <b>IEC SP-5025</b>             | 37                 | <b>50.0 × 300</b>              | SP-825           |
| F6709604     | <b>IEC SP-G 8B (IEC SP-LG)</b> | 20                 | <b>8.0 × 50</b>                | (guard column)   |
| F6548003     | <b>IEC CM-2025</b>             | 20                 | <b>20.0 × 150</b>              | CM-825           |
| F6548053     | <b>IEC CM-5025</b>             | 37                 | <b>50.0 × 300</b>              | CM-825           |
| F6709605     | <b>IEC CM-LG</b>               | 20                 | <b>8.0 × 50</b>                | (guard column)   |
| F6840003     | <b>Asahipak ES-502C 20C</b>    | 13                 | <b>20.0 × 100</b>              | ES-502C 7C       |
| F6710021     | <b>Asahipak GS-20G 7B</b>      | 20                 | <b>7.5 × 50</b>                | (guard column)   |

## Protein separation using cation exchange columns

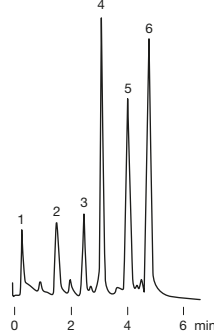
(I) CM-825  
(Weak cation exchange)  
90 $\mu$ L injection



(II) SP-825  
(Strong cation exchange)  
30 $\mu$ L injection



(III) SP-420N  
(Strong cation exchange)  
non-porous type gel



Column : (I) Shodex IEC CM-825, (II) Shodex IEC SP-825, (III) Shodex IEC SP-420N

Eluent : (A); 20mM Sodium phosphate buffer (pH7.0)  
(B); (A) + 0.5M NaCl

Flow rate : (I,II) 1.0mL/min (III) 1.5mL/min  
Detector : UV (280nm)

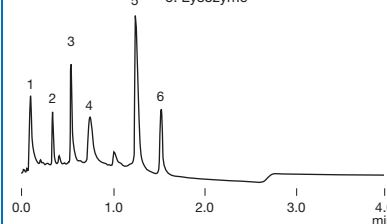
Column temp. : Room temp.

Sample :

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

## Rapid analysis of proteins using UHPLC

Sample : 5 $\mu$ L (13mg total protein)  
1. Myoglobin  
2. Trypsinogen  
3. Ribonuclease A  
4.  $\alpha$ -Chymotrypsinogen A  
5. Cytochrome c  
6. Lysozyme



Column : Shodex PIKES SP-2B

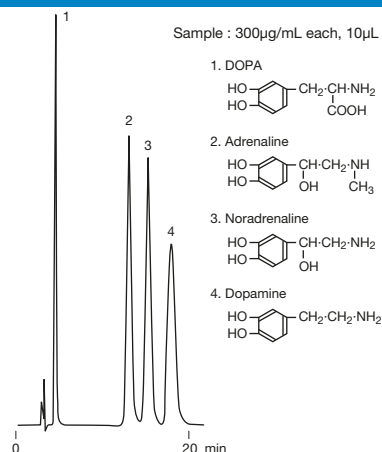
Eluent : (A); 20mM Sodium phosphate buffer (pH 7.0)  
(B); (A) + 0.5 M NaCl  
Linear gradient; 100% (A) to 50% (B), 2.5min

Flow rate : 1.2mL/min

Detector : UV (280nm)

Column temp. : 25°C

## Catecholamines



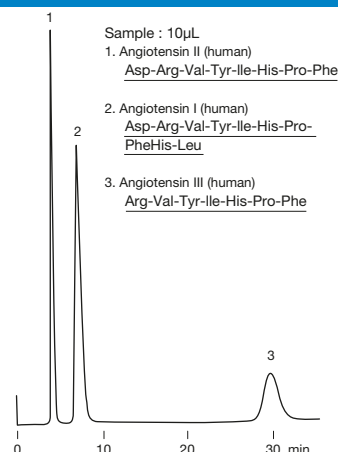
Column : Shodex Asahipak ES-502C 7C  
Eluent : 20mM Sodium malonate buffer + 0.5M NaCl (pH6.0)

Flow rate : 1.0mL/min

Detector : UV (280nm)

Column temp. : 30°C

## Angiotensins



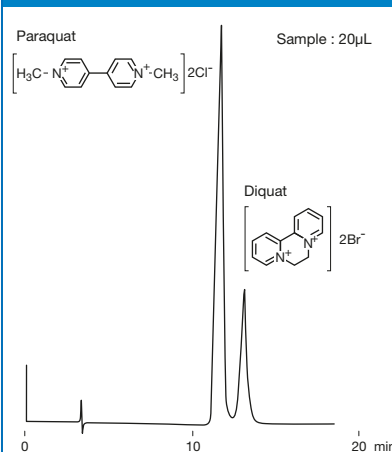
Column : Shodex Asahipak ES-502C 7C  
Eluent : 50mM Sodium malonate buffer (pH6.0) /CH<sub>3</sub>CN=80/20

Flow rate : 1.0mL/min

Detector : UV (280nm)

Column temp. : 30°C

## Paraquat and diquat



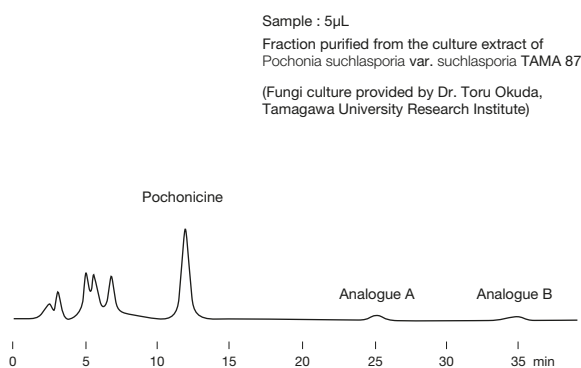
Column : Shodex Asahipak ES-502C 7C  
Eluent : 50mM Sodium phosphate buffer + 150mM NaCl (pH7.0)

Flow rate : 1.0mL/min

Detector : UV (288nm)

Column temp. : 30°C

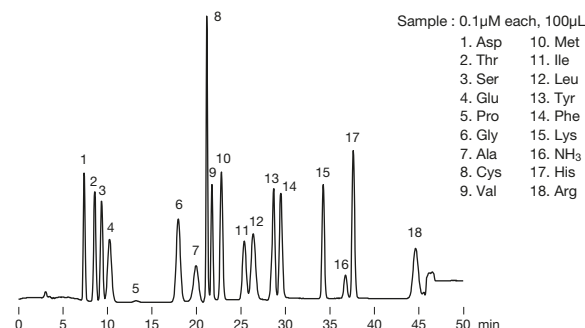
## Analysis of pochonicine and its analogues in filamentous fungi culture extract



Column : Shodex Asahipak ES-502C 7C  
Eluent : 10mM Ammonium bicarbonate aq.  
Flow rate : 0.6mL/min  
Detector : UV (210nm)  
Column temp. : 40°C

Data provided by Dr. Teruhiko Nitoda, Faculty of Agriculture, Okayama University.

## Standard amino acids



Column : Shodex CXpak P-421S  
Eluent : MCI Buffer L-8500-PH Kit (Mitsubishi Chemical Corporation)

Low pressure gradient:  
0min; PH-1, 0.2min; PH-2, 12.5min; PH-3, 22.7min; PH-4 40.0-53.0min; PH-RG

Reagent : Ninhydrin Coloring Solution Kit for HITACHI (Wako Pure Chemical Industries, Ltd.)  
0-52min; R1:R2=50:50

Flow rate : (Eluent) 0.5mL/min  
(Reagent) 0.35mL/min

Detector : VIS (570nm)

Column Temp. : 63°C

Reaction Temp. : 120°C

# Columns for Special Separation Modes

## Column for Hydrophobic Interaction Chromatography

### Features

- PH-814**
- Separates proteins without denaturation
  - Applicable to samples obtained after ammonium sulfate fraction treatment

### Standard columns

| Product Code | Product Name      | Functional Group | Particle Size (µm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent |
|--------------|-------------------|------------------|--------------------|---------------|--------------------------------|------------------|
| F6110003     | <b>HIC PH-814</b> | Phenyl           | 10                 | 2,000         | <b>8.0 × 75</b>                | H <sub>2</sub> O |

Base Material : Polyhydroxymethacrylate

## Columns for Affinity Chromatography

### Features

- AFpak**
- Rigid polymer-based packing materials enable high speed analysis
  - Functional group is modified with chemically stable ligand (spacer)
  - Minimum detachment of functional groups ensures highly reproducible analysis

### Standard columns

| Product Code | Product Name         | Ligand                                  | Ligand Load/Gel (g) | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent                                                                             |
|--------------|----------------------|-----------------------------------------|---------------------|--------------------|--------------------------------|----------------------------------------------------------------------------------------------|
| F7118954     | <b>AFpak ADS-894</b> | Dextran sulfate                         | 30mg                | 18                 | <b>8.0 × 50</b>                | 50mM Sodium phosphate buffer + 0.02% Na <sub>3</sub> (pH7.4)                                 |
| F7118945     | <b>AFpak AHR-894</b> | Heparin                                 | 5mg                 | 18                 | <b>8.0 × 50</b>                | 10mM Tris-HCl buffer + 10mM NaCl + 0.02% Na <sub>3</sub> (pH7.4)                             |
| F7118946     | <b>AFpak APA-894</b> | Protein A                               | 4mg                 | 18                 | <b>8.0 × 50</b>                | 0.1M Sodium phosphate buffer + 0.5M NaCl + 0.02% Na <sub>3</sub> (pH7.0)                     |
| F7113050     | <b>AFpak APG-894</b> | Protein G                               | 4–5mg               | 18                 | <b>8.0 × 50</b>                | 10mM Sodium phosphate buffer + 0.15M NaCl + 0.02% Na <sub>3</sub> (pH7.4)                    |
| F7118959     | <b>AFpak AWG-894</b> | Wheat germ agglutinin (WGA)             | 14mg                | 18                 | <b>8.0 × 50</b>                | 0.1M Tris-HCl buffer + 0.15M NaCl + 0.2M N-Acetylglucosamine + 0.02% Na <sub>3</sub> (pH7.4) |
| F7118964     | <b>AFpak ACH-494</b> | Choline oxydase, Acetylcholine esterase | –                   | 18                 | <b>4.6 × 10</b>                | 10mM Phosphate buffer + 1.0M NaCl (pH7.4)                                                    |

Base Material : Polyhydroxymethacrylate

## Columns for Chiral Separation

### Features

- CDBS-453**
- Separates optical isomers by using their conformational compatibility differences
  - Versatile column for chiral separation
  - Corresponds to USP L45
- CRX-853**
- Separates optical isomers by using the differences in metal complex formation capacities of functional group and metal ion in eluent and optical isomers
  - Suitable for amino acids, hydroxyl acids, and their derivatives

### Standard columns

| Product Code | Product Name          | Functional Group          | Base Material           | Particle Size (µm) | Column Size (mm) I.D. x Length | Shipping Solvent                                           |
|--------------|-----------------------|---------------------------|-------------------------|--------------------|--------------------------------|------------------------------------------------------------|
| F7146003     | <b>ORpak CDBS-453</b> | β-Cyclodextrin derivative | Silica                  | 3                  | <b>4.6 × 150</b>               | 1.0% Acetic acid + 0.2M NaCl aq. /CH <sub>3</sub> CN=70/30 |
| F7140040     | <b>ORpak CRX-853</b>  | L-amino acid derivative   | Polyhydroxymethacrylate | 6                  | <b>8.0 × 50</b>                | 0.25mM CuSO <sub>4</sub> aq.                               |
| F6709300     | <b>ORpak CRX-G</b>    | L-amino acid derivative   | Polyhydroxymethacrylate | 6                  | <b>4.6 × 10</b>                | 0.25mM CuSO <sub>4</sub> aq.                               |

## Column for High Temperature Reversed Phase Chromatography

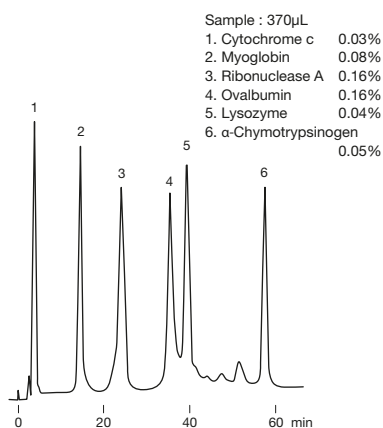
### Features

- ET-RP1**
- Capable of high temperature analysis up to 150°C
  - High temperature analysis improves column efficiency and enables rapid analysis
  - Corresponds to USP L67

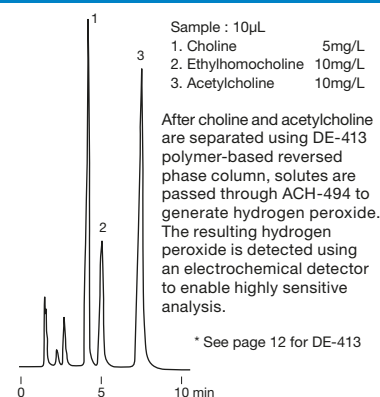
### Standard columns

| 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                          |
|--------------|------------------|--------------------------|------------------|--------------------|---------------|--------------------------------|-------------------------------------------|
| F7623001     | <b>ET-RP1 4D</b> | ≥ 11,000                 | Octadecyl        | 4                  | 250           | <b>4.6 × 150</b>               | H <sub>2</sub> O/CH <sub>3</sub> CN=35/65 |

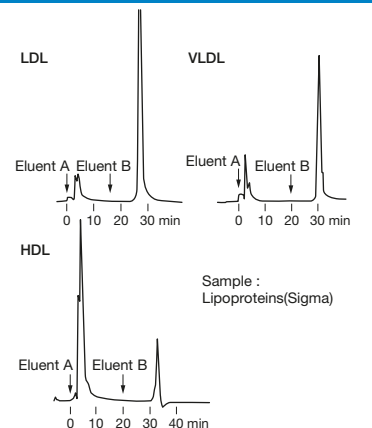
Base Material : Polyvinyl alcohol

**Protein separation by hydrophobic interaction chromatography**

**Column** : Shodex HIC PH-814  
**Eluent** : (A); 1.8M Ammonium sulfate + (B)  
 (B); 0.1M Phosphate buffer (pH7.0)  
 Linear gradient; (A) to (B), 60min  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

**Choline and acetylcholine**

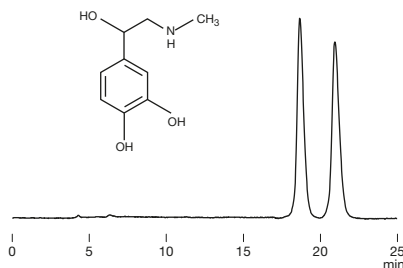
**Column** : Shodex RSpak DE-413  
**Post column** : Shodex AFpak ACH-494  
**Eluent** : 0.1M H<sub>3</sub>PO<sub>4</sub> +  
 300mg/L Sodium 1-decansulfonate +  
 65mg/L Tetramethylammonium chloride  
 (pH8.0 adjusted by 1.0M NaOH)  
**Flow rate** : 1.0mL/min  
**Detector** : Electrochemical (Electrode : Pt, 350mV SCE)  
**Column temp.** : 37°C

**Lipoproteins in plasma**

**Column** : Shodex AFpak ADS-894  
**Eluent** : (A); 50mM Sodium phosphate buffer  
 (pH7.4)  
 (B); (A) + 1.0M NaCl  
 Step gradient; (A) to (B)  
**Flow rate** : 1.0mL/min  
**Detector** : UV (280nm)  
**Column temp.** : Room temp.

**Chiral separation of epinephrines**

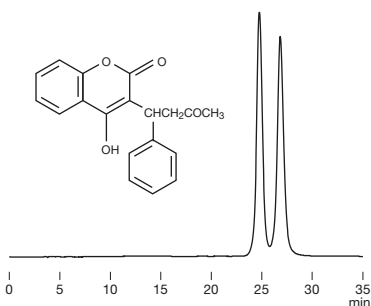
Sample : Epinephrine 50 $\mu$ g/mL, 50 $\mu$ L



**Column** : Shodex ORpak CDBS-453  
**Eluent** : 0.05% Acetic acid + 0.2M NaCl aq.  
 /CH<sub>3</sub>CN=95/5  
**Flow rate** : 0.5mL/min  
**Detector** : UV (254nm)  
**Column temp.** : 10°C

**Chiral separation of warfarin**

Sample : Warfarin 20 $\mu$ g/mL, 20 $\mu$ L

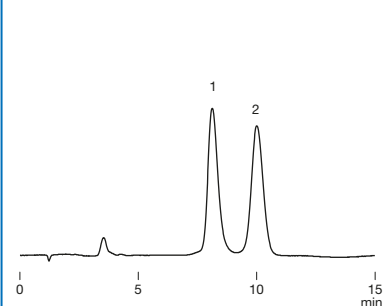


**Column** : Shodex ORpak CDBS-453  
**Eluent** : 1.0% Acetic acid + 0.2M NaCl aq.  
 /CH<sub>3</sub>CN=80/20  
**Flow rate** : 0.6mL/min  
**Detector** : UV (310nm)  
**Column temp.** : 16°C

**Chiral separation of lactic acids**

Sample : Lactic acid 50 $\mu$ g/mL, 50 $\mu$ L

1. L-Lactic acid
2. D-Lactic acid

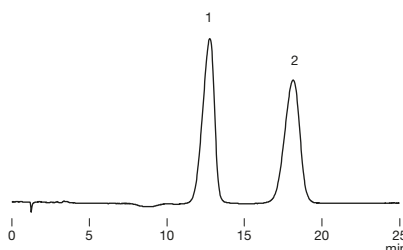


**Column** : Shodex ORpak CRX-853  
**Eluent** : 0.5mM CuSO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (230nm)  
**Column temp.** : 50°C

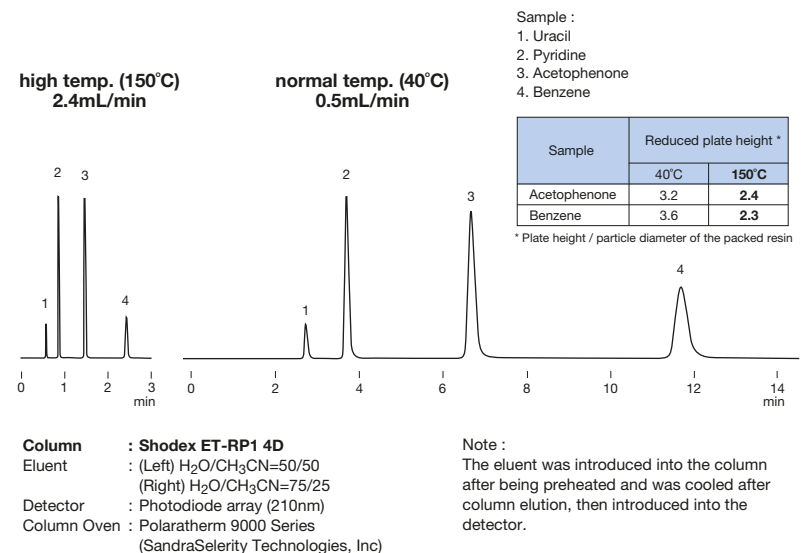
**Chiral separation of mandelic acids**

Sample : Mandelic acid 100 $\mu$ g/mL, 20 $\mu$ L

1. D-Mandelic acid
2. L-Mandelic acid



**Column** : Shodex ORpak CRX-853  
**Eluent** : 0.25mM CuSO<sub>4</sub> aq.  
**Flow rate** : 1.0mL/min  
**Detector** : UV (230nm)  
**Column temp.** : 50°C

**Comparison of ET-RP1's column efficiencies (theoretical plate height) observed at high and normal temperature conditions**

Data provided by Research Institute for Chromatography bvba

# Columns for GPC Clean-up

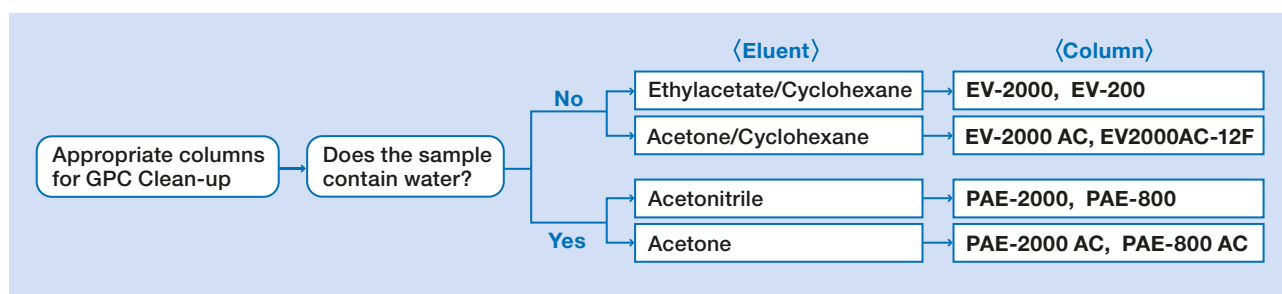
## Features

### EV

- Suitable for fractionation of residual pesticides in foods
- EV-2000 AC is used in Shoku-An No. 1003001 (October 3rd, 2006, 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”.

### PAE

- Suitable for cleaning up high-moisture samples such as blood and bottom sediment
- Highly effective for fractionation of endocrine disruptors in environmental samples



## GPC Clean-up for residual pesticides in foods, etc.

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

Base Material : Styrene divinylbenzene copolymer

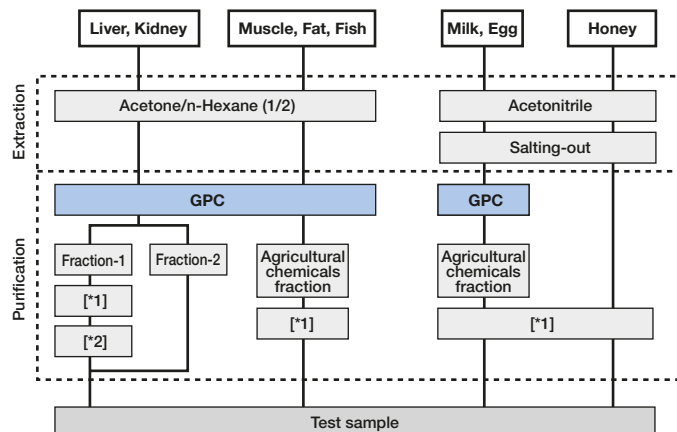
## GPC Clean-up for phthalic acid esters in sediments, biological samples, blood, etc.

| Product Code | Product Name       | Particle Size (μm) | Pore Size (Å)  | Column Size (mm)<br>I.D. x Length | Shipping Solvent |
|--------------|--------------------|--------------------|----------------|-----------------------------------|------------------|
| F6810022     | CLNpak PAE-2000    | 5                  | 400            | 20.0 × 300                        | Acetonitrile     |
| F6714007     | CLNpak PAE-G       | 9                  | (guard column) | 8.0 × 50                          | Acetonitrile     |
| F7600025     | CLNpak PAE-800     | 5                  | 400            | 8.0 × 300                         | Acetonitrile     |
| F6810023     | CLNpak PAE-2000 AC | 5                  | 400            | 20.0 × 300                        | Acetone          |
| F6714008     | CLNpak PAE-G AC    | 9                  | (guard column) | 8.0 × 50                          | Acetone          |
| F7600026     | CLNpak PAE-800 AC  | 5                  | 400            | 8.0 × 300                         | Acetone          |

Base Material : Polyvinyl alcohol

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

## [Outline]

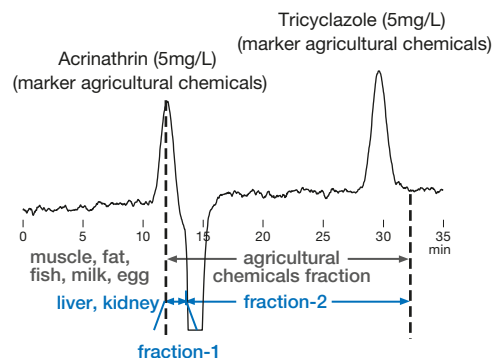


GPC column : Shodex CLNpak EV-2000 AC + EV-G AC

\*1 Purification with ethylenediamine-N-propylsilylated silica gel mini-column

\*2 Purification with silica gel mini-column

## Preparation range of agricultural chemicals using EV-2000 AC



Column : Shodex CLNpak EV-G AC + EV-2000 AC

Eluent : Acetone/Cyclohexane=1/4

Flow rate : 5.0mL/min

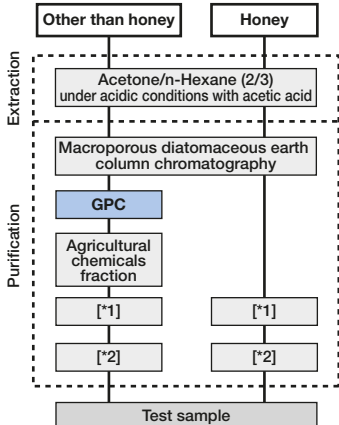
Detector : UV (254nm)

Column temp. : 40°C

Injection vol. : 5mL

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

## [Outline]



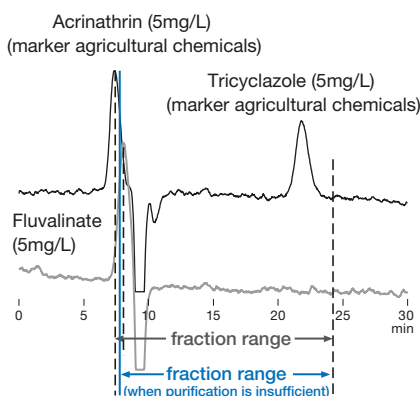
GPC column :

Shodex CLNpak EV2000AC-12F + EV-G AC12C

\*1 Purification with trimethyl aminopropylsilylated silica gel mini-column

\*2 Purification with ethylenediamine-N-propylsilylated silica gel mini-column

## Preparation range of agricultural chemicals using EV2000AC-12F



Column : Shodex CLNpak EV-G AC12C + EV2000AC-12F

Eluent : Acetone/Cyclohexane=3/17

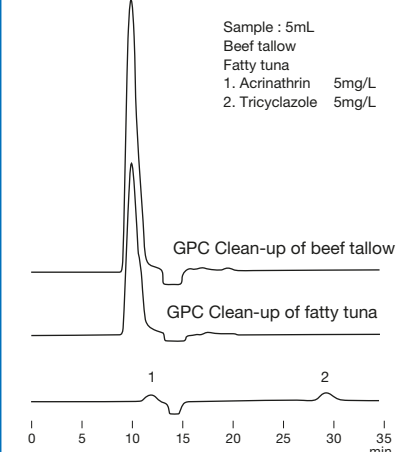
Flow rate : 3.0mL/min

Detector : UV (254nm)

Column temp. : 45°C

Injection vol. : 2mL

## GPC Clean-up of fatty tuna and beef tallow



Column : Shodex CLNpak EV-G AC + EV-2000 AC

Eluent : Acetone/Cyclohexane=1/4

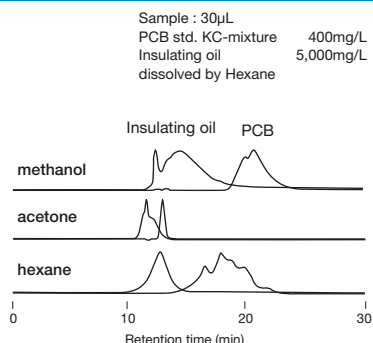
Flow rate : 5.0mL/min

Detector : UV (254nm)

Column temp. : 40°C

Injection vol. : 5mL

## Separation of PSB and insulating oil using PAE-800



Column : Shodex CLNpak PAE-800

Eluent : Methanol, Acetone, Hexane

Flow rate : 0.8mL/min

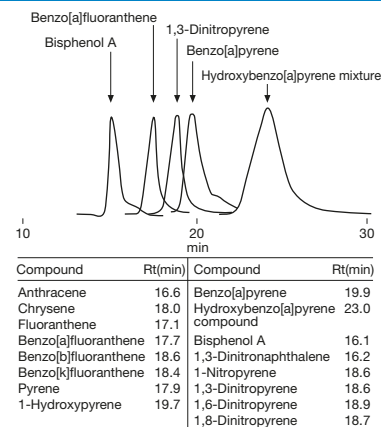
Detector : Photodiode array (209nm)

Column temp. : 40°C

Source:

Mr. Tetsuya Sawatsubashi (Mitsubishi Heavy Industries, Ltd.) et al., Search of Liquid Chromatographic Clean-up Materials for Rapid PCB Analysis and Evaluation of Their Separation Characteristics. Journal of Environmental Chemistry, 2007, Vol. 17, No. 3, p. 471-481.

## GPC Clean-up of carcinogens in diesel dust measured using PAE-800 AC



Column : Shodex CLNpak PAE-800 AC

Eluent : Acetone

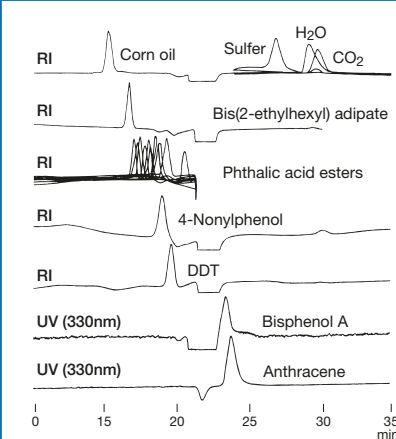
Flow rate : 0.8mL/min

Detector : UV (210nm)

Column temp. : Room temp.

Data provided by Kazuichi Hayakawa Ph.D., Faculty of Pharmaceutical Sciences, Kanazawa University.

## Elution positions of phthalic acid esters using PAE-800 AC



Column : Shodex CLNpak PAE-800 AC

Eluent : Acetone

Flow rate : 0.5mL/min

Detector : UV (330nm), RI

Column temp. : Room temp.

# Pretreatment Columns for Column Switching Method

## Features

- PK**
- Effective for both hydrophilic and hydrophobic substances
  - The high protein removal rate enables efficient pretreatment
- 
- GF-4A**
- Higher protein removal rate than PK columns
- \* GF-4A column removes proteins well but is not suitable for trapping hydrophilic substances.  
Use PK columns for this purpose.

## Cartridge columns and holder for column switching method

| Product Code | Product Name          | Particle Size (μm) | Pore Size (Å) | Column Size (mm) I.D. x Length | Shipping Solvent | Pcs/box |
|--------------|-----------------------|--------------------|---------------|--------------------------------|------------------|---------|
| F8700000     | <b>MSpak PK-2A 2p</b> | 30                 | 30            | <b>2.0 x 10</b>                | H <sub>2</sub> O | 2       |
| F8700012     | <b>MSpak PK-4A 2p</b> | 30                 | 30            | <b>4.0 x 10</b>                | H <sub>2</sub> O | 2       |
| F8700001     | <b>MSpak HLD</b>      | –                  | –             | <b>(Holder for PK)</b>         | –                | 1       |

Base Material : Hydrophilic copolymers containing N-vinyl acetoamide

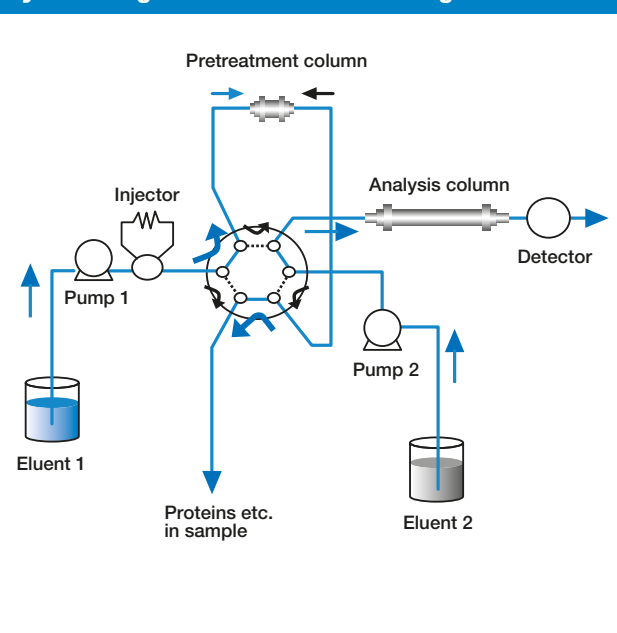
\* PK series are cartridge columns and thus should be installed in a column holder "MSpak HLD" before use.

## 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     | <b>MSpak GF-4A</b> | 9                  | 400           | <b>4.6 x 10</b>                | H <sub>2</sub> O |

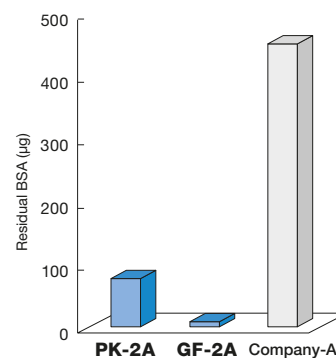
Base Material : Polyvinyl alcohol

## System diagram for column switching



## Protein removal rate using pretreatment columns

| Column    | Protein removal rate |
|-----------|----------------------|
| PK-2A     | 99.62%               |
| *GF-2A    | 99.80%               |
| Company-A | 97.68%               |



(Pretreatment)  
 Eluent : 10mM Ammonium acetate buffer (pH7.0)  
 Flow rate : 0.5mL/min  
 Column temp. : Room temp.

(Analysis)  
 Column : Shodex PROTEIN \*\*KW-604S  
 Eluent : 0.1% TFA in (H<sub>2</sub>O/CH<sub>3</sub>CN=50/50)  
 Flow rate : 0.5mL/min  
 Detector : UV (280nm)  
 Column temp. : Room temp.  
 Switching time: 5min

\*GF-2A : Custom-made column of GF-4A (2.0mmI.D. x 10mm)  
 \*\*KW-604S is phase-out product.

## Recovery rate of medical compounds using PK-2A

| Sample            | Recovery (%) | Sample                   | Recovery (%) | Sample             | Recovery (%) |
|-------------------|--------------|--------------------------|--------------|--------------------|--------------|
| Acetaminophen     | 115          | Cloxacolam               | 91           | Mianserin          | 92           |
| Acetylpheneturide | 92           | Desipramine              | 109          | Nimetazepam        | 90           |
| Aconitine         | 110          | Diazepam                 | 97           | Nitrazepam         | 97           |
| Alprazolam        | 99           | Diphenhydramine          | 93           | Nortriptyline      | 86           |
| Amitriptyline     | 93           | Estazolam                | 101          | Oxazepam           | 97           |
| Amobarbital       | 93           | Ethenzamide              | 98           | Oxazolam           | 99           |
| Barbital          | 94           | Etizolam                 | 105          | Pentobarbital      | 93           |
| Benzoylaconitine  | 96           | Fludiazepam              | 97           | Perfenazine        | 86           |
| Benzoylhypaconine | 83           | Flumazenil               | 93           | Phenacetin         | 108          |
| Biperiden         | 99           | Flunitrazepam            | 97           | Phenobarbital      | 96           |
| Bromazepam        | 102          | Flurazepam               | 106          | Phenytoin          | 99           |
| Bromocriptine     | 80           | Glutethimide             | 93           | Primidone          | 91           |
| Bromperidol       | 89           | Haloperidol              | 99           | Promethazine       | 92           |
| Bromvalerylurea   | 94           | Haloxazolam              | 93           | Propericiazine     | 90           |
| Brotizolam        | 97           | 1-Hydroxymethyltriazolam | 90           | Propranolol        | 97           |
| Caffeine          | 106          | 4-Hydroxytriazolam       | 91           | Secobarbital       | 97           |
| Carbamazepine     | 97           | Hydroxyzine              | 99           | Sildenafil citrate | 95           |
| Carpipramine      | 99           | Hypaconitine             | 97           | Thioridazine       | 97           |
| Chlordiazepoxide  | 133          | Imipramine               | 97           | Timiperone         | 88           |
| Chlormezanone     | 92           | Indomethacin             | 93           | Triazolam          | 96           |
| Chlorpheniramine  | 111          | Levomepromazine          | 96           | Trihexyphenidyl    | 91           |
| Chlorpromazine    | 77           | Lofepamine               | 65           | Trimethadione      | 137          |
| Clocapramine      | 95           | Maprotyline              | 90           | Trimipramine       | 107          |
| Clofedanol        | 91           | Medazepam                | 91           | Warfarin           | 81           |
| Clomipramine      | 95           | Mephobarbital            | 99           | Zotepine           | 92           |
| Clonazepam        | 96           | Mesaconine               | 118          |                    |              |
| Clotiazepam       | 96           | Metharbitol              | 94           |                    |              |

(Adsorption)  
 Eluent : 10mM Ammonium acetate buffer (pH7.0)  
 Flow rate : 0.5mL/min

(Elution)  
 Eluent : 10mM Ammonium acetate buffer (pH7.0)/CH<sub>3</sub>CN  
 Flow rate : 0.5mL/min  
 Detector : UV (220nm)  
 Switching time: 5min

# Notice of Product Name Changes

Some of Shodex guard columns have been renamed.  
There is no change of product code.

## Renamed products list

| Page   | New Product Name        | Former Product Name  | Product Code |
|--------|-------------------------|----------------------|--------------|
| 12     | <b>RSpak DE-G 4A</b>    | <b>RSpak DE-G</b>    | F6700150     |
| 12     | <b>RSpak DE-G 2A</b>    | <b>RSpak DE-SG</b>   | F6700151     |
| 12     | <b>RSpak DM-G 4A</b>    | <b>RSpak DM-G</b>    | F6700160     |
| 13     | <b>RSpak DE-G 8B</b>    | <b>RSpak DE-LG</b>   | F6700190     |
| 13     | <b>RSpak DE-G 20C</b>   | <b>RSpak DE-LLG</b>  | F6700191     |
| 13     | <b>RSpak DM-G 8B</b>    | <b>RSpak DM-LG</b>   | F6700404     |
| 13     | <b>RSpak DM-G 20C</b>   | <b>RSpak DM-LLG</b>  | F6700162     |
| 24     | <b>SUGAR SC-G 6B</b>    | <b>SUGAR SC-LG</b>   | F6700090     |
| 24     | <b>SUGAR SP-G 6B</b>    | <b>SUGAR SP-G</b>    | F6700081     |
| 24     | <b>SUGAR KS-G 6B</b>    | <b>SUGAR KS-G</b>    | F6700020     |
| 24     | <b>RSpak DC-G 4A</b>    | <b>RSpak DC-G</b>    | F6700170     |
| 24     | <b>SUGAR SC1211G 4A</b> | <b>SUGAR SC-G</b>    | F6700120     |
| 25     | <b>SUGAR KS-G 8B</b>    | <b>SUGAR KS-LG</b>   | F6700002     |
| 25     | <b>RSpak DC-G 8B</b>    | <b>RSpak DC-LG</b>   | F6700402     |
| 25     | <b>RSpak DC-G 20C</b>   | <b>RSpak DC-LLG</b>  | F6700172     |
| 28     | <b>RSpak KC-G 6B</b>    | <b>RSpak KC-G</b>    | F6700030     |
| 28     | <b>RSpak KC-G 8B</b>    | <b>RSpak KC-LG</b>   | F6700010     |
| 36     | <b>PROTEIN KW-G 6B</b>  | <b>PROTEIN KW-G</b>  | F6700131     |
| 36     | <b>PROTEIN KW-G 8B</b>  | <b>PROTEIN KW-LG</b> | F6709556     |
| 38     | <b>OHpak SB-G 6B</b>    | <b>OHpak SB-G</b>    | F6709430     |
| 39     | <b>OHpak SB-G 8B</b>    | <b>OHpak SB-LG</b>   | F6709555     |
| 46, 52 | <b>GPC KF-G 4A</b>      | <b>GPC KF-G</b>      | F6700300     |
| 48     | <b>GPC K-G 4A</b>       | <b>GPC K-G</b>       | F6700401     |
| 50     | <b>GPC KD-G 4A</b>      | <b>GPC KD-G</b>      | F6700411     |
| 54     | <b>GPC KF-G 8B</b>      | <b>GPC KF-LG</b>     | F6700406     |
| 54     | <b>GPC K-G 8B</b>       | <b>GPC K-LG</b>      | F6700407     |
| 55     | <b>GPC H-G 8B</b>       | <b>GPC H-G</b>       | F6700310     |
| 55     | <b>GPC KF-G 20B</b>     | <b>GPC KF-LLG</b>    | F6700408     |
| 55     | <b>GPC K-G 20B</b>      | <b>GPC K-LLG</b>     | F6700409     |
| 60     | <b>GPC HFIP-G 8B</b>    | <b>GPC HFIP-LG</b>   | F6700500     |
| 60     | <b>GPC HFIP-G 4A</b>    | <b>GPC HFIP-G</b>    | F6700511     |
| 66     | <b>IEC SP-G 8B</b>      | <b>IEC SP-LG</b>     | F6709604     |

# USP (Ver.38) Column List

| No. | Packing Material                                                                                                                                                                                                                                                                                                                                               | Recommended Column                                                                                                                                                                                                               | Page                                                                             |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| L1  | Octadecyl silane chemically bonded to porous or non-porous silica or ceramic micro-particles, 1.5 to 10µm in diameter, or a monolithic rod                                                                                                                                                                                                                     | Silica C18M<br>Silica C18P                                                                                                                                                                                                       | 16<br>16                                                                         |
| L3  | Porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.                                                                                                                                                                                                                                                                                  | Silica 5SIL                                                                                                                                                                                                                      | 17                                                                               |
| L7  | Octylsilane chemically bonded to totally or superficially porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.                                                                                                                                                                                                                        | Silica 5C8                                                                                                                                                                                                                       | 17                                                                               |
| L8  | An essentially monomolecular layer of aminopropylsilane chemically bonded to totally porous silica gel support, 1.5 to 10µm in diameter                                                                                                                                                                                                                        | Silica 5NH                                                                                                                                                                                                                       | 17                                                                               |
| L10 | Nitrile groups chemically bonded to porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.                                                                                                                                                                                                                                              | Silica 5CN                                                                                                                                                                                                                       | 17                                                                               |
| L11 | Phenyl groups chemically bonded to porous silica particles, 1.5 to 10µm in diameter, or a monolithic silica rod.                                                                                                                                                                                                                                               | Silica 5NPE                                                                                                                                                                                                                      | 17                                                                               |
| L17 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the hydrogen form, 6 to 12µm in diameter                                                                                                                                                                                                                | SUGAR SH1011<br>SUGAR SH1821<br>RSpak KC-811<br>IC Y-521                                                                                                                                                                         | 28<br>28<br>28<br>32                                                             |
| L19 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the calcium form, about 9µm in diameter                                                                                                                                                                                                                 | SUGAR SC1011<br>SUGAR SC1821<br>SUGAR SC1211<br>EP SC1011-7F<br>USPpak MN-431                                                                                                                                                    | 24<br>24<br>24<br>25<br>25                                                       |
| L20 | Dihydroxypropane groups chemically bonded to porous silica or hybrid particles, 1.5 to 10µm in diameter, or a monolithic silica rod.                                                                                                                                                                                                                           | PROTEIN KW-800 series<br>KW400 series                                                                                                                                                                                            | 36<br>36                                                                         |
| L21 | A rigid, spherical styrene-divinylbenzene copolymer, 3 to 30µm in diameter                                                                                                                                                                                                                                                                                     | RSpak RP18-415<br>RSpak DS-613<br>RSpak DS-413<br>GPC KF,K,KD,LF,HT,UT,AT,HFIP series                                                                                                                                            | 12<br>12<br>12<br>46, 48, 50, 52, 56, 58, 60                                     |
| L22 | A cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, about 10µm in size                                                                                                                                                                                                                                                           | SUGAR SC1011<br>SUGAR SC1821<br>SUGAR SP0810<br>SUGAR KS-800 series<br>RSpak DC-613<br>SUGAR SZ5532<br>SUGAR SC1211<br>EP SC1011-7F<br>USPpak MN-431<br>SUGAR SH1011<br>SUGAR SH1821<br>RSpak KC-811<br>IC Y-521<br>CXpak P-421S | 24<br>24<br>24<br>24<br>24<br>24<br>24<br>25<br>25<br>28<br>28<br>28<br>32<br>66 |
| L23 | An anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, 7-12µm in size                                                                                                                                                                                                                                    | IEC QA-825                                                                                                                                                                                                                       | 64                                                                               |
| 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<br>OHpak SB-802.5 HQ                                                                                                                                                                                             | 38<br>38                                                                         |
| L26 | Butyl silane chemically bonded to totally porous silica particles, 1.5 to 10µm in diameter                                                                                                                                                                                                                                                                     | Silica 5C4                                                                                                                                                                                                                       | 17                                                                               |
| 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<br>KW400 series                                                                                                                                                                                            | 36<br>36                                                                         |
| L34 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the lead form, about 7 to 9µm in diameter                                                                                                                                                                                                               | SUGAR SP0810                                                                                                                                                                                                                     | 24                                                                               |
| 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<br>OHpak LB-803                                                                                                                                                                                                  | 38<br>38                                                                         |
| L38 | A methacrylate-based size-exclusion packing for water-soluble samples                                                                                                                                                                                                                                                                                          | OHpak SB-800 HQ series<br>OHpak LB-800 series                                                                                                                                                                                    | 38<br>38                                                                         |
| L39 | A hydrophilic polyhydroxymethacrylate gel of totally porous spherical resin                                                                                                                                                                                                                                                                                    | ODP2 HP<br>RSpak DM-614<br>OHpak SB-800 HQ series<br>OHpak LB-800 series                                                                                                                                                         | 8<br>12<br>38<br>38                                                              |
| L45 | Beta cyclodextrin, R,S-hydroxypropyl ether derivative, bonded to porous silica particles, 5 to 10µm in diameter                                                                                                                                                                                                                                                | ORpak CDBS-453                                                                                                                                                                                                                   | 68                                                                               |
| L58 | Strong cation-exchange resin consisting of sulfonated cross-linked styrene-divinylbenzene copolymer in the sodium form, about 6 to 30µm diameter                                                                                                                                                                                                               | SUGAR KS-800 series<br>RSpak DC-613<br>CXpak P-421S                                                                                                                                                                              | 24<br>24<br>66                                                                   |
| L59 | Packing for the size-exclusion separations of proteins (separation by molecular weight) over the range of 5 to 7000 kDa. It is spherical (1.5-10µm), silica or hybrid packing with a hydrophilic coating.                                                                                                                                                      | PROTEIN KW-800 series<br>KW400 series                                                                                                                                                                                            | 36<br>36                                                                         |
| L67 | Porous vinyl alcohol copolymer with a C18 alkyl group attached to the hydroxyl group of the polymer, 2 to 10µm in diameter                                                                                                                                                                                                                                     | Asahipak ODP-40<br>Asahipak ODP-50<br>ET-RP1                                                                                                                                                                                     | 10<br>10<br>68                                                                   |
| L71 | A rigid, spherical polymetacrylate, 4 to 6µm in diameter                                                                                                                                                                                                                                                                                                       | RSpak DE-613<br>RSpak DE-413<br>RSpak DE-213                                                                                                                                                                                     | 12<br>12<br>12                                                                   |
| L82 | Polyamine chemically bonded to cross-linked polyvinyl alcohol polymer, 4-5µm in diameter                                                                                                                                                                                                                                                                       | Asahipak NH2P-50<br>Asahipak NH2P-40                                                                                                                                                                                             | 22<br>22                                                                         |

# Column Cleaning Procedures

Change in peak shapes, elution timing, and the elevated column pressure may be resolved by cleaning the column. This section describes general indications of column deterioration and column cleaning procedures. For details of column cleaning procedures, refer to each column's specific operation manual.

## ■ Typical indicators of column deterioration possibility

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

## ■ Selection guide to the cleaning solvent

Solvents capable of dissolving the adsorbed substances.

Solvents with high eluting power (variable depending on separation mode)

\*Use the solvent specified in the operation manual.

## ■ Standard cleaning procedures

For an efficient cleaning, reverse the direction and reduce the flow rate to 1/3 of the regular flow.

|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Columns for reversed phase chromatography          | Clean the columns with solvent containing higher concentration of organic solvent such as methanol, acetonitrile, or THF.<br>(In case of using buffer as a mobile phase, miscibility of the buffer solution and the organic solvents need to be checked)                                                                                                                                                                                                                                                                                                                   |
| Columns for sugar analysis chromatography          | <b>[Ligand exchange columns (SUGAR series)]</b> <ul style="list-style-type: none"><li>• <b>In case of counter ion detachment</b><br/>Flush or inject solvent containing the salt corresponding to the modified counter-ligand.</li></ul> <b>[Polymer-base amino columns (NH2P series)]</b> <ul style="list-style-type: none"><li>• <b>In cases where an acidic substance has been bound to the amino functional group</b><br/>Flush with solvents in the following sequence: water, 0.1M perchloric acid (aq.), water, 0.1M NaOH (aq.), water, and mobile phase.</li></ul> |
| Columns for aqueous SEC(GFC) chromatography        | <ul style="list-style-type: none"><li>• <b>In cases where an ionic substance has been adsorbed</b><br/>Use a solvent with higher salt concentration or solvent with different pH from the mobile phase.</li><li>• <b>In cases where a hydrophobic substance has been adsorbed</b><br/>Use a solvent containing organic solvent.<br/>(In case of using buffer as a mobile phase, miscibility of the buffer solution and the organic solvents need to be checked)</li></ul>                                                                                                  |
| Columns for ion exchange chromatography            | <ul style="list-style-type: none"><li>• <b>In cases where an ionic substance has been adsorbed</b><br/>Use a solvent with higher salt concentration or solvent with different pH from the mobile phase.</li><li>• <b>In cases where a hydrophobic substance has been adsorbed</b><br/>Use a solvent containing organic solvent.<br/>(In case of using buffer as a mobile phase, miscibility of the buffer solution and the organic solvents need to be checked)</li></ul>                                                                                                  |
| Columns for hydrophobic interaction chromatography | <ul style="list-style-type: none"><li>• <b>In cases where protein have been adsorbed</b><br/>Inject 1-2 mL of 0.1 M NaOH (aq.) or 30% (v/v) acetic acid (aq.) several times.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                     |

\*The volume of the cleaning solvent required is 5-10 times the column volume.

\*Avoid pressure elevation during the cleaning.

\*The cleaning is limited and does not guarantee the full regeneration of the column to its original condition.

## ■ For your information

One typical cause of the column pressure elevation is the clogging of solid substances at the inlet filter of the column. In this case, reverse the direction and reduce the flow to 1/3 of the regular flow rate. This may remove the solid substance causing the elevated pressure.

# General Precautions for Column Handling

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

## ■ Column mounting

- Before mounting the column, replace the eluent within all the HPLC system with the mobile phase used for the analysis. \*If the mobile phase of the choice is not miscible with the eluent already in the system, use solvent that is miscible with both solvents first to clean the system. \*Buffer or salt solution may precipitate when mixed with organic solvent of different concentrations.
- Attach the column in the direction as indicated by arrow marked on the column. Gradually increase the flow rate of the solvent introduced to the column.
- When heating the column, be sure to pump the eluent at a low flow rate until the specified temperature is reached, and then gradually increase the flow rate up to the requirement after the column has been heated sufficiently.

## ■ Column dismounting

- If the column is heated, turn off the heater while keeping the flow rate at 1/3 of the regular flow.
- Turn off the pump when the column is cooled to room temperature.
- Remove the column from the system securely tighten the end caps.

## ■ Column storage

- For long-term storage, replace the solvent with shipping solvent and securely tighten the end caps.
- Store the column in a location with stable temperature.
- For long-term storage of SEC columns, immersion method is recommended.  
\*Please refer to the immersion method on the operation manual.

## ■ Other

- Avoid physical shock on the column. Be cautious not to drop the column from a high position.
- Do not bend the column.
- Avoid opening the column's end-fitting, it can cause alteration of column's performance.

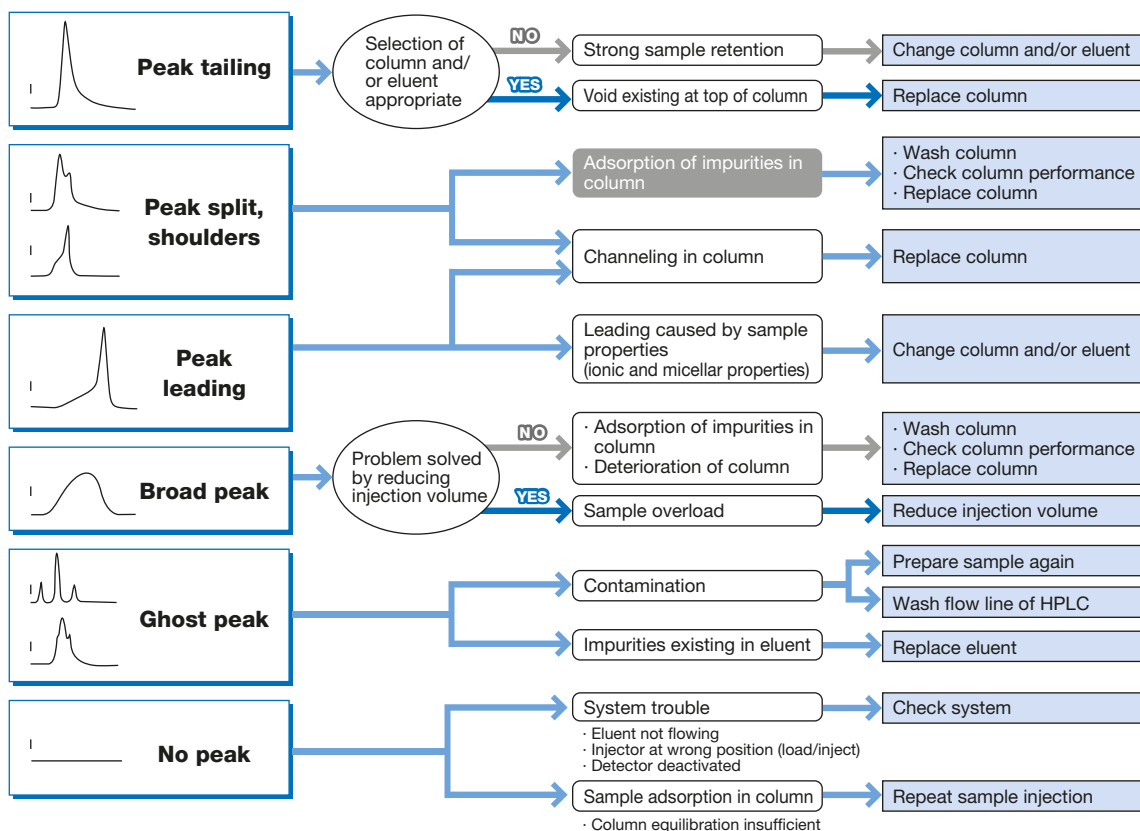
\* Read the operation manual before using the column.

# Column Trouble Shooting

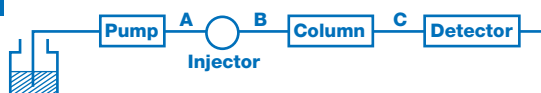
Common causes for abnormal chromatograms

## Abnormal peak shapes

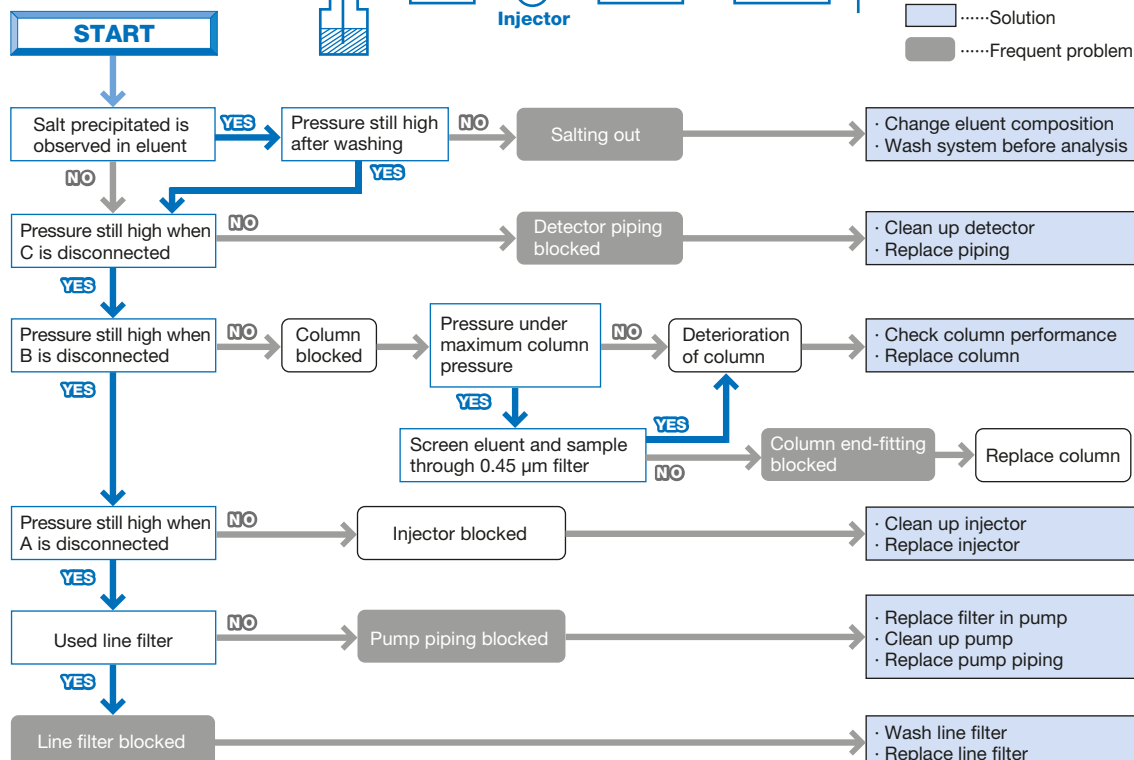
□ .....Main cause    □ .....Solution    ■ .....Frequent problem



## Pressure elevation



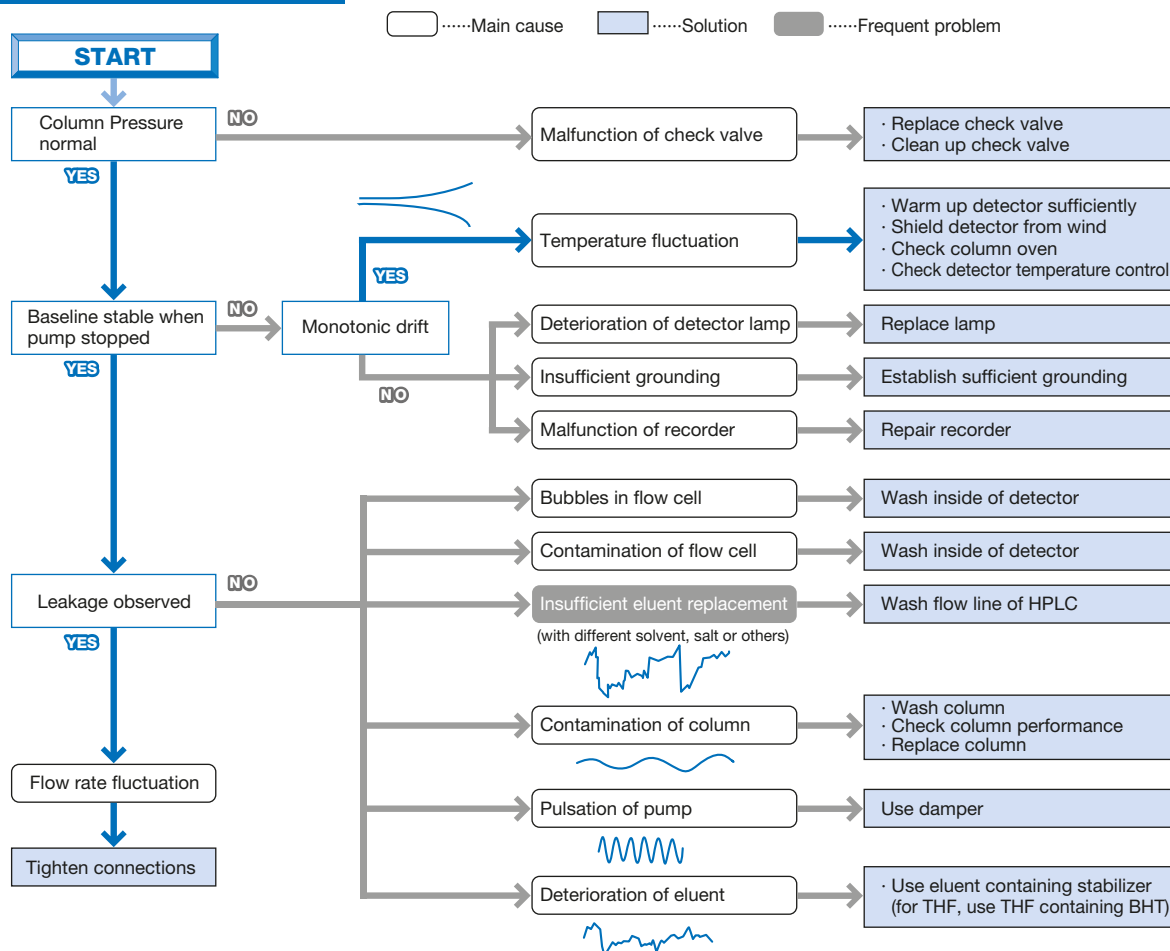
□ .....Main cause    □ .....Solution    ■ .....Frequent problem



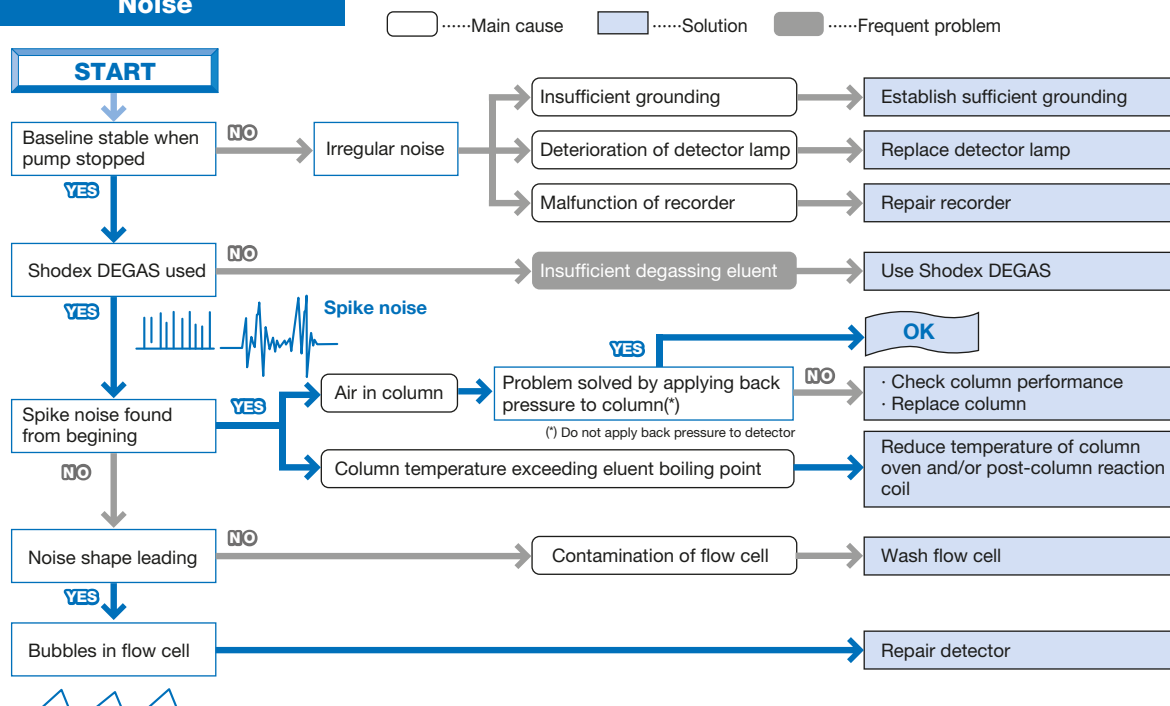
# HPLC System Trouble Shooting

Common causes for abnormal chromatograms

## Unstable baseline values



## Noise



# Index by Product Name

Columns are listed in alphabetical order under the product name excluding series name.

[Series name]

| AFpak  | Asahipak | AXpak | CLNpak | CXpak    | EP    | GPC    |
|--------|----------|-------|--------|----------|-------|--------|
| HIC    | HILICpak | IC    | IEC    | MSpak    | OHpak | ORpak  |
| PIKESS | PROTEIN  | RSpak | Silica | STANDARD | SUGAR | USPpak |

## A

|          |    |
|----------|----|
| ACH-494  | 68 |
| ADS-894  | 68 |
| AHR-894  | 68 |
| APA-894  | 68 |
| APG-894  | 68 |
| AT-806MS | 58 |
| AWG-894  | 68 |

## C

|          |    |
|----------|----|
| C18M     | 16 |
| C18P     | 16 |
| C4P-50   | 10 |
| 5C4      | 17 |
| 5C8      | 17 |
| C8P-50   | 10 |
| CDBS-453 | 68 |
| CM       | 66 |
| 5CN      | 17 |
| CRX-853  | 68 |

## D

|      |        |
|------|--------|
| DC   | 24, 25 |
| DE   | 12, 13 |
| DEAE | 64     |
| DM   | 12, 13 |
| DS   | 12     |

## E

|           |    |
|-----------|----|
| ET-RP1 4D | 68 |
| ES-502C   | 66 |
| ES-502N   | 64 |
| EV        | 70 |

## F

|                   |        |
|-------------------|--------|
| FL-1, FL-1 filter | 30, 32 |
|-------------------|--------|

## G

|          |    |
|----------|----|
| GF-210   | 44 |
| GF-310   | 44 |
| GF-4A    | 72 |
| GF-510   | 44 |
| GF-710   | 44 |
| GF-7M HQ | 44 |
| GS-220   | 42 |
| GS-310   | 44 |
| GS-320   | 42 |
| GS-510   | 44 |
| GS-520   | 42 |
| GS-620   | 42 |
| GS-710   | 44 |
| GSM-700  | 44 |

## H

|          |    |
|----------|----|
| H-2000   | 55 |
| HFIP-600 | 60 |
| HFIP-800 | 60 |
| HLD      | 72 |
| HT-800   | 58 |

## I

|        |    |
|--------|----|
| I-524A | 30 |
|--------|----|

## J

|       |    |
|-------|----|
| JJ-50 | 12 |
|-------|----|

## K

|          |        |
|----------|--------|
| K-2000   | 54     |
| K-5000   | 55     |
| K-800    | 48     |
| K-800D   | 48, 50 |
| KC-811   | 28     |
| KD-800   | 50     |
| KF-2000  | 54     |
| KF-5000  | 55     |
| KF-400HQ | 52     |
| KF-600   | 52     |
| KF-800D  | 46, 50 |
| KF-800   | 46     |
| KS-2000  | 25     |
| KS-800   | 24     |
| KW-2000  | 36     |
| KW400    | 36     |
| KW-800   | 36     |

## L

|        |    |
|--------|----|
| LB-800 | 38 |
| LF     | 56 |

## M

|        |    |
|--------|----|
| M-75   | 63 |
| MN-431 | 25 |

## N

|         |        |
|---------|--------|
| 5NH     | 17     |
| NH2P    | 22     |
| NI-424  | 30     |
| NN      | 12, 13 |
| 5NPE 4D | 17     |

## O

|         |    |
|---------|----|
| ODP2 HP | 8  |
| ODP     | 10 |

## P

|         |    |
|---------|----|
| P-421S  | 66 |
| P-82    | 63 |
| PAE     | 70 |
| PH-814  | 68 |
| PK      | 72 |
| 5PYE 4D | 17 |

## Q

|        |    |
|--------|----|
| QA-825 | 64 |
|--------|----|

## R

|          |    |
|----------|----|
| RP18-415 | 12 |
|----------|----|

## S

|                |    |
|----------------|----|
| SB-2000        | 39 |
| SB-800 HQ      | 38 |
| SC1011, SC1821 | 24 |
| SC1011-7F      | 25 |
| SC1211         | 24 |
| SH1011, SH1821 | 28 |
| SH-75          | 63 |
| SI-35 4D       | 30 |
| SI-50 4E       | 30 |
| SI-52 4E       | 30 |
| SI-90 4E       | 30 |
| 5SIL           | 17 |
| SL-105         | 63 |
| SM-105         | 63 |
| SP0810         | 24 |
| SP             | 66 |
| SZ5532         | 24 |

## T

|       |    |
|-------|----|
| T-521 | 32 |
|-------|----|

## U

|        |    |
|--------|----|
| UT-800 | 58 |
|--------|----|

## V

|       |    |
|-------|----|
| VG-50 | 20 |
| VT-50 | 20 |

## W

|        |    |
|--------|----|
| WA-624 | 64 |
|--------|----|

## Y

|        |    |
|--------|----|
| Y-521  | 32 |
| YK-421 | 32 |
| YS-50  | 32 |

# Index by Product Code

| Product Code | Product Name | Page |
|--------------|--------------|------|
| F6021030     | HFIP-603     | 60   |
| F6021040     | HFIP-604     | 60   |
| F6021041     | LF-804       | 56   |
| F6021042     | LF-604       | 56   |
| F6021043     | LF-404       | 56   |
| F6021050     | HFIP-605     | 60   |
| F6021060     | HFIP-606     | 60   |
| F6021070     | HFIP-607     | 60   |
| F6021080     | HFIP-606M    | 60   |
| F6027030     | KF-803L      | 46   |
| F6027040     | KF-804L      | 46   |
| F6027050     | KF-805L      | 46   |
| F6027060     | KF-806L      | 46   |
| F6027070     | KF-807L      | 46   |
| F6028010     | KF-801       | 46   |
| F6028020     | KF-802       | 46   |
| F6028025     | KF-802.5     | 46   |
| F6028030     | KF-803       | 46   |
| F6028040     | KF-804       | 46   |
| F6028050     | KF-805       | 46   |
| F6028060     | KF-806       | 46   |
| F6028070     | KF-807       | 46   |
| F6028090     | KF-806M      | 46   |
| F6028091     | KF-601       | 52   |
| F6028092     | KF-602       | 52   |
| F6028093     | KF-602.5     | 52   |
| F6028094     | KF-603       | 52   |
| F6028095     | KF-604       | 52   |
| F6028096     | KF-605       | 52   |
| F6028097     | KF-606       | 52   |
| F6028098     | KF-606M      | 52   |
| F6028099     | KF-607       | 52   |
| F6028110     | K-801        | 48   |
| F6028111     | KF-401HQ     | 52   |
| F6028112     | KF-402HQ     | 52   |
| F6028114     | KF-402.5HQ   | 52   |
| F6028116     | KF-403HQ     | 52   |
| F6028118     | KF-404HQ     | 52   |
| F6028119     | KF-405LHQ    | 52   |
| F6028120     | K-802        | 48   |
| F6028122     | KF-406LHQ    | 52   |
| F6028125     | K-802.5      | 48   |
| F6028130     | K-803        | 48   |
| F6028140     | K-804        | 48   |
| F6028150     | K-805        | 48   |
| F6028160     | K-806        | 48   |
| F6028170     | K-807        | 48   |
| F6028190     | K-806M       | 48   |
| F6028194     | K-803L       | 48   |
| F6028195     | K-804L       | 48   |
| F6028196     | K-805L       | 48   |
| F6028197     | K-806L       | 48   |
| F6028198     | K-807L       | 48   |
| F6028210     | KD-801       | 50   |
| F6028220     | KD-802       | 50   |

| Product Code | Product Name | Page |
|--------------|--------------|------|
| F6028225     | KD-802.5     | 50   |
| F6028230     | KD-803       | 50   |
| F6028240     | KD-804       | 50   |
| F6028250     | KD-805       | 50   |
| F6028260     | KD-806       | 50   |
| F6028270     | KD-807       | 50   |
| F6028290     | KD-806M      | 50   |
| F6028530     | HFIP-803     | 60   |
| F6028540     | HFIP-804     | 60   |
| F6028550     | HFIP-805     | 60   |
| F6028560     | HFIP-806     | 60   |
| F6028570     | HFIP-807     | 60   |
| F6028590     | HFIP-806M    | 60   |
| F6090001     | EV-2000      | 70   |
| F6090002     | EV-G         | 70   |
| F6090003     | EV-2000 AC   | 70   |
| F6090004     | EV-G AC      | 70   |
| F6090005     | EV-200       | 70   |
| F6090006     | EV2000AC-12F | 70   |
| F6090007     | EV-G AC12C   | 70   |
| F6102001     | H-2001       | 55   |
| F6102002     | H-2002       | 55   |
| F6102003     | H-2003       | 55   |
| F6102004     | H-2004       | 55   |
| F6102005     | H-2005       | 55   |
| F6102009     | H-2006M      | 55   |
| F6102025     | H-2002.5     | 55   |
| F6102301     | K-2001       | 54   |
| F6102303     | K-2003       | 54   |
| F6102304     | K-2004       | 54   |
| F6102305     | K-2005       | 54   |
| F6102306     | K-2006       | 54   |
| F6102309     | K-2006M      | 54   |
| F6102312     | K-2002       | 54   |
| F6102315     | K-2002.5     | 54   |
| F6102401     | KF-2001      | 54   |
| F6102402     | KF-2002      | 54   |
| F6102403     | KF-2003      | 54   |
| F6102404     | KF-2004      | 54   |
| F6102405     | KF-2005      | 54   |
| F6102406     | KF-2006      | 54   |
| F6102409     | KF-2006M     | 54   |
| F6102425     | KF-2002.5    | 54   |
| F6108010     | KF-5001      | 55   |
| F6108020     | KF-5002      | 55   |
| F6108025     | KF-5002.5    | 55   |
| F6108030     | KF-5003      | 55   |
| F6108040     | KF-5004      | 55   |
| F6110002     | CM-825       | 66   |
| F6110003     | PH-814       | 68   |
| F6110011     | QA-825       | 64   |
| F6112100     | DEAE3N-4T    | 64   |
| F6112110     | DEAE-2B      | 64   |
| F6113000     | SP-420N      | 66   |
| F6113110     | SP-2B        | 66   |

| Product Code | Product Name | Page |
|--------------|--------------|------|
| F6118250     | SP-825       | 66   |
| F6118255     | DEAE-825     | 64   |
| F6208390     | AT-806MS     | 58   |
| F6208600     | UT-802.5     | 58   |
| F6208610     | UT-806M      | 58   |
| F6208620     | UT-807       | 58   |
| F6208700     | HT-803       | 58   |
| F6208710     | HT-804       | 58   |
| F6208720     | HT-805       | 58   |
| F6208730     | HT-806       | 58   |
| F6208740     | HT-806M      | 58   |
| F6208770     | HT-807       | 58   |
| F6354211     | P-421S       | 66   |
| F6356240     | WA-624       | 64   |
| F6378010     | KS-801       | 24   |
| F6378020     | KS-802       | 24   |
| F6378025     | KS-803       | 24   |
| F6378030     | KC-811       | 28   |
| F6378033     | KC-811 6E    | 28   |
| F6378035     | KS-804       | 24   |
| F6378050     | KS-805       | 24   |
| F6378060     | KS-806       | 24   |
| F6378070     | KS-807       | 24   |
| F6378100     | SH1011       | 28   |
| F6378101     | SH1821       | 28   |
| F6378102     | SC1011       | 24   |
| F6378103     | SC1821       | 24   |
| F6378105     | SP0810       | 24   |
| F6379230     | MN-431       | 25   |
| F6379300     | SC1011-7F    | 25   |
| F6429100     | SB-802 HQ    | 38   |
| F6429101     | SB-802.5 HQ  | 38   |
| F6429102     | SB-803 HQ    | 38   |
| F6429103     | SB-804 HQ    | 38   |
| F6429104     | SB-805 HQ    | 38   |
| F6429105     | SB-806 HQ    | 38   |
| F6429106     | SB-806M HQ   | 38   |
| F6429108     | SB-807 HQ    | 38   |
| F6429201     | LB-803       | 38   |
| F6429202     | LB-806M      | 38   |
| F6502007     | KS-2001      | 25   |
| F6502008     | KS-2002      | 25   |
| F6502009     | KS-2003      | 25   |
| F6502010     | KS-2004      | 25   |
| F6502011     | KS-2005      | 25   |
| F6502012     | KS-2006      | 25   |
| F6505012     | KC-2011      | 28   |
| F6505020     | KW-2002.5    | 36   |
| F6505021     | KW-2003      | 36   |
| F6505022     | KW-2004      | 36   |
| F6513013     | DE-2013      | 13   |
| F6513015     | DE-5013      | 13   |
| F6514013     | DC-2013      | 25   |
| F6514014     | DM-2014      | 13   |
| F6514021     | DC-5013      | 25   |

| Product Code | Product Name      | Page |
|--------------|-------------------|------|
| F6514022     | DM-5014           | 13   |
| F6516011     | SB-2002           | 39   |
| F6516012     | SB-2002.5         | 39   |
| F6516013     | SB-2003           | 39   |
| F6516014     | SB-2004           | 39   |
| F6516015     | SB-2005           | 39   |
| F6516016     | SB-2006           | 39   |
| F6516017     | SB-2006M          | 39   |
| F6548000     | QA-2025           | 64   |
| F6548001     | DEAE-2025         | 64   |
| F6548002     | SP-2025           | 66   |
| F6548003     | CM-2025           | 66   |
| F6548050     | QA-5025           | 64   |
| F6548051     | DEAE-5025         | 64   |
| F6548052     | SP-5025           | 66   |
| F6548053     | CM-5025           | 66   |
| F6650040     | C18M 4D           | 16   |
| F6650041     | C18M 4E           | 16   |
| F6650042     | C18M 2D           | 16   |
| F6650045     | C18P 4D           | 16   |
| F6650046     | C18P 4E           | 16   |
| F6650047     | C18P 2D           | 16   |
| F6650050     | 5SIL 4D           | 17   |
| F6650051     | 5SIL 4E           | 17   |
| F6650052     | 5C8 4D            | 17   |
| F6650053     | 5C8 4E            | 17   |
| F6650054     | 5C4 4D            | 17   |
| F6650055     | 5C4 4E            | 17   |
| F6650058     | 5CN 4D            | 17   |
| F6650059     | 5CN 4E            | 17   |
| F6650060     | 5NH 4D            | 17   |
| F6650061     | 5NH 4E            | 17   |
| F6650062     | 5NPE 4D           | 17   |
| F6650063     | 5PYE 4D           | 17   |
| F6700002     | KS-G 8B (KS-LG)   | 25   |
| F6700010     | KC-G 8B (KC-LG)   | 28   |
| F6700020     | KS-G 6B (KS-G)    | 24   |
| F6700021     | KS-807G           | 24   |
| F6700030     | KC-G 6B (KC-G)    | 28   |
| F6700080     | SH-G              | 28   |
| F6700081     | SP-G 6B (SP-G)    | 24   |
| F6700090     | SC-G 6B (SC-LG)   | 24   |
| F6700110     | SZ-G              | 24   |
| F6700120     | SC1211G 4A (SC-G) | 24   |
| F6700131     | KW-G 6B (KW-G)    | 36   |
| F6700132     | KW400G-4A         | 36   |
| F6700140     | DS-G              | 12   |

| Product Code | Product Name        | Page  |
|--------------|---------------------|-------|
| F6700150     | DE-G 4A (DE-G)      | 12    |
| F6700151     | DE-G 2A (DE-SG)     | 12    |
| F6700160     | DM-G 4A (DM-G)      | 12    |
| F6700162     | DM-G 20C (DM-LLG)   | 13    |
| F6700170     | DC-G 4A (DC-G)      | 24    |
| F6700172     | DC-G 20C (DC-LLG)   | 25    |
| F6700190     | DE-G 8B (DE-LG)     | 13    |
| F6700191     | DE-G 20C (DE-LLG)   | 13    |
| F6700210     | P-G                 | 66    |
| F6700230     | Y-G                 | 32    |
| F6700245     | WA-G                | 64    |
| F6700280     | AT-G                | 58    |
| F6700300     | KF-G 4A (KF-G)      | 46,52 |
| F6700310     | H-G 8B (H-G)        | 55    |
| F6700400     | IA-G                | 30    |
| F6700401     | K-G 4A (K-G)        | 48    |
| F6700402     | DC-G 8B (DC-LG)     | 25    |
| F6700404     | DM-G 8B (DM-LG)     | 13    |
| F6700406     | KF-G 8B (KF-LG)     | 54    |
| F6700407     | K-G 8B (K-LG)       | 54    |
| F6700408     | KF-G 20B (KF-LLG)   | 55    |
| F6700409     | K-G 20B (K-LLG)     | 55    |
| F6700411     | KD-G 4A (KD-G)      | 50    |
| F6700412     | T-G                 | 32    |
| F6700500     | HFIP-G 8B (HFIP-LG) | 60    |
| F6700510     | NN-G                | 12    |
| F6700511     | HFIP-G 4A (HFIP-G)  | 60    |
| F6700530     | YS-G                | 32    |
| F6709300     | CRX-G               | 68    |
| F6709350     | KF-800D             | 46,50 |
| F6709400     | UT-G                | 58    |
| F6709410     | HT-G                | 58    |
| F6709430     | SB-G 6B (SB-G)      | 38    |
| F6709431     | SB-807G             | 38    |
| F6709434     | LB-G 6B             | 38    |
| F6709450     | K-800D              | 48,50 |
| F6709555     | SB-G 8B (SB-LG)     | 39    |

| Product Code | Product Name    | Page     |
|--------------|-----------------|----------|
| F6709556     | KW-G 8B (KW-LG) | 36       |
| F6709558     | RP18-G          | 12       |
| F6709602     | QA-LG           | 64       |
| F6709603     | DEAE-LG         | 64       |
| F6709604     | SP-G 8B (SP-LG) | 66       |
| F6709605     | CM-LG           | 66       |
| F6709608     | YK-G            | 32       |
| F6709616     | NI-G            | 30       |
| F6709620     | SI-90G          | 30       |
| F6709621     | LF-G            | 56       |
| F6709625     | SI-50G          | 30       |
| F6709626     | SI-92G          | 30       |
| F6709627     | SI-95G          | 30       |
| F6710001     | ODP-50G 6A      | 10       |
| F6710002     | C8P-50G 4A      | 10       |
| F6710003     | C4P-50G 4A      | 10       |
| F6710004     | ODP-130G 7B     | 10       |
| F6710016     | NH2P-50G 4A     | 22       |
| F6710017     | NH2P-130G 7B    | 22       |
| F6710018     | GF-1G 7B        | 44       |
| F6710019     | GS-2G 7B        | 42       |
| F6710020     | GS-10G 7B       | 44       |
| F6710021     | GS-20G 7B       | 42,64,66 |
| F6710022     | ODP-50G 4A      | 10       |
| F6710023     | ODP-50 4B       | 10       |
| F6710030     | NH2P-50G 3A     | 22       |
| F6710100     | NH2P-LF         | 22       |
| F6711100     | VG-50G 4A       | 20       |
| F6711200     | VG-50G 2A       | 20       |
| F6711300     | VT-50G 2A       | 20       |
| F6713000     | NH2P-50G 2A     | 22       |
| F6713001     | ODP-50G 2A      | 10       |
| F6714004     | C8P-50G 7B      | 10       |
| F6714005     | C4P-50G 7B      | 10       |
| F6714007     | PAE-G           | 70       |
| F6714008     | PAE-G AC        | 70       |
| F6714010     | ODP2 HPG-4A     | 8        |
| F6714011     | ODP2 HPG-2A     | 8        |
| F6714013     | ODP-40G 3A      | 10       |
| F6714014     | ODP2 HPG-3A     | 8        |
| F6810017     | GS-220 20F      | 42       |
| F6810018     | GS-320 20F      | 42       |
| F6810019     | GS-520 20F      | 42       |
| F6810020     | GS-620 20F      | 42       |
| F6810022     | PAE-2000        | 70       |
| F6810023     | PAE-2000 AC     | 70       |
| F6810030     | GS-310 20F      | 44       |
| F6810031     | GS-510 20F      | 44       |
| F6810032     | GS-710 20F      | 44       |
| F6810033     | GSM-700 20F     | 44       |
| F6810034     | GS-220 20G      | 42       |
| F6810035     | GS-320 20G      | 42       |

| Product Code | Product Name | Page |
|--------------|--------------|------|
| F6810036     | GS-520 20G   | 42   |
| F6810037     | GS-620 20G   | 42   |
| F6810038     | GS-310 20G   | 44   |
| F6810039     | GS-510 20G   | 44   |
| F6810040     | GS-710 20G   | 44   |
| F6810041     | GSM-700 20G  | 44   |
| F6820001     | ODP-50 10E   | 10   |
| F6820003     | C8P-50 10E   | 10   |
| F6820005     | C4P-50 10E   | 10   |
| F6820035     | ODP-90 20F   | 10   |
| F6830001     | NH2P-50 10E  | 22   |
| F6830031     | NH2P-90 20F  | 22   |
| F6840003     | ES-502C 20C  | 66   |
| F6840004     | ES-502N 20C  | 64   |
| F6989000     | KW-802.5     | 36   |
| F6989103     | KW-803       | 36   |
| F6989104     | KW-804       | 36   |
| F6989201     | KW402.5-4F   | 36   |
| F6989202     | KW403-4F     | 36   |
| F6989203     | KW404-4F     | 36   |
| F6989204     | KW405-4F     | 36   |
| F6995210     | Y-521        | 32   |
| F6995240     | I-524A       | 30   |
| F6995243     | NI-424       | 30   |
| F6995244     | SI-90 4E     | 30   |
| F6995245     | SI-50 4E     | 30   |
| F6995250     | T-521        | 32   |
| F6995260     | SI-52 4E     | 30   |
| F6995290     | SI-35 4D     | 30   |
| F7001001     | DS-613       | 12   |
| F7001002     | DM-614       | 12   |
| F7001003     | DC-613       | 24   |
| F7001004     | DE-613       | 12   |
| F7001005     | DE-413       | 12   |
| F7001007     | DE-213       | 12   |
| F7001012     | DS-413       | 12   |
| F7001300     | SZ5532       | 24   |
| F7001400     | SC1211       | 24   |
| F7008140     | NN-814       | 12   |
| F7008150     | NN-614       | 12   |
| F7008160     | NN-414       | 12   |
| F7008220     | JJ-50 2D     | 12   |
| F7008240     | JJ-50 4D     | 12   |
| F7009000     | RP18-415     | 12   |
| F7009030     | DE-413L      | 13   |
| F7113050     | APG-894      | 68   |
| F7118946     | APA-894      | 68   |
| F7118954     | ADS-894      | 68   |
| F7118959     | AWG-894      | 68   |
| F7118964     | ACH-494      | 68   |
| F7120012     | YK-421       | 32   |
| F7122000     | YS-50        | 32   |
| F7140040     | CRX-853      | 68   |
| F7146003     | CDBS-453     | 68   |
| F7560040     | C18M 10E     | 16   |

| Product Code | Product Name | Page |
|--------------|--------------|------|
| F7560041     | C18M 20E     | 16   |
| F7560050     | 5SIL 10E     | 17   |
| F7560051     | 5SIL 20E     | 17   |
| F7560054     | 5C4 10E      | 17   |
| F7560055     | 5C4 20E      | 17   |
| F7560060     | 5NH 10E      | 17   |
| F7560061     | 5NH 20E      | 17   |
| F7560062     | 5C8 10E      | 17   |
| F7560063     | 5C8 20E      | 17   |
| F7600000     | GF-210 HQ    | 44   |
| F7600001     | GF-310 HQ    | 44   |
| F7600002     | GF-510 HQ    | 44   |
| F7600003     | GF-710 HQ    | 44   |
| F7600004     | GF-7M HQ     | 44   |
| F7600005     | GS-220 HQ    | 42   |
| F7600006     | GS-320 HQ    | 42   |
| F7600007     | GS-520 HQ    | 42   |
| F7600008     | GS-620 HQ    | 42   |
| F7600024     | GF-310 4E    | 44   |
| F7600025     | PAE-800      | 70   |
| F7600026     | PAE-800 AC   | 70   |
| F7600100     | GF-310 4B    | 44   |
| F7600110     | GF-310 4D    | 44   |
| F7600120     | GF-310 2D    | 44   |
| F7600200     | GF-210 4D    | 44   |
| F7600201     | GF-210 4E    | 44   |
| F7620001     | ODP-50 6E    | 10   |
| F7620002     | ODP-50 6D    | 10   |
| F7620003     | ODP-50 4E    | 10   |
| F7620004     | ODP-50 4D    | 10   |
| F7620005     | C8P-50 4E    | 10   |
| F7620006     | C8P-50 4D    | 10   |
| F7620007     | C4P-50 4E    | 10   |
| F7620008     | C4P-50 4D    | 10   |
| F7620009     | ODP-50 2D    | 10   |
| F7621001     | ODP-40 4D    | 10   |
| F7621002     | ODP-40 4E    | 10   |
| F7621101     | ODP-40 3B    | 10   |
| F7621102     | ODP-40 3D    | 10   |
| F7622001     | ODP2 HP-4B   | 8    |
| F7622002     | ODP2 HP-4D   | 8    |
| F7622003     | ODP2 HP-4E   | 8    |
| F7622004     | ODP2 HP-2B   | 8    |
| F7622005     | ODP2 HP-2D   | 8    |
| F7622006     | ODP2 HP-3B   | 8    |
| F7622007     | ODP2 HP-3D   | 8    |
| F7623001     | ET-RP1 4D    | 68   |
| F7630001     | NH2P-50 4E   | 22   |
| F7630002     | NH2P-50 4D   | 22   |
| F7630005     | NH2P-50 4B   | 22   |
| F7630006     | NH2P-50 2D   | 22   |
| F7630007     | NH2P-40 3E   | 22   |
| F7630008     | NH2P-40 2B   | 22   |
| F7630009     | NH2P-40 2D   | 22   |
| F7630010     | NH2P-40 2E   | 22   |

| Product Code | Product Name | Page  |
|--------------|--------------|-------|
| F7630011     | NH2P-40 3B   | 22    |
| F7630012     | NH2P-40 3D   | 22    |
| F7630100     | VG-50 4E     | 20    |
| F7630200     | VG-50 4D     | 20    |
| F7630300     | VG-50 2D     | 20    |
| F7630400     | VT-50 2D     | 20    |
| F7640001     | ES-502C 7C   | 66    |
| F7640002     | ES-502N 7C   | 64    |
| F7750311     | GS320A-4E    | 42    |
| F7750312     | GS320A-4D    | 42    |
| F7750613     | GS620A-4B    | 42    |
| F7760511     | GF510A-4E    | 44    |
| F7760512     | GF510A-4D    | 44    |
| F7760712     | GF710A-4D    | 44    |
| F7781212     | KW402.5-4D   | 36    |
| F7781213     | KW402.5-4B   | 36    |
| F7781312     | KW403-4D     | 36    |
| F7781313     | KW403-4B     | 36    |
| F7838022     | ODP40-2D     | 8     |
| F7838023     | ODP40-2B     | 8     |
| F7840121     | DE413-2E     | 13    |
| F7840123     | DE413-2B     | 13    |
| F7860122     | NN414-2D     | 13    |
| F7960122     | DEAE9A-2D    | 64    |
| F8400000     | P-82         | 63    |
| F8500630     | FL-1         | 30,32 |
| F8500640     | FL-1 filter  | 30,32 |
| F8601105     | SL-105       | 63    |
| F8602105     | SM-105       | 63    |
| F8603075     | SH-75        | 63    |
| F8604075     | M-75         | 63    |
| F8700000     | PK-2A 2P     | 72    |
| F8700001     | HLD          | 82    |
| F8700012     | PK-4A 2P     | 72    |
| F8700015     | GF-4A        | 72    |

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These are the advantages of polymer-based columns:

- The great chemical stability leads to an extended pH range (2 to 13).
- The low bleeding allows the use of sensitive detection.
- Large variety of material properties create a higher resolution.
- They are available for almost all separation techniques.
- The price per injection is cheaper than in silica-based columns due to their extended lifetime (2-3 times longer than silica-based).

NO



**Still no reason to use them?**

## Reversed Phase

### Asahipak ODP-50

- Polymer-based RP C18 column
- better separation of basic substances
- silanol free
- pH stability from 2 to 13
- lower bleeding and higher S/N ratio
- recommended for MS detection
- 100 % water or buffer possible
- 2-3 times longer life time

## HILIC

### Asahipak NH2P-50

- Polymer-based amino column (NH<sub>2</sub>)
- for sugars and polar compounds
- silanol free
- pH stability from 2 to 13
- recommended for MS, CAD, and light scattering detectors
- bestseller column for HILIC
- 2-3 times longer life time

## SUGAR

### SUGAR columns

- ligand exchange with Na<sup>+</sup>, Zn<sup>2+</sup>, Ca<sup>2+</sup> and Pb<sup>2+</sup> as counter ion
- for mono-, di- and oligosaccharides
- cost and eco-friendly: pure water as solvent
- higher exclusion limits for polysaccharides

### Organic acids columns

- ion exclusion with H<sup>+</sup>
- for organic acids or mixtures with sugars and alcohols

## SEC (aqueous GFC)

### PROTEIN KW

- for proteins, peptides, enzymes, antibodies
- silica-based
- for water (buffer, salt) and organic solvents
- many applications for biopolymers

### OHpak SB

- for modified proteins, polysaccharides, water-soluble polymers
- polymer-based
- many exclusion limits available

Pullulan Standard for calibration

## SEC (organic GPC)

### GPC columns

- for (synthetic) polymers, plastics, resins, rubbers, silicones, copolymers
- single pore, linear and mixed-bed columns
- huge variety of exclusion limits
- prefilled with THF, Chloroform, DMF, HFIP
- Special high temperature GPC columns
- Best stability and reproducibility

Polystyrene (PS) and PMMA Standard for calibration

## IC

### Ion Chromatography columns

- for inorganic anions and cations
- for non-suppressed or suppressor methods
- with carbonate buffer (anions and oxyhalides)
- compatible with all instruments

## Company info

Shodex HPLC columns are manufactured by Showa Denko in Japan since 50 years, which leads to a great knowledge, experience and application data base. The European headquarters for Shodex are located in Munich (Germany) and are responsible for Europe, Russia, Africa and Middle East. We offer profound technical support and have a strong partnership with customers and distributors in different countries. Shodex is a specialist for high-quality and long lifetime polymer-based columns.

# Refractive Index Detector

## Shodex RI-501, 502, 504

The Shodex RI-500 series is a versatile and high sensitive RI detectors that can be used with various manufactures' HPLC systems. It consists of an automatic start-up function, a double temperatur control and a validation wizard. The detector series are available as Analytic, semi-micro and preparative line up.



### <Features>

- The automatic start-up function controls the complicated operations such as blank substitution and baseline stabilization automatically.
- The validation wizard enables easy component validation.
- Improved double temperature control system shortens the required warm-up time and provides stable background.
- The leak sensor automatically stops the pump in case of solvent leakage.
- External input and output terminals and LAN (RJ45) communication ports can be used to connect various HPLC systems for an advanced automation.
- Usable in UHPLC systems.

| Product Code                      | F4010501                                                                                                                                                                        | F4010502                                                                                                                              | F4010504                                                                                                                             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Model                             | <b>RI-501</b><br><b>Analysis</b>                                                                                                                                                | <b>RI-502</b><br><b>Preparative</b>                                                                                                   | <b>RI-504</b><br><b>Micro</b>                                                                                                        |
| Flow cell type                    | 2 chamber-type                                                                                                                                                                  |                                                                                                                                       |                                                                                                                                      |
| Measuring method                  | Deflection type                                                                                                                                                                 |                                                                                                                                       |                                                                                                                                      |
| Refractive Index range            | 1.00~1.75                                                                                                                                                                       |                                                                                                                                       |                                                                                                                                      |
| Measurement range                 | 0.25~512 $\mu$ RIU                                                                                                                                                              | 2.5~5120 $\mu$ RIU                                                                                                                    | 0.25~512 $\mu$ RIU                                                                                                                   |
| Drift *                           | 0.2 $\mu$ RIU/h                                                                                                                                                                 | 2 $\mu$ RIU/h                                                                                                                         | 0.2 $\mu$ RIU/h                                                                                                                      |
| Linearity range                   | $\geq 600$ $\mu$ RIU                                                                                                                                                            | $\geq 6000$ $\mu$ RIU                                                                                                                 | $\geq 600$ $\mu$ RIU                                                                                                                 |
| Noise **                          | $\leq 2.5$ nRIU                                                                                                                                                                 | $\leq 25$ nRIU                                                                                                                        | $\leq 5$ nRIU                                                                                                                        |
| Response                          | 0.1, 0.25, 0.5, 1, 1.5, 2, 3, 6sec                                                                                                                                              |                                                                                                                                       |                                                                                                                                      |
| Auto zero                         | Full auto zero                                                                                                                                                                  |                                                                                                                                       |                                                                                                                                      |
| Auto zero range                   | All Refractive Index Range                                                                                                                                                      |                                                                                                                                       |                                                                                                                                      |
| Recorder output range selection   | 0.25 - 512 $\mu$ RIU/FS                                                                                                                                                         | 2.5~5120 $\mu$ RIU                                                                                                                    | 2.5~5120 $\mu$ RIU                                                                                                                   |
| Integrator output range selection | 128/512 $\mu$ RIU/FS                                                                                                                                                            | 1280/5120 $\mu$ RIU/FS                                                                                                                | 128/512 $\mu$ RIU/FS                                                                                                                 |
| Integrator output (Sensitivity)   | DC 0~1V<br>(2mV/ $\mu$ RIU, 8mV/ $\mu$ RIU)                                                                                                                                     | DC 0~1V<br>(0.2mV/ $\mu$ RIU, 0.8mV/ $\mu$ RIU)                                                                                       | DC 0~1V<br>(2mV/ $\mu$ RIU, 8mV/ $\mu$ RIU)                                                                                          |
| Cell volume                       | 8 $\mu$ L                                                                                                                                                                       | 8 $\mu$ L                                                                                                                             | 2.5 $\mu$ L                                                                                                                          |
| Flow rate<br>(Usual)<br>(Max.)    | 0.2~3.0mL/min<br>10mL/min (solvent ; pure water)                                                                                                                                | 1.0~50mL/min<br>100mL/min (solvent ; pure water)                                                                                      | 0.2~1.0mL/min<br>1.0mL/min (solvent ; pure water)                                                                                    |
| Maximum back pressure             | 50kPa                                                                                                                                                                           |                                                                                                                                       |                                                                                                                                      |
| Internal volume                   | IN $\rightarrow$ Cell : ca. 60 $\mu$ L<br>Cell $\rightarrow$ OUT : ca. 630 $\mu$ L<br>All (Cell $\rightarrow$ OUT) : ca. 690 $\mu$ L                                            | IN $\rightarrow$ Cell : ca. 120 $\mu$ L<br>Cell $\rightarrow$ OUT : ca. 540 $\mu$ L<br>All (Cell $\rightarrow$ OUT) : ca. 660 $\mu$ L | IN $\rightarrow$ Cell : ca. 10 $\mu$ L<br>Cell $\rightarrow$ OUT : ca. 385 $\mu$ L<br>All (Cell $\rightarrow$ OUT) : ca. 395 $\mu$ L |
| Recorder output                   | 0~10mV/FS                                                                                                                                                                       |                                                                                                                                       |                                                                                                                                      |
| External input                    | Purge On/Off, Auto Zero, Marker                                                                                                                                                 |                                                                                                                                       |                                                                                                                                      |
| External output                   | ① READY (Automatic start-up)<br>② LEAK<br>③ ERROR (OVER HEAT/LOW LIGHT INTENSITY/NULL GLASS HOME POSITION/LOST PARAMETERS/OPTICAL BALANCE) (Contact capacity : DC24V 0.1A max.) |                                                                                                                                       |                                                                                                                                      |
| Temperature control               | OFF, 30~55°C (double Temperature control)                                                                                                                                       |                                                                                                                                       |                                                                                                                                      |
| Communication port                | LAN                                                                                                                                                                             |                                                                                                                                       |                                                                                                                                      |
| CE / RoHS certificates available  | YES                                                                                                                                                                             |                                                                                                                                       |                                                                                                                                      |
| Wetted materials                  | Stainless steel 316, Teflon, Quartz glass                                                                                                                                       |                                                                                                                                       |                                                                                                                                      |
| Power source, Power consumption   | AC100~240 $\pm$ 10%, 50/60Hz, 150VA max                                                                                                                                         |                                                                                                                                       |                                                                                                                                      |
| Dimensions, Weight                | W260 x D420 x H165 (mm), ca.12.5kg                                                                                                                                              |                                                                                                                                       |                                                                                                                                      |
| Accessories                       | Power cable, signal cable, connector tube, operation manual                                                                                                                     |                                                                                                                                       |                                                                                                                                      |

\*Pure water 1mL/min, PURGE OFF

\*\*Pure water, response : 1.5sec

## Electric Conductivity Detector

# Shodex CD-200

The electric conductivity detector is designed for ion chromatography. It is recommended for anion or cation analysis in aqueous solution.

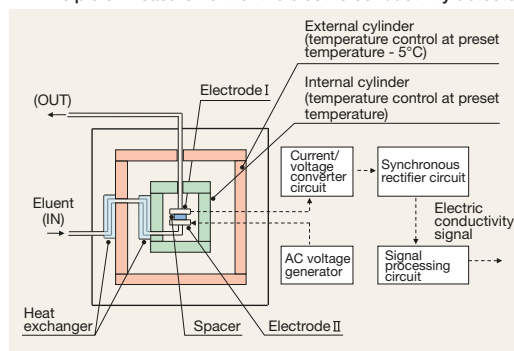
### <Features>

- With use of the built-in double temperature control cell, this detector enables highly sensitive measurement.
- The detector supports a wide range of measurement and is usable for ion chromatography with or without suppressor method.

|                                 |                                                                                                                         |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Product Code                    | F5515010                                                                                                                |
| Model                           | <b>CD-200</b>                                                                                                           |
| Measurement method              | Two-electrode system                                                                                                    |
| Measurement limit               | 0~600mS/m (0~6mS/cm)                                                                                                    |
| Measurement range               | 0.0025~5.12mS/m, 0.025~51.2mS/m, 0.25~512mS/m                                                                           |
| Linearity range                 | 600mS/m                                                                                                                 |
| Response                        | 0.1, 0.25, 0.5, 1.0, 1.5, 2, 3, 6sec                                                                                    |
| Auto zero limit                 | Same as measurement limit                                                                                               |
| Baseline shift                  | Range;0~2mS/m, Resolution;0.01mS/m                                                                                      |
| Integrator output               | 0~1V (Sensitivity;200, 20, 2mV/mS/m)                                                                                    |
| Recorder output                 | 0~10mV/FS                                                                                                               |
| External input                  | ① ZERO IN ② MARKER IN                                                                                                   |
| External Output                 | ① READY(TEMPERATURE STABILIZED)<br>② LEAK<br>③ ERROR(ROM, RAM, PARAMETER, SENSOR, OVER HEAT, ZERO OVER)<br>④ MARKER OUT |
| Cell Temperature control        | OFF, 30~50°C (1°C step), 77°C Temp. fuse                                                                                |
| Communication port              | USB                                                                                                                     |
| Cell volume                     | 2.5μL                                                                                                                   |
| Pressure rating                 | 1MPa                                                                                                                    |
| Wetted materials                | Stainless steel 316, Teflon, PEEK                                                                                       |
| Dimension, Weight               | W260 x D400 x H150 (mm), ca. 8kg                                                                                        |
| Power source, Power consumption | AC 100~240V±10%, 200VA max                                                                                              |



■ Principle of measurement of the electric conductivity detector



## Dissolved Gas Removal Devices

# DEGASSER ERC-3215α, 3415α

The ERC-3000α series efficiently remove dissolved gases in the eluent.

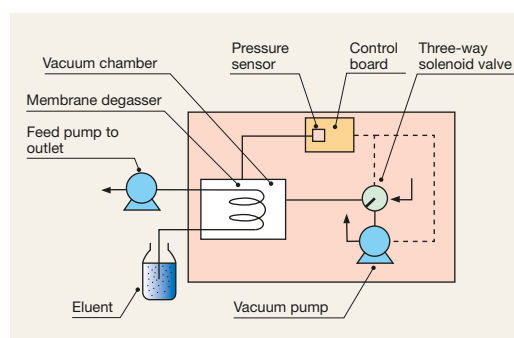
### <Degassing principle>

A special synthetic resin membrane (degassing membrane) is used to selectively remove dissolved gasses; using the characteristics of the small molecular size of the dissolved gas with high mobility and affinity to the membrane.

### <Features>

- Pressure sensor and leak monitor assure a high degree of safety.
- Dead volume is minimized to 7 ml/flow channel.
- Any pump can be used since differential pressure is low.
- Continuous degassing mode aids eluent preparation for high-sensitivity analysis.

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Product Code        | Y4617000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Y4617004         |
| Model               | <b>ERC-3215α</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>ERC-3415α</b> |
| Solvent Channels    | 2 channels                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4 channels       |
| Degassing capacity  | When ion-exchanged water saturated with air at 25°C is put through at a flow rate of 3 mL/min, no bubble is observed at the outlet of the apparatus. (Measured dissolved oxygen level at the outlet: 2 ppm at flow rate of 3 mL/min)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |
| Internal volume     | 7mL/Channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |
| Max. Flow Rate      | 20mL/min for each channel (Eluent : 25°C Pure water)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |
| External output     | An open connector signal is delivered to the external output signal terminal, when "PRES" and "LEAK" LEDs lights are on.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |
| Dimensions          | W71 x D310 x H136 (mm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |
| Power source        | AC100V~AC240V, 50/60Hz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |
| Functions, Displays | <ul style="list-style-type: none"> <li>• Power On/Off display : "POWER" LED lights, when the power is supplied.</li> <li>• Status monitoring function : "READY" LED lights, when the internal pressure in the vacuum chamber is below a predetermined limit.</li> <li>• Pressure monitoring function : "PRES" LED lights, when the internal pressure in the vacuum chamber does not reach a predetermined level within a predetermined time.</li> <li>• Leak monitor : "LEAK" LED lights, when the liquid leaks in the apparatus.</li> <li>• Self cleaning : The vacuum line is cleaned by air suction.</li> <li>• Vacuum pump operation switching function:               <ul style="list-style-type: none"> <li>NORM. : Controlled operation in normal run</li> <li>CONT. : Continuous operation in case of high degree of degassing</li> </ul> </li> </ul> |                  |
| Weight              | ca. 5.1kg                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ca. 5.5kg        |



■ In addition to this product, various degassers are available including the six-flow channel type and the high flow rate type. For details, please contact Shodex or our distributors near you.



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 application data and uses.

Shodex website

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2. For improvement purposes, some specifications are subject to change without notice.
3. Provided to help you select the appropriate column, the figures and descriptions in this catalogue are not guaranteed and do not warrant 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 on the operating manual.
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