

TSKgel Amide-80

TSKgel NH2-100



#### **HILIC Tips:**

- TSKgel HILIC columns are offered in stainless steel. Stainless steel (SS) frits are embedded in the body of the column end-fittings of the metal columns. The nominal frit size for SS columns is engraved in the end-fittings.
- Halide salts corrode stainless steel tubing, fitting, and frits. Do not store SS columns in a mobile phase containing NaCl and, where possible, use another salt in the operating buffer.
- Good laboratory procedures demand that the analytical column be protected by a guard column. Guard cartridges and packed guard columns are available for use with TSKgel HILIC columns.
- Column shipping solvents are: 85% acetonitrile 15% water for TSKgel Amide-80, 2 μm, 3 μm & HR columns and TSKgel NH<sub>2</sub>-100 columns; 75% acetonitrile - 25% water for 5 μm & 10 μm TSKgel Amide-80 columns.
- TSKgel HILIC columns are supplied with an Inspection Data Sheet, which includes a QC chromatogram and test data, and an OCS Sheet summarizing the recommended operating conditions for optimum column performance.
- A separate TSKgel Column Instruction Manual that reviews general guidelines for column installation and care, as well as troubleshooting tips for commonly encountered problems, can be downloaded from the Tosoh Bioscience LLC website (www.tosohbioscience.com).



### **About Hydrophilic Interaction Chromatography**

Normal phase and hydrophilic interaction liquid chromatography (HILIC) are primarily used to separate polar and hydrophilic compounds. In reversed phase mode very polar compounds are often not sufficiently retained in low percent organic, or even in 100% aqueous mobile phase. The order of elution in normal phase is opposite that found in reversed phase for the same mixture of compounds. Although non-polar organic mobile phases and a silica stationary phase were used traditionally in normal phase LC, today most separations are performed with aqueous-organic mobile phases and a more polar-bonded stationary phase. This mode of HPLC is now commonly referred to as HILIC, hydrophilic interaction liquid chromatography.

By using an amide or amino bonded phase column, polar compounds can be retained by a normal phase or hydrophilic interaction chromatography retention mechanism. Typical mobile phases in HILIC are aqueous buffers with organic modifiers – primarily acetonitrile. In contrast to the retention behavior in reversed phase, in HILIC, solutes will be retained longer when increasing the percent acetonitrile.

Typical applications for HILIC are:

- Analysis of polyols, carbohydrates, or vitamins
- Characterization of protein glycosylation by fluorescence or mass spectrometric detection
- Separation of polar peptides, e.g. after enzymatic digestion of proteins (peptide mapping)
- Analysis of polar drugs and separation of drug metabolites
- LC/MS analysis of polar compounds





#### **TSKgel HILIC Chromatography Columns**

The TSKgel HILIC chromatography column line consists of TSKgel Amide-80 and TSKgel NH<sub>2</sub>-100. TSKgel Amide-80 columns are covalently bonded with carbamoyl groups. Offering a different selectivity from the TSKgel Amide-80 columns, the TSKgel NH<sub>2</sub>-100 amino-bonded phase columns offer superior chemical stability. The structures of the TSKgel Amide-80 and NH<sub>2</sub>-100 resins are shown in Figure 2. See Table 1 for details on these two TSKgel HILIC columns.

Figure 2: Structures of TSKgel HILIC resins



	TSKgel Amide-80	TSKgel NH <sub>2</sub> -100	
Bonded Phase	Does not react with reducing sugars. Anomer formation can be prevented by raising mobile phase temperature up to 50 °C for 2 & 3 µm columns and up to 80 °C for 5 & 10 µm columns.	More stable than conventional amino phases due to a special endcapping prior to introduction of aminoalkyl groups. Amino-bonded phase can react with a reducing sugar to form a Schiff base	
Detectors	Can be used with evaporative light scattering (ELS) and mass spec (MS) detectors		
Mobile Phase	Stable in 100% organic eluents		
Solutes	Retains very polar drug candidates and drug metabolites		
	Saccharides		
	Polyols (po	lyalcohols)	
Applications	Drug metabolites	Methotrexate polyglutamate derivatives	
	Peptides	Pyridylaminated oligosaccharides	
	Melamine and cyanuric acid	Water-soluble vitamins	
	Oligonucleotides	Nucleic acid fragments	
	Polar compounds in fermentation broth		
	Cytosine		

#### About: TSKgel Amide-80 HILIC Chromatography Columns

TSKgel Amide-80 columns are packed with 2, 3, 5, or 10 µm spherical silica particles that are covalently bonded with carbamoyl groups. The amide stationary phase provides a unique selectivity under regular normal phase conditions or in the hydrophilic interaction mode of chromatography. TSKgel Amide-80 columns possess superior stability in aqueous/organic solvent systems, an advantage over other hydrophilic stationary phases such as traditional aminobonded phase columns. In addition, it is ideally suited for sensitive LC/MS analysis of water-soluble polar compounds because the high organic content in the mobile phase provides rapid evaporation of solvent during electrospray ionization.

The 2  $\mu$ m TSKgel Amide-80 columns offer higher resolution and faster analysis with equivalent retention and selectivity as TSKgel Amide-80, 3  $\mu$ m columns. This allows for smooth method transfer from a 3  $\mu$ m to a 2  $\mu$ m column. In addition, TSKgel Amide-80, 2  $\mu$ m columns more highly retain hydrophilic compounds than competitive amide columns on the market.

Also available within this line is a TSKgel Amide-80 HR column in 5  $\mu$ m, 4.6 mm ID × 25 cm size. These columns are prepared from the same 5  $\mu$ m packing material and thus offer the same selectivity as existing 5  $\mu$ m TSKgel Amide-80 columns. In contrast to traditional 4.6 mm ID × 25 cm TSKgel Amide-80 columns, the new TSKgel Amide-80 HR columns offer higher specifications for plate count (N = >18,000 vs. 8,000). Because HR columns are prepared from the same bonded phase lots as standard 5  $\mu$ m TSKgel Amide-80 columns, the only change you will notice is more efficient chromatography!

#### **Attributes and Applications**

Table 2 lists the attributes of TSKgel Amide-80 columns. Target applications for the TSKgel Amide-80 columns include the analysis of saccharides, glycans, oligosaccharides, peptides, and polar compounds from natural products. Unique advantages of the TSKgel Amide-80 phase for saccharide analysis include a novel hydrogen bonding retention mechanism between hydroxyl groups of the sample and the carbamoyl group in the stationary phase. The stationary phase does not react with reducing sugars and can be used at elevated temperatures (4 to 80 °C) to prevent peak splitting of carbohydrates that can occur at lower temperatures.

#### Table 2: Product attributes

Attribute	Value
Pore size (silica)*	8 nm
Particle size	2 μm, 3 μm, 5 μm, or 10 μm
pH stability	2.0-7.5
Functional group	carbamoyl
Max. temperature	50 °C (2 & 3 μm), 80 °C (5 & 10 μm)
Surface area (m²/g)	450

\*The pore size of the bonded phase is indicated by the number in the product description, in this case TSKgel Amide-80 has 8 nm nominal pore size. The nominal pore size of the starting base silica is 10 nm.

#### Glycans

Pyridylamination is a fluorescence-tagging method for oligosaccharides that enables measurement and structural analyses of glycans. Glycans do not contain fluorophores and thus must be labeled with fluorescent tags prior to analysis. 2-aminobenzamide (2-AB) is one of the most common labels used.

Several peaks of glycans were separated from both mouse IgG and human IgG (Figure 3). These peaks were similar in elution time to 6-8 mer glucose. When comparing chromatograms A and B, different ratios of glycan attached to each mAb is implied.

Figure 3: Comparison of Glycan Peak Profile of Monoclonal Antibodies





#### **Hydrophilic Molecules**

A set of hydrophilic molecules, such as nucleosides, sugars, hydrotropes etc., were analyzed using TSKgel Amide-80, 3.0 mm ID  $\times$  15 cm columns of 2 and 3 µm particle size. As seen in Figure 4, similar chromatographic profiles were obtained with similar selectivity. The smaller particle size of the TSKgel Amide-80, 2 µm column yielded a 1.6-fold increase in theoretical plates and a 1.3-fold higher resolution.

A TSKgel Amide-80, 2  $\mu$ m column showed impressive results for an ultra-high speed analysis of these same samples (Figure 5). A less than one minute separation was obtained using a TSKgel Amide-80, 2  $\mu$ m column at a flow rate of 1.29 mL/min. In addition, the 2  $\mu$ m column showed a lower pressure drop than the maximum pressure of a conventional HPLC system. Therefore, it is not necessary to use a UHPLC system for this type of ultra-high fast separation.

Figure 4: Higher Resolution with TSKgel Amide-80, 2 µm Column







#### Melamine and Cyanuric Acid in Milk

To aid chemists charged with the determination of melamine and related products in milk, Tosoh scientists developed a method for the simultaneous determination of melamine and cyanuric acid by HILIC/MS/MS using a 3  $\mu$ m TSKgel Amide-80 column. Milk was spiked with melamine and cyanuric acid standards to serve as a model sample. High recovery and excellent resolution was obtained for both compounds, as shown in Figure 6.



1 8×10 1.6×104 1.4×104 1.2×104 Intensity (cps) 1.0×10 8.0×10<sup>3</sup> 6.0×10 4.0×10 2.0×10<sup>3</sup> 0 0 3 4 5 6 9 Rete ne (minutes) Column: TSKgel Amide-80, 3  $\mu$ m, 2.0 mm ID  $\times$  15 cm Mobile phase: A: 0.05% formic acid in H<sub>2</sub>0 B: 0.05% formic acid in ACN A/B = 25/75Flow rate: 0.2 mL/min Temperature: 40°C Injection vol.: 5μL Q TRAP® (AB Sciex) Instrument: lon source: ESI 127/85+ (melamine) 128/42- (cyanuric acid)

Multiple Reaction Monitoring is a mode of MS/MS that yields maximum sensitivity and selectivity for known target analytes. Figure 7 shows the results of this type of mass analysis on unspiked and spiked milk samples. The figure demonstrates that the original milk sample did not contain any amount of either melamine or cyanuric acid. After adding the compounds to the milk sample, melamine and cyanuric acid were independently detected, with more than sufficient resolution between the compounds.







### **Tryptic Digest**

Scientists have begun to employ the hydrophilic stationary phase in separations of natural product extracts, peptide digests, and other polar compound mixtures. Often, these complex mixtures are analyzed using the power of mass spectrometry in conjunction with liquid chromatography. TSKgel Amide-80 columns are advantageous for these applications because unwanted secondary ionic interactions from residual silanols can be eliminated by adding trifluoroacetic acid (TFA) to the mobile phase. The use of "mass-spec friendly" TFA eliminates extra steps involved with removing salts or non-volatile acids required by aminobonded columns to eliminate ionic interactions.

Figure 8 details the use of a 5  $\mu$ m TSKgel Amide-80 column for the separation of a  $\beta$ -lactoglobulin tryptic digest, with separation achieved within 12 minutes.

Figure 8: Separation of  $\beta$ -lactoglobulin tryptic digest



#### **Sugar Alcohols**

Figure 9 shows comparative chromatograms of the separation of sugar alcohols using a TSKgel Amide-80 column and competitive HILIC columns. The TSKgel Amide-80, 3 µm column showed high column efficiency for mannitol, while the selectivity for saccharides was as good or better for the TSKgel Amide-80 column compared to the competitive HILIC columns.





# Carbohydrates

Column:

Detection:

Sample:

A TSKgel Amide-80 column can separate oligosaccharides very rapidly and efficiently. Figure 10 shows a separation of a  $\beta$ -cyclodextrin hydrolysate in less than 10 minutes. The peak numbers indicate the degree of polymerization of the repeating base sugar in the oligosaccharide with 1 representing a single glucose unit, 2 a dimer, etc.





Carbohydrates

TSKgel Amide-80 chemistry is ideally suited for the separation of carbohydrate structures. Figure 11 shows the high resolution separation of a 2-aminobenzamide (2AB) labeled dextran ladder within 30 minutes on a TSKgel Amide-80, 3 µm column. This ladder can be used as a calibration standard for HPLC and MS analysis of glycans. The ladder contains glucose homopolymer species from degree of polymerization (dp) 1 to dp 22 (i.e. the glucose monomer GU1-2AB to GU22-2AB).







#### **Polar Drugs**

TSKgel Amide-80 columns are also a valuable tool for the analysis of small molar mass polar drugs that are not sufficiently retained on reversed phase columns. Figure 12 shows the separation of polar drug standards in HILIC mode using a 3  $\mu$ m TSKgel Amide-80 column coupled with electrospray ionization mass spectroscopy (ESI/MS). Due to the high organic content of the eluent, HILIC analysis provides increased detection sensitivity.

#### Figure 12: Separation of polar drug standards



Ion Source: ESI+

#### Polyalcohols

Polyalcohols are typically separated using a TSKgel Amide-80 column with a mobile phase of organic solvent and water as shown in Figure 13.

Figure 13: Separation of polyalcohols



#### About: TSKgel NH2-100 HILIC Chromatography Columns

TSKgel NH<sub>2</sub>-100 amino columns expand the range of TSKgel columns for hydrophilic interaction chromatography (HILIC). Offering a different selectivity from the well known TSKgel Amide-80 columns, these novel amino-bonded phase columns stand out by providing much improved chemical stability, a prerequisite for achieving reproducible and reliable results.

TSKgel NH<sub>2</sub>-100 columns are packed with 3  $\mu$ m silica particles containing 10 nm pores. A novel bonding strategy was adopted to improve chemical stability of the bonded phase. First, the silica is reacted with a trimethylsilane endcapping reagent at a low stoichiometric ratio before reacting residual and accessible silanol groups with trifunctional alkylaminosilane reagent. The resulting bonded phase provides a better safeguard against hydrolysis of the underlying silica.

TSKgel NH<sub>2</sub>-100 columns are unique in that the bonded phase ligand not only has a terminal primary amino group as expected, but that the spacer also incorporates secondary as well as tertiary amino groups. Anionic compounds are retained on the column by ionic interaction. This allows for the use of gradients in salt concentration in addition to gradient elutions with acetonitrile. Since the TSKgel NH<sub>2</sub>-100 columns have cationic sites, the columns can be used as mixed mode columns under some conditions.

Also available within this line is a TSKgel NH<sub>2</sub>-100 DC column that connects directly to TSKgel reversed phase columns. The DC in TSKgel NH<sub>2</sub>-100 DC emphasizes this Direct Connect aspect. This column has the same packing material as the TSKgel NH<sub>2</sub>-100 columns, so therefore shows high retention for hydrophilic compounds/ions. A male-type outlet end-fitting enables the direct connection to the screw-type end-fitting of a TSKgel reversed phase column. This allows for the simultaneous separation using a linear gradient of an active pharmaceutical ingredient (API) and its counterion without the loss of column efficiency normally experienced when connecting two columns with capillary tubing.

#### **Attributes and Applications**

Product attributes of the TSKgel NH<sub>2</sub>-100 columns are listed in Table 3. TSKgel NH<sub>2</sub>-100 columns are well suited for the analysis of all types of hydrophilic compounds, including carbohydrates and peptides. Due to a high ligand density and large surface area, these columns show stronger retention of polar compounds than TSKgel Amide-80 columns.

Table 3: TSKgel NH2	100 product attributes
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Attribute	Value
Pore size (silica)	10 nm
Particle size (mean)	3 µm
pH stability	2.0-7.5
Functional group	alkylamine
Temperature range (°C)	10-50
Surface area (m²/g)	450

#### **Performance Data**

Figure 14 shows the result of a long term chemical stability comparison between the more recently developed TSKgel NH<sub>2</sub>-100 column and the older TSKgel NH<sub>2</sub>-60 column. Both columns were purged for 300 hours in 25%  $H_2O/75\%$  ACN and you can see that the retention time of inositol on the TSKgel NH<sub>2</sub>-60 column decreased more than 60% from its initial retention time. In the case of the endcapped TSKgel NH<sub>2</sub>-100 HILIC column, the retention time of inositol decreased less than 20%.

Figure 14: Chemical stability study





#### Sugars

A TSKgel NH<sub>2</sub>-100 column was used to analyze sugars - a typical analysis done in the food industry. Two different eluents were used to compare retention times and peak shapes. As shown in Figure 15, a mixture of water and acetone provided superior resolution within 6 minutes; whereas an eluent mixture of triethylaluminium-hydroxymethylfuranal and acetone did not produce as sharp of peaks and the retention time was over 4 minutes longer.





#### **Methotrexate and Derivatives**

Figure 16 shows the results of methotrexate and its derivatives ( $MTXPG_{2-7}$ ) analyzed on TSKgel NH<sub>2</sub>-100, 3 µm HILIC and TSKgel ODS-100V, 3 µm reversed phase narrow bore columns. The MTX and polyglutamate derivatives were eluted in the order of the number of glutamate groups in their molecules on the TSKgel NH<sub>2</sub>-100 HILIC column, but eluted in reverse order on the TSKgel ODS-100V column. Despite the early elution of MTX and MTXPG<sub>2</sub> on the TSKgel NH<sub>2</sub>-100 HILIC column, the overall separation is better than what can be accomplished on the C18 column.





# Ginomato

## Drug and Counter lons at pH 7.0

Maleic acid and p-toluene sulfonic acid are commonly used as counter ions in pharmaceutical preparations. Both of these organic acids are hydrophilic and are not retained on a TSKgel ODS-100V reversed phase column at pH 7.0 in 70% methanol eluent (Figure 17). With the connection of a TSKgel NH<sub>2</sub>-100 DC column prior to the TSKgel ODS-100V column, the simultaneous determination of maleic acid and the API desipramine becomes possible. Maleic acid is slightly retained on the TSKgel NH<sub>2</sub>-100 DC column by an anion exchange interaction. Desipramine, on the other hand, does not interact with the protonated amino groups as it is positively charged.

Figure 17: Simultaneous determination of maleic acid and the API desipramine at pH 7.0



#### **Cold Medicine Ingredients**

Guaiacol sulfonic acid, a hydrophilic counter ion, is an expectorant used in pharmaceutical cold preparations that are sold over the counter (OTC) in many countries, but not in the US. Guaiacol sulfonic acid elutes in the solvent front on a C18 column, but is retained on a TSKgel NH<sub>2</sub>-100 DC, 3  $\mu$ m column. Direct Connection (DC) of the TSKgel NH<sub>2</sub>-100 DC, 3  $\mu$ m column to a TSKgel ODS-100V, 3  $\mu$ m column allows for the simultaneous determination of APIs and guaiacol sulfonic acid in a single run as shown in Figure 18.

Figure 18: Separation of cold medicine ingredients





#### **Therapeutic Drug Monitoring**

Therapeutic drug monitoring (TDM) by HPLC is required for several drug classes, as the effective dosage range, varying between insufficient activity and toxic levels, is patient dependent. Although a reversed phase column is typically adopted for separating drugs in blood samples, hydrophilic compounds show poor retention times on an ODS column. A TSKgel NH<sub>2</sub>-100, 3  $\mu$ m HILIC column was investigated for the separation of hydrophilic drugs and its metabolites in blood.

Theophylline is a medication that is used for treating airway spasms in people with asthma or chronic obstructive pulmonary disease (COPD). Serum levels of this drug correlate well with both therapeutic and toxic effects. As demonstrated in Figure 19, spiked samples of theophylline and its metabolites could be separated successfully with a TSKgel NH<sub>2</sub>-100 column using an off-line deproteinization procedure.

Figure 19: Separation of theophylline and metabolites



# 2D-LC Separation of Cationic, Anionic, and Hydrotropic Surfactants

Surfactants are frequently found in pharmaceutical and biopharmaceutical drug applications as well as in common household products. Because they can be polar, non-polar, or amphoteric, the structural diversity of the surfactants and complexity of the sample matrix can make their separation and identification by HPLC challenging.

Figure 20 illustrates the characterization of the surfactant profile of Armor All<sup>TM</sup> Wash and Wax using a TSKgel ODS-140HTP and TSKgel NH<sub>2</sub>-100 columns in series. As shown, the use of these columns yielded excellent separation and retention of the anionic surfactant sodium dodecylbenzene sulfonate and the hydrotropic surfactant sodium xylene sulfonate present in the Armor All formulation. Additionally, the use of fluorescence detection ( $\lambda$ ex: 225 nm,  $\lambda$ em: 300-400 nm) allowed for increased sensitivity of the low level surfactants found in the product.



Figure 20: Characterization of surfactant profile in Armor All Wash and Wax using 2D-LC with the TSKgel ODS-140HTP and TSKgel NH2-100 columns

## **Ordering Information**

Part #	Description	Matrix	Housing	ID (mm)	Length (cm)
21999	TSKgel NH2-100 DC, 3 μm, 10 nm	silica	Stainless Steel	4.6	5
21967	TSKgel NH2-100, 3 μm, 10 nm	silica	Stainless Steel	2	5
21968	TSKgel NH2-100, 3 µm, 10 nm	silica	Stainless Steel	2	15
21969	TSKgel NH2-100, 3 µm, 10 nm	silica	Stainless Steel	4.6	5
21970	TSKgel NH2-100, 3 µm, 10 nm	silica	Stainless Steel	4.6	15
21971	TSKgel Guard Cartridge for 2 mm ID TSKgel NH2-100 columns, 3 pk, 3 μm	silica	Stainless Steel	2	1
19308	TSKgel Guard Cartridge Holder for 2 mm ID cartridges		Stainless Steel	2	1
21972	TSKgel Guard Cartridge for 4.6 mm ID TSKgel NH2-100 columns, 3 pk, 3 μm	silica	Stainless Steel	3.2	1.5
19018	TSKgel Guard Cartridge Holder for 3.2 mm ID cartridges		Stainless Steel	3.2	1.5
00454					
23454	TSKgel Amide-80, 2 µm, 10 nm	silica	Stainless Steel	2	5
23455	TSKgel Amide-80, 2 µm, 10 nm	silica	Stainless Steel	2	10
23456	TSKgel Amide-80, 2 µm, 10 nm	silica	Stainless Steel	2	15
23457	TSKgel Amide-80, 2 μm, 10 nm	silica	Stainless Steel	3	5
23458	TSKgel Amide-80, 2 μm, 10 nm	silica	Stainless Steel	3	10
23459	TSKgel Amide-80, 2 μm, 10 nm	silica	Stainless Steel	3	15
23460	TSKgel Guard Column for 10 um TSKgel Amide-80 columns	silica	Stainless Steel	2	1
20100		oniou		-	
21864	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	2	5
21865	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	2	15
22850	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	3	5
22851	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	3	10
22852	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	3	15
21866	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	4.6	5
22849	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	4.6	10
21867	TSKgel Amide-80, 3 μm, 10 nm	silica	Stainless Steel	4.6	15
21982	TSKgel Amide-80 HR, 5 µm, 10 nm	silica	Stainless Steel	4.6	25
20009	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	1	5
20010	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	1	10
21486	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	1	15
21487	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	1	25
19694	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	2	5
19695	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	2	10
19696	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	2	15
19697	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	2	25
19532	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	4.6	5
19533	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	4.6	10
13071	TSKgel Amide-80, 5 μm, 10 nm	silica	Stainless Steel	4.6	25
14459	TSKgel Amide-80, 10 µm, 10 nm	silica	Stainless Steel	7.8	30
14460	TSKgel Amide-80, 10 μm, 10 nm	silica	Stainless Steel	21.5	30



Part #	Description	Matrix	Housing	ID (mm)	Length (cm)
21862	TSKgel Guard Cartridge for 2 mm ID TSKgel Amide-80 columns, 3 pk, 3 μm	silica	Stainless Steel	2	1
19308	TSKgel Guard Cartridge Holder for 2 mm ID cartridges		Stainless Steel	2	1
21863	TSKgel Guard Cartridge for 4.6 mm ID TSKgel Amide-80 columns, 3 pk, 3 μm	silica	Stainless Steel	3.2	1.5
19018	TSKgel Guard Cartridge Holder for 3.2 mm ID cartridges		Stainless Steel	3.2	1.5
21941	TSKgel Guard Cartridge for 2 mm ID TSKgel Amide-80 columns, 3 pk, 5 μm	silica	Stainless Steel	2	1
19308	TSKgel Guard Cartridge Holder for 2 mm ID cartridges		Stainless Steel	2	1
19021	TSKgel Guard Column for 4.6 mm ID TSKgel Amide-80 columns, 5 µm	silica	Stainless Steel	4.6	1
19010	TSKgel Guard Cartridge for 4.6 mm ID TSKgel Amide-80 columns, 3 pk, 5 μm	silica	Stainless Steel	3.2	1.5
19018	TSKgel Guard Cartridge Holder for 3.2 mm ID cartridges		Stainless Steel	3.2	1.5
14461	TSKgel Guard Column for 21.5 mm ID TSKgel Amide-80 column, 10 µm	silica	Stainless Steel	21.5	7.5

