# Shodex RSpak Polymer Reversed-Phase Columns

Shodex RSpak Columns are packed with porous polymeric particles that remain stable in a pH range of 2–12. Similar to conventional polymer-based materials, the DS-613 sorbent works well with samples that are more hydrophobic than hydrophilic, and which, consequently, require relatively high concentrations of organic modifiers. DE-613 columns, with a polymethacrylate packing, are more hydrophilic than hydrophobic, and work well with mobile phases containing relatively high concentrations of water. The least hydrophobic sorbent is used for the DE-613 columns.

For weakly cationic species, the DC-613 column is a cation exchanger with unique selectivity (mixed-mode, ion-exchange, and reversed-phase partition chromatography).

## Ordering Information

Shodex RSpak D Series Columns

| Description | Base-polymer | Functional Group | Dimension | P/N |
|---|---|---|---|---|
| DS-613 | Polystyrene | None | 6 × 150 mm | WAT034220 |
| DE-613 | Polymethacrylate | None | 6 × 150 mm | WAT034221 |
| DC-613 | Polystyrene | Sulfonated | 6 × 150 mm | WAT034223 |
| DS-G Pre-column | — | — | 4.6 × 10 mm | WAT034224 |
| DE-G Pre-column | — | — | 4.6 × 10 mm | WAT034225 |
| DC-G Pre-column | — | — | 4.6 × 10 mm | WAT034227 |

# Application-Specific Columns

## SUGAR AND CARBOHYDRATE ANALYSIS

### High-Performance Carbohydrate Analysis Cartridge Column, p/n: WAT044355

Waters High-Performance Carbohydrate Cartridge Column, with reusable end-fittings, is packed with a 4 µm, spherical silica. This column was developed to separate five monosaccharides and disaccharides with baseline resolution in less than 12 minutes. The 4.6 mm I.D. × 250 mm High-Performance Carbohydrate Cartridge Column offers optimal speed, resolution, and longevity. The pre-packed, disposable cartridge column requires reusable end-fittings, which are available separately.

### Carbohydrate Analysis Column, p/n: WAT084038

The Carbohydrate Analysis Column uses a covalently bonded amino packing on a silica substrate. It is best suited for low-molecular-weight sugars such as mono-, di-, and tri-saccharides.

### Sugar Pak I Column, p/n: WAT085188

The Sugar Pak I Column separates monosaccharides and sugar alcohols via a strong cation-exchange mechanism. The resin is based on a sulfonated styrene-divinylbenzene polymer that provides pH stability by means of a calcium counter ion.

Waters offers a range of columns for the analysis of sugars, carbohydrates, organic acids, and alcohols. Refer to the following tables for ordering information.

**Typical Applications for Sugar and Carbohydrate Columns**

| Cartridge/ Column | Carbohydrate Analysis Column | SAM™ I Reagent with Silica Cartridge | Sugar-Pak™ I, SC-1011, SP-0810 | SH-1011, IC-Pak™ Ion-Exclusion Fast Fruit Juice | Dextro-Pak™ | KS-800 series |
|---|---|---|---|---|---|---|
| Mode | Partition | Partition | Ion exchange/ size exclusion | Ion exchange/ size exclusion | Reversed phase | Size exclusion |
| Eluent | 65–85% acetonitrile/ water ambient to 70 ˚C | 70–80% acetonitrile/water 0.1% SAM I ambient | Water 75–95 ˚C | 0.01 N phosphoric acid 50–60 ˚C | Water ambient | — |
| Application | Mono-, di- and tri-saccharides up to DP 8 sugars and sugar alcohols | Mono-, di- and tri-saccharides | Mono-, di-, oligosaccharides and sugar alcohols | Sugar acids, sugar alcohols, organic acids | Hydrolysed syrups, derivatized sugars | Mono- through oligosaccharides such as syrups |
| Elution Order | Smallest elute first | Smallest elute first | Largest elute first | Largest and most acidic elute first | Smallest elute first | Largest elute first |

### Guide to Shodex Sugar Columns

| S | C | 18 | 2 | 1 |
|---|---|---|---|---|
| Type of Column | Cation | % Cross Linkage | Pore Size | 0 - Gel Type |
| S = sugar | H = $H^+$ | — | 1 = 20Å | 1 - Semimacropore gel |
| | C = $Ca^{2+}$ | — | 2 = 50Å | 2 - Permanent pore gel |
| | P = $Pb^{2+}$ | — | 3 = 100Å | |
| | Z = $Zn^{2+}$ | — | 4 = 500Å | |
| | — | — | 5 = 1000Å | |
| **Example:** | | | | |
| S | C | 10 | 1 | 1 |
| Sugar column | $Ca^{2+}$ | 10% cross linkage | 20Å | Semimacropore gel |

## Ordering Information

### SAM I Reagent Column

| Description | Dimension | Qty. | P/N |
|---|---|---|---|
| SAM I Reagent | 7.8 × 300 mm | 1/pk | WAT010873 |

### Columns for Alcohols and Carbohydrates

| Description | Dimension | Particle Size | Qty. | P/N |
|---|---|---|---|---|
| Carbohydrate Analysis Column | — | — | 1/pk | WAT084038 |
| Dextro-Pak Cartridge Column | 8.0 × 100 mm | — | 1/pk | WAT085650 |
| High-Performance Carbohydrate Sentry Guard Column | 3.9 × 20 mm | 4 µm | 2/pk | WAT046895[1] |
| SC-1011 Column | 8.0 × 300 mm | — | 1/pk | WAT034238 |
| SC-1011P Pre-column | 6.0 × 50 mm | — | 1/pk | WAT034244 |
| SH-1011 | 8.0 × 300 mm | — | 1/pk | WAT034236 |
| SH-1011P Pre-column | 6.0 × 50 mm | — | 1/pk | WAT034243 |
| SP-0810 Column | 8.0 × 300 mm | — | 1/pk | WAT036954 |
| SP-0810P Pre-column | 6.0 × 50 mm | — | 1/pk | WAT034245 |
| Sugar-Pak 1 Column | 6.5 × 300 mm | — | 1/pk | WAT085188 |
| Sugar-Pak 1 Guard-Pak Inserts | — | — | 10/pk | WAT015209[2] |
| Shodex KS-801 | — | 7 µm | 1/pk | WAT034276 |

[1] Requires Sentry Guard Holder, p/n: WAT046905.
[2] Requires Guard-Pak Holder, p/n: WAT088141.

### High-Performance Carbohydrate Analysis Cartridge Column

| Description | Dimension | P/N |
|---|---|---|
| High-Performance Carbohydrate Cartridge Column (requires end-fittings) | 4.6 × 250 mm | WAT044355 |
| Sentry Integrated Guard Holder (for Waters cartridge columns) | — | WAT046905 |

## FERMENTATION ANALYSIS, ORGANIC ACIDS, ALCOHOLS, AND CARBOHYDRATES

The ion-exclusion mode is ideally suited for the separation of monosaccharides, organic acids, or sugar acids. The column packings are sulfonated styrene divinylbenzene resins in the hydrogen form (IC-Pak Ion-Exclusion or SH-1011), and the mobile phase is a dilute acid such as 0.01 N phosphoric acid using column temperatures of 50–60 °C.

In this mode, the Fast Juice column can effectively separate glycerol, acetic acid, and ethanol in grape or other fruit juice. The column can also analyze the degree of microbial defect, the extent of natural fermentation in grapes, and the amount of sulfite in various foods and beverages. The IC-Pak Ion-exclusion Column can separate a wide range of organic acids while the Shodex SH Column separates acids as well as larger carbohydrates.

The analysis of alcohols and organic acids is important, for they typically help determine the flavor characteristics of beverages such as wine, beer, and some distilled spirits. The presence of alcohols in fruit juices can indicate product deterioration. The Shodex KC-811 Column, which provides ion-exchange and reversed-phase chromatography modes, is packed with a sulfonated, rigid, styrene-divinylbenzene copolymer. With high efficiency, this packing separates low-molecular-weight organic acids and water-soluble organics such as alcohols, aldehydes, and nitriles. The column provides ion-exclusion and reversed-phase mode of chromatography. Typical mobile phases, run at 1 mL/min at 45–80 °C, are composed of aqueous solutions containing 1% phosphoric acid, acetic acid, or perchloric acid.

**Shodex KC-811 Column Retention Chart for Organic Acids**

| Sample | Retention Time | Sample | Retention Time |
|---|---|---|---|
| Oxalic Acid | 5.20 | ß- Hydroxy-propionic Acid | 8.60 |
| Maleic Acid | 5.80 | D-Glucuronic Acid | 8.65 |
| a-Ketoglutaric Acid | 5.90 | Fumaric Acid | 8.95 |
| Citric Acid | 6.20 | Formic Acid | 9.20 |
| Tartaric Acid | 6.55 | Acetic Acid | 9.80 |
| Pyruvic Acid | 6.65 | Adipic Acid | 9.80 |
| trans-Aconitic Acid | 6.95 | Levulinic Acid | 10.00 |
| Glyoxylic Acid | 7.00 | Mesaconic Acid | 10.40 |
| Malic Acid | 7.05 | Pyroglutamic Acid | 10.70 |
| Malonic Acid | 7.07 | Propionic Acid | 11.25 |
| Citraconic Acid | 7.20 | Acrylic Acid | 11.60 |
| Succinic Acid | 8.00 | Pivalic Acid | 14.05 |
| Glycolic Acid | 8.40 | Methacrylic Acid | 14.10 |
| Itaconic | 8.50 | trans-Crotonic Acid | 15.65 |
| Lactic Acid | 8.60 | | |

Eluent: Water with 0.1% phosphoric acid, Temperature: 60 °C, Flow rate: 1 mL/min.

## Ordering Information

Columns for Fermentation Analysis, Organic Acids, Alcohols, and Carbohydrates

| Description | Dimension | Qty. | P/N |
|---|---|---|---|
| Fast Fruit Juice Analysis | 8.0 × 100 mm | 1/pk | WAT010639 |
| Fast Fruit Juice Guard-Pak Inserts | — | 10/pk | WAT015207[1] |
| IC-Pak Ion-Exclusion | 7.8 × 300 mm | 1/pk | WAT010290 |
| SC-1011 Column | 8.0 × 300 mm | 1/pk | WAT034238 |
| SC-1011P Pre-column | 6.0 × 50 mm | 1/pk | WAT034244 |
| KC-811 | 8.0 × 300 mm | 1/pk | WAT034298 |
| KC-811 Pre-column | 6.0 × 50 mm | 1/pk | WAT035501 |

[1]Requires 7.8 × 10 mm Cartridge Holder, p/n: 186000708.

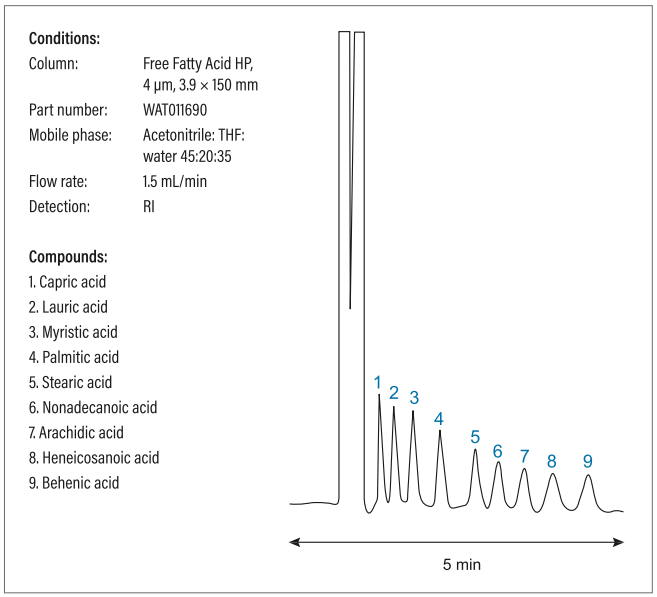
## FREE FATTY ACID ANALYSIS

The Waters Free Fatty Acid HP Column uses a phenyl-bonded packing and a simple isocratic elution method to separate free fatty acids on the basis of carbon-chain length and degree of saturation. The short column dimension (3.9 × 150 mm) significantly reduces analysis time and increases sensitivity.

Column performance is based on:

- Straight chain saturated acids, which elute in order of increasing carbon number
- Unsaturated acids which elute before the analogous saturated compound
- Carbon number and chain configuration: the greater the unsaturation, the earlier the elution

**Fatty Acid Standards**




### Ordering Information

Free Fatty Acid HP Column

| Description | Dimension | Particle Size | Qty. | P/N |
|---|---|---|---|---|
| Free Fatty Acid HP | 3.9 × 150 mm | 4 µm | 1/pk | WAT011690 |

## CARBAMATE ANALYSIS KITS

Waters Carbamate Analysis Kits for environmental and food testing include the Waters Carbamate Column, Oasis HLB Cartridges, vials, and reference standards. When used, in part, with regulated methods, these proven kits simplify your analysis while increasing your confidence in the result.

### Ordering Information

Carbamate Analysis Kits

| Description | P/N |
|---|---|
| Carbamate Analysis Kit for Environmental Testing | 176001740 |
| Carbamate Analysis Kit for Food Testing | 186004719 |

Carbamate Analysis Column for Pesticides

| Description | Dimension | Qty. | P/N |
|---|---|---|---|
| Carbamate Analysis | 3.9 × 150 mm | 1/pk | WAT035577 |