




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) or technical notebook (No.2 and 3).

Features

- SC1011, 1821, SP0810, KS-801, 802**
- Separates saccharides by combination of ligand exchange and size exclusion modes
 - Three types of counter ions are available: Ca²⁺, Pb²⁺, and Na⁺
 - Only water is required for the analysis of neutral sugars
- [KS-801, 802]**  p.80
- KS-803~807**
- Suitable for separation of polysaccharides by size exclusion mode
 - Can be used in tandem e.g., KS-802 and KS-801
 - Only water is required for the analysis of neutral sugars
- [KS-803~806]**  p.80
- DC-613, SZ5532, SC1211**
- Separates by combination of ligand exchange and HILIC modes
 - DC-613 can analyze sugars without removing sodium salts in the sample
 - SZ5532 is recommended for the separation of disaccharides or trisaccharides
 - SC1211 is suitable for separation of sugar alcohols
- [DC-613]**  p.80
- MN-431, SC1011-7F**
- MN-431 is for the analysis of mannitol in conformity with USP
 - SC1011-7F is for the analysis of sugar alcohols and saccharides in conformity with EP
 - Ca-type ligand exchange chromatography columns

Standard columns

Ligand exchange and size exclusion



AUTHORIZED DISTRIBUTOR

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Product Code	Product Name	Plate Number (TP/column)	Functional Group (Counter Ion)	Exclusion Limit (Pullulan)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6378102	SUGAR SC1011	≥ 13,000	Sulfo (Ca ²⁺)	1,000	6	8.0 x 300	H ₂ O
F6378103	SUGAR SC1821	≥ 13,000	Sulfo (Ca ²⁺)	10,000	6	8.0 x 300	H ₂ O
F6700090	SUGAR SC-LG	(guard column)	Sulfo (Ca ²⁺)	–	10	6.0 x 50	H ₂ O
F6378105	SUGAR SP0810	≥ 11,000	Sulfo (Pb ²⁺)	1,000	7	8.0 x 300	H ₂ O
F6700081	SUGAR SP-G	(guard column)	Sulfo (Pb ²⁺)	–	10	6.0 x 50	H ₂ O
F6378010	SUGAR KS-801	≥ 17,000	Sulfo (Na ⁺)	1,000	6	8.0 x 300	H ₂ O
F6378020	SUGAR KS-802	≥ 17,000	Sulfo (Na ⁺)	10,000	6	8.0 x 300	H ₂ O
F6378025	SUGAR KS-803	≥ 17,000	Sulfo (Na ⁺)	50,000	6	8.0 x 300	H ₂ O
F6378035	SUGAR KS-804	≥ 17,000	Sulfo (Na ⁺)	400,000	7	8.0 x 300	H ₂ O
F6378050	SUGAR KS-805	≥ 9,000	Sulfo (Na ⁺)	5,000,000	17	8.0 x 300	H ₂ O
F6378060	SUGAR KS-806	≥ 9,000	Sulfo (Na ⁺)	(50,000,000)*	17	8.0 x 300	H ₂ O
F6700020	SUGAR KS-G	(guard column)	Sulfo (Na ⁺)	–	10	6.0 x 50	H ₂ O
F6378070	SUGAR KS-807	≥ 4,000	Sulfo (Na ⁺)	(200,000,000)*	30	8.0 x 300	H ₂ O
F6700021	SUGAR KS-807G	(guard column)	Sulfo (Na ⁺)	–	30	8.0 x 50	H ₂ 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	RSPak DC-613	≥ 5,500	Sulfo (Na ⁺)	6	100	6.0 x 150	H ₂ O/CH ₃ CN=30/70
F6700170	RSPak DC-G	(guard column)	Sulfo (Na ⁺)	10	–	4.6 x 10	H ₂ O/CH ₃ CN=30/70
F7001300	SUGAR SZ5532	≥ 5,500	Sulfo (Zn ²⁺)	6	100	6.0 x 150	H ₂ O/CH ₃ CN=30/70
F6700110	SUGAR SZ-G	(guard column)	Sulfo (Zn ²⁺)	6	–	4.6 x 10	H ₂ O/CH ₃ CN=30/70
F7001400	SUGAR SC1211	≥ 5,500	Sulfo (Ca ²⁺)	6	50	6.0 x 250	H ₂ O/CH ₃ CN=75/25
F6700120	SUGAR SC-G	(guard column)	Sulfo (Ca ²⁺)	10	–	4.6 x 10	H ₂ O/CH ₃ CN=75/25

Base Material : Styrene divinylbenzene copolymer

For the United States Pharmacopeia (USP)

Product Code	Product Name	Functional Group (Counter Ion)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6379230	USPpak MN-431	Sulfo (Ca ²⁺)	8	4.0 x 250	H ₂ O

See p.71 for USP (Ver.35) Column List.

Base Material : Styrene divinylbenzene copolymer

For the European Pharmacopeia (EP)

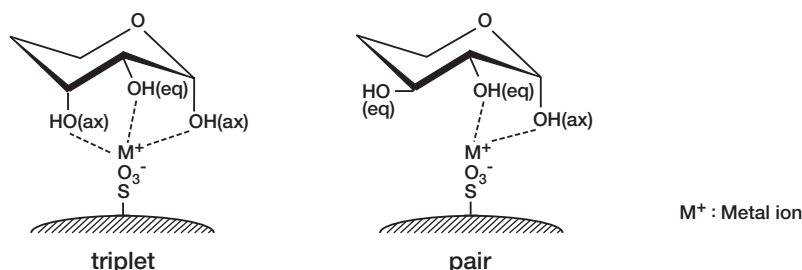
Product Code	Product Name	Functional Group (Counter Ion)	Particle Size (µm)	Column Size (mm) I.D. x Length	Shipping Solvent
F6379300	EP SC1011-7F	Sulfo (Ca ²⁺)	8	7.8 x 300	H ₂ O

Base Material : Styrene divinylbenzene copolymer

*Contact Shodex or our distributors near you for customized columns.

Mechanism of saccharide separation using the ligand exchange mode

Saccharides exhibit an energy-stable chair conformation in 5-membered ring (furanose) or 6-membered ring (pyranose) forms. Since hydroxyl groups on each carbon can take either equatorial or axial position, even two saccharides having the same molecular structures may have different three-dimensional configurations. Ligand exchange mode separates saccharides using this configuration difference of the complex formed between saccharides' hydroxyl groups and metal ions. As shown in the left figure, saccharides having a larger number of ax-eq-ax configuration (triplet) units form stronger complexes with metal ions. Meanwhile, as right figure shows, saccharides lacking such a triplet structure form complexes with ax-eq (pair) hydroxyl group. As the unit number of this pair structure increases, saccharides become more potent forming complexes with metal ions. The complex formation capacity also differs depending on modified metal ions.



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	DC-613
Arabinose	10.42	8.91	8.21	5.11	6.18	5.56	5.75
D-Arabitol	15.86	11.33	7.63	7.27	6.29	8.16	5.81
Dulcitol	20.18	12.76	7.40	9.46	7.45	11.28	7.33
meso-Erythritol	12.70	10.09	7.86	5.73	5.43	6.27	4.84
D(-)-Fructose	11.05	8.85	7.71	5.37	6.75	5.90	6.19
D(+)-Fucose	10.48	8.84	8.09	4.50	5.43	4.96	4.81
D(+)-Galactose	9.74	7.98	7.58	6.46	8.10	4.98	7.28
Gentiobiose	7.22	6.08	5.75	10.50	16.36	*	14.45
Glucose	8.63	7.30	7.17	5.87	8.61	4.76	6.83
myo-Inositol	12.77	8.86	7.99	12.63	9.96	7.87	15.80
Isomaltose	7.68	6.26	5.95	10.57	15.18	*	13.82
Isomaltotriose	7.09	5.75	5.34	21.17	27.55	*	32.02
1-Kestose	6.79	5.75	5.26	13.09	20.11	*	—
Kojibiose	7.56	6.21	5.88	9.65	14.82	*	11.47
Lactitol	13.27	8.09	6.13	16.35	11.82	6.67	14.04
Lactose	8.05	6.51	5.99	10.12	13.27	4.07	11.69
Lactulose	9.13	6.99	6.19	9.16	10.72	4.65	10.80
Maltitol	12.23	8.26	6.03	13.04	11.82	6.77	11.81
Maltose	7.85	6.34	5.94	8.67	14.24	*	10.61
Maltotriose	7.48	5.89	5.38	13.79	24.96	*	17.88
Mannitol	15.80	11.10	7.23	8.75	7.39	9.03	6.84

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

Substances	Elution Volume (mL)						
	SP0810	SC1011	KS-801	SZ5532	NH2P-50 4E	SC1211	DC-613
D-Mannose	10.72	8.17	7.64	5.83	7.84	5.01	6.72
Melibiose	8.16	6.45	5.98	11.69	14.70	4.23	14.83
Nystose	6.38	5.45	4.93	20.05	31.90	*	—
Palatinin	2peaks	2peaks	5.90	2peaks	12.73	2peaks	2peaks
Palatinose	7.84	6.45	5.89	8.08	12.12	3.99	9.81
Panose	7.14	5.78	5.32	16.87	25.60	*	23.14
D(+)-Raffinose	7.14	5.78	5.29	16.36	20.25	*	19.11
Rhamnose	9.77	8.23	7.37	3.93	5.52	4.43	4.09
D(-)-Ribose	19.35	13.66	9.04	4.82	5.45	8.64	5.30
D(-)-Sorbitol	21.61	13.31	7.42	9.79	7.09	11.88	7.27
Sorbose	9.67	8.03	7.38	5.12	7.35	4.92	5.91
Stachyose	6.82	5.57	4.97	—	36.22	*	—
Sucrose	7.54	6.29	5.87	7.91	11.87	*	8.68
α-D-Talose	21.33	12.59	8.76	5.69	6.47	8.51	6.32
Trehalose	7.62	6.27	5.78	10.85	13.25	*	11.49
Trehalulose	8.92	6.95	6.10	9.54	11.68	4.78	11.38
Xylitol	19.87	13.14	7.94	7.77	6.10	10.16	6.19
Xylobiose	8.16	6.68	6.40	5.65	9.05	*	6.71
D(+)-Xylose	9.21	7.90	7.71	4.55	6.58	4.48	5.21
D-Xylulose	10.64	9.02	8.04	4.06	5.41	5.07	4.56

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

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

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

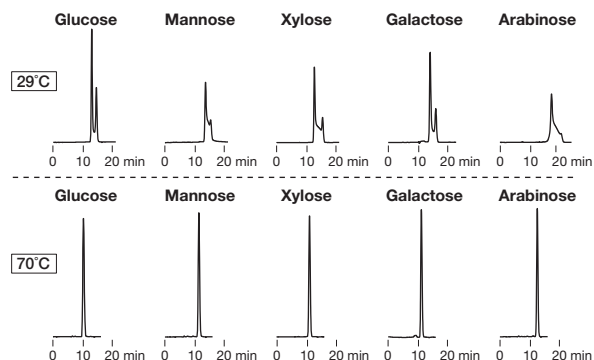
Column : SUGAR SZ5532
 Eluent : H₂O/CH₃CN=25/75
 Flow rate : 1.0mL/min
 Detector : RI
 Column temp. : 60°C

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

Column : RSpak DC-613
 Eluent : H₂O/CH₃CN=25/75
 Flow rate : 1.0mL/min
 Detector : RI
 Column temp. : 70°C

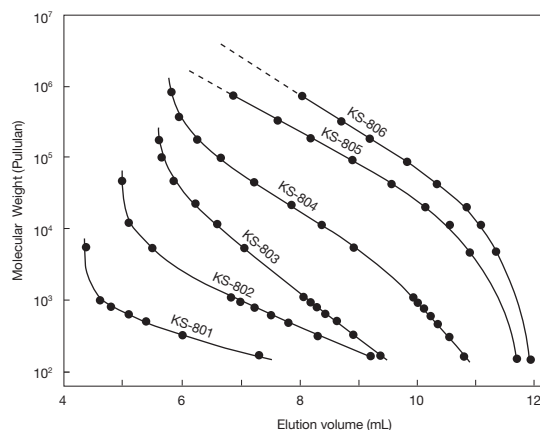
Anomer separation of saccharides

Anomer separation of saccharides affects the chromatogram. When using a SUGAR column to analyze saccharides, the analysis at high temperatures would suppress the influence of anomer separation, resulting in proper chromatograms.



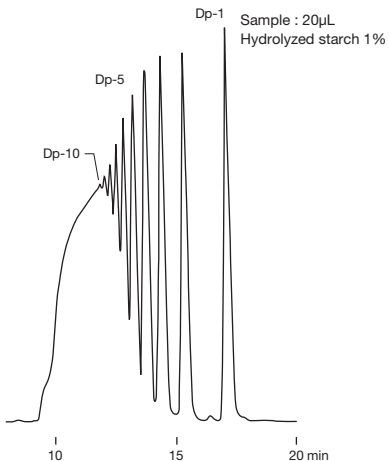
Sample : 0.5% each, 10 μ L
 Column : Shodex SUGAR SC1011
 Eluent : H₂O
 Flow rate : 0.7mL/min
 Detector : RI
 Column temp. : 29°C, 70°C

Calibration curves for KS-800 series using pullulan



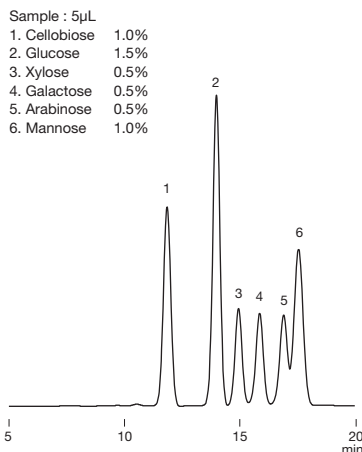
Column : Shodex SUGAR KS-800 series
 Eluent : H₂O
 Detector : RI
 Column temp. : 80°C

Hydrolyzed starch



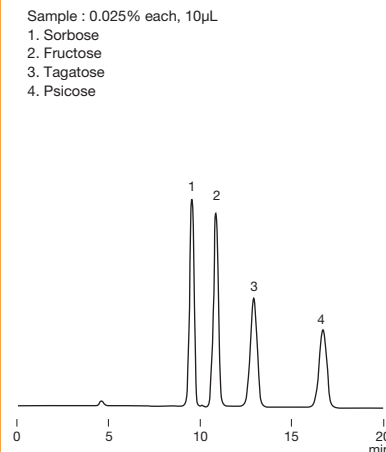
Sample : 20 μ L
 Hydrolyzed starch 1%
 Column : Shodex SUGAR KS-802 x 2
 Eluent : H₂O
 Flow rate : 1.0mL/min
 Detector : RI
 Column temp. : 80°C

Saccharides in wood (model)



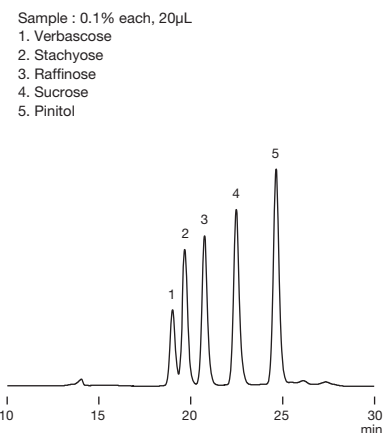
Sample : 5 μ L
 1. Cellobiose 1.0%
 2. Glucose 1.5%
 3. Xylose 0.5%
 4. Galactose 0.5%
 5. Arabinose 0.5%
 6. Mannose 1.0%
 Column : Shodex SUGAR SP0810
 Eluent : H₂O
 Flow rate : 0.6mL/min
 Detector : RI
 Column temp. : 85°C

Ketohexoses



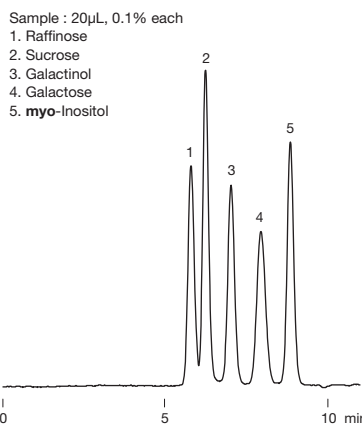
Sample : 0.025% each, 10 μ L
 1. Sorbose
 2. Fructose
 3. Tagatose
 4. Psicose
 Column : Shodex SUGAR SP0810
 Eluent : H₂O
 Flow rate : 1.0mL/min
 Detector : RI
 Column temp. : 80°C

Oligosaccharides in soybean



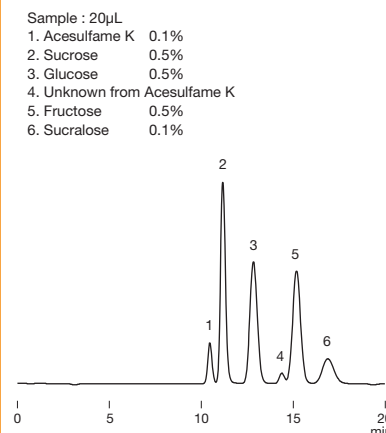
Sample : 0.1% each, 20 μ L
 1. Verbascose
 2. Stachyose
 3. Raffinose
 4. Sucrose
 5. Pinitol
 Column : Shodex SUGAR KS-802 + KS-801
 Eluent : H₂O
 Flow rate : 0.6mL/min
 Detector : RI
 Column temp. : 85°C

Saccharides related to raffinose biosynthesis



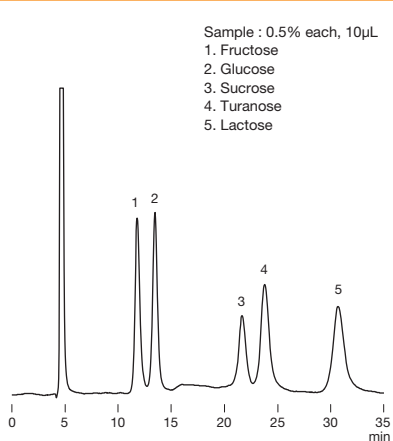
Sample : 20 μ L, 0.1% each
 1. Raffinose
 2. Sucrose
 3. Galactinol
 4. Galactose
 5. myo-Inositol
 Column : Shodex SUGAR SC1011
 Eluent : H₂O
 Flow rate : 1.0mL/min
 Detector : RI
 Column temp. : 80°C

Acesulfame K and sucralose



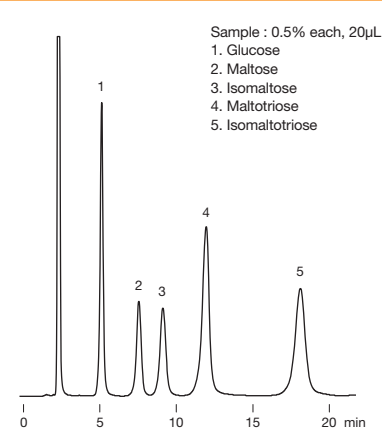
Sample : 20 μ L
 1. Acesulfame K 0.1%
 2. Sucrose 0.5%
 3. Glucose 0.5%
 4. Unknown from Acesulfame K
 5. Fructose 0.5%
 6. Sucralose 0.1%
 Column : Shodex SUGAR SC1011
 Eluent : 10mM CaSO₄ aq.
 Flow rate : 0.6mL/min
 Detector : RI
 Column temp. : 80°C

Sucrose and turanose



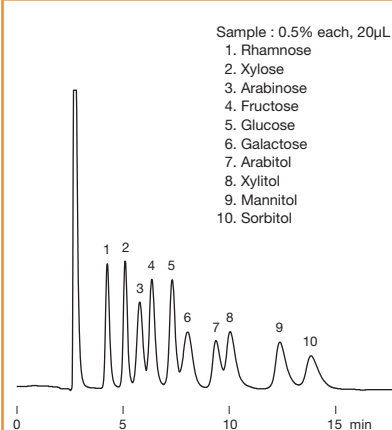
Column : Shodex SUGAR SZ5532
 Eluent : H₂O/CH₃CN=20/80
 Flow rate : 0.6mL/min
 Detector : RI
 Column temp. : 60°C

Maltose and isomaltose



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

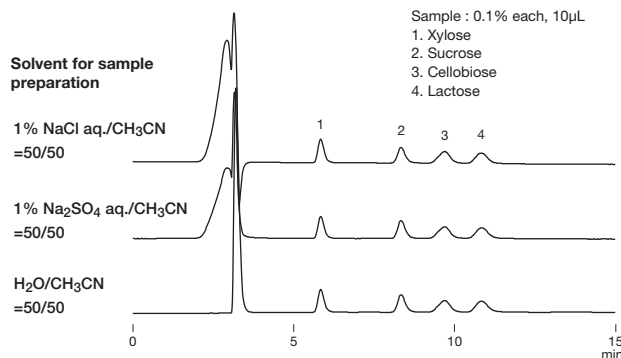
Saccharides and sugar alcohols



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

Saccharides in presence of sodium salt

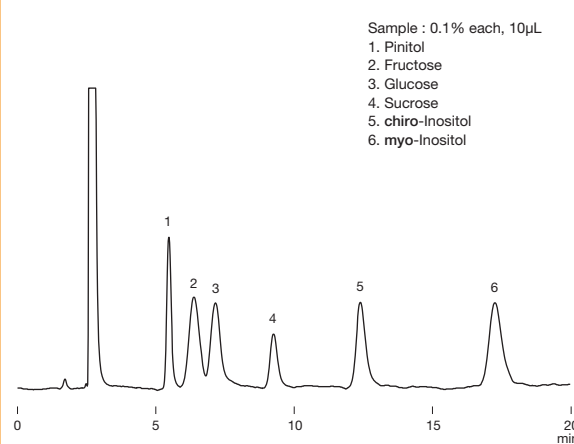
Since DC-613 uses Na⁺ as counter ion, it enables the analysis of saccharides in sodium salt containing samples without desalting. Acid hydrolyzed sample can be analyzed after neutralizing the remaining acid, such as hydrochloric or sulfuric acid, with sodium hydroxide.



Column : Shodex RSpak DC-613
 Eluent : H₂O/CH₃CN=30/70
 Flow rate : 0.8mL/min
 Detector : RI
 Column temp. : 50°C

* High concentration of acetonitrile is used for saccharide analysis by DC-613. Pay attention to possible salt deposition when analyzing with high salt concentration samples.

Pinitol

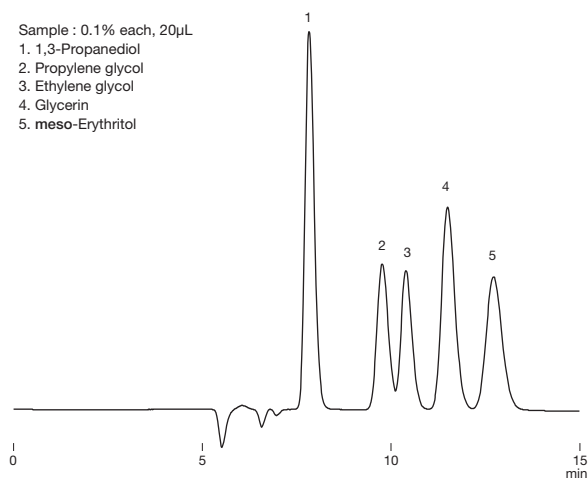


Column : Shodex RSpak DC-613
 Eluent : H₂O/CH₃CN=25/75
 Flow rate : 1.0mL/min
 Detector : RI
 Column temp. : 70°C

Moisturizing components

Sample : 0.1% each, 20 μ L

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



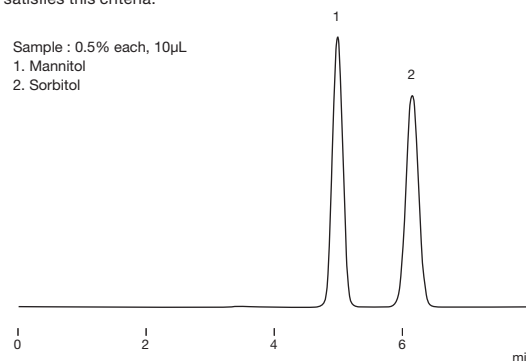
Column : Shodex SUGAR SC1211
 Eluent : H₂O/CH₃CN=60/40
 Flow rate : 0.6mL/min
 Detector : RI
 Column temp. : 40°C

Mannitol analysis with USP method

According to the USP (United States Pharmacopeia) method, mannitol should be analyzed using a column which can separate mannitol and sorbitol with a resolution equal to or greater than 2.0. MN-431 is a column specially designed for mannitol analysis, which satisfies this criteria.

Sample : 0.5% each, 10 μ L

1. Mannitol
2. Sorbitol



Column : Shodex USPpak MN-431
 Eluent : H₂O
 Flow rate : 0.5mL/min
 Detector : RI
 Column temp. : 60°C