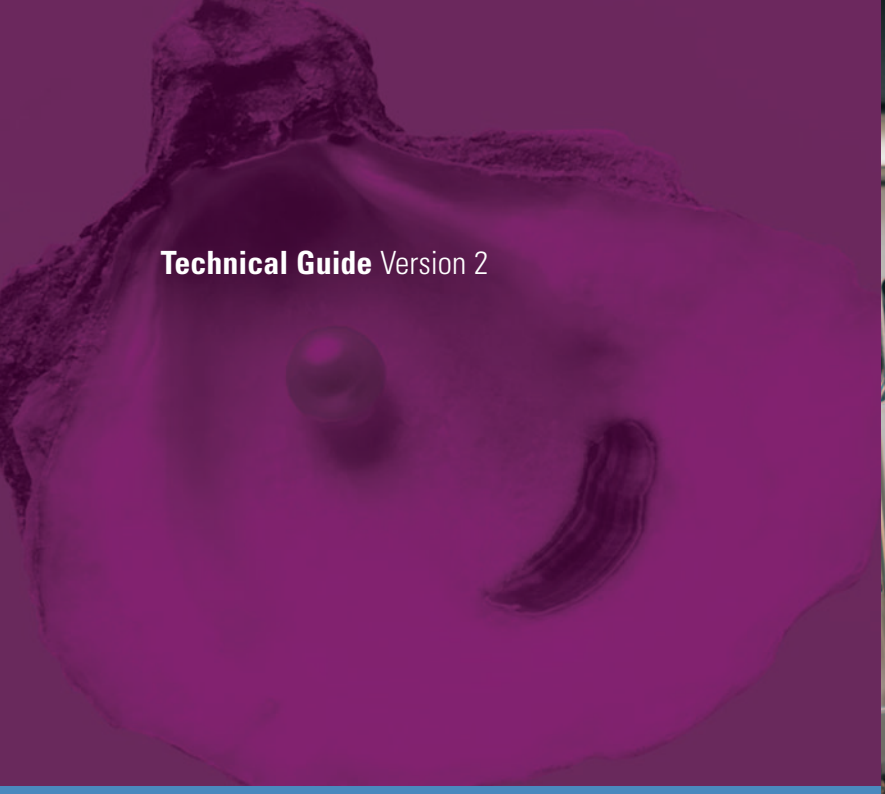


**Technical Guide** Version 2

# Thermo Scientific HyPURITY HPLC Columns

The Pure Choice for Method Development

Part of Thermo Fisher Scientific

Thermo SCIENTIFIC

# Thermo Scientific HyPURITY Columns

## The best choice for superior chromatography

For more than 30 years, we have designed and manufactured HPLC media and columns featuring the highest quality program including ISO 9001:2000 certification.

The Thermo Scientific HyPURITY family of columns sets new standards in column performance, characterization and validation. Our quality assurance program has been designed to probe a number of diagnostic chromatographic tests to ensure exceptional column-to-column and batch-to-batch reproducibility.

We feature a wide range of stationary phases bonded to the HyPURITY silica including C18, C8, C4, Cyano as well as the unique HyPURITY ADVANCE™ and HyPURITY AQUASTAR™ phases.

This versatile range of phases offers exceptional selectivity allowing the operator to resolve compounds at high and low pH and at polarity extremes with excellent peak shape and outstanding column performance time after time.

- **HyPURITY C18 columns: one of the most rugged and reliable columns available**
- **HyPURITY ADVANCE columns for alternative selectivity and exceptional peak shape for bases**
- **HyPURITY AQUASTAR columns for optimum aqueous stability and polar retention**
- **Ultra-pure, stable silica enhances column lifetime, performance and reliability**
- **Superior efficiency and peak shape across a wide range of analyte types**
- **190Å pore size provides extensive chromatographic options from small molecule to large peptide analyses**

| Phase | Particle Size | Pore Size | Carbon Load | End-Capping | Silica Type High Purity |
|---|---|---|---|---|---|
| HyPURITY C18 | 3 and 5 µm | 190Å | 13% | Yes | High purity base deactivated |
| HyPURITY C8 | 5 µm | 190Å | 8% | Yes | High purity base deactivated |
| HyPURITY C4 | 5 µm | 190Å | 4.5% | Yes | High purity base deactivated |
| HyPURITY Cyano | 5 µm | 190Å | 4% | Yes | High purity base deactivated |
| HyPURITY ADVANCE | 3 and 5 µm | 190Å | 10% | - | High purity base deactivated |
| HyPURITY AQUASTAR | 3 and 5 µm | 190Å | 10% | Polar End-Capped | High purity base deactivated |

Table 1: HyPURITY phase specifications

### Outstanding Silica Quality

HyPURITY silica delivers unparalleled quality and is manufactured in our dedicated, state-of-the-art facility by a team of highly experienced chemists. The silica is essentially metal-free and the C18 is exceptionally stable at high and low pH. The rugged and robust manufacturing process ensures reproducibility and optimum quality, batch after batch. Extra care is taken to ensure an extensively homogenous silica surface – a critical key precursor in the preparation of uniform bonded phases.

### Increased Stability and Lifetime

For superior column reliability and longevity, the advanced manufacturing process generates outstanding chromatographic performance across a wide pH range. Silica-based reversed phase columns are generally stable in the pH range 2 to 8. At pH values below 2, the bond holding the alkyl chain to the silica surface starts to dissociate and at pH values higher than 8, silica dissolution occurs. Analyses outside the pH range 2 to 8 have therefore previously resulted in decreased column lifetime and performance.

Each HyPURITY C18 batch has undergone rigorous stability trials at pH 0.9 and 10.6 to ensure that demanding analyses at extremes of pH and high temperature can be performed with confidence. This extension to the stable operating range at both high and low pH enhances column lifetime and enables columns to be used with conditions that would previously have resulted in a rapid deterioration of performance and lifetime. Example of the stability of HyPURITY C18 media are shown in Figures 1 and 2.

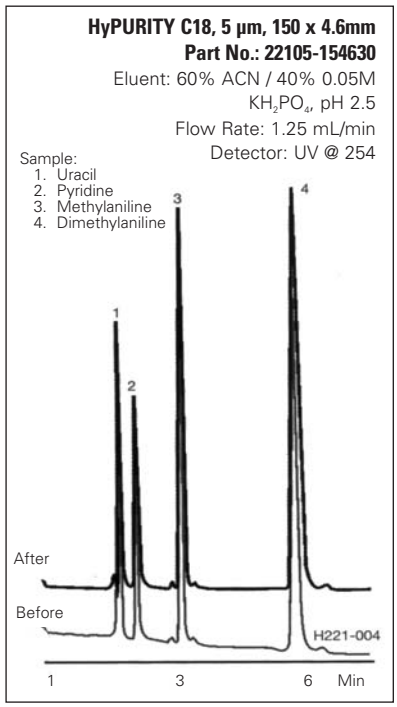



Figure 1: Analysis of Bases Before and After Exposure to 5.8L of pH 0.9 at 90°C

## Highly Reproducible Columns

Six physical properties are monitored for each batch of silica and bonded phase manufactured to ensure reproducibility of retention and column efficiency, (Figures 3 and 4).

- Surface area
- Pore size
- Carbon load
- Mean particle size
- Particle size distribution
- Full BET adsorption and desorption isotherm

A series of chromatographic tests are also run on the base silica as well as bonded phases to ensure reproducibility. The HyPURITY C18 media has a total of six chromatographic tests probing the nature of the surface, and are further explained on page 7.

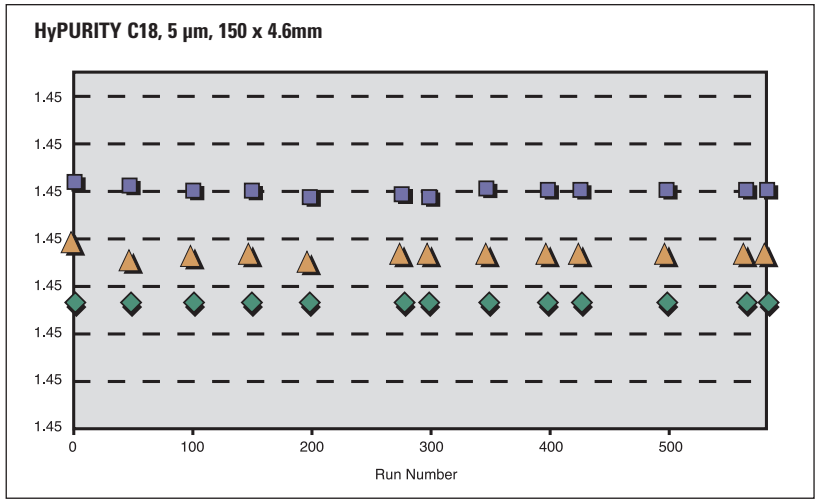



Figure 2: Enhanced Column Stability at pH 10.6

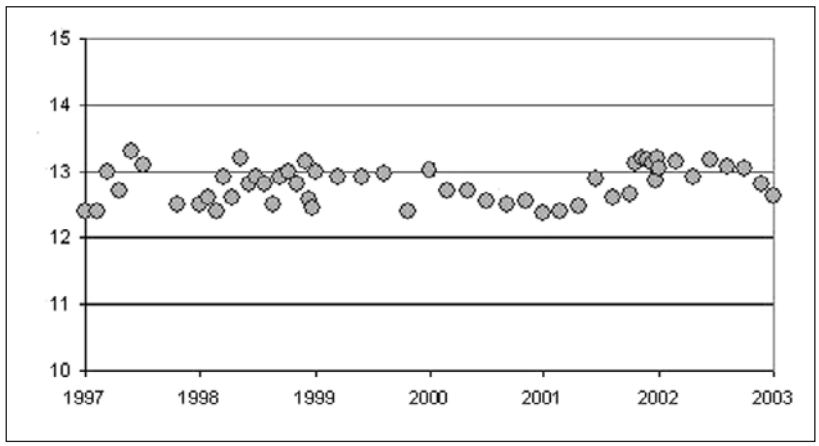



Figure 3: Excellent Reproducibility of Carbon Load on 5 µm HyPURITY C18 media

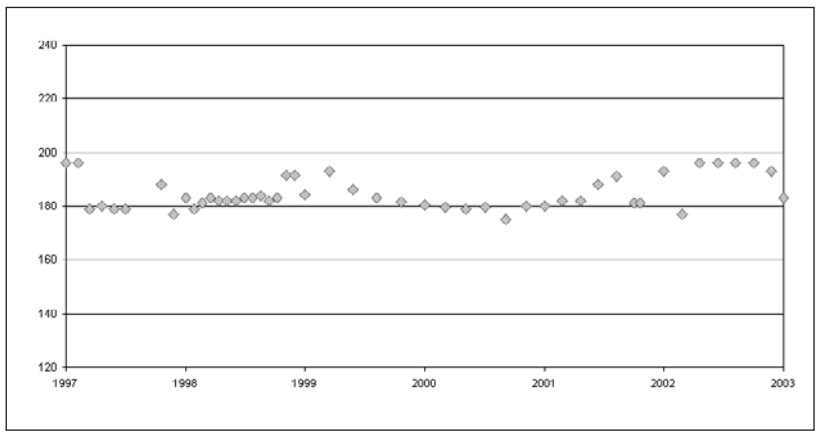



Figure 4: Median Pore Diameter for HyPURITY Silica (Å)

## Thermo Scientific HyPURITY Column Selection

| | Non Polar | Polar | Acidic | Basic | Chelator | Hydrophobic Retention | Shape Selectivity | LC/MS | pH 9-10.6 | pH 0.9-2 | Extreme Aqueous |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C18 | | | | | | | | | | | |
| C8 | | | | | | | | | | | |
| C4 | | | | | | | | | | | |
| AQUASTAR | | | | | | | | | | | |
| ADVANCE | | | | | | | | | | | |
| CN | | | | | | | | | | | |
| | Peak Shape | | | | | | | Column Stability | | | |

Legend
- Excellent
- Good
- Suitable. Next Best Choice
- Not Recommended

Table 2: Choosing the Appropriate HyPURITY Column

The choice of the appropriate column for a particular application can be a daunting task. With a range of bonded phases offering different selectivity, the HyPURITY family includes columns to meet most separation needs, including LC/MS compatibility. The chart (Table 2) will help you choose the best HyPURITY column for a particular application.

The HyPURITY column chosen for a particular analysis will depend on the analytes present in the sample, operating conditions, and the selectivity required. Selectivity is controlled by the nature of the stationary phase and the interactions of analytes with the media surface and mobile phase. If you change the surface chemistry of the stationary phase, the selectivity changes. For example, an acidic polar analyte that shows little to no retention using a traditional alkyl chain column may be retained using a column with enhanced polar character where polar groups in the stationary phase offer another type of interaction, such as seen with HyPURITY ADVANCE columns.

Selectivity changes between column packing materials due to changes in the interaction mechanisms predominantly manifest in two ways: either by a change in elution order, by a change in peak separation, or both. In most cases, selectivity changes are a combination of both these factors. This is illustrated in Figure 5 where the peak elution and separation between peaks is changed by moving from a C18 to a polar embedded phase.

The different selectivity achievable from six HyPURITY column chemistries is demonstrated in Figure 6. The same dimension of column, test mix and analysis conditions were used with each column. The test mix components are steroids with similar structure. By polar end-capping the alkyl C18 chain, the resolution between peaks 3 and 4 is drastically improved as seen in the comparison of HyPURITY C18 and HyPURITY AQUASTAR columns. By adding a polar embedded group to the alkyl chain, changes in selectivity are possible as illustrated by comparing HyPURITY C8 and HyPURITY ADVANCE columns.

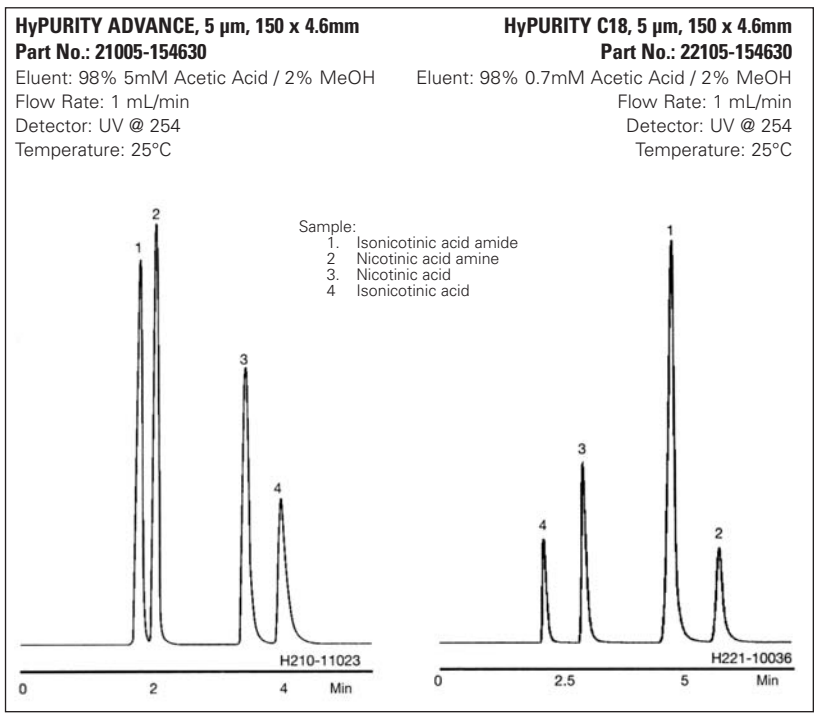



Figure 5: Elution Order Changes Possible using Phases with Alternative Selectivity

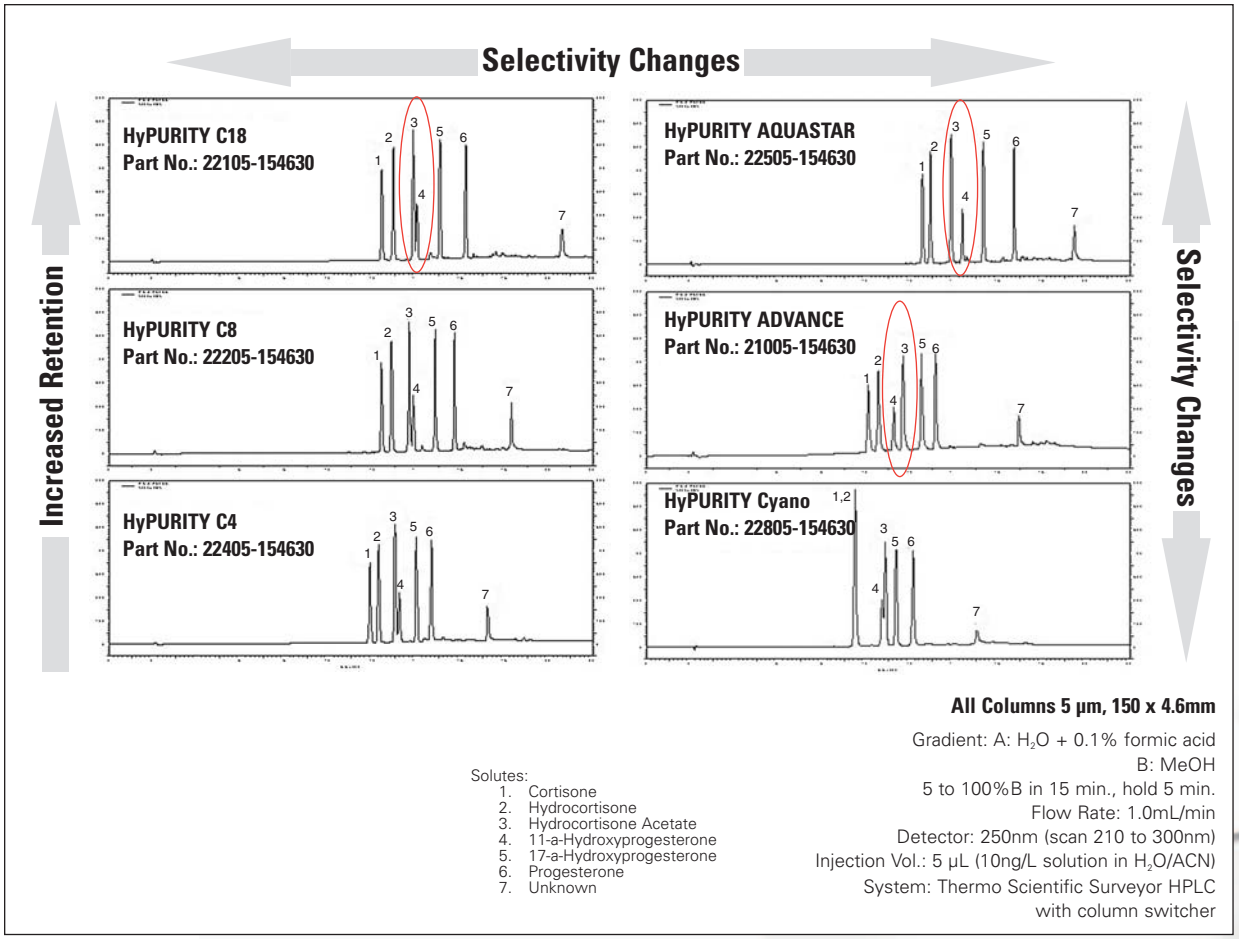
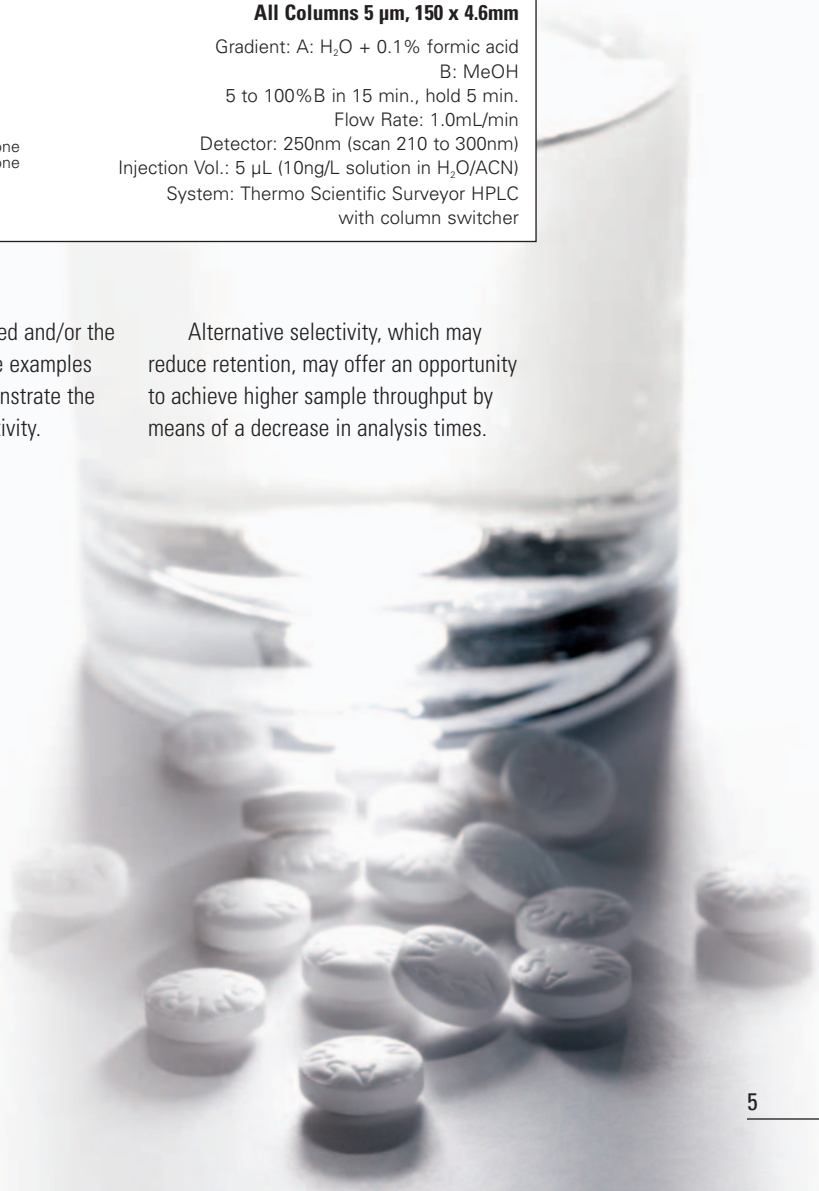



Figure 6: Selectivity and Retention Time Differences with Various HyPURITY Phases

Alternative selectivity, including a change in peak elution order, is beneficial when two peaks of a chromatogram coelute or elute very closely. Often the separation of such peaks requires that chromatographic conditions be drastically changed and/or the column chemistry modified. The examples shown in Figures 7 and 8 demonstrate the usefulness of alternative selectivity.

Alternative selectivity, which may reduce retention, may offer an opportunity to achieve higher sample throughput by means of a decrease in analysis times.



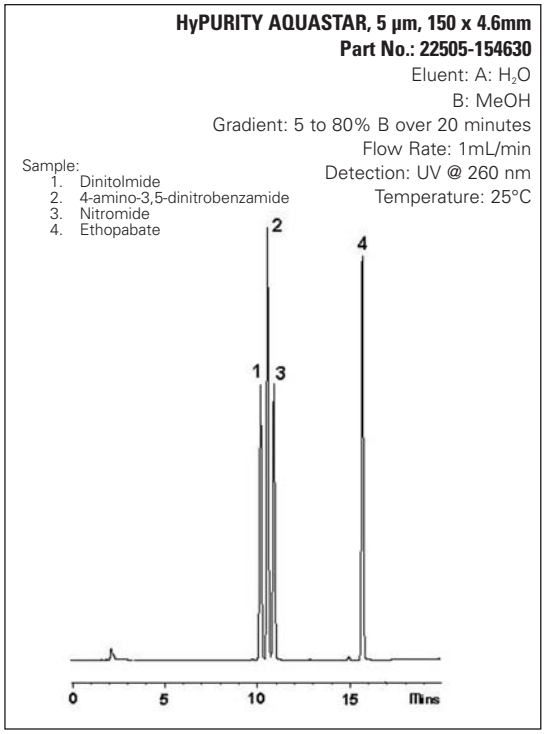



Figure 7: Enhanced Separation of Structurally Similar Drugs

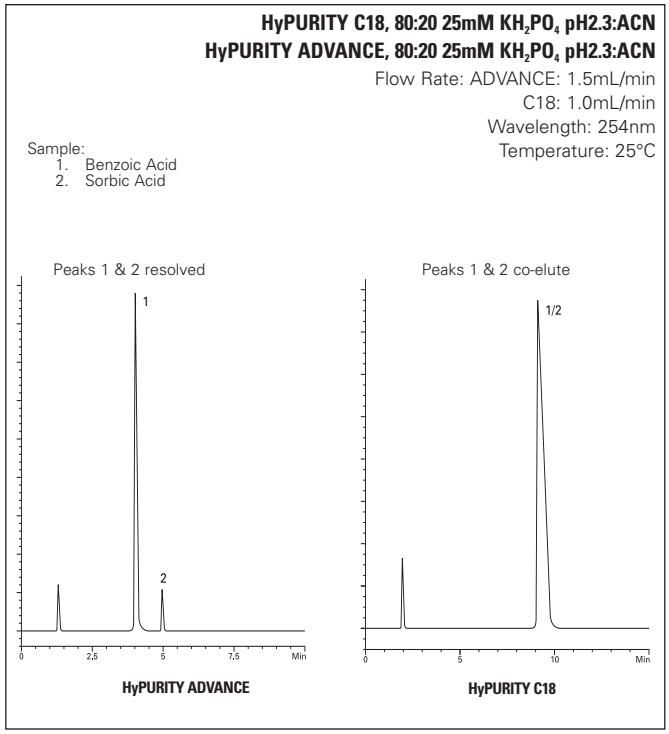



Figure 8: Separation of Analytes Improved by Adding Polar Character to the Column

## Increased Sensitivity with 3 µm Columns

Quantitation of trace components in complex mixtures is generally performed by measurement of peak height, so the chromatographic separation needs to produce sharp, efficient peaks. The accuracy and sensitivity of the analysis is therefore determined by parameters such as particle size. Peak efficiency increases with a decrease in the particle diameter. Figure 9 illustrates the effect of the particle size (3 µm versus 5 µm HyPURITY C18) for the analysis of a parent drug and three related substances.

Maintaining all the analysis conditions constant, the increase in peak height with the 3 µm column is 54, 22 and 42% for peaks 1, 2 and 4 respectively. Therefore, the related substances present at trace levels in this drug were more accurately quantified when the 3 µm column was used.

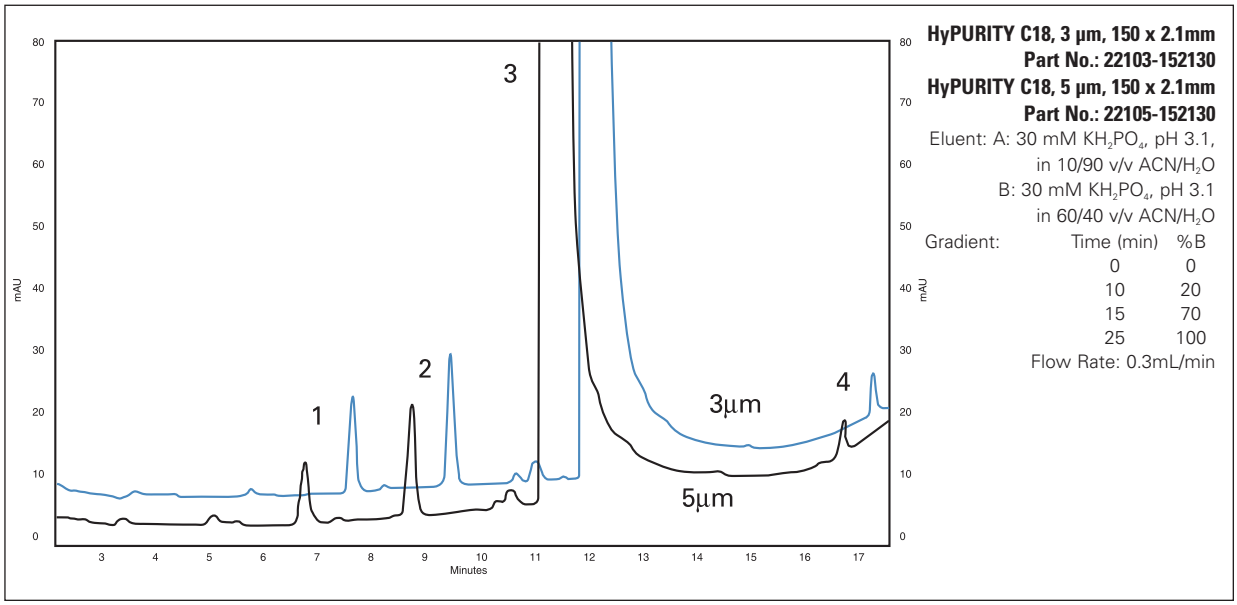



Figure 9: Increased Sensitivity using a Smaller Particle Size

# HyPURITY C18 Columns

## Introduction

HyPURITY C18 columns are based on the latest in silica technology – HyPURITY silica with less than 10 ppm total metals and exceptionally stable at low pH. The HyPURITY silica manufacturing process ensures reproducibility and quality. The homogeneous surface ensures uniform bonding coverage and eliminates silanol-analyte interactions that cause poor peak shapes for bases, acids and chelating compounds. The 190Å pore size and excellent mass transfer properties of HyPURITY C18 makes it ideal for chromatography of large peptides, as well as small molecules, with unbeatable peak shape for all sample types.

- **The ultimate in chromatographic validation**
- **Rigorously quality tested throughout manufacturing process**
- **First-class efficiency and performance**
- **Highly reproducible, rugged and robust**
- **Ideal for LC/MS applications**

## Extensive Chromatographic Testing

HyPURITY silica and bonded phases are subject to extensive quality assurance testing to probe the chemical, physical and chromatographic nature of the media. The physical testing of the media reveals only some of the characteristics of the column.

The actual chromatography obtained on a wide range of analytes fully characterizes the chromatographic surface of the HyPURITY C18 media. The chromatographic probes employed cover the broad range of possible analyte/stationary phase surface interactions, and have been chosen only after an in-depth literature survey and extensive consultation. Table 3 lists the tests performed on each batch of HyPURITY C18 after the final media production stage to ensure full characterization and ultimate performance.

This wide range of tests ensures the outstanding reproducibility of both the base silica and bonded phase.

| Test | Characteristic Tested | Method |
|---|---|---|
| Steric Selectivity Polyaromatics | Bonded Phase Uniformity | Relative Retention of Shape Differentiated |
| Hydrophobicity | Hydrophobic Character & Surface Coverage of Bonded Phase | Retention & Selectivity of Non-Polar Hydrocarbons |
| Hydrogen Bonding Capacity | Measure of Activity of Residual Silanols at Silica Surface | Selectivity of Caffeine Relative to Phenol |
| Ion Exchange Capacity at pH 2.7 | Presence of Active Ion Exchange Sites | Benzylamine Retention |
| Ion Exchange Capacity at pH 7.2 | Presence of Active Ion Exchange Sites & Dissociated Silanol Sites | Benzylamine Retention |
| Analysis of Bases at pH 7 | Effect of Dissociated Silanols on Basic Analytes | Peak Shape & Selectivity Parameters of Tricyclic Antidepressants |
| Analysis of Acids & Chelators | Metal/Silanol Sites & Analyte Selectivity Sensitivity to Changes in Surface Silanol Content | Peak Shape & Selectivity Parameters of Acids & Chelators |

Table 3: Chromatographic Validation Tests Conducted on HyPURITY C18 columns

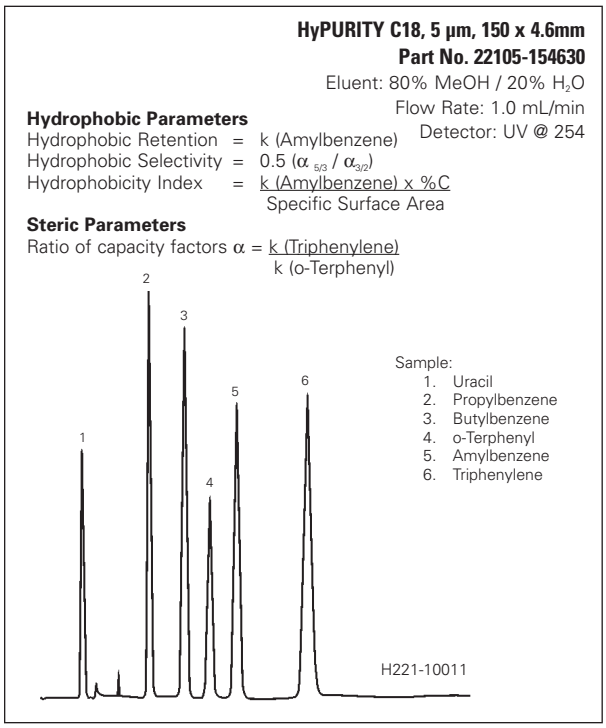



Figure 10: Hydrophobic Retention Reliability on a Lot-to-Lot Basis

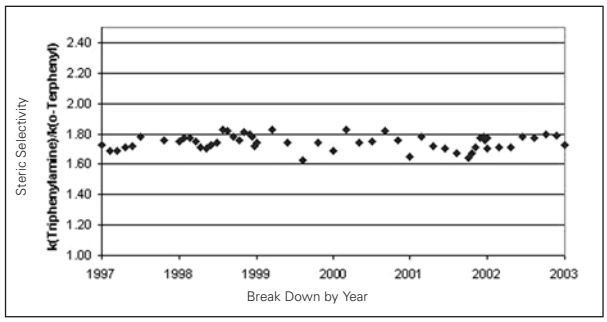



Figure 11: Reproducibility of HyPURITY C18 Columns as shown by Steric Selectivity

## Steric Selectivity and Hydrophobicity

Steric selectivity is the ability of the stationary phase to recognize and differentiate between molecules with similar molecular formulas but different shapes. It is often indicative of the surface coverage of the bonding chemistry and also provides a characteristic by which different HPLC packings can be compared. The hydrophobicity index provides an indication of the hydrophobic character of the column per unit area.

## Hydrogen Bonding Capacity

The function of this test is to provide a measure of the activity of the residual silanol groups on the silica surface. Residual silanol groups are not shielded by the C18 alkyl ligand and are available to form hydrogen bonds with analytes. Caffeine is prone to such bonding and is therefore used as the test probe (Figure 12). HyPURITY C18 columns have an exceptionally low hydrogen bonding capacity, indicating minimal residual silanols present on the silica surface that are available for unwanted secondary interactions.

## Ion Exchange Capacity

The retention of protonated amines at pH 2.7 is used to determine the level of ion exchange sites on the silica surface. The majority of the silanol groups (Si-OH) are undissociated at this pH and therefore do not contribute to the retention of protonated amines. Acidic silanols remaining on the silica surface will be in the ionized form (SiO-) and contribute to the retention of protonated amines by an ion exchange mechanism.

At pH 7.6, all of the surface silanol groups are dissociated to form ion exchange sites that increase the retention of protonated amines. To accurately determine the ion exchange capacity of a bonded phase, retention of amines should be measured at both high and low pH. HyPURITY C18 columns possess minimal ion exchange sites at both high and low pH and so are ideal for use at extended pH and with analytes in the protonated form. The careful monitoring of ion exchange capacity ensures reproducible column performance.

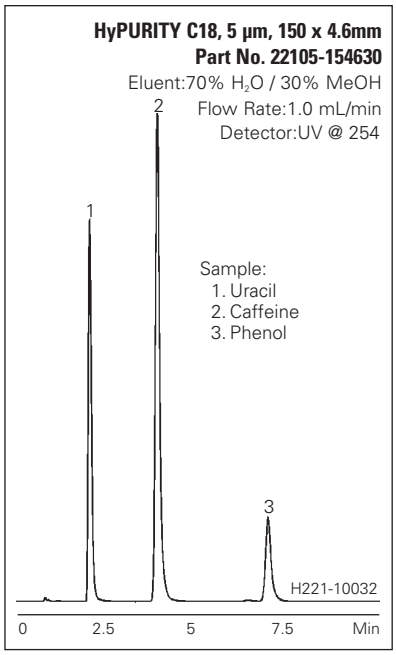



Figure 12: Hydrogen Bonding Capacity

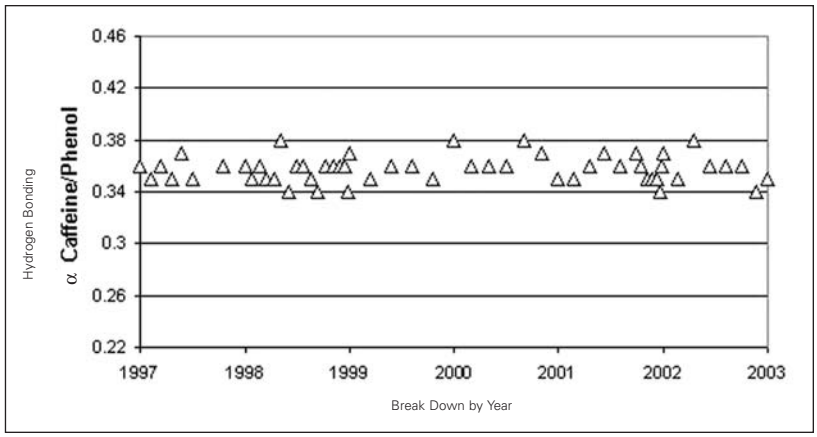



Figure 13: Hydrogen Bonding Capacity on HyPURITY C18 Columns Measured as the Separation Factor between Caffeine and Phenol

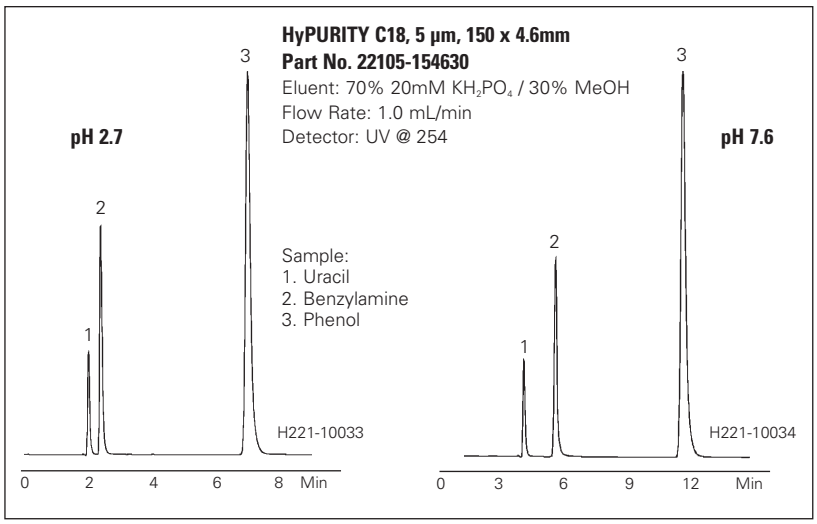



Figure 14: Ion Exchange Tests at pH 2.7 and 7.6

## Analysis of Bases at pH 7

Tricyclic antidepressants (TCAs) are difficult to chromatograph with good peak shape. They are highly basic compounds that can often produce severe peak tailing or irreversibly adsorb to the media surface, particularly at pH 7. The use of this sensitive test on HyPURITY C18 columns ensures the highest standard of reproducibility for selectivity and peak shape for the analysis of basic compounds. The high surface coverage of the bonded phase and minimal ion exchange interactions contribute to the outstanding peak shape and chromatographic performance as illustrated in Figure 15.

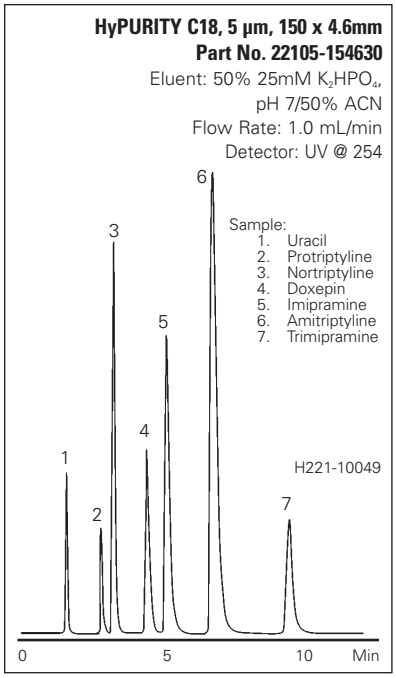




Figure 15: Excellent Peak Shape of Basic Compounds

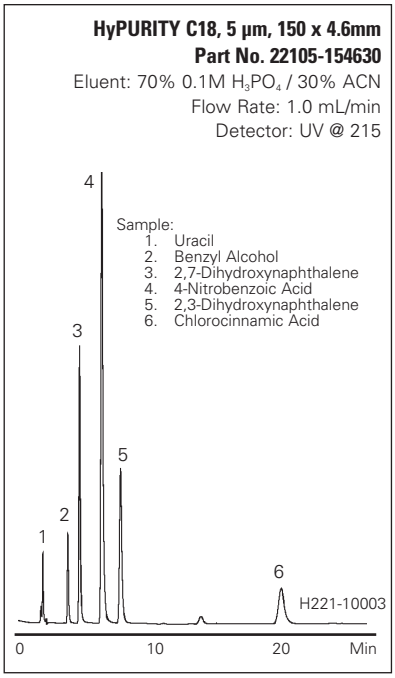



Figure 16: Outstanding Peak Shape for Acids, Alcohols and Chelating Compounds

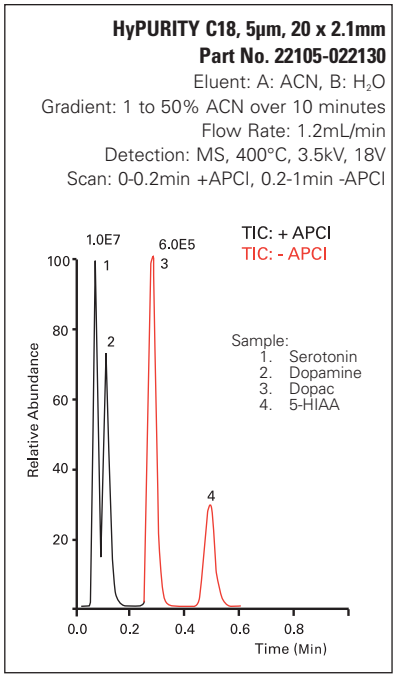



Figure 17: High Throughput Fast Analysis using Short Columns

## Analysis of Acids, Alcohols and Chelators

Surface metal interactions can cause changes in selectivity or peak shape for chelating solutes. The presence of metal ions can be attributed not only to the base silica but also can be traced to the column hardware, such as frits. This only happens if the column is stored in a solvent that will promote leaching such as a strong acid or base. This test probes the variability of the HyPURITY surface by determining the presence of metal ions. Comparison of peak symmetry of two regioisomers, 2,3- and 2,7-dihydroxynapthalene is monitored. The former chelates while the latter does not. Acids and alcohols are also included in this test mixture to illustrate the applicability of the HyPURITY C18 media to a range of analytes where both chelating and hydrogen bonding secondary interactions are possible. Without careful control of the media surface, these interactions can change the overall selectivity and performance in terms of peak shape. This test gives the chromatographer confidence in the lot-to-lot reproducibility of the HyPURITY C18 media.

Its excellent peak shapes make HyPURITY C18 columns the ideal choice for use with demanding LC/MS applications (Figure 18). Mobile phase modifier compatibility and enhanced stability and lifetime make HyPURITY C18 columns the best all-round choice for LC/MS method development.

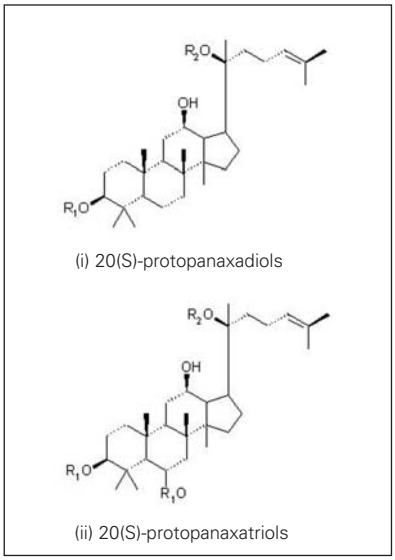



Figure 19: Structure of Ginsenosides

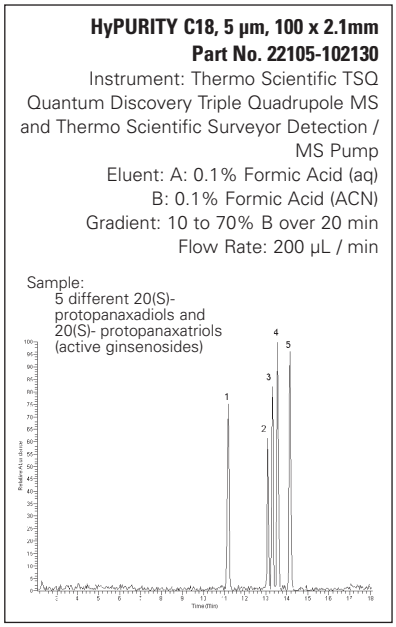



Figure 18: Analysis of Ginseng

| Ginsenoside | $R_1$ | $R_2$ | Mass | Ginsenoside | $R_1$ | $R_2$ | Mass |
|---|---|---|---|---|---|---|---|
| Rb1 | Glc(b1-2)Glc | Glc(b1-6)Glc | 1108.6 | Re | Rha(a1-2)Glc | Glc | 946.5 |
| Rb2 | Glc(b1-2)Glc | Ara(pyr)(a1-6)Glc | 1078.6 | Rf | Glc(b1-2)Glc | HY | 800.5 |
| Rc | Glc(b1-2)Glc | Ara(fur)(a1-6)Glc | 1078.6 | Rg1 | Glc | Glc | 800.5 |
| Rd | Glc(b1-2)Glc | Glc | 946.5 | | | | |

# HyPURITY ADVANCE Columns

## Introduction

HyPURITY ADVANCE media is a reversed phase material with polar embedded groups close to the silica surface. These groups block surface silanols from interacting with polar analytes, and also provide alternative selectivity compared to C18 and C8 phases. HyPURITY ADVANCE columns offer improved chromatographic performance with broad applicability and improved peak shape.

- **A polar embedded stationary phase for alternate selectivity**
- **Ideal for high throughput fast analyses**
- **Enhanced aqueous stability**
- **Exceptional peak shape for acids, bases and chelators**

## Alternative Selectivity through Alternative Retention Mechanisms

Multiple interactions occur between analytes and the HyPURITY ADVANCE bonded phase to determine selectivity. The C8 chain portion of the HyPURITY ADVANCE media retains analytes according to the hydrophobic interactions that occur in standard reversed phase chromatography. In addition, dipole-dipole interactions occur between the polar embedded group and the polar compounds. Retention mechanisms for HyPURITY ADVANCE columns are illustrated in Figure 20.

The unique polar embedded chemistry of HyPURITY ADVANCE columns can also act to positively repel ionized basic species, resulting in excellent peak shape for these typically problematic compounds. The additional interactions shown may result in a change of elution order for some compounds when compared to a C18 or C8 phase.

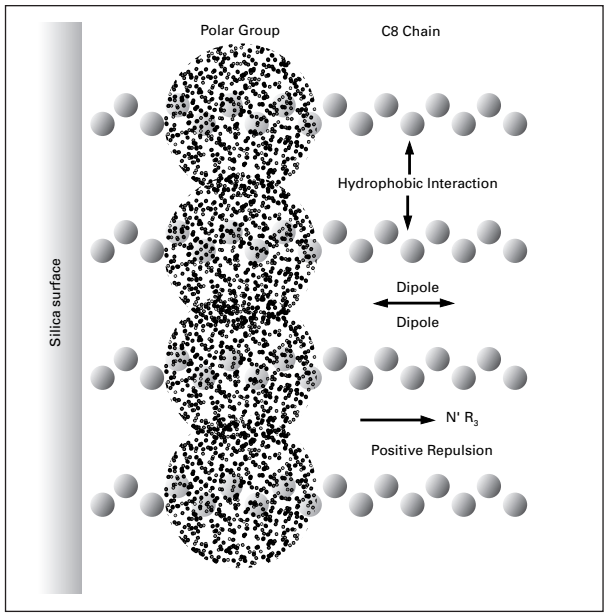



Figure 20: HyPURITY ADVANCE Retention Mechanisms

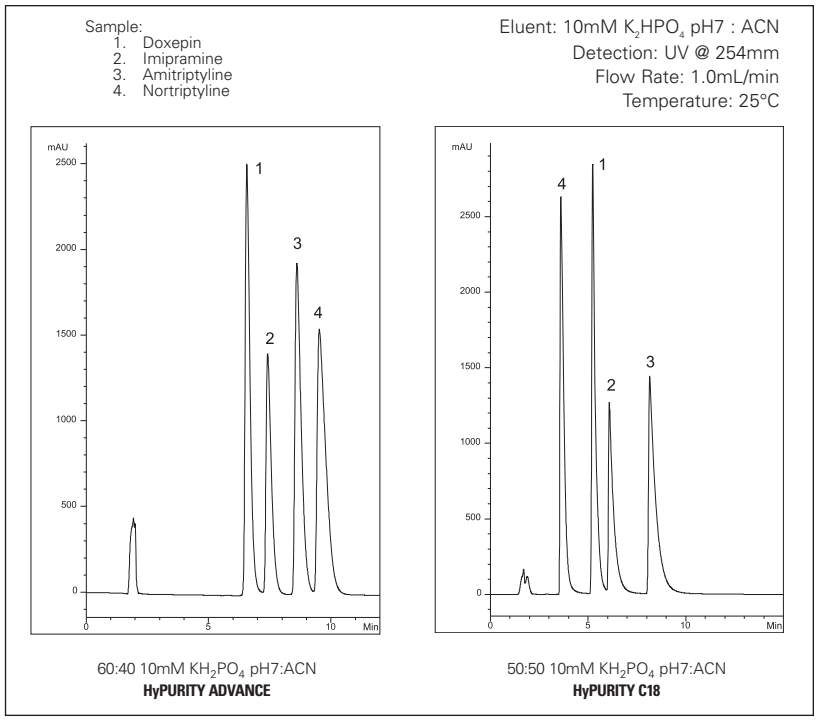



Figure 21: Improved Selectivity using HyPURITY ADVANCE Columns

Changes in elution order can also result from changing the organic solvent in the mobile phase. As in Figure 22, using methanol causes the coelution of peaks 3 and 4, but by changing to acetonitrile, peaks 3 and 4 separate.

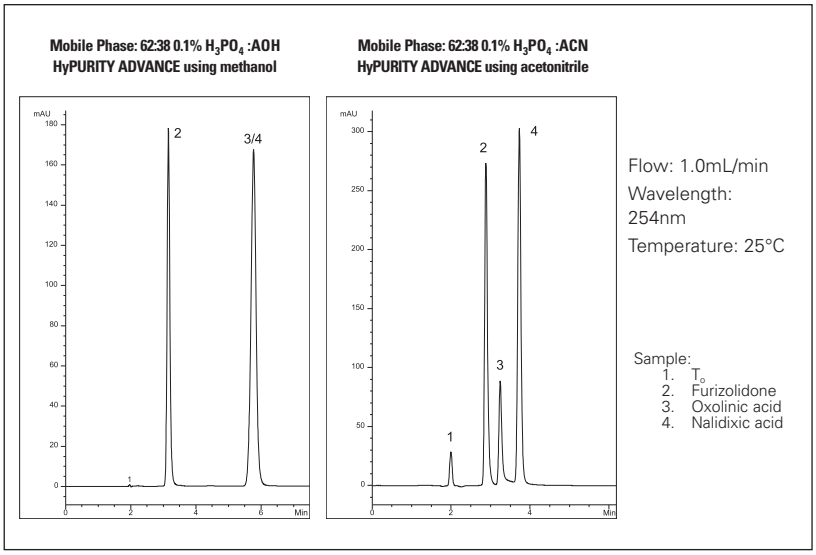
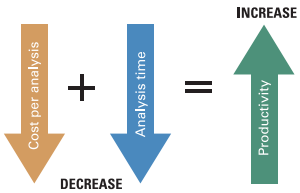



Figure 22: Selectivity Changes by Changing Organic Solvent

## Outstanding Sample Throughput

HyPURITY ADVANCE columns are designed to provide high sample throughput. Fast analyses use less solvent and their turn-around time is shorter, therefore providing an overall decrease in the real cost per sample analysis.




Not all polar embedded phases are the same. The polar group and the attached alkyl ligand often differ and result in different elution profiles for the same analytes under the same. Using a HyPURITY ADVANCE column, the analysis time for a basic analyte mixture can be reduced by almost 50% without compromising baseline resolution and performance.

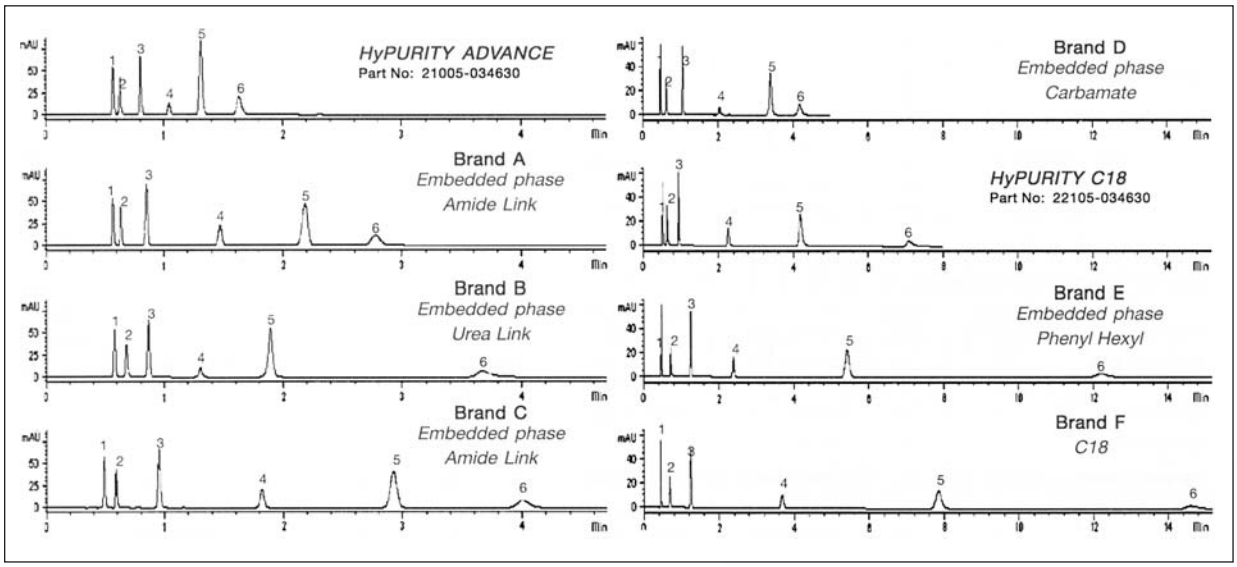



Figure 23: Similar Polar Embedded Chemistries Generate Markedly Different Results

## Enhanced Peak Shape

The embedded polar group within the alkyl chain in HyPURITY ADVANCE columns inhibits secondary interactions between the analyte and any silanol groups present at the silica surface. This results in exceptional peaks shapes for a wide variety of compounds as shown in Figures 24 and 25. This polar group also inhibits water molecules from collapsing the alkyl chains and causing a loss of column performance in highly aqueous mobile phases.

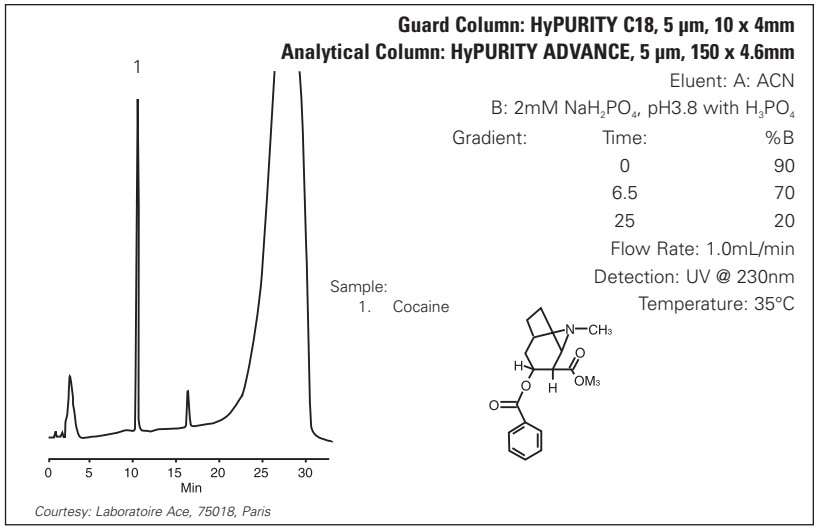



Figure 24: Excellent Peak Shape for Basic Compounds

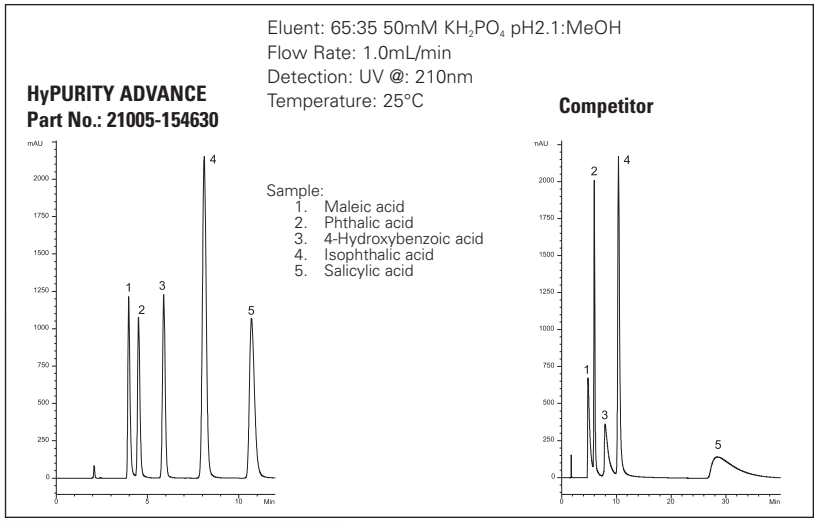
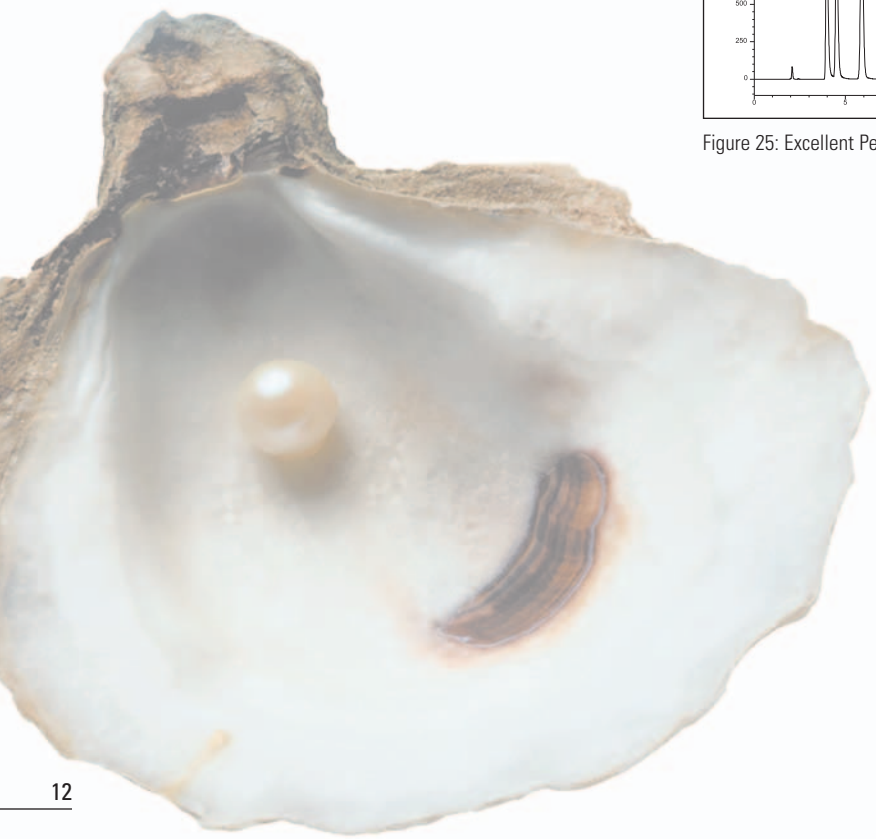



Figure 25: Excellent Peak Shape for Acidic Compounds



# HyPURITY AQUASTAR Columns

## Introduction

Thermo Scientific HyPURITY AQUASTAR columns are a silica-based polar end-capped C18 that is designed to offer superior retention of polar compounds and increased sensitivity in 100% aqueous conditions. The robust nature of the bonded phase makes the column is ideal for HPLC and LC/MS applications. This next generation column also offers unmatched batch reproducibility over previous polar end-capped columns.

- **Increased retention of polar compounds**
- **Chromatographic improvements over end-capped C18**
- **Optimized for LC/MS applications**
- **Unaffected by 100% aqueous conditions**
- **Ideal for critical pairs analyses**

## Increased Polar Analyte Retention

Dispersive interactions are the primary mechanism of retention in traditional alkyl chain columns. Secondary interactions are usually associated with residual silanols and can be reduced by the use of end-capping, high purity silica and increased density of the derivatized ligand.

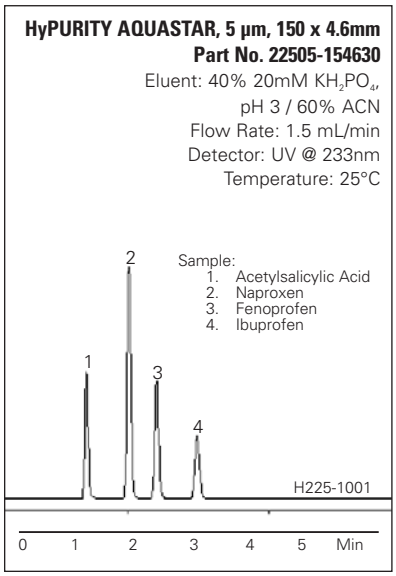



Figure 26: Impressive Polar Analyte Retention on a Silica-Based Column

With HyPURITY AQUASTAR columns, dispersive interactions are reduced but still play a major role in retention of both polar and non polar compounds. The additional of polar end-capping provides a controlled level of secondary interaction to give an additional mechanism by which polar compounds can be retained. This additional mechanism often will result in quite different selectivity or retention behavior over the more traditional C18 packing materials.

## Chromatographic Improvements

Changing to an MS-friendly buffer allows analyses to easily transfer from UV detection to MS detection. The analysis time on HyPURITY AQUASTAR is roughly 50% of that on HyPURITY C18, allowing higher sample throughput and reduced solvent costs (Figure 27).

Compounds that are rich in nitrogen and chlorine such as pesticides, often exhibit poor peak shape on traditional C18 columns. The peak shape is dramatically improved using HyPURITY AQUASTAR and the requirement for complex gradients diminished (Figure 28).

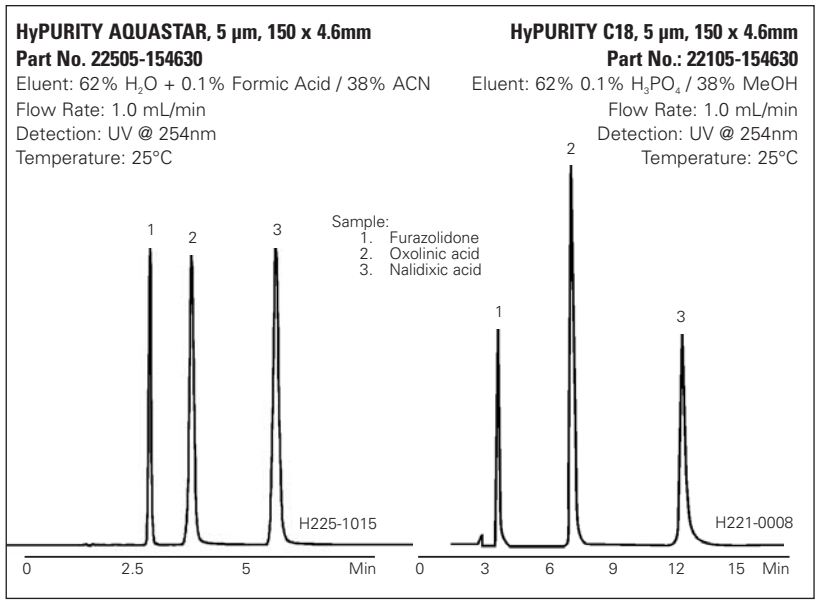



Figure 27: Higher Productivity Achievable using a Polar End-Capped Column

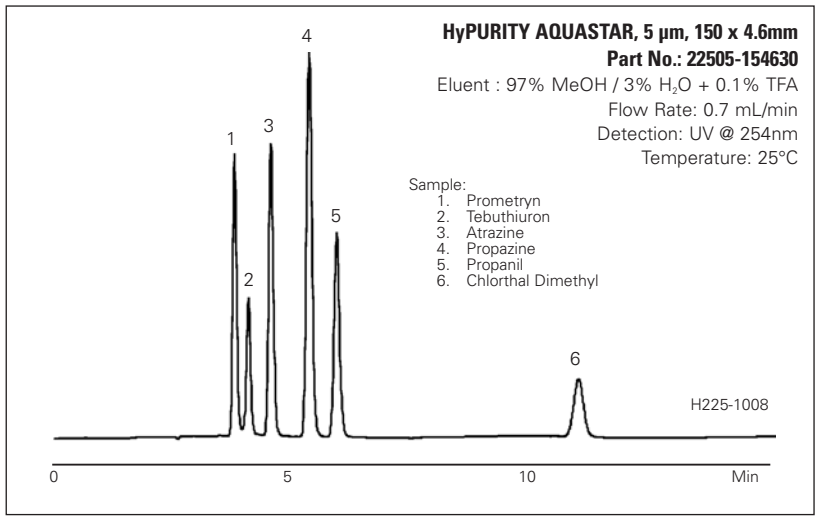



Figure 28: Good Peak Shape for Nitrogen and Chlorine Rich Analytes

## Enhanced Separation Performance

Structurally similar analytes such as cephalosporin antibiotics can be separated using a simple solvent mixture on HyPURITY AQUASTAR columns as shown in Figure 29.

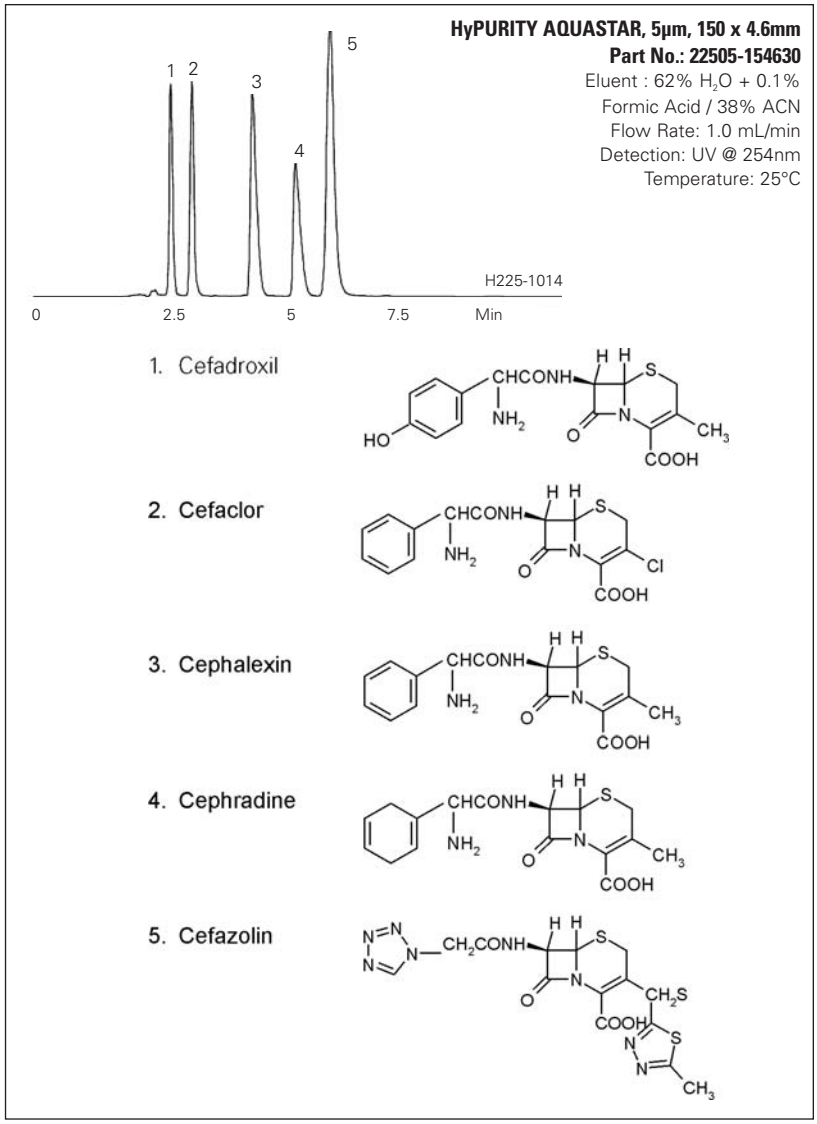



Figure 29: Enhanced Performance in Separation of Closely Related Analytes

## Analyses in 100% Aqueous Conditions

The wetting characteristic of a media in highly aqueous conditions can be increased by the addition of polar functionality. The polar end-capping of the HyPURITY AQUASTAR phase allows it to be used for routine analysis in 100% aqueous conditions without the risk of phase collapse, and the resulting decrease in performance.

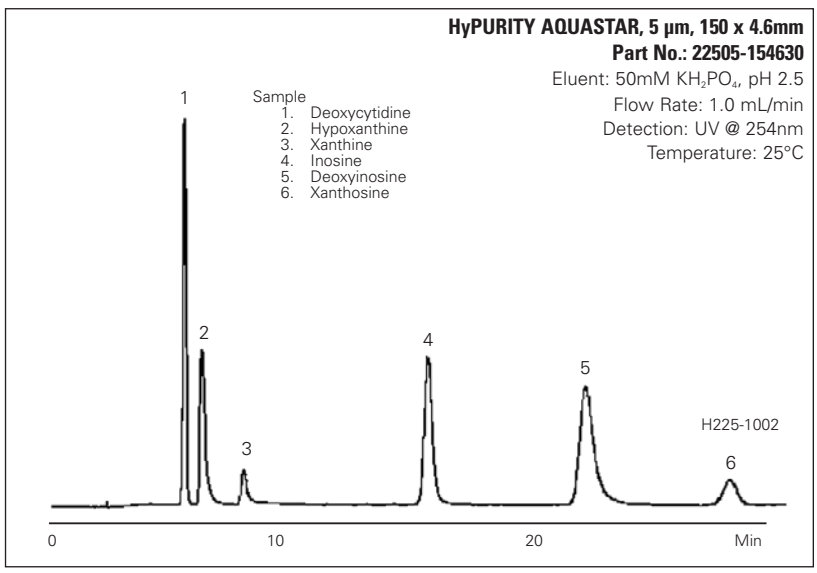



Figure 30: No Phase Collapse in 100% Aqueous Conditions

*HyPURITY columns are available in other column formats. Please contact your local customer support for more details.*

### 5 µm HyPURITY Columns

| Description | Length (mm) | 4.6 mm ID | 4.0 mm ID | 3.0 mm ID | 2.1 mm ID | 1.0 mm ID |
|---|---|---|---|---|---|---|
| HyPURITY C18 | 30 | 22105-034630 | 22105-034030 | 22105-033030 | 22105-032130 | 22105-031030 |
| | 50 | 22105-054630 | 22105-054030 | 22105-053030 | 22105-052130 | 22105-051030 |
| | 100 | 22105-104630 | 22105-104030 | 22105-103030 | 22105-102130 | 22105-101030 |
| | 150 | 22105-154630 | 22105-154030 | 22105-153030 | 22105-152130 | 22105-151030 |
| | 250 | 22105-254630 | 22105-254030 | 22105-253030 | 22105-252130 | 22105-251030 |
| HyPURITY C8 | 50 | 22205-054630 | 22205-054030 | 22205-053030 | 22205-052130 | 22205-051030 |
| | 100 | 22205-104630 | 22205-104030 | 22205-103030 | 22205-102130 | 22205-101030 |
| | 150 | 22205-154630 | 22205-154030 | 22205-153030 | 22205-152130 | 22205-151030 |
| | 250 | 22205-254630 | 22205-254030 | 22205-253030 | 22205-252130 | 22205-251030 |
| HyPURITY C4 | 50 | 22405-054630 | 22405-054030 | 22405-053030 | 22405-052130 | 22405-051030 |
| | 100 | 22405-104630 | 22405-104030 | 22405-103030 | 22405-102130 | 22405-101030 |
| | 150 | 22405-154630 | 22405-154030 | 22405-153030 | 22405-152130 | 22405-151030 |
| | 250 | 22405-254630 | 22405-254030 | 22405-253030 | 22405-252130 | 22405-251030 |
| HyPURITY Cyano | 50 | 22805-054630 | 22805-054030 | 22805-053030 | 22805-052130 | 22805-051030 |
| | 100 | 22805-104630 | 22805-104030 | 22805-103030 | 22805-102130 | 22805-101030 |
| | 150 | 22805-154630 | 22805-154030 | 22805-153030 | 22805-152130 | 22805-151030 |
| | 250 | 22805-254630 | 22805-254030 | 22805-253030 | 22805-252130 | 22805-251030 |
| HyPURITY ADVANCE | 50 | 21005-054630 | 21005-054030 | 21005-053030 | 21005-052130 | 21005-051030 |
| | 100 | 21005-104630 | 21005-104030 | 21005-103030 | 21005-102130 | 21005-101030 |
| | 150 | 21005-154630 | 21005-154030 | 21005-153030 | 21005-152130 | 21005-151030 |
| | 250 | 21005-254630 | 21005-254030 | 21005-253030 | 21005-252130 | 21005-251030 |
| HyPURITY AQUASTAR | 50 | 22505-054630 | 22505-054030 | 22505-053030 | 22505-052130 | 22505-051030 |
| | 100 | 22505-104630 | 22505-104030 | 22505-103030 | 22505-102130 | 22505-101030 |
| | 150 | 22505-154630 | 22505-154030 | 22505-153030 | 22505-152130 | 22505-151030 |
| | 250 | 22505-254630 | 22505-254030 | 22505-253030 | 22505-252130 | 22505-251030 |

*Other column dimensions and hardware designs are available. Please call Customer Service for more information.*

### 5 µm HyPURITY Drop-In Guard Cartridges

| Description | Length (mm) | 4.6 mm ID | 4.0 mm ID | 3.0 mm ID | 2.1 mm ID | 1.0 mm ID |
|---|---|---|---|---|---|---|
| HyPURITY C18 | 10 | 22105-014001 | 22105-014001 | 22105-013001 | 22105-012101 | 22105-011001 |
| HyPURITY C8 | 10 | 22205-014001 | 22205-014001 | 22205-013001 | 22205-012101 | 22205-011001 |
| HyPURITY C4 | 10 | 22405-014001 | 22405-014001 | 22405-013001 | 22405-012101 | 22405-011001 |
| HyPURITY Cyano | 10 | 22805-014001 | 22805-014001 | 22805-013001 | 22805-012101 | 22805-011001 |
| HyPURITY ADVANCE | 10 | 21005-014001 | 21005-014001 | 21005-013001 | 21005-012101 | 21005-011001 |
| HyPURITY AQUASTAR | 10 | 22505-014001 | 22505-014001 | 22505-013001 | 22505-012101 | 22505-011001 |
| UNIGUARD™ Direct-Connect Drop-in Guard Cartridge Holder  | | 850-00 | 850-00 | 852-00 | 852-00 | 851-00 |

### 3 µm HyPURITY Columns

| Description | Length (mm) | 4.6 mm ID | 4.0 mm ID | 3.0 mm ID | 2.1 mm ID | 1.0 mm ID |
|---|---|---|---|---|---|---|
| HyPURITY C18 | 30 | 22103-034630 | 22103-034030 | 22103-033030 | 22103-032130 | 22103-031030 |
| | 50 | 22103-054630 | 22103-054030 | 22103-053030 | 22103-052130 | 22103-051030 |
| | 100 | 22103-104630 | 22103-104030 | 22103-103030 | 22103-102130 | 22103-101030 |
| | 150 | 22103-154630 | 22103-154030 | 22103-153030 | 22103-152130 | 22103-151030 |
| HyPURITY ADVANCE | 50 | 21003-054630 | 21003-054030 | 21003-053030 | 21003-052130 | 21003-051030 |
| | 100 | 21003-104630 | 21003-104030 | 21003-103030 | 21003-102130 | 21003-101030 |
| | 150 | 21003-154630 | 21003-154030 | 21003-153030 | 21003-152130 | 21003-151030 |
| HyPURITY AQUASTAR | 30 | 22503-034630 | 22503-034030 | 22503-033030 | 22503-032130 | 22503-031030 |
| | 50 | 22503-054630 | 22503-054030 | 22503-053030 | 22503-052130 | 22503-051030 |
| | 100 | 22503-104630 | 22503-104030 | 22503-103030 | 22503-102130 | 22503-101030 |
| | 150 | 22503-154630 | 22503-154030 | 22503-153030 | 22503-152130 | 22503-151030 |

*Other column dimensions are available. Please call customer service for more information.*

### 3µm HyPURITY Drop-In Guard Cartridges

| Description | Length (mm) | 4.6 mm ID | 4.0 mm ID | 3.0 mm ID | 2.1 mm ID | 1.0 mm ID |
|---|---|---|---|---|---|---|
| HyPURITY C18 | 10 | 22103-014001 | 22103-014001 | 22103-013001 | 22103-012101 | 22103-011001 |
| HyPURITY ADVANCE | 10 | 21003-014001 | 21003-014001 | 21003-013001 | 21003-012101 | 21003-011001 |
| HyPURITY AQUASTAR | 10 | 22503-014001 | 22503-014001 | 22503-013001 | 22503-012101 | 22503-011001 |
| UNIGUARD™ Direct-Connect Drop-in Guard Cartridge Holder  | | 850-00 | 850-00 | 852-00 | 852-00 | 851-00 |

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