Chromatography

NUCLEODUR®

Professional solutions for HPLC

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An optimized phase for every field of application

MACHEREY-NAGEL
www.mn-net.com
MN Since 1911

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Meeting your needs

If you have any questions concerning our NUCLEODUR® program or other chromatography products, please feel free to contact us:

Technical support and customer service **phone** +49 24 21 969-175
e-mail tech-chroma@mn-net.com

The MACHEREY-NAGEL internet catalog with integrated webshop is full of useful information about our wide product range. In addition our online database offers more than 3000 applications which might actually already solve your analytical questions.

www.mn-net.com

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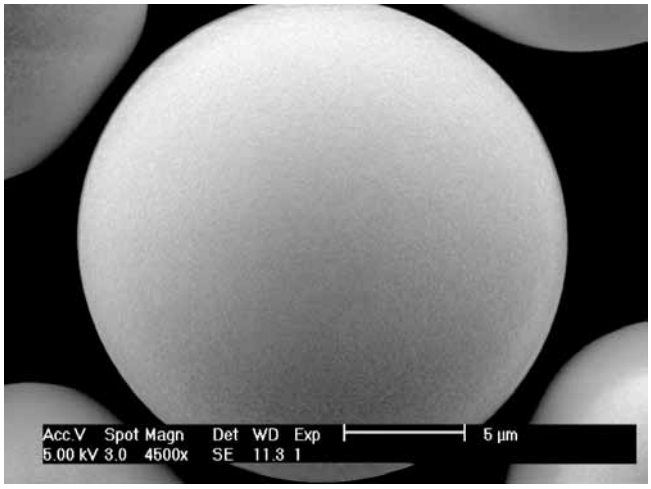
NUCLEODUR®

NUCLEODUR® is a fully synthetical type B silica (silica of 3rd generation) offering highly advanced physical properties like **totally spherical** particle shape, outstanding **surface smoothness**, high pressure stability and **low metal content**.

NUCLEODUR® as a state-of-the-art silica is the ideal base material for modern HPLC phases. It is the result of MACHEREY-NAGEL's pioneering research in chromatography for more than 40 years and worthy successor of MN's world famous NUCLEOSIL® silica.

In RP liquid chromatography the efficiency of the packing is strongly affected by the quality of the base silica itself. Shortcomings in the surface geometry of the particles or metal contaminants are the main reasons for inadequate coverage with the covalently bonded alkylsilanes in the subsequent derivatization steps. It is well known, that poor surface coverage and, in consequence, high activity of residual free silanols often results in peak tailing or adsorption, particularly with basic compounds.

Particle shape and surface symmetry



NUCLEODUR® silicas are synthesized in a unique and carefully controlled manufacturing process which provides silica particles, which are totally spherical. The picture shows the outstanding smoothness of the NUCLEODUR® surface.

Purity

As already mentioned above, a highly pure silica is required for achieving symmetric peak shapes and maximum resolution.

Inclusions of, e.g., iron or alkaline earth metal ions on the silica surface are largely responsible for the unwanted interactions with ionizable analytes, e.g., amines or phenolic compounds (see appl. 118630 on page 63).

NUCLEODUR® is virtually free of metal impurities and low acidic surface silanols. Elemental analysis data of NUCLEODUR® 5 µm measured by AAS are listed below.

Elementary analysis (metal ions) of NUCLEODUR® 100-5

Aluminium	<	5	ppm
Iron	<	5	ppm
Sodium	<	5	ppm
Calcium	<	10	ppm
Titanium	<	1	ppm
Zirconium	<	1	ppm
Arsenic	<	0.5	ppm
Mercury	<	0.05	ppm

Pressure stability

The totally spherical and 100% synthetic silica gel exhibits an outstanding mechanical stability, even at high pressures and elevated eluent flow rates. In addition, after several cycles of repeated packing, no significant drop in pressure can be observed. The latter is of prime importance for preparative and process-scale applications.

Physical data of NUCLEODUR®

Surface area (BET)	340 m^2/g
Pore size	110 Å
Pore volume	0.9 mL/g

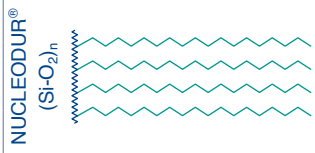
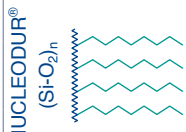
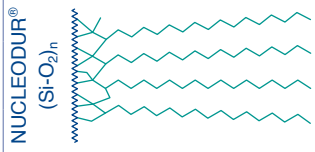
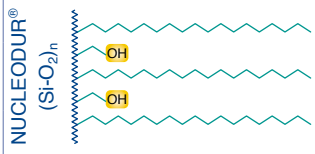
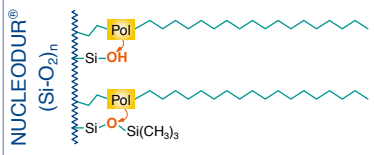
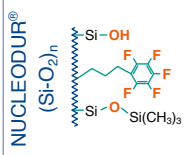
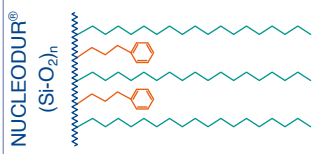
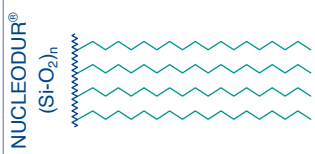
NUCLEODUR® modifications

Several different surface modifications based on NUCLEODUR® silica have been developed over the last years providing a full range of specified HPLC phases and an ideal tool for every separation:

- NUCLEODUR® C_{18} Gravity and C_8 Gravity
- NUCLEODUR® C_{18} Isis
- NUCLEODUR® C_{18} Pyramid
- NUCLEODUR® PolarTec
- NUCLEODUR® PFP
- NUCLEODUR® Sphinx RP
- NUCLEODUR® C_{18} HTec
- NUCLEODUR® C_{18} ec and C_8 ec
- NUCLEODUR® HILIC
- NUCLEODUR® CN and CN-RP
- NUCLEODUR® NH_2 and NH_2-RP
- unmodified NUCLEODUR®

All phases are described in detail on the following pages.

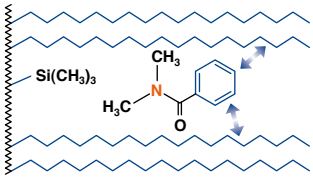
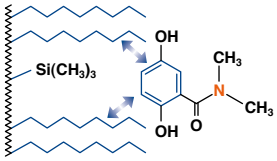
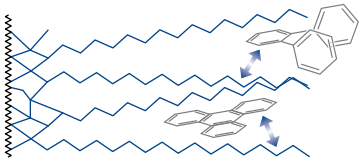
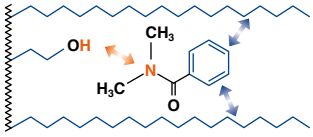
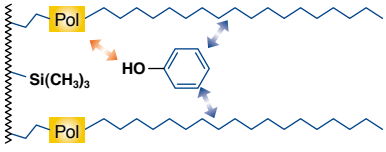
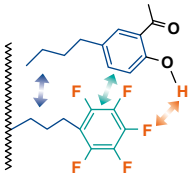
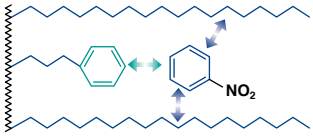
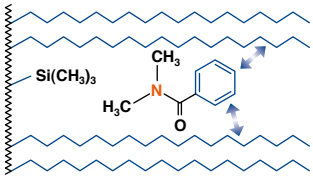
Overview of NUCLEODUR® HPLC phases

Phase	Specification	Characteristics*	Stability	Structure
C_{18} Gravity	octadecyl phase, high density coating, multi-endcapping 18 % C · USP **L1**	A B C	pH stability 1–11, suitable for LC/MS	
C_8 Gravity	octyl phase, high density coating, multi-endcapping 11 % C · USP **L7**	A B C	pH stability 1–11, suitable for LC/MS	
C_{18} Isis	octadecyl phase with specially crosslinked surface modification, endcapping 20 % C · USP **L1**	A B C	pH stability 1–10, suitable for LC/MS	
C_{18} Pyramid	C_{18} modification with polar endcapping 14 % C · USP **L1**	A B C	stable against 100 % aqueous eluents, pH stability 1–9, suitable for LC/MS	
PolarTec	octadecyl phase with embedded polar group, endcapping 15.5 % C · USP **L1** and **L60**	A B C	stable against 100 % aqueous eluents, pH stability 1–9, suitable for LC/MS	
PFP	pentafluorophenyl-propyl modification with multi-endcapping 8 % C · USP **L43**	A B C	pH stability 1–9, suitable for LC/MS	
Sphinx RP	bifunctional RP phase, propylphenyl and C_{18} ligands, endcapping 15 % C · USP **L1** and **L11**	A B C	pH stability 1–10, suitable for LC/MS	
C_{18} HTec	octadecyl phase with high capacity, high density coating, multi-endcapping 18 % C · USP **L1**	A B C	pH stability 1–11, suitable for LC/MS	

* A = hydrophobic selectivity, B = polar / ionic selectivity, C = steric selectivity

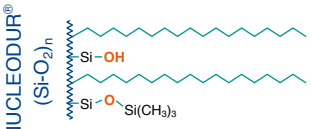
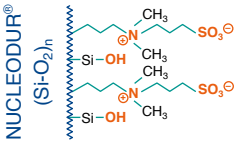
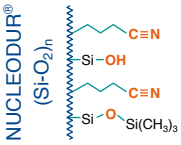
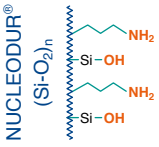
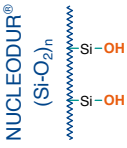
NUCLEODUR®

An optimized phase for every separation

	Application	Similar phases**	Separation principle · Retention mechanism	
	in general compounds with ionizable functional groups such as basic pharmaceuticals and pesticides	**NUCLEOSIL® C_{18} HD** XTerra® RP18 / MS C_{18}; Luna® C18(2), Gemini®, Synergi® Max RP; Zorbax® Extend-C18; Inertsil® ODS III; Purospher® STAR RP-18; Hypersil™ BDS	**only hydrophobic interactions** (van der Waals interactions)	
	like C_{18} Gravity, however generally shorter retention times for nonpolar compounds	**NUCLEOSIL® C_8 HD** XTerra® RP8 / MS C_8; Luna® C8; Zorbax® Eclipse XDB-C8	**only hydrophobic interactions** (van der Waals interactions)	
	high steric selectivity, thus suited for separation of positional and structural isomers, planar/nonplanar molecules	**NUCLEOSIL® C_{18} AB** Inertsil® ODS-P; Pro C18 RS; Zorbax® SB	**steric interactions** and **hydrophobic interactions**	
	basic pharmaceutical ingredients, very polar compounds, organic acids	Aqua, Synergi® Hydro-RP; AQ; Atlantis® dC_{18}	**hydrophobic interactions** and **polar interactions** (H bonds)	
	basic pharmaceuticals, organic acids, pesticides, amino acids, water-soluble vitamins	**NUCLEOSIL® C_{18} Nautilus** ProntoSIL® C18; Zorbax® Bonus-RP, Polaris® Amide-C18; Ascentis® RP Amide; SymmetryShield™ RP18; SUPELCOSIL™ LC-ABZ+; HyPURITY™ ADVANCE	**hydrophobic interactions** and **polar interactions** (H bonds)	
	aromatic and unsaturated compounds, halogen compounds, phenols, isomers, polar pharmaceuticals, antibiotics	ACQUITY® CSH Fluoro-Phenyl; Hypersil™ GOLD PFP; Luna® PFP(2); Discovery® HS F5; Allure® PFP Propyl, Ultra II PFP Propyl	**polar interactions** (H bonds), **dipole-dipole interactions** **π-π interactions** and **hydrophobic interactions**	
	compounds with aromatic and multiple bond systems	no similar phases	**π-π interactions** and **hydrophobic interactions**	
	robust and well base deactivated C_{18} phase; all separation tasks with preparative potential	XTerra® RP18 / MS C_{18} / SunFire™ C_{18}; Luna® C18(2), Gemini®, Synergi® Max RP; Zorbax® Extend-C18; Inertsil® ODS III; Purospher® STAR RP-18; Hypersil™ BDS	**only hydrophobic interactions** (van der Waals interactions)	

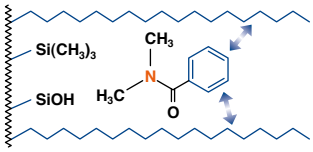
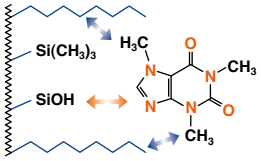
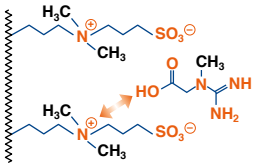
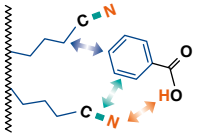
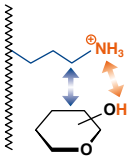
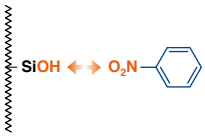
** phases which provide a similar selectivity based on chemical and physical properties

Overview of NUCLEODUR® HPLC phases

Phase	Specification	Characteristics*	Stability	Structure
C_{18} ec	octadecyl phase, medium density coating endcapping 17.5 % C · USP **L1**	A B C	pH stability 1–9	
C_8 ec	octyl phase, medium density coating endcapping 10.5 % C · USP **L7**	A B C	pH stability 1–9	
HILIC	zwitterionic ammonium sulfonic acid modification 7 % C	A B C –	pH stability 2–8.5, suitable for LC/MS	
CN / CN–RP	cyano (nitrile) phase for NP and RP separations 7 % C · USP **L10**	A B C –	pH stability 1–8, stable towards highly aqueous mobile phases	
NH_2 / NH_2–RP	amino phase for NP and RP separations 2.5 % C · USP **L8**	A B C –	pH stability 2–8, stable towards highly aqueous mobile phases	
SiOH	unmodified high purity silica USP **L3**	A – B n.a. C –	pH stability 2–8	

* A = hydrophobic selectivity, B = polar / ionic selectivity, C = steric selectivity

An optimized phase for every separation

	Application	Similar phases**	Separation principle · Retention mechanism	
	robust C_{18} phase for routine analyses	**NUCLEOSIL® C_{18}** Spherisorb® ODS II, Symmetry® C_{18}; Hypersil™ ODS; Inertsil® ODS II; Kromasil C_{18}; LiChrospher® RP-18	**only hydrophobic interactions** (van der Waals interactions) some residual silanol interactions	
	robust C_8 phase for routine analyses	**NUCLEOSIL® C_8 ec / C_8** Spherisorb® C_8, Symmetry® C_8; Hypersil™ MOS; Kromasil C_8; LiChrospher® RP-8	**only hydrophobic interactions** (van der Waals interactions) some residual silanol interactions	
	hydrophilic compounds such as organic polar acids and bases, polar natural compounds	SeQuant™ ZIC®-HILIC; Obelisc™	**ionic / hydrophilic interactions, electrostatic interactions**	
	polar organic compounds (basic drugs), molecules containing π electron systems	**NUCLEOSIL® CN / CN-RP**	**π-π interactions, polar interactions** (H bonds), **hydrophobic interactions**	
	sugars, sugar alcohols and other hydroxy compounds, DNA bases, polar compounds in general	**NUCLEOSIL® NH_2 / NH_2-RP**	**polar / ionic interactions, hydrophobic interactions**	
	polar compounds in general	**unmodified NUCLEOSIL®**	**polar / ionic interactions**	

** phases which provide a similar selectivity based on chemical and physical properties

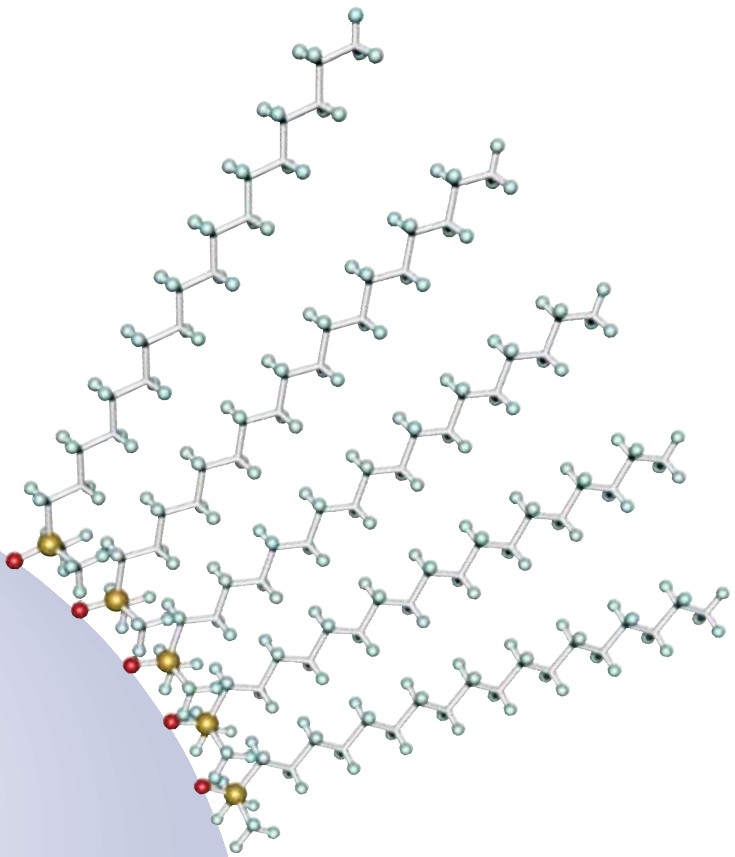
1.8 µm particle size

- **Key features**
  - Decrease of analysis time (ultra fast HPLC)
  - Shorter columns with high separation efficiency
  - Significant improvement of resolution and detection sensitivity
  - Suitable for **LC/MS** due to low bleeding characteristics
- NUCLEODUR® 1.8 µm particles are fractionated to limit the increase in back pressure

- **NUCLEODUR® phases available in 1.8 µm:**
  C_{18} Gravity
  C_8 Gravity
  C_{18} Isis
  C_{18} Pyramid
  Sphinx RP
  C_{18} HTec
  HILIC

Advantages of 1.8 µm particle size

Miniaturization in HPLC has a long history. It started in the early stage of HPLC development with the reduction of particle size from 10 µm via 7 µm to standard 5 µm – which is still the most widely used particle diameter in analytical HPLC – to 3 µm spherical particles which so far was the smallest particle size available for gaining higher theoretical plates and efficiencies. With the introduction of 1.8 µm NUCLEODUR® particles researchers have turned over a new leaf in HPLC column technology. Columns packed with these microspherical particles show extraordinary improvements in terms of plate numbers, column efficiencies and resolution compared with their 3 µm counterparts.



Features of 1.8 µm NUCLEODUR® silica particles

- **Increase of separation efficiency by higher number of theoretical plates (N):**

  50 x 4.6 mm NUCLEODUR® C_{18} Gravity
  3 µm: N ≥ 100 000 plates/m (h value ≤ 10)
  1.8 µm: N ≥ 166 667 plates/m (h value ≤ 6)

  Increase of the plate number by app. 67% offers the possibility of using shorter columns with equal plate numbers resulting in a decrease of analysis time.

- **Significant improvement in resolution**

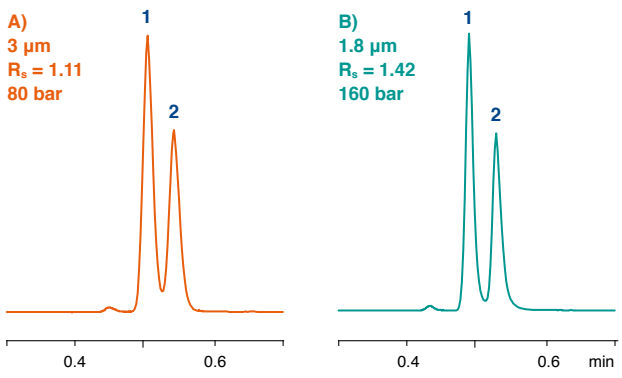
  Use of 1.8 µm instead of 3 µm particles leads to an increase of resolution by a factor 1.29 (29%) since the resolution is inversely proportional to the square root of the particle size:

$$R_s = \frac{\sqrt{N}}{4}\left(\frac{\alpha - 1}{\alpha}\right)\left(\frac{k_i'}{k_i' + 1}\right)$$

R_s = resolution
α = selectivity (separation factor)
k_i' = retention
N = plate number with $N \propto 1/d_P$
d_P = particle size

Resolution as a function of particle size

Column: 50 x 4 mm NUCLEODUR® C_{18} Gravity
A) 3 µm, B) 1.8 µm
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 2 mL/min, pressure: A) 80 bar, B) 160 bar
Detection: UV, 254 nm
Peaks:
1. Naphthalene
2. Ethylbenzene



Increase in separation efficiency

Column back pressure

Due to the smaller particle size the back pressure will increase according to

$$\Delta_P = \frac{\Phi \cdot L_C \cdot \eta \cdot u}{d_P^2}$$

Δ_P = pressure drop
Φ = flow resistance (nondimensional)
L_C = column length
η = viscosity
u = linear velocity
d_P = particle diameter

Because of the high sphericity of the NUCLEODUR® particles and the very narrow particle size distribution we were able to keep the back pressure on a moderate level. Nevertheless the use of columns packed with sub 2 µm particles generally makes special demands on the HPLC equipment. Pumps should be designed for pressures of 250–1000 bars and the entire system should feature the lowest possible dead volume.

Comparison of back pressures:

Eluent: 100 % methanol
Flow rate: 1.5 mL/min
Temperature: 22 °C
Column dimension: 50 x 4.6 mm

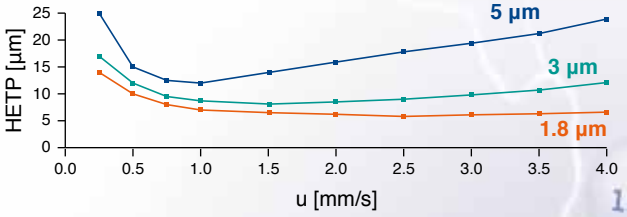
	NUCLEODUR® C_{18} Gravity	Competitor A
3 µm	70 bar	-
1.8 µm	130 bar	170 bar

Higher flow rates and shorter run times

optimal flow rate for 1.8 µm particles is higher than for 3 and 5 µm particles (see figures – the flow rate should be at the van-Deemter minimum)

Van-Deemter plot

column 50 x 4.6 mm, acetonitrile – water (50:50, v/v), analyte toluene



Technical requirements

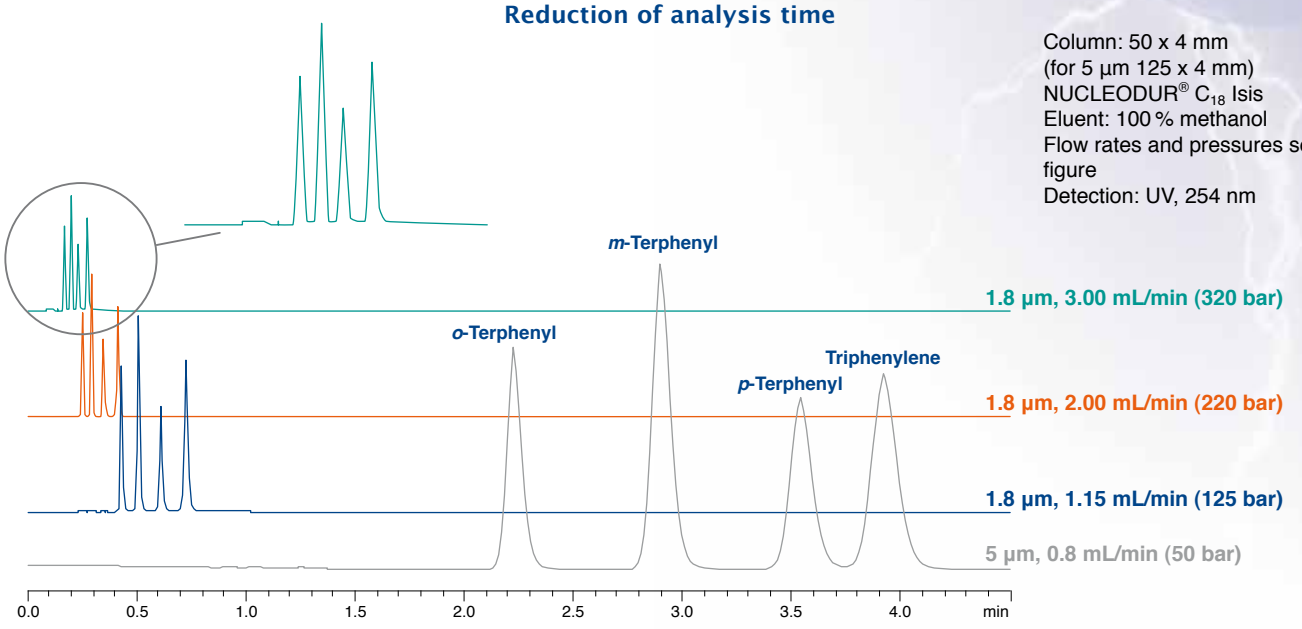
To gain the best result in ultra fast HPLC based on 1.8 µm particles certain technical demands on the instrument are made. Pumps for pressures of 250–1000 bar realizing a flow rate of 2–3 mL are required. The dead volume of the LC system has to be reduced to a minimum. In addition, fast data recording is necessary for an optimum chromatographic result.

Currently the following NUCLEODUR® premium phases (C_{18} Gravity, C_8 Gravity, C_{18} Isis, C_{18} Pyramid, Sphinx RP, C_{18} HTec, HILIC) are available in 1.8 µm. The description of each phase and its selectivity can be found in the individual chapters.

More applications on NUCLEODUR® 1.8 µm can be found in the "Applications" section from page 32.

Reduction of analysis time

Column: 50 x 4 mm
(for 5 µm 125 x 4 mm)
NUCLEODUR® C_{18} Isis
Eluent: 100 % methanol
Flow rates and pressures see figure
Detection: UV, 254 nm



C_{18} Gravity / C_8 Gravity

- **Key features:**
  - Suitable for **LC/MS** and HPLC at pH extremes (pH 1–11)
  - Superior base deactivation
  - Ideal for method development
- **Technical characteristics:**
  Available as octadecyl (C_{18}) and octyl (C_8), multi-endcapped; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm for C_{18}, 1.8 and 5 µm for C_8; 7, 10, 12 and 16 µm particles for preparative purposes on request;
  carbon content 18% for C_{18}, 11% for C_8
- **Recommended application:**
  Overall sophisticated analytical separations

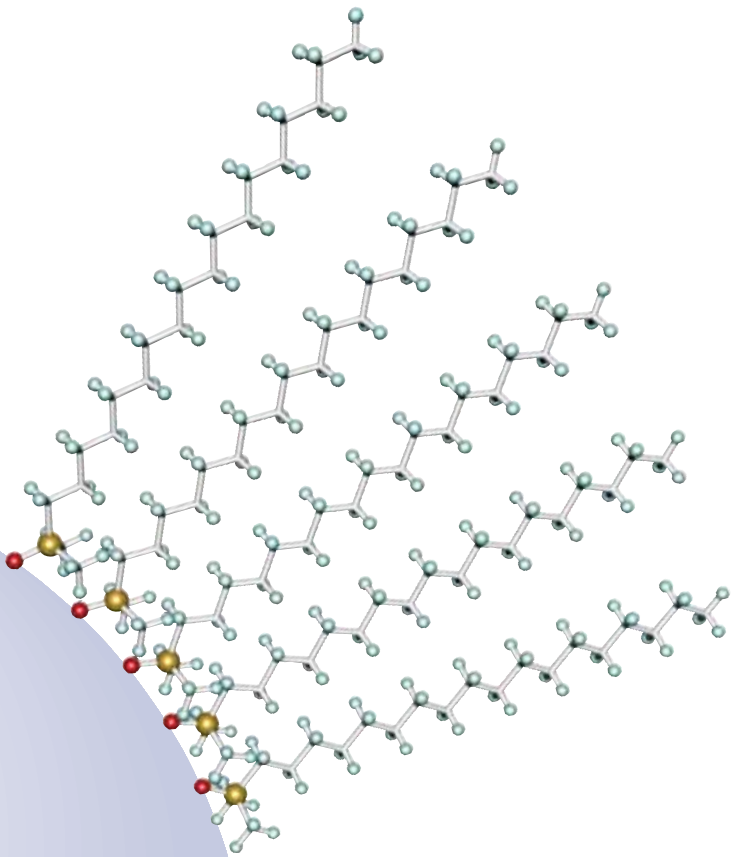
  Compound classes separated include: pharmaceuticals, e.g., analgesics, anti-inflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants

  USP L1 (C_{18}) / USP L7 (C_8)

Base deactivation

NUCLEODUR® C_{18} Gravity and NUCLEODUR® C_8 Gravity are based on the ultrapure NUCLEODUR® silica.

A unique derivatization process generates a homogeneous surface with a high density of bonded silanes (carbon content ~18% for C_{18}, ~11% for C_8). The following thorough endcapping suppresses any unwanted polar interactions between the silica surface and the sample, which makes "Gravity" particularly suitable for the separation of basic and other ionizable analytes. The figure on the right shows a comparison study, where the strongly basic amitriptyline is eluted on various highly base deactivated C_{18} phases under isocratic conditions. For a discussion of the different retention behavior of octadecyl phases compared to octyl phases see page 25.



Tanaka diagrams

Several NUCLEODUR® phases have been examined in accordance with Tanaka et al. [J. Chromatogr. Sci. 27 (1989) 721] and Johnson et al. [Chromatographia 44 (1997) 151] with respect to the following parameters:

Capacity = k'(pentylbenzene)

Hydrophobicity = α(pentylbenzene, butylbenzene)

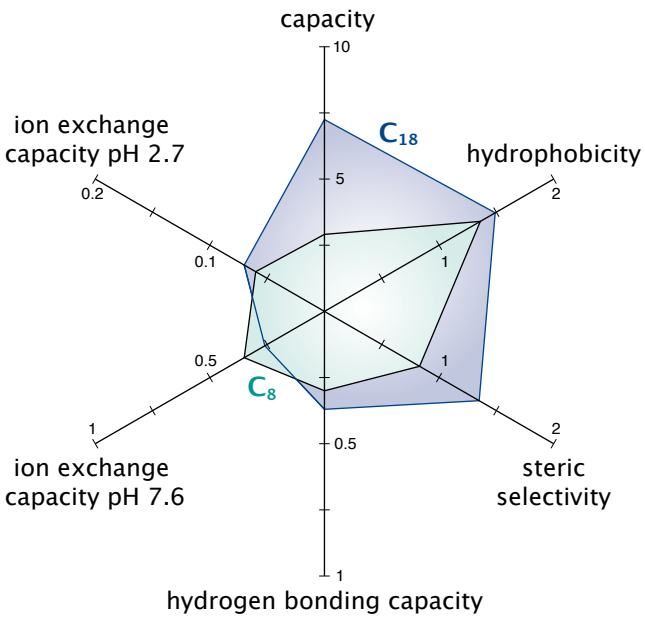
Steric selectivity = α(triphenylene, *o*-terphenyl)

Hydrogen bonding capacity (silanol capacity) = α(caffeine, phenol)

Ion exchange capacity at 2 different pH values (2.7 and 7.6) = α(benzylamine, phenol)

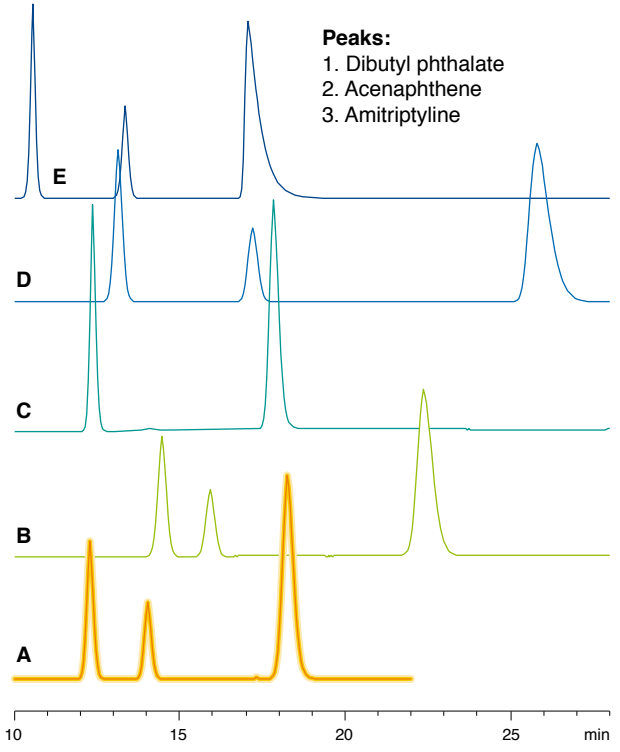
The resulting Tanaka plots are shown with the respective phases.

Tanaka plots of NUCLEODUR® C_8 and C_{18} Gravity



Comparison of different base deactivated phases

Columns: 250 x 4 mm, all phases C_{18}, 5 µm
A) NUCLEODUR Gravity
B) phase I
C) phase L (1 and 2 overlap)
D) phase P
E) phase S
Eluent: methanol – 20 mM KH_2PO_4, pH 7.0 (75:25, v/v)
Flow rate: 1.0 mL/min
Temperature: 30 °C
Detection: UV, 254 nm



MN Appl. No. 120810

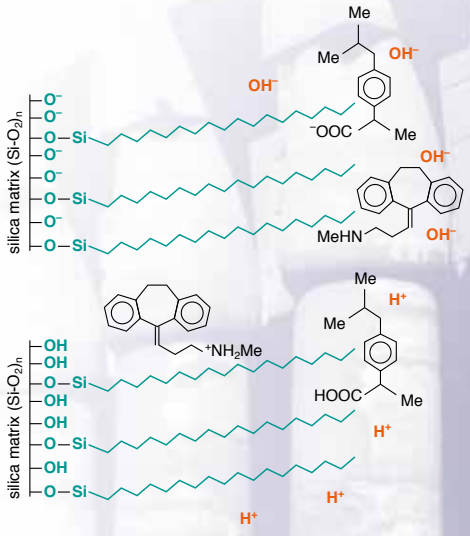
Enhanced pH stability

One major disadvantage of using silica stationary phases is the limited stability at strongly acidic or basic pH ranges. Cleavage of the siloxane bonding by hydrolysis, or dissolution of the silica will rapidly lead to a considerable loss in column performance. Therefore conventional RP phases are usually not recommended to be run with mobile phases at pH > 8 or pH < 2 for extended periods of time. The special surface bonding technology and the low concentration of trace elements of NUCLEODUR® C_8 / C_{18} Gravity allow for use at an expanded pH range from pH 1 to 11.

When is enhanced pH stability beneficial?

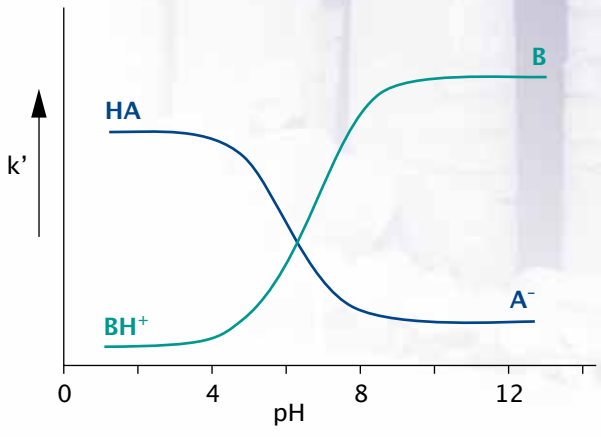
The option to work at an expanded pH range is often required in method development. Many nitrogen containing compounds like basic drugs are protonated at acidic or neutral pH and exhibit poor retention on a standard C_{18} phase. The retention behavior can be improved by working at a higher pH, where the analyte is no longer protonated, but formally neutrally charged, as a rule between pH 9–10. For acidic analytes it is exactly in inverse proportion, maximum retention can be attained at low pH.

Surface silanols at different pH values



The figure above shows the extent of protonation of surface silanols and of two exemplary analytes at acidic and alkaline pH. The following graph explains the general correlation between retention and pH.

Correlation between retention and pH for basic and acidic compounds



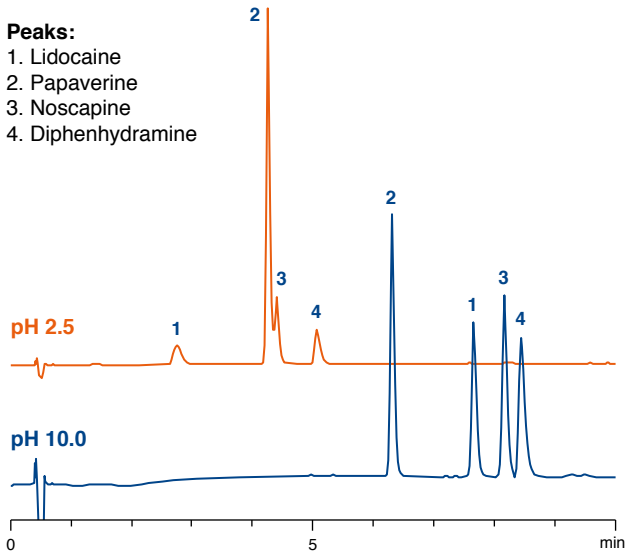
C_{18} Gravity / C_8 Gravity

As it was previously mentioned, pH stability of the stationary phase can be helpful for improving selectivity in method development. The figure below shows the separation of 4 basic drugs under acidic and basic conditions.

Separation of basic alkaloids

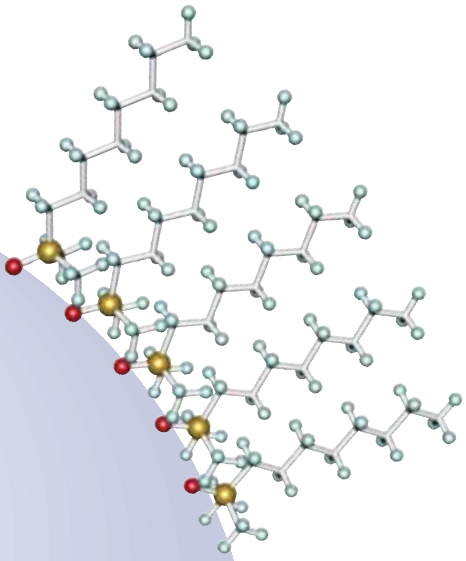
Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent A: acetonitrile
Eluent B: 20 mM $(NH_4)_2HPO_4$, pH 2.5 / 10.0
Gradient: 10 % A (1 min) → 75 % A in 10 min
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 2 µL

Peaks:
1. Lidocaine
2. Papaverine
3. Noscapine
4. Diphenhydramine



MN Appl. No. 118010

At pH 2.5 the protonated analytes exhibit poor retention (early elution) and in addition an inadequate resolution for papaverine and noscapine, whilst the formally non ionized molecules can be baseline separated due to the better retention pattern at alkaline pH.

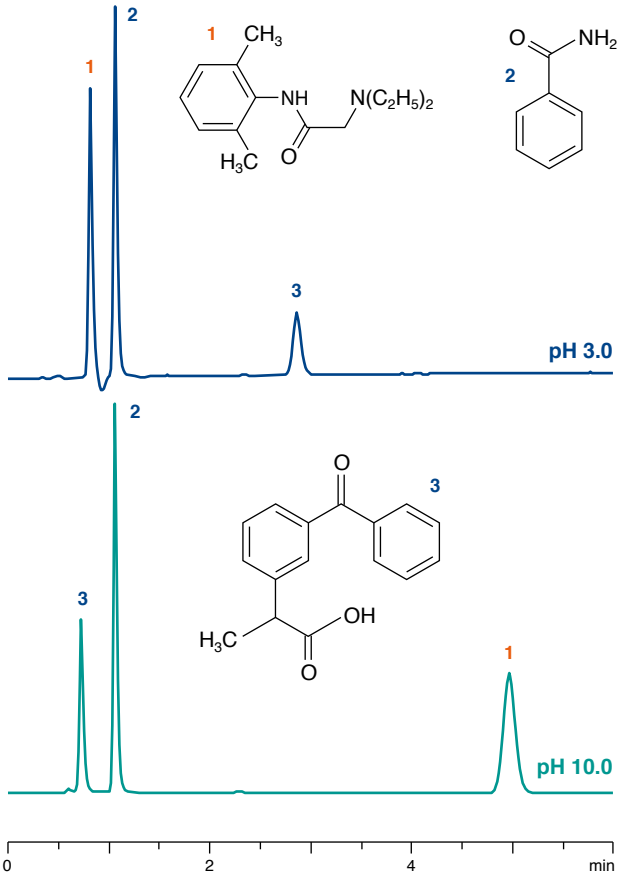


A further example how selectivity can be controlled by the pH value is demonstrated below. The sample mixture consists of an acid (ketoprofen), a base (lidocaine) and benzamide. Under acidic conditions the protonated lidocaine is eluted very fast due to lack of sufficiently strong hydrophobic interactions between analyte and C_{18} chains, in contrary to the formally neutral ketoprofen, which is eluted after about 3 minutes. However at pH 10 a reversal of the elution order, with a visibly longer retention time for the basic lidocaine, can be achieved.

Influence of the pH value on selectivity

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluents: A) acetonitrile – 10 mM ammonium formate, pH 3.0 (50:50, v/v)
B) acetonitrile – 10 mM ammonium bicarbonate, pH 10.0 (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 30 °C
Detection: UV, 230 nm
Injection volume: 2 µL

Peaks:
1. Lidocaine
2. Benzamide
3. Ketoprofen



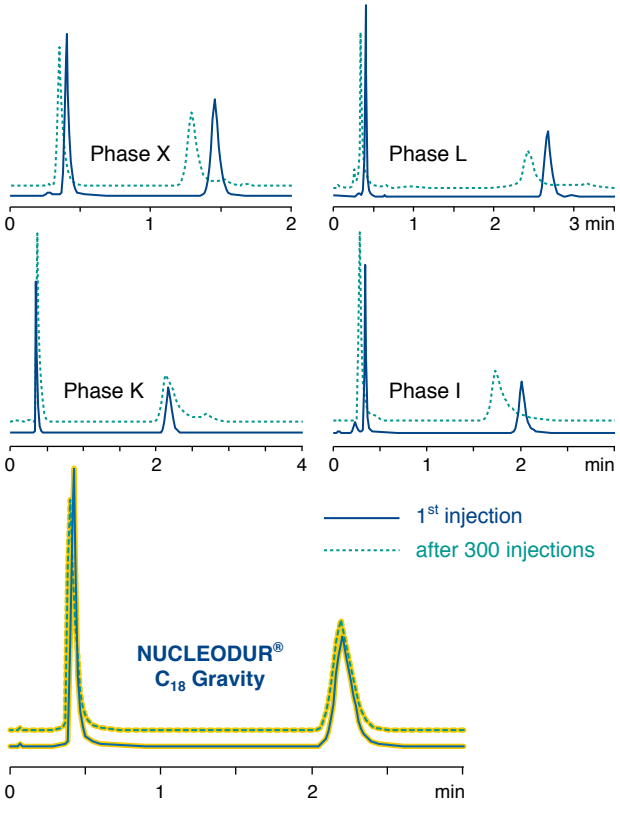
MN Appl. No. 120860

The following chromatograms demonstrate the stability of NUCLEODUR® C_{18} Gravity under alkaline conditions in comparison with 4 commercially available modern RP18 phases. Again, the ultrapure Gravity with its unique high density surface bonding technology withstands strong alkaline mobile phase conditions. Even after 300 injections no loss of column efficiency, identified, e.g., by peak broadening or decrease in retention times, could be observed.

Stability of NUCLEODUR® C_{18} Gravity under alkaline conditions compared with different C_{18} phases

Columns: 50 x 4.6 mm
Eluent: methanol – water – ammonia (20:80:0.5, v/v/v), pH 11
Flow rate: 1.3 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 2.0 µL

Peaks:
1. Theophylline
2. Caffeine



MN Appl. No. 120850

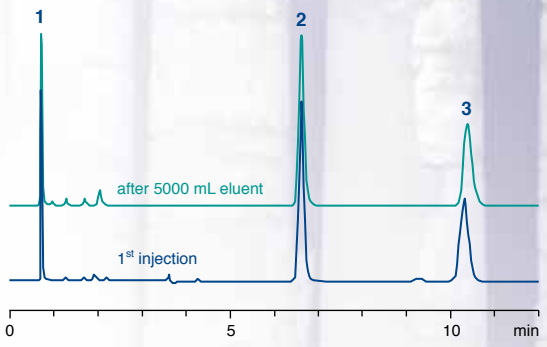
The pH stability of silica under alkaline conditions is mainly a kinetic effect and based on the velocity of the dissolution of the silica support. It is worth mentioning, that this phenomenon also depends on type and concentration of buffers, as well as on the temperature. It is well known, that the use of phosphate buffers, particularly at elevated temperatures, can reduce column lifetime even at moderate pH. If possible, phosphate buffers should be replaced by less harmful alternatives.

The following chromatograms show the excellent column stability of NUCLEODUR® C_{18} Gravity in acidic conditions. The retention time of all three compounds in the column performance test remains consistent and virtually unchanged, even after the column is run with 5000 mL eluent. Due to the extremely stable surface modification, no cleavage of the Si-O-Si bonding occurs, column deterioration is therefore successfully prevented.

Stability of NUCLEODUR® C_{18} Gravity at pH 1.5

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – 1 % TFA in water (50:50, v/v), pH 1.5
Flow rate: 1.0 mL/min
Temperature: 30 °C,
Detection: UV, 230 nm
Injection volume: 5 µL

Peaks:
1. Pyridine
2. Toluene
3. Ethylbenzene



MN Appl. No. 120840

For comparison of the selectivity of NUCLEODUR® C_8 Gravity and C_{18} Gravity please also see the application "Retention behavior of different NUCLEODUR® phases" on page 15. Some general selection criteria and principals of different retention and selectivity of C_{18} and C_8 columns can be found on page 25.

C_{18} Isis

- **Key features:**
  - Exceptional steric selectivity
  - Outstanding surface deactivation
  - Suitable for **LC/MS** and HPLC at pH 1–10
- **Technical characteristics:**
  C_{18} phase with special polymeric, crosslinked surface modification; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 20 %

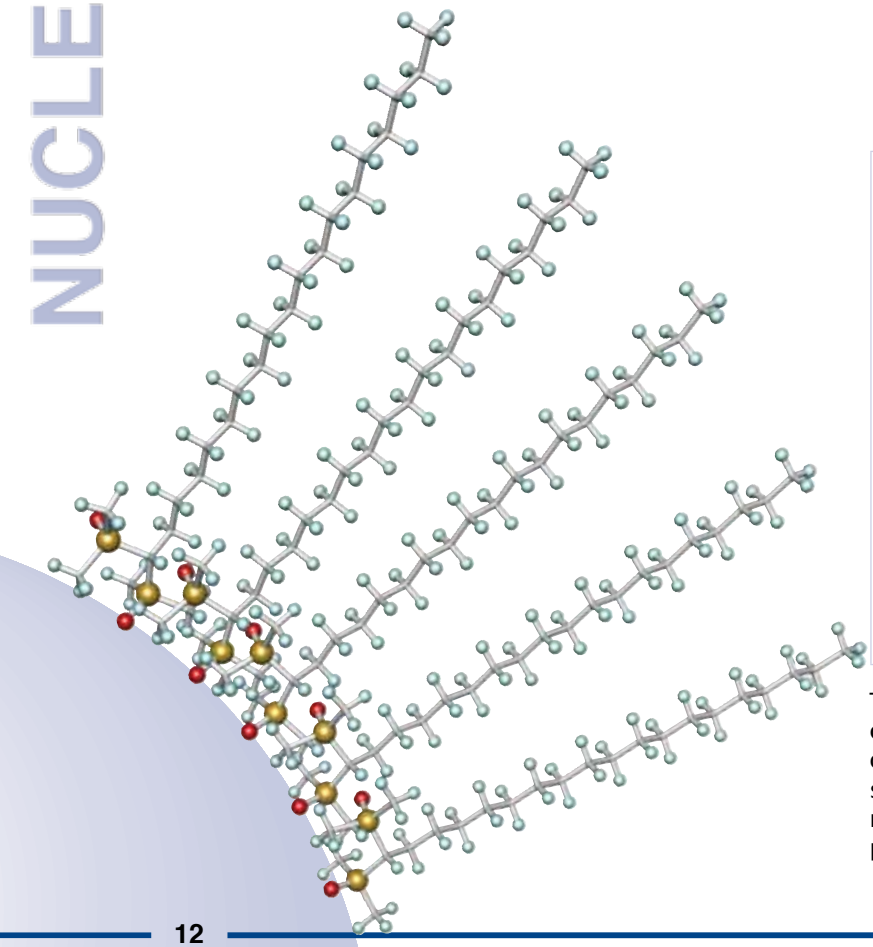
- **Recommended application:**
  Steroids,
  (*o, p, m*–) substituted aromatics,
  fat–soluble vitamins
  USP L1

Surface modification

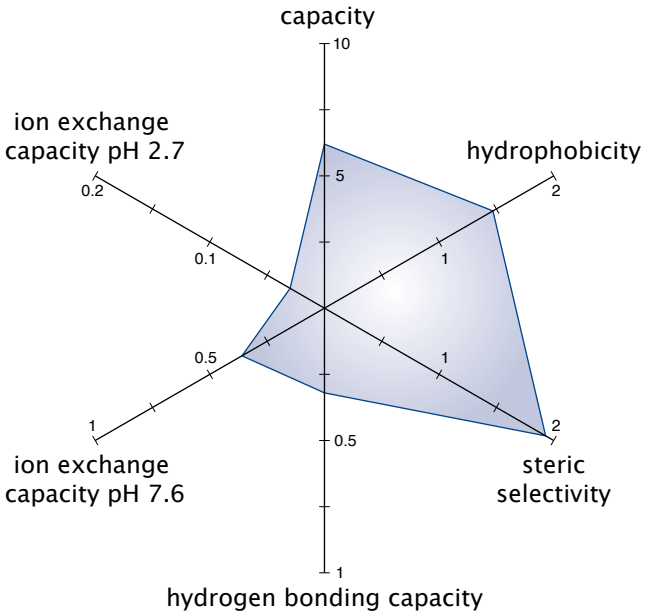
By use of specific C_{18} silanes and appropriate polymeric bonding technologies a dense shield of alkyl chains protects the subjacent silica matrix. Elemental analysis of NUCLEODUR® C_{18} Isis shows a carbon load of 20 %.

The target crosslinking of the C_{18} chains on the surface enables the separation of compounds with similar molecular structure but different stereochemical properties. The technical term for this feature is steric selectivity.

The chromatograms on the right reveal the improved resolution for positional isomers in a test mixture of aromatic compounds on NUCLEODUR® C_{18} Isis (1) in direct comparison with monomerically coated (2) and polar endcapped (3) C_{18} columns.



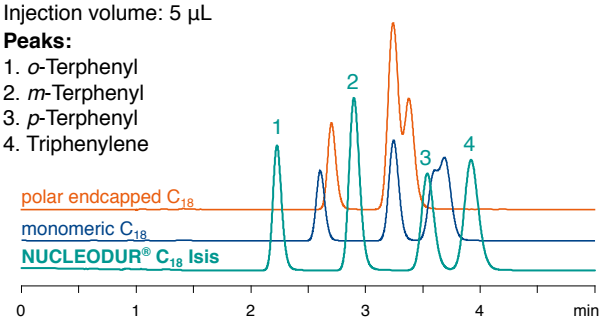
Tanaka plot of NUCLEODUR® C_{18} Isis



Steric selectivity of NUCLEODUR® C_{18} Isis

Columns: 125 x 4 mm; **NUCLEODUR® C_{18} Isis**, monomerically coated C_{18} phase, polar endcapped phase
Eluent: methanol – water (90:10, v/v)
Flow rate: 1 mL/min, temperature: 35 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. *o*-Terphenyl
2. *m*-Terphenyl
3. *p*-Terphenyl
4. Triphenylene

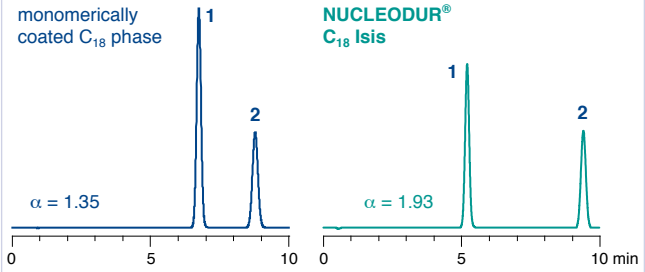


The separation of *o*–terphenyl and triphenylene is a concrete example to evaluate the selectivity potential of a reversed phase column in terms of the different shape of two molecules. The phenyl rings of *o*–terphenyl are twisted out of plane while triphenylene has a planar geometry.

The separation factor (α-value) is a measure for the steric selectivity. As is shown in the following chromatograms the α-value is considerable larger on NUCLEODUR® C_{18} Isis compared to a conventional C_{18} column.

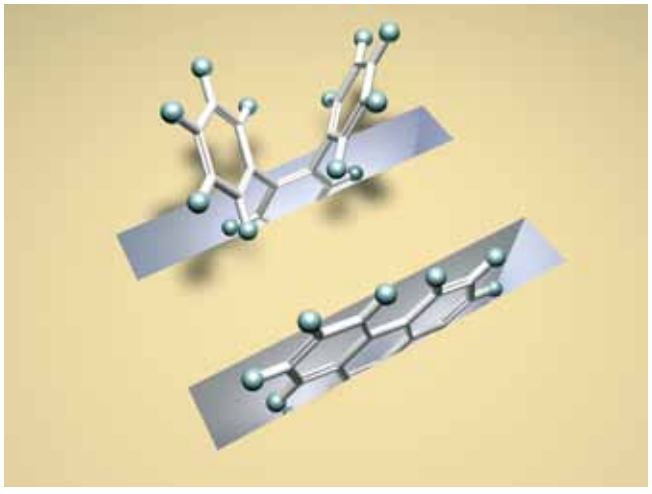
Steric selectivity of NUCLEODUR® C_{18} Isis

Columns: 125 x 4 mm
Eluent: methanol – water (80:20, v/v)
Flow rate: 1 mL/min, temperature: 40 °C
Detection: UV, 254 nm, injection volume: 1 µL
Peaks: 1. *o*-Terphenyl, 2. Triphenylene



Sander and Wise [LCGC 8 (1990) 378–390] proposed a model for the retention of aromatic compounds based on molecular shape, which is referred to as "Slot Model". This model pictures the bonded C_{18} phase on the silica surface with slots which the analytes have to penetrate during retention. Planar molecules are able to penetrate these slots deeper than nonplanar molecules of similar molecular weight and length-to-breadth ratio. Thus triphenylene is longer retained than *o*-terphenyl.

Slot model



Surface deactivation

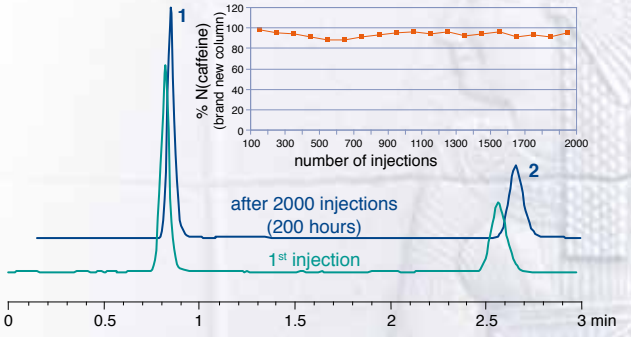
The chromatography of basic analytes requires a high density of surface-bonded C_{18} silanes combined with a thorough endcapping procedure to keep silanol activity at a minimum. This ensures tailing-free elution of even strongly basic amino-containing compounds (see appl. 121210 on page 35).

Stability

The applied special surface bonding technology also provides improved stability features for the NUCLEODUR® C_{18} Isis phase. The proof for this was given in a long-term test in which the decrease of plate counts for caffeine at pH 10 and 50 °C has been observed over a period of 200 hours and 2000 sample injections, respectively. In addition retention and peak shape of caffeine and theophylline were compared with the chromatographic performance of the brand new column.

Stability of NUCLEODUR® C_{18} Isis at pH 10

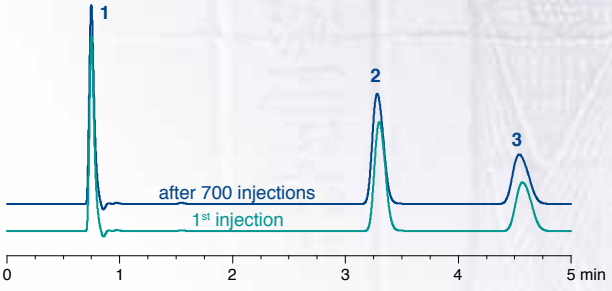
Column: 125 x 4 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: methanol – 50 mM triethylamine, pH 10 (25:80, v/v)
Flow rate: 1 mL/min, temperature: 50 °C
Detection: UV, 254 nm, injection volume: 5 µL
Peaks: 1. Theophylline, 2. Caffeine



The following chromatograms exhibit the excellent stability of NUCLEODUR® C_{18} Isis at pH 1 and 80 °C. After 700 column runs retention time and peak shape of the three test compounds remain almost unchanged.

Stability of NUCLEODUR® C_{18} Isis at pH 1

Column: 125 x 4 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: acetonitrile – 1 % TFA, pH 1 (50:50, v/v)
Flow rate: 1 mL/min, temperature: 80 °C
Detection: UV, 254 nm, injection volume: 5 µL
Peaks: 1. Pyridine, 2. Toluene, 3. Ethylbenzene



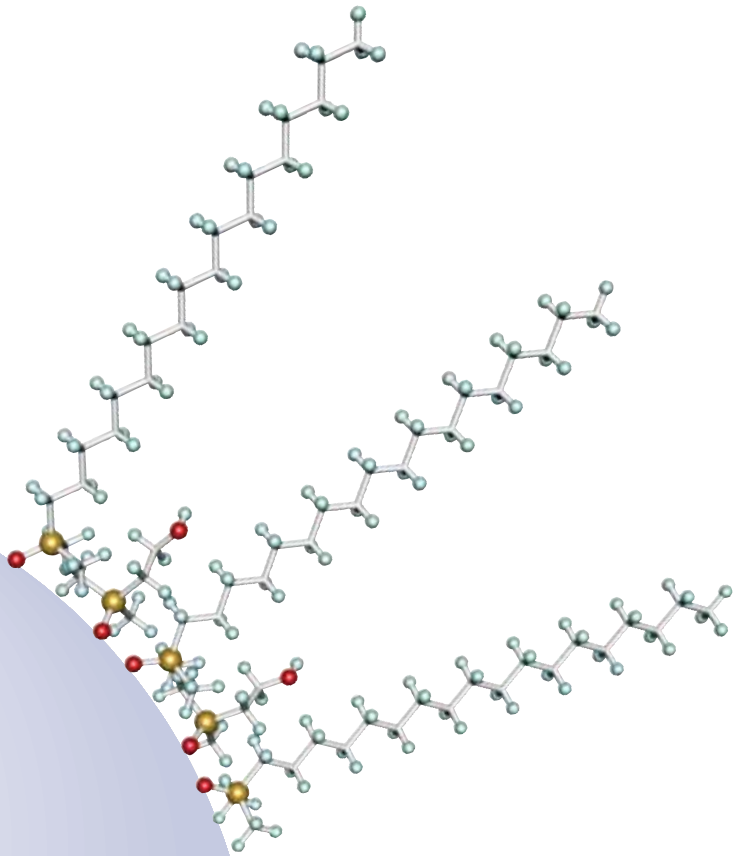
- NUCLEODUR® C_{18} Isis does not show any degradation under the applied mobile phase conditions. An enhanced pH stability in the range from pH 1 to 10 can be certified for this phase.

C_{18} Pyramid

- **Key features:**
  - Stable in 100 % aqueous mobile phase systems
  - Interesting polar selectivity features
  - Excellent base deactivation; suitable for **LC/MS** due to low bleeding characteristics
- **Technical characteristics:**
  Special phase with polar endcapping; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm (7 and 10 µm particles for preparative purposes on request); carbon content 14 %; pH stability 1–9
- **Recommended application:**
  Analgesics, penicillin antibiotics, nucleic acid bases, water-soluble vitamins, complexing agents, organic acids
  USP L1

RP-HPLC with highly aqueous mobile phases

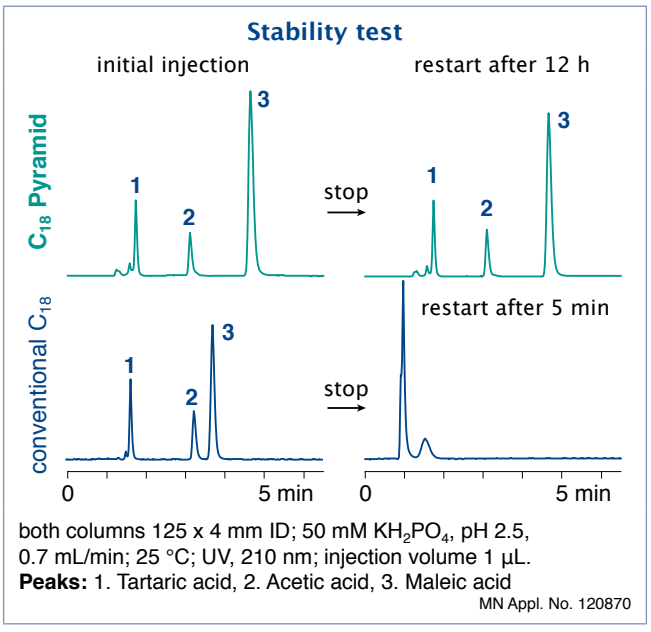
The efforts to neutralize unwanted activity of unreacted surface silanols often results in well base-deactivated phases with high carbon load, but a limited scope of selectivity beyond non-polar interactions. In particular polar compounds like carboxylic acids, drug metabolites, etc. show only weak retention on densely bonded reversed phase columns due to distinct hydrophobic properties but low polar interactions. Very polar analytes require highly aqueous mobile phases for solubility and retention. Conventional reversed phase columns often display stability problems in eluent systems with high percentage of water (> 95 %) as evidenced by a sudden decrease of retention time and overall poor reproducibility. This phenomenon is described as phase collapse caused by the mobile phase expelled from the pores due to the fact, that hydrophobic RP phases are incompletely wetted with the mobile phase [U. D. Neue et al., Chromatographia 54 (2001) 169–177].



Different approaches can be used to increase column stability with highly aqueous mobile phase systems. The most promising concepts are incorporating a polar group in the hydrophobic alkyl chain, or using hydrophilic endcapping procedures to improve the wettability of the reversed phase modification. NUCLEODUR® PolarTec may be taken as an example for the embedded polar group strategy, in which a C_{18} silane with a polar function is successfully linked to the silica surface.

Stability features

NUCLEODUR® C_{18} Pyramid is a silica phase with hydrophilic endcapping, designed especially for use in eluent systems of up to 100 % water. The figure below shows the retention behavior of tartaric, acetic and maleic acid under purely aqueous conditions on NUCLEODUR® C_{18} Pyramid in comparison with a conventionally bonded RP phase.



both columns 125 x 4 mm ID; 50 mM KH_2PO_4, pH 2.5, 0.7 mL/min; 25 °C; UV, 210 nm; injection volume 1 µL.
Peaks: 1. Tartaric acid, 2. Acetic acid, 3. Maleic acid
MN Appl. No. 120870

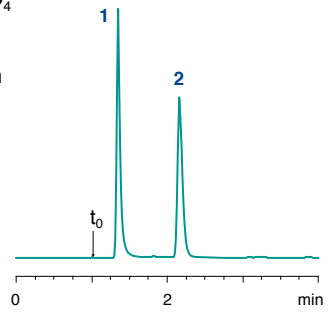
It can be shown that the retention times for NUCLEODUR® C_{18} Pyramid remain nearly unchanged between initial injection and restart after the flow has been stopped for 12 hours, whilst the performance of the conventional RP column already collapsed totally after 5 min.

Retention characteristics

Based on the ultrapure NUCLEODUR® silica the polar surface derivatization exhibits retention characteristics, which differentiate the "Pyramid" from conventional C_{18} stationary phases. The chromatogram below shows the improved retention behavior of very polar compounds such as short chain organic acids, which are insufficiently retained on RP columns with predominantly hydrophobic surface properties. For more separations on NUCLEODUR® C_{18} Pyramid see the "Applications" section from page 32.

Separation of very polar compounds

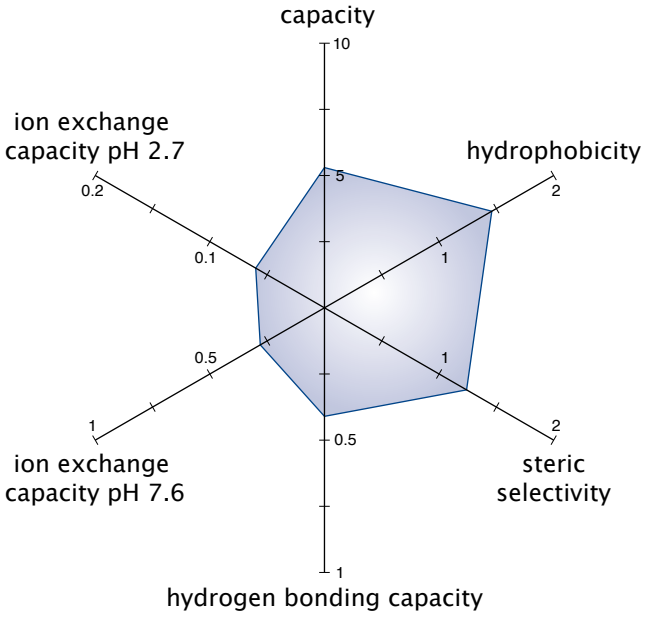
Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: 0.2 % H_3PO_4
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 202 nm
Injection volume: 2 µL
Peaks:
1. Formic acid
2. Acetic acid



MN Appl. No. 119170

In addition to the exceptional polar selectivity NUCLEODUR® C_{18} Pyramid also provides adequate hydrophobic retention (see application 119190 at *www.mn-net.com*). The capacity factors of the non-polar, alkyl-substituted benzenes toluene and ethylbenzene do not go too far in comparison with standard C_{18} phases.

Tanaka plot of NUCLEODUR® C_{18} Pyramid

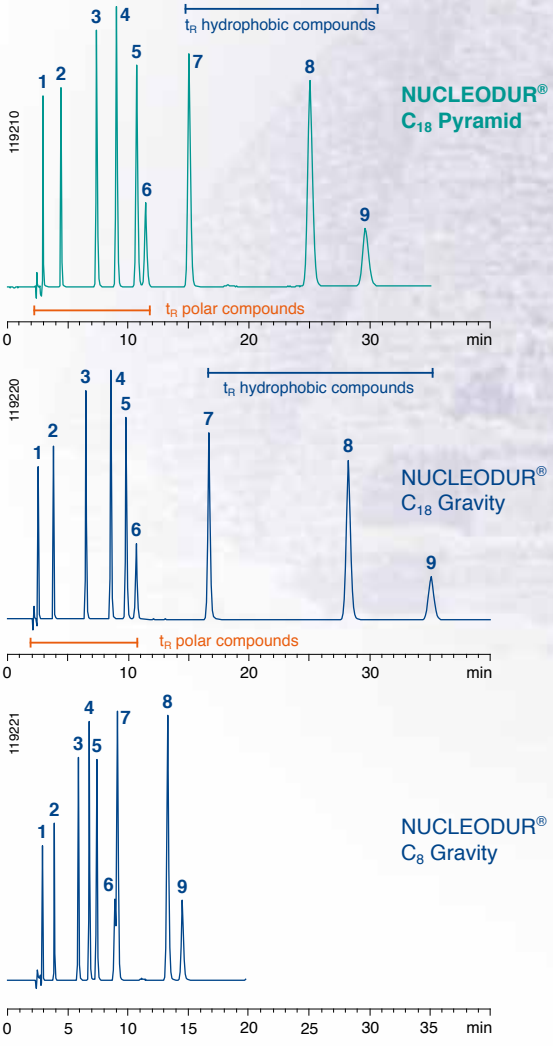


Base deactivation

The perceptible increase in polarity has no impact on the retention behavior of ionizable analytes. Even with the strongly basic compounds of the tricyclic antidepressant drug test mixture, no unwanted interactions or a so-called lack in base deactivation are observed (see application 119200 on page 35).

Retention behavior of polar and non-polar compounds on different NUCLEODUR® RP columns

Columns: 250 x 4 mm, 5 µm particles
Eluent: methanol – 25 mM $NH_4H_2PO_4$, pH 7 (65:35, v/v)
Flow rate: 0.8 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 5 µL
Peaks:
1. Chlorpheniramine
2. Dimethyl phthalate
3. Benzamide
4. Ethyl benzoate
5. Benzophenone
6. Lidocaine
7. Naphthalene
8. Biphenyl
9. Acenaphthene



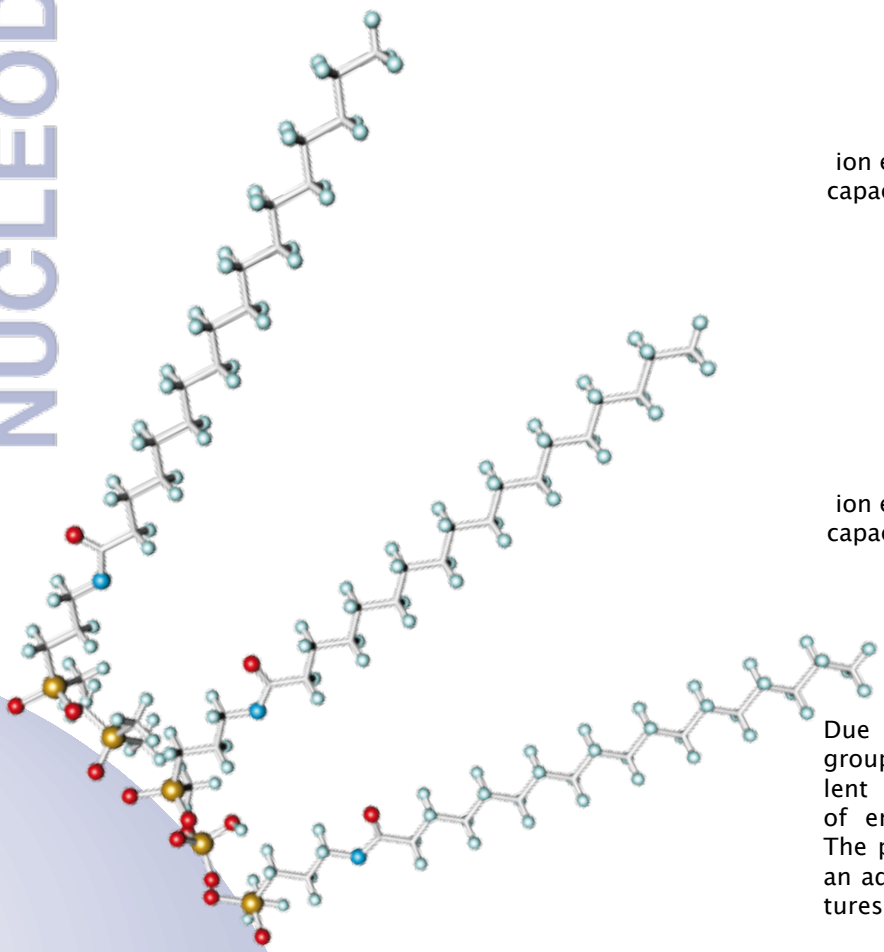
PolarTec

- **Key features:**
  - Excellent base deactivation
  - Suitable for **LC/MS** and stable in 100% aqueous mobile phases
  - Pronounced steric selectivity
- **Technical characteristics:**
  Phase with embedded polar group; pore size 110 Å; particle sizes 3 µm and 5 µm; carbon content 17 %; pH stability 1–9
- **Recommended application:**
  Exceptional selectivity for carbocyclic acids, phenols and nitrogen containing compounds, polar compounds like basic pharmaceuticals, organic acids, pesticides, amino acids, water soluble vitamins, etc.
  USP L1 and L60

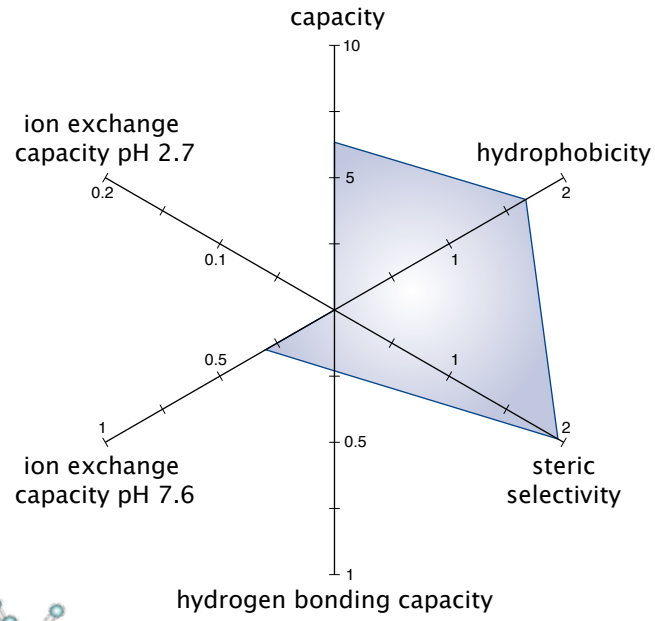
RP-HPLC under 100 % aqueous conditions

The dominant form of interactions of conventional C_{18} phases are non-polar London dispersion forces. Besides non-polar interactions phases with embedded polar groups possess the ability to show polar interactions (dipol-dipol, hydrogen-bondings, π-π, etc.) These interactions enhance retention and selectivity for polar compounds like carbocyclic acids, phenols and nitrogen containing compounds (see applications).

In order to increase retention for polar compounds it is often necessary to decrease the organic ratio of the mobile phase to zero. Under these conditions many conventional C_{18} phases display the so-called dewetting effect which means that the mobile phase is expelled from the pores. This phenomenon leads to a dramatic loss in retention. NUCLEODUR® PolarTec is stable in 100 % aqueous mobile phases and therefore especially suited for the separation of polar compounds like organic acids (see appl. 124562 on page 55).



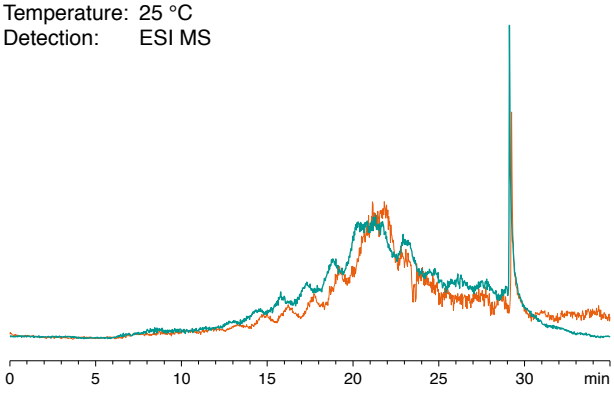
Tanaka plot of NUCLEODUR® PolarTec



Due to the shielding effect of the embedded group NUCLEODUR PolarTec shows an excellent base deactivation, which is at the top-notch of embedded polar group phases on the market. The pronounced steric selectivity (see Tanaka plot) is an additional tool for the separation of complex mixtures.

Bleeding of NUCLEODUR® PolarTec

Columns: **150 x 3 mm NUCLEODUR® PolarTec, 5 µm**
150 x 3 mm Waters SymmetryShield™ RP18, 5 µm
Eluent: A) acetonitrile, B) water
Gradient: 10 % B → 90 % B in 10 min
Flow rate: 0.2 mL/min
Temperature: 25 °C
Detection: ESI MS



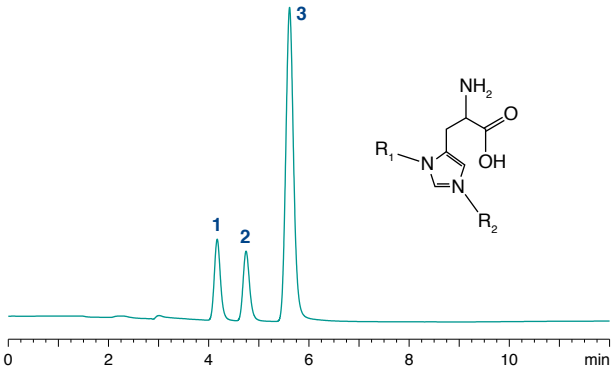
MN Appl. No. 124600

Due to low bleeding characteristics NUCLEODUR® PolarTec is also suitable for LC/MS.

Separation of histidine

Column: 150 x 3 mm NUCLEODUR® PolarTec, 3 µm
Eluent: 1.0 mM perfluoropentanoic acid in water – 0.5 mM perfluoropentanoic acid in acetonitrile (99.5:0.5, v/v)
Flow rate: 0.4 mL/min
Temperature: 20 °C
Detection: UV, 230 nm

Peaks:
1. 3-Methylhistidine $R_1 = H, R_2 = CH_3$
2. Histidine $R_1 = R_2 = H$
3. 1-Methylhistidine $R_1 = CH_3, R_2 = H$



MN Appl. No. 125140

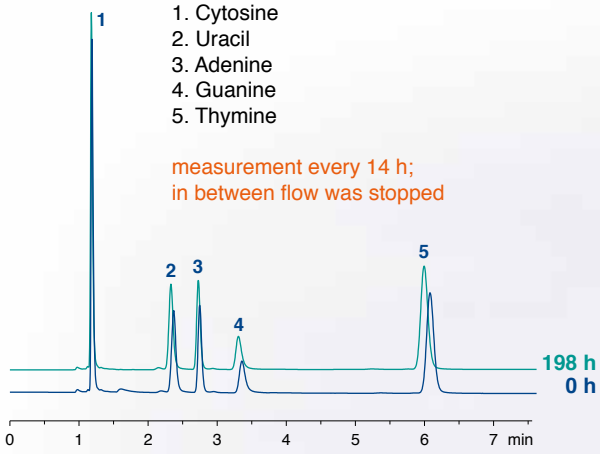
Even after days or weeks of operation in purely aqueous eluents the C_{18} chains of NUCLEODUR® PolarTec are neither folded nor show any collapsing. A significant reduction of retention time cannot be observed.

Stability of NUCLEODUR® PolarTec

Column: 150 x 3 mm NUCLEODUR® PolarTec, 3 µm
Eluent: 30 mM KH_2PO_4, pH 3.0
Flow rate: 0.5 mL/min
Temperature: 30 °C
Detection: UV, 220 nm

Peaks:
1. Cytosine
2. Uracil
3. Adenine
4. Guanine
5. Thymine

measurement every 14 h;
in between flow was stopped



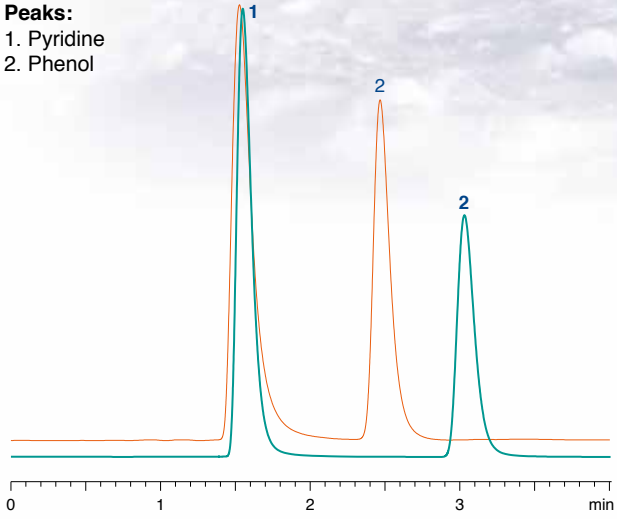
MN Appl. No. 124610

In spite of the polar character of the embedded functional group NUCLEODUR® exhibits sufficient hydrophobic properties and is very well suited for analyzing basic compounds. Good base deactivation of NUCLEODUR® PolarTec is illustrated by the separation of pyridine and phenol.

Phase comparison of NUCLEODUR® PolarTec

Columns: **150 x 3 mm NUCLEODUR® PolarTec, 5 µm**
150 x 3 mm Waters SymmetryShield™ RP18, 5 µm
Eluent: acetonitrile – water (50:50, v/v)
Flow rate: 0.56 mL/min
Temperature: 25 °C
Detection: UV, 254 nm

Peaks:
1. Pyridine
2. Phenol



MN Appl. No. 124711

PFP

- **Key features:**
  - Hydrophobic phase with alternative selectivity in comparison to classical C_{18} modifications
  - Separation principle based on 4 retention mechanisms:
    - polar interactions (H bonds)
    - dipole-dipole interactions
    - π-π interactions
    - hydrophobic interactions
  - Suitable for **LC/MS** due to low bleeding characteristics
- **Technical characteristics:**
  Phase with pentafluorophenyl-propyl modification and multi-endcapping; pore size 110 Å; particle sizes 3 µm and 5 µm; carbon content 8 %; pH stability 1-9
- **Recommended application:**
  Aromatic and unsaturated compounds, phenols, halogenated compounds, isomers, polar compounds like pharmaceuticals, antibiotics; high retention of basic compounds
  USP L43

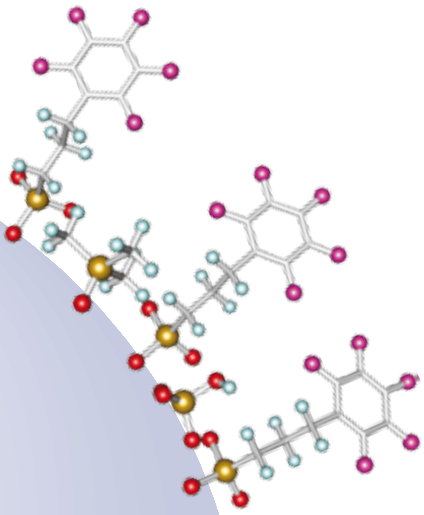
NUCLEODUR®

Orthogonality in selectivity

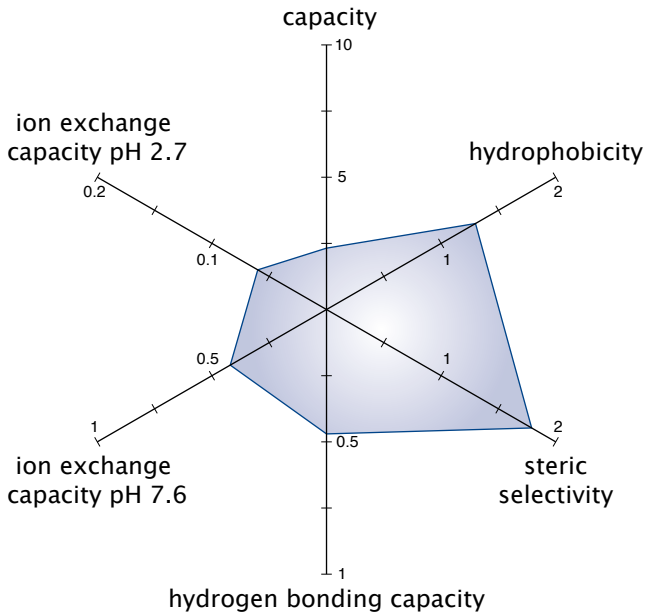
Fluorinated stationary phases in HPLC have gained increasing interest over the last years. Most common representative of fluorinated silica phases is the pentafluorophenyl modification (PFP or F5). Especially the orthogonal selectivity compared to traditional alkyl phases widens the scope in analytical HPLC. Thus NUCLEODUR® PFP offers an excellent selectivity especially for highly polar analytes like aromatic and unsaturated compounds, phenols or halogenated hydrocarbons.

Halogen substitutes in molecules result often in an increase of their polarity accompanied by a decrease of typical retention characteristics in RP-HPLC.

While a typical C_{18} phase just provides hydrophobic interactions between stationary phase and analyte NUCLEODUR® PFP offers four different retention mechanisms: polar interactions (H bonds), dipole-dipole interactions, π-π interactions and hydrophobic interactions. Especially the pronounced ion exchange capacity and distinct steric selectivity are typical for the character of fluorinated phases.



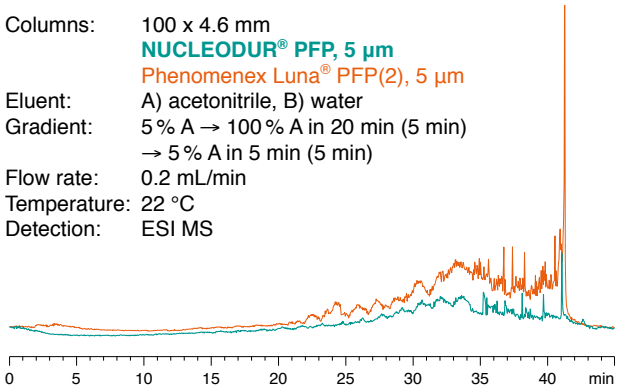
Tanaka plot of NUCLEODUR® PFP



Due to low bleeding characteristics NUCLEODUR® PFP is also suitable for LC/MS.

Bleeding of NUCLEODUR® PFP

Columns: 100 x 4.6 mm
NUCLEODUR® PFP, 5 µm
Phenomenex Luna® PFP(2), 5 µm
Eluent: A) acetonitrile, B) water
Gradient: 5 % A → 100 % A in 20 min (5 min)
→ 5 % A in 5 min (5 min)
Flow rate: 0.2 mL/min
Temperature: 22 °C
Detection: ESI MS



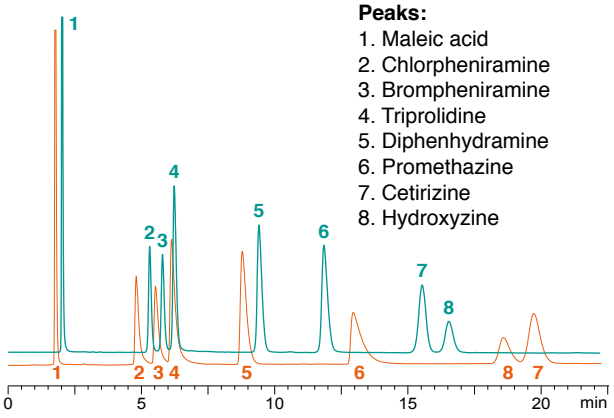
MN Appl. No. 124730

Hydrophobic pentafluorophenyl phase

Separation of antihistamines

Columns: **250 x 3 mm NUCLEODUR® PFP, 5 µm**
250 x 3 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – 20 mM KH_2PO_4 (30:70, v/v)
Flow rate: 0.563 mL/min
Temperature: 30 °C
Detection: UV, 210 nm

Peaks:
1. Maleic acid
2. Chlorpheniramine
3. Brompheniramine
4. Triprolidine
5. Diphenhydramine
6. Promethazine
7. Cetirizine
8. Hydroxyzine

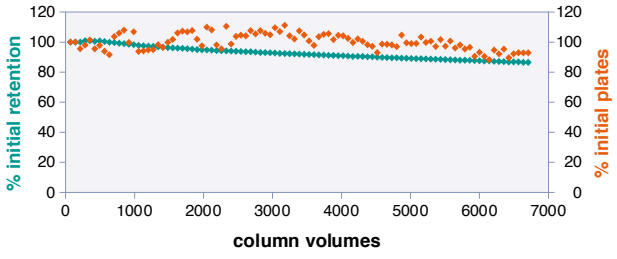


MN Appl. No. 124861

Based on a special surface modification procedure NUCLEODUR® PFP offers highest stability also at low pH values.

Stability of NUCLEODUR® PFP

Column: 125 x 4 mm NUCLEODUR® PFP, 5 µm
Eluent: acetonitrile – water, 0.1 % TFA, pH 1 (50:50, v/v)
Flow rate: 1 mL/min
Temperature: 80 °C
Detection: UV, 254 nm
Injection volume: 2 µL
Sample: ethylbenzene



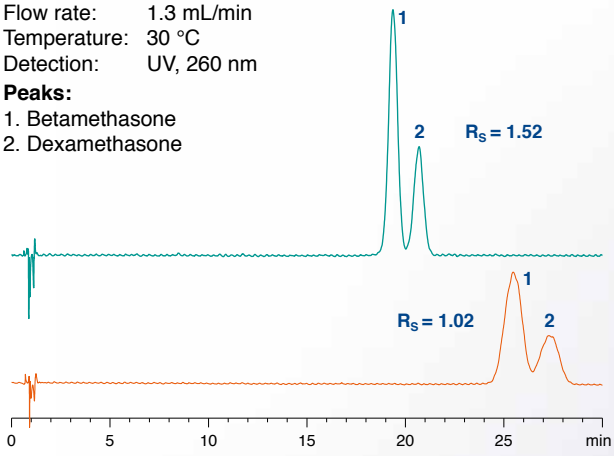
MN Appl. No. 124720

Compared to fluorinated HPLC columns of other manufactures NUCLEODUR® PFP shows excellent separation capabilities and shorter retention times e.g., for critical isomers like beta- and dexamethasone.

Separation of beta- and dexamethasone

Columns: **100 x 4.6 mm NUCLEODUR® PFP, 5 µm**
100 x 4.6 mm Phenomenex Luna® PFP(2), 5 µm
Eluent: acetonitrile – water (20:80, v/v)
Flow rate: 1.3 mL/min
Temperature: 30 °C
Detection: UV, 260 nm

Peaks:
1. Betamethasone
2. Dexamethasone



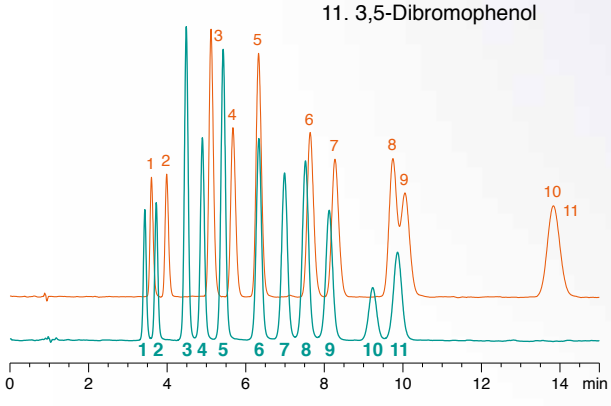
MN Appl. No. 124771

NUCLEODUR® PFP offers a completely different retention behavior compared to alkyl modified silica and is often used successfully for separations which provide just insufficient results on traditional C_{18} phases. More and more applications in the areas of (bio-) pharma, natural compounds and environment are published and show the broad application field for fluorinated phases.

Separation of phenol isomers

Columns: **125 x 4 mm NUCLEODUR® PFP, 5 µm**
125 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: acetonitrile, 0.1 % formic acid – water, 0.1 % formic acid (35:65, v/v)
Flow rate: 1 mL/min
Temperature: 35 °C
Detection: UV, 280 nm

Peaks:
1. *o*-Cresol
2. *m*-Cresol
3. 3,4-Dimethylphenol
4. 3,5-Dimethylphenol
5. 2,5-Dimethylphenol
6. 2,6-Dichlorophenol
7. 2,3-Dichlorophenol
8. 2,4-Dichlorophenol
9. 3,4-Dichlorophenol
10. 2,4-Dibromophenol
11. 3,5-Dibromophenol



MN Appl. No. 124531

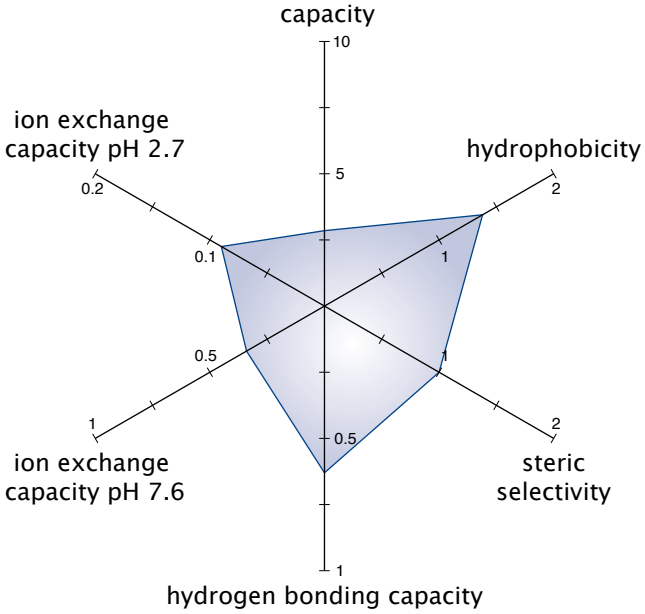
Sphinx RP

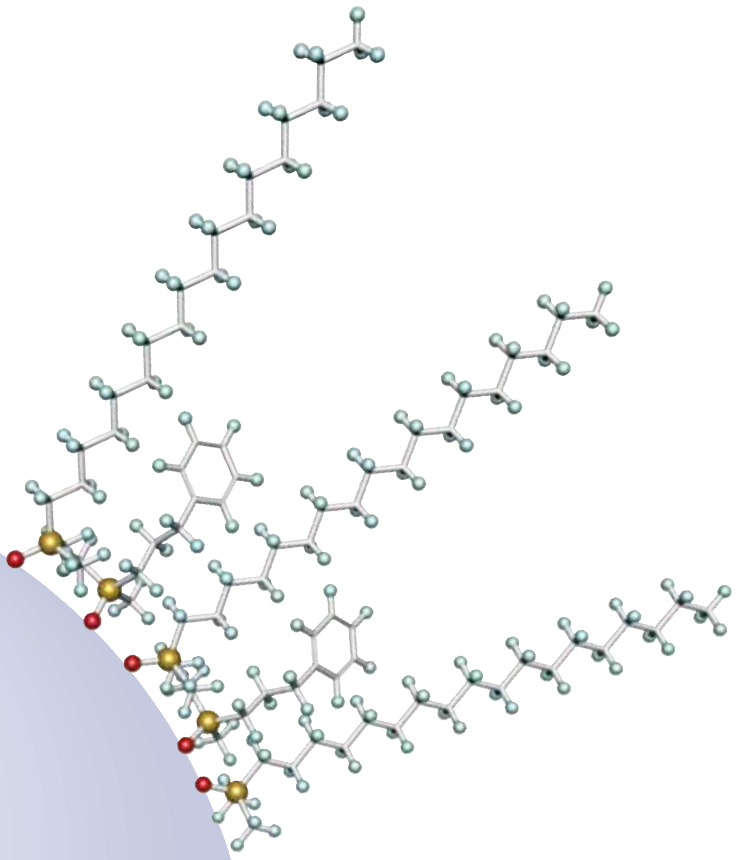
- **Key features:**
  - Distinct selectivity based on well-balanced bifunctional surface coverage
  - Widens the scope for method development based on additional π–π interactions
  - Suitable for **LC/MS** due to low bleeding characteristics
- **Technical characteristics:**
  Octadecyl and propylphenyl modified silica; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 15 %; pH stability 1–10; high reproducibility and consistent quality
- **Recommended application:**
  Quinolone antibiotics, sulfonamides, xanthines, substituted aromatics
  USP L1 and L11

Alternative RP selectivity

NUCLEODUR® Sphinx RP is characterized by exceptional selectivity features generated by a **well-balanced ratio of covalently bonded octadecyl and phenyl groups.** The combination of classical hydrophobic with π–π interactions (aromatic ring system) expands the scope of selectivity in comparison with conventional reversed phase packings. NUCLEODUR® Sphinx RP is particularly suited for the separation of molecules containing aromatic and multiple bonds. For the separation of polar compounds NUCLEODUR® Sphinx RP can be especially recommended and can also outperform many customary C_{18} phases. In addition, exhaustive endcapping steps minimize unwanted surface silanol activity and guarantee excellent peak shapes even for strong basic analytes.

Tanaka plot of NUCLEODUR® Sphinx RP

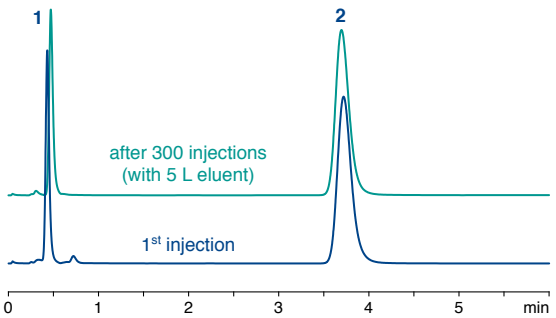




Stability of NUCLEODUR® Sphinx RP at pH 10

Column: 50 x 4.6 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: methanol – dil. NH_3, pH 10 (20:80, v/v)
Flow rate: 1.0 mL/min
Temperature: 30 °C
Detection: UV, 275 nm
Injection volume: 3 µL

Peaks:
1. Theophylline
2. Caffeine



MN Appl. No. 120900

NUCLEODUR®

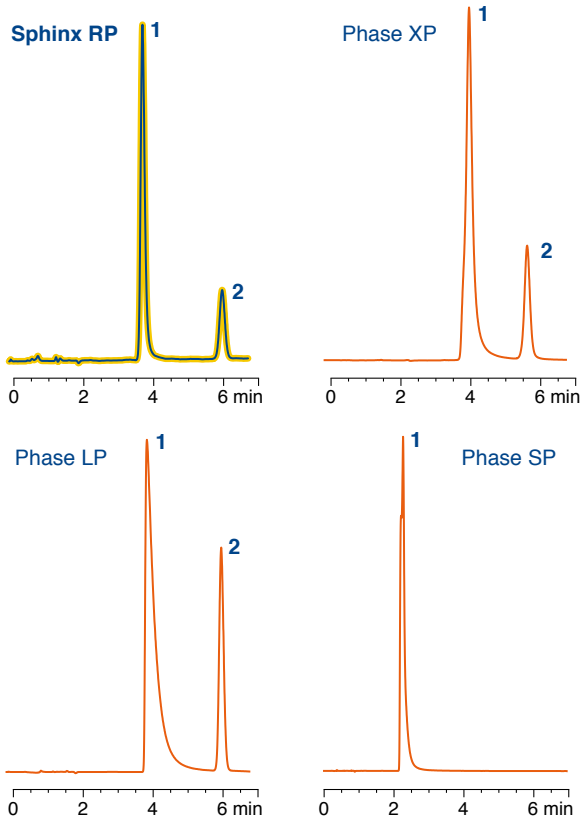
Different from standard phenyl phases, NUCLEODUR® Sphinx RP is far more stable towards hydrolysis and is also suggested for LC/MS applications.

Due to the additional intermolecular interactions NUCLEODUR® Sphinx RP is an interesting replenishment to the high density bonded phases NUCLEODUR® C_8 / C_{18} Gravity and the polar endcapped NUCLEODUR® C_{18} Pyramid.

Comparison of surface deactivation of different phenyl modified RP phases

Columns: 150 x 4.6 mm
NUCLEODUR® Sphinx RP, 5 µm
Competitor 1 (column XP)
Competitor 2 (column LP)
Competitor 3 (column SP)
Eluent: methanol – water (30:70, v/v)
Flow rate: 1 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 2 µL

Peaks:
1. Pyridine
2. Phenol



MN Appl. No. 120910

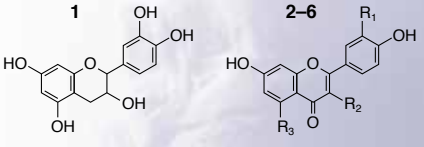
The selectivity advantage of NUCLEODUR® Sphinx RP is impressively shown in the flavonoid application below.

While a baseline separation of kaempferol and isorhamnetin can be achieved on NUCLEODUR® Sphinx RP, the two compounds are not or just poorly separated on NUCLEODUR® C_8 Gravity or C_{18} Gravity. The additional π–π interactions of the aromatic ring systems provide the necessary difference in retention to outperform the classical C_{18} and C_8 phases.

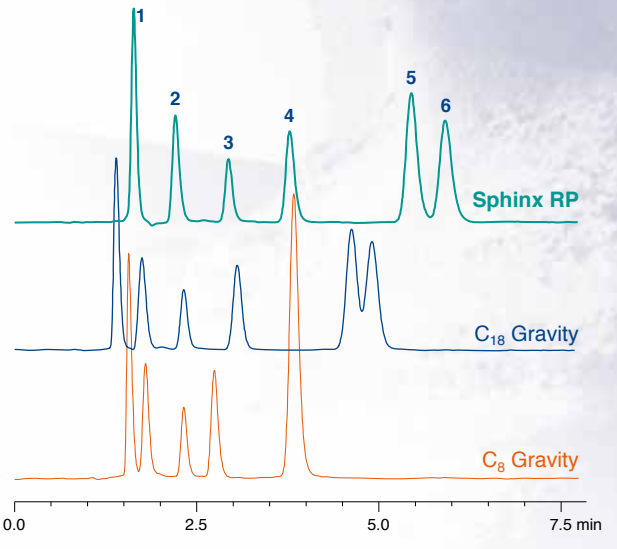
Separation of flavonoids on 3 different NUCLEODUR® phases

Columns: 150 x 4.6 mm
NUCLEODUR® Sphinx RP, 5 µm
NUCLEODUR® C_{18} Gravity, 5 µm
NUCLEODUR® C_8 Gravity, 5 µm
Eluent: water – methanol (40:60, v/v)
Flow rate: 1 mL/min
Temperature: 30 °C
Detection: UV, 270 nm
Injection volume: 3 µL

Peaks:



1. Catechin
2. Rutin — $R_1 = R_3 = OH$, R_2 = O-rutinose
3. Fisetin — $R_1 = R_2 = OH$, $R_3 = H$
4. Quercetin — $R_1 = R_2 = R_3 = OH$
5. Kaempferol — $R_1 = H$, $R_2 = R_3 = OH$
6. Isorhamnetin — $R_1 = OCH_3$, $R_2 = R_3 = OH$



MN Appl. No. 119830

C_{18} HTec

- **Key features:**
  - Reliable and durable standard RP phase for up-scaling to preparative scale, suited for **LC/MS**
  - High loadability and excellent stability
  - Outstanding base deactivation
- **Technical characteristics:**
  High density octadecyl modification (C_{18}); pore size 110 Å; particle sizes 1.8 µm, 3 µm, 5 µm, 7 µm and 10 µm for analytical and preparative separations; carbon content 18 %; pH stability 1–11
- **Recommended application:**
  Sophisticated analytical and preparative separations of basic, neutral and acidic pharmaceuticals, derivatized amino acids, pesticides, fat-soluble vitamins, aldehydes, ketones and phenolic compounds
  USP L1

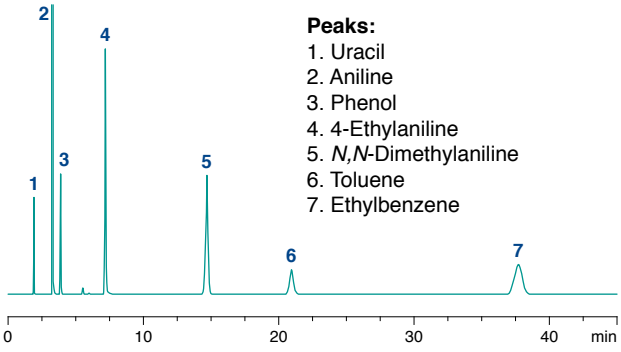
Preparative separations place high demands on silica based HPLC materials. Apart from excellent selectivity and base deactivation, robustness (pH, pressure stability, ...) and capacity are vital criteria for optimal and efficient separation at the preparative scale.

Selectivity and base deactivation

The innovative and special endcapping procedure leads to exceptionally good base deactivation – the Engelhardt test demonstrates superb selectivity, peak symmetry and peak shape over the entire polarity range. In addition NUCLEODUR® C_{18} HTec scores in low bleed characteristics and is therefore highly suitable for LC/MS.

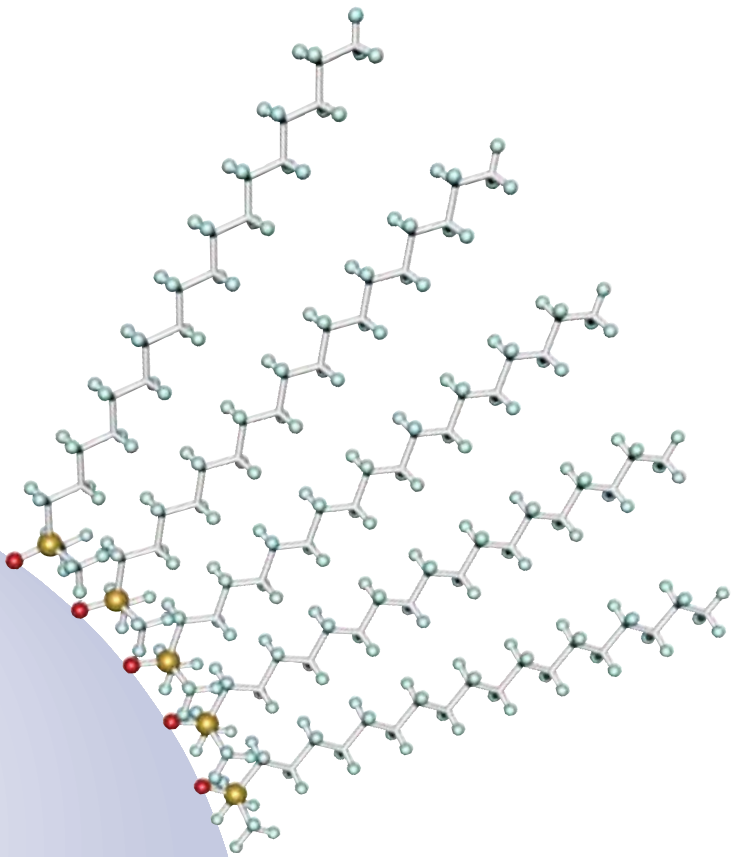
Engelhardt test

Column:	250 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent:	methanol – water (49:51, v/v)
Flow rate:	1 mL/min
Temperature:	40 °C
Detection:	UV, 254 nm
Injection volume:	5 µL

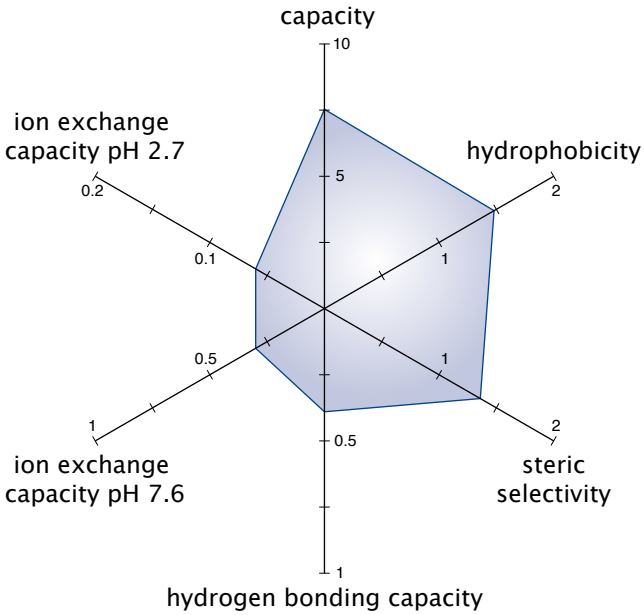


Peaks:
1. Uracil
2. Aniline
3. Phenol
4. 4-Ethylaniline
5. *N,N*-Dimethylaniline
6. Toluene
7. Ethylbenzene

MN Appl. No. 123580



Tanaka plot of NUCLEODUR® C_{18} HTec



NUCLEODUR®

Stability and lifetime

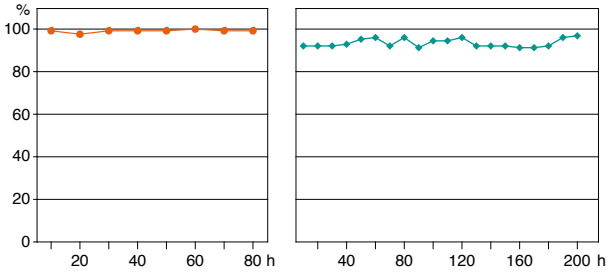
Based on fully synthetic and extremely robust totally spherical NUCLEODUR® silica, NUCLEODUR® C_{18} HTec offers outstanding mechanical rigidity and is thus the perfect choice also for self-packing of prep-columns. The special surface modification and endcapping procedure result in high chemical stability even at extreme chromatographic conditions like high flow rates, temperature or critical solvents (DMSO). Furthermore, NUCLEODUR® C_{18} HTec columns show a remarkably long lifetime in acidic (pH 1) as well as basic (pH 10) mobile phases.

pH stability test

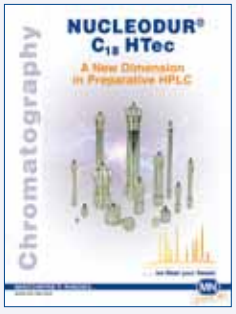
Column: 150 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Flow rate: 1 mL/min
Detection: UV, 254 nm
Injection: 5 µL

pH 1:
Eluent: acetonitrile – 1 % TFA in water (50:50, v/v); 80 °C
● % initial retention of ethylbenzene
693 injections

pH 10:
Eluent: methanol – 50 mM triethylamine (25:85, v/v); 50 °C
◆ % initial N of theophylline
1034 injections



Due to innovative surface coating procedures NUCLEODUR® C_{18} HTec offers excellent analytical separation properties and is the first choice for up-scaling to preparative column dimensions.



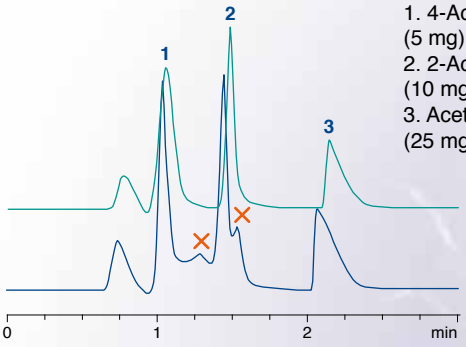
Please ask for our special NUCLEODUR® C_{18} HTec brochure for preparative HPLC separation.

Capacity

A vital criterion for efficiency in preparative HPLC is the capacity of the separation medium. NUCLEODUR® C_{18} HTec is characterized by a notably high loadability under both basic and acidic conditions, while competitor columns show overload effects even at lower loads (x).

Loadability under acidic conditions

Columns: VP 100 x 21 mm NUCLEODUR® C_{18} HTec, 5 µm
100 x 21.2 mm AXIA™ Gemini® 5 µm C_{18} 110 Å
Eluent: acetonitrile – formic acid in H_2O pH 3.0 (30:70, v/v)
Flow rate: 28 mL/min; temperature 22 °C; pressure 124 bar
Detection: UV, 254 nm
Peaks (total load 40 mg): (sample dissolved in DMSO)



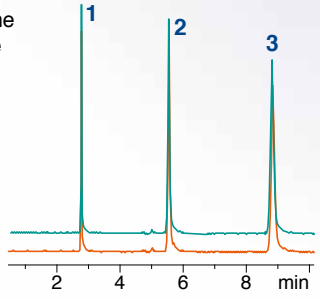
1. 4-Acetamidophenol (5 mg)
2. 2-Acetamidophenol (10 mg)
3. Acetylsalicylic acid (25 mg)

Up-scaling

Due to highest quality standards in our silica production and phase chemistry combined with optimized packing technology, NUCLEODUR® C_{18} HTec delivers exceptional transferability from analytical to preparative scale. This doesn't just apply to the use of different particle sizes (e.g., 5, 7 or 10 µm) but also for diverse column dimensions (e.g., ID 4.6 to 21 mm).

Up-scaling with NUCLEODUR® C_{18} HTec

Columns: EC 250 x 4.6 mm NUCLEODUR® C_{18} HTec, 5 µm
VP 250 x 21 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: acetonitrile – water (80:20, v/v)
Flow rates: 1.3 mL/min, 27 mL/min
Temperature: 22 °C
Pressure: 84 bar, 109 bar
Detection: UV, 254 nm
Inj. volume: 3 µL, 60 µL
Peaks: (1 mg/mL of each compound)
1. Phenol
2. Naphthalene
3. Anthracene



MN Appl. No. 123780

C_{18} ec / C_8 ec

- **Key features:**
  - Ideal and reliable standard RP phase for daily routine analysis and up-scaling for preparative HPLC
  - Medium density octadecyl (C_{18}) and octyl (C_8) modification with exhaustive endcapping
  - Wide range of application areas
- **Technical characteristics:**
  Pore size 110 Å; particle sizes 3 µm and 5 µm; 7 µm, 10 µm, 12 µm, 16 µm, 20 µm, 30 µm and 50 µm for preparative separations; carbon content 17.5 % for C_{18}, 10.5 % for C_8; pH stability 1–9, high reproducibility from lot to lot
- **Recommended application:**
  Basic, neutral or acidic drugs
  derivatized amino acids
  pesticides
  fat-soluble vitamins
  aldehydes and ketones
  phenolic compounds
  USP L1 (C_{18}) / L7 (C_8)

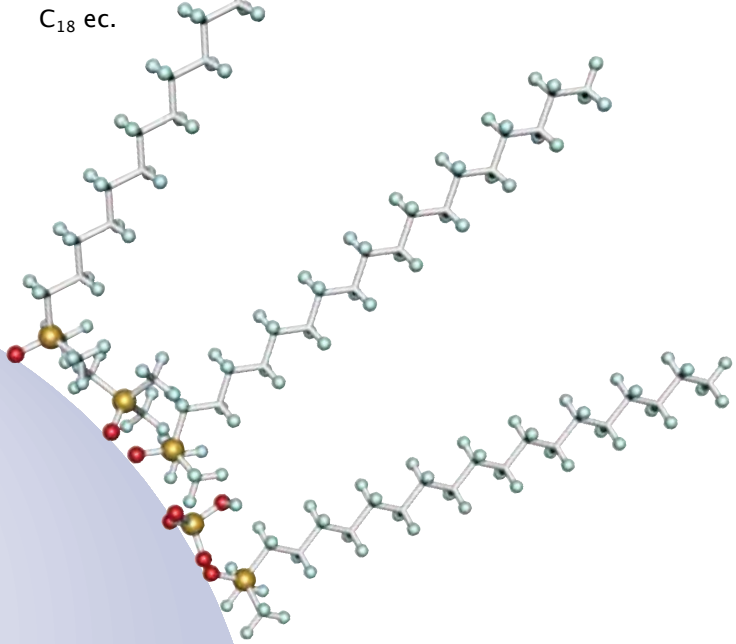
NUCLEODUR® C_{18} ec for daily routine analysis and up-scaling for preparative HPLC

The efficiency of a separation is controlled by particle size and selectivity of the stationary phase. The exceptional surface coverage of monomeric bonded alkylsilanes, combined with an exhaustive endcapping, results in a surface with lowest silanol activity. This allows the tailing-free elution of polar compounds such as basic drugs. NUCLEODUR® C_{18} ec is available in 9 different particle sizes (3, 5, 7, 10, 12, 16, 20, 30 and 50 µm) which cover the whole range from high speed analytical HPLC up to medium and low pressure prep LC. NUCLEODUR® C_{18} ec is also an ideal tool for scale-up purposes.

Chemical stability

The utmost purity of the base silica and the exceptional silane bonding chemistry minimizes the risk of dissolution, or hydrolysis at pH extremes.

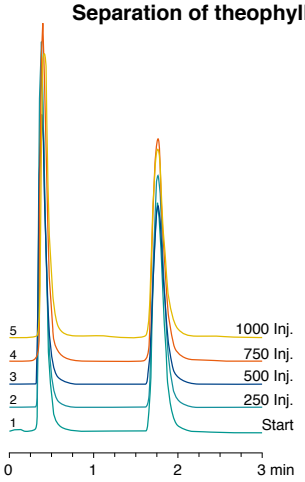
The following chromatograms show the retention behavior at pH values of 1.5 and 10.0 for NUCLEODUR® 100-5 C_{18} ec.



pH stability of NUCLEODUR® C_{18} ec

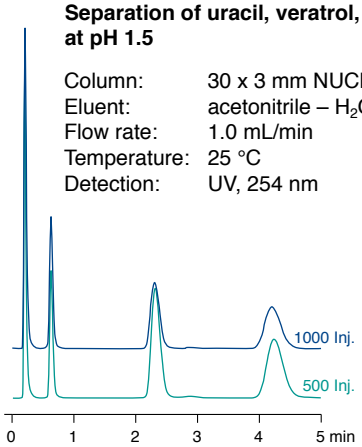
Separation of theophylline and caffeine at pH 10

Column: 30 x 3 mm
NUCLEODUR® 100-5 C_{18} ec
Eluent:
methanol – aq. NH_3
(20:80, v/v), pH 10
Flow rate: 0.5 mL/min
Temperature: 25 °C
Detection: UV, 254 nm



Separation of uracil, veratrol, toluene and ethylbenzene at pH 1.5

Column:	30 x 3 mm NUCLEODUR® 100-5 C_{18} ec
Eluent:	acetonitrile – H_2O (65:35, v/v), TFA, pH 1.5
Flow rate:	1.0 mL/min
Temperature:	25 °C
Detection:	UV, 254 nm



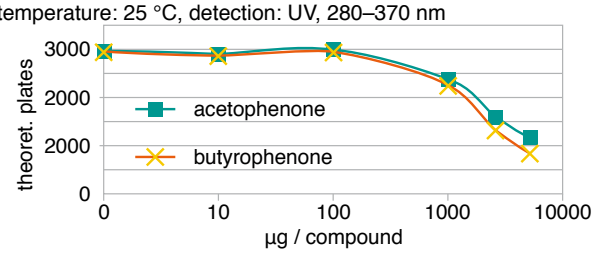
Loadability

Loadability, probably the most important feature for preparative LC applications, is determined by pore size, pore volume and surface area of the packing. However, it can also be influenced by the molecular weight of the analytes. In the figure below the mass loading curve for acetophenone and butyrophenone on a NUCLEODUR®

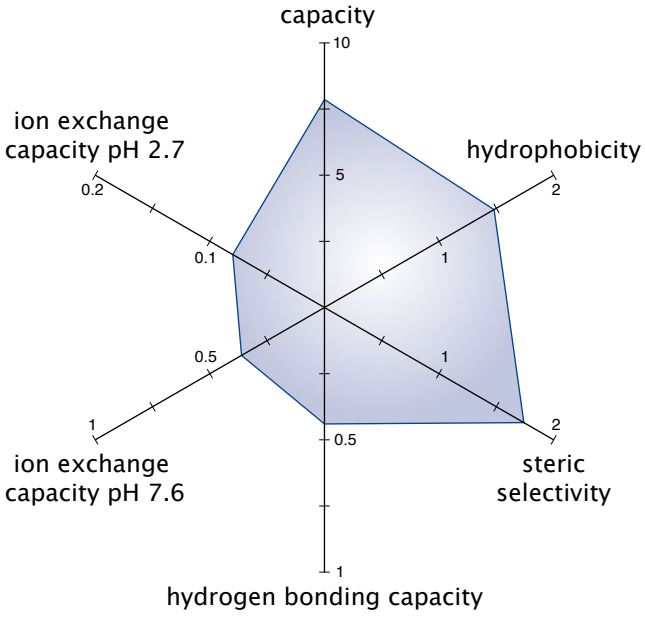
100–20 C_{18} ec column describes the correlation between the increase of column loading and the decrease of separation efficiency.

Loading curve

Column: 250 x 4.6 mm NUCLEODUR® 100-20 C_{18} ec, eluent: acetonitrile – H_2O 80:20 (v/v), flow rate: 1.0 mL/min, temperature: 25 °C, detection: UV, 280–370 nm



Tanaka plot of NUCLEODUR® C_{18} ec



NUCLEODUR® octyl phases

In addition to the program of NUCLEODUR® C_{18} phases MACHEREY-NAGEL offers the corresponding octyl modified NUCLEODUR® C_8 Gravity and NUCLEODUR® C_8 ec columns to expand the reversed phase tool box effectively. Based on the same totally spherical and highly pure silica the C_8 phases exhibit the same excellent chemical and mechanical stability features as the C_{18} counterparts. Indeed NUCLEODUR® C_8 Gravity can also be run at pH extremes (pH 1–11) by choosing appropriate elution parameters. Due to the shorter chain and less hydrophobic properties of the stationary phase the retention of non-polar compounds is decreased, and in consequence a reduction in time of analysis can be achieved. Moreover a stronger polar selectivity, particularly with the separation of ionizable analytes is frequently observed (as distinct from the C_{18} phases).

NUCLEODUR® C_8 ec and NUCLEODUR® C_8 Gravity are most suitable for the development of new methods but also for robust routine analysis.

C_{18} or C_8 · the best of both worlds

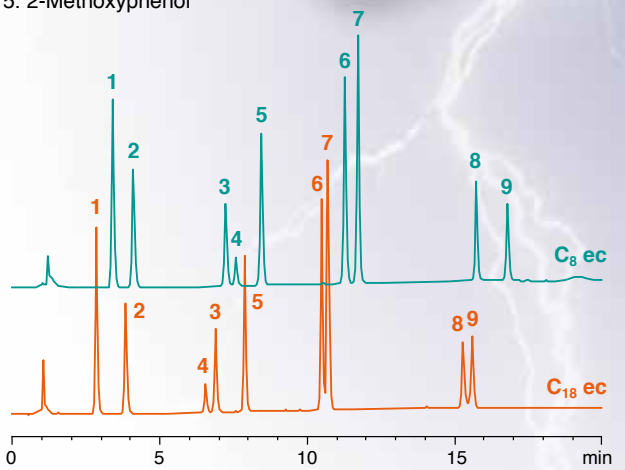
Chromatographers now might wonder about the differences between C_8 and C_{18} phases and the preferred range of application. Indeed there are no general guidelines which could make the choice easier but it will always be beneficial to add both phases to the existing pool of reversed phase columns in the laboratory.

However, comparative studies reveal some different selectivity patterns of NUCLEODUR® C_8 ec and NUCLEODUR® C_{18} ec. The separation of phenols below shows baseline separation for 2-ethoxyphenol and dimethoxybenzene (veratrol) and in addition a reversal of the elution order of phenol and 4-methoxyphenol can be shown on the octyl phase.

Separation of phenols

Columns: **250 x 4 mm NUCLEODUR® 100-5 C_8 ec**
250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: A) water, B) methanol
Gradient for C_8: 20 % B (2 min) → 60 % B in 12 min
Gradient for C_{18}: 25 % B (2 min) → 65 % B in 12 min
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 275 nm, injection volume: 10 µL

Peaks:
1. Resorcinol
2. Pyrocatechol
3. 4-Methoxyphenol
4. Phenol
5. 2-Methoxyphenol
6. 2-Ethoxyphenol
7. Veratrol
8. Biphenyl-2-ol
9. Phenetole



MN Appl. No. 120890 / 120891

Some general principles are:

- High density C_8 and C_{18} phases allow tailing-free elution, also for very polar compounds
- Octyl phases (C_8) show superior polar selectivity
- Octadecyl phases (C_{18}) show superior hydrophobic selectivity
- Hydrophobic compounds show shorter retention times on C_8 phases

HILIC

- **Key features:**
  - Ideal for reproducible and stable chromatography of highly polar analytes
  - Suitable for analytical and preparative applications as well as **LC/MS**
  - Very short column conditioning period
- **Technical characteristics:**
  Ammonium – sulfonic acid modified silica; pore size 110 Å; particle sizes 1.8, 3 and 5 µm; carbon content 7%; pH stability 2–8.5
- **Recommended application:**
  Hydrophilic compounds such as organic polar acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water soluble vitamins

NUCLEODUR® HILIC

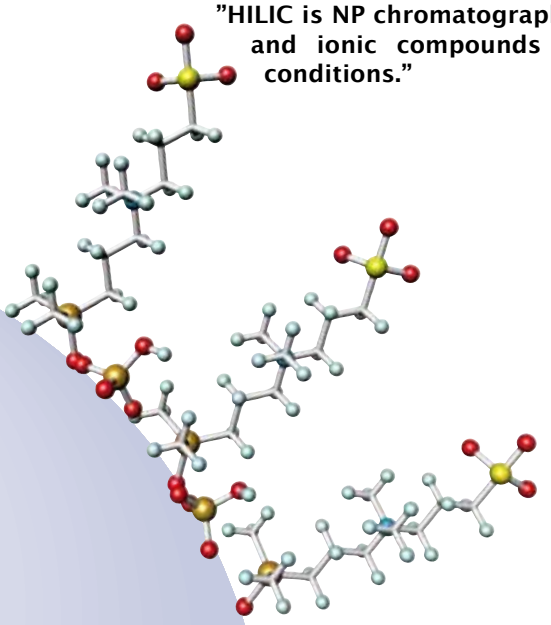
Separation science is always looking for new and effective strategies to accomplish the tasks of modern analytics. Especially for polar compounds reversed phase HPLC – the most common analytical method – is often limited. Here, hydrophilic stationary phases provide an additional tool for the separation of polar analytes in HPLC.

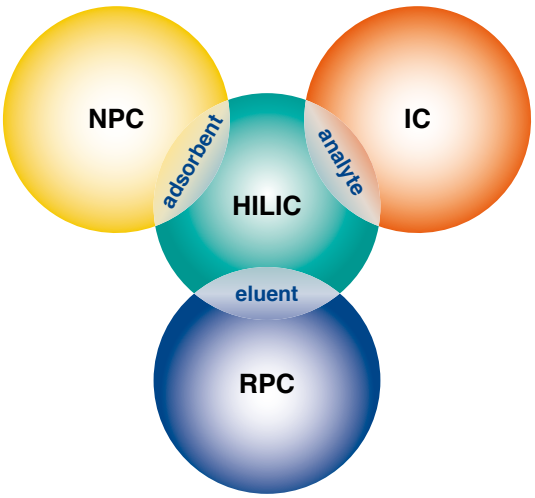
The expression **HILIC** (**H**ydrophilic **I**nteraction **LI**quid **C**hromatography) was firstly published by Andrew Alpert in 1990 – since then it took quite some efforts to develop robust and reproducible hydrophilic HPLC phases for HILIC chromatography [A. Alpert, J. Chromatography 499 (1990), 177–196].

HILIC combines the characteristics of the 3 major methods in liquid chromatography – reversed phase (RPC), normal phase (NPC) and ion chromatography (IC):

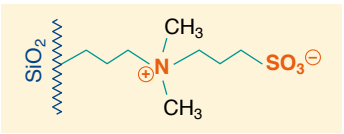
- stationary phases (adsorbents) are mostly polar modifications of silica or polymers (SiOH, NH_2, Diol, (zwitter) ions, ...) – like in NPC
- mobile phases (eluents) are mixtures of aqueous buffer systems and organic modifier like acetonitrile or methanol – like in RPC
- fields of application include quite polar compounds as well as organic and inorganic ions – like in IC

"HILIC is NP chromatography of polar and ionic compounds under RP conditions."





NUCLEODUR® HILIC is a special zwitterionic modified stationary phase based on ultra spherical NUCLEODUR® particles. The betaine character of the ammonium-sulfonic acid ligands results in total charge equalization and in an overall neutrally charged but highly polar surface.



Retention characteristic

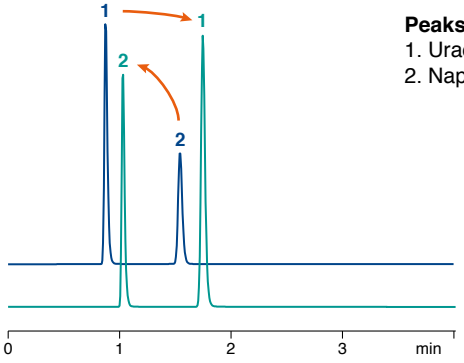
Commonly HILIC is described as partition chromatography or liquid/liquid extraction system between the mobile and stationary phase. Versus a water-poor mobile phase a water-rich layer on the surface of the polar stationary phase is formed. Thus, a distribution of the analytes between these two layers will occur.

Furthermore HILIC includes weak electrostatic mechanisms as well as hydrogen donor interactions between neutral polar molecules under high organic elution conditions. This distinguishes HILIC from ion exchange chromatography – main principle for HILIC separation is based on compound's polarity and degree of solvation. More polar compounds will have stronger interaction with the stationary aqueous layer than less polar compounds – resulting in a stronger retention. Nonpolar

compounds exhibit faster elution profiles due to minor hydrophobic interactions. Thus, as shown for the separation of uracil and naphthalene the elution order is quite often inverse on HILIC columns compared to RP columns.

Separation of uracil and naphthalene

Columns: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 3 µm
125 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – water (90:10, v/v)
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 254 nm



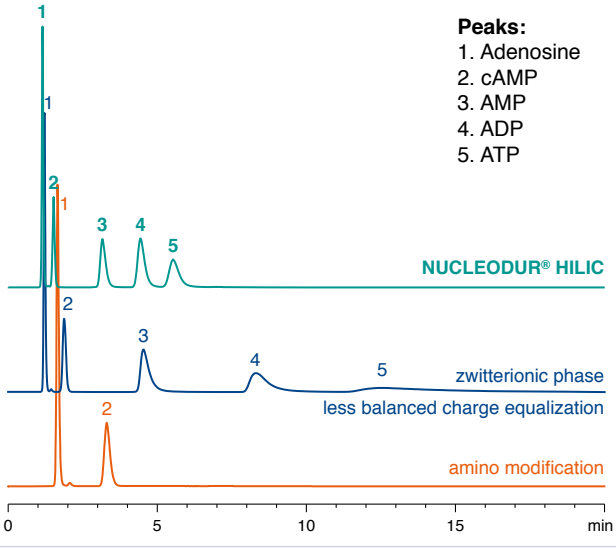
Peaks:
1. Uracil
2. Naphthalene

MN Appl. No. 122911/122912

In comparison with medium polar aminopropyl phases or modification with less balanced charge equalization NUCLEODUR® HILIC shows a superb separation and peak shape for critical compounds like adenosine phosphates.

Separation of adenosine and phosphates

Columns: **125 x 4 mm NUCLEODUR® HILIC, 5 µm**
125 x 4 mm zwitterionic phase with quat. ammonium – sulfonic acid ratio 1:0.9
125 x 4 mm amino-modified silica
Eluent: acetonitrile – 100 mM ammonium acetate, pH 5.3 (70:30, v/v)
Flow rate: 1.3 mL/min, temperature 25 °C
Detection: UV, 259 nm



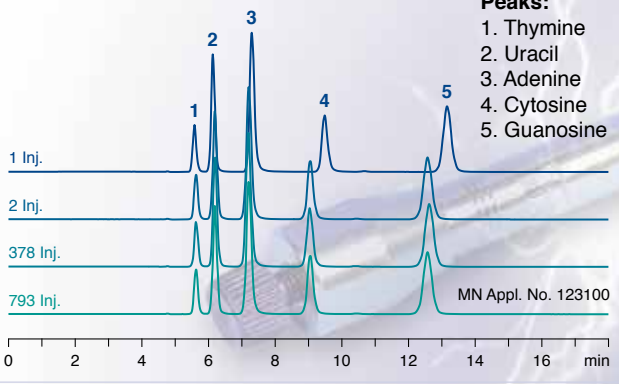
Peaks:
1. Adenosine
2. cAMP
3. AMP
4. ADP
5. ATP

Stability features

Due to an advanced and unique surface modification procedure (pat. pend.) NUCLEODUR® HILIC columns provide short equilibration times – after just 20 min equilibration already the 2nd injection shows stable and reproducible results. Beyond this, NUCLEODUR® HILIC columns are characterized by an outstanding column life time – even after nearly 800 runs the columns show no loss of pristine performance – peak shape and retention are still immaculate.

Stability and equilibration

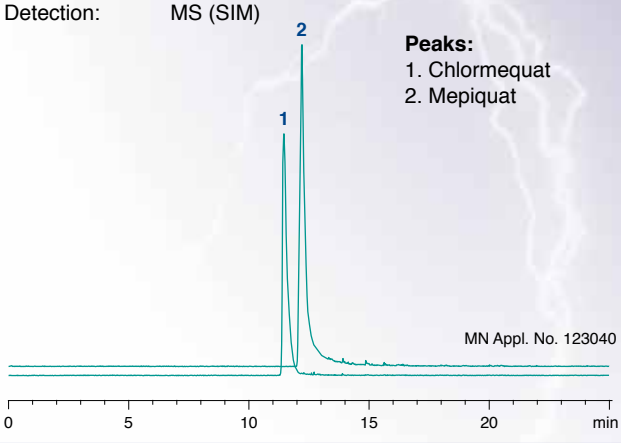
Column: 250 x 4 mm NUCLEODUR® HILIC, 5 µm
Eluent: acetonitrile – 5 mM ammonium acetate (80:20, v/v)
Flow rate: 0.6 mL/min
Temperature: 25 °C
Detection: UV, 254 nm



Peaks:
1. Thymine
2. Uracil
3. Adenine
4. Cytosine
5. Guanosine

Separation of growth regulators

Column: 125 x 2 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – 25 mM ammonium acetate, pH 6.82 (80:20, v/v)
Flow rate: 0.3 mL/min, temperature 25 °C
Detection: MS (SIM)



Peaks:
1. Chlormequat
2. Mepiquat

Due to its high loadability NUCLEODUR® HILIC is absolutely suitable for preparative and semi-preparative applications.

Overall NUCLEODUR® HILIC provides excellent chromatographic features and is hereby the perfect choice for separation of polar or charged compounds.

CN / CN-RP

- **Key features:**
  - High retention capacity especially for very polar and unsaturated compounds
  - Multi-mode column (RP and NP) widens scope of selectivity
  - Stable against hydrolysis at low pH (working range pH 1–8)
- **Technical characteristics:**
  Cyanopropyl-modified high purity silica; pore size 110 Å; particle sizes 3 µm and 5 µm; carbon content 7%; special endcapping; high reproducibility from lot to lot; different retention characteristics in comparison to C_8 and C_{18}

- **Recommended application:**
  Tricyclic antidepressants, steroids, organic acids
  USP L10

Alternative bonded-phase functionality

In reversed phase HPLC it is fairly common to start with C_{18} or C_8 columns, if new methods have to be developed. However, superior polarity and selectivity properties often required for more sophisticated separations, are not always sufficiently provided by classical RP phases, which are usually characterized by a hydrophobic layer of monomeric or polymeric bonded alkylsilanes.

One approach to improve the resolution of compounds poorly separated on nonpolar stationary phases, is to change bonded-phase functionality.

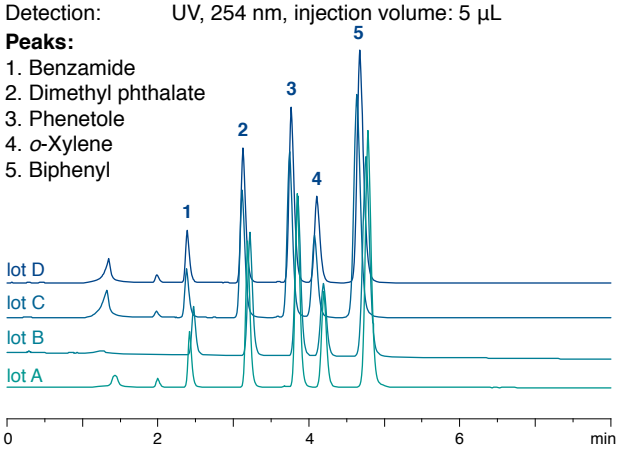
The fully endcapped and highly reproducible (see figure top right) NUCLEODUR® CN-RP phase has cyanopropyl groups on the surface able to generate a clearly recognizable different retention behavior compared to purely alkyl-functionalized surface modifications (see figure down right).

The polarity of the NUCLEODUR® CN-RP phase can be classified as intermediate based on multiple retention mechanisms such as dipole-dipole, π-π, and also hydrophobic interactions [C. S. Young and R. J. Weigand, LCGC 20 (2002) 464–473]. Therefore, this phase shows a distinct selectivity for polar organic compounds as well as for molecules containing π-electron systems (e.g., analytes with double bonds, tricyclic antidepressants) [V. R. Meyer, Practical High Performance Liquid Chromatography (John Wiley & Sons, New York, 3rd. ed., 1999)].

Reproducibility of NUCLEODUR® CN-RP

Column: 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water (60:40, v/v)
Flow rate: 1.0 mL/min, temperature 20 °C
Detection: UV, 254 nm, injection volume: 5 µL

Peaks:
1. Benzamide
2. Dimethyl phthalate
3. Phenetole
4. *o*-Xylene
5. Biphenyl

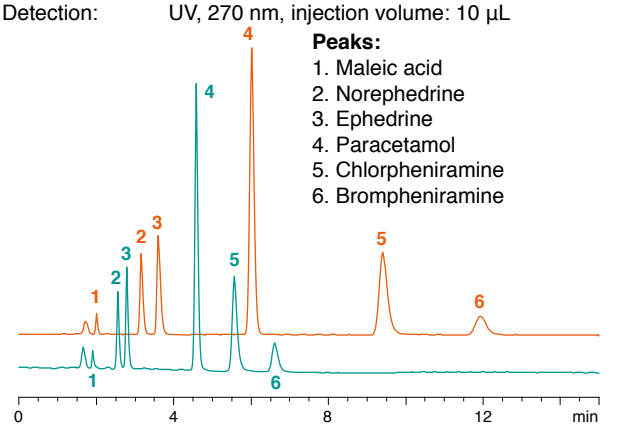


MN Appl. No. 120380

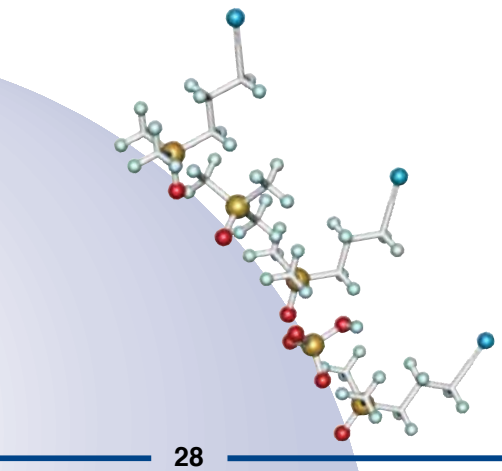
Separation of cold medicine ingredients on two different NUCLEODUR® phases

Columns: 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – 100 mM sodium citrate, pH 2.5 (15:85, v/v)
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 270 nm, injection volume: 10 µL

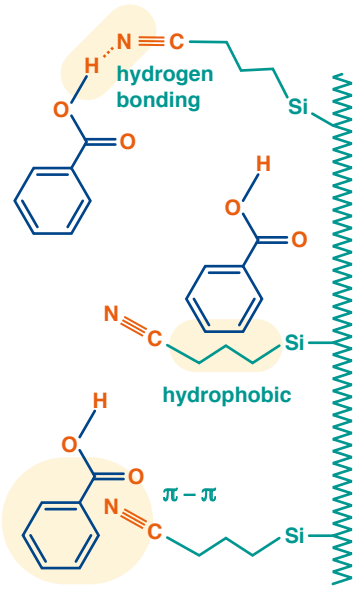
Peaks:
1. Maleic acid
2. Norephedrine
3. Ephedrine
4. Paracetamol
5. Chlorpheniramine
6. Brompheniramine



MN Appl. No. 119340



Interactions on cyano-modified silica

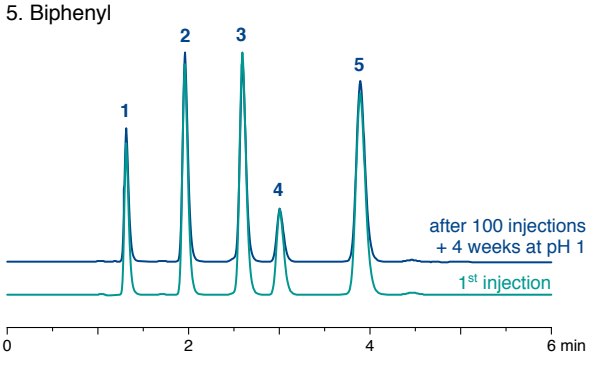


Short-chain bonded phases are sometimes suspected of revealing shortcomings in stability towards hydrolysis at low pH [J. J. Kirkland, LCGC 14 (1996) 486–500]. The following chromatograms show that even after 100 sample injections and four weeks storage at pH 1 (blue curve), neither a considerable shift in retention, nor a visible change in peak symmetry could be noticed (green curve = new column).

Stability of NUCLEODUR® CN-RP at pH 1

Column: 125 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water, 2 % TFA, pH 1 (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Benzamide
2. Dimethyl phthalate
3. Phenetole
4. *o*-Xylene
5. Biphenyl



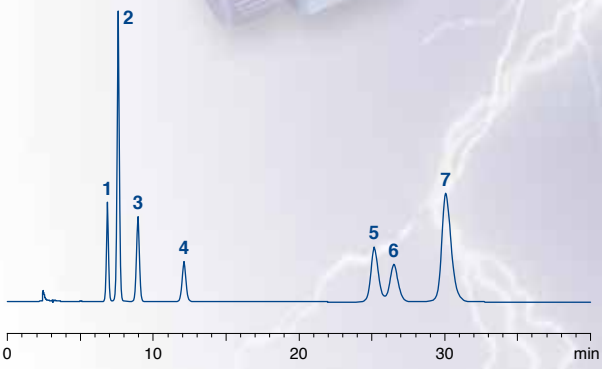
MN Appl. No. 119350

Due to the exceptional polarity features the cyano phase can also be run in the normal phase mode. NUCLEODUR® CN columns for normal phase applications are shipped in *n*-heptane. The drastic change in selectivity and order of elution for a mixture of various steroids in normal and reversed phase mode is displayed in following figure. Moreover the high coverage combined with a thorough endcapping makes NUCLEODUR® 100-5 CN-RP suitable for the separation of ionizable compounds such as basic drugs.

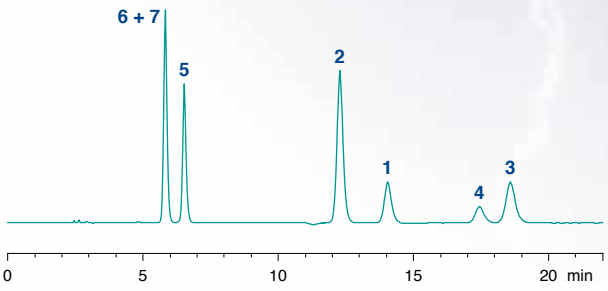
Separation of steroids in normal phase and reversed phase mode

Normal phase mode
Column: 250 x 4 mm NUCLEODUR® 100-5 CN
Eluent: *n*-heptane – 2-propanol (90:10, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 10 µL

Peaks:
1. Methyltestosterone
2. Testosterone
3. Norgestrel
4. Medrysone
5. Cortisone
6. Hydrocortisone
7. Prednisolone



Reversed phase mode
Column: 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water (25:75, v/v)
other conditions as for normal phase mode



MN Appl. Nos. 119271 / 119272

NH_2 / NH_2-RP — Amino-modified silica

- **Key features:**
  - Multi-mode columns (for RP, NP and IC)
  - Stable against hydrolysis at low pH (working range pH 2–8), 100 % stable in water; suitable for **LC/MS**
  - Widens scope of analytical HPLC into the polar range
- **Technical characteristics:**
  Aminopropyl-modified high purity silica; pore size 110 Å; particle sizes 3, 5 and 7 µm; carbon content 2.5 %; not endcapped

- **Recommended application:**
  Polar compounds under RP conditions (sugars, DNA bases), hydrocarbons under NP conditions
  USP L8

- **Normal phase chromatography (NP)** with hexane, dichloromethane or 2-propanol as mobile phase for polar compounds such as substituted anilines, esters, chlorinated pesticides
- **Reversed phase chromatography (RP)** of polar compounds in aqueous-organic eluent systems
- **Ion exchange chromatography** of anions and organic acids using conventional buffers and organic modifiers

NUCLEODUR®

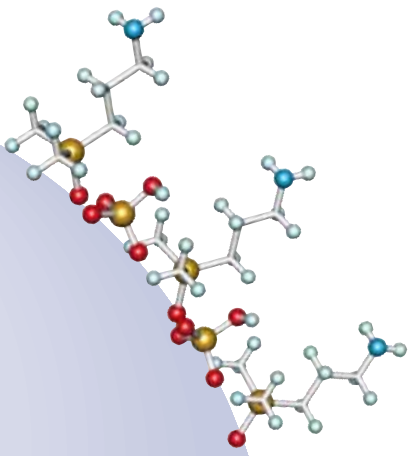
Some compounds, especially polar substances, cannot be sufficiently resolved on C_{18} phases. Polar-modified silica phases offer alternative selectivities such expanding the spectrum of analytical HPLC into the polar range.

Multi-mode columns

Besides cyano modifications, amino modifications belong to the most frequently used polar silica phases – both feature the important advantage, that they can be run in the RP mode using aqueous-organic eluent mixtures as well as in the NP mode e.g., with hexane as mobile phase. NUCLEODUR® NH_2, too, belongs to the so-called multi-mode columns.

It can be used for reversed phase chromatography (RP) of polar compounds such as sugars in aqueous-organic eluent systems, for normal phase chromatography (NP) of substituted aromatics or chlorinated pesticides with organic mobile phases such as hexane, dichloromethane or 2-propanol, but also for ion exchange chromatography of anions and organic acids using conventional buffers and organic modifiers.

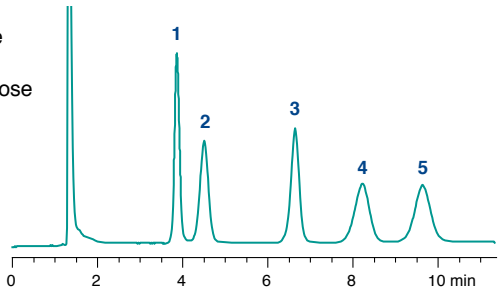
Main field of application of NUCLEODUR® NH_2 is the separation of simple and complex sugars, sugar alcohols and other hydroxy compounds under RP conditions as well as hydrocarbons under NP conditions.



Reversed phase separation of sugars

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – water (79:21, v/v)
Flow rate: 2 mL/min
Detection: RI

Peaks:
1. Fructose
2. Glucose
3. Saccharose
4. Maltose
5. Lactose

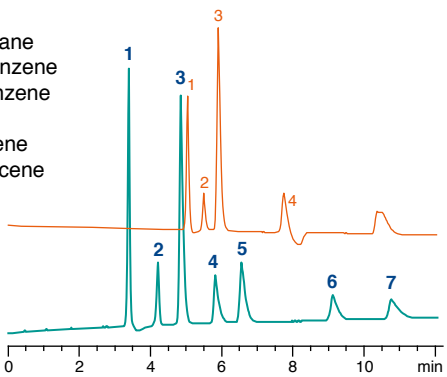


MN Appl. No. 122160

Normal phase separation of middle distillates in accordance with DIN EN 12916

Columns: 250 x 4 mm NUCLEODUR® 100-5 NH_2 conventional aminopropyl phase
Eluent: heptane
Flow rate: 1 mL/min
Detection: RI

Peaks:
1. Cyclohexane
2. 1-Phenyldodecane
3. 1,2-Dimethylbenzene
4. Hexamethylbenzene
5. Naphthalene
6. Dibenzothiophene
7. 9-Methylanthracene



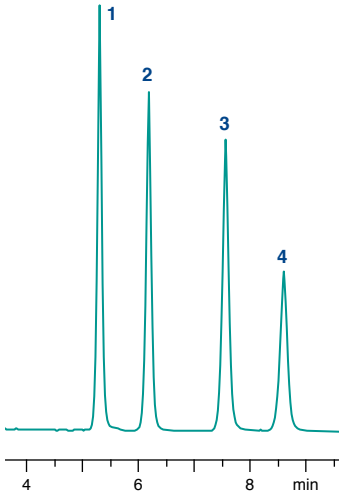
MN Appl. No. 122180

Even at lower flow rates than for C_{18} phases, NUCLEODUR® NH_2 achieves good separations of polar compounds such as DNA bases – this reduces the back pressure as well as the solvent consumption. Even very polar compounds like streptomycin are retained sufficiently for quantitative and qualitative analysis.

Separation of DNA bases

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 0.6 mL/min
Temperature: 35 °C
Pressure: 30 bar
Detection: UV, 254 nm

Peaks:
1. Thymine
2. Uracil
3. Cytosine
4. Adenine



MN Appl. No. 122170

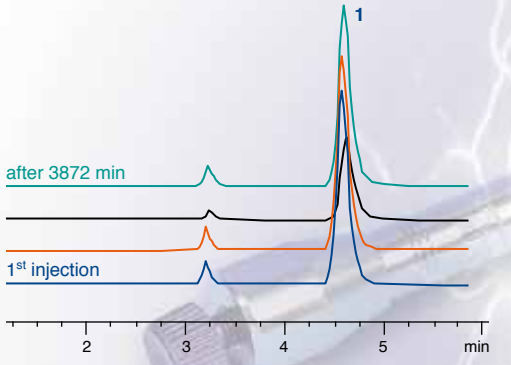
One of the main problems with conventional amino phases is insufficient resistance towards hydrolysis. Due to a special method of surface modification NUCLEODUR® NH_2 features a pronounced stability at higher as well as at lower pH values. The figure at right shows, that even after several days of exposure of the column material at pH 1.75 good separation efficiency and peak symmetry are maintained. The resulting high column life allows cost reduction due to lower column consumption.

The example below proves the enhanced pH stability of the NUCLEODUR® amino phase and also the outstanding suitability of this column for the separation of total herbicides (AMPA, glyphosate, glufonisate, ...) – you may find the complete application 122190 in the "Applications" section on page 60.

Resistance towards hydrolysis for NUCLEODUR® NH_2-RP

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – 50 mmol KH_2PO_4, pH 1.75 (50:50, v/v)
Flow rate: 0.6 mL/min
Detection: UV, 254 nm

Peaks:
1. Aminomethyl-phosphonic acid (AMPA)



Based on the superspherical silica NUCLEODUR® this amino phase – like all other members of the NUCLEODUR® family – features a very good pressure stability, which makes it the perfect choice for preparative separations as well as for LC-MS applications. Additionally, the high batch-to-batch reproducibility of NUCLEODUR® NH_2 offers the advantage of reliable analyses especially for routine work.

SiOH

- **Key features:**
  - Totally spherical high purity silica
  - Pressure stable up to 600 bar
  - Suitable for analytical and preparative separation of polar and midpolar compounds
- **Technical characteristics:**
  Unmodified high purity silica; pore size 110 Å; particle sizes 3 to 50 µm; pore volume 0.9 mL/g, surface area (BET) 340 m^2/g; pH stability 2–8; metal content < 10 ppm (see table on page 1)
- **Recommended application:**
  Polar and mid-polar compounds under normal phase conditions
  USP L3

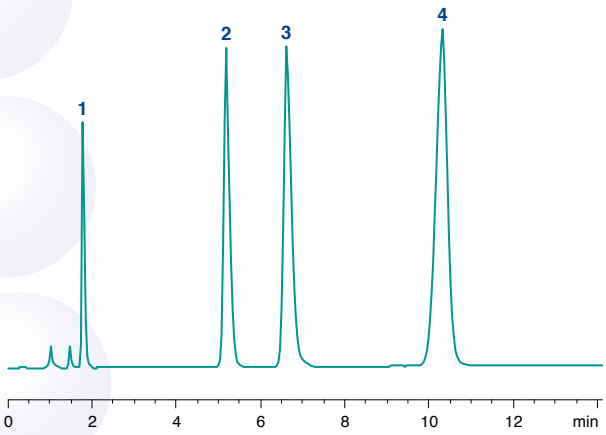
Applications

Anesthetics

MN Appl. No. 119410

Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: methanol – 20 mM KH_2PO_4, pH 6.95 (65:35, v/v)
Flow rate: 1 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 13 µL

Peaks:
1. Benzocaine
2. Lidocaine
3. Tetracaine
4. Butacaine

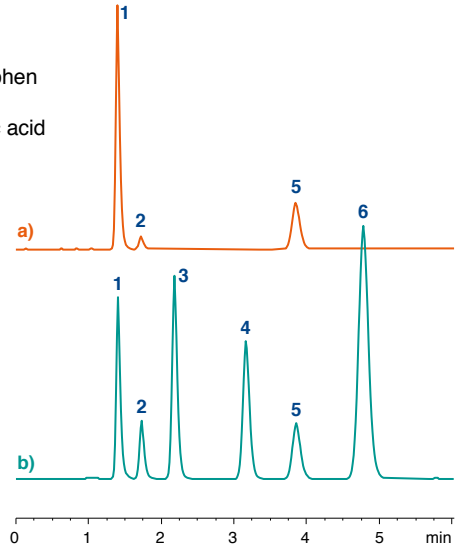


Analgesics

MN Appl. No. 118600

Column: 125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
Eluent: methanol – 0.1 % phosphoric acid (40:60, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 240 nm
a) Thomapyrin® tablet; b) standard
Thomapyrin® is a trademark of Boehringer Ingelheim Pharma KG

Peaks:
1. Paracetamol
2. Caffeine
3. 2-Acetamidophen
4. Acetanilide
5. Acetylsalicylic acid
6. Phenactin

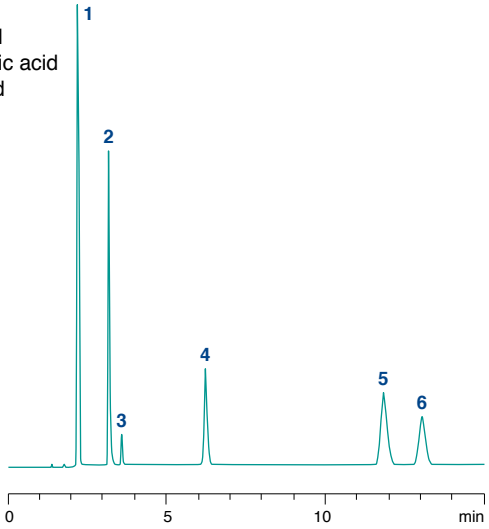


Analgesics

MN Appl. No. 117770

Column: 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 2.5 (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 230 nm
Injection volume: 5 µL

Peaks:
1. Paracetamol
2. Acetylsalicylic acid
3. Salicylic acid
4. Ketoprofen
5. Diclofenac
6. Ibuprofen



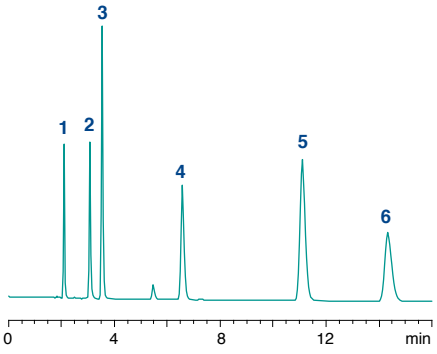
For a fast separation (< 1 min) of acetylsalicylic acid and salicylic acid on NUCLEODUR® 100-5 C_{18} ec see application 117780 at *www.mn-net.com.*

Analgesics

MN Appl. No. 119160

Column: 250 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: acetonitrile – 0.1 % TFA (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Paracetamol
2. Acetylsalicylic acid
3. Methyl-4-hydroxybenzoate
4. Ketoprofen
5. Flurbiprofen
6. Ibuprofen

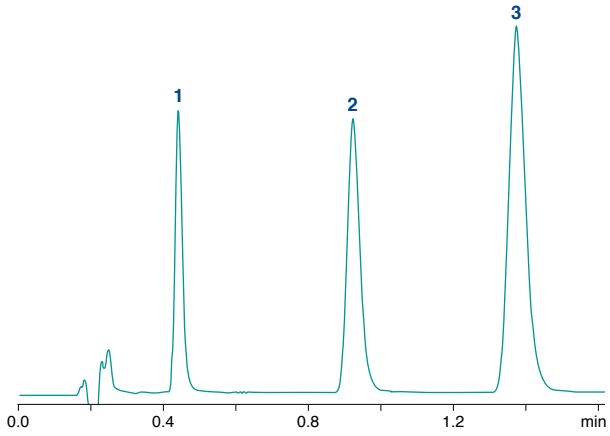


Anti-inflammatory drugs

MN Appl. No. 122130

Column: 50 x 3 mm NUCLEODUR® C_{18} Pyramid, 1.8 µm
Eluent: phosphate buffer, pH 2.5 – acetonitrile – methanol (425:475:100, v/v/v)
Flow rate: 1.0 mL/min
Temperature: 50 °C
Detection: UV, 240 nm
Injection volume: 2 µL

Peaks:
1. Chlorocresol
2. Clobetasol 17-propionate
3. Beclometasone dipropionate

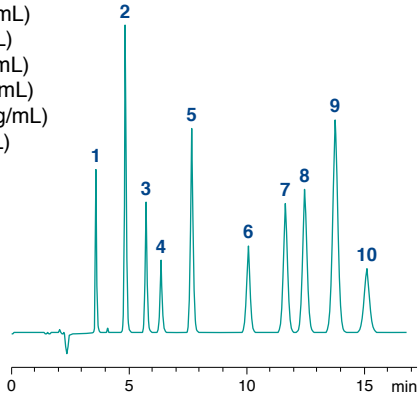


Analgesic and anti-inflammatory drugs

MN Appl. No. 118590

Column: 250 x 4 mm NUCLEODUR® 100-5 C_8 ec
Eluent: acetonitrile – 1 % acetic acid (48:52, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 230 nm
Injection volume: 10 µL

Peaks:
1. Acetylsalicylic acid (1.6 µg/mL)
2. Tolmetin (26 µg/mL)
3. Piroxicam (26 µg/mL)
4. Suprofen (26 µg/mL)
5. Naproxen (0.64 µg/mL)
6. Diflunisal (1.6 µg/mL)
7. Fenoprofen (26 µg/mL)
8. Flurbiprofen (26 µg/mL)
9. Indomethacin (52 µg/mL)
10. Ibuprofen (52 µg/mL)

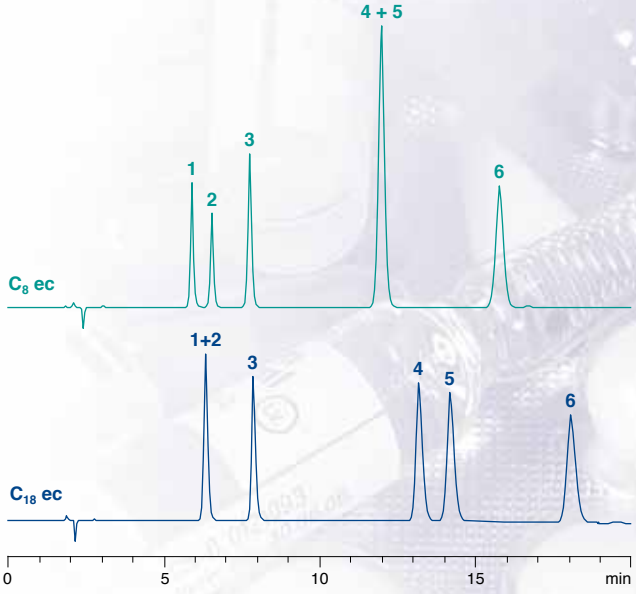


Anti-inflammatory drugs

MN Appl. No. 120880/120881

Columns: 50 x 4 mm NUCLEODUR® 100-5 C_8 ec
250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – water, 1 % acetic acid (48:52, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 230 nm
Injection volume: 10 µL

Peaks:
1. Piroxicam
2. Suprofen
3. Ketoprofen
4. Carprofen
5. Fenoprofen
6. Diclofenac



This separation of various non-steroidal anti-inflammatory drugs illustrates the differences in polarity between C_8 and C_{18} and the resulting impact on efficiency. NUCLEODUR® C_8 ec exhibits enhanced selectivity and excellent resolution for the polar compounds piroxicam and suprofen which co-elute on the C_{18} column. However due to the longer alkyl chain NUCLEODUR® C_{18} ec shows a distinct hydrophobic selectivity that leads to baseline separation of the more non-polar analytes carprofen and fenoprofen with superior peak shapes.

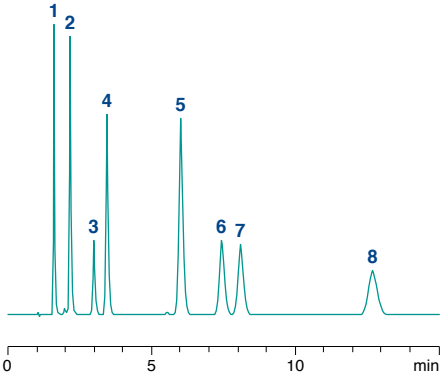
Applications

Anti-inflammatory drugs

MN Appl. No. 117830

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 2.5 (45:55, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 230 nm
Injection volume: 5 µL

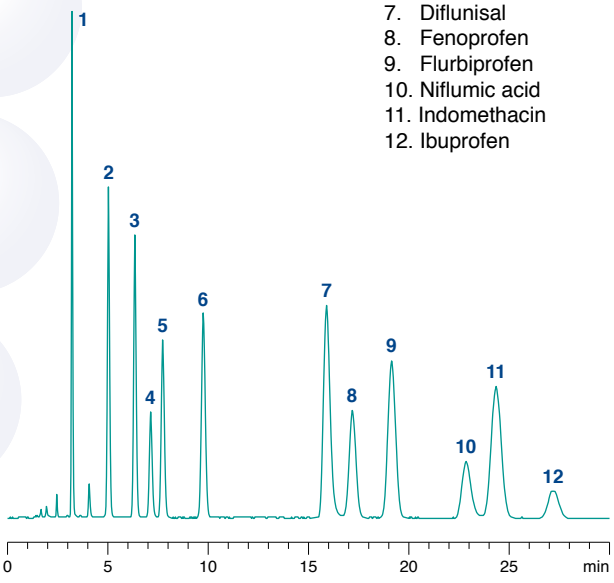
Peaks:
1. Acetylsalicylic acid
2. Sulindac
3. Tolmetin
4. Ketoprofen
5. Flurbiprofen
6. Diclofenac
7. Ibuprofen
8. Meclofenamic acid



MN App. No. 122550

Column: 250 x 4.6 mm NUCLEODUR® C_{18} Gravity, 5 µm
Flow rate: 1.3 mL/min
other conditions as above

Peaks:
1. Acetylsalicylic acid
2. Sulindac
3. Piroxicam
4. Suprofen
5. Tolmetin
6. Naproxen
7. Diflunisal
8. Fenoprofen
9. Flurbiprofen
10. Niflumic acid
11. Indomethacin
12. Ibuprofen

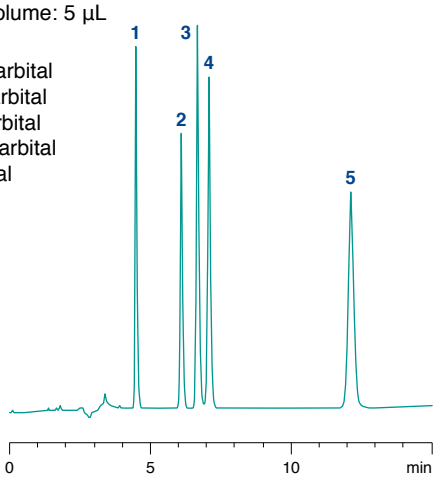


Barbiturates

MN Appl. No. 117820

Column: 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – water (50:50, v/v)
Flow rate: 0.7 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Phenobarbital
2. Pentobarbital
3. Hexobarbital
4. Mephobarbital
5. Thiamylal

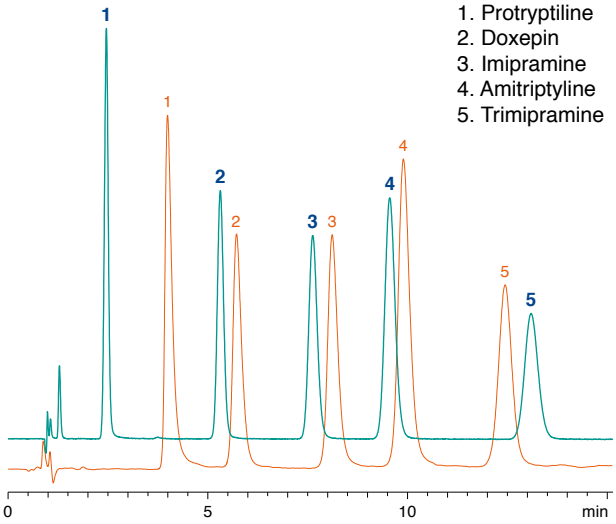


Tricyclic antidepressants

MN Appl. No. 124622

Columns: **150 x 3 mm NUCLEODUR® PolarTec, 5 µm**
150 x 3 mm Waters SymmetryShield™ RP18, 5 µm
Eluent: methanol – 25 mM KH_2PO_4, pH 7 (70:30, v/v)
Flow rate: 0.66 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 1 µL

Peaks:
1. Protryptiline
2. Doxepin
3. Imipramine
4. Amitriptyline
5. Trimipramine



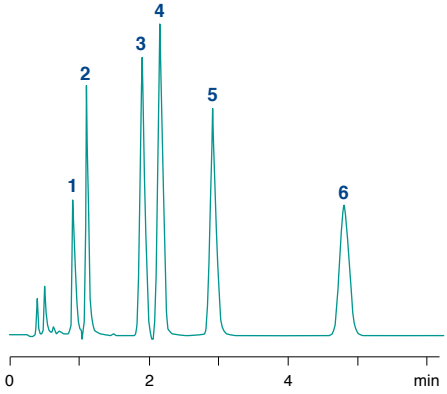
Excellent endcapping of NUCLEODUR® PolarTec displays significantly better peak shapes and less tailing for strong basic components compared to other phases with embedded polar group.

Tricyclic antidepressants

MN Appl. No. 117800

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 7.0 (65:35, v/v)
Flow rate: 1.0 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 2 µL

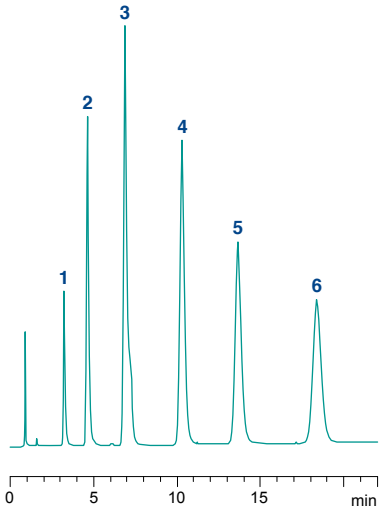
Peaks:
1. Protriptyline
2. Nortriptyline
3. Doxepin
4. Imipramine
5. Amitriptyline
6. Trimipramine



MN Appl. No. 118520

Column: 125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
Eluent: methanol – 20 mM KH_2PO_4, pH 7.0 (65:35, v/v)
Temperature: 25 °C

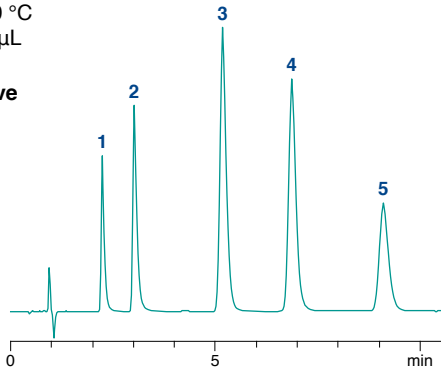
Peaks and other conditions as above



MN Appl. No. 119200

Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: methanol – 20 mM $NH_4H_2PO_4$, pH 6.95 (70:30, v/v)
Temperature: 40 °C
Injection volume: 5 µL

Peaks and other conditions as above

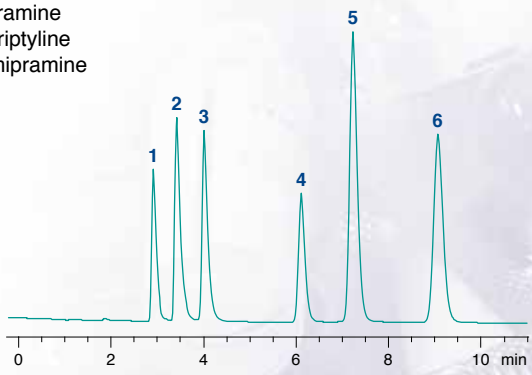


Tricyclic antidepressants

MN Appl. No. 121210

Column: 150 x 4 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: methanol – 20 mM KH_2PO_4, pH 7 (75:25, v/v)
Flow rate: 1 mL/min
Temperature: 40 °C
Detection: UV, 230 nm
Injection volume: 8 µL

Peaks:
1. Protriptyline
2. Maprotiline
3. Nortriptyline
4. Imipramine
5. Amitriptyline
6. Clomipramine

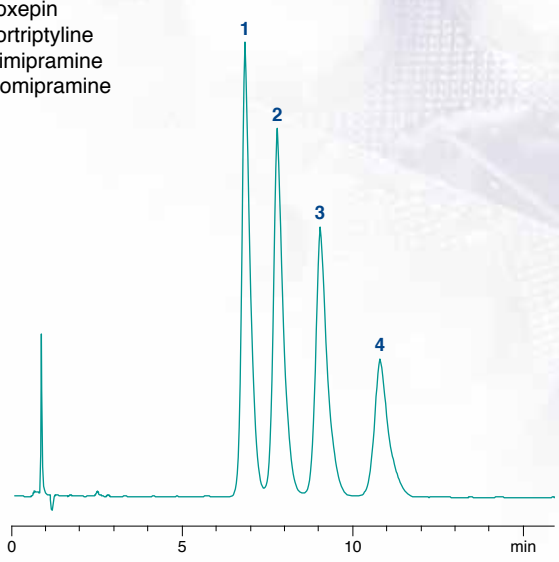


Peak symmetry at 10 % of peak height:
A_s (imipramine): 1.29
A_s (amitriptyline): 1.26
A_s (clomipramine): 1.16

MN Appl. No. 119280

Column: 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 6.5 (55:45, v/v)
Flow rate: 1 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 2.5 µL (25 µg/mL)

Peaks:
1. Doxepin
2. Nortriptyline
3. Trimipramine
4. Clomipramine



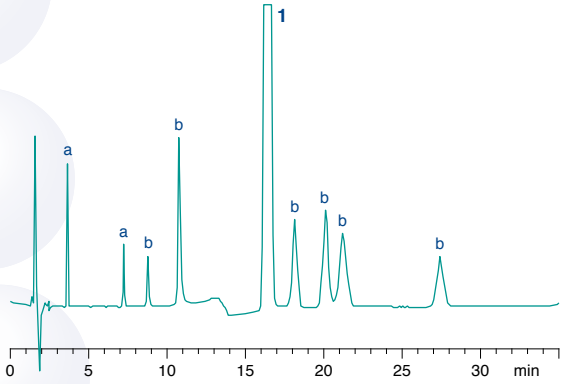
Applications

Neuroleptics

MN Appl. No. 121612

Column: 250 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
Eluent: acetonitrile – 6.0 g/L KH_2PO_4, 2.9 g/L sodium dodecylsulfate, 9.0 g/L tetra-*n*-butylammonium bromide pH 8 (40:60, v/v)
Flow rate: 1.5 mL/min
Temperature: 40 °C
Detection: 237 nm
Injection volume: 5 µL

Peaks:
1. Chloroprothixene hydrochloride
a. Additives
b. Impurities



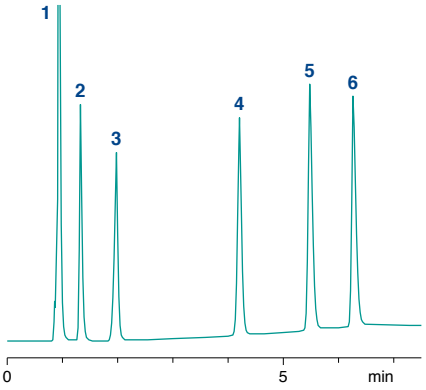
For separation on NUCLEODUR® C_{18} Gravity see application 121611 at *www.mn-net.com.*

Cold medicine

MN Appl. No. 117810

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluents: A) 50 mM KH_2PO_4 + 5 mM pentanesulfonate (Na salt), pH 2.5; B) methanol
35 % B → 55 % B in 5 min
Flow rate: 1.0 mL/min
Temperature: 40 °C
Detection: UV, 230 nm
Injection volume: 5 µL

Peaks:
1. Maleic acid
2. Paracetamol
3. Pseudoephedrine
4. Benzoic acid
5. Chlorpheniramine
6. Dextromethorphan

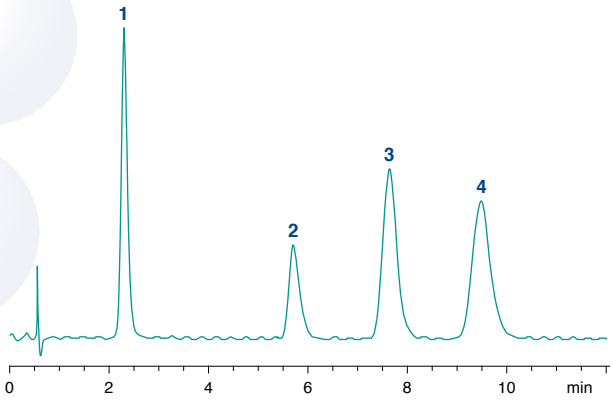


Gastric acid inhibitors

MN Appl. No. 122520

Column: 75 x 4.6 mm NUCLEODUR® C_{18} Gravity, 3 µm
Eluent: methanol – 20 mM KH_2PO_4, pH 7 with TEA (20:80, v/v)
Flow rate: 1.3 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 10 µL

Peaks:
1. Famotidine
2. Cimetidine
3. Nizatidine
4. Pirenzepine hydrochloride

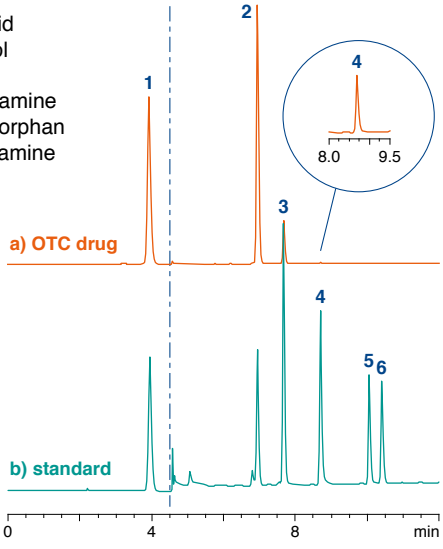


Cold medicine ingredients

MN Appl. No. 119110/119120

Column: 250 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: A) 50 mM $NH_4H_2PO_4$, pH 2.5; B) acetonitrile
0 % B → 60 % B in 13 min
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 230 nm for 4.5 min, then 261 nm
Injection volume: a) 2 µL, b) 4 µL

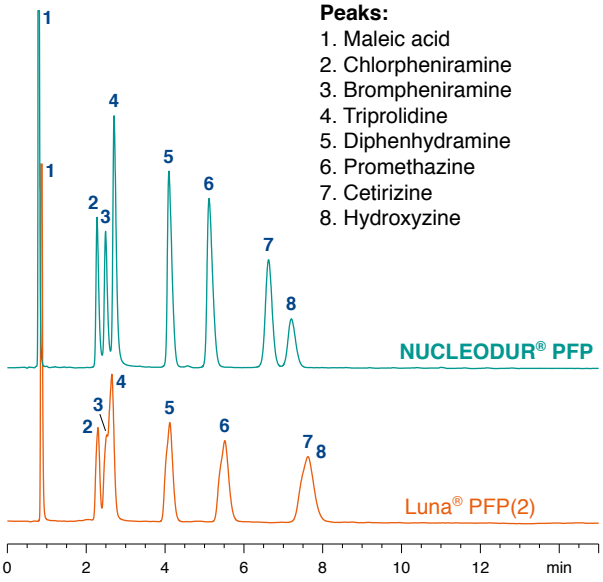
Peaks:
1. Ascorbic acid
2. Paracetamol
3. Caffeine
4. Chlorpheniramine
5. Dextromethorphan
6. Diphenhydramine



Antihistamines

MN Appl. No. 124851

Columns: **100 x 4.6 mm NUCLEODUR® PFP, 5 µm**
100 x 4.6 mm Phenomenex Luna® PFP(2), 5 µm
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 3.0 (30:70, v/v)
Flow rate: 1.3 mL/min
Temperature: 30 °C
Detection: UV, 210 nm
Injection volume: 1 µL

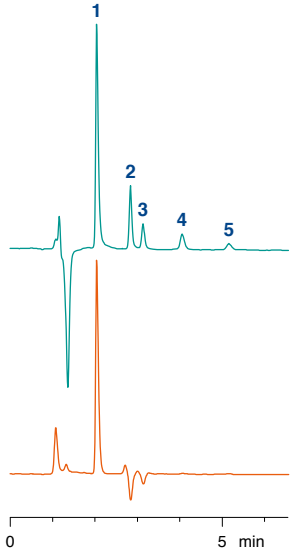


Peaks:
1. Maleic acid
2. Chlorpheniramine
3. Brompheniramine
4. Triprolidine
5. Diphenhydramine
6. Promethazine
7. Cetirizine
8. Hydroxyzine

Xylometazoline in nasal spray

MN Appl. No. 120390

Column: 125 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – 50 mM Na citrate, pH 3.0 (50:50, v/v)
Flow rate: 0.8 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 100 µL



Peaks:
1. Xylometazoline
2.–5. Benzalkonium chlorides with different chain lengths (C_8, C_{10}, C_{12}, C_{14})

a) nasal spray
(1 mg/mL, diluted 1:10 in eluent)

b) standard

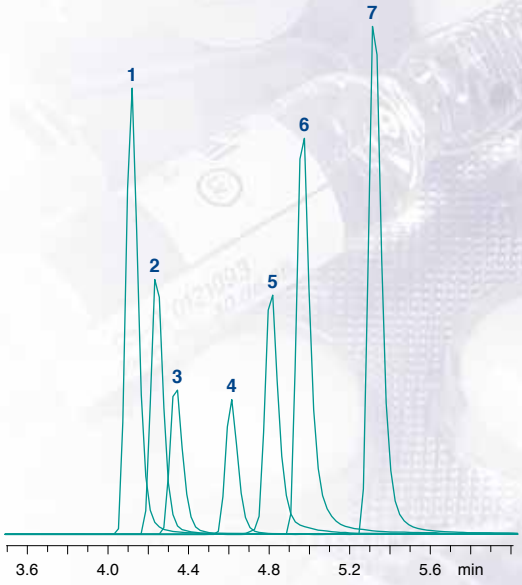
β_2-Agonists in human urine by LC-MS/MS

MN Appl. No. 119760

Column: 75 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Sample prep.: please refer to Thevis et al., J. Mass Spectrom **38** (2003) 1197–1206
Eluents: A) 5 mM ammonium acetate with 0.1 % acetic acid, pH 3.5; B) acetonitrile; 0 % B → 100 % B in 6 min, reequilibration at 100 % A for 3.5 min
Flow rate: 0.8 mL/min
Temperature: 25 °C
Detection: electrospray ionization / multiple reaction monitoring (MRM) on an Applied Biosystems API 2000
Injection volume: 20 µL

LC-MS/MS chromatogram
2 mL urine aliquot fortified with 200 ng each

Peaks:
1. Reproterol (4.12 min)
2. Fenoterol (4.24 min)
3. Ritodrine (4.34 min)
4. Ractopamine (4.61 min)
5. Clenbuterol (4.81 min)
6. Bambuterol (4.97 min)
7. Mapenterol (5.32 min)



Courtesy of M. Thevis and W. Schänzer, Institute of Biochemistry, German Sport University, Cologne, Germany.

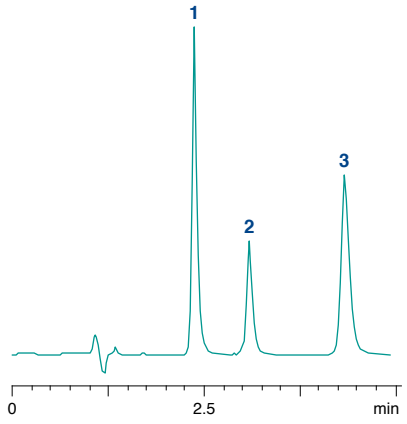
Applications

Basic drugs

MN Appl. No. 119320

Column: 125 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 6.5 (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 1.0 µL

Peaks:	Tailing factor
1. Procainamide (5 ng/µL)	1.3
2. Clonidin (10 ng/µL)	1.2
3. Clenbuterol (12 ng/µL)	1.2

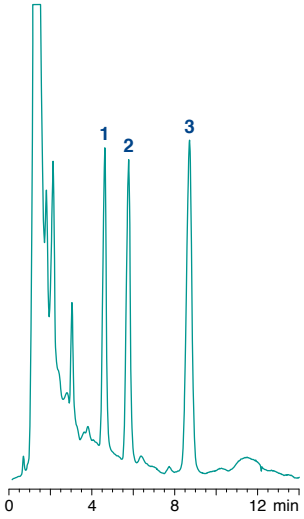


Benzodiazepine midazolam and metabolite from plasma

MN Appl. No. 118470

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 3 µm
Eluent: 127 mL KH_2PO_4 (9.1 g/L H_2O) + 309 mL Na_2HPO_4 (11.9 g/L H_2O) + 852 mL methanol + 0.15 g octanesulfonic acid, pH 5.56
Flow rate: 0.7 mL/min
Temperature: 25 °C
Detection: UV, DAD

Peaks:
1. α-Hydroxymidazolam (metabolite)
2. Midazolam (250 ng/mL)
3. Internal standard



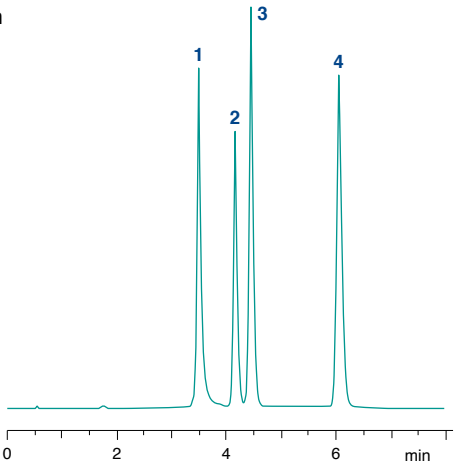
Courtesy of Mrs. Richter, Institute of Anesthetics, Biochemical Laboratory, University of Erlangen, Germany

Benzodiazepines

MN Appl. No. 117850

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 6.5 (45:55, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Bromazepam
2. Oxazepam
3. Lorazepam
4. Temazepam

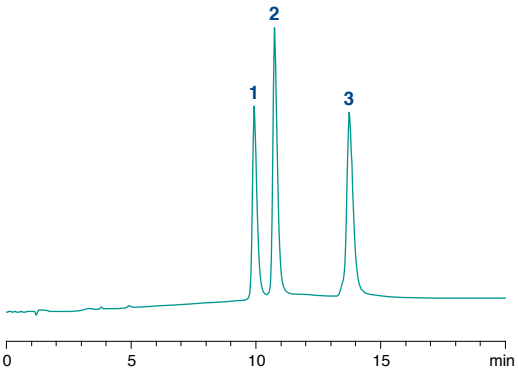


Sedative drugs

MN Appl. No. 119300

Column: 125 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: A) methanol
B) 50 mM ammonium acetate, pH 5.0
70 % B → 50 % B in 10 min (10 min)
Flow rate: 1.5 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 1 µL (1 + 2: 670 µg/mL, 3: 335 µg/mL)

Peaks:
1. Promethazine
2. Promazine
3. Chlorpromazine

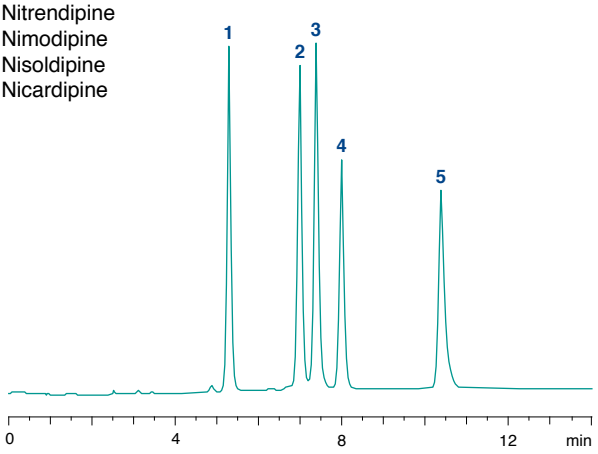


Coronary therapeutic drugs
(Ca-antagonists)

MN Appl. No. 119310

Column: 125 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: A) acetonitrile, B) 20 mM KH_2PO_4, pH 6.5
30 % B → 50 % B in 7.5 min (7.5 min)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 2.5 µL (25 µg/mL each)

Peaks:
1. Nifedipine
2. Nitrendipine
3. Nimodipine
4. Nisoldipine
5. Nicardipine

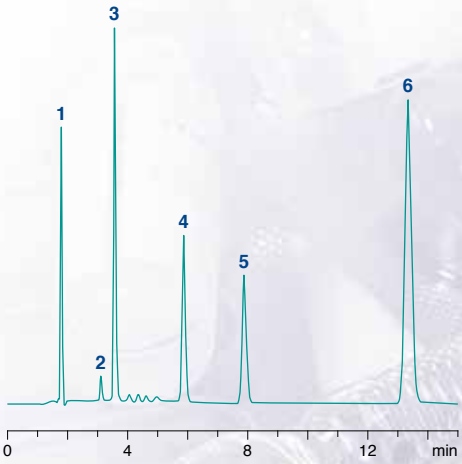


Antibacterial drugs

MN Appl. No. 117870

Column: 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – water (40:60, v/v) 0.05 % TFA
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Ofloxacin
2. Ciprofloxacin
3. Cinoxacin
4. Penicillin G
5. Penicillin V
6. Cloxacillin

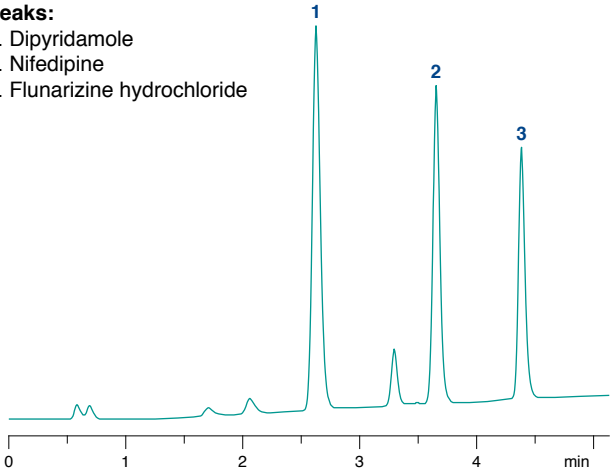


Cardiovascular drugs

MN Appl. No. 122560

Column: 75 x 4.6 mm NUCLEODUR® C_{18} Gravity, 3 µm
Eluent: A) 50 mM KH_2PO_4 + Na pentanesulfonate pH 2.5
B) methanol
45 % B → 90 % B in 6 min
Flow rate: 1.3 mL/min
Temperature: 35 °C
Detection: UV, 230 nm
Injection volume: 5 µL

Peaks:
1. Dipyridamole
2. Nifedipine
3. Flunarizine hydrochloride

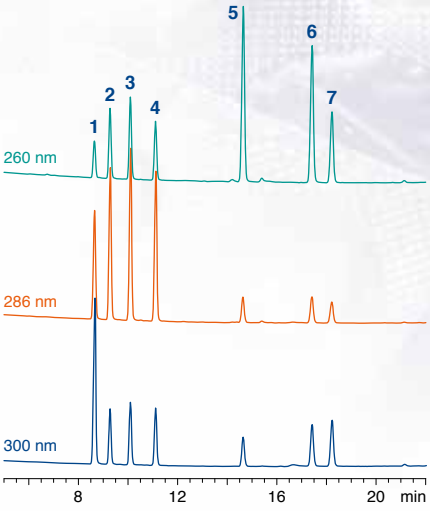


Gyrase inhibitors

MN Appl. No. 120400

Column: 150 x 3 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: A) 0.05 M H_3PO_4, B) acetonitrile
5 % B → 50 % B in 20 min
Flow rate: 0.5 mL/min
Detection: UV DAD, 260 nm, 286 nm and 300 nm
Injection volume: 20 µL (0.625 ng/µL of each compound)

Peaks:
1. Marbofloxacin
2. Ciprofloxacin
3. Enrofloxacin
4. Sarafloxacin
5. Oxolinic acid
6. Nalidixic acid
7. Flumequine



Courtesy of R. Lippold, Chemical and Veterinary Research Agency, Freiburg, Germany.

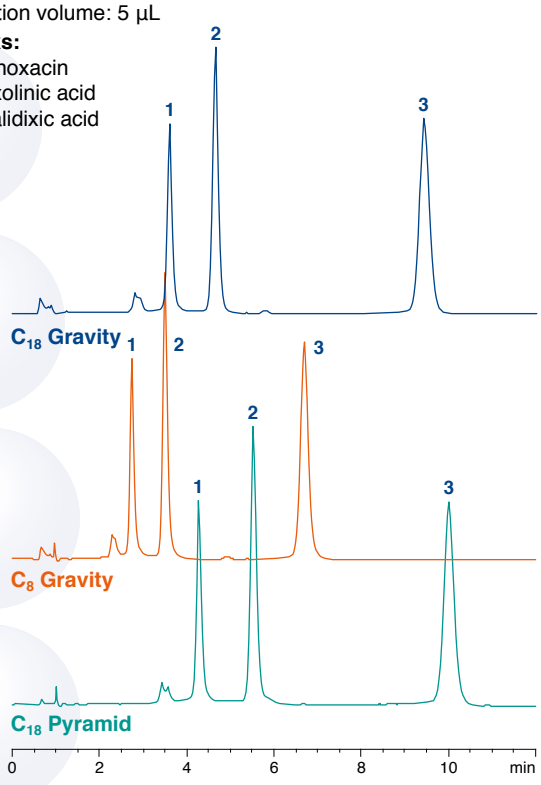
Applications

Quinolone antibiotics

MN Appl. No. 120460/120470

Columns: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: methanol – 0.2 % formic acid (40:60, v/v)
Flow rate: 1.0 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 5 µL

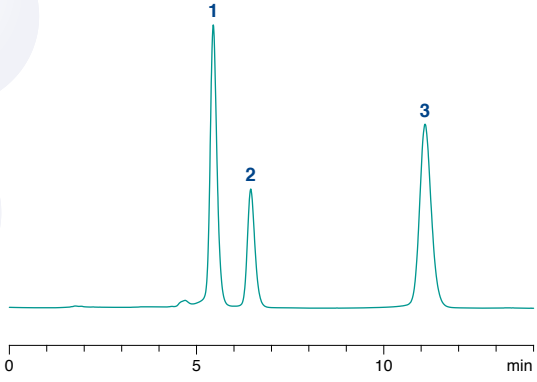
Peaks:
1. Cinoxacin
2. Oxolinic acid
3. Nalidixic acid



MN Appl. No. 119870

Column: 150 x 4.6 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: methanol – 20 mM KH_2PO_4, pH 2.5 (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks as listed above

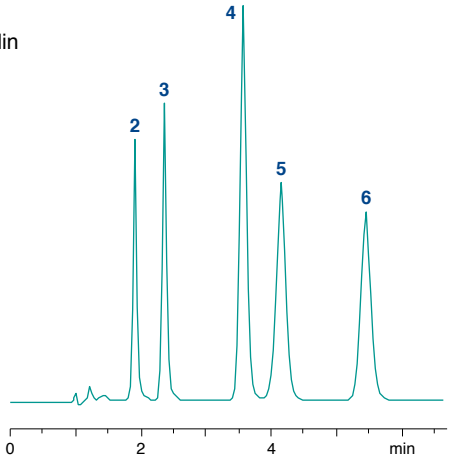


Penicillin antibiotics

MN Appl. No. 117860

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 3.0 (40:60, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 254 nm
Injection volume: 5 µL

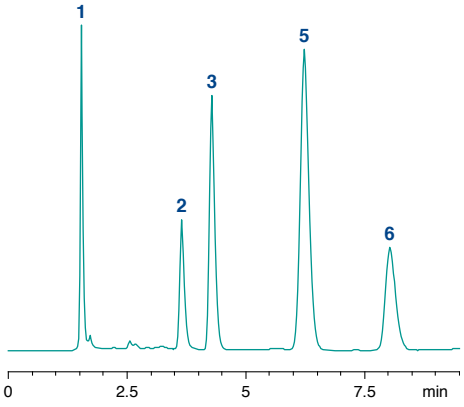
Peaks:
1. Amoxicillin
2. Penicillin G
3. Penicillin V
4. Cloxacillin
5. Nafcillin
6. Dicloxacillin



MN Appl. No. 119150

Column: 250 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: acetonitrile – 0.1 % TFA (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 1 µL

Peaks as listed above



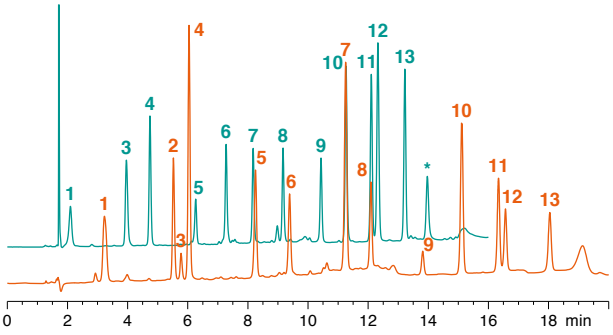
β-lactam antibiotics

MN Appl. No. 124840

Column: 150 x 3 mm NUCLEODUR® PFP, 5 µm
Eluents: A) acetonitrile, B) 25 mM KH_2PO_4, pH 2.7
10 % A → 60 % A in 15 min
A) acetonitrile, B) 0.1 % TFA
10 % A → 45 % A in 15 min (5 min)
Flow rate: 0.563 mL/min
Temperature: 40 °C, 50 °C
Detection: UV, 220 nm, UV, 240 nm
Injection volume: 1 µL

Peaks:

1. Amoxicillin
2. Cephalexin
3. Ampicillin
4. Cefotaxime
5. Cefoxitin
6. Cefamandole
7. Cefalotin
8. Piperacillin
9. Penicillin V
10. Oxacillin
11. Cloxacillin
12. Nafcillin
13. Dicloxacillin
* Impurity

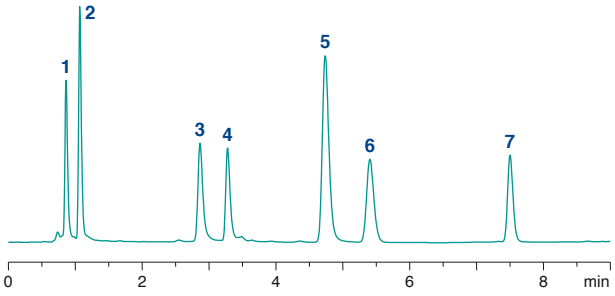


MN Appl. No. 123760

Column: 125 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: A) acetonitrile, B) 0.05 % TFA in water
70 % B (1 min) → 60 % B in 0.5 min (3.5 min) →
50 % B in 1 min → 37.5 % B in 4 min
Flow rate: 0.9 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 10 µL
Concentration: 300 µg/mL

Peaks:

1. Amoxicillin
2. Enrofloxacin
3. Cinoxacin
4. Oxolinic acid
5. Nalidixic acid
6. Penicillin V
7. Cloxacillin



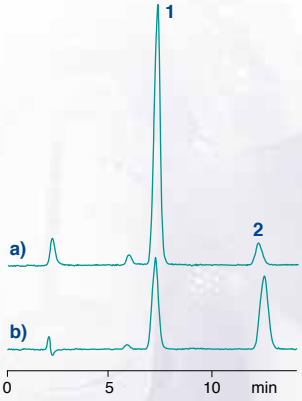
Anticoccidial drugs (polyether antibiotics)

MN Appl. No. 118760

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 3 µm
Eluent: methanol – 50 mmol phosphate buffer pH 3.0 – methylheptylamine (900:99:1, v/v/v)
Flow rate: 0.7 mL/min
Temperature: 23 °C
Detection: UV/VIS, 600 nm after post column derivatization with dimethylaminobenzaldehyde (0.4 mL/min)
Injection volume: 100 µL

Peaks:

1. Monensin sodium
2. Salinomycin sodium



a): Sample spiked with monensin sodium and content of salinomycin sodium
b): Standard of monensin sodium and salinomycin sodium

Courtesy of J. Schönherr, Saxon State Institute for Agriculture, Leipzig, Germany

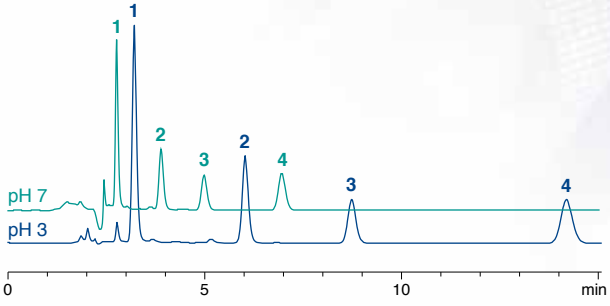
Cephalosporin antibiotics

MN Appl. No. 122580/122590

Column: 150 x 4.6 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – 25 mM KH_2PO_4 (20:80, v/v)
pH 3 with H_3PO_4, pH 7
Flow rate: 0.8 mL/min
Temperature: 35 °C
Detection: UV, 254 nm
Injection volume: 2 µL

Peaks:

1. Cefotaxime
2. Cefoxitin
3. Cefamandole
4. Cephalothin



Protonation causes a drastic increase in retention time, but an improved peak symmetry.

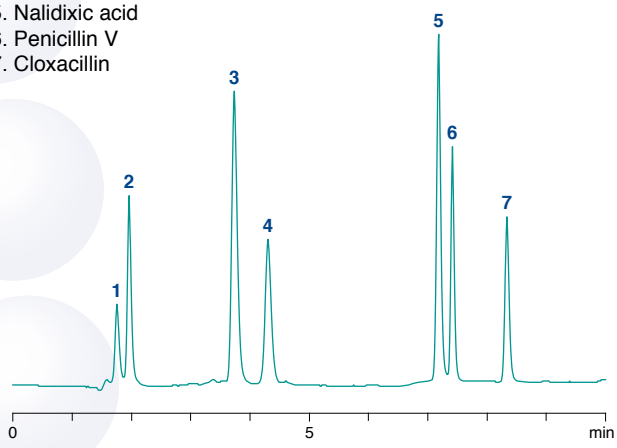
Applications

Antibacterial drugs

MN Appl. No. 122470

Column: 250 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile, B) water + 0.05 % TFA
60 % B (4 min) → 40 % B in 1 min (5 min)
Flow rate: 0.9 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Amoxicillin
2. Enrofloxacin
3. Cinoxacin
4. Oxolinic acid
5. Nalidixic acid
6. Penicillin V
7. Cloxacillin

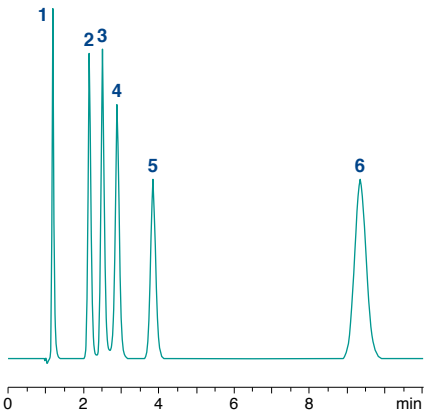


Sulfonamides

MN Appl. No. 117880

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: methanol – 0.1 % TFA (20:80, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 230 nm
Injection volume: 4 µL

Peaks:
1. Sulfanilamide
2. Sulfadiazine
3. Sulfathiazole
4. Sulfamerazine
5. Sulfadimidine
6. Succinylsulfathiazole

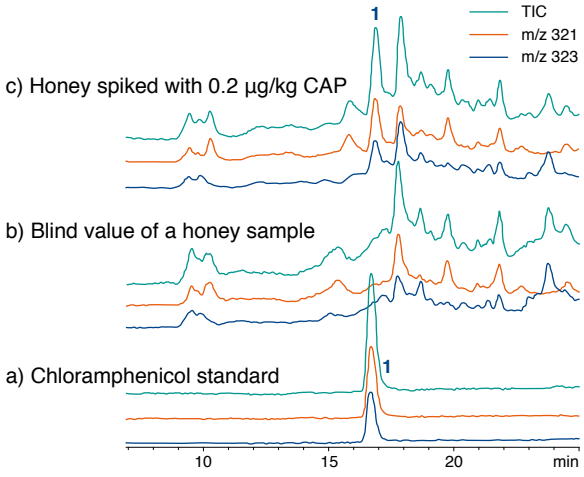


Determination of chloramphenicol residues in honey by microbore HPLC

MN Appl. No. 119810

Column: 100 x 1 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) methanol, B) water
15 % A → 80 % A in 9 min (15 min) → 15 % A in 1 min; injection after 7 min
Flow rate: 60 µL/min
Detection: MS
Injection volume: 1 µL

Peaks
1. Chloramphenicol (CAP)



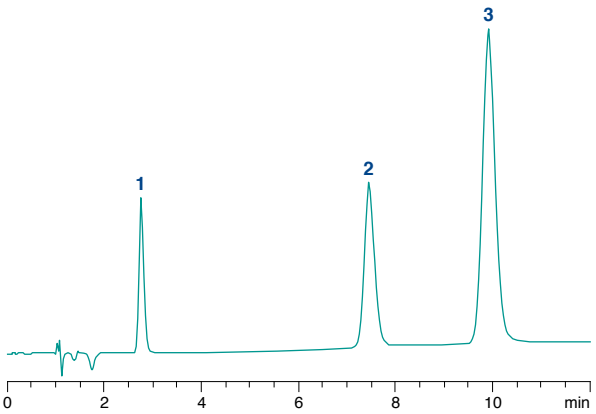
S. Oepkemeier, H.D. Winkler, GIT **46** (2002) 982–985.

Separation of theobromine, vanillin and caffeine

MN Appl. No. 119920

Column: 125 x 4 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: methanol – 1.25 % acetic acid (20:80, v/v)
Flow rate: 1 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 0.8 µL

Peaks:
1. Theobromine
2. Caffeine
3. Vanillin

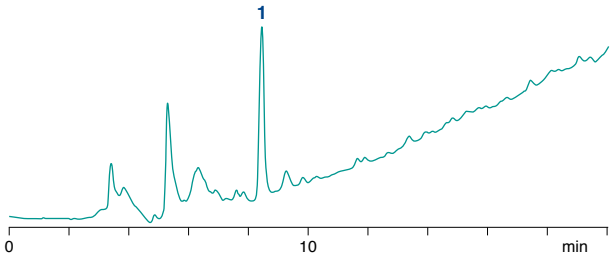


Alkaline tannic acid mixture

MN Appl. No. 120450

Column: 250 x 4.6 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: A) 0.425 % H_3PO_4, pH 1.4, B) acetonitrile
5 % B → 25 % B in 15 min (5 min) → 5 % B in 2 min (3 min)
Flow rate: 0.8 mL/min
Detection: UV, 275 nm (optimized for gallic acid)
Injection volume: 10 µL

Peaks:
1. Gallic acid



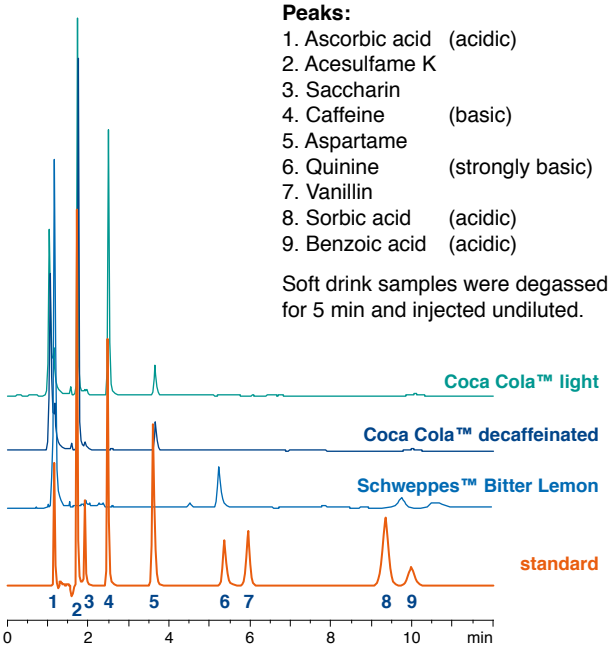
Soft drink additives

MN Appl. No. 118560

Column: 150 x 4.6 mm NUCLEODUR® 100-5 C_8 ec
Eluent: 20 mM KH_2PO_4, pH 3 – acetonitrile (5:1, v/v)
Flow rate: 1.9 mL/min
Temperature: 25 °C
Detection: UV, 220 nm
Injection volume: 10 µL

Peaks:
1. Ascorbic acid (acidic)
2. Acesulfame K
3. Saccharin
4. Caffeine (basic)
5. Aspartame
6. Quinine (strongly basic)
7. Vanillin
8. Sorbic acid (acidic)
9. Benzoic acid (acidic)

Soft drink samples were degassed for 5 min and injected undiluted.



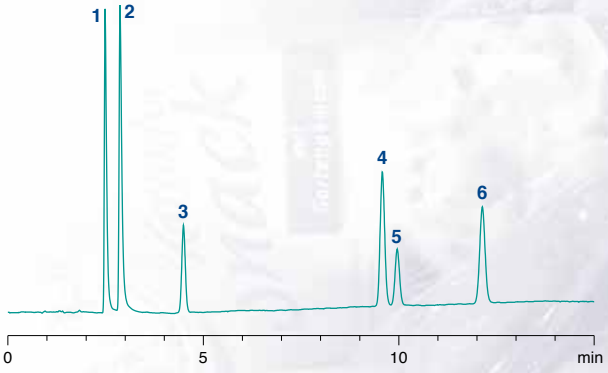
For fast separation of sweeteners on NUCLEODUR® 100-5 C_{18} ec see appl. 117940 at *www.mn-net.com.*

Sweeteners

MN Appl. No. 123750

Column: 150 x 4.6 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: A) acetonitrile, B) 25 mM KH_2PO_4, pH 3.5
15 % A (2.5 min) → 25 % A in 9.5 min (3 min)
Flow rate: 1.3 mL/min
Temperature: 40 °C
Detection: UV, 220 nm
Injection volume: 5 µL
Concentration: 0.1 mg/mL each

Peaks:
1. Acesulfame K
2. Saccharin
3. Aspartame
4. Benzoic acid
5. Sorbic acid
6. Dehydroacetic acid

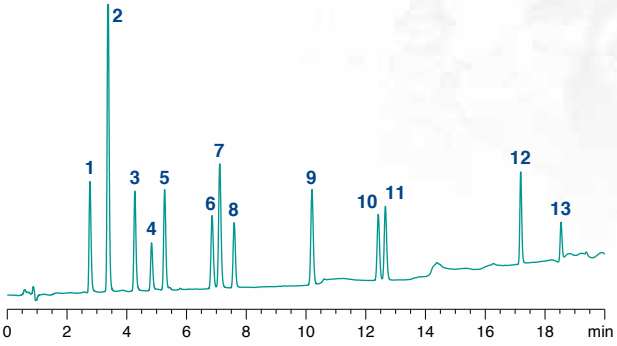


Preservatives

MN Appl. No. 124590

Column: 150 x 3 mm NUCLEODUR® PolarTec, 3 µm
Eluent: A) acetonitrile, 0.1 % TFA, B) water, 0.1 % TFA
20 % A → 50 % A in 12 min → 65 % A in 2 min → 95 % A in 6 min
Flow rate: 0.9 mL/min
Temperature: 45 °C
Detection: UV, 220 nm
Injection volume: 5 µL

Peaks:
1. Benzyl alcohol
2. Phenoxyethanol
3. Dehydroacetic acid
4. *p*-Anisic acid
5. Methyl paraben
6. Salicylic acid
7. Benzoic acid
8. Ethyl paraben
9. Propyl paraben
10. Isobutyl paraben
11. Butyl paraben
12. Irgasan
13. 3,3,4-Triclocarbanilid



Applications

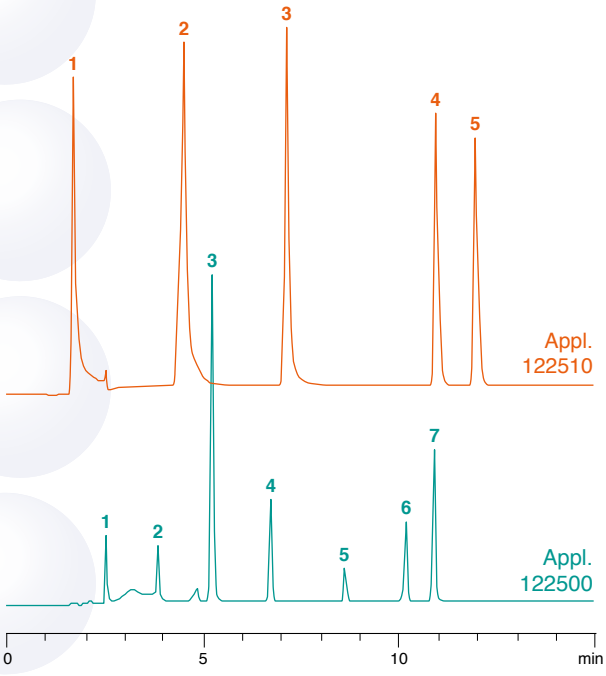
Food dyes

MN Appl. No. 122500/122510

Column: 250 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile, B) 20 mM KH_2PO_4, pH 5
95 % B → 50 % B in 20 min → 20 % B in 5 min → 95 % B in 1 min (4 min)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks application 122510
1. Ponceau 6R (E 126)
2. Ponceau 4R (E 124)
3. Azorubine (E 122)
4. Erythrosine (E 127)
5. Fast Red E

Peaks application 122500
1., 2. Tartrazine (E 102)
3. Fast Yellow
4.–6. Quinoline yellow (E 104)
7. Yellow orange S (sunset yellow CFC, E 110)

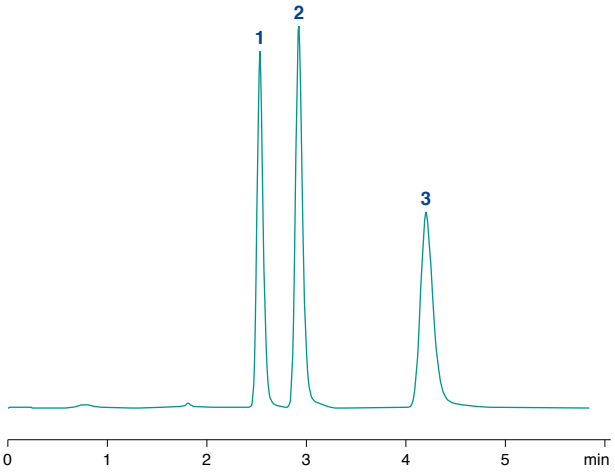


Acrylamide, methacrylamide and methacrylic acid

MN Appl. No. 123010

Column: 125 x 4 mm NUCLEODUR® HILIC, 5 µm
Eluent: acetonitrile – 0.1 % formic acid (98:2, v/v)
Flow rate: 0.6 mL/min
Temperature: 22 °C
Detection: UV, 210 nm
Injection volume: 0.5 µL

Peaks:
1. Methacrylamide
2. Acrylamide
3. Methacrylic acid

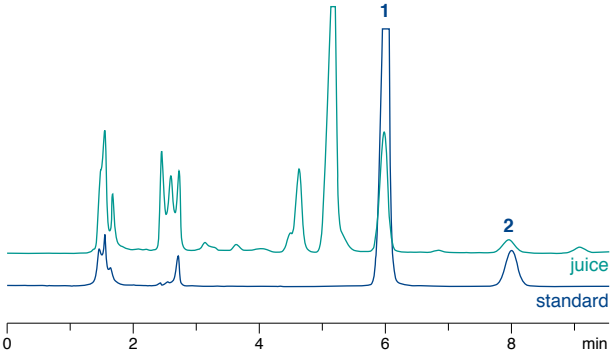


Patulin and hydroxymethylfurfural in apple juice

MN Appl. No. 121800

Column: 250 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm + 8 x 4 mm guard column
Sample prep.: see appl. 121800 at *www.mn-net.com*
Eluent: water – acetonitrile (95:5, v/v)
Flow rate: 1.5 mL/min
Detection: UV, 276 nm
Injection volume: 10 µL

Peaks:
1. Hydroxymethylfurfural
2. Patulin



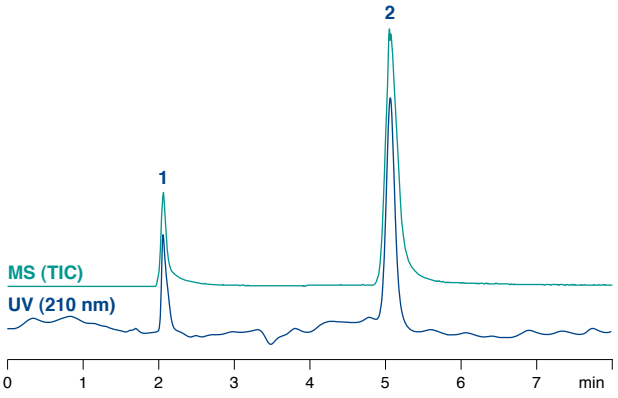
Courtesy of A. Gessler, Wesergold Getränkeindustrie GmbH & Co. KG, Rinteln, Germany.

Melamine and cyanuric acid

MN Appl. No. 123070

Column: 125 x 2 mm NUCLEODUR® HILIC, 5 µm
Eluent: acetonitrile – 10 mM ammonium formate, pH 4 (90:10, v/v)
Flow rate: 0.2 mL/min
Temperature: 25 °C
Detection: UV, 210 nm and MS (TIC)
Injection volume: 2 µL

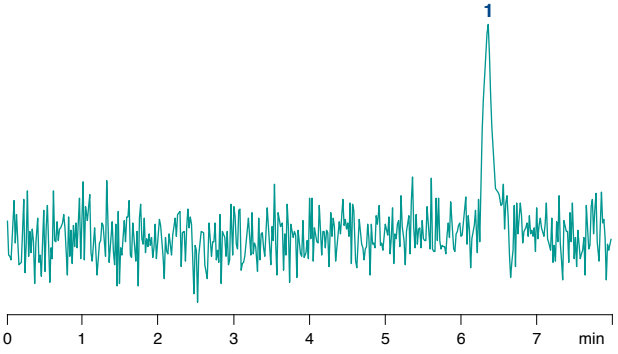
Peaks:
1. Melamine (10 µg/mL)
2. Cyanuric acid (490 µg/mL)



MN Appl. No. 123090

Column: 125 x 4 mm NUCLEODUR® HILIC, 5 µm
Eluent: acetonitrile – 10 mM ammonium formate, pH 4 (90:10, v/v)
Flow rate: 0.6 mL/min
Temperature: 25 °C
Detection: MS
Injection volume: 1 µL

Peaks:
1. Melamine in milk (100 pg/injection)

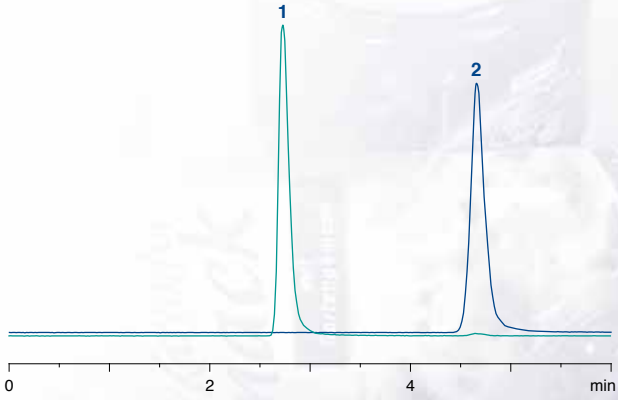


Creatinine and creatine

MN Appl. No. 123000

Column: 125 x 2 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – 10 mM ammonium acetate, pH 4 (70:30, v/v)
Flow rate: 0.2 mL/min
Temperature: 25 °C
Detection: MS
Injection volume: 5 µL (30 ng/µL)

Peaks:
1. Creatinine
2. Creatine



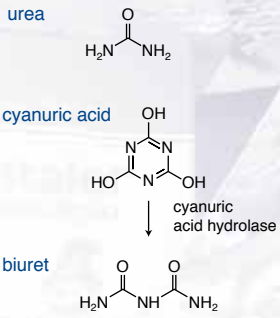
For UV detection see appl. 122990 at *www.mn-net.com*.

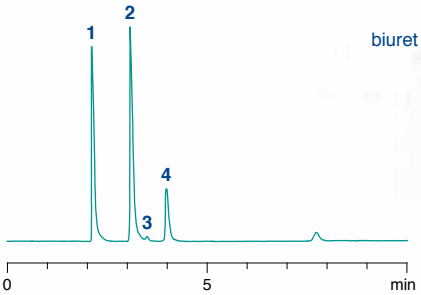
Separation of urea, biuret and cyanuric acid

MN Appl. No. 120440

Column: 250 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: water (100 %)
Flow rate: 1 mL/min
Detection: UV, 190 nm
Injection volume: 10 µL

Peaks:
1. Urea (0.5 mg/mL)
2. Biuret (0.09 mg/mL)
3. impurity in biuret
4. Cyanuric acid (0.05 mg/mL)





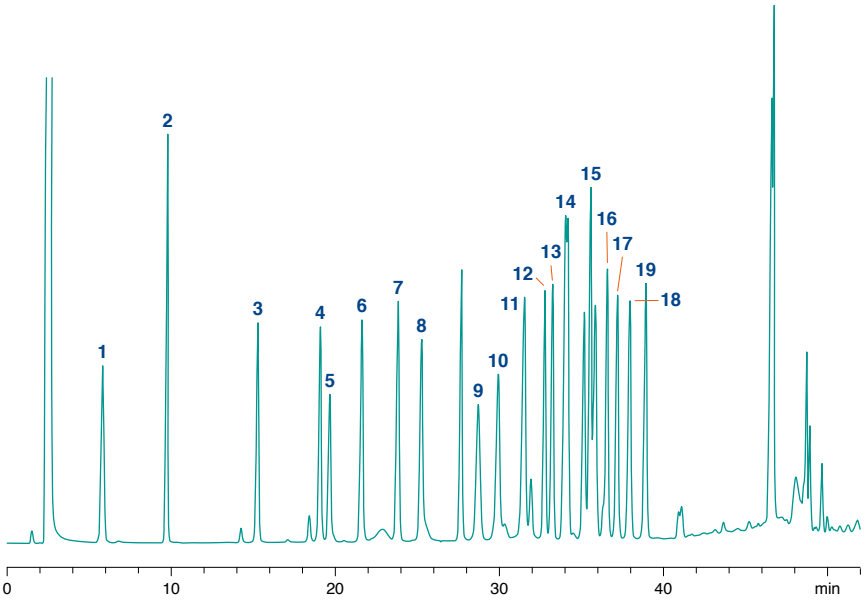
Courtesy of C. Greve, Institute of Chemical Engineering, University of Clausthal, Germany.

Amino acids as OPA derivatives

MN Appl. No. 118450

Column: 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: A) methanol – acetonitrile (50:50, v/v), B) Na acetate buffer pH 6.5 + 5 % A)
100 % B (2.9 min) → 95 % B in 3.1 min → 85 % B in 11 min → 83 % B in 3 min → 70 % B in 10 min → 62 % B in 8 min → 35 % B in 7 min → 0 % B in 1 min (2 min) → 80 % B in 0.5 min (2.5 min) → 100 % B in 0.1 min
Flow rate: 1 mL/min
Detection: fluorescence,
λ_{ex} 230 nm, λ_{em} 450 nm

Peaks:
1. Aspartic acid
2. Glutamic acid
3. Asparagine
4. Serine
5. Glutamine
6. Histidine
7. Glycine
8. Alanine
9. Arginine
10. γ-Aminobutyric acid
11. Tyrosine
12. Valine
13. Methionine
14. Norvaline (int. std.)
15. Tryptophan
16. Phenylalanine
17. Isoleucine
18. Leucine
19. Lysine



Courtesy of Mr. Zürcher, Technical University of Munich, Chair of Brewing Technology, Freising Weihenstephan, Germany.
For separation of amino acids also see appl. 120510 at *www.mn-net.com.*

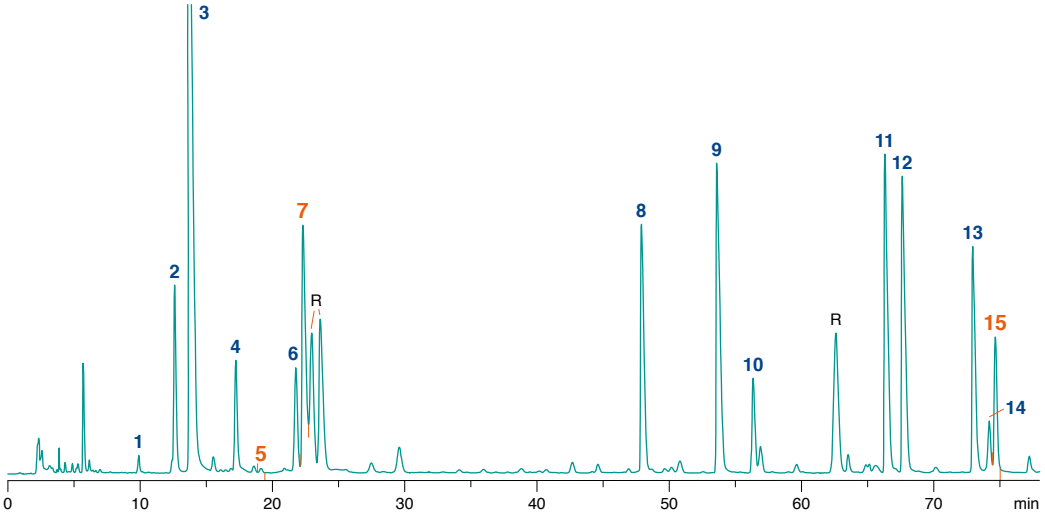
Determination of physiological amino acids from supernatants of cell cultures

MN Appl. No. 118980

Column: 250 x 4 mm NUCLEODUR® C_{18} Gravity, 3 µm
Sample preparation: supernatants from cell cultures are deproteinated, derivatized with phenylisothiocyanate and filtered
Eluent: A) 70 mM sodium acetate, pH 6.5, 2.5 % acetonitrile, 1 ppm EDTA; B) acetonitrile – water – methanol (45:40:15, v/v/v)
3 % B (2 min) → 7.5 % B in 16 min (8 min) → 44 % B in 49 min
(washing: 100 % B for 10 min; equilibration: 3 % B for 5 min)
Flow rate: 0.8 mL/min
Temperature: 47 ± 1 °C
Detection: UV, 254 nm
Injection volume: 40 µL

Peaks:
1. 4-Hydroxyproline
2. Serine
3. Glutamine
4. Histidine
5. Citrulline (5.90 µmol/L)
6. Threonine
7. Arginine (504.33 µmol/L)
8. Tyrosine
9. Valine
10. Methionine
11. Isoleucine
12. Leucine
13. Phenylalanine
14. Tryptophan
15. Ornithine (143.54 µmol/L)

R = reagents
Citrulline, arginine and ornithine were determined quantitatively.



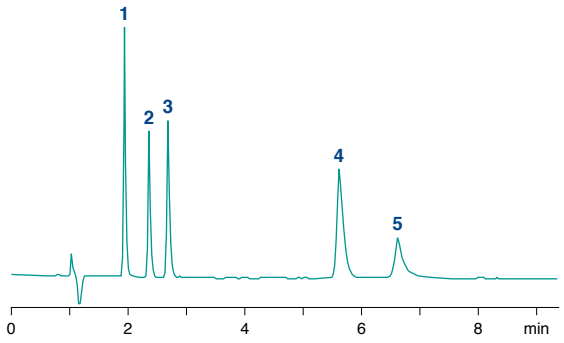
Courtesy of Dr. J. Weinreich, Center for Medical Research, Clinic for General Surgery, University Clinical Center, Tübingen, Germany.

Aromatic amino acids and histamine

MN Appl. No. 122980

Column: 125 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – 100 mM ammonium acetate, pH 4 (75:25, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 218 nm
Injection volume: 0.5 µL

Peaks:
1. Phenylalanine
2. Phenylglycine
3. Tyrosine
4. Histamine
5. Histidine

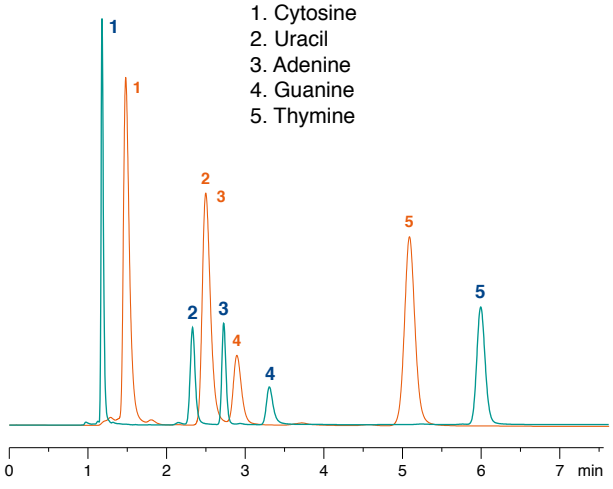


Nucleic acid bases

MN Appl. No. 124672

Columns: **150 x 3 mm NUCLEODUR® PolarTec, 5 µm**
150 x 3 mm Waters SymmetryShield™ RP18, 5 µm
Eluent: 30 mM KH_2PO_4, pH 3.0
Flow rate: 0.5 mL/min
Temperature: 30 °C
Detection: UV, 220 nm
Injection volume: 1 µL, 3 µL

Peaks:
1. Cytosine
2. Uracil
3. Adenine
4. Guanine
5. Thymine



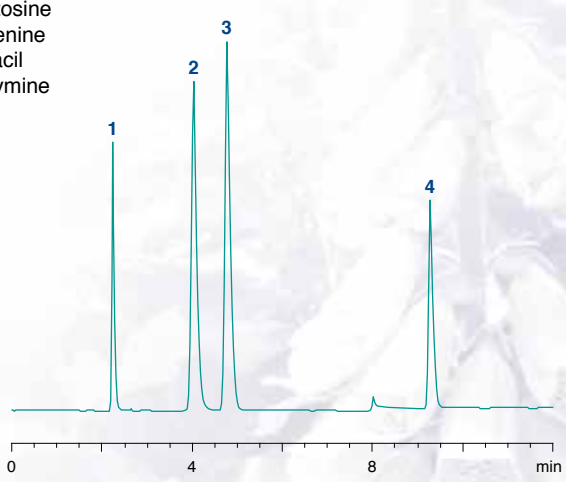
Separation of all five nucleic acid bases just on NUCLEODUR® PolarTec

Nucleic acid bases

MN Appl. No. 119140

Column: 250 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: A) 50 mM $NH_4H_2PO_4$, pH 2.5, B) acetonitrile
100 % A (2.5 min) → 90 % A in 10 min
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 3 µL

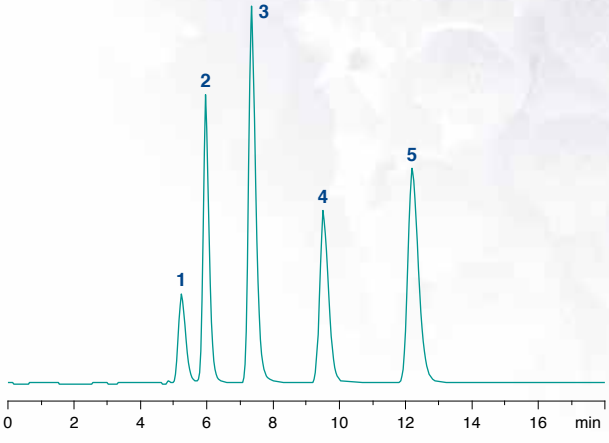
Peaks:
1. Cytosine
2. Adenine
3. Uracil
4. Thymine



MN Appl. No. 122950

Column: 125 x 4 mm NUCLEODUR® HILIC, 5 µm
Eluent: acetonitrile – 5 mM ammonium acetate (80:20, v/v)
Flow rate: 0.3 mL/min
Temperature: 25 °C
Detection: UV, 254 nm

Peaks:
1. Thymine
2. Uracil
3. Adenine
4. Cytosine
5. Guanosine



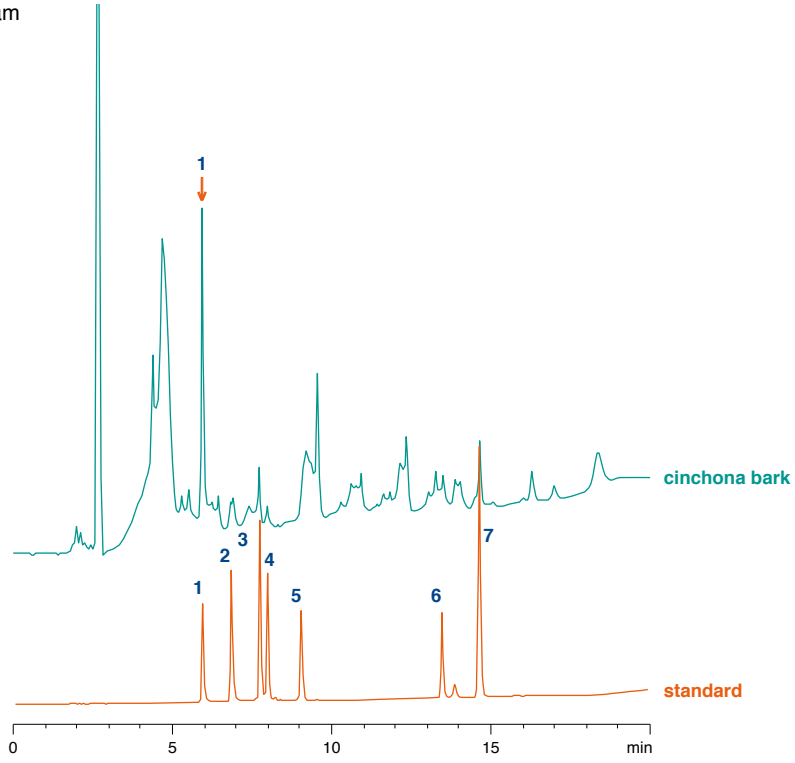
Applications

Determination of quinine in cinchona bark

MN Appl. No. 118580

Column: 125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
Eluent: A) 20 mM $NH_4H_2PO_4$, pH 2
B) acetonitrile
Gradient: 10 % B → 30 % B in 15 min
Flow rate: 1 mL/min
Temperature: 30 °C
Detection: UV, 210 nm

Peaks:
1. Quinine
2. Scopolamine
3. Brucine
4. Strychnine
5. Atropine
6. Papaverine
7. Noscapine

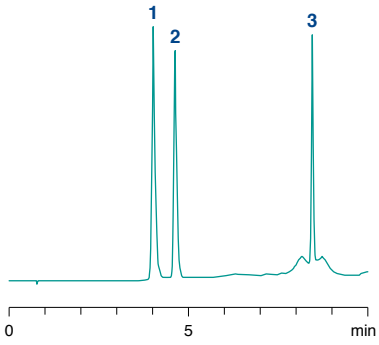


Quinine alkaloids

MN Appl. No. 117960

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) methanol, B) 20 mM KH_2PO_4, pH 2.5
90 % B → 70 % B in 4 min → 30 % B in 7 min
Flow rate: 1.3 mL/min
Temperature: 25 °C
Detection: UV, 240 nm
Injection volume: 10 µL

Peaks:
1. Chloroquine
2. Quinine
3. Mefloquine

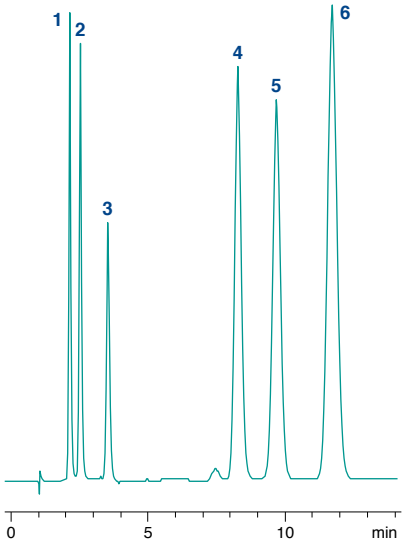


Steroids

MN Appl. No. 118540

Column: 125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
Eluent: acetonitrile – water (60:40, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 240 nm

Peaks:
1. Cortisone
2. Hydrocortisone
3. Hydrocortisone 21-acetate
4. 6α-Methyl-11β-hydroxyprogesterone
5. 6α-Methyl-17α-hydroxyprogesterone
6. 6α-Methyl-17α-hydroxyprogesterone acetate

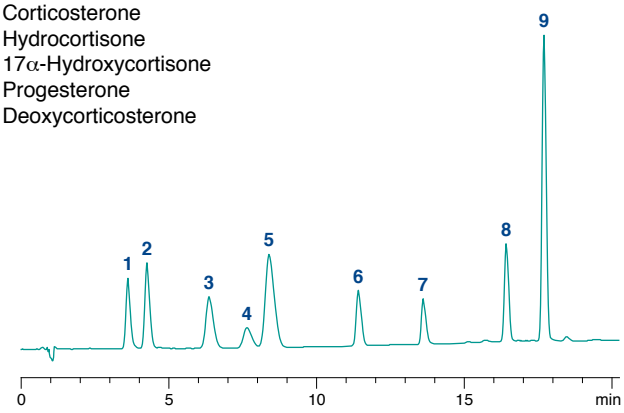


Steroids

MN Appl. No. 122530

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile, B) water
70 % B (7 min) → 20 % B in 16 min → 70 % B in 2 min
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 240 nm
Injection volume: 3 µL

Peaks:
1. Cortisone
2. Prednisolone
3. 6α-Methylprednisolone
4. Dexamethasone
5. Corticosterone
6. Hydrocortisone
7. 17α-Hydroxycortisone
8. Progesterone
9. Deoxycorticosterone

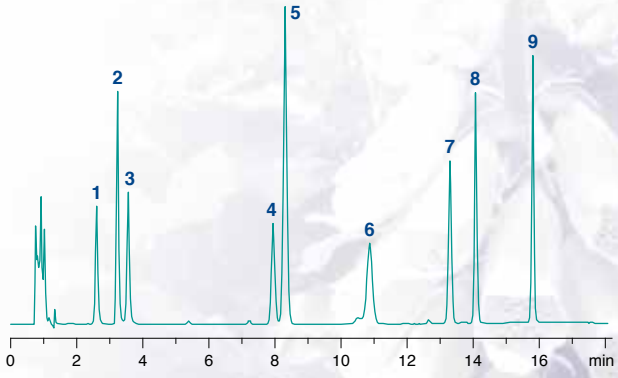


Steroids

MN Appl. No. 123710

Column: 125 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: A) acetonitrile, B) water
70 % B → 60 % B in 5 min (5 min) → 35 % B in 5 min (5 min)
Flow rate: 1.0 mL/min
Temperature: 35 °C
Detection: UV, 254 nm
Injection volume: 10 µL

Peaks:
1. Estriol
2. Prednisolone
3. Cortisone
4. Estradiol
5. Testosterone
6. Estrone
7. 6α-Methyl-11β-hydroxyprogesterone
8. 6α-Methyl-17α-hydroxyprogesterone
9. Progesterone

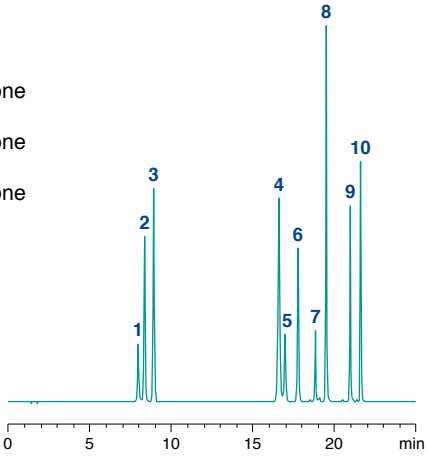


Steroids

MN Appl. No. 118550

Column: 125 x 4 mm NUCLEODUR® 100-5 C_8 ec
Eluent: A) water, B) methanol
20 % B (1 min) → 35 % B in 10 min (3 min) → 60 % B in 6 min (5 min)
Flow rate: 1.0 mL/min
Temperature: 30 °C
Detection: UV, 230 nm
Injection volume: 10 µL (each ~10–50 µg/mL)

Peaks:
1. Estriol
2. Prednisolone
3. Cortisone
4. Testosterone
5. 6α-Methyl-11β-hydroxyprogesterone
6. 6α-Methyl-17α-hydroxyprogesterone
7. 6α-Methyl-17α-hydroxyprogesterone acetate
8. Estradiol
9. Estrone
10. Progesterone

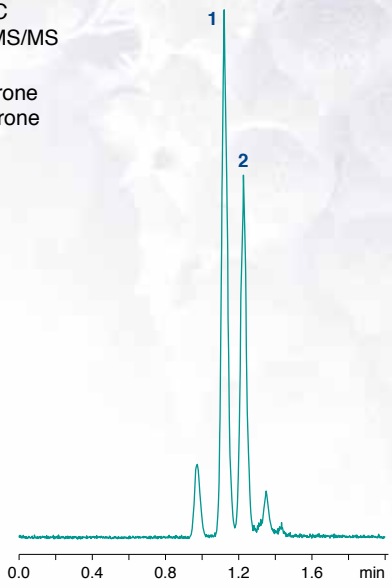


Hydroxytestosterones from cytochrome P450

MN Appl. No. 122140

Colum: 50 x 2 mm NUCLEODUR® C_{18} Isis, 1.8 µm
Eluent: A) water + 0.1 % formic acid; B) acetonitrile – methanol + 0.3 % formic acid
75 % A → 60 % A in 1.1 min → 0 % A in 0.05 min, → 75 % A in 0.05 min (0.95 min)
Flow rate: 0.9 mL/min
Temperature: 70 °C
Detection: LC-MS/MS

Peaks:
1. 6β-Hydroxytestosterone
2. 7α-Hydroxytestosterone



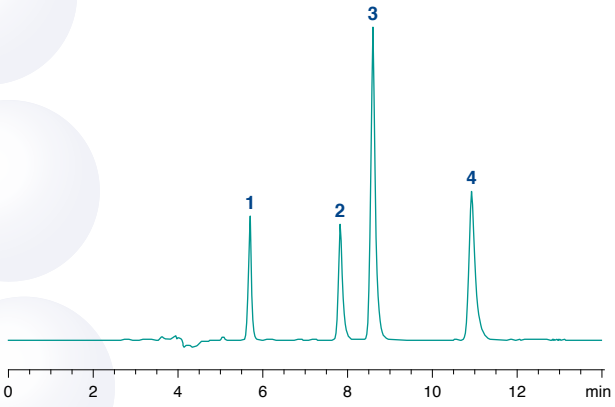
Applications

Catecholamines

MN Appl. No. 123030

Column: 250 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – 25 mM ammonium formate, pH 3 (75:25, v/v)
Flow rate: 0.8 mL/min
Temperature: 25 °C
Detection: UV, 218 nm
Injection: 5 µL, 30 ng/µL

Peaks:
1. Norephedrine
2. Dopamine
3. Adrenaline
4. L-DOPA

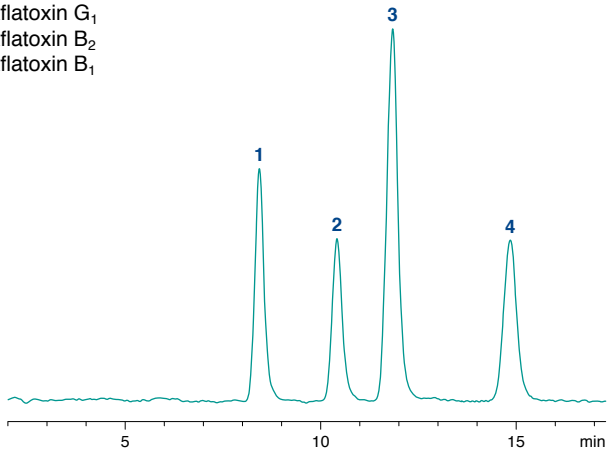


Analysis of aflatoxins from baby food

MN Appl. No. 120780

Column: 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: methanol – acetonitrile – water (26:17:57, v/v/v) with 119 mg KBr and 100 µL HNO_3 (65 %) per liter
Flow rate: 1.0 mL/min
Detection: fluorescence, λ_{ex} 362 nm, λ_{em} 440 nm, post column derivatization in a CoBrA cell (Dr. Weber Consulting Kft)
Injection volume: 100 µL

Peaks:
1. Aflatoxin G_2
2. Aflatoxin G_1
3. Aflatoxin B_2
4. Aflatoxin B_1

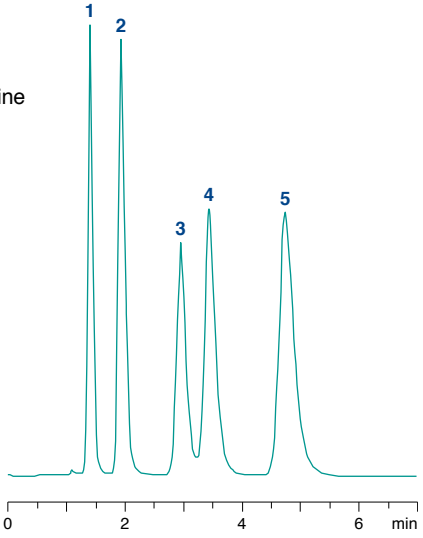


Catecholamines

MN Appl. No. 117930

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: 100 mM NaH_2PO_4, pH 3.0
Flow rate: 0.8 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Norephedrine
2. Adrenaline
3. Dihydroxyphenylalanine
4. Hydroxytyramine
5. Tyrosine

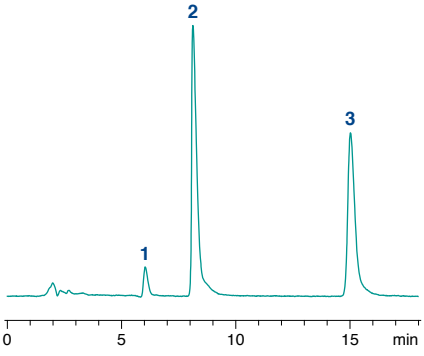


Analysis of mycotoxins

MN Appl. No. 119800

Column: 250 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Guard column: 8 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – water (45:55, v/v), 2 mL conc. H_3PO_4/L, adjusted to pH 2.6 with NaOH
Flow rate: 0.9 mL/min
Detection: fluorescence 273 nm and 455 nm
Injection volume: 40 µL (7.5 ng of each substance)

Peaks:
1. β-Zearalenol
2. α-Zearalenol
3. Zearalenone



Courtesy of K.H. Ueberschär, Federal Agricultural Research Centre, Institute of Animal Feed, Celle, Germany.

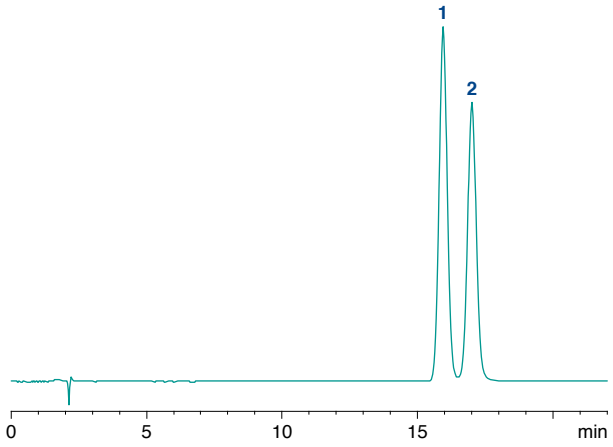
NUCLEODUR®

Dexa- and betamethasone

MN Appl. No. 121170

Column: 250 x 4 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: acetonitrile – water (30:70, v/v)
Flow rate: 1 mL/min
Temperature: 25 °C
Detection: UV, 260 nm
Injection volume: 5 µL

Peaks:
1. Betamethasone
2. Dexamethasone

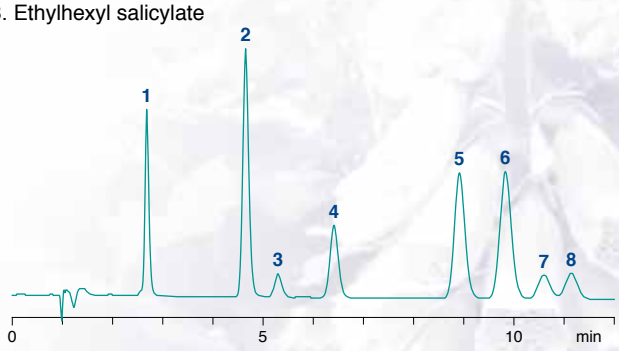


Sunscreen ingredients

MN Appl. No. 121500

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: methanol – 0.5 % H_3PO_4 (82:18, v/v)
Flow rate: 1.0 mL/min
Temperature: 42 °C
Detection: UV, 300 nm
Injection volume: 10 µL

Peaks:
1. Benzimidazolecarboxylic acid
2. Benzophenone-3
3. 4-Methylbenzylidine camphor
4. Octocrylene
5. Ethylhexyldimethyl PABA
6. Ethylhexyl methoxycinnamate
7. Butyl methoxydibenzoylmethane (BMDBM)
8. Ethylhexyl salicylate



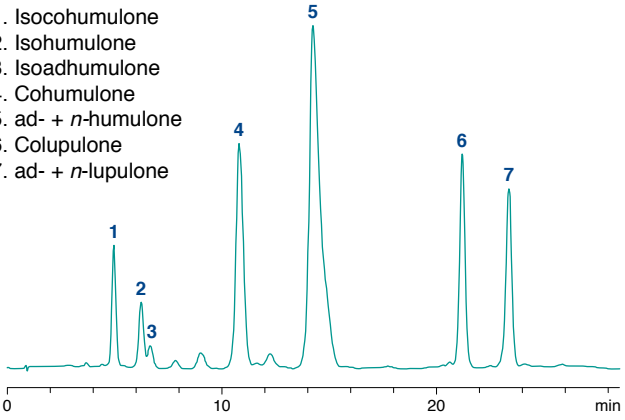
For separation on C_{18} Gravity see appl. 122660 at *www.mn-net.com.*

Determination of iso-alpha-acids, alpha- and beta-acids in isomerized hop pellets

MN Appl. No. 121100

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: A) methanol, B) methanol – water – H_3PO_4 (75:24:1, v/v/v); 100 % B (17 min) → 65 % B in 8 min → 100 % B in 5 min
Flow rate: 1.0 mL/min
Temperature: 35 °C
Detection: UV, 9 min 270 nm, then 314 nm

Peaks:
1. Isocohumulone
2. Isohumulone
3. Isoadhumulone
4. Cohumulone
5. ad- + *n*-humulone
6. Colupulone
7. ad- + *n*-lupulone



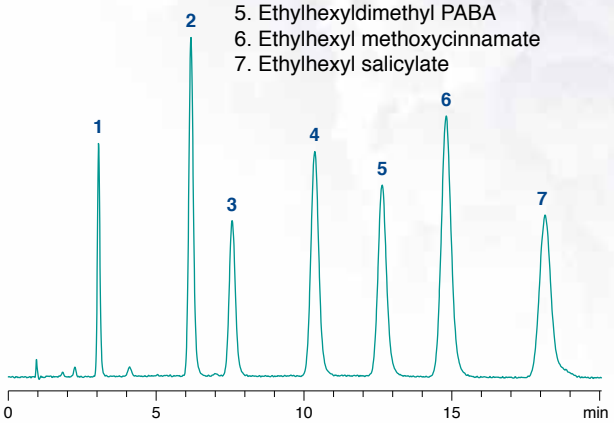
M. Biendl et al., European Brewery Convention, J. of the Institute of Brewing **110** (2004) 242–243.

Sunscreen ingredients

MN Appl. No. 123640

Column: 125 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: methanol – 100 mM ammonium acetate, pH 4.5 (80:20, v/v)
Flow rate: 0.9 mL/min
Temperature: 35 °C
Detection: UV, 275 nm
Injection volume: 12 µL

Peaks:
1. Benzophenone
2. 4-Methylbenzylidine camphor
3. Uvinul Plus
4. Octocrylene
5. Ethylhexyldimethyl PABA
6. Ethylhexyl methoxycinnamate
7. Ethylhexyl salicylate



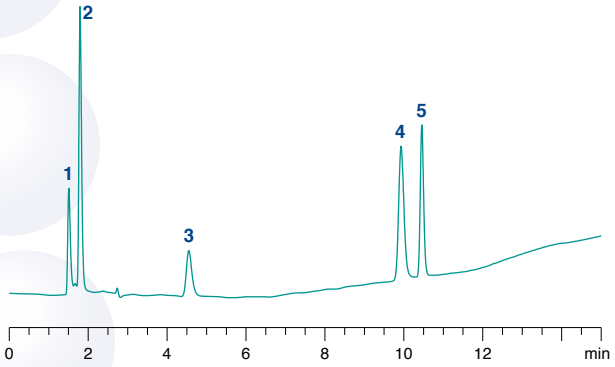
Applications

Water-soluble vitamins

MN Appl. No. 124570

Column: 150 x 3 mm NUCLEODUR® PolarTec, 5 µm
Eluent: A) 25 mM KH_2PO_4, pH 3.0, B) acetonitrile
10 % B (3 min) → 40 % B in 12 min
Flow rate: 0.7 mL/min
Temperature: 30 °C
Detection: UV, 220 nm
Injection volume: 5 µL

Peaks:
1. Vitamin B_1
2. Vitamin B_6
3. Panthotenic acid
4. *p*-Aminobenzoic acid
5. Vitamin B_2

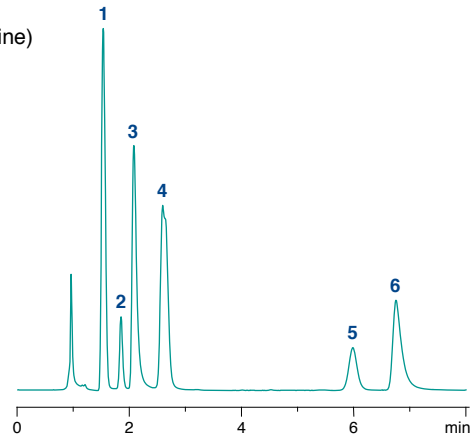


Water-soluble vitamins

MN Appl. No. 122970

Column: 125 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: A) acetonitrile, B) 25 mM ammonium acetate, pH 4
80 % A (1 min) → 70 % A in 1 min (11 min)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 30 µL

Peaks:
1. Nicotinamide
2. Vitamin B_7 (vitamin B_8, vitamin H, biotin)
3. Vitamin B_6 (pyridoxine)
4. Vitamin C (ascorbic acid)
5. Vitamin B_{12} (cyanocobalamine)
6. Vitamin B_1 (thiamine)



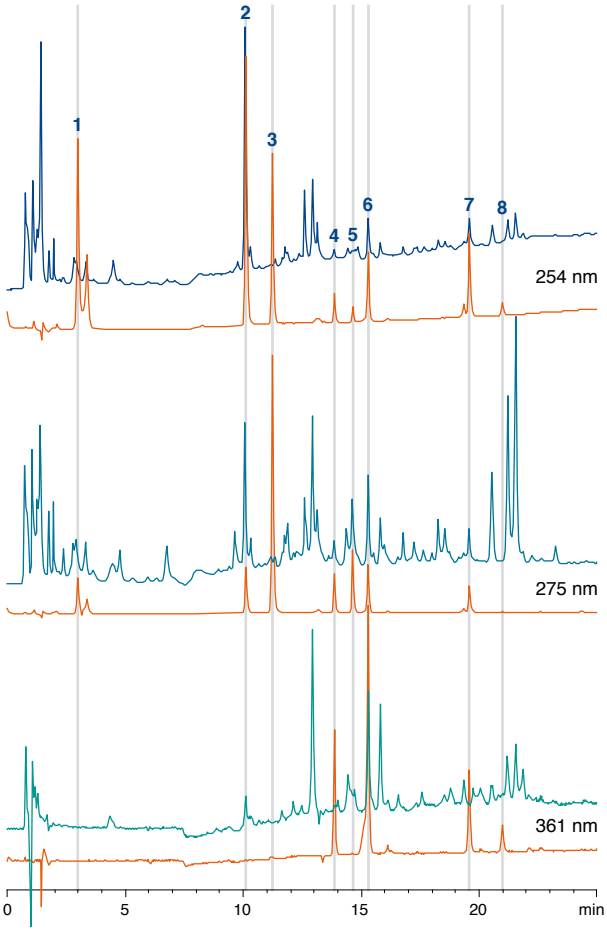
Water-soluble vitamins

MN Appl. No. 119770

Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: A) water, 15 mM heptanesulfonic acid (Na salt), 25 mM NaH_2PO_4, 0.25 % CH_3COOH, 0.005 % triethylamine (pH 3.5),
B) acetonitrile – water (40:60, v/v), 15 mM heptanesulfonic (Na salt), 0.25 % CH_3COOH, 0.005 % triethylamine (pH ~ 3.5);
multistep gradient:
0 % B (5 min) → 10 % B in 2.5 min → 25 % B in 2.5 min → 50 % B in 8 min → 70 % B in 7 min → 0 % B in 1 min
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254, 275 and 361 nm
Injection volume: 10 µL

Peaks:
1. Nicotinic acid (0.12 mg/mL)
2. Nicotinamide (0.12 mg/mL)
3. 4-Aminobenzoic acid (0.03 mg/mL)
4. Folic acid (0.24 mg/mL)
5. Vitamin B_6 (pyridoxine hydrochloride, 0.06 mg/mL)
6. Vitamin B_2 (riboflavin, 0.012 mg/mL)
7. Vitamin B_1 (thiamine hydrochloride, 0.06 mg/mL)
8. Rutin (0.012 mg/mL)

orange curves: vitamin test mixture (in eluent A)
blue curves: multivitamin juice (undiluted)
both detected at three different wave lengths

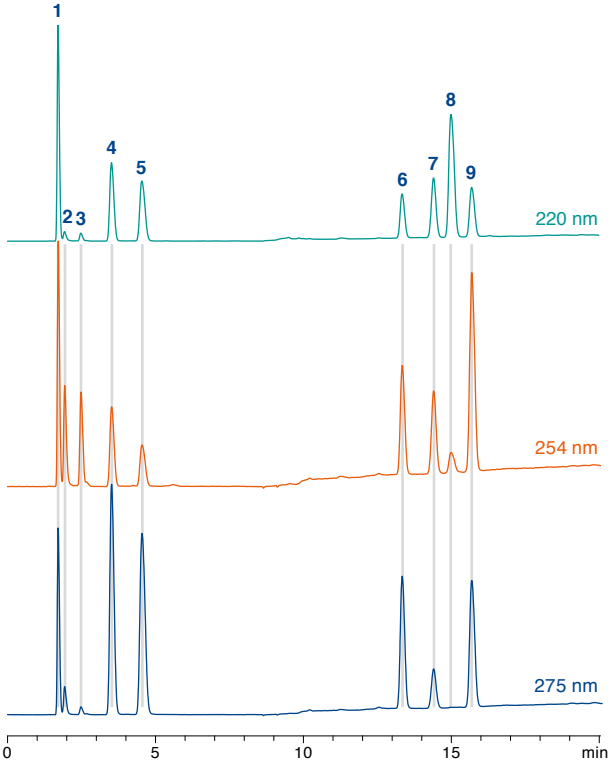


Water-soluble vitamins

MN Appl. No. 122450

Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: A) 50 mM KH_2PO_4, pH 3,
B) methanol – acetonitrile (70:30, v/v)
0 % B (6 min) → 15 % B in 2 min → 35 % B in 10 min (5 min)
Flow rate: 0.6 mL/min
Temperature: 40 °C
Detection: UV, 218, 254 and 275 nm
Injection volume: 10 µL

Peaks:
1. Vitamin B_1 (thiamine)
2. Pyridoxamine
3. Vitamin C (ascorbic acid)
4. Pyridoxal
5. Vitamin B_6 (pyridoxine)
6. Vitamin B_9 (viamin M, folic acid)
7. Vitamin B_{12} (cyanocobalamine)
8. Vitamin B_7 (vitamin B_8, vitamin H, (+)-biotin)
9. Vitamin B_2 (riboflavin)

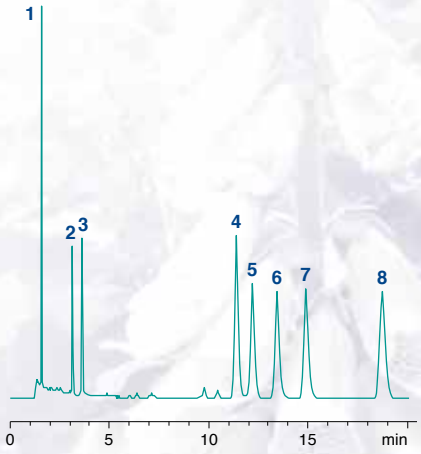


Fat-soluble vitamins and tocopherols

MN Appl. No. 117890

Column: 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile
Flow rate: 1.5 mL/min
Temperature: 30 °C
Detection: UV, 280 nm
Injection volume: 4 µL

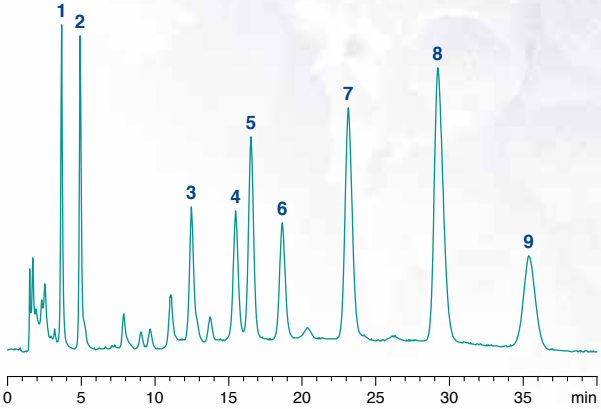
Peaks:
1. Vitamin K_3
2. Vitamin A
3. Vitamin A acetate
4. Vitamin D_2
5. Vitamin D_3
6. Vitamin E (α-tocopherol)
7. Vitamin E acetate (α-tocopherol acetate)
8. Vitamin K_1



MN Appl. No. 121160

Column: 125 x 2 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: acetonitrile – water (100:5, v/v)
Flow rate: 0.2 mL/min
Temperature: 25 °C
Detection: UV, 275 nm
Injection volume: 5 µL

Peaks:
1. Vitamin A
2. Vitamin A acetate
3. Vitamin K_2
4. Vitamin D_2
5. Vitamin D_3
6. γ-Tocopherol
7. Vitamin E (α-tocopherol)
8. Vitamin E acetate (α-tocopherol acetate)
9. Vitamin K_1



For separation of tocopherols on NUCLEODUR® 100-5 C_{18} ec see appl. 117910 at *www.mn-net.com.*

Applications

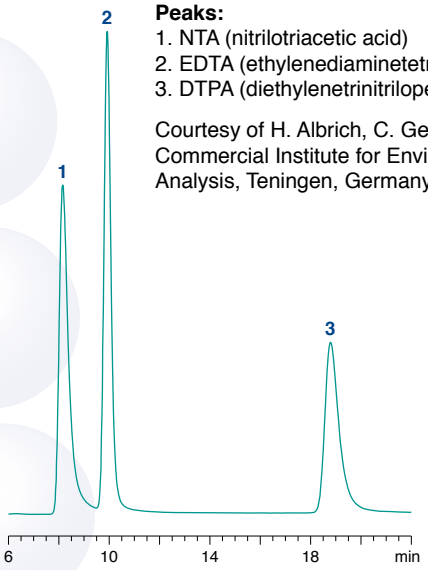
Complexing agents acc. to DIN 38 413-8

MN Appl. No. 119780

Column: 250 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: 0.6 mM HNO_3, 7.53 mM $N(C_4H_9)_4HSO_4$, 2.6 mM $N(C_4H_9)_4OH$, 37 µM Fe^{3+}
Flow rate: 0.6 mL/min
Temperature: 20 °C
Detection: UV, 260 nm
Injection volume: 50 µL

Peaks:
1. NTA (nitrilotriacetic acid)
2. EDTA (ethylenediaminetetraacetic acid)
3. DTPA (diethylenetrinitrilopentaacetic acid)

Courtesy of H. Albrich, C. Geis, GIU; Commercial Institute for Environmental Analysis, Teningen, Germany.

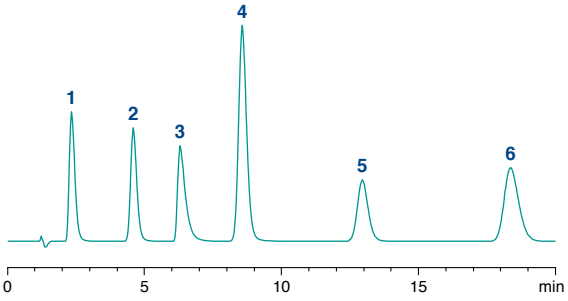


Aromatic acids

MN Appl. No. 121180

Column: 125 x 2 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: methanol – 50 mM KH_2PO_4, pH 3 (10:90, v/v)
Flow rate: 0.25 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Gallic acid
2. 3,4-Dihydroxybenzoic acid
3. 2,5-Dihydroxybenzoic acid
4. 4-Hydroxybenzoic acid
5. Syringic acid
6. Vanillic acid

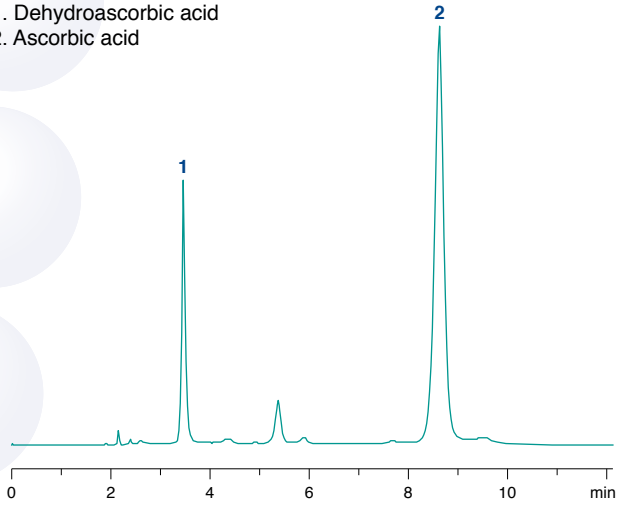


Ascorbic acid and dehydroascorbic acid

MN Appl. No. 122940

Column: 250 x 4 mm NUCLEODUR® HILIC, 5 µm
Eluent: acetonitrile – 100 mM ammonium acetate (70:30, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 240 nm

Peaks:
1. Dehydroascorbic acid
2. Ascorbic acid

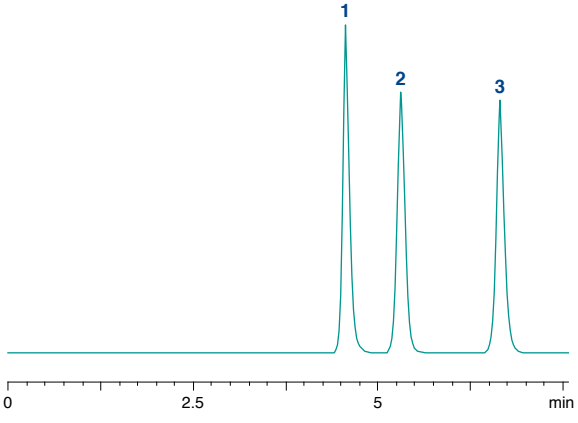


Organic acids

MN Appl. No. 119290

Column: 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: 25 mM KH_2PO_4, pH 4.0
Flow rate: 0.5 mL/min
Temperature: 30 °C
Detection: UV, 210 nm
Injection volume: 15 µL

Peaks:
1. Aspartic acid
2. Fumaric acid
3. Maleic acid

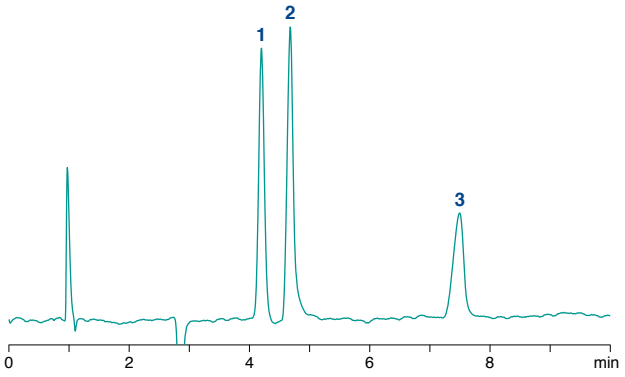


Organic acids

MN Appl. No. 122930

Column: 125 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – 200 mM ammonium acetate, pH 6.8 (70:30, v/v)
Flow rate: 1 mL/min
Temperature: 25 °C
Detection: UV, 220 nm
Injection volume: 0.5 µL

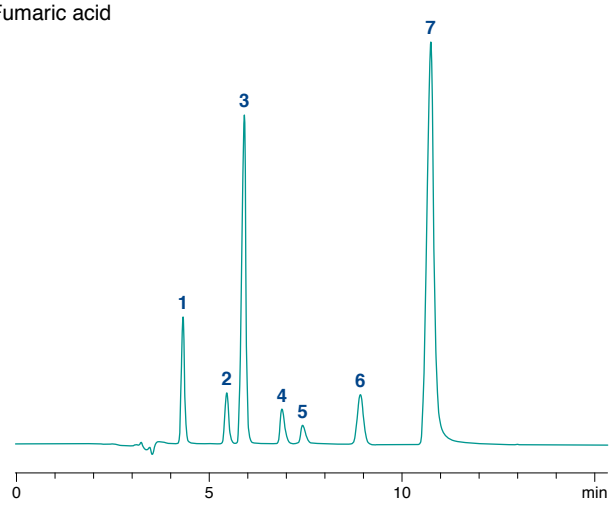
Peaks:
1. Fumaric acid
2. Oxalic acid
3. Citric acid



MN Appl. No. 120500

Column: 250 x 4.6 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: 20 mM KH_2PO_4, pH 2.6
Flow rate: 0.7 mL/min
Detection: UV, 210 nm
Injection volume: 20 µL

Peaks:
1. Tartaric acid
2. Malic acid
3. Shikimic acid
4. Lactic acid
5. Acetic acid
6. Citric acid
7. Fumaric acid



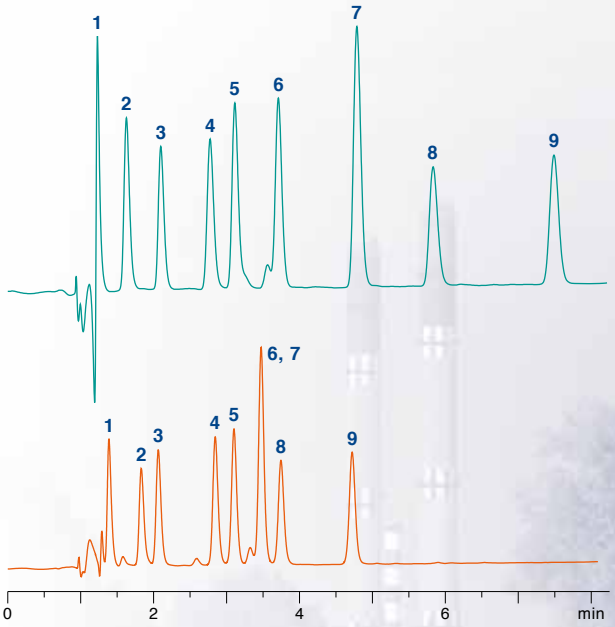
Also see appl. 119180 at *www.mn-net.com.*

Organic acids

MN Appl. No. 124562

Columns: **150 x 3 mm NUCLEODUR® PolarTec, 5 µm**
150 x 3 mm Waters SymmetryShield™ RP18, 5 µm
Eluent: A) acetonitrile, 0.1 % TFA, B) water, 0.1 % TFA
20 % A → 60 % A in 12 min
Flow rate: 0.73 mL/min
Temperature: 20 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Dihydroxymandelic acid
2. Gallic acid
3. Dihydroxyphenylacetic acid
4. 3,4-Dihydroxybenzoic acid
5. Syringic acid
6. Vanillic acid
7. 3-Hydroxybenzoic acid
8. 2,5-Dihydroxybenzoic acid
9. 2,4-Dihydroxybenzoic acid



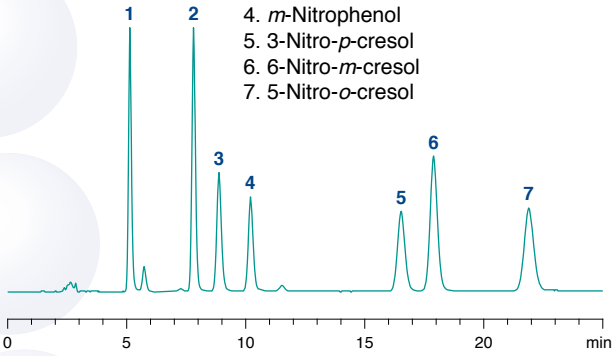
Applications

Nitrophenols

MN Appl. No. 122650

Column: 250 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: methanol – 20 mM NaH_2PO_4, pH 5 (49:51, v/v)
Flow rate: 0.8 mL/min
Temperature: 20 °C
Detection: UV, 235 nm
Injection volume: 2.0 µL

Peaks:
1. *p*-Nitrophenol
2. *o*-Nitrophenol
3. 4-Nitro-*m*-cresol
4. *m*-Nitrophenol
5. 3-Nitro-*p*-cresol
6. 6-Nitro-*m*-cresol
7. 5-Nitro-*o*-cresol



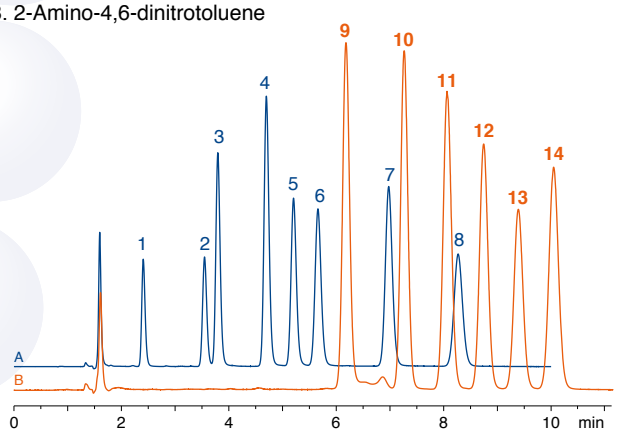
Nitroaromatics EPA 8330

MN Appl. No. 124490/124500

Column: 150 x 3 mm NUCLEODUR® PolarTec, 5 µm
Eluent: Mix A: water – methanol (50:50, v/v)
Mix B: water, 0.1 % formic acid – methanol (45:55, v/v)
Flow rate: 0.46 mL/min
Temperature: 50 °C, 60 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks Mix A:
1. Octogen (HMX)
2. Hexogen (RDX)
3. 1,3,5-Trinitrobenzene
4. 1,3-Dinitrobenzene
5. Nitrobenzene
6. 2,4,6-Trinitrotoluene
7. 2,4-Dinitrotoluene
8. 2-Amino-4,6-dinitrotoluene

Peaks Mix B:
9. *N*-Methyl-*N*-2,4,6-tetranitroaniline (Tetryl)
10. 4-Amino-2,6-dinitrotoluene
11. 2,6-Dinitrotoluene
12. 2-Nitrotoluene
13. 4-Nitrotoluene
14. 3-Nitrotoluene



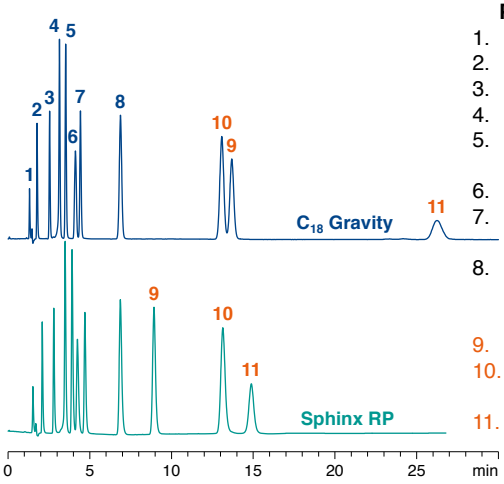
For separation of Mix A and Mix B in a single run see appl. 124510 at *www.mn-net.com*.

Substituted aromatics

MN Appl. No. 119840/119850

Columns: 150 x 4.6 mm NUCLEODUR® C_{18} Gravity, 5 µm
150 x 4.6 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: methanol – water (55:45, v/v)
Flow rate: 1.0 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 2 µL

Peaks:
1. Uracil
2. Benzamide
3. Phenol
4. Benzaldehyde
5. Aceto-phenone
6. 2-Nitrophenol
7. Nitrobenzene
8. Propyl 4-hydroxy-benzoate
9. Toluene
10. Benzo-phenone
11. Xylene



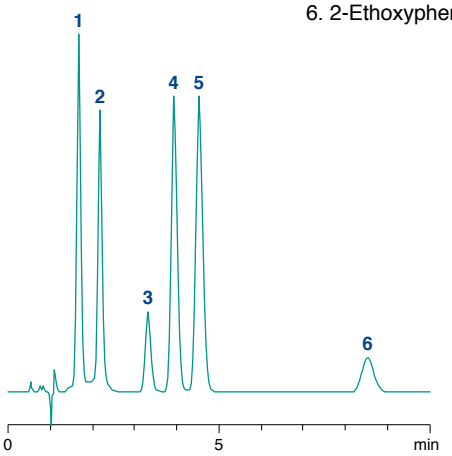
Selectivity comparison of NUCLEODUR® C_{18} Gravity and Sphinx RP shows lower hydrophobicity and retention of Sphinx RP for substituted aromatics like toluene and xylene.

Phenolic compounds

MN Appl. No. 117970

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: methanol – water, 0.1 % H_3PO_4 (40:60, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 254 nm
Injection volume: 5 µL

Peaks:
1. Resorcinol
2. Pyrocatechol
3. 4-Methoxyphenol
4. Phenol
5. 2-Methoxyphenol
6. 2-Ethoxyphenol



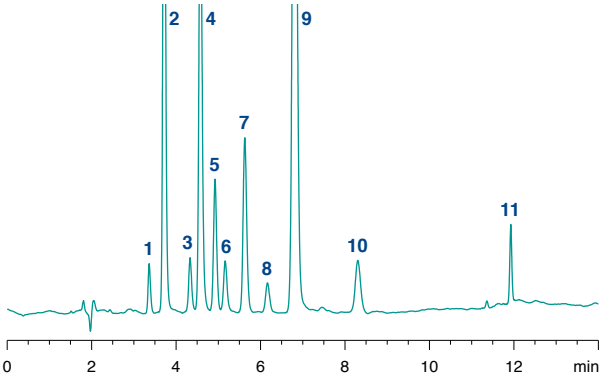
Phenolic compounds

MN Appl. No. 124740

Column: 250 x 3 mm NUCLEODUR® PFP, 5 µm
Eluent: A) acetonitrile + 1 % acetic acid
B) water + 1 % acetic acid
Gradient: 45 % A (7 min) → 70 % A in 2 min (5 min)
Flow rate: 0.6 mL/min
Temperature: 45 °C
Detection: UV, 254 nm
Injection volume: 1 µL

Peaks:

1. Phenol
2. 4-Nitrophenol
3. 2-Nitrophenol
4. 2,4-Dinitrophenol
5. 2-Chlorophenol
6. 2-Methyl-4,6-dinitrophenol
7. 4-Chloro-3-methylphenol
8. 2,4-Dichlorophenol
9. 2,4-Dimethylphenol
10. 2,4,6-Trichlorophenol
11. Pentachlorophenol



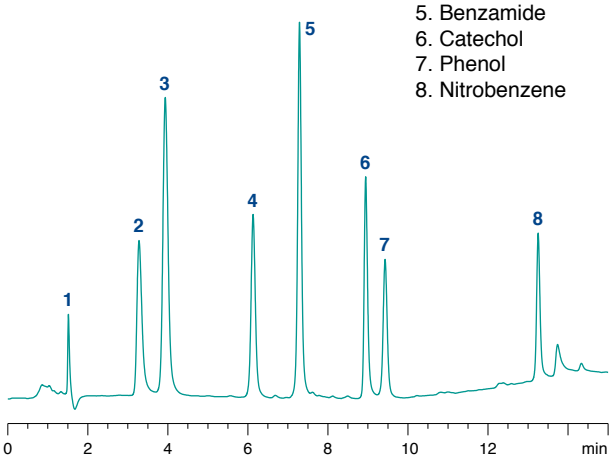
Phenolic compounds

MN Appl. No. 124750

Column: 100 x 2 mm NUCLEODUR® PFP, 3 µm
Eluent: A) methanol, B) 10 mM ammonium acetate, pH 6.8
5 % A → 80 % A in 15 min
Flow rate: 0.25 mL/min
Temperature: 18 °C
Detection: UV, 230 nm
Injection volume: 1 µL

Peaks:

1. Uracil
2. Pyrogallol
3. Phloroglucinol
4. Resorcinol
5. Benzamide
6. Catechol
7. Phenol
8. Nitrobenzene



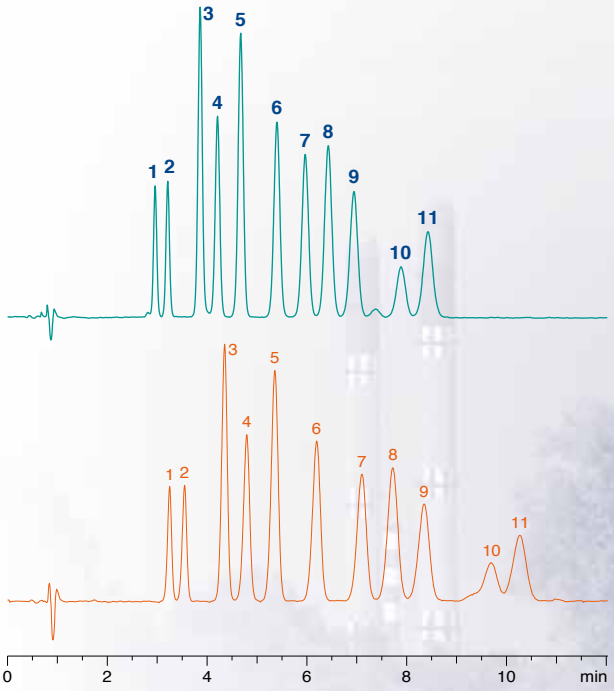
Separation of phenol isomers

MN Appl. No. 124541

Columns: **100 x 4.6 mm NUCLEODUR® PFP, 5 µm**
100 x 4.6 mm Phenomenex Luna® PFP(2), 5 µm
Eluent: acetonitrile, 0.1 % formic acid – water, 0.1 % formic acid (35:65, v/v)
Flow rate: 1.3 mL/min
Temperature: 35 °C
Detection: UV, 280 nm

Peaks:

1. *o*-Cresol
2. *m*-Cresol
3. 3,4-Dimethylphenol
4. 3,5-Dimethylphenol
5. 2,5-Dimethylphenol
6. 2,6-Dichlorophenol
7. 2,3-Dichlorophenol
8. 2,4-Dichlorophenol
9. 3,4-Dichlorophenol
10. 2,4-Dibromophenol
11. 3,5-Dibromophenol



NUCLEODUR® PFP provides under identical conditions a better separation than Luna® PFP(2). While on Luna® PFP(2) for peaks 10 and 11 only a resolution of 1.27 is obtained, on NUCLEODUR® PFP the peaks are baseline separated (R_S = 1.56).

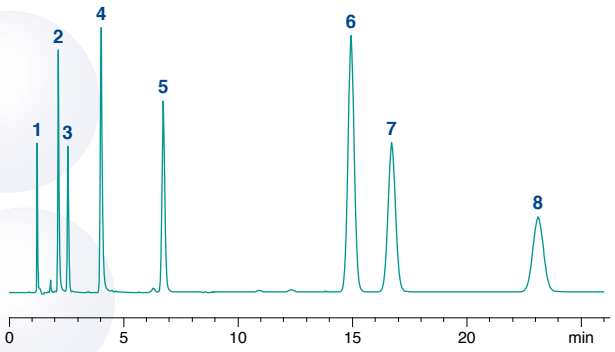
Applications

Amines

MN Appl. No. 121200

Column: 150 x 4.6 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: acetonitrile – 50 mM K_2HPO_4 (40:60, v/v), pH 8
Flow rate: 1 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 8 µL

Peaks:
1. Uracil
2. Pyridine
3. Desethylatrazine
4. 4-Acetylpyridine
5. 4-Ethylaniline
6. *N,N*-Dimethylaniline
7. 4-Aminoanthraquinone
8. 3,5-Dinitro-(1-phenylethylbenzamide)

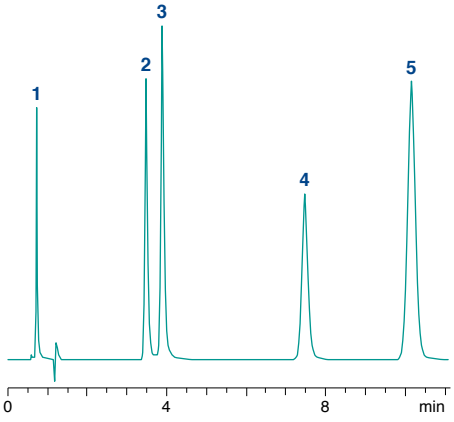


Aromatic aldehydes

MN Appl. No. 117990

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – water, pH 6.0 (22:78, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 254 nm
Injection volume: 5 µL (~10–50 µg/mL)

Peaks:
1. *p*-Carboxybenzaldehyde
2. *p*-Hydroxybenzaldehyde
3. Vanillin
4. 4-Ethoxyvanillin
5. Benzaldehyde

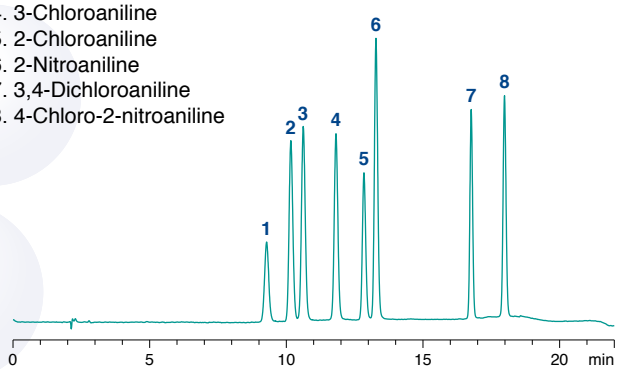


Aromatic amines

MN Appl. No. 124800

Column: 250 x 4 mm NUCLEODUR® PFP, 5 µm
Eluent: A) methanol, B) 20 mM K_2HPO_4, pH 3
40 % A (5 min) → 70 % A in 10 min (7 min)
Flow rate: 1 mL/min
Temperature: 20 °C
Detection: UV, 254 nm
Injection volume: 1 µL

Peaks:
1. 4-Chloroaniline
2. 4-Nitroaniline
3. 3-Nitroaniline
4. 3-Chloroaniline
5. 2-Chloroaniline
6. 2-Nitroaniline
7. 3,4-Dichloroaniline
8. 4-Chloro-2-nitroaniline

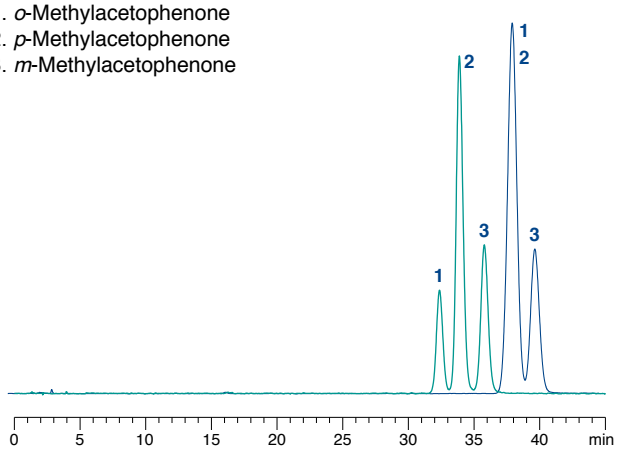


Aromatic ketones

MN Appl. No. 124761

Columns: 250 x 4 mm NUCLEODUR® PFP, 5 µm
250 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: methanol – water (35:65, v/v)
Flow rate: 1.0 mL/min
Temperature: 35 °C
Detection: UV, 254 nm
Injection volume: 1 µL

Peaks:
1. *o*-Methylacetophenone
2. *p*-Methylacetophenone
3. *m*-Methylacetophenone



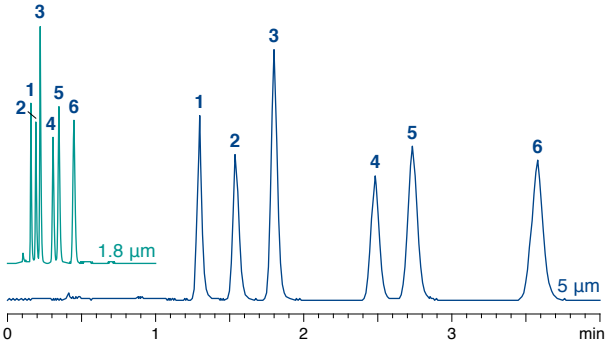
Distinct steric selectivity of NUCLEODUR® PFP provides separation of all three regioisomers, while on NUCLEODUR® C_{18} Gravity baseline separation can't be achieved.

Aromatic ketones

MN Appl. No. 122720/122730

Column: 125 x 2 mm NUCLEODUR® C_{18} Gravity, 5 µm
50 x 2 mm NUCLEODUR® C_{18} Gravity, 1.8 µm
Eluent: acetonitrile – water (60:40, v/v)
Flow rate: 0.33 mL/min, 1.25 mL/min
Temperature: 25 °C
Detection: UV, 230 nm

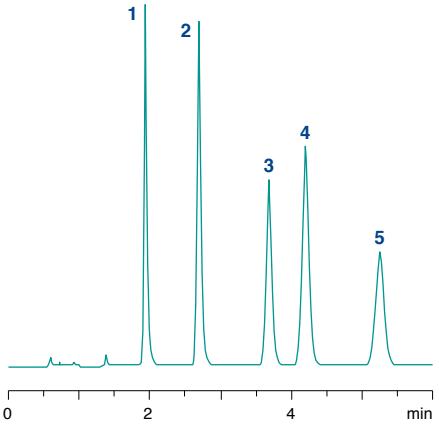
Peaks:
1. Acetophenone
2. Eugenol
3. Propiophenone
4. Butyrophenone
5. Benzophenone
6. Valerophenone



MN Appl. No. 117980

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – water (60:40, v/v)
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 230 nm
Injection volume: 2 µL (~10–50 µg/mL)

Peaks:
1. Acetophenone
2. Propiophenone
3. Butyrophenone
4. Benzophenone
5. Valerophenone

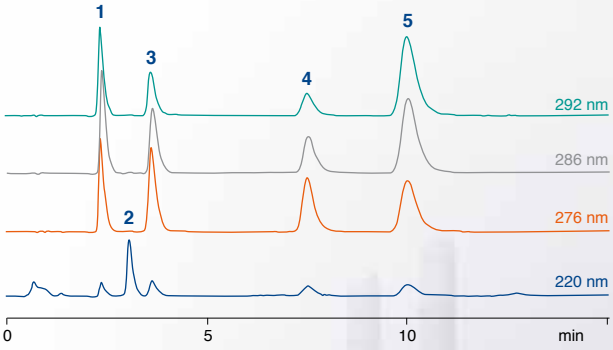


Furfurol and related compounds in transformer oil in accordance with DIN EN 61198-B

MN Appl. No. 121662

Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Sample prep.: SPE see appl. 304180 at *www.mn-net.com*
Eluent: methanol – water (10:90, v/v)
Flow rate: 2.0 mL/min
Detection: UV, 220, 276, 286 and 292 nm

Peaks:
1. 5-Hydroxymethyl-2-furfurol
2. 2-Furfuryl alcohol
3. 2-Furfurol
4. 2-Acetylfuran
5. 5-Methyl-2-furfurol



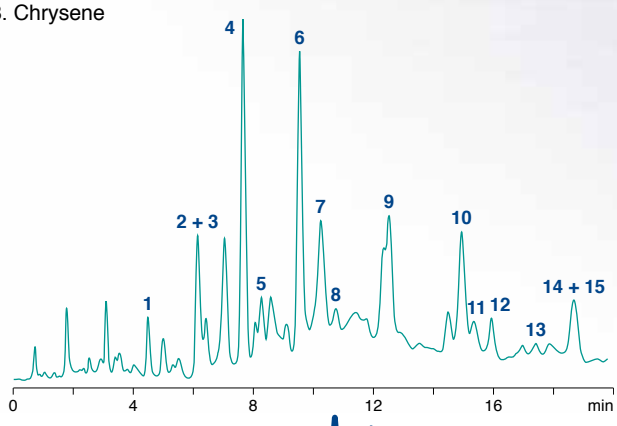
A. Heiseler et al., GIT (2004) 504–505

PAHs from tar

MN Appl. No. 120740

Column: 150 x 4.6 mm NUCLEODUR® C_{18} Gravity, 5 µm
Sample prep.: see Appl. 120740 at *www.mn-net.com*
Eluent: A) water, B) acetonitrile
60 % B (3 min) → 100 % B in 27 min
Flow rate: 1.0 mL/min
Detection: UV, 220 nm

Peaks:
1. Naphthalene
2. Fluorene
3. Acenaphthylene
4. Phenanthrene
5. Anthracene
6. Fluoranthene
7. Pyrene
8. Chrysene
9. Benz[a]anthracene
10. Benzo[b]fluoranthene
11. Benzo[k]fluoranthene
12. Benzo[a]pyrene
13. Dibenz[ah]anthracene
14. Indeno[1,2,3-cd]pyrene
15. Benzo[ghi]perylene



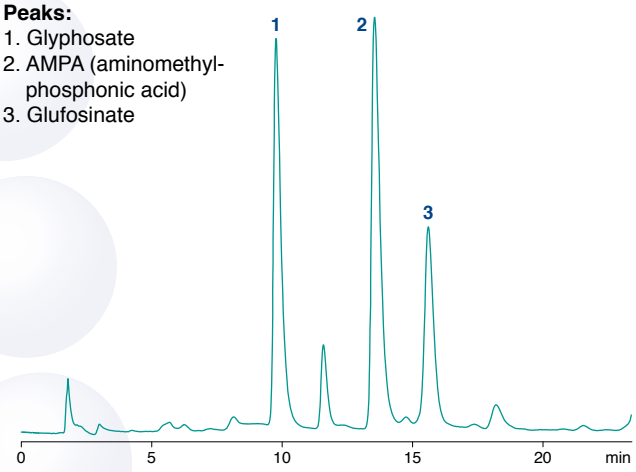
Applications

Organophosphorus herbicides

MN Appl. No. 120490

Column:	250 x 3 mm NUCLEODUR® C_{18} Gravity, 5 µm
Sample prep.:	for SPE see Appl. 303780 at *www.mn-net.com*; derivatization with FMOC-Cl
Eluent:	A) acetonitrile, B) H_3PO_4, pH 1.2 30 % A → 35 % A in 27 min → 90 % A in 3 min (6 min) → 30 % A in 2 min (7 min)
Flow rate:	0.5 mL/min
Temperature:	30 °C
Detection:	fluorescence, λ_{ex} 263 nm, λ_{em} 317 nm

Peaks:
1. Glyphosate
2. AMPA (aminomethyl-phosphonic acid)
3. Glufosinate

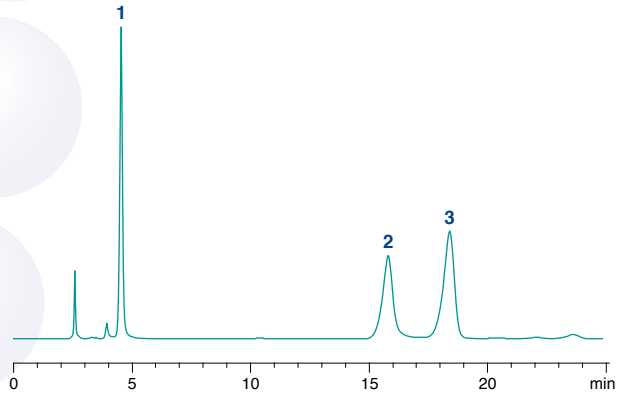


Courtesy of Mr. Schüssler, Mrs. Mikler, Bavarian State Agency for Water Management, Munich.

MN Appl. No. 122190

Column:	250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Sample prep.:	derivatization with FMOC, concentration of each pesticide 0.3 mg/mL
Eluent:	acetonitrile – 50 mM KH_2PO_4, pH 4.6 (60:40, v/v)
Flow rate:	0.8 mL/min
Temperature:	40 °C
Detection:	UV, 254 nm
Injection volume:	5 µL

Peaks:
1. AMPA
2. Glyphosate
3. Glufosinate

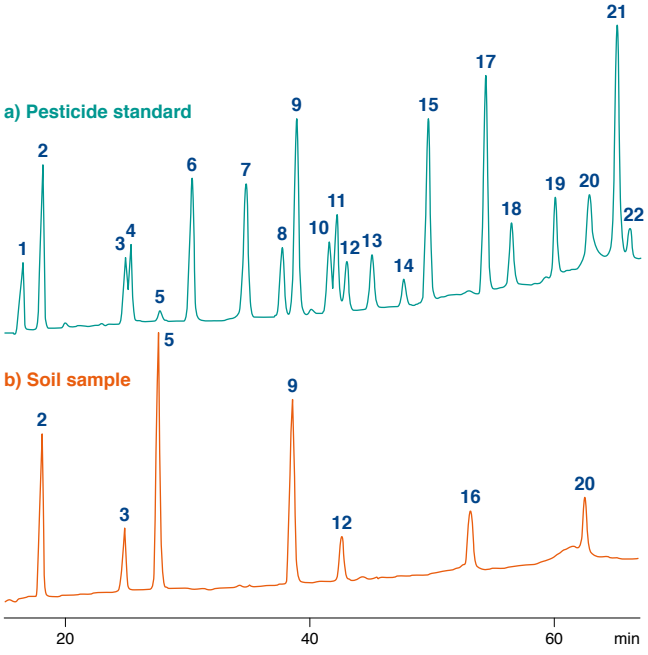


Pesticides from soil

MN Appl. No. 119890

Column:	250 x 4 mm NUCLEODUR® 100-3 C_8 ec
Eluent:	A) water, B) acetonitrile, 10 % B → 25 % B in 10 min → 30 % B in 10 min (5 min) → 40 % B in 20 min → 50 % B in 20 min (10 min)
Flow rate:	0.8 mL/min
Temperature:	35 °C
Detection:	UV, 230 nm

Peaks:
1. Metamitron
2. Desethylatrazine
3. Hexazinone
4. Metoxuron
5. Simazine
6. Cyanazine
7. Methabenzthiazuron (Tribunil®)
8. Chlortoluron
9. Atrazine
10. Monolinuron
11. Isoproturon
12. Diuron
13. Metobromuron
14. Metazachlor
15. Sebuthylazine
16. Dichlobenil
17. Terbuthylazine
18. Linuron
19. Chloroxuron
20. Propyzamid
21. Terbutryn
22. Metolachlor



Courtesy of E. Marek, LUFA Center for Analyses, Münster, Germany.

Also see appl. 118010 at *www.mn-net.com.*

Pesticides

MN Appl. No. 120481: triazines

MN Appl. No. 120482: phenylurea derivatives

MN Appl. No. 120483: phenoxycarboxylic acids

MN Appl. No. 120485: 21 pesticides

Column: 250 x 4 mm NUCLEODUR® 100-3 C_8 ec with 8 x 4 mm guard column
Eluent: A) acetonitrile, B) 20 mM KH_2PO_4 + 1 mL conc. H_3PO_4, 85 % B (5 min) → 47 % B in 60 min
Flow rate: 0.7 mL/min
Temperature: 35 °C
Detection: UV, 218 nm
Injection volume: 50 µL

Peaks:

1. Desisopropylatrazine
2. 2,4-Dichlorobenzamide
3. Desethylatrazine
4. Hexazinone
5. Metoxuron
6. Dicamba
7. Bromacil
8. Simazine
9. Desethylterbuthylazine
10. Cyanazine
11. Methabenzthiazuron
12. Chlortoluron
13. Bentazone
14. Atrazine
15. 2,4-D
16. Metalaxyl
17. Monolinuron
18. MCPA
19. Isoproturon
20. Diuron
21. Metobromuron
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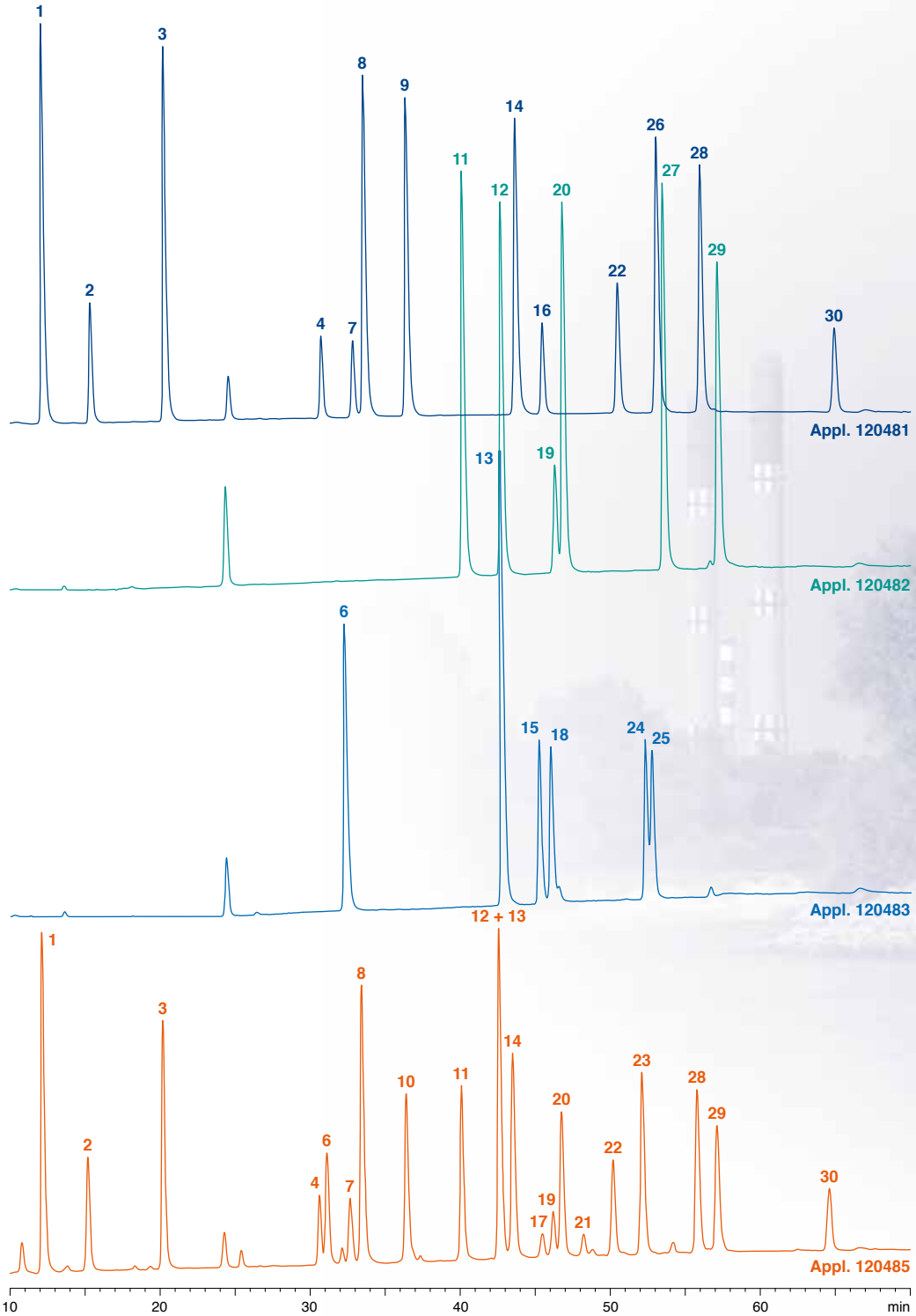
23. Sebuthylazine
24. Dichlorprop
25. Mecoprop
26. Propazine
27. Dimefuron
28. Terbuthylazine
29. Linuron
30. Metolachlor

Courtesy of C. Geis, GIU; Commercial Institute for Environmental Analysis, Teningen, Germany.



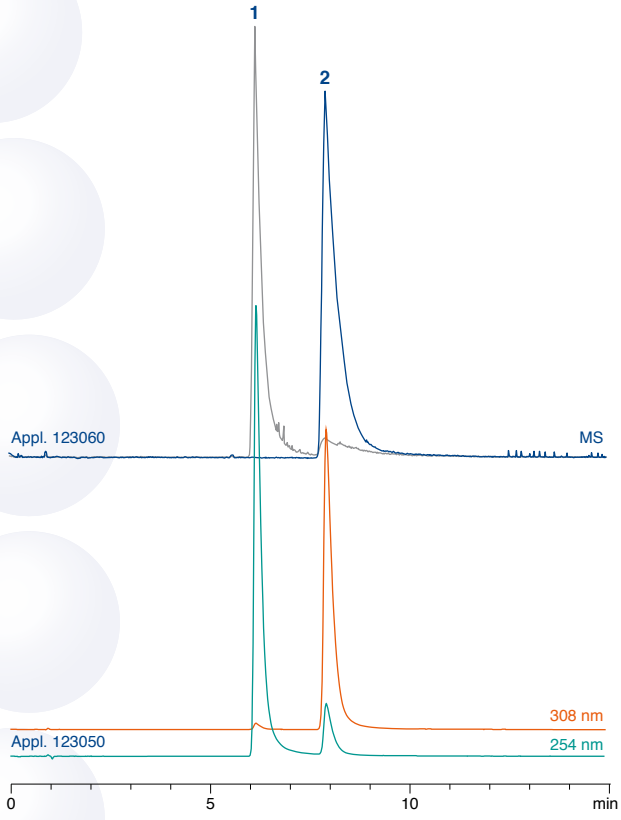
Applications

Herbicides

MN Appl. No. 123050/123060

Column: 125 x 2 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – 50 mM ammonium formate, pH 3.2 (80:20, v/v)
Flow rate: 0.3 mL/min
Temperature: 45 °C
Detection: UV, 254 and 308 nm; MS
Injection volume: 1 µL, 0.5 mg/mL

Peaks:
1. Paraquat
2. Diquat

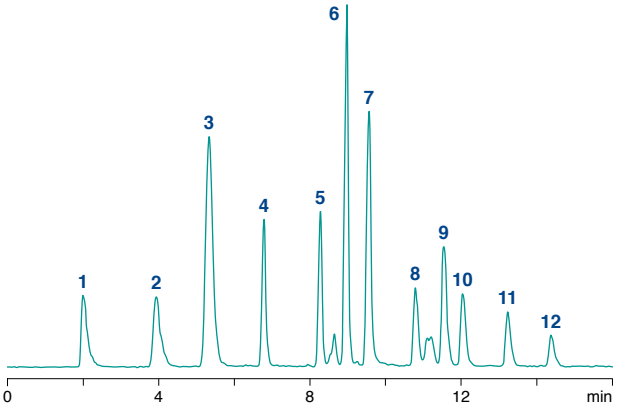


Perfluorinated surfactants in water

MN Appl. No. 121590

Column: 125 x 2 mm NUCLEODUR® Sphinx RP, 3 µm
Sample prep.: see appl. 121590 at *www.mn-net.com*
Eluent: A) 10 mM NH_4 acetate in water – methanol (75:25, v/v); B) 10 mM NH_4 acetate in acetonitrile – methanol (75:25, v/v); 10 % B → 30 % B in 3 min → 55 % B in 8 min → 70 % B in 4 min
Flow rate: 0.3 mL/min; temperature 50 °C
Detection: LC-MS-MS; injection volume 50 µL

Peaks:
1. Perfluorobutanoic acid
2. Perfluoropentanoic acid
3. K perfluorobutanesulfonate
4. Perfluorohexanoic acid
5. Perfluoroheptanoic acid
6. K perfluorohexansulfonate
7. Perfluorooctanoic acid
8. Perfluorononanoic acid
9. K perfluorooctanesulfonate
10. Perfluorodecanoic acid
11. Perfluoroundecanoic acid
12. Perfluorododecanoic acid



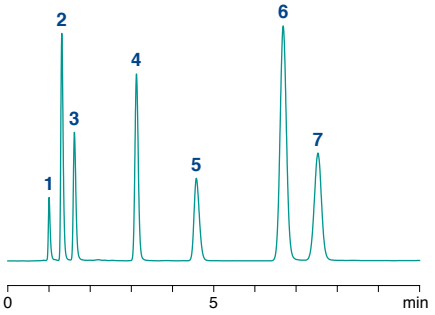
D. Skutlarek et al., Environ Sci Pollut Res 13 (2006) 299–307

Selectivity test

MN Appl. No. 119880

Column: 125 x 4 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: methanol – 25 mM $NH_4H_2PO_4$, pH 7 (65:35, v/v)
Flow rate: 1.0 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection volume: 6 µL

Peaks:
1. Uracil
2. 2,7-Dihydroxynaphthalene
3. 2,3-Dihydroxynaphthalene
4. Ethyl benzoate
5. Lidocaine
6. Biphenyl
7. Acenaphthene

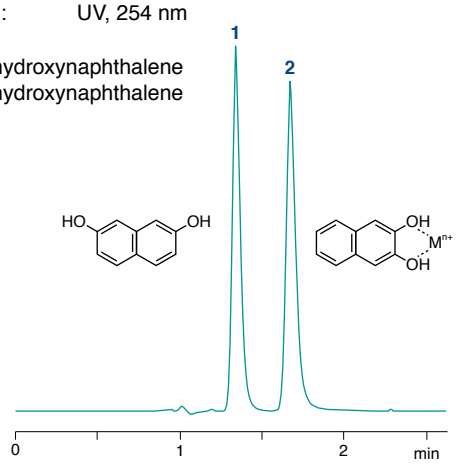


Test for metal ions in silica adsorbent

MN Appl. No. 118630

Column: 125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
Eluent: methanol – 20 mM KH_2PO_4, pH 7 (65:35, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm

Peaks:
1. 2,7-Dihydroxynaphthalene
2. 2,3-Dihydroxynaphthalene



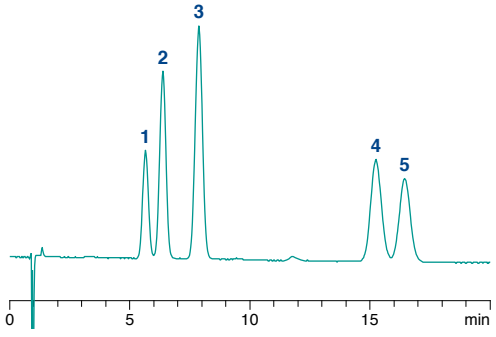
The ratio of the asymmetry factors of 2,3-dihydroxynaphthalene (2) and 2,7-dihydroxynaphthalene (1) is a measure for the metal ion content of the silica phase, because (2) can form complexes with metal ions, resulting in broad peaks for this compound.

Dihydroxynaphthalenes

MN Appl. No. 121190

Column: 125 x 4 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: methanol – 0.5 % H_3PO_4 (30:70, v/v)
Flow rate: 1 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 15 µL

Peaks:
1. 1,5-Dihydroxynaphthalene
2. 1,6-Dihydroxynaphthalene
3. 2,7-Dihydroxynaphthalene
4. 1,3-Dihydroxynaphthalene
5. 2,3-Dihydroxynaphthalene



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	C_{18} Pyramid, 5 µm	36, 53
	HILIC, 3 µm	52
	HILIC, 5 µm	54
Asparagine	100-5 C_{18} ec	46
Aspartame	100-5 C_8 ec	43
	C_{18} HTec, 5 µm	43
Aspartic acid	100-5 C_{18} ec	46
	100-5 CN-RP	54
Atrazine	100-3 C_8 ec	60, 61
Atropine	C_8 Gravity, 5 µm	48
Azorubine	C_{18} Gravity, 5 µm	44

B

Bambuterol	C_{18} Pyramid, 5 µm	37
Beclometasone dipropionate		
	C_{18} Pyramid, 1.8 µm	33
Bentazone	100-3 C_8 ec	61
Benzaldehyde	100-5 C_{18} ec	58
	C_{18} Gravity, Sphinx RP, 5 µm	56
Benzalkonium chlorides	100-5 CN-RP	37
Benzamide	100-5 CN-RP	28, 29
	C_{18} Gravity, 5 µm	10, 15, 56
	C_{18} Pyramid, C_8 Gravity, 5 µm	15
	PFP, 3 µm	57
	Sphinx RP, 5 µm	56
Benz[a]anthracene	C_{18} Gravity, 5 µm	59
Benzocaine	C_{18} Pyramid, 5 µm	32
Benzo[b]fluoranthene	C_{18} Gravity, 5 µm	59
Benzo[k]fluoranthene	C_{18} Gravity, 5 µm	59
Benzoic acid	100-5 C_8 ec	43
	C_{18} Gravity, 5 µm	36
	C_{18} HTec, 5 µm	43
	PolarTec, 3 µm	43
Benzo[ghi]perylene	C_{18} Gravity, 5 µm	59
Benzophenone	100-5 C_{18} ec	59
	C_{18} Gravity, 1.8 vs. 3 µm	59
	C_{18} Gravity, 5 µm	15, 56
	C_{18} HTec, 5 µm	51
	C_{18} Pyramid, C_8 Gravity, 5 µm	15
	Sphinx RP, 5 µm	56
Benzophenone-3	100-5 C_{18} ec	51
Benzo[a]pyrene	C_{18} Gravity, 5 µm	59
Benzyl alcohol	PolarTec, 3 µm	43
Betamethasone	C_{18} Isis, 5 µm	51
	PFP, 5 µm	19
Biotin	C_{18} Pyramid, 5 µm	53
	HILIC, 3 µm	52
Biphenyl	100-5 CN-RP	28, 29
	C_{18} Pyramid, C_{18} Gravity, C_8 Gravity	15
	Sphinx RP, 5 µm	62
Biphenyl-2-ol	100-5 C_8 ec / C_{18} ec	25
Biuret	C_{18} Pyramid, 5 µm	45
Bromacil	100-3 C_8 ec	61
Bromazepam	100-5 C_{18} ec	38
Brompheniramine	100-5 C_{18} ec / 100-5 CN-RP	28
	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19
Brucine	C_8 Gravity, 5 µm	48
Butacaine	C_{18} Pyramid, 5 µm	32
Butyl methoxydibenzoylmethane		
	100-5 C_{18} ec	51
Butyl paraben	PolarTec, 3 µm	43
Butyrophenone	100-5 C_{18} ec	59
	C_{18} Gravity, 1.8 vs. 3 µm	59

C

Caffeine	100-5 C_8 ec	43
	100-5 C_{18} ec	24
	C_8 Gravity, 5 µm	32
	C_{18} Gravity, 5 µm	11
	C_{18} Isis, 5 µm	13
	C_{18} Pyramid, 5 µm	36
	Sphinx RP, 5 µm	20, 42
4-Carboxybenzaldehyde	100-5 C_{18} ec	58
Carprofen	100-5 C_8 ec / C_{18} ec	33
Catechin	Sphinx RP, C_{18} Gravity, C_8 Gravity	21
Catechol	PFP, 3 µm	57

Cefalotin	PFP, 5 µm	41
Cefamandole	C_{18} Gravity, PFP, 5 µm	41
Cefotaxime	C_{18} Gravity, PFP, 5 µm	41
Cefoxitin	C_{18} Gravity, PFP, 5 µm	41
Cephalexin	PFP, 5 µm	41
Cephalothin	C_{18} Gravity, 5 µm	41
Cetirizine	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19
Chloramphenicol	C_{18} Gravity, 5 µm	42
Chlormequat	HILIC, 3 µm	27
4-Chloro-2-nitroaniline	PFP, 5 µm	58
4-Chloro-3-methylphenol	PFP, 5 µm	57
Chloroaniline isomers	PFP, 5 µm	58
Chlorocresol	C_{18} Pyramid, 1.8 µm	33
2-Chlorophenol	PFP, 5 µm	57
Chloroprothixene hydrochloride		
	C_8 Gravity, 5 µm	36
Chloroquine	C_{18} Gravity, 5 µm	48
Chloroxuron	100-3 C_8 ec	60
Chlorpheniramine	100-5 C_{18} ec / 100-5 CN-RP	28
	C_8 Gravity, 5 µm	15
	C_{18} Gravity, 5 µm	15, 36
	C_{18} Pyramid, 5 µm	15, 36
	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19
Chlorpromazine	100-5 CN-RP	38
Chlortoluron	100-3 C_8 ec	60, 61
Chrysene	C_{18} Gravity, 5 µm	59
Cimetidine	C_{18} Gravity, 3 µm	36
Cinoxacin	100-5 C_{18} ec	39
	C_{18} Gravity, 5 µm	42
	C_{18} Gravity, C_8 Gravity, C_{18} Pyramid	40
	C_{18} HTec, 5 µm	41
	Sphinx RP, 5 µm	40
Ciprofloxacin	100-5 C_{18} ec	39
	Sphinx RP, 5 µm	39
Citric acid	C_{18} Pyramid, 5 µm	55
	HILIC, 3 µm	55
Citrulline	C_{18} Gravity, 3 µm	46
Clenbuterol	100-5 CN-RP	38
	C_{18} Pyramid, 5 µm	37
Clobetasol 17-propionate	C_{18} Pyramid, 1.8 µm	33
Clomipramine	100-5 CN-RP; C_{18} Isis, 5 µm	35
Clonidin	100-5 CN-RP	38
Cloxacillin	100-5 C_{18} ec	39, 40
	C_{18} Gravity, 5 µm	42
	C_{18} HTec, 5 µm	41
	PFP, 5 µm	41
Cohumulone, colupulone	100-5 C_{18} ec	51
Corticosterone	C_{18} Gravity, 5 µm	49
Cortisone	100-5 C_8 ec	49
	100-5 CN / CN-RP	29
	C_8 Gravity, 5 µm	48
	C_{18} Gravity, 5 µm	49
	C_{18} HTec, 5 µm	49
Creatine	HILIC, 3 µm	45
Creatinine	HILIC, 3 µm	45
o-, *m*-Cresol	PFP, 5 µm	57
	PFP, C_{18} HTec, 5 µm	19
Cyanazine	100-3 C_8 ec	60, 61
Cyanocobalamine	C_{18} Pyramid, 5 µm	53
	HILIC, 3 µm	52
Cyanuric acid	C_{18} Pyramid, 5 µm	45
	HILIC, 5 µm	45
Cyclohexane	100-5 NH_2	30
Cytosine	100-5 NH_2-RP	31
	C_{18} Pyramid, 5 µm	47
	HILIC, 5 µm	27, 47
	PolarTec, 3 µm	17
	PolarTec, 5 µm	47

D

2,4-D	100-3 C_8 ec	61
Dehydroacetic acid	C_{18} HTec, 5 µm	43
	PolarTec, 3 µm	43
Dehydroascorbic acid	HILIC, 5 µm	54
Deoxycorticosterone	C_{18} Gravity, 5 µm	49
Desethylatrazine	100-3 C_8 ec	60, 61
	C_{18} Isis, 5 µm	58
Desethylterbuthylazine	100-3 C_8 ec	61
Desisopropylatrazine	100-3 C_8 ec	61
Dexamethasone	C_{18} Gravity, 5 µm	49
	C_{18} Isis, 5 µm	51
	PFP, 5 µm	19
Dextromethorphan	C_{18} Gravity, 5 µm	36
	C_{18} Pyramid, 5 µm	36
Dibenz[ah]anthracene	C_{18} Gravity, 5 µm	59
Dibenzothiophene	100-5 NH_2	30
Dibromophenol isomers	PFP, 5 µm	57
	PFP, C_{18} HTec, 5 µm	19
Dibutyl phthalate	C_{18} Gravity, 5 µm	9
Dicamba	100-3 C_8 ec	61
Dichlobenil	100-3 C_8 ec	60
3,4-Dichloroaniline	PFP, 5 µm	58
2,4-Dichlorobenzamide	100-3 C_8 ec	61
2,4-Dichlorophenol	PFP, 5 µm	57
Dichlorophenol isomers	PFP, 5 µm	57
	PFP, C_{18} HTec, 5 µm	19
Dichlorprop	100-3 C_8 ec	61
Diclofenac	100-5 C_8 ec	33
	100-5 C_{18} ec	32, 33, 34
Dicloxacillin	100-5 C_{18} ec, C_{18} Pyramid, 5 µm	40
	PFP, 5 µm	41
Diethylenetrinitrilopentaacetic acid		
	C_{18} Pyramid, 5 µm	54
Diflunisal	100-5 C_8 ec	33
	C_{18} Gravity, 5 µm	34
Dihydroxybenzoic acid isomers		
	C_{18} Isis, 5 µm	54
	PolarTec, 5 µm	55
Dihydroxymandelic acid	PolarTec, 5 µm	55
Dihydroxynaphthalene isomers		
	C_8 Gravity, 5 µm	63
	C_{18} Isis, 5 µm	63
	Sphinx RP, 5 µm	62
Dihydroxyphenylacetic acid		
	PolarTec, 5 µm	55
Dihydroxyphenylalanine	C_{18} Gravity, 5 µm	50
Dimefuron	100-3 C_8 ec	61
N,*N*-Dimethylaniline	C_{18} HTec, 5 µm	22
	C_{18} Isis, 5 µm	58
1,2-Dimethylbenzene	100-5 NH_2	30
2,4-Dimethylphenol	PFP, 5 µm	57
Dimethylphenol isomers	PFP, 5 µm	57
	PFP, C_{18} HTec, 5 µm	19
Dimethyl phthalate	100-5 CN-RP	28, 29
	C_{18} Pyramid, C_{18} Gravity, C_8 Gravity	15
1,3-Dinitrobenzene	PolarTec, 5 µm	56
2,4-Dinitrophenol	PFP, 5 µm	57
3,5-Dinitro-(1-phenylethylbenzamide)		
	C_{18} Isis, 5 µm	58
Dinitrotoluene isomers	PolarTec, 5 µm	56

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Diphenhydramine	C_{18} Gravity, 5 µm	10
	C_{18} Pyramid, 5 µm	36
	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19
Dipyridamole	C_{18} Gravity, 3 µm	39
Diquat	HILIC, 3 µm	62
Diuron	100-3 C_8 ec	60, 61
L-DOPA	HILIC, 3 µm	50
Dopamine	HILIC, 3 µm	50
Doxepin	100-5 CN-RP; C_8 Gravity, C_{18} Gravity,	
	C_{18} Pyramid, 5 µm	35
	PolarTec, 5 µm	34
DTPA	C_{18} Pyramid, 5 µm	54

E

E 102 / 104 / 110 / 122 / 124 / 126 / 127		
	C_{18} Gravity, 5 µm	44
EDTA	C_{18} Pyramid, 5 µm	54
Enrofloxacin	C_{18} Gravity, 5 µm	42
	C_{18} HTec, 5 µm	41
	Sphinx RP, 5 µm	39
Ephedrine	100-5 C_{18} ec / 100-5 CN-RP	28
Erythrosine	C_{18} Gravity, 5 µm	44
Estradiol	100-5 C_8 ec; C_{18} HTec, 5 µm	49
Estriol	100-5 C_8 ec; C_{18} HTec, 5 µm	49
Estrone	100-5 C_8 ec; C_{18} HTec, 5 µm	49
2-Ethoxyphenol	100-5 C_8 ec	25
	100-5 C_{18} ec	25, 56
4-Ethoxyvanillin	100-5 C_{18} ec	58
4-Ethylaniline	C_{18} HTec, 5 µm	22
	C_{18} Isis, 5 µm	58
Ethylbenzene	100-5 C_{18} ec	24
	C_{18} Gravity, 1.8 vs. 3 µm	6
	C_{18} Gravity, 5 µm	11
	C_{18} HTec, 5 µm	22
	C_{18} Isis, 5 µm	13
Ethyl benzoate	C_{18} Pyramid, C_{18} Gravity, C_8 Gravity	15
	Sphinx RP, 5 µm	62
Ethylenediaminetetraacetic acid		
	C_{18} Pyramid, 5 µm	54
Ethylhexyldimethyl PABA	100-5 C_{18} ec; C_{18} HTec, 5 µm	51
Ethylhexyl methoxycinnamate		
	100-5 C_{18} ec; C_{18} HTec, 5 µm	51
Ethylhexyl salicylate	100-5 C_{18} ec; C_{18} HTec, 5 µm	51
Ethyl paraben	PolarTec, 3 µm	43
Eugenol	C_{18} Gravity, 1.8 vs. 3 µm	59

F

Famotidine	C_{18} Gravity, 3 µm	36
Fast Red E	C_{18} Gravity, 5 µm	44
Fast Yellow	C_{18} Gravity, 5 µm	44
Fenoprofen	100-5 C_8 ec;	33
	100-5 C_{18} ec	33
	C_{18} Gravity, 5 µm	34
Fenoterol	C_{18} Pyramid, 5 µm	37
Fisetin	Sphinx RP, C_{18} Gravity, C_8 Gravity	21
Flumequine	Sphinx RP, 5 µm	39
Flunarizine hydrochloride	C_{18} Gravity, 3 µm	39
Fluoranthene	C_{18} Gravity, 5 µm	59
Fluorene	C_{18} Gravity, 5 µm	59
Flurbiprofen	100-5 C_8 ec	33
	100-5 C_{18} ec	34
	C_{18} Gravity, 5 µm	34
	C_{18} Pyramid, 5 µm	32
Folic acid	C_{18} Pyramid, 5 µm	52, 53
Formic acid	C_{18} Pyramid, 5 µm	15
Fructose	100-5 NH_2-RP	30
Fumaric acid	100-5 CN-RP	54
	C_{18} Pyramid, 5 µm	55
	HILIC, 3 µm	55
2-Furfurol	100-5 C_{18} ec	59
2-Furfuryl alcohol	100-5 C_{18} ec	59

G

Gallic acid	C_{18} Isis, 5 µm	54
	C_{18} Pyramid, 5 µm	43
	PolarTec, 5 µm	55
Glucose	100-5 NH_2-RP	30
Glufosinate	100-5 NH_2-RP	60
	C_{18} Gravity, 5 µm	60
Glutamic acid	100-5 C_{18} ec	46
Glutamine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
Glycine	100-5 C_{18} ec	46
Glyphosate	100-5 NH_2-RP	60
	C_{18} Gravity, 5 µm	60
Guanine	PolarTec, 3 µm	17
	PolarTec, 5 µm	47
Guanosine	HILIC, 5 µm	27, 47

H

Hexamethylbenzene	100-5 NH_2	30
Hexazinone	100-3 C_8 ec	60, 61
Hexobarbital	100-5 C_{18} ec	34
Hexogen (RDX)	PolarTec, 5 µm	56
Histamine	HILIC, 3 µm	47
Histidine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
	HILIC, 3 µm	47
	PolarTec, 3 µm	17
n-Humulone	100-5 C_{18} ec	51
Hydrocortisone	100-5 CN / CN-RP	29
	C_8 Gravity, 5 µm	48
	C_{18} Gravity, 5 µm	49
Hydrocortisone acetate	C_8 Gravity, 5 µm	48
4-Hydroxybenzaldehyde	100-5 C_{18} ec	58
4-Hydroxybenzoic acid	C_{18} Isis, 5 µm	54
3-Hydroxybenzoic acid	PolarTec, 5 µm	55
17α-Hydroxycortisone	C_{18} Gravity, 5 µm	49
Hydroxymethylfurfural	C_{18} Gravity, 5 µm	44
5-Hydroxymethyl-2-furfurol	100-5 C_{18} ec	59
α-Hydroxymidazolam	C_{18} Gravity, 3 µm	38
4-Hydroxyproline	C_{18} Gravity, 3 µm	46
Hydroxytestosterone isomers		
	C_{18} Isis, 1.8 µm	49
Hydroxytyramine	C_{18} Gravity, 5 µm	50
Hydroxyzine	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19

I

Ibuprofen	100-5 C_8 ec	33
	100-5 C_{18} ec	32, 34
	C_{18} Gravity, 5 µm	34
	C_{18} Pyramid, 5 µm	32
Imipramine	C_8 Gravity, C_{18} Gravity, C_{18} Isis,	
	C_{18} Pyramid, 5 µm	35
	PolarTec, 5 µm	34
Indeno[1,2,3-cd]pyrene	C_{18} Gravity, 5 µm	59
Indomethacin	100-5 C_8 ec	33
	C_{18} Gravity, 5 µm	34
Irgasan	PolarTec, 3 µm	43
Isoadhumulone	100-5 C_{18} ec	51
Isobutyl paraben	PolarTec, 3 µm	43
Isocohumulone	100-5 C_{18} ec	51
Isohumulone	100-5 C_{18} ec	51

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Isoleucine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
Isoproturon	100-3 C_8 ec	60, 61
Isorhamnetin	Sphinx RP, C_{18} Gravity, C_8 Gravity	21

K

Kaempferol	Sphinx RP, C_{18} Gravity, C_8 Gravity	21
Ketoprofen	100-5 C_8 ec	33
	100-5 C_{18} ec	32, 33, 34
	C_{18} Gravity, 5 µm	10
	C_{18} Pyramid, 5 µm	32

L

Lactic acid	C_{18} Pyramid, 5 µm	55
Lactose	100-5 NH_2-RP	30
Leucine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
Lidocaine	C_8 Gravity, 5 µm	15
	C_{18} Gravity, 5 µm	10, 15
	C_{18} Pyramid, 5 µm	15, 32
	Sphinx RP, 5 µm	62
Linuron	100-3 C_8 ec	60, 61
Lorazepam	100-5 C_{18} ec	38
n-Lupulone	100-5 C_{18} ec	51
Lysine	100-5 C_{18} ec	46

M

Maleic acid	100-5 C_{18} ec	28
	100-5 CN-RP	28, 54
	C_{18} Gravity, 5 µm	36
	C_{18} Pyramid, 5 µm	14
	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19
Malic acid	C_{18} Pyramid, 5 µm	55
Maltose	100-5 NH_2-RP	30
Mapenterol	C_{18} Pyramid, 5 µm	37
Maprotiline	C_{18} Isis, 5 µm	35
Marbofloxacin	Sphinx RP, 5 µm	39
MCPA	100-3 C_8 ec	61
Meclofenamic acid	100-5 C_{18} ec	34
Mecoprop	100-3 C_8 ec	61
Medrysone	100-5 CN / CN-RP	29
Mefloquine	C_{18} Gravity, 5 µm	48
Melamine	HILIC, 5 µm	45
Mephobarbital	100-5 C_{18} ec	34
Mepiquat	HILIC, 3 µm	27
Metalaxyl	100-3 C_8 ec	61
Metamitron	100-3 C_8 ec	60
Metazachlor	100-3 C_8 ec	60, 61
Methabenzthiazuron	100-3 C_8 ec	60, 61
Methacrylamide	HILIC, 5 µm	44
Methacrylic acid	HILIC, 5 µm	44
Methionine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
Methoxyphenol isomers	100-5 C_8 ec	25
	100-5 C_{18} ec	25, 56
2-Methyl-4,6-dinitrophenol	PFP, 5 µm	57
o-, *m*-, *p*-Methylacetophenone		
	PFP, C_{18} Gravity, 5 µm	58
9-Methylanthracene	100-5 NH_2	30
4-Methylbenzylidine camphor		
	100-5 C_{18} ec	51
	C_{18} HTec, 5 µm	51
5-Methyl-2-furfurol	100-5 C_{18} ec	59
Methylhistidine isomers	PolarTec, 3 µm	17
Methyl-4-hydroxybenzoate	C_{18} Pyramid, 5 µm	32
6α-Methyl-11β-hydroxyprogesterone		
	100-5 C_8 ec; C_{18} HTec, 5 µm	49
	C_8 Gravity, 5 µm	48
6α-Methyl-17α-hydroxyprogesterone / + acetate		
	100-5 C_8 ec; C_{18} HTec, 5 µm	49
	C_8 Gravity, 5 µm	48
Methyl paraben	PolarTec, 3 µm	43
6α-Methylprednisolone	C_{18} Gravity, 5 µm	49
Methyltestosterone	100-5 CN / CN-RP	29
Metobromuron	100-3 C_8 ec	60, 61
Metolachlor	100-3 C_8 ec	60, 61
Metoxuron	100-3 C_8 ec	60, 61
Midazolam	C_{18} Gravity, 3 µm	38
Monensin sodium	C_{18} Gravity, 3 µm	41
Monolinuron	100-3 C_8 ec	60, 61

N

Nafcillin	100-5 C_{18} ec, C_{18} Pyramid, 5 µm	40
	PFP, 5 µm	41
Nalidixic acid	C_{18} Gravity, 5 µm	42
	C_{18} Gravity, C_8 Gravity, C_{18} Pyramid	40
	Sphinx RP, 5 µm	40
	C_{18} HTec, 5 µm	41
	Sphinx RP, 5 µm	39
Naphthalene	100-5 NH_2	30
	C_{18} Gravity, 1.8 vs. 3 µm	6
	C_{18} Gravity, 5 µm	15, 59
	C_{18} HTec, 5 µm; EC vs. VP	23
	C_{18} Pyramid, C_8 Gravity	15
	HILIC, 3 µm	27
Naproxen	100-5 C_8 ec	33
	C_{18} Gravity, 5 µm	34
Nicardipine	100-5 CN-RP	39
Nicotinamide	C_{18} Pyramid, 5 µm	52
	HILIC, 3 µm	52
Nicotinic acid	C_{18} Pyramid, 5 µm	52
Nifedipine	100-5 CN-RP	39
	C_{18} Gravity, 3 µm	39
Niflumic acid	C_{18} Gravity, 5 µm	34
Nimodipine	100-5 CN-RP	39
Nisoldipine	100-5 CN-RP	39
Nitrendipine	100-5 CN-RP	39
Nitrilotriacetic acid	C_{18} Pyramid, 5 µm	54
Nitroaniline isomers	PFP, 5 µm	58
Nitrobenzene	C_{18} Gravity, Sphinx RP, 5 µm	56
	PFP, 3 µm	57
	PolarTec, 5 µm	56
Nitrocresol isomers	C_{18} Gravity, 5 µm	56
2-Nitrophenol	C_{18} Gravity, Sphinx RP, 5 µm	56
Nitrophenol isomers	C_{18} Gravity, 5 µm	56
	PFP, 5 µm	57
Nitrotoluene isomers	PolarTec, 5 µm	56
Nizatidine	C_{18} Gravity, 3 µm	36
N-Methyl-*N*-2,4,6-tetranitro-aniline (Tetryl)		
	PolarTec, 5 µm	56
Norephedrine	100-5 C_{18} ec / 100-5 CN-RP	28
	C_{18} Gravity, 5 µm	50
	HILIC, 3 µm	50
Norgestrel	100-5 CN / CN-RP	29
Nortriptyline	100-5 CN-RP; C_8 Gravity, C_{18} Gravity, C_{18} Isis, C_{18} Pyramid, 5 µm	35
Norvaline	100-5 C_{18} ec	46
Noscapine	C_8 Gravity, 5 µm	48
	C_{18} Gravity, 5 µm	10
NTA	C_{18} Pyramid, 5 µm	54

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O

Octocrylene	100-5 C_{18} ec; C_{18} HTec, 5 µm	51
Octogen (HMX)	PolarTec, 5 µm	56
Ofloxacin	100-5 C_{18} ec	39
Ornithine	C_{18} Gravity, 3 µm	46
Oxacillin	PFP, 5 µm	41
Oxalic acid	HILIC, 3 µm	55
Oxazepam	100-5 C_{18} ec	38
Oxolinic acid	C_8 Gravity, C_{18} Pyramid, 5 µm	40
	C_{18} Gravity, 5 µm	40, 42
	C_{18} HTec, 5 µm	41
	Sphinx RP, 5 µm	39, 40

P

Panthotenic acid	PolarTec, 5 µm	52
Papaverine	C_8 Gravity, 5 µm	48
	C_{18} Gravity, 5 µm	10
Paracetamol	100-5 C_{18} ec	28, 32
	100-5 CN-RP	28
	C_8 Gravity, 5 µm	32
	C_{18} Gravity, 5 µm	36
	C_{18} Pyramid, 5 µm	32, 36
Paraquat	HILIC, 3 µm	62
Patulin	C_{18} Gravity, 5 µm	44
Penicillins G + V	100-5 C_{18} ec	39, 40
	C_{18} Pyramid, 5 µm	40
Penicillin V	C_{18} Gravity, 5 µm	42
	C_{18} HTec, PFP, 5 µm	41
Pentachlorophenol	PFP, 5 µm	57
Pentobarbital	100-5 C_{18} ec	34
Perfluorinated surfactants	Sphinx RP, 3 µm	62
Phenactin	C_8 Gravity, 5 µm	32
Phenanthrene	C_{18} Gravity, 5 µm	59
Phenetole	100-5 C_8 ec / C_{18} ec	25
	100-5 CN-RP	28, 29
Phenobarbital	100-5 C_{18} ec	34
Phenol	100-5 C_8 ec	25
	100-5 C_{18} ec	25, 56
	C_{18} Gravity, 5 µm	56
	C_{18} HTec, 5 µm	22
	C_{18} HTec, 5 µm; EC vs. VP	23
	PFP, 3 µm	57
	PFP, 5 µm	57
	PolarTec, 5 µm	17
	Sphinx RP, 5 µm	21, 56
Phenoxyethanol	PolarTec, 3 µm	43
Phenylalanine	100-5 C_{18} ec; C_{18} Gravity, 3 µm	46
	HILIC, 3 µm	47
1-Phenyldodecane	100-5 NH_2	30
Phenylglycine	HILIC, 3 µm	47
Phloroglucinol	PFP, 3 µm	57
Piperacillin	PFP, 5 µm	41
Pirenzepine hydrochloride	C_{18} Gravity, 3 µm	36
Piroxicam	100-5 C_8 ec, 100-5 C_{18} ec	33
	C_{18} Gravity, 5 µm	34
Ponceau 4R and 6R	C_{18} Gravity, 5 µm	44
Prednisolone	100-5 C_8 ec	49
	100-5 CN / CN-RP	29
	C_{18} Gravity, 5 µm	49
	C_{18} HTec, 5 µm	49
Procainamide	100-5 CN-RP	38
Progesterone	100-5 C_8 ec; C_{18} Gravity, C_{18} HTec, 5 µm	49
Promazine	100-5 CN-RP	38
Promethazine	100-5 CN-RP	38
	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19
Propazine	100-3 C_8 ec	61
Propiophenone	100-5 C_{18} ec	59
	C_{18} Gravity, 1.8 vs. 3 µm	59
Propyl 4-hydroxybenzoate	C_{18} Gravity, Sphinx RP, 5 µm	56
Propyl paraben	PolarTec, 3 µm	43
Propyzamid	100-3 C_8 ec	60
Protriptyline	C_8 Gravity, C_{18} Gravity, C_{18} Isis, C_{18} Pyramid, 5 µm	35
Protryptiline	PolarTec, 5 µm	34
Pseudoephedrine	C_{18} Gravity, 5 µm	36
Pyrene	C_{18} Gravity, 5 µm	59
Pyridine	C_{18} Gravity, 5 µm	11
	C_{18} Isis, 5 µm	13, 58
	PolarTec, 5 µm	17
	Sphinx RP, 5 µm	21
Pyridoxal	C_{18} Pyramid, 5 µm	53
Pyridoxamine	C_{18} Pyramid, 5 µm	53
Pyridoxine	C_{18} Pyramid, 5 µm	53
	HILIC, 3 µm	52
Pyridoxine hydrochloride	C_{18} Pyramid, 5 µm	52
Pyrocatechol	100-5 C_8 ec	25
	100-5 C_{18} ec	25, 56
Pyrogallol	PFP, 3 µm	57

Q

Quercetin	Sphinx RP, C_{18} Gravity, C_8 Gravity	21
Quinine	100-5 C_8 ec	43
	C_8 Gravity, C_{18} Gravity, 5 µm	48
Quinoline yellow	C_{18} Gravity, 5 µm	44

R

Ractopamine	C_{18} Pyramid, 5 µm	37
Reproterol	C_{18} Pyramid, 5 µm	37
Resorcinol	100-5 C_8 ec	25
	100-5 C_{18} ec	25, 56
	PFP, 3 µm	57
Riboflavin	C_{18} Pyramid, 5 µm	52, 53
Ritodrine	C_{18} Pyramid, 5 µm	37
Rutin	C_{18} Pyramid, 5 µm	52
	Sphinx RP, C_{18} Gravity, C_8 Gravity	21

S

Saccharin	100-5 C_8 ec; C_{18} HTec, 5 µm	43
Saccharose	100-5 NH_2-RP	30
Salicylic acid	100-5 C_{18} ec	32
	PolarTec, 3 µm	43
Salinomycin sodium	C_{18} Gravity, 3 µm	41
Sarafloxacin	Sphinx RP, 5 µm	39
Scopolamine	C_8 Gravity, 5 µm	48
Sebuthylazine	100-3 C_8 ec	60, 61
Serine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
Shikimic acid	C_{18} Pyramid, 5 µm	55
Simazine	100-3 C_8 ec	60, 61
Sorbic acid	100-5 C_8 ec; C_{18} HTec, 5 µm	43
Strychnine	C_8 Gravity, 5 µm	48
Succinylsulfathiazole	C_{18} Gravity, 5 µm	42
Sulfadiazine	C_{18} Gravity, 5 µm	42
Sulfadimidine	C_{18} Gravity, 5 µm	42
Sulfamerazine	C_{18} Gravity, 5 µm	42
Sulfanilamide	C_{18} Gravity, 5 µm	42
Sulfathiazole	C_{18} Gravity, 5 µm	42
Sulindac	100-5 C_{18} ec; C_{18} Gravity, 5 µm	34
Sunset yellow CFC	C_{18} Gravity, 5 µm	44
Suprofen	100-5 C_8 ec, 100-5 C_{18} ec	33
	C_{18} Gravity, 5 µm	34
Syringic acid	C_{18} Isis, 5 µm	54
	PolarTec, 5 µm	55

T

Tartaric acid	C_{18} Pyramid, 5 µm	14, 55
Tartrazine	C_{18} Gravity, 5 µm	44
Temazepam	100-5 C_{18} ec	38
Terbuthylazine	100-3 C_8 ec	60, 61
Terbutryn	100-3 C_8 ec	60
o-, *m*-, *p*-Terphenyl	C_{18} Isis, 1.8 vs. 5 µm	7
	C_{18} Isis, 5 µm	12
o-Terphenyl	C_{18} Isis, 5 µm	13
Testosterone	100-5 C_8 ec	49
	100-5 CN / CN-RP	29
	C_{18} HTec, 5 µm	49
Tetracaine	C_{18} Pyramid, 5 µm	32
Theobromine	Sphinx RP, 5 µm	42
Theophylline	100-5 C_{18} ec	24
	C_{18} Gravity, 5 µm	11
	C_{18} Isis, 5 µm	13
	Sphinx RP, 5 µm	20
Thiamine	C_{18} Pyramid, 5 µm	53
	HILIC, 3 µm	52
Thiamine hydrochloride	C_{18} Pyramid, 5 µm	52
Thiamylal	100-5 C_{18} ec	34
Threonine	C_{18} Gravity, 3 µm	46
Thymine	100-5 NH_2-RP	31
	C_{18} Pyramid, 5 µm	47
	HILIC, 5 µm	27, 47
	PolarTec, 3 µm	17
	PolarTec, 5 µm	47
α-Tocopherol see Vitamin E		
Tocopherols	C_{18} Isis, 5 µm	53
Tolmetin	100-5 C_8 ec	33
	100-5 C_{18} ec	34
	C_{18} Gravity, 5 µm	34
Toluene	100-5 C_{18} ec	24
	C_{18} Gravity, 5 µm	11, 56
	C_{18} HTec, 5 µm	22
	C_{18} Isis, 5 µm	13
	Sphinx RP, 5 µm	56
Tribunil see Methabenzthiazuron		
2,4,6-Trichlorophenol	PFP, 5 µm	57
3,3,4-Triclocarbanilid	PolarTec, 3 µm	43
Trimipramine	100-5 CN-RP; C_8 Gravity,	
	C_{18} Gravity, 5 µm	35
	PolarTec, 5 µm	34
1,3,5-Trinitrobenzene	PolarTec, 5 µm	56
2,4,6-Trinitrotoluene	PolarTec, 5 µm	56
Triphenylene	C_{18} Isis, 1.8 vs. 5 µm	7
	C_{18} Isis, 5 µm	12, 13
Triprolidine	PFP, 5 µm	37
	PFP, C_{18} Gravity, 5 µm	19
Tryptophan	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
Tyrosine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
	C_{18} Gravity, 5 µm	50
	HILIC, 3 µm	47

U

Uracil	100-5 C_{18} ec	24
	100-5 NH_2-RP	31
	C_{18} Gravity, 5 µm	56
	C_{18} HTec, 5 µm	22
	C_{18} Isis, 5 µm	58
	C_{18} Pyramid, 5 µm	47
	HILIC, 3 µm	27
	HILIC, 5 µm	27, 47
	PFP, 3 µm	57
	PolarTec, 3 µm	17
	PolarTec, 5 µm	47
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V

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	C_{18} Gravity, 1.8 vs. 3 µm	59
Valine	100-5 C_{18} ec	46
	C_{18} Gravity, 3 µm	46
Vanillic acid	C_{18} Isis, 5 µm	54
	PolarTec, 5 µm	55
Vanillin	100-5 C_8 ec	43
	100-5 C_{18} ec	58
	Sphinx RP, 5 µm	42
Veratrol	100-5 C_8 ec	25
	100-5 C_{18} ec	24, 25
Vitamin A + acetate	100-5 C_{18} ec; C_{18} Isis, 5 µm	53
Vitamin B_1 / B_2 / B_6	PolarTec, 5 µm	52
Vitamin D_2 / D_3	100-5 C_{18} ec; C_{18} Isis, 5 µm	53
Vitamin E + acetate	100-5 C_{18} ec; C_{18} Isis, 5 µm	53
Vitamin K_1	100-5 C_{18} ec; C_{18} Isis, 5 µm	53
Vitamin K_2	C_{18} Isis, 5 µm	53
Vitamin K_3	100-5 C_{18} ec	53
Vitamins, water-soluble (B_1, B_2, B_6, B_7, B_9, B_{12}, C, H)		
	HILIC, 3 µm	52
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X

o-Xylene	100-5 CN-RP	28, 29
Xylene	C_{18} Gravity, Sphinx RP, 5 µm	56
Xylometazoline	100-5 CN-RP	37

Y

Yellow orange S	C_{18} Gravity, 5 µm	44

Z

Zearalenol	C_{18} Gravity, 5 µm	50
Zearalenone	C_{18} Gravity, 5 µm	50

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Trademarks

MACHEREY-NAGEL trademarks

ALUGRAM	coated aluminium sheets for TLC
CHROMABOND	columns for solid phase extraction (SPE)
ChromCart	cartridge system for HPLC
NUCLEODUR	spherical high purity silica for HPLC
NUCLEOSIL	spherical standard silica for HPLC
OPTIMA	high performance fused silica capillary columns with immobilized phases

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NUCLEODUR® C_{18} Gravity

Pore size 110 Å; high density octadecyl phase, endcapped, 18 % C;
eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} Gravity, 1.8 µm							particle size 1.8 µm
EC analytical columns							
2 mm ID	760078.20	760079.20	760071.20	760076.20		760075.20	
3 mm ID	760078.30	760079.30		760076.30			
4 mm ID	760078.40	760079.40		760076.40			
4.6 mm ID	760078.46	760079.46		760076.46			
EC guard columns*		4 x 2 mm: 761901.20		4 x 3 mm: 761901.30			
NUCLEODUR® C_{18} Gravity, 3 µm							particle size 3 µm
Microbore analytical columns							
1 mm ID				717714.10	717715.10	717716.10	717717.10
EC analytical columns							
2 mm ID		760080.20		760084.20	760081.20	760083.20	760082.20
3 mm ID		760080.30		760084.30	760081.30	760083.30	760082.30
4 mm ID		760080.40		760084.40	760081.40	760083.40	760082.40
4.6 mm ID		760080.46	760086.46	760084.46	760081.46	760083.46	760082.46
EC guard columns*		4 x 2 mm: 761902.20		4 x 3 mm: 761902.30			
CC guard columns**		8 x 3 mm: 761124.30		8 x 4 mm: 761124.40			
NUCLEODUR® C_{18} Gravity, 5 µm							particle size 5 µm
Microbore analytical columns							
1 mm ID				717706.10	717707.10	717708.10	717705.10
EC analytical columns							
2 mm ID		760102.20		760104.20	760100.20	760103.20	760101.20
3 mm ID		760102.30		760104.30	760100.30	760103.30	760101.30
4 mm ID		760102.40		760104.40	760100.40	760103.40	760101.40
4.6 mm ID		760102.46	760106.46	760104.46	760100.46	760103.46	760101.46
EC guard columns*		4 x 2 mm: 761903.20		4 x 3 mm: 761903.30			
CC guard columns**		8 x 3 mm: 761125.30		8 x 4 mm: 761125.40			
VarioPrep preparative columns							
10 mm ID		762103.100			762109.100		762113.100
21 mm ID		762103.210			762109.210		762113.210
32 mm ID							762113.320
40 mm ID						762100.400	762113.400
VP guard columns***		10 x 8 mm: 762160.80		10 x 16 mm: 762160.160		15 x 32 mm: 762163.320	
NUCLEODUR® C_{18} Gravity, 10 µm							particle size 10 µm
VarioPrep preparative columns							
21 mm ID							762250.210
40 mm ID							762250.400
VP guard columns***		10 x 8 mm: 762160.80		10 x 16 mm: 762160.160		15 x 32 mm: 762163.320	

Microbore, EC, and VarioPrep columns in packs of 1, guard columns see page 73

Packed columns

NUCLEODUR® C_8 Gravity

Pore size 110 Å; high density octyl phase, endcapped, 11 % C;
eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_8 Gravity, 1.8 µm							particle size 1.8 µm
EC analytical columns							
2 mm ID	760756.20	760755.20	760760.20	760757.20		760759.20	
3 mm ID	760756.30	760755.30		760757.30			
4 mm ID	760756.40	760755.40		760757.40			
4.6 mm ID	760756.46	760755.46		760757.46			
EC guard columns*		4 x 2 mm: 761905.20		4 x 3 mm: 761905.30			
NUCLEODUR® C_8 Gravity, 5 µm							particle size 5 µm
EC analytical columns							
2 mm ID		760750.20		760754.20	760751.20	760752.20	760753.20
3 mm ID		760750.30		760754.30	760751.30	760752.30	760753.30
4 mm ID		760750.40		760754.40	760751.40	760752.40	760753.40
4.6 mm ID		760750.46	760749.46	760754.46	760751.46	760752.46	760753.46
EC guard columns*		4 x 2 mm: 761907.20		4 x 3 mm: 761907.30			
CC guard columns**		8 x 3 mm: 761754.30		8 x 4 mm: 761754.40			
VarioPrep preparative columns							
10 mm ID		762081.100			762071.100		762070.100
21 mm ID		762081.210			762071.210	762082.210	762070.210
VP guard columns***		10 x 8 mm: 762097.80		10 x 16 mm: 762097.160			

EC and VarioPrep columns in packs of 1, guard columns see right, Microbore columns with NUCLEODUR® C_8 Gravity on request!

NUCLEODUR®

HPLC column systems from MACHEREY-NAGEL

Microbore columns: On request available in lengths of 40, 60, 100, 125, 150, 200, 250 and 300 mm and with 0.05, 0.075, 0.1, 0.15, 0.3, 0.4, 0.5, 0.75, 1.0 and 1.5 mm ID.

EC columns: Analytical ready-to-use columns; available dimensions see page 85.

VarioPrep columns: Preparative columns with axially adjustable endfitting; available dimensions see page 88.

NUCLEODUR® C_{18} Isis

Pore size 110 Å; octadecyl phase with high steric selectivity, polymer modification, 20 % C; eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} Isis, 1.8 µm						particle size 1.8 µm	
EC analytical columns							
2 mm ID	760406.20	760405.20	760396.20	760407.20		760409.20	
3 mm ID	760406.30	760405.30		760407.30			
4 mm ID	760406.40	760405.40		760407.40			
4.6 mm ID	760406.46	760405.46		760407.46			
EC guard columns*		4 x 2 mm: 761910.20		4 x 3 mm: 761910.30			
NUCLEODUR® C_{18} Isis, 3 µm						particle size 3 µm	
Microbore analytical columns							
1 mm ID		717760.10		717761.10	717762.10		
EC analytical columns							
2 mm ID		760400.20		760401.20	760402.20	760403.20	760404.20
3 mm ID		760400.30		760401.30	760402.30	760403.30	760404.30
4 mm ID		760400.40		760401.40	760402.40	760403.40	760404.40
4.6 mm ID		760400.46	760397.46	760401.46	760402.46	760403.46	760404.46
EC guard columns*		4 x 2 mm: 761911.20		4 x 3 mm: 761911.30			
CC guard columns**		8 x 3 mm: 761300.30		8 x 4 mm: 761300.40			
NUCLEODUR® C_{18} Isis, 5 µm						particle size 5 µm	
Microbore analytical columns							
1 mm ID		717770.10		717771.10	717772.10		
EC analytical columns							
2 mm ID		760410.20		760415.20	760412.20	760413.20	760414.20
3 mm ID		760410.30		760415.30	760412.30	760413.30	760414.30
4 mm ID		760410.40		760415.40	760412.40	760413.40	760414.40
4.6 mm ID		760410.46	760416.46	760415.46	760412.46	760413.46	760414.46
EC guard columns*		4 x 2 mm: 761912.20		4 x 3 mm: 761912.30			
CC guard columns**		8 x 3 mm: 761310.30		8 x 4 mm: 761310.40			
VarioPrep preparative columns							
10 mm ID		762404.100			762405.100		762403.100
21 mm ID		762404.210			762405.210		762403.210
32 mm ID							762403.320
40 mm ID						762406.400	762403.400
VP guard columns***		10 x 8 mm: 762420.80		10 x 16 mm: 762420.160		15 x 32 mm: 762422.320	

Microbore, EC, and VarioPrep columns in packs of 1, guard columns see below

Guard column systems **Guard columns for EC columns with ID**		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VarioPrep guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

Packed columns

NUCLEODUR® C_{18} Pyramid

Pore size 110 Å; octadecyl phase with hydrophilic endcapping, 14 % C;
eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} Pyramid, 1.8 µm						particle size 1.8 µm	
EC analytical columns							
2 mm ID	760271.20	760272.20	760275.20	760273.20		760274.20	
3 mm ID	760271.30	760272.30		760273.30			
4 mm ID	760271.40	760272.40		760273.40			
4.6 mm ID	760271.46	760272.46		760273.46			
EC guard columns*		4 x 2 mm: 761915.20		4 x 3 mm: 761915.30			
NUCLEODUR® C_{18} Pyramid, 3 µm						particle size 3 µm	
Microbore analytical columns							
1 mm ID		717740.10		717741.10	717742.10	717743.10	717744.10
EC analytical columns							
2 mm ID		760263.20		760264.20	760260.20	760261.20	760262.20
3 mm ID		760263.30		760264.30	760260.30	760261.30	760262.30
4 mm ID		760263.40		760264.40	760260.40	760261.40	760262.40
4.6 mm ID		760263.46	760259.46	760264.46	760260.46	760261.46	760262.46
EC guard columns*		4 x 2 mm: 761916.20		4 x 3 mm: 761916.30			
CC guard columns**		8 x 3 mm: 761854.30		8 x 4 mm: 761854.40			
NUCLEODUR® C_{18} Pyramid, 5 µm						particle size 5 µm	
Microbore analytical columns							
1 mm ID				717722.10	717723.10	717724.10	717725.10
EC analytical columns							
2 mm ID		760200.20		760204.20	760201.20	760203.20	760202.20
3 mm ID		760200.30		760204.30	760201.30	760203.30	760202.30
4 mm ID		760200.40		760204.40	760201.40	760203.40	760202.40
4.6 mm ID		760200.46	760205.46	760204.46	760201.46	760203.46	760202.46
EC guard columns*		4 x 2 mm: 761917.20		4 x 3 mm: 761917.30			
CC guard columns**		8 x 3 mm: 761800.30		8 x 4 mm: 761800.40			
VarioPrep preparative columns							
10 mm ID		762271.100			762273.100		762272.100
21 mm ID		762271.210			762273.210		762272.210
32 mm ID							762272.320
40 mm ID						762269.400	762272.400
VP guard columns***		10 x 8 mm: 762291.80		10 x 16 mm: 762291.160		15 x 32 mm: 762293.320	

Microbore, EC, and VarioPrep columns in packs of 1, guard columns see right

NUCLEODUR®

NUCLEODUR® PolarTec

Pore size 110 Å; octadecyl phase with embedded polar group, endcapped, 17 % C;
eluent in column acetonitrile – water

Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® PolarTec, 3 µm						particle size 3 µm
EC analytical columns						
2 mm ID	760473.20		760476.20	760477.20	760478.20	760479.20
3 mm ID	760473.30		760476.30	760477.30	760478.30	760479.30
4 mm ID	760473.40		760476.40	760477.40	760478.40	760479.40
4.6 mm ID	760473.46	760475.46	760476.46	760477.46	760478.46	760479.46
EC guard columns*		4 x 2 mm: 761981.20		4 x 3 mm: 761981.30		
CC guard columns**		8 x 3 mm: 761160.30		8 x 4 mm: 761160.40		
NUCLEODUR® PolarTec, 5 µm						particle size 5 µm
EC analytical columns						
2 mm ID	760483.20		760486.20	760487.20	760488.20	760489.20
3 mm ID	760483.30		760486.30	760487.30	760488.30	760489.30
4 mm ID	760483.40		760486.40	760487.40	760488.40	760489.40
4.6 mm ID	760483.46	760485.46	760486.46	760487.46	760488.46	760489.46
EC guard columns*		4 x 2 mm: 761982.20		4 x 3 mm: 761982.30		
CC guard columns**		8 x 3 mm: 761161.30		8 x 4 mm: 761161.40		
VarioPrep preparative columns						
10 mm ID	762220.100			762221.100		762223.100
21 mm ID	762220.210			762221.210		762223.210
32 mm ID						762223.320
40 mm ID					762222.400	762223.400
VP guard columns***	10 x 8 mm: 762224.80		10 x 16 mm: 762224.160		15 x 32 mm: 762226.320	

EC and VarioPrep columns in packs of 1, guard columns see below

Guard column systems						Guard column holder
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VarioPrep guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

Packed columns

NUCLEODUR® PFP

Pore size 110 Å; pentafluorophenyl-propyl modification, multi-endcapped, 8 % C;
eluent in column acetonitrile – water

Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® PFP, 3 µm						particle size 3 µm
EC analytical columns						
2 mm ID	760443.20		760446.20	760447.20	760448.20	760449.20
3 mm ID	760443.30		760446.30	760447.30	760448.30	760449.30
4 mm ID	760443.40		760446.40	760447.40	760448.40	760449.40
4.6 mm ID	760443.46	760445.46	760446.46	760447.46	760448.46	760449.46
EC guard columns*		4 x 2 mm: 761976.20		4 x 3 mm: 761976.30		
CC guard columns**		8 x 3 mm: 761145.30		8 x 4 mm: 761145.40		
NUCLEODUR® PFP, 5 µm						particle size 5 µm
EC analytical columns						
2 mm ID	760453.20		760456.20	760457.20	760458.20	760459.20
3 mm ID	760453.30		760456.30	760457.30	760458.30	760459.30
4 mm ID	760453.40		760456.40	760457.40	760458.40	760459.40
4.6 mm ID	760453.46	760455.46	760456.46	760457.46	760458.46	760459.46
EC guard columns*		4 x 2 mm: 761977.20		4 x 3 mm: 761977.30		
CC guard columns**		8 x 3 mm: 761146.30		8 x 4 mm: 761146.40		
VarioPrep preparative columns						
10 mm ID	762210.100			762211.100		762213.100
21 mm ID	762210.210			762211.210		762213.210
32 mm ID						762213.320
40 mm ID					762212.400	762213.400
VP guard columns***	10 x 8 mm: 762214.80		10 x 16 mm: 762214.160		15 x 32 mm: 762216.320	

EC and VarioPrep columns in packs of 1, guard columns see right

NUCLEODUR®

Online Application Database • *www.mn-net.com/apps*

MACHEREY-NAGEL, one of the leading companies for chromatography products and the manufacturer of well known brands like NUCLEODUR®, NUCLEOSIL®, CHROMABOND®, and OPTIMA® presents its free Online Application Database!

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As one of the pioneers in chromatography MACHEREY-NAGEL is a leading producer of HPLC, GC, SPE and TLC products resulting in this highly informative and helpful collection of applications.

NUCLEODUR® Sphinx RP

Pore size 110 Å; special bifunctional RP phase, 15 % C;
eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® Sphinx RP, 1.8 µm						particle size 1.8 µm	
EC analytical columns							
2 mm ID	760821.20	760822.20	760825.20	760823.20		760824.20	
3 mm ID	760821.30	760822.30		760823.30			
4 mm ID	760821.40	760822.40		760823.40			
4.6 mm ID	760821.46	760822.46		760823.46			
EC guard columns*		4 x 2 mm: 761920.20		4 x 3 mm: 761920.30			
NUCLEODUR® Sphinx RP, 3 µm						particle size 3 µm	
EC analytical columns							
2 mm ID		760806.20		760812.20	760807.20	760805.20	760808.20
3 mm ID		760806.30		760812.30	760807.30	760805.30	760808.30
4 mm ID		760806.40		760812.40	760807.40	760805.40	760808.40
4.6 mm ID		760806.46	760813.46	760812.46	760807.46	760805.46	760808.46
EC guard columns*		4 x 2 mm: 761921.20		4 x 3 mm: 761921.30			
CC guard columns**		8 x 3 mm: 761557.30		8 x 4 mm: 761557.40			
NUCLEODUR® Sphinx RP, 5 µm						particle size 5 µm	
Microbore analytical columns							
1 mm ID		717680.10		717681.10	717682.10	717683.10	717684.10
EC analytical columns							
2 mm ID		760800.20		760809.20	760801.20	760802.20	760803.20
3 mm ID		760800.30		760809.30	760801.30	760802.30	760803.30
4 mm ID		760800.40		760809.40	760801.40	760802.40	760803.40
4.6 mm ID		760800.46	760815.46	760809.46	760801.46	760802.46	760803.46
EC guard columns*		4 x 2 mm: 761922.20		4 x 3 mm: 761922.30			
CC guard columns**		8 x 3 mm: 761550.30		8 x 4 mm: 761550.40			
VarioPrep preparative columns							
10 mm ID		762372.100			762375.100		762373.100
21 mm ID		762372.210			762375.210		762373.210
32 mm ID							762373.320
40 mm ID						762371.400	762373.400
VP guard columns***		10 x 8 mm: 762390.80		10 x 16 mm: 762390.160		15 x 32 mm: 762392.320	

Microbore, EC, and VarioPrep columns in packs of 1, guard columns see below

Guard column systems						
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VarioPrep guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

Packed columns

NUCLEODUR® C_{18} HTec

Pore size 110 Å; high density octadecyl phase, endcapped, 18 % C;
eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} HTec, 1.8 µm							particle size 1.8 µm
EC analytical columns							
2 mm ID	760301.20	760305.20	760304.20	760306.20		760308.20	
3 mm ID	760301.30	760305.30		760306.30			
4 mm ID	760301.40	760305.40		760306.40			
4.6 mm ID	760301.46	760305.46		760306.46			
EC guard columns*		4 x 2 mm: 761925.20		4 x 3 mm: 761925.30			
NUCLEODUR® C_{18} HTec, 3 µm							particle size 3 µm
EC analytical columns							
2 mm ID		760321.20		760323.20	760324.20	760325.20	760326.20
3 mm ID		760321.30		760323.30	760324.30	760325.30	760326.30
4 mm ID		760321.40		760323.40	760324.40	760325.40	760326.40
4.6 mm ID		760321.46	760322.46	760323.46	760324.46	760325.46	760326.46
EC guard columns*		4 x 2 mm: 761926.20		4 x 3 mm: 761926.30			
CC guard columns**		8 x 3 mm: 761120.30		8 x 4 mm: 761120.40			
NUCLEODUR® C_{18} HTec, 5 µm							particle size 5 µm
EC analytical columns							
2 mm ID		760311.20		760313.20	760314.20	760315.20	760316.20
3 mm ID		760311.30		760313.30	760314.30	760315.30	760316.30
4 mm ID		760311.40		760313.40	760314.40	760315.40	760316.40
4.6 mm ID		760311.46	760312.46	760313.46	760314.46	760315.46	760316.46
EC guard columns*		4 x 2 mm: 761927.20		4 x 3 mm: 761927.30			
CC guard columns**		8 x 3 mm: 761110.30		8 x 4 mm: 761110.40			
VarioPrep preparative columns							
10 mm ID		762551.100			762554.100		762556.100
21 mm ID		762551.210		762553.210	762554.210		762556.210
32 mm ID				762553.320		762555.320	762556.320
40 mm ID						762555.400	762556.400
50 mm ID				762553.500		762555.500	762556.500
VP guard columns***		10 x 8 mm: 762591.80		10 x 16 mm: 762591.160			
		15 x 32 mm: 762592.320		15 x 50 mm: 762592.500			
NUCLEODUR® C_{18} HTec, 7 µm							particle size 7 µm
VarioPrep preparative columns							
10 mm ID		762561.100			762564.100		762566.100
21 mm ID		762561.210		762563.210	762564.210		762566.210
32 mm ID				762563.320		762565.320	762566.320
40 mm ID						762565.400	762566.400
50 mm ID				762563.500		762565.500	762566.100
VP guard columns***		10 x 8 mm: 762591.80		10 x 16 mm: 762591.160			
		15 x 32 mm: 762592.320		15 x 50 mm: 762592.500			

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} HTec, 10 µm							particle size 10 µm
VarioPrep preparative columns							
10 mm ID		762571.100			762574.100		762576.100
21 mm ID		762571.210		762573.210	762574.210		762576.210
32 mm ID				762573.320		762575.320	762576.320
40 mm ID						762575.400	762576.400
50 mm ID				762573.500		762575.500	762576.100
VP guard columns***		10 x 8 mm: 762591.80 15 x 32 mm: 762592.320		10 x 16 mm: 762591.160 15 x 50 mm: 762592.500			
EC and VarioPrep columns in packs of 1, guard columns see below							

Guard column systems **Guard columns for EC columns with ID**		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VarioPrep guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

Scale up factors and parameters for typical MN column dimensions

ID x length [mm]	4 x 250	8 x 250	10 x 250	16 x 250	21 x 250	32 x 250	40 x 250	50 x 250	80 x 250
Linear scale-up factor	1	4	6.25	16	28	64	100	161	400
Typical sample mass* [mg]	0.02–2	0.08–8	0.13–13	0.3–35	0.6–60	1.3–130	2–210	3–350	10–850
Typical flow rate [ml/min]	0.5–1.5	2–6	3–9	8–24	14–40	32–96	50–150	80–250	200–600

* For RP material; the maximum amounts given here always depend on the separation problem and on the sample composition. In some cases even half of the amounts given can cause drastic overload, in other cases the maximum amounts can be even higher still giving acceptable separations.

Packed columns

NUCLEODUR® C_{18} ec

Pore size 110 Å; octadecyl phase, endcapped, 17.5 % C;
eluent in column acetonitrile – water

Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3 C_{18} ec						particle size 3 µm
EC analytical columns						
2 mm ID	760050.20		760054.20	760051.20	760053.20	760052.20
3 mm ID	760050.30		760054.30	760051.30	760053.30	760052.30
4 mm ID	760050.40		760054.40	760051.40	760053.40	760052.40
4.6 mm ID	760050.46	760046.46	760054.46	760051.46	760053.46	760052.46
EC guard columns*		4 x 2 mm: 761931.20		4 x 3 mm: 761931.30		
CC guard columns**		8 x 3 mm: 761005.30		8 x 4 mm: 761005.40		
NUCLEODUR® 100-5 C_{18} ec						particle size 5 µm
Microbore analytical columns						
1 mm ID			717701.10	717700.10	717702.10	717703.10
EC analytical columns						
2 mm ID	760004.20		760013.20	760001.20	760008.20	760002.20
3 mm ID	760004.30		760013.30	760001.30	760008.30	760002.30
4 mm ID	760004.40		760013.40	760001.40	760008.40	760002.40
4.6 mm ID	760004.46	760035.46	760013.46	760001.46	760008.46	760002.46
EC guard columns*		4 x 2 mm: 761932.20		4 x 3 mm: 761932.30		
CC guard columns**		8 x 3 mm: 761100.30		8 x 4 mm: 761100.40		
VarioPrep preparative columns						
10 mm ID	762003.100			762029.100		762022.100
21 mm ID	762003.210			762029.210		762022.210
32 mm ID						762022.320
40 mm ID					762027.400	762022.400
VP guard columns***		10 x 8 mm: 762090.80 15 x 32 mm: 762311.320		10 x 16 mm: 762090.160 15 x 50 mm: 762311.500		
NUCLEODUR® 100-10 C_{18} ec						particle size 10 µm
VarioPrep preparative columns						
10 mm ID	762011.100			762302.100		762010.100
21 mm ID	762011.210			762302.210		762010.210
32 mm ID						762010.320
40 mm ID					762303.400	762010.400
50 mm ID						762010.500
VP guard columns***		10 x 8 mm: 762090.80 15 x 32 mm: 762311.320		10 x 16 mm: 762090.160 15 x 50 mm: 762311.500		

Microbore, EC, and VarioPrep columns in packs of 1, guard columns see right

NUCLEODUR® C_8 ec

Pore size 110 Å; octyl phase, endcapped, 10.5 % C;
eluent in column acetonitrile – water

Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3 C_8 ec						particle size 3 µm
EC analytical columns						
2 mm ID	760063.20		760059.20	760060.20		760062.20
3 mm ID	760063.30		760059.30	760060.30		760062.30
4 mm ID	760063.40		760059.40	760060.40		760062.40
4.6 mm ID	760063.46	760064.46	760059.46	760060.46	760061.46	760062.46
EC guard columns*		4 x 2 mm: 761936.20		4 x 3 mm: 761936.30		
CC guard columns**		8 x 3 mm: 761012.30		8 x 4 mm: 761012.40		
NUCLEODUR® 100-5 C_8 ec						particle size 5 µm
EC analytical columns						
2 mm ID	760700.20		760704.20	760701.20		760703.20
3 mm ID	760700.30		760704.30	760701.30		760703.30
4 mm ID	760700.40		760704.40	760701.40		760703.40
4.6 mm ID	760700.46	760706.46	760704.46	760701.46	760702.46	760703.46
EC guard columns*		4 x 2 mm: 761937.20		4 x 3 mm: 761937.30		
CC guard columns**		8 x 3 mm: 761704.30		8 x 4 mm: 761704.40		
VarioPrep preparative columns						
10 mm ID	762072.100			762061.100		762062.100
21 mm ID	762072.210			762061.210		762062.210
32 mm ID						762062.320
40 mm ID					762079.400	762062.400
VP guard columns***	10 x 8 mm: 762092.80		10 x 16 mm: 762092.160		15 x 32 mm: 762321.320	

EC and VarioPrep columns in packs of 1, guard columns see below, Microbore columns with NUCLEODUR® C_8 ec on request!

Guard column systems						Guard column holder
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VarioPrep guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

Packed columns

NUCLEODUR® HILIC

Pore size 110 Å; zwitterionic phase for HILIC chromatography, 7 % C;
eluent in column acetonitrile – water 80:20

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® HILIC, 1.8 µm							particle size 1.8 µm
EC columns							
2 mm ID	760521.20	760523.20	760525.20	760526.20		760528.20	
3 mm ID	760521.30	760523.30		760526.30			
4 mm ID	760521.40	760523.40		760526.40			
4.6 mm ID	760521.46	760523.46		760526.46			
EC guard columns*		4 x 2 mm: 761960.20		4 x 3 mm: 761960.30			
NUCLEODUR® HILIC, 3 µm							particle size 3 µm
EC columns							
2 mm ID		760532.20		760534.20	760531.20		760530.20
3 mm ID		760532.30		760534.30	760531.30		760530.30
4 mm ID		760532.40		760534.40	760531.40		760530.40
4.6 mm ID		760532.46		760534.46	760531.46	760533.46	760530.46
EC guard columns*		4 x 2 mm: 761961.20		4 x 3 mm: 761961.30			
CC guard columns**		8 x 3 mm: 761580.30		8 x 4 mm: 761580.40			
NUCLEODUR® HILIC, 5 µm							particle size 5 µm
EC columns							
2 mm ID		760552.20		760554.20	760551.20		760550.20
3 mm ID		760552.30		760554.30	760551.30		760550.30
4 mm ID		760552.40		760554.40	760551.40		760550.40
4.6 mm ID		760552.46		760554.46	760551.46	760553.46	760550.46
EC guard columns*		4 x 2 mm: 761962.20		4 x 3 mm: 761962.30			
CC guard columns**		8 x 3 mm: 761590.30		8 x 4 mm: 761590.40			

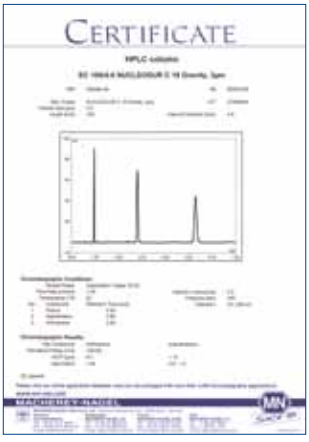
Columns in packs of 1, guard columns see right, Microbore columns and preparative columns with NUCLEODUR® HILIC on request!

NUCLEODUR®

Our HPLC QC policy

- **Highest production standard**
  our facilities are EN ISO 9001:2008 certified
- **Strict quality specifications** for outstanding reliability
- **Perfect reproducibility** within each batch and from lot to lot

- Each column is individually tested and supplied with test chromatogram and test conditions



Test mixture for reversed phase columns

Designation	Pack of	REF
Test mixture for reversed phase columns in acetonitrile	1 ml	722394

NUCLEODUR® CN and CN-RP

Pore size 110 Å; cyano phase (nitrile), 7 % C

Length →	50 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3 CN-RP	particle size 3 µm; **eluent in column acetonitrile – water**			
EC columns				
2 mm ID	760159.20	760157.20		
3 mm ID		760157.30		
4 mm ID			760156.40	
4.6 mm ID			760156.46	
EC guard columns*	4 x 2 mm: 761941.20		4 x 3 mm: 761941.30	
CC guard columns**	8 x 3 mm: 761430.30		8 x 4 mm: 761430.40	
NUCLEODUR® 100-5 CN-RP	particle size 5 µm; **eluent in column acetonitrile – water**			
EC columns				
4 mm ID		760153.40		760152.40
4.6 mm ID		760153.46	760154.46	760152.46
EC guard columns*			4 x 3 mm: 761944.30	
CC guard columns**			8 x 4 mm: 761420.40	
NUCLEODUR® 100-5 CN	particle size 5 µm; **eluent in column *n*-heptane**			
EC columns				
4 mm ID		760151.40	760149.40	760150.40
4.6 mm ID		760151.46	760149.46	760150.46
EC guard columns*			4 x 3 mm: 761943.30	
CC guard columns**			8 x 4 mm: 761419.40	

Columns in packs of 1, guard columns see below, Microbore columns and preparative columns with NUCLEODUR® CN / CN-RP on request!

Guard column systems **Guard columns for EC columns with ID**		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VarioPrep guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

Packed columns

NUCLEODUR® NH_2 and NH_2-RP

Pore size 110 Å; amino phase, 2.5 % C

Length →	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3 NH_2-RP		particle size 3 µm; **eluent in column acetonitrile – water**		
EC columns				
2 mm ID	760740.20	760741.20		
4.6 mm ID			760742.46	760739.46
EC guard columns*	4 x 2 mm: 761951.20		4 x 3 mm: 761951.30	
CC guard columns**	8 x 3 mm: 761035.30		8 x 4 mm: 761035.40	
NUCLEODUR® 100-5 NH_2-RP		particle size 5 µm; **eluent in column acetonitrile – water**		
EC columns				
2 mm ID		760730.20		760732.20
3 mm ID		760730.30		760732.30
4 mm ID		760730.40		760732.40
4.6 mm ID		760730.46	760731.46	760732.46
EC guard columns*	4 x 2 mm: 761953.20		4 x 3 mm: 761953.30	
CC guard columns**	8 x 3 mm: 761137.30		8 x 4 mm: 761137.40	
NUCLEODUR® 100-5 NH_2		particle size 5 µm; **eluent in column *n*-heptane**		
EC columns				
4 mm ID		760720.40		760722.40
4.6 mm ID		760720.46	760721.46	760722.46
EC guard columns*			4 x 3 mm: 761952.30	
CC guard columns**			8 x 4 mm: 761130.40	

Columns in packs of 1, guard columns see page 83, Microbore and preparative columns with NUCLEODUR® NH_2 / NH_2-RP on request!

Unmodified NUCLEODUR®

Pore size 110 Å; unmodified;
eluent in column *n*-heptane

Length →	50 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3				particle size 3 µm
EC analytical columns				
4.6 mm ID	760170.46		760172.46	760173.46
EC guard columns*			4 x 3 mm: 761966.30	
CC guard columns**			8 x 4 mm: 761007.40	
NUCLEODUR® 100-5				particle size 5 µm
EC analytical columns				
4 mm ID				760007.40
4.6 mm ID	760023.46		760012.46	760007.46
EC guard columns*			4 x 3 mm: 761967.30	
CC guard columns**			8 x 4 mm: 761055.40	
VarioPrep preparative columns				
10 mm ID	762077.100	762078.100		762007.100
21 mm ID	762077.210	762078.210		762007.210
40 mm ID			762075.400	762007.400
VP guard columns***	10 x 8 mm: 762094.80	10 x 16 mm: 762094.160		15 x 32 mm: 762330.320

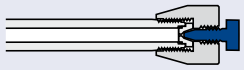
Columns in packs of 1, guard columns see page 83, Microbore columns with unmodified NUCLEODUR® on request!

EC standard columns for analytical HPLC

Features

- Analytical column system manufactured from stainless steel
  M 8 outer threads on both ends
  Combination of sealing element and very fine-meshed stainless steel screen, PTFE ring and fitting adapter
  Column heads SW 12, with inner threads M8 x 0.75 and UNF 10-32 (= 1/16" fitting)
- As screw-on guard column system we recommend the **Column Protection System** used with EC guard column cartridges with 4 mm length (see page 86).
- As built-in guard columns ChromCart® guard column cartridges with 8 mm length can be used with the guard column adapter EC (see page 87).
- Supplied with NUCLEODUR®, NUCLEOSHELL and NUCLEOSIL® spherical silicas

Available standard dimensions of EC columns

ID [mm]	Length [mm] 20	30	50	75	100	125	150	200	250	300	End fitting design
2	+	+	+	+	+	+	+	+	+	+	
3	+	+	+	+	+	+	+	+	+	+	
4	+	+	+	+	+	+	+	+	+	+	
4.6	+	+	+	+	+	+	+	+	+	+	

Please ask for availability of certain phases

Guard columns for EC columns

(pack of 3 each)		EC columns with ID 2 mm	3 mm	4 mm	4.6 mm	Use guard column holder
EC guard columns for Column Protection System guard column holder	EC	4/2	4/3	4/3	4/3	REF 718966
ChromCart® guard columns for EC guard column holder	CC	8/3	8/3	8/4	8/4	REF 721359

Guard column systems, accessories and replacement parts for EC columns · Ordering information

Description	Pack of	REF	
Column Protection System	**1 kit**	**718966**	**see figures and description on page 86**
Guard column adapter EC	**1**	**721359**	**see figures and description on page 87**
EC fitting adapter	1	718987	
EC column head (nut)	1	718988	
EC PTFE sealing ring	4	718992	
3-part sealing combination for EC columns	5 kits	718998	

Packed columns

Column Protection System

Innovative and universal screw-on guard column holder system
Suitable for all analytical HPLC columns with 1/16" fittings

Features

- Cartridges filled with specified NUCLEODUR®, NUCLEOSIL® and NUCLEOSHELL HPLC adsorbents
- Ideal protection for your analytical main column → significant increase in column lifetime
- Minimized void volume → suitable also for ultra fast HPLC
- Special ferrules → pressure stability up to 1034 bar (15 000 psi)
- Visual contamination check → in-time changing of the guard column
- Guard column length 4 mm, ID 2 mm (for main columns with 2 mm ID) or ID 3 mm (for main columns with 3, 4 and 4.6 mm ID)
- UNIVERSAL RP guard columns suitable for all HPLC columns under RP conditions

Content of the Column Protection System

Description	REF
Column Protection System	718966
Details	**Content**
Cartridge Holder	1
Capillaries	2
Ferrules	3
Wrenches	2
Manual	1

Replacement parts for the Column Protection System • Ordering information

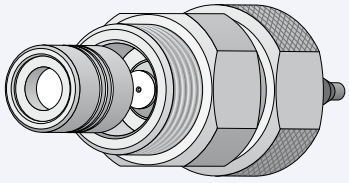
Description	Pack of	REF
Ferrules	5	718967
Replacement connector including O-ring	1	718968
Capillary tubes, nuts and metal ferrules	3	718969
Wrench (size 12 and 14 mm)	1	718970
EC 4/2 UNIVERSAL RP guard column (for main columns with 2 mm ID)	3	728777.20
EC 4/3 UNIVERSAL RP guard column (for main columns with 3, 4 and 4.6 mm ID)	3	728777.30

Visual Contamination Check

The cartridge is fitted with a white filter membrane:

A discoloration of the filter membrane usually indicates that the cartridge should be replaced.

In case of colorless contaminants, a rising back pressure and / or loss of chromatographic performance advise to change the guard column.

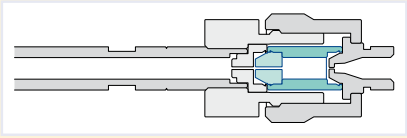


EC guard column adapter

Standard guard column built-in adapter system
Suitable for EC columns

Features

- Cartridges filled with specified NUCLEODUR® and NUCLEOSIL® HPLC adsorbents
- Ideal protection for your analytical EC main column → significant increase of column lifetime
- Guard column length 8 mm, ID 3 mm (for main columns with 2 and 3 mm ID) or ID 4 mm (for main columns with 4 and 4.6 mm ID)



EC guard column adapter · Ordering information

Description	Pack of	REF
EC guard column adapter	1	721359

Installation of the EC guard column adapter

1. Unscrew the column head
2. Remove the fitting
3. Unscrew the EC guard column adapter

4. Screw the adapter sleeve onto the column
5. Insert the CC guard column
6. Screw the nut of the guard column adapter in place

Packed columns

VarioPrep (VP) columns for preparative HPLC

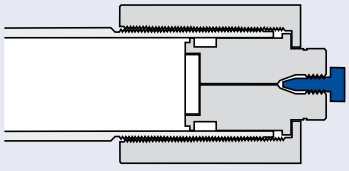
Features

- Column system for preparative HPLC manufactured from stainless steel with two adjustable end fittings, e.g. for frequent use of back-flushing techniques
- Allows compensation of a dead volume, which could result at the column inlet after some time of operation, without need for opening the column
- Supplied with all NUCLEODUR® and NUCLEOSIL® spherical silicas

Available standard dimensions of VarioPrep columns with axially adjustable end fittings

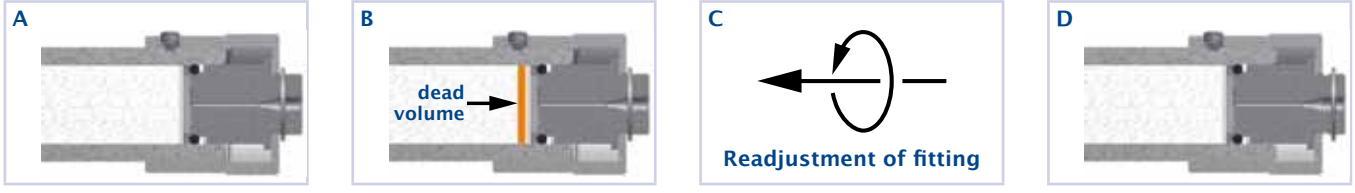
ID [mm]	Length [mm] 10*	15*	50	75	100	125	150	250	500
8	+		+		+	+	+	+	
10			+		+	+	+	+	
16	+		+		+	+	+	+	
21			+	+	+	+	+	+	
32		+			+		+	+	
40			+		+	+	+	+	+
50		+			+		+	+	
80								+	+

End fitting design



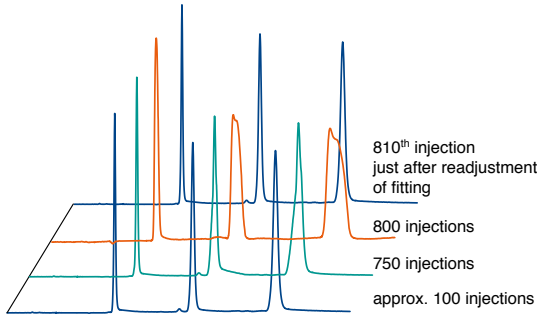
* 10 x 8, 10 x 16, 15 x 32 and 15 x 50 mm ID columns are used as guard columns and require adequate holders, see page 89.

The VarioPrep principle



Based on our special packing procedure VarioPrep columns are produced with highest packing quality and bed density (A). Due to intensively chemical and/or mechanical exposure of the column adsorbent, shrinking of the column bed can occur (B; orange gap). In this even unlikely case readjustment of the VarioPrep column fitting (C; turning the nut at column inlet clockwise) will eliminate the emerged dead volume (D). The performance of the VarioPrep column is completely reconstituted and column lifetime is significantly extended.

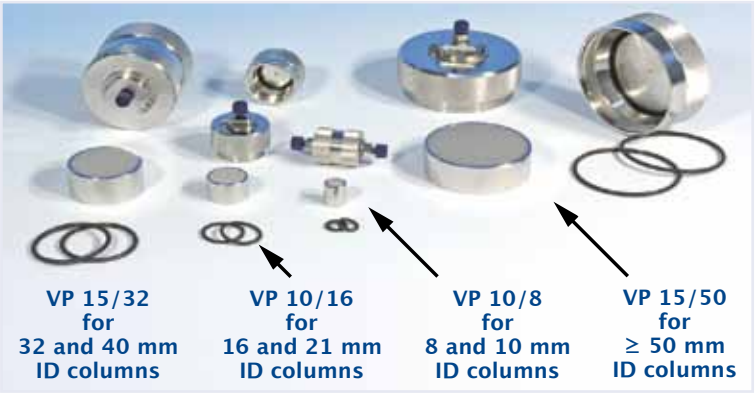
Column Reconstitution



Reconstitution of VarioPrep column performance

- Slight peak broadening and deformation after 800 injections under strongly demanding conditions (pH 11; 50 °C; sample in DMSO)
- Readjustment of the column fitting restores the column performance and prolongs column lifetime noticeably

NUCLEODUR®

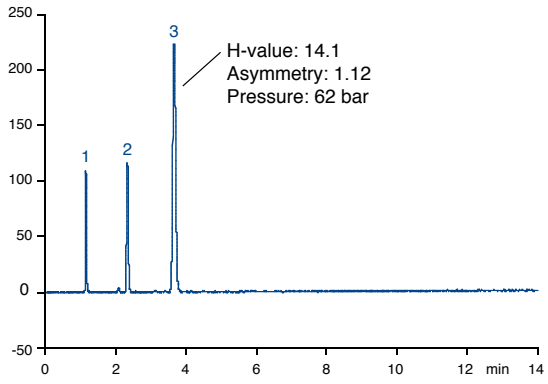


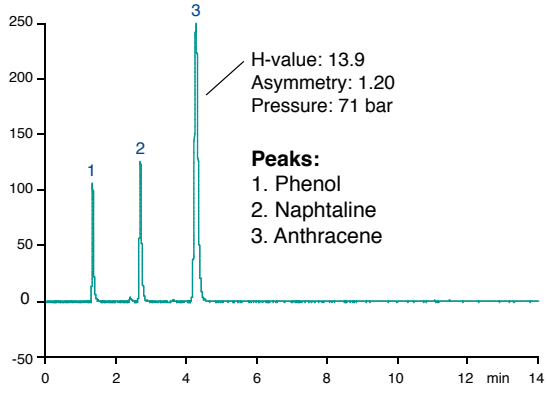
The new guard column system for (semi-) preparative HPLC

- Easy handling and cartridge exchange
- Robust hardware
- Free rotary plunger fittings – low O-ring abrasion
- Cost-efficient cartridges
- Minimally invasive / no disturbance of the separation efficiency of main column
- Low back pressure
- Designed for pressures up to 400 bar

Performance of preparative column when used with VarioPrep guard column

Columns: **125 x 16 mm NUCLEODUR® C_{18} HTec, 5 µm**
125 x 16 mm NUCLEODUR® C_{18} HTec, 5 µm + 10 x 16 mm NUCLEODUR® C_{18} HTec guard column
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 16 mL/min
Temperature: 22 °C





Using VarioPrep guard columns provides ideal protection of your main column – symmetry, pressure and retention stay almost constant.

Technical data

1/16" thread · free rotary plunger fittings – low O-ring abrasion · stainless steel

Guard cartridge	Holder	Holder ID	Replacement O-ring (2 pcs)	Recommended for column ID	Preferred capillary ID	Typical flow rate
VP 10/8	REF 718251	8 mm	REF 718975	8 and 10 mm ID	0.17 and 0.25 mm	1–12 mL/min
VP 10/16	REF 718256	16 mm	REF 718976	16 and 21 mm ID	0.17, 0.25 and 0.5 mm	2–32 mL/min
VP 15/32	REF 718253	32 mm	REF 718977	32 and 40 mm ID	0.25, 0.5 and 1.0 mm	5–150 mL/min
VP 15/50	REF 718255	50 mm	REF 718978	≥ 50 mm ID	0.5 and 1.0 mm	20–250 mL/min

Guard columns for VarioPrep columns · Ordering information

		VP columns with ID				Use guard column holder	Holder ID
		8, 10 mm	16, 21 mm	32, 40 mm	≥ 50 mm		
VP guard columns for VarioPrep guard column holder (pack of)	VP	10/8 (2)				REF 718251	8 mm
	VP		10/16 (2)			REF 718256	16 mm
	VP			15/32 (1)		REF 718253	32 mm
	VP				15/50 (1)	REF 718255	50 mm

HPLC

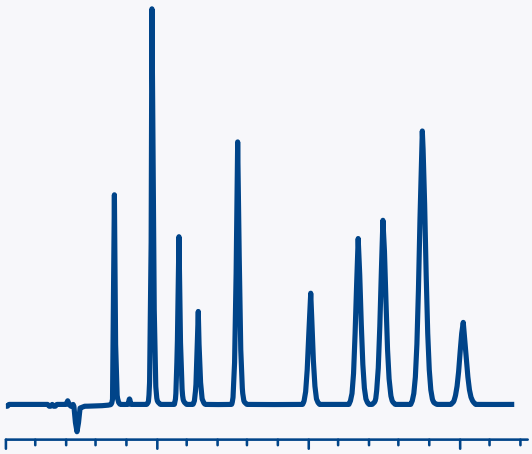
GC

TLC

SPE & Flash

Syringe Filters

Vials



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