TSK-GEL® Nonporous Resin Columns for Rapid Analysis of Proteins, Peptides, and Nucleic Acids

TSK-GEL nonporous resin columns are especially suited for microscale analysis of high molecular weight proteins, polypeptides, and nucleic acids. TSK-GEL columns are available for gel filtration, ion exchange, reversed phase, hydrophobic interaction, and affinity chromatography.

Key Words

● nonporous resin ● proteins ● peptides ● nucleic acids

Proteins, peptides, and nucleic acids are successfully analyzed by HPLC with the use of microparticulate, nonporous resin (NPR) packings. These chemically and mechanically stable nonporous resins enable large, high molecular weight proteins and polypeptides to be analyzed rapidly, with high resolution and excellent recovery.

Porous resin HPLC columns have limited capability for protein and peptide analyses. Large molecules, such as proteins, diffuse slowly through the porous matrix, slowing the separation process. If proteins are trapped in the pores, diffusion basically stops and the molecule is essentially lost — making sample recovery impossible. Protein diffusion slows the kinetics of separation and can cause peak broadening, loss in resolution, and poor sample recovery.

High resolution is attained with TSK-GEL NPR columns because their phases are covalently bonded to spherical, nonporous beads of a very small diameter — 2.5µm. Since there are no pores to trap molecules or slow the separation process, resolution and recovery are maximized.

Interaction between sample and phase is limited to the surface of these resin beads, making interaction kinetics extremely fast. Fast kinetics, combined with excellent resolution and recovery, make TSK-GEL NPR columns particularly useful for both quantitative recovery of submicrogram levels of protein and microscale purification.

Applications

Especially suited for microscale analysis — generally less than 100µg of sample — TSK-GEL NPR columns are available for ion exchange, reversed phase, and hydrophobic interaction chromatography.

DEAE-NPR and SP-NPR columns are packed with anion and cation exchangers prepared by introducing diethylaminoethyl and sulfopropyl groups into the 2.5µm diameter spherical nonporous hydrophilic polymer. Both DEAE-NPR and SP-NPR columns are well suited for protein ion exchange analyses. Oligonucleotides, RNA, and DNA fragments are best separated on DEAE-NPR.

Exposed silanols of silica-based columns can exhibit secondary binding with your sample. On the reversed phase Octadecyl-NPR column, octadecyl (C18) groups are covalently bonded to a hydrophilic polymeric backbone that eliminates this secondary binding. Reversed phase analyses of high molecular weight peptides, oligonucleotides, and proteins can be performed on this column.

Butyl groups bonded to nonporous resin beads form the packing of the TSKgel Butyl-NPR column. Proteins are separated by hydrophobic interaction chromatography, using small sample loads, with high resolution and excellent recovery of enzymatic activity.

Compared to porous columns, TSK-GEL NPR columns separate proteins and peptides more rapidly — without sacrificing resolution. A mixture of five proteins is separated at least 35 minutes faster on a Butyl-NPR column than on conventional porous hydrophobic interaction columns (Figure A). A mixture of ovalbumin and trypsin inhibitor is separated five times faster on a nonporous anion exchange column than on a conventional porous anion exchange column (Figure B). By cation exchange analysis, another protein mixture is separated in less than 1/6 the time required by a porous column (Figure C). In all cases, not only is the analysis more rapid, but excellent resolution is obtained.

TSK-GEL columns also separate large DNA restriction fragments that were traditionally performed by agarose or polyacrylamide gel electrophoresis. A plasmid DNA, pBR322, is digested into fragments with the restriction enzyme BstNI. TSKgel DEAE-NPR columns separate these DNA fragments without shearing (Figure D). DNA fragments of up to 50,000 base pairs can be separated — in 30 minutes or less — in predictable elution orders with high recovery. Separation is obtained without the frequent band broadening caused by sample diffusion through porous packing. Nonporous, hydrophilic, weak anion-exchange resins also eliminate size range limitations characteristic of most porous resin ion exchange gels.

A fast, precise, quantitative assay for PCR product, which separates specific and non-specific products, is required for optimization of PCR yield. PCR analysis traditionally utilizes gel electrophoresis, fluorescence assay, and liquid- or solid-phase hybridization to a labeled probe (1). None of these techniques provides a fast, simple, specific quantitation procedure. Figure E shows efficient separation of a *Hae III* digest of pBR322 DNA obtained on a TSKgel DEAE-NPR column with a 5mm guard column.

TSK-GEL NPR columns are especially effective for micropreparative separations, accurate analyses of rare proteins, or instances where samples are very small (low nanogram levels). In these cases, optimum recovery is important. TSK-GEL NPR columns provide excellent recovery of a wide range of proteins, even though their loading capacity is very low (Table 1).

Figure A. TSK-GEL Nonporous Resin Columns Offer Higher Resolution and More Rapid Analyses than Porous Resin Columns

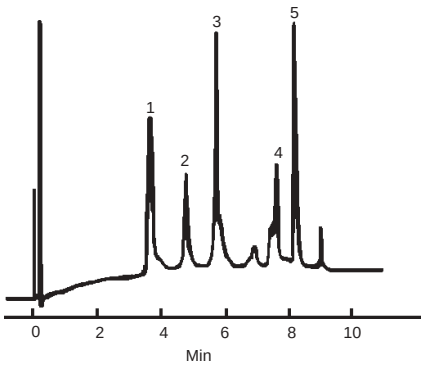
Mobile Phase: **A-1** $(NH_4)_2SO_4$, 12 min linear gradient elution, 2.3M-0 in 0.1M phosphate buffer (pH 7.0)
A-2, A-3 $(NH_4)_2SO_4$, 60 min linear gradient elution, 1.8M-0 in 0.1M phosphate buffer (pH 7)
Flow Rate: 1.0mL/min
Det.: 280nm UV
Temp.: 25°C

Mixture
1. Myoglobin
2. Ribonuclease
3. Lysozyme
4. α-Chymotrypsin
5. α-Chymotrypsinogen

Hydrophobic Interaction Separation

A-1 — Butyl-NPR

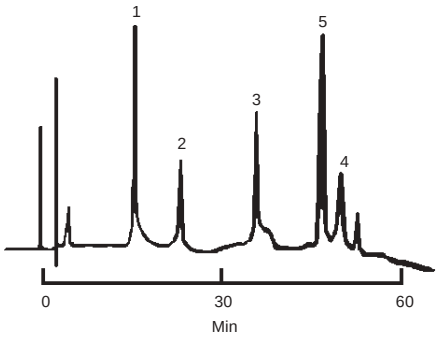
Column: **TSKgel Butyl-NPR, 3.5cm x 4.6mm ID, 2.5µm particles**
Cat. No.: **8-14947**



794-0014

A-2 — Phenyl-5PW

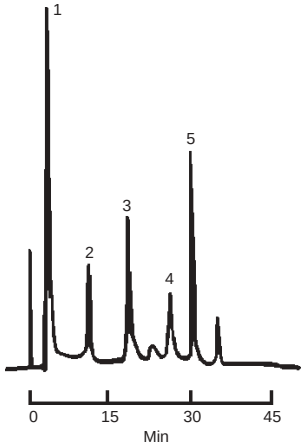
Column: **TSKgel Phenyl-5PW, 7.5cm x 7.5mm ID, 10µm particles**
Cat. No.: **8-07573**



794-0015

A-3 — Ether-5PW

Column: **TSKgel Ether-5PW, 7.5cm x 7.5mm ID, 10µm particles**
Cat. No.: **808641**



794-0016

Figure B. Higher Resolution by Anion Exchange

B-1

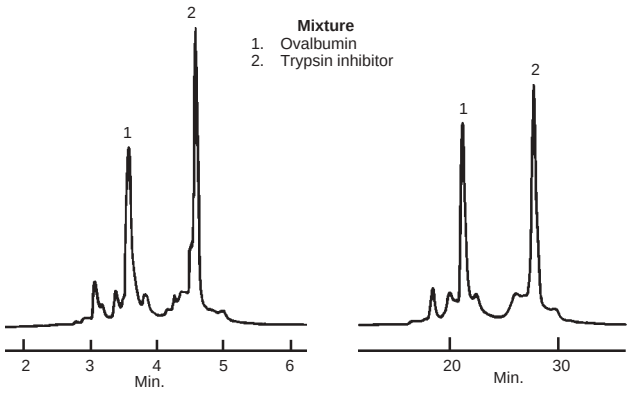
Column: **TSKgel DEAE-NPR, 3.5cm x 4.6mm ID, 2.5µm particles**
Cat. No.: **813075**

B-2

Column: **TSKgel DEAE-5PW, 7.5cm x 7.5mm ID, 10µm particles**
Cat. No.: **807164**
Mobile Phase: NaCl linear gradient 0-0.5M in 20mM Tris-HCl buffer (pH 8.0), **B-1** 10 min; **B-2** 60 min
Flow Rate: **B-1** 1.5mL/min, **B-2** 1.0mL/min
Det.: 280nm UV
Temp.: 25°C

B-1 — DEAE-NPR **B-2 — DEAE-5PW**

Mixture
1. Ovalbumin
2. Trypsin inhibitor



794-0017,0018

Figure C. Cation Exchange Analysis on Nonporous Resin Saves Time

C-1

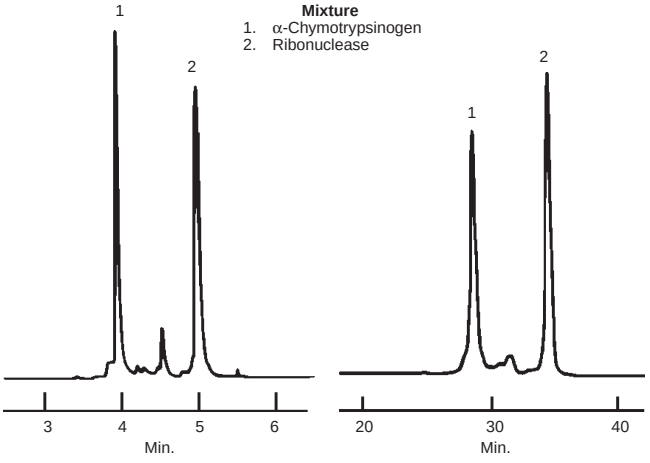
Column: **TSKgel SP-NPR, 3.5cm x 4.6mm ID, 2.5µm particles**
Cat. No.: **813076**

C-2

Column: **TSKgel SP-5PW, 7.5cm x 7.5mm ID, 10µm particles**
Cat. No.: **807161**
Mobile Phase: NaCl linear gradient 0-0.5M in 20mM MES buffer (pH 6.0) (z[N-morpholine]ethanesulfonic acid-NaOH), **C-1** 10 min, **C-2** 60 min
Flow Rate: **C-1** 1.5mL/min, **C-2** 1.0mL/min
Det.: 280nm UV

C-1 — SP-NPR **C-2 — SP-5PW**

Mixture
1. α-Chymotrypsinogen
2. Ribonuclease

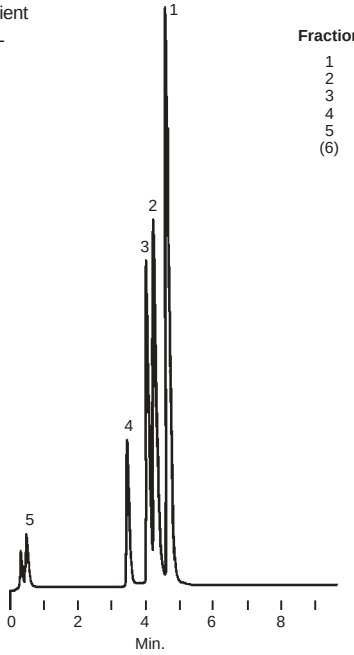


794-0019, 0020

Figure D. Effective Separation of pBR 322 DNA, Digested with BstNI

Column: **TSKgel DEAE-NPR, 3.5cm x 4.6mm ID, 2.5µm particles**
Cat. No.: **813075**
Mobile Phase: A = 25mM Tris, pH 9.0
B = A + 1M NaCl
Linear gradient, 50% B to 70% B in 10 min
Flow Rate: 0.8mL/min
Det.: 254nm UV, 0.04 AUFS, 110psi
Temp.: ambient
Inj.: 10µL

Fraction	Base pairs
1	1857
2	1060
3	929
4	383
5	121
(6)	(13)

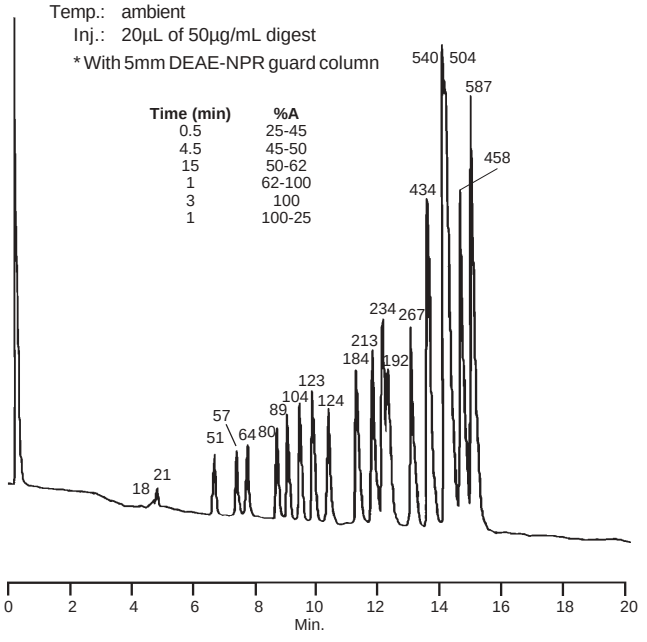


794-0021

Figure E. pBR322 DNA-HAE III Digest Using DEAE-NPR Column

Column: **TSKgel DEAE-NPR, 3.5cm x 4.6mm ID, 2.5µm particles***
Cat. No.: **813075**
Mobile Phase: A = 1M NaCl/25mm Tris-HCl, pH 9.0
B = 25mM Tris-HCl, pH 9.0
Flow Rate: 1mL/min
Det.: 260nm
Temp.: ambient
Inj.: 20µL of 50µg/mL digest
* With 5mm DEAE-NPR guard column

Time (min)	%A
0.5	25-45
4.5	45-50
15	50-62
1	62-100
3	100
1	100-25



794-0036

Table 1. Protein Recovery from TSK-GEL NPR Columns

Protein	Recovery (%) DEAE-NPR■	SP-NPR▲	Octadecyl-NPR▼	Butyl-NPR◆
α-Chymotrypsin	——	100	——	91
α-Chymotrypsinogen	——	——	——	93
α-Chymotrypsinogen A	——	95	——	——
β-Lactoglobulin	101	——	——	——
Bovine serum albumin	102	——	96	——
Cytochrome C	——	93	95	——
Ferritin	99	——	——	——
δ-Globulin	104	——	——	——
Hemoglobin	91	88	——	——
Insulin	——	——	102	——
Lysozyme	——	96	104	101
Myoglobin	——	——	97	95
Ovalbumin	103	——	74	90
Ribonuclease	——	95	94	89
Thyroglobulin	100	——	——	——
Transferrin	——	——	101	——
Trypsin inhibitor	98	——	——	84
Trypsinogen	——	87	——	——

All Columns: 3.5cm x 4.6mm ID.
■ DEAE-NPR: 5µg protein, 10 min., linear gradient NaCl 0-0.5M in 20mM Tris-HCl buffer (pH 8.0), Flow Rate: 1.5mL/min., Det.: 280nm.
▲ SP-NPR: 5µg protein, 10 min., linear gradient NaCl 0-0.5M in 20mM phosphate buffer (pH 7.0), Flow Rate: 1.5mL/min., Det.: 280nm.
▼ Octadecyl-NPR: 0.5µg protein, 8 min., linear gradient acetonitrile 20-80% in 0.05% TFA, Flow Rate: 1.5mL/min., Det.: 220nm.
◆ Butyl-NPR: 2µg protein, 12 min., linear gradient $(NH_4)_2SO_4$ from 2.3M-0 in 0.1M phosphate buffer (pH 7.0), Flow Rate: 1.0mL/min., Det.: 280nm.

Using TSK-GEL NPR Columns

Preparing Your HPLC System for Column Installation

TSK-GEL NPR columns are provided with zero dead volume compression fittings and include nuts and ferrules. A TSK-GEL NPR column requires 1/16" fittings for connection to your HPLC system. If your system has other fittings, adapters are available from our current Supelco Chromatography Supplies Catalog.

Since most HPLC column end fittings differ from one another, we recommend you make up two short pieces of 1/16" OD x 0.010" (0.25mm) ID capillary tubing to connect the column to the injector (or better, in-line frit filter) and the detector. Use enclosed 1/16" nuts and ferrules, plus the appropriate fittings for connecting the injector and detector, to prepare these connectors. Or you can use our 1/16" handtight fittings, Cat. No. 58478 or 58462.

In either case, make sure you insert the capillary tubing fully into the column end fitting before setting the ferrule. Once the tubing is fully inserted, set the ferrule by tightening the nut. In the same manner, make connections at the other end of the 1/16" capillary tubing.

Before installing your new TSK-GEL NPR column, flush all nonwater-miscible solvents from the system. Be sure to flush injector loops, valves, and other portions of the system that could trap previously used mobile phases. Flush the entire system with at least 100mL of distilled water to remove the last traces of organic solvents, then flush with 50mL of each of the concentrated salt buffers you intend to use.

Preparing Buffers and Solvents

Prevent air bubbles from entering the column during installation, use, and storage. Air bubbles may cause degradation of column performance due to formation of channels in the packed bed. Mobile phases must be thoroughly degassed by filtration or helium sparging. Filtration will also remove small particles that could clog the column frit.

Only high quality reagents, water, and solvents should be used for preparing buffers (e.g., super distilled or HPLC grade distilled water, and special grade reagents). Resin fouling, leading to a loss in resolution and/or efficiency, occurs faster in TSK-GEL NPR columns due to the small surface area of nonporous resin particles.

Use 0.20 or 0.45µm microporous membranes to filter all buffers, salt solutions, aqueous and aqueous/organic mobile phases (e.g., a 0.45µm Nylon-66 membrane).

Be careful not to mix, or use in sequence, solutions that might precipitate or gel in the column or system. When replacing an aqueous buffer with an organic solvent, flush the column with distilled water as an intermediate step.

Column Equilibration

In ion exchange chromatography, counterions can have a significant influence on a separation. Cationic SP-NPR columns are shipped in the Na^+ form, and anionic DEAE-NPR columns are shipped in the Cl^- form. Both columns are shipped in an aqueous form, and should be equilibrated by using a buffered mobile phase containing appropriate ions specific to your analyses. Equilibration typically requires ~40-50 column volumes and is indicated by a stable baseline.

Solvent changes are often needed to fine-tune a specific separation. Gradient changes made to achieve a new mobile phase composition must be done *slowly* and *gradually*. We recommend a gradient change of not more than 2%/minute and a flow rate of not more than 0.5mL/minute. After the new composition is reached, equilibrate the column with ~20-30 column volumes of mobile phase. The system will then be ready for use. To ensure a stable baseline, run the selected gradient profile once or twice without injecting the sample.

Salt Solutions

Continuous, indiscriminate use of highly concentrated salt solutions can cause instrument and analysis problems. The following precautions are recommended during analyses utilizing salt solutions.

Be sure your system has no leaks. Salt deposits at a fitting (buffer creep) reveal a leak that can cause poor reproducibility, and, eventually, instrument downtime. Wash the area thoroughly with distilled water. Remove the fitting and wash the inside with distilled water. *Do not try to compensate for the leak by overtightening the fitting, or you might damage it.*

Do not shut off the pump for more than a few minutes at a time, while the system contains concentrated salts. When you do shut down the system, turn off the pump and remove the column, then thoroughly flush the entire system with distilled water. (Note: the column should not be stored for any length of time in a concentrated salt solution. See Table 2 for recommended storage solutions.)

Periodically — or when you want to use an organic mobile phase in the system (e.g., a reversed phase analysis on another column) — completely flush the system, *but not the column*, with a 10% nitric acid solution. Then rinse it with distilled water. Refer to your instrument manuals or contact the manufacturer, however, before using nitric acid.

Sample Preparation

If possible, always dissolve your sample in mobile phase, or in the starting mobile phase when operating under gradient conditions. Try to match the pH, salt concentration, and organic solvent of the sample with those of the mobile phase and run a test to ensure that no precipitate, suspension, or flocculate is formed. Finally, before making an injection, filter the sample through a 0.20µm porosity filter.

Table 2. TSK-GEL NPR Column Operating Conditions and Specifications

Condition/Specification	DEAE-NPR	SP-NPR	Octadecyl-NPR	Butyl-NPR
Column Dimensions	3.5cm x 4.6mm	3.5cm x 4.6mm	3.5cm x 4.6mm	3.5cm x 4.6mm
Shipping and Storage Solvent	Distilled Water	Distilled Water	70% Methanol/30% Water	Distilled Water
Max. Flow Rate	1.6mL/min.	1.6mL/min.	1.6mL/min.	1.2mL/min.
Standard Flow Rate	1.0-1.5mL/min	1.0-1.5mL/min	1.0-1.5mL/min	0.5-1.0mL/min
Max Pressure	200kg/cm² (3000psi)	200kg/cm² (3000psi)	200kg/cm² (3000psi)	200kg/cm² (3000psi)
pH Range❐	2-12	2-12	2-12	2-12
Salt Conc.	≤ 1 Molar	≤ 1 Molar	≤ 0.5 Molar	< 4 Molar
Organic Conc.	≤ 20%	≤ 20%	0-100%	≤ 20% (Confirm salt does not precipitate)
Sample Loading Capacity▲	10µg (proteins) 1-5µg (oligonucleotides)	10µg	0.5µg	2µg
Temperature	≥ 0°C	≥ 0°C	≤ 40°C	≥ 0°C
Resolution▼	≥ 6.0 (a)	≥10.0 (b)		≥ 3.0 (c)

❐ pH above 12 or below 2 can be used only for a short time.

▲ Defined as the amount of pure portein that can be injected onto the column before peak broadening, due to overload, occurs. The loading capacity for crude samples can be as much as 100 times greater since it is the sum of the loading capacity of the proteins in the (crude) mixture.

▼ Resolution: $(RX1, X2) = \frac{2(V2-V1)}{1.7(W2+W1)}$

where V1, V2 = elution volumes
W1, W2 = widths of peaks X1 and X2, at half height

(a) = Resolution for trypsin inhibitor and ovalbumin
(b) = Resolution for α-trypsinogen and trypsinogen
(c) = Resolution for ovalbumin and lysozyme

Column Flow Direction

The recommended flow direction through a TSK-GEL NPR column is indicated by the arrow on the tag (FLOW ⟶). Operating the column with flow in the reverse direction is recommended only as a last resort when removing particulates from a clogged frit, or as part of the following column installation procedure. (Refer to the *Column Instruction Manual* for the specific procedure to clean a clogged frit.)

Column Installation

Your column was tested by our quality assurance department after manufacture, then flushed with storage solvent and closed with caps to prevent solvent evaporation. During installation, use, and storage, you should take precautions to prevent air from entering the column.

Perform the following checks before using a new column:

a. Remove the cap from the column *inlet* side. Solvent should be visible at the inlet fitting. If the fitting appears dry, see step (f).

b. Connect the column inlet to the injector outlet tubing.

c. Remove the cap from the column outlet.

d. Start mobile phase flow using a slow rate (0.2-0.3mL/min).

e. After liquid flows from column exit, connect the column to the detector inlet line. The column is now ready for use.

If the column inlet fitting appears dry, we recommend the following:

f. Disconnect the column outlet cap. Hook the column outlet to the injector outlet tubing.

g. Slowly start flow (0.1mL/min) in this reversed flow direction until a few drops of mobile phase exit the column.

h. Turn off flow. Let the pressure go to zero and disconnect the column from the system.

i. Turn the column around, connecting it so flow is now in the direction of arrow indicated on the tag (FLOW ⟶).

j. Now you can hook the column to the detector inlet, and slowly increase the flow rate to its desired setting.

Column Operating Conditions

Table 2 summarizes operating conditions and specifications for each TSK-GEL NPR column. Additional information can also be found in the *Operating Conditions and Specifications* sheet, and the *Column Instruction Manual*, included with each TSK-GEL column you receive.

Connecting Columns in Series

For complex samples, or those containing components with widely differing molecular weights, you can use up to TSK-GEL NPR columns in series to maximize resolution. Equilibrate all columns with the same mobile phase *before* connecting them. Operate the system within recommended flow rates for each column (Table 2) to avoid exceeding maximum back pressure. As in other types of HPLC, doubling column length (e.g., by coupling two columns in series) increases resolution by $\sqrt{2}$.

To minimize dead volume, use small bore connecting tubing. Insert it fully into the end fitting before tightening. Keep air out of the columns and connecting tubing to avoid channeling in the packing bed. Make connections while maintaining a mobile phase flow (0.3mL/minute), but be sure to follow safety precautions (hand protection, etc.) appropriate for the mobile phase you are using.

Column Protection

Guard columns are not available — and are usually not needed — for these very short TSK-GEL columns. However, we recommend using a 0.45µm in-line frit filter (Supelco Cat. No. 59124) to prevent particulates from plugging the column frit. For PCR applications, it is important to include a DEAE-NPR guard column.

Column Cleaning

Occasionally — usually after long-term use — elution times may differ significantly from original analyses. To remedy, follow cleaning procedures, using recommended solvents for each column (Table 3).

Column Storage

The column does not need to be removed from the system if used daily. The mobile phase may be left in the column overnight if the buffer salt has good solubility.

When storing the column, flush it with the shipping solvent, remove it from the instrument and seal the ends with the screws provided. All columns should be stored at room temperature.

During all the above steps, prevent air from entering the column.

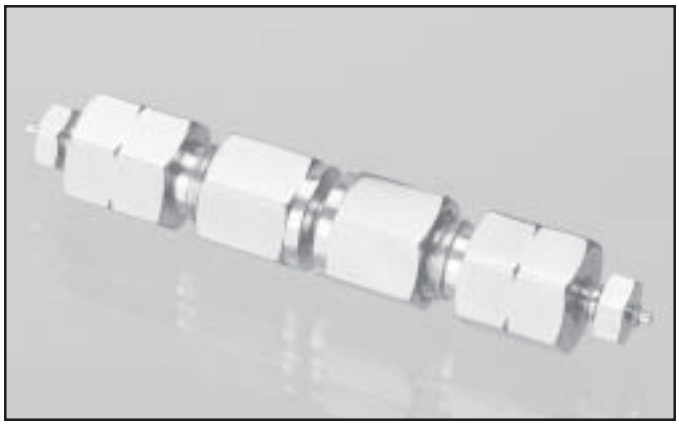
Column Longevity

Column life depends on mobile phases, pH, sample matrix, contaminants, and other factors. You can make more than 1000 injections onto a properly protected column. Longer column life can be anticipated when you use simple, clean samples and mild mobile phases.

Table 3. Cleaning Solvents and Procedures for TSK-GEL NPR Columns

	DEAE-NPR & SP-NPR	Octadecyl-NPR	Butyl-NPR
Solvents	1. 0.1-0.2M NaOH 2. 20-40% Acetic Acid, aqueous 3. Urea or nonionic surfactant in buffer 4. Aq. buffer in 20% organic solvent	1. Acetonitrile or methanol 2. Aq. buffer in organic solvent 3. 0.1-0.2M NaOH 4. 20-40% Acetic Acid, aqueous 5. 60% Acetonitrile/40% 0.2M NaOH	1. 0.1-0.2M NaOH 2. 20% Acetic Acid, aqueous
Procedures	Clean column regularly by injecting up to one column volume 0.1-0.2M NaOH with: ● 100-250µL increments on DEAE-NPR ● 250µL-2mL increments on SP-NPR	Clean column regularly by injecting up to one column volume cleaning solution in 100-250µL increments.	Clean column daily after use, or regenerate column, by injecting 100-250µL NaOH. If repeated injections are not effective, use repeated 100-250µL injections of acetic acid.

Ordering Information:



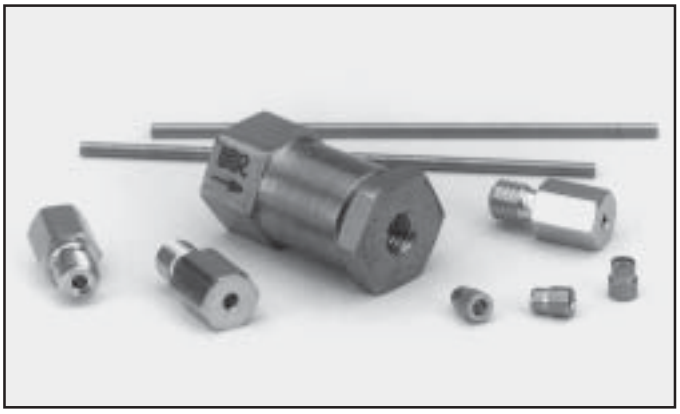
910-0274

TSK-GEL NPR Ion Exchange Columns

3.5cm x 4.6mm ID

Description	Cat. No.	Exchange Mechanism	Functional Group/ Counterion
SP-NPR	**813076**	Strong Cation	$-SO_3^-/Na^+$
DEAE-NPR	**813075**	Weak Anion	$-CH_2CH_2N^+(Et)_2/Cl^-$

Description	Cat. No.
Guard Column	
DEAE-NPR, 0.5cm x 4.6mm, 5µm particles	**817088**
Reversed Phase Column	
3.5cm x 4.6mm ID, Octadecyl-NPR	**814005**
Hydrophobic Interaction Column	
3.5cm x 4.6mm ID, Butyl-NPR	**814947**

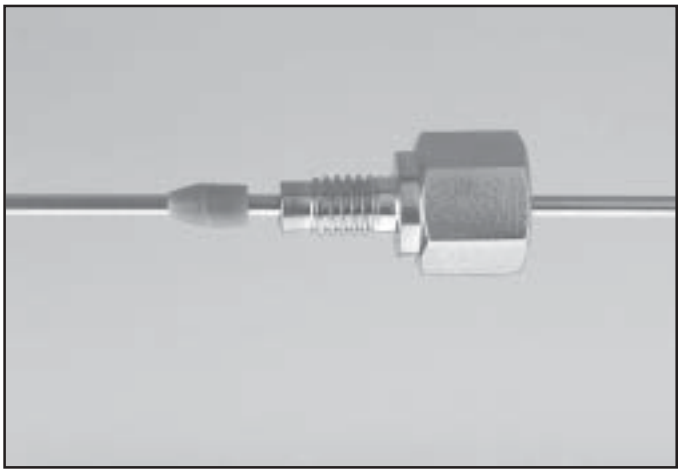


910-0142

Column Inlet Filter

Prevents particulates from clogging column and frit. Minimizes dead volume and band broadening.

Description	Cat. No.
Frit, 3mm, 0.5µm pores	**59124**
Replacement Frits, 3mm, 0.5µm pores, pk. of 5	**59126**

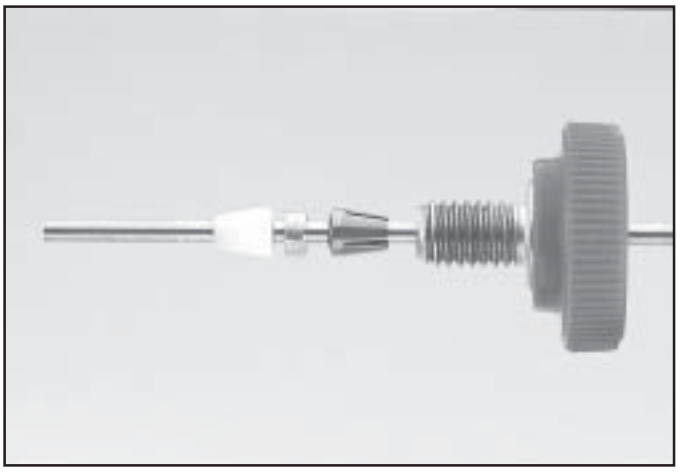


910-0146

High Pressure Fingertight Upchurch Fittings

Use these stainless steel fingertight fittings with all common 1/16" external fittings used on HPLC columns. Will hold to 6000psi (420kg/cm^2) when finger tightened, or to 10,000psi (700kg/cm^2) with a slight turn of a wrench.

Description	Cat. No.
Fingertight Fittings, ea.	**58478-U**
Ferrules, 1/16", pk. of 5	**58479**



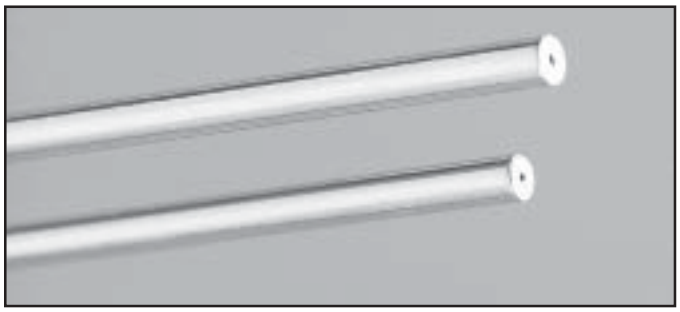
913-0340

Dynaseal Handtight Fittings

Will seal against pressures to over 7000psi (490kg/cm^2). Each fittings consists of a reusable nut, collet, and ferrule. The ferrule will not deform stainless steel seats and can be reused.

The fittings are compatible with all 1/16" female compression-type fittings now used on HPLC columns. Spacers are helpful for leak-free sealing with some column end fittings where thread depth varies.

Description	Cat. No.
Handtight Fittings, pk. of 2	**58462**
Replacement Ferrules, pk. of 5	**58463**
Collets, pk. of 2	**58464**
Ferrules, KEL-F® polymer, pk. of 10	**58468**
Spacers, pk. of 2	**58679**



910-0160

Stainless Steel Capillary Tubing

Capillary tubing for use between pump and injector. 1/16" OD x 0.010" ID. One piece each.

Description	Cat. No.
5cm lengths	**56713**
10cm lengths	**56714**
20cm lengths	**56715-U**
30cm lengths	**56716**
0.5m lengths	**56717**
1.0m lengths	**56718-U**

Peek Tubing

Polyetheretherketone, 1/16" OD, 10-foot lengths.

ID (in.)	Color	Cat. No.
0.005	Red	**Z227307**
0.007	Yellow	**Z226688**
0.01	Blue	**Z226661**
0.02	Orange	**Z227293**
0.03	Green	**Z226955**

910-0354

Replaceable Frit and Screen Filters

Replaceable 1/8" frit has 0.5µm pores to protect 3µm or larger column packings from particles. Use with 1/16" tubing.

Description	Cat. No.
Frit Filter	**58420-U**
Replacement Frits (pk. of 10)	
0.5µm pores	**59037**
2.0µm pores	**59129**

Use this efficient, low dead volume in-line filter between your pump and injector to trap particles. The replaceable screen has 2µm pores. Use with 1/16" tubing.

Screen Filter	**58279-U**
Replacement Screen (pk. of 10)	**58284**

TSK-GEL Columns:

Affinity Chromatography

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
TSKgel ABA-5PW	10	7.5	7.5	**813067**
TSKgel ABA-5PW guard column kit	20	1	6.0	**813127**
TSKgel ABA-5PW packing (5mL)	20	—	—	**813128**
TSKgel Boronate-5PW	10	7.5	7.5	**813066**
TSKgel Boronate-5PW packing (5mL)*	20	—	—	**813126**
TSKgel Chelate-5PW	10	7.5	7.5	**808645**
TSKgel Chelate-5PW guard column kit	20	1	6.0	**808647**
TSKgel Chelate-5PW packing (5mL)	20	—	—	**808648**
TSKgel Heparin-5PW	10	7.5	7.5	**813064**
TSKgel Heparin-5PW guard column kit	20	1	6.0	**813121**
TSKgel Heparin-5PW packing (5mL)	20	—	—	**813122**
TSKgel Tresyl-5PW	10	4	6.0	**814455**
TSKgel Tresyl-5PW	10	7.5	7.5	**814456**

*Requires a TSKgel Guardgel holder, 6mm x 1cm (**803432**). Replacement frits, 2µm, pk. of 10 (**803430**).

Gel Filtration Chromatography — Polymer-Based

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
TSKgel G-Oligo-PW	6	30	7.8	**808031**
TSKgel Oligo guard column	12	4	6.0	**808034**
TSKgel G2500PWXL	6	30	7.8	**808020**
TSKgel G3000PWXL	6	30	7.8	**808021**
TSKgel G4000PWXL	10	30	7.8	**808022**
TSKgel G5000PWXL	10	30	7.8	**808023**
TSKgel G6000PWXL	13	30	7.8	**808024**
TSKgel GMPWXL	13	30	7.8	**808025**
TSKgel G-DNA-PW	10	30	7.8	**808032**
TSKgel PWXL guard column	12	4	6.0	**808033**
TSKgel PWXL packing (1g)	10	—	—	**808035**
TSKgel G1000PW**	10	30	7.5	**805760**
TSKgel G2000PW**	10	30	7.5	**805761**
TSKgel G2500PW	10	30	7.5	**808028**
TSKgel G3000PW	10	30	7.5	**805762**
TSKgel G4000PW	17	30	7.5	**805763**
TSKgel G5000PW	17	30	7.5	**805764**
TSKgel G6000PW	17	30	7.5	**805765**
TSKgel GMPW	17	30	7.5	**808026**
TSKgel PWH guard column	17	7.5	7.5	**806732**

Use Oligo guard column **(808034) for G1000PW and G2000PW; PWH guard column (**806732**) for G2500PW through GMPW.

Gel Filtration Chromatography — Silica-Based

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
TSKgel G2000SWXL	5	30	7.8	**808540**
TSKgel G3000SWXL	5	30	7.8	**808541**
TSKgel G4000SWXL	8	30	7.8	**808542**
TSKgel SWXL guard column	7	4	6.0	**808543**
TSKgel SWXL packing (1g)	5	—	—	**808544**
TSKgel G2000SW	10	30	7.5	**805788**
TSKgel G2000SW	10	60	7.5	**805102**
TSKgel G3000SW	10	30	7.5	**805789**
TSKgel G3000SW	10	60	7.5	**805103**
TSKgel G4000SW	13	30	7.5	**805790**
TSKgel G4000SW	13	60	7.5	**805104**
TSKgel SW guard column	10	7.5	7.5	**805371**
TSKgel SW packing (1g)	10	—	—	**806819**
TSKgel QC-PAK GFC 200 `(stainless steel)	5	15	7.8	**816215**
TSKgel QC-PAK GFC 200GL (glass)	5	15	8.0	**816214**
TSKgel QC-PAK GFC 300 (stainless steel)	5	15	7.8	**816049**
TSKgel QC-PAK GFC 300GL (glass)	5	15	8.0	**816216**

Guard column kits include 1cm x 6.0mm column, column holder, 5mL packing, 2 frits, 2 nuts and ferrules for 1/16" tubing, 5cm of 1/16" tubing.

Hydrophobic Interaction Chromatography

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
TSKgel Butyl-NPR	2.5	3.5	4.6	**814947**
TSKgel Ether-5PW	10	7.5	7.5	**808641**
TSKgel Ether-5PW guard column kit	20	—	—	**808643**
TSKgel Ether-5PW packing (5mL)	20	—	—	**808644**
TSKgel Phenyl-5PW	10	7.5	7.5	**807573**
TSKgel Phenyl-5PW guard column kit	20	—	—	**807652**
TSKgel Phenyl-5PW packing (5mL)	20	—	—	**807651**

Hydroxyapatite Chromatography

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
TSKgel HA-1000 packing (5mL)	10	—	—	**813130**

Trademarks

KEL-F — 3M Co., Chemical Div.
TSK-GEL — Tosoh Corp.

Reference

1. *Amplifications,* Perkin-Elmer Corp., June 1992, Issue 8, pp 10-13, Elena Katz, Will Block, and John Wages.

Reference not available from Supelco.

Contact our Technical Service Department (phone 800-359-3041 or 814-359-3041, FAX 814-359-5468) for expert answers to your questions.

Ion Exchange Chromatography — Anion Exchange

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
TSKgel DEAE-NPR	2.5	3.5	4.6	**813075**
TSKgel DEAE-NPR guard column	5	0.5	4.6	**817088**
TSKgel DEAE-5PW	10	7.5	7.5	**807164**
TSKgel DEAE-5PW guard column kit	20	—	—	**807210**
TSKgel DEAE-5PW packing (5mL)	20	—	—	**807207**
TSKgel DEAE-2SW	5	25	4.6	**807168**
TSKgel DEAE-3SW	10	7.5	7.5	**807163**
TSKgel DEAE-SW guard column kit	10	—	—	**807648**
TSKgel DEAE-SW packing (5mL)	10	—	—	**807647**

Ion Exchange Chromatography — Cation Exchange

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
TSKgel CM-5PW	10	7.5	7.5	**813068**
TSKgel CM-5PW guard column kit	20	—	—	**813069**
TSKgel CM-5PW packing (5mL)	20	—	—	**813070**
TSKgel SP-NPR	2.5	3.5	4.6	**813076**
TSKgel SP-5PW	10	7.5	7.5	**807161**
TSKgel SP-5PW guard column kit	20	—	—	**807211**
TSKgel SP-5PW packing (5mL)	20	—	—	**807208**
TSKgel CM-2SW	5	25	4.6	**807167**
TSKgel CM-3SW	10	7.5	7.5	**807162**
TSKgel CM-SW guard column kit	10	—	—	**807650**
TSKgel CM-SW packing (5mL)	10	—	—	**807649**

Reversed Phase Chromatography

Column	Particle Size (µm)	Column Length (cm)	Dimensions Diameter (mm)	Cat. No.
Silica-Based Columns				
TSKgel Oligo-DNA RP	5	15	4.6	**813352**
TSKgel Oligo-DNA RP	5	15	7.8	**813353**
TSKgel Super-ODS	2	5	4.6	**818154**
TSKgel Super-ODS	2	10	4.6	**818197**
TSKgel G Filter** (pk. of 3)	—	—	—	**818207**
Resin-Based Columns				
TSKgel Octadecyl-NPR	2.5	3.5	4.6	**814005**
TSKgel Octadecyl-4PW	7	15	4.6	**813351**
TSKgel Phenyl-5PW RP	10	7.5	4.6	**808043**
TSKgel Phenyl-5PW RP packing (5mL)*	20	—	—	**814019**

*Requires a TSKgel Guardgel holder, 6mm x 1cm (**803432**); Replacement frits, 2µm, pk. of 10 (**803430**)

Requires a guard holder, 4mm x 4cm (818206**)

Guard column kits include 1cm x 6.0mm column, column holder, 5mL packing, 2 frits, 2 nuts and ferrules for 1/16" tubing, 5cm of 1/16" tubing.

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