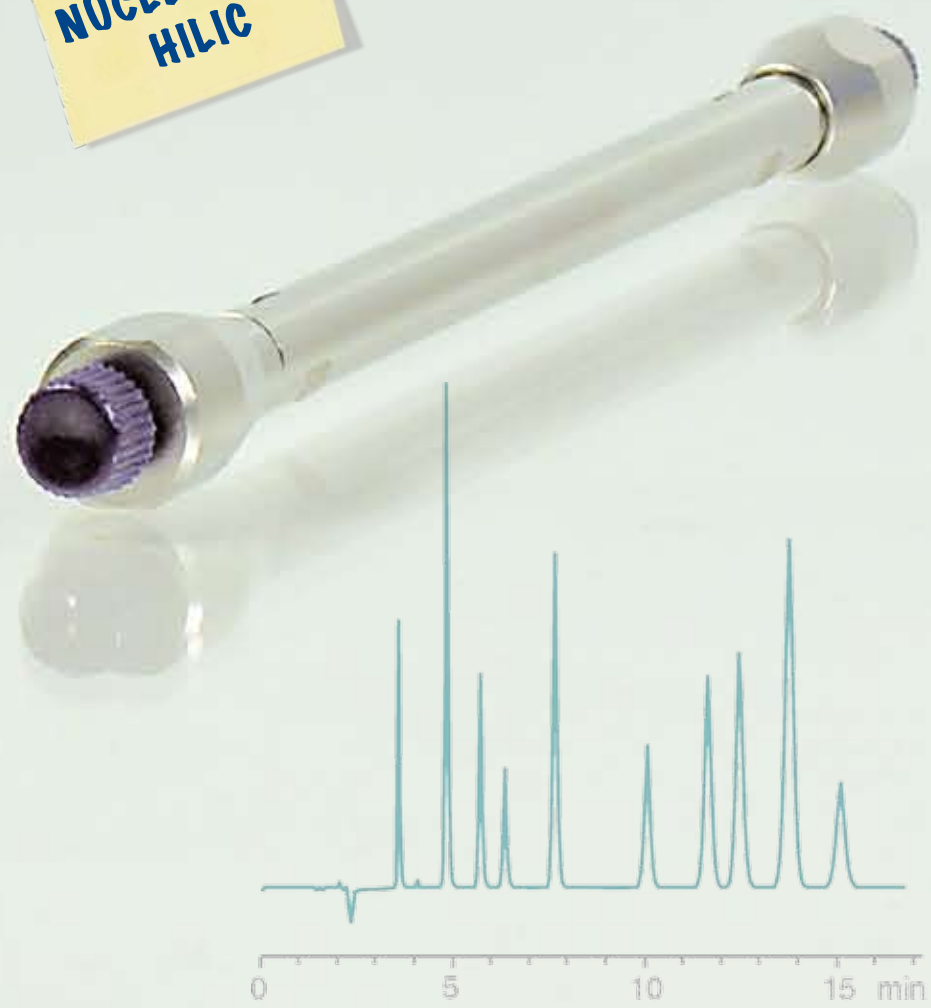
Chromatography

NUCLEODUR®

Professional Solutions for HPLC

NEW NUCLEODUR® HILIC



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

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The MACHEREY-NAGEL internet pages with integrated webshop (in selected countries only) are full of useful information about our wide range of products. Our online database offers more than 3000 applications which might actually already solve your analytical questions.

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Ask for our application guides

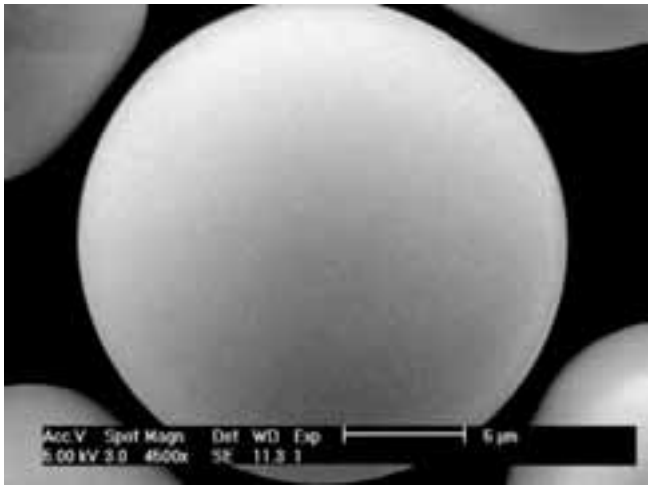
NUCLEODUR®

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 pictures show the uniform particle size distribution and the outstanding smoothness of the NUCLEODUR® surface is emphasized.

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 50).

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

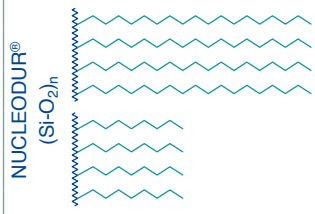
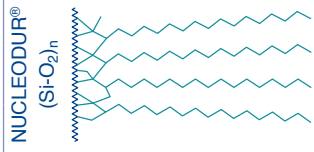
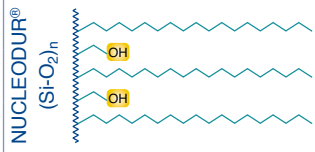
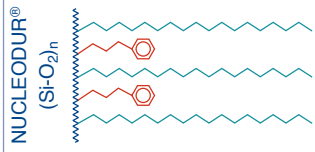
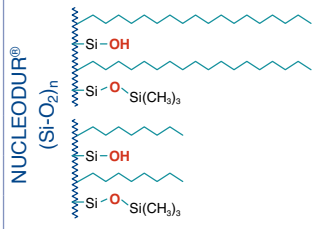
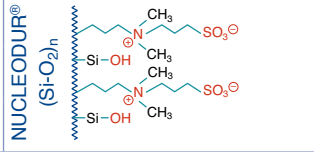
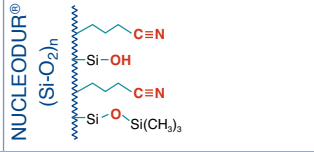
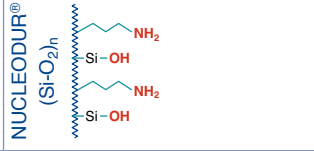
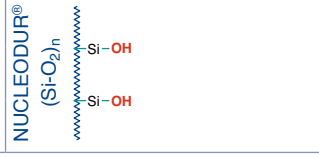
NUCLEODUR® Modifications

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® Sphinx RP
- NUCLEODUR® C_{18} ec and C_8 ec
- NUCLEODUR® HILIC
- NUCLEODUR® CN and CN-RP
- NUCLEODUR® NH_2 and NH_2-RP
- unmodified NUCLEODUR®

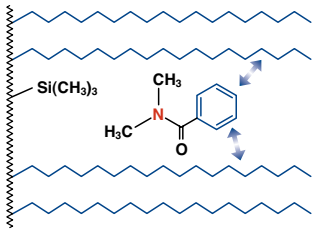
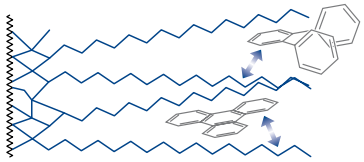
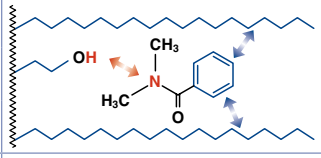
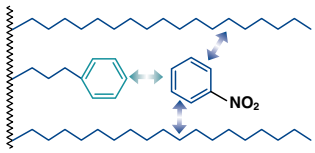
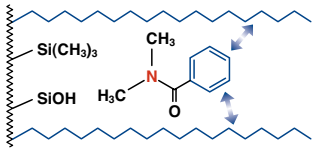
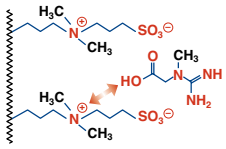
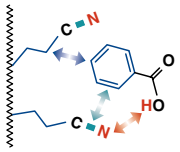
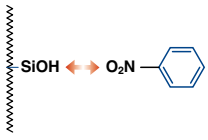
All phases are described in detail on the following pages.

Overview of NUCLEODUR® HPLC Phases

Phase	Specification	Characteristics*			Stability	Structure
C_{18} / C_8 Gravity	octadecyl phase, high density coating multi-endcapping C_{18} Gravity: 18 % C · USP **L1** C_8 Gravity: 11 % C · USP **L7**	A	C_{18}	⬢⬢⬢⬢⬢	pH stability 1 – 11, suitable for LC/MS	
			C_8	⬢⬢◖		
		B	C_{18}	◖		
			C_8	⬢		
		C	C_{18}	⬢⬢◖		
			C_8	⬢◖		
C_{18} Isis	octadecyl phase with specially crosslinked surface modification endcapping 20 % C · USP **L1**	A		⬢⬢⬢⬢◖	pH stability 1 – 10, suitable for LC/MS	
		B		⬢⬢		
		C		⬢⬢⬢⬢⬢		
C_{18} Pyramid	C_{18} modification with polar endcapping 14 % C · USP **L1**	A		⬢⬢⬢⬢	stable against 100 % aqueous eluents, pH stability 1 – 9, suitable for LC/MS	
		B		⬢⬢◖		
		C		⬢⬢		
Sphinx RP	bifunctional RP phase, propylphenyl and C_{18} ligands; endcapping 15 % C; USP **L1** and **L11**	A		⬢⬢⬢	pH stability 1 – 10, suitable for LC/MS	
		B		⬢⬢◖		
		C		⬢		
C_{18} ec C_8 ec	octadecyl / octyl phase, medium density coating endcapping C_{18} ec: 17.5 % C · USP **L1** C_8 ec: 10.5 % C · USP **L7**	A	C_{18}	⬢⬢⬢⬢	pH stability 1 – 9	
			C_8	⬢⬢		
		B	C_{18}	⬢		
			C_8	⬢◖		
		C	C_{18}	⬢⬢⬢◖		
			C_8	⬢⬢◖		
HILIC	zwitterionic ammonium sulfonic acid modification 7 % C	A		⬢	pH stability 2 – 8.5, suitable for LC/MS	
		B		⬢⬢⬢⬢⬢		
		C		–		
CN / CN-RP	cyano (nitrile) phase for NP and RP separations 7 % C · USP **L10**	A		⬢	pH stability 1 – 8, stable towards highly aqueous mobile phases	
		B		⬢⬢⬢⬢		
		C		–		
NH_2 / NH_2-RP	amino phase for NP and RP separations 2.5 % C · USP **L8**	A		⬢	pH stability 1 – 8, stable towards highly aqueous mobile phases	
		B		⬢⬢⬢⬢		
		C		–		
SiOH	unmodified high purity silica USP **L3**	A		–	pH stability 2 – 8	
		B		n.a.		
		C		–		

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

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 for C_8 Gravity generally shorter retention times for nonpolar compounds	**NUCLEOSIL® C_{18} HD** Waters Xterra® RP_{18} / MS C_{18}; Phenomenex Luna C18 (2), Synergi™ and Max RP; Zorbax Extend C18; Inertsil ODS III; Purospher RP-18; Star RP-18 **NUCLEOSIL® C_8 HD;** Waters Xterra® RP_8 / MS C_8; Phenomenex 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; YMC Pro C18RS	**steric interactions** and **hydrophobic interactions**	
basic pharmaceutical ingredients, very polar compounds, organic acids	Phenomenex Aqua; YMC AQ; Waters Atlantis® dC18	**hydrophobic interactions** and **polar interactions** (H bonds)	
compounds with aromatic and multiple bond systems	no similar phases	**π-π interactions** and **hydrophobic interactions**	
robust C_{18} / C_8 phase for routine analyses	**NUCLEOSIL® C_{18}** Spherisorb® ODS II; Hypersil ODS; Waters Symmetry® C18; Inertsil ODS II; Kromasil C18; LiChrospher RP 18 **NUCLEOSIL® C_8 ec / C_8** Spherisorb® C8; Hypersil MOS; Waters Symmetry® C8; Kromasil C8; 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	Merck Sequant ZIC®-HILIC; Sielc 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

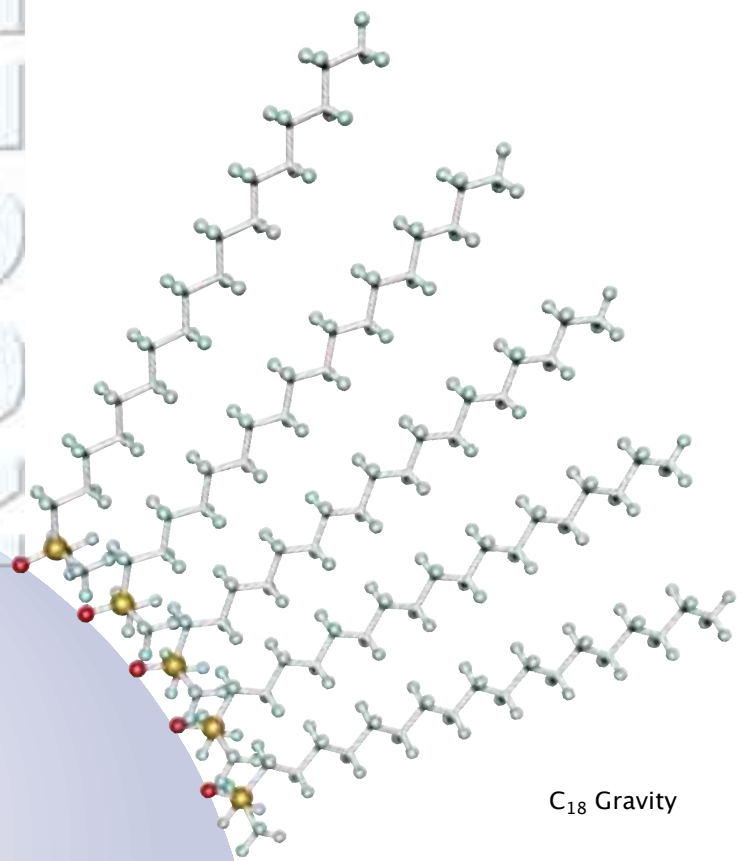
1.8 µm Particle Size

- **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

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 the new 1.8 µm NUCLEODUR® particles now 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.



C_{18} Gravity

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**

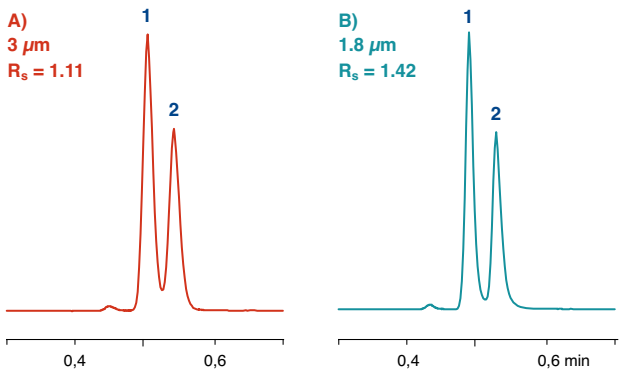
  Use of 1.8 µm instead of 3 µm particles leads to an increase of resolution by a factor 1.29 (29%) since the resolution is inversely proportional to the square root of the particle size:

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

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

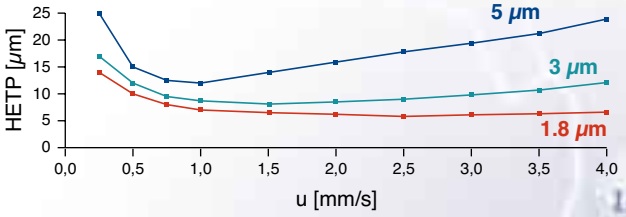
	NUCLEODUR® C_{18} Gravity	Competitor A
3 µm	70 bar	–
1.8 µm	130 bar	170 bar

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

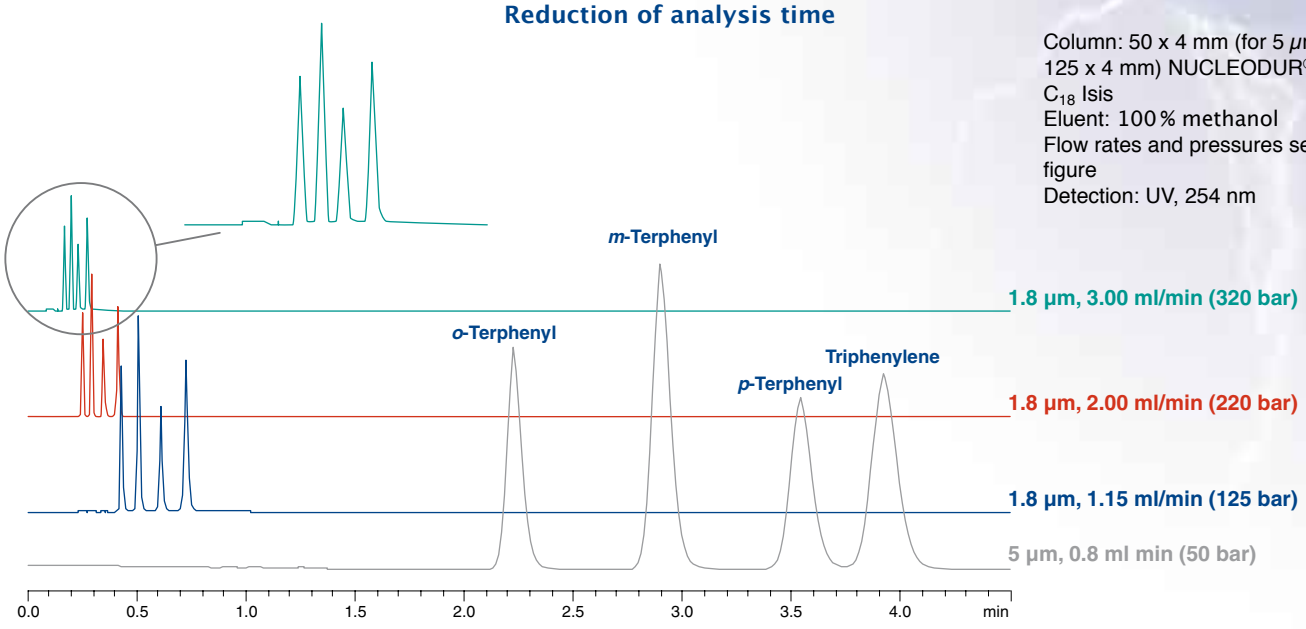
To gain the best result in ultra fast HPLC based on 1.8 µm particles certain technical demands on the instrument are made. Pumps for pressures of 250 – 1000 bar realizing a flow rate of 2 – 3 ml are required. The dead volume of the LC system has to be reduced to a minimum. In addition, fast data recording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

Currently all NUCLEODUR® premium phases (C_{18} Gravity, C_8 Gravity, C_{18} Isis, C_{18} Pyramid, Sphinx RP) 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 application section from page 24.

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



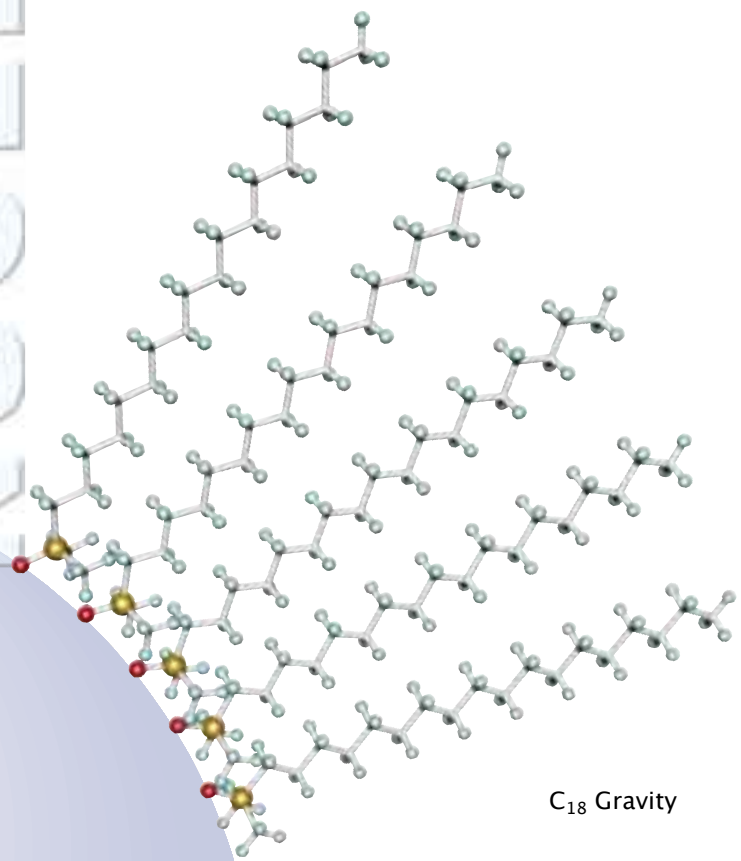
C_{18} Gravity · C_8 Gravity

- **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)
  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 so far: pharmaceuticals, e.g. analgesics, antiinflammatory 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, which is described above.

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 17.



C_{18} Gravity

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)

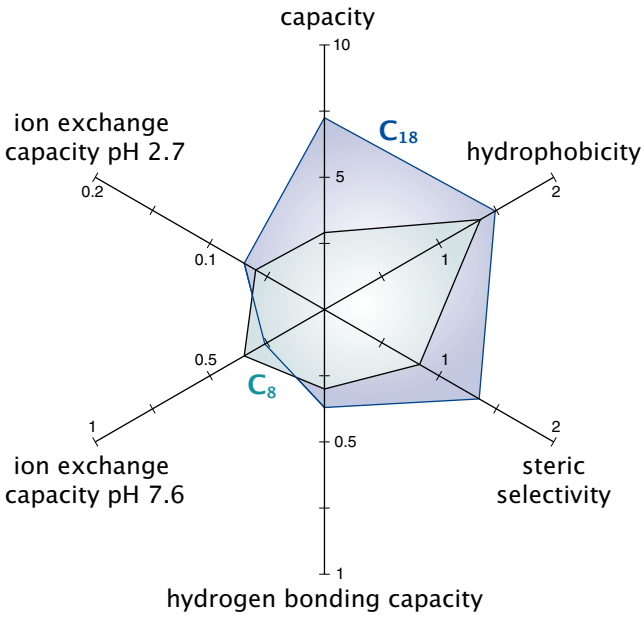
Steric selectivity = α(triphenylene, *o*-terphenyl)

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

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

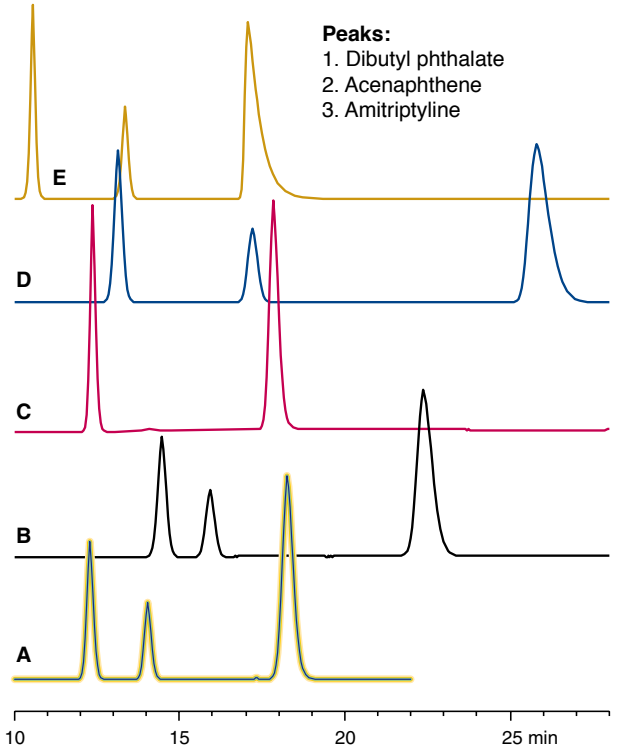
The resulting Tanaka plots are shown with the respective phases.

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

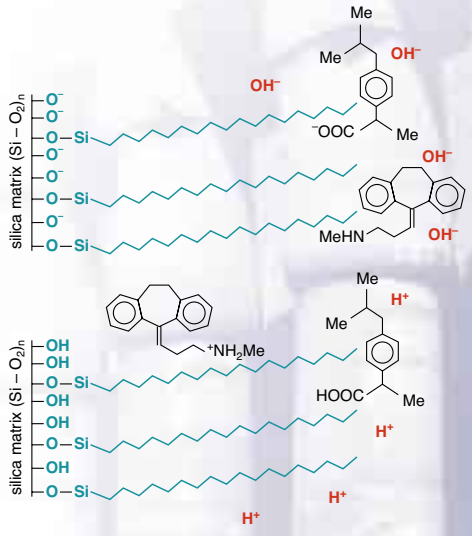
Enhanced pH stability

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?

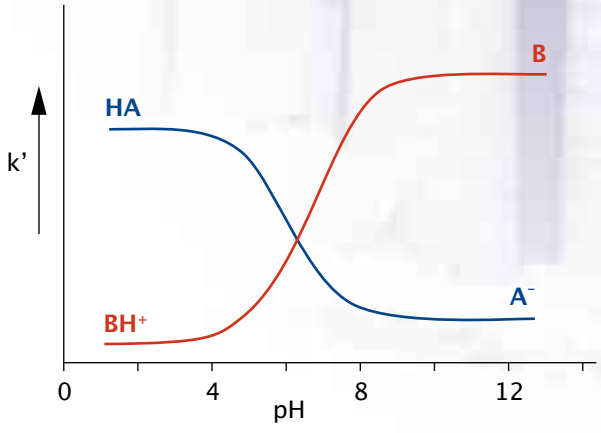
The option to work at an expanded pH range is often required in method development. Many nitrogen containing compounds like basic drugs are protonated at acidic or neutral pH and exhibit poor retention on a standard C_{18} phase. The retention behavior can be improved by working at a higher pH, where 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



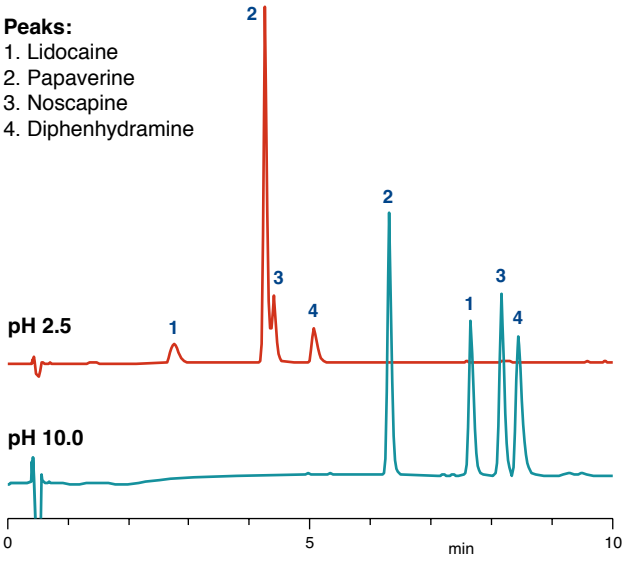
C_{18} Gravity · C_8 Gravity

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

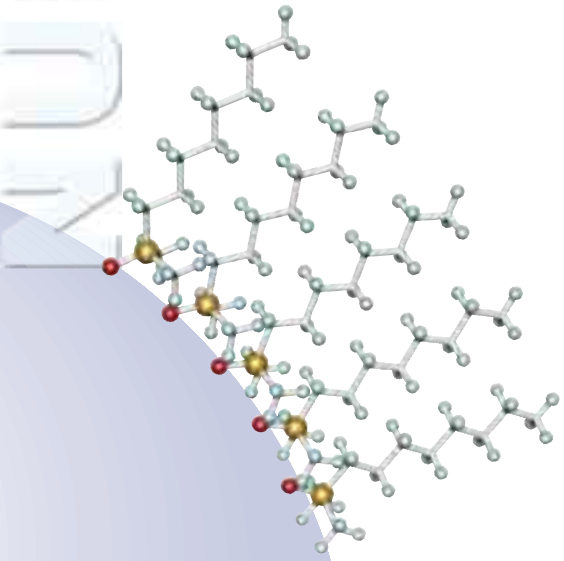
Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent A: acetonitrile
Eluent B: 20 mM $(NH_4)_2HPO_4$, pH 2.5 / 10.0
Gradient: 10 % A (1 min) → 75 % A in 10 min
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 2 µl

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.



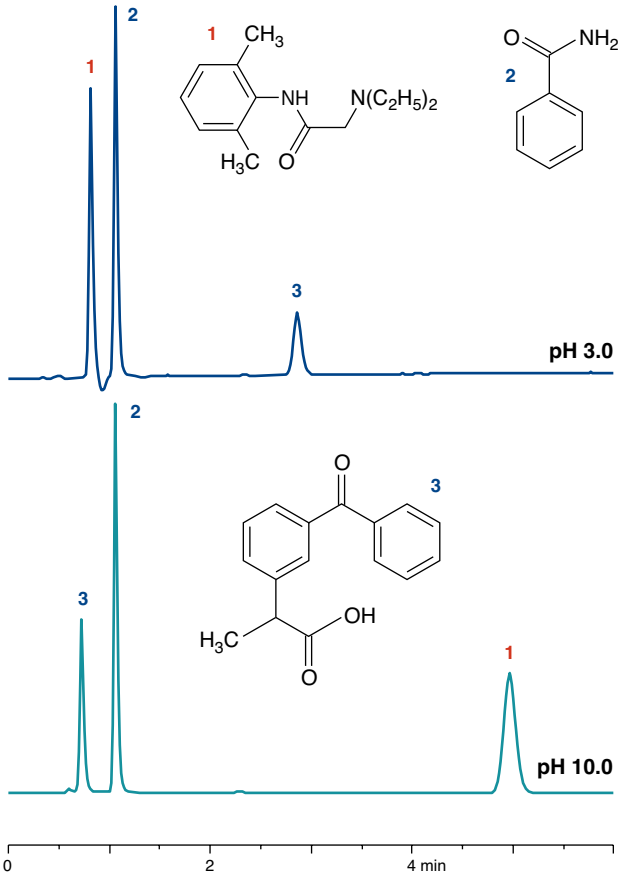
C_8 Gravity

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® C18 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



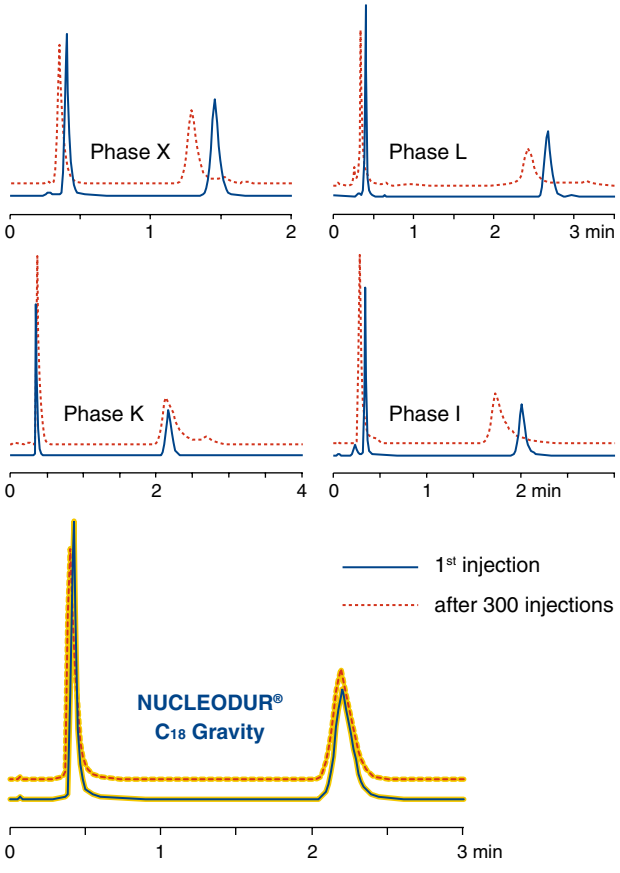
MN Appl. No. 120860

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

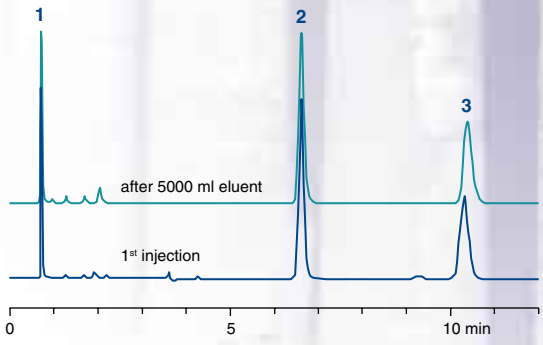
The pH stability of silica under alkaline conditions is mainly a kinetic effect and based on the velocity of the dissolution of the silica support. It is worth mentioning, that this phenomenon also depends on type and concentration of buffers, as well as on the temperature. It is well known, that the 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 13. Some general selection criteria and principals of different retention and selectivity of C18 and C8 columns can be found on page 17.

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 %

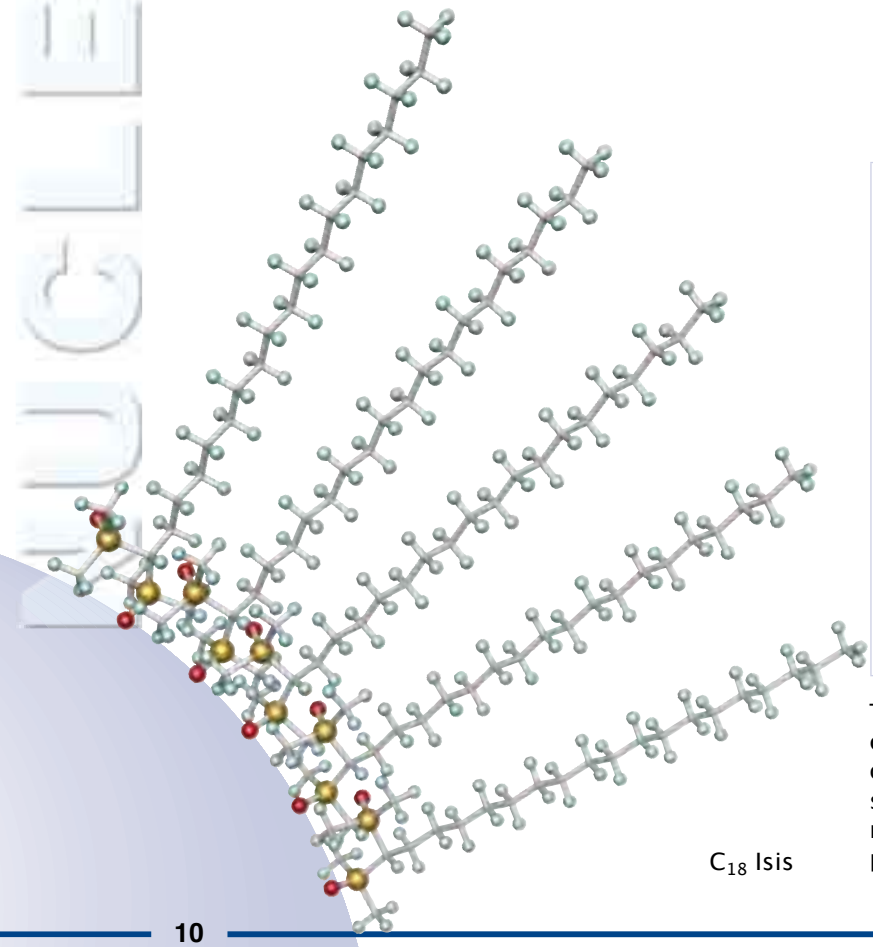
- **recommended application:**
  steroids
  (*o*,*p*,*m*–) substituted aromatics
  fat-soluble vitamins
  USP L1

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 %.

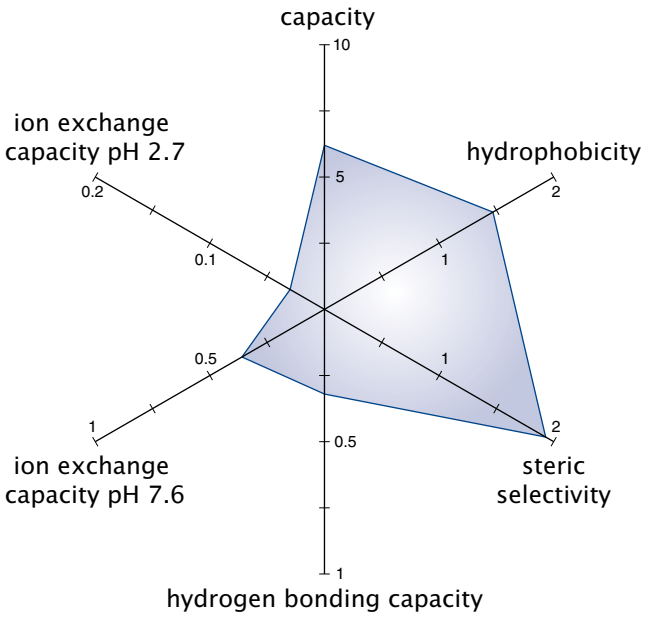
The target crosslinking of the C_{18} chains on the surface enables the separation of compounds with similar molecular structure but different stereochemical properties. The technical term for this feature is steric selectivity.

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.



C_{18} Isis

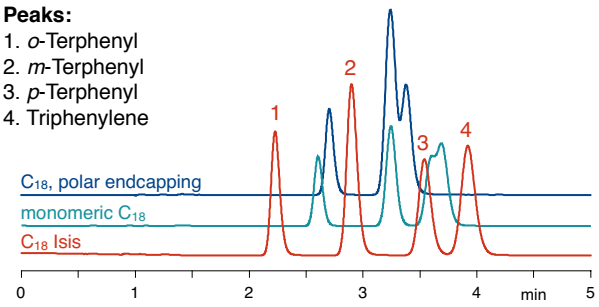
Tanaka plot of NUCLEODUR® C_{18} Isis



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

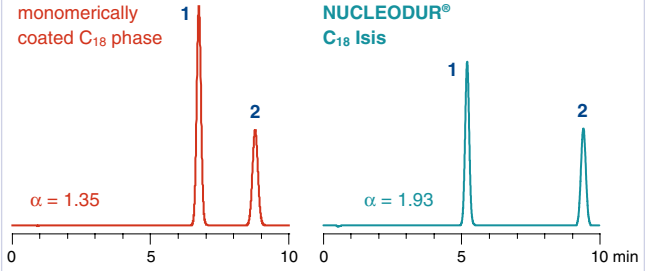


The separation of *o*-terphenyl and triphenylene is a concrete example to evaluate the selectivity potential of a reversed phase column in terms of the different shape of two molecules. The phenyl rings of *o*-terphenyl are twisted out of plane while triphenylene has a planar geometry.

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.

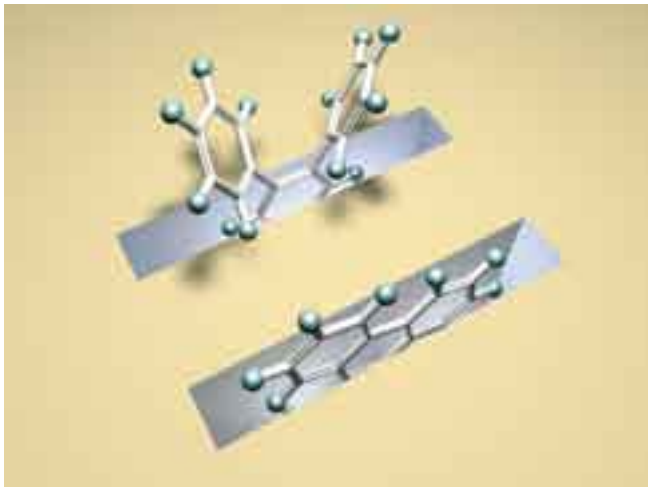
Steric selectivity of NUCLEODUR® C_{18} Isis

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

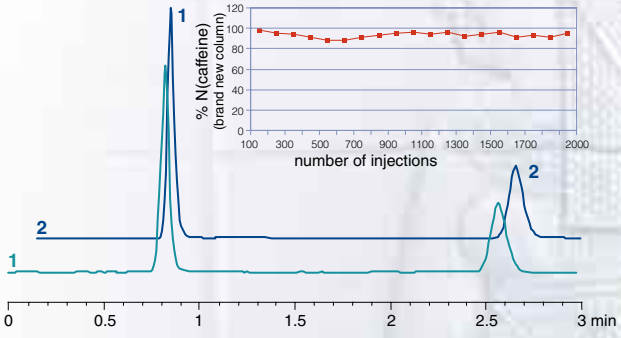
The chromatography of basic analytes requires a high density of surface-bonded C_{18} silanes combined with a thorough endcapping procedure to keep silanol activity at a minimum. This ensures tailing-free elution of even strongly basic amino-containing compounds (see Appl. 121210 on page 27).

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

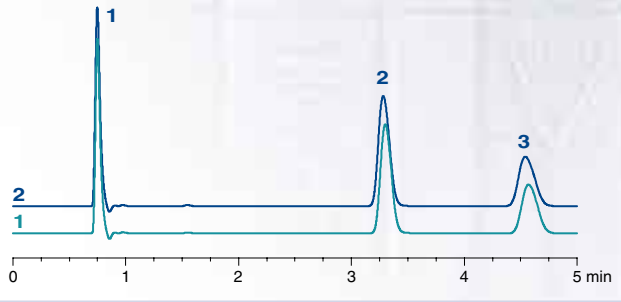
Columns: 125 x 4 mm NUCLEODUR® C_{18} Isis, 5 µm
Eluent: methanol – 50 mM triethylamine, pH 10 (25:80, v/v)
Flow rate: 1 ml/min, temperature: 50 °C
Detection: UV, 254 nm, injection volume: 5 µl
Peaks: 1. theophylline, 2. caffeine



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

Columns: 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



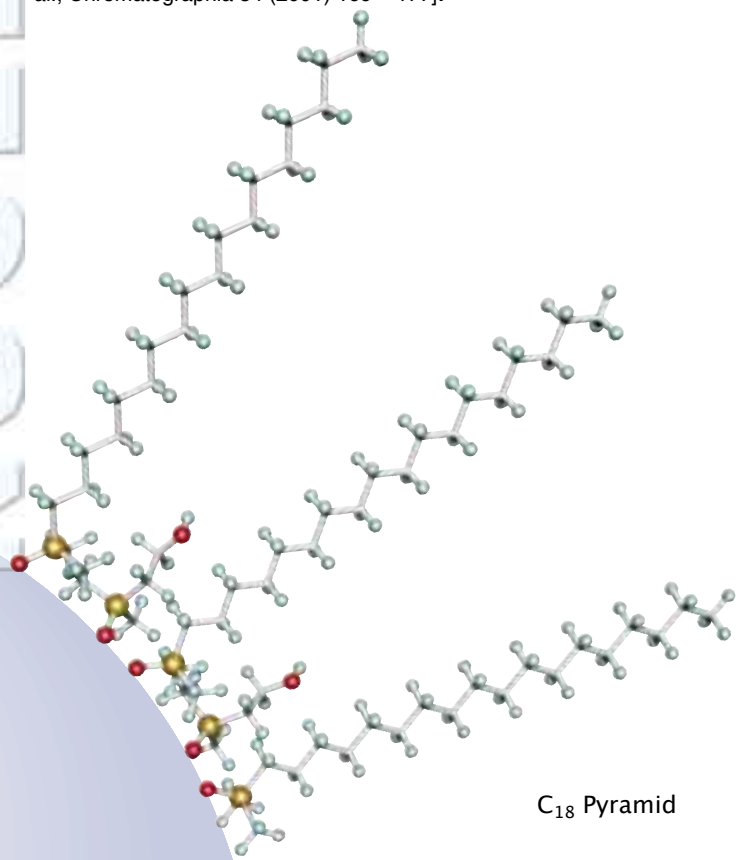
- NUCLEODUR® C_{18} Isis does not show any degradation under the applied mobile phase conditions. An enhanced pH stability in the range from pH 1 to 10 can be certified for this phase.

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].

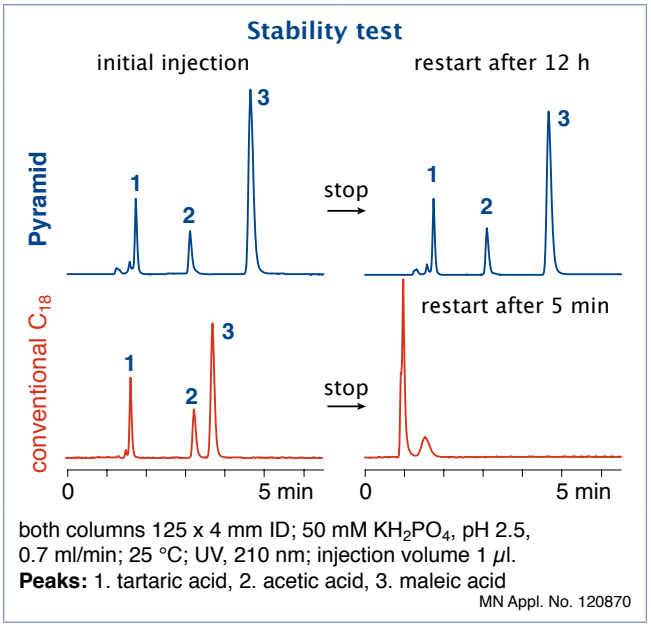


C_{18} Pyramid

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. NUCLEOSIL® Nautilus 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 [D. Rieger, H. Riering, Int. Laboratory Aug. 2000, Vol. 30 (4A), 12].

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

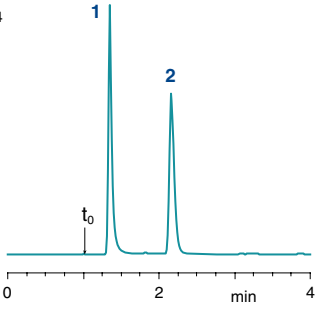
It can be shown that the retention times for NUCLEODUR® C_{18} Pyramid remain nearly unchanged between initial injection and restart after the flow has been stopped for 12 hours, whilst the performance of the conventional RP column collapsed totally after the same period.

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 24.

Separation of very polar compounds

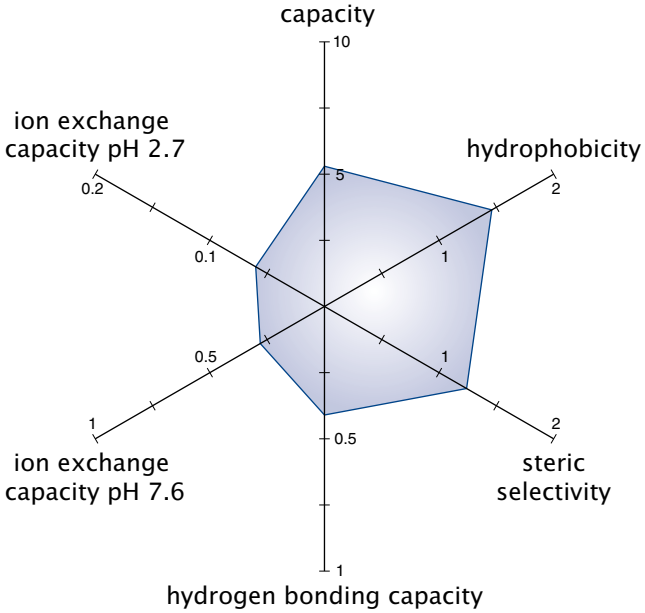
Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: 0.2 % H_3PO_4
Flow rate: 1.0 ml/min
Temperature: 22 °C
Detection: UV, 202 nm
Injection volume: 2 µl
Peaks:
1. Formic acid
2. Acetic acid



MN Appl. No. 119170

In addition to the exceptional polar selectivity NUCLEODUR® C_{18} Pyramid also provides adequate hydrophobic retention. 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

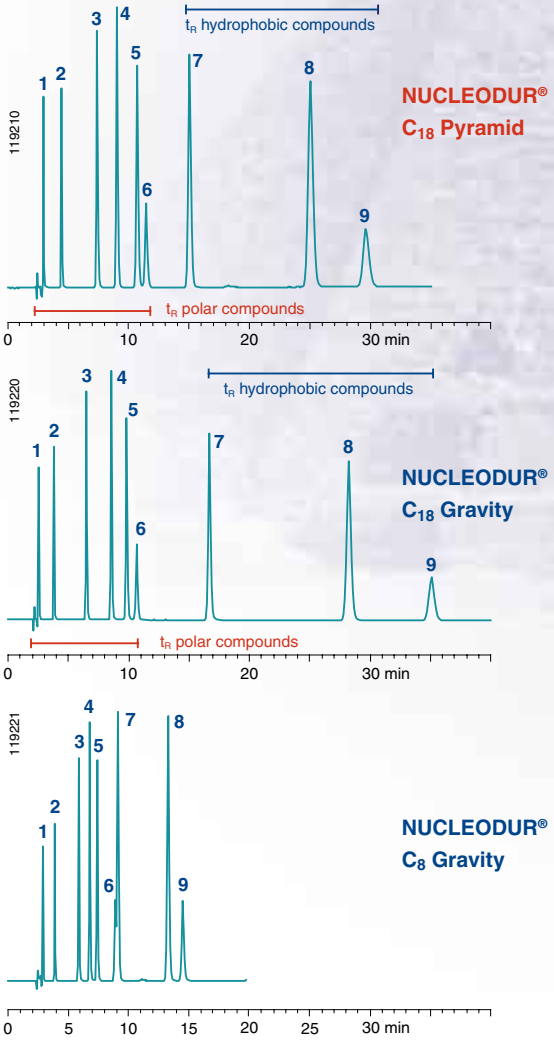


Base deactivation

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 27).

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



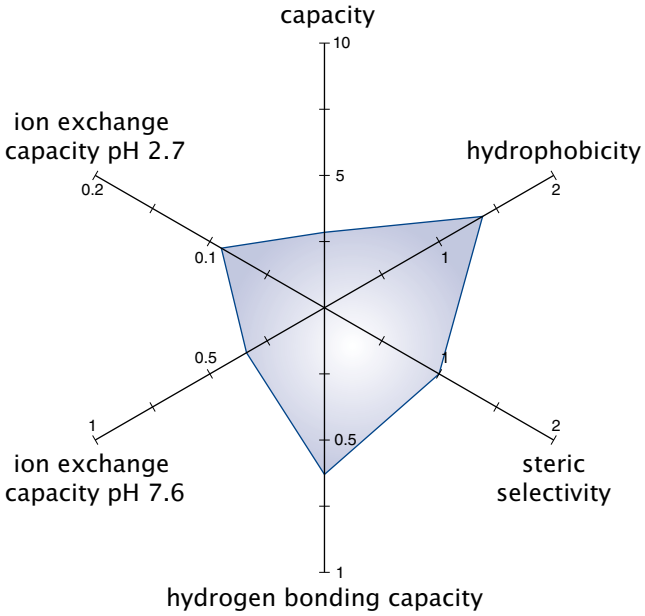
Sphinx RP

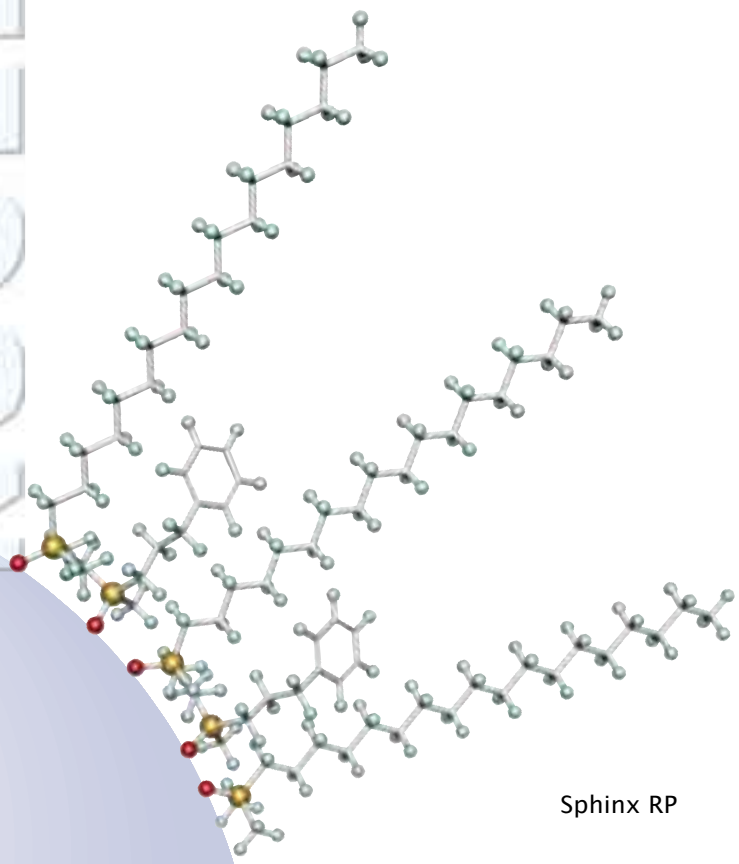
- **key features:**
  - distinct selectivity based on well-balanced bifunctional surface coverage
  - widens the scope for method development based on additional π–π interactions
  - suitable for **LC/MS** due to low bleeding characteristics
- **technical characteristics:**
  octadecyl and propylphenyl 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



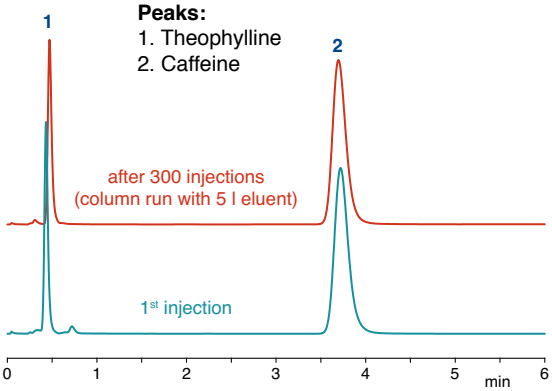


Sphinx RP

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

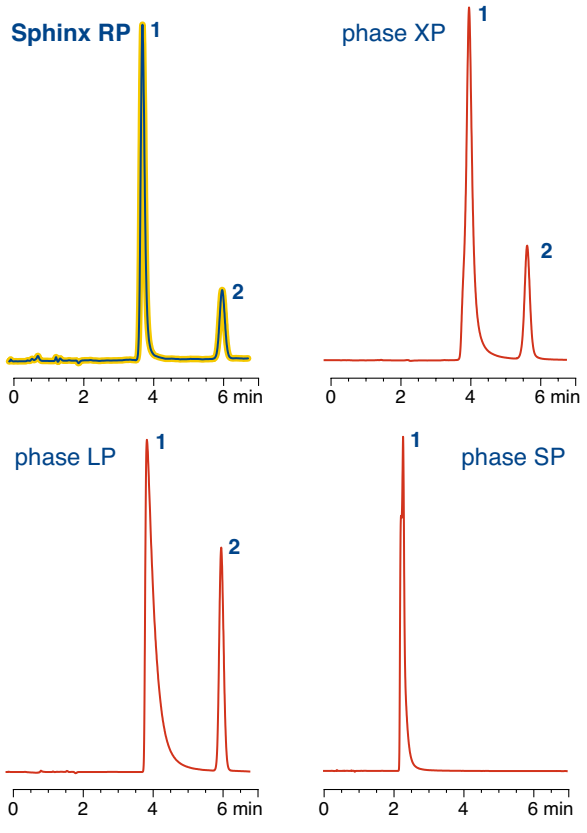
Different from standard phenyl phases, NUCLEODUR® Sphinx RP is far more stable towards hydrolysis and is also suggested for LC/MS applications.

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
A) NUCLEODUR® Sphinx RP, 5 µm
B) competitor 1 (column XP)
C) competitor 2 (column LP)
D) 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

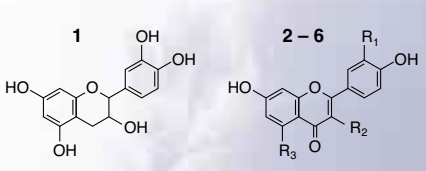
The selectivity advantage of NUCLEODUR® Sphinx RP is impressively shown in the flavonoid application below.

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.

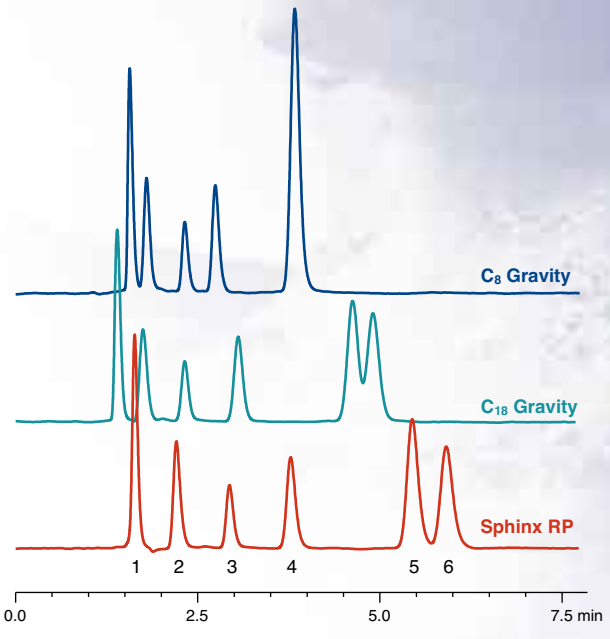
Separation of flavonoids on 3 different NUCLEODUR® phases

Columns: 150 x 4.6 mm
NUCLEODUR® C_8 Gravity, 5 µm
NUCLEODUR® C_{18} Gravity, 5 µm
NUCLEODUR® Sphinx RP, 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} 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 (C18) and octyl (C8) 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 C18, 10.5 % for C8
  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)

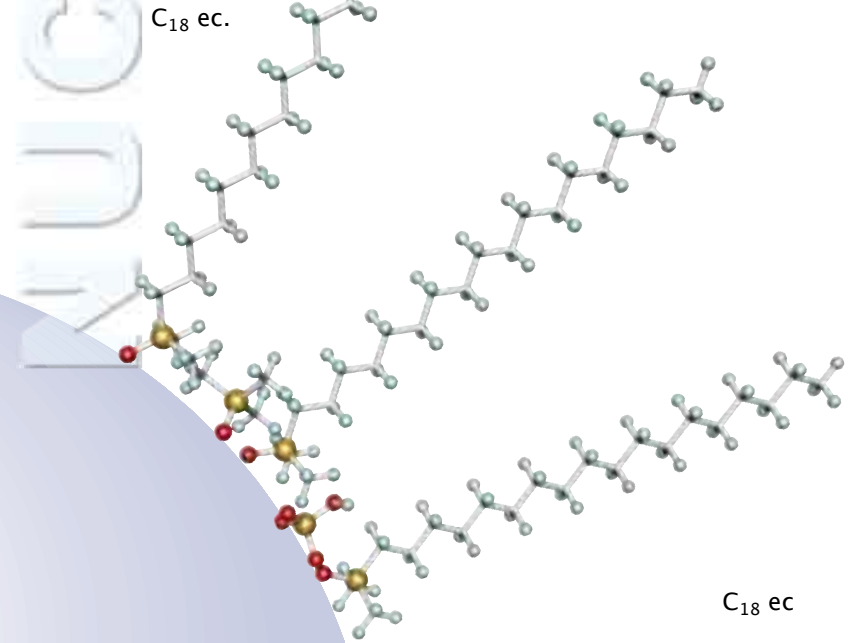
NUCLEODUR® C_{18} ec for daily routine analysis and up-scaling for preparative HPLC

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.

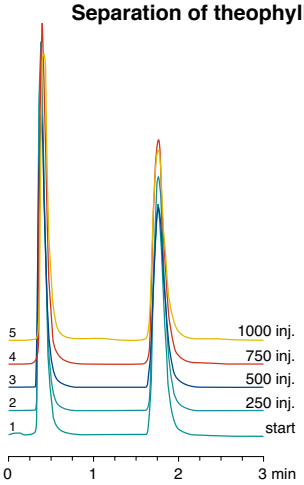


C_{18} ec

pH stability of NUCLEODUR® C_{18} ec

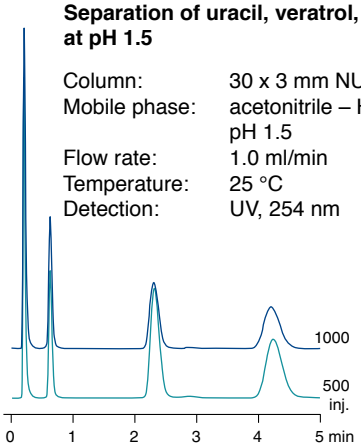
Separation of theophylline and caffeine at pH 10

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



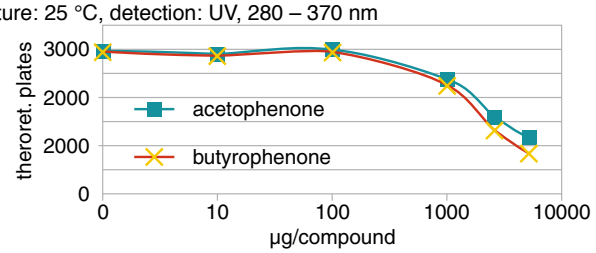
Loadability

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®

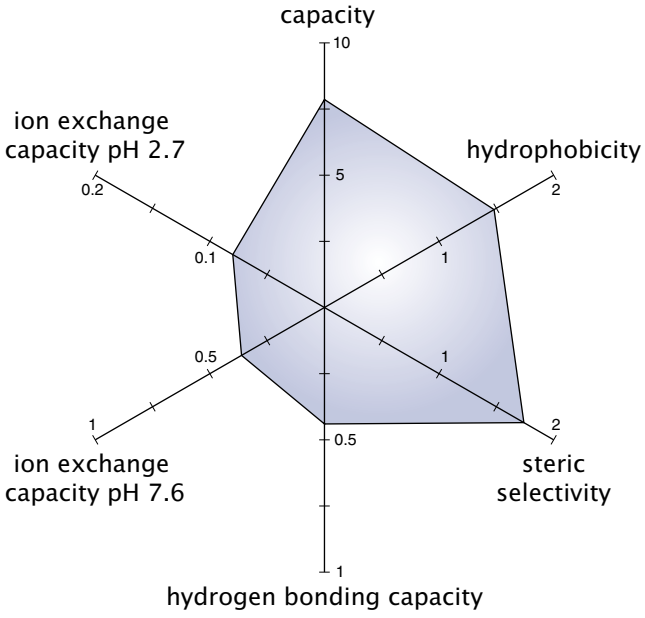
100–20 C_{18} ec column describes the correlation between the increase of column loading and the decrease of separation efficiency.

Loading curve

Column: 250 x 4.6 mm NUCLEODUR® 100-20 C_{18} ec, mobile phase: acetonitrile – H_2O 80:20 (v/v), flow: 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.

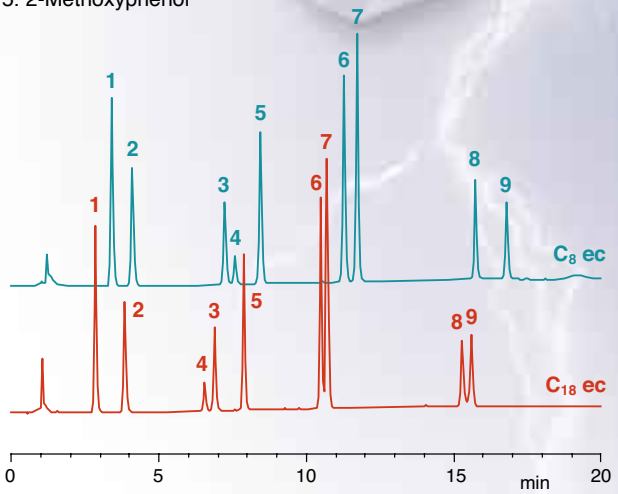
However, comparative studies reveal some different selectivity patterns of NUCLEODUR® C_8 ec and NUCLEODUR® C_{18} ec. The separation of phenols below shows baseline separation for 2-ethoxyphenol and dimethoxybenzene (veratrol) and in addition a reversal of the elution order of phenol and 4-methoxyphenol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

Separation of phenols

Column: 250 x 4 mm NUCLEODUR® 100-5 C_8 ec / C_{18} ec
Eluent: A) water, B) methanol
Gradient for C_8: 2 min 20 % B, then to 60 % B in 12 min
Gradient for C_{18}: 2 min 25 % B, then to 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 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

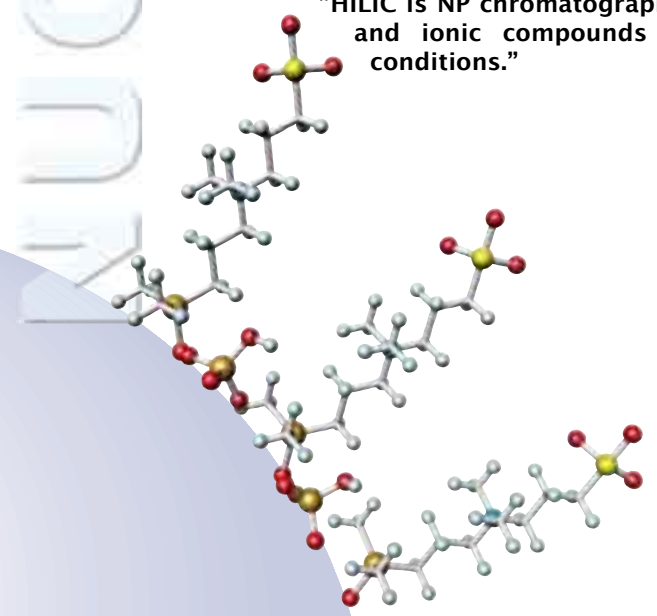
Separation science is always looking for new and effective strategies to accomplish the tasks of modern analytics. Especially for polar compounds reversed phase HPLC – the most common analytical method – is often limited. Here, hydrophilic stationary phases provide an additional tool for the separation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

The expression HILIC (Hydrophilic Interaction LIquid Chromatography) 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].

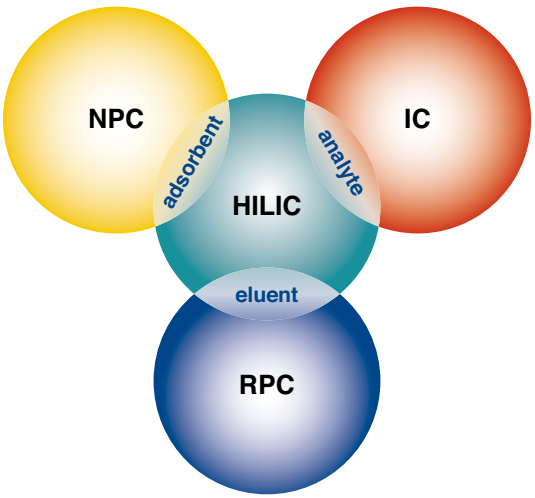
HILIC combines the characteristics of the 3 major methods in liquid chromatography – reversed phase (RPC), normal phase (NPC) and ion chromatography (IC):

- 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

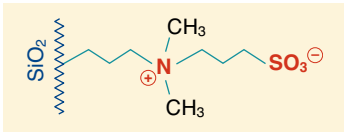
"HILIC is NP chromatography of polar and ionic compounds under RP conditions."



HILIC



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 equalisation and in an overall neutrally charged but highly polar surface.



Retention characteristic

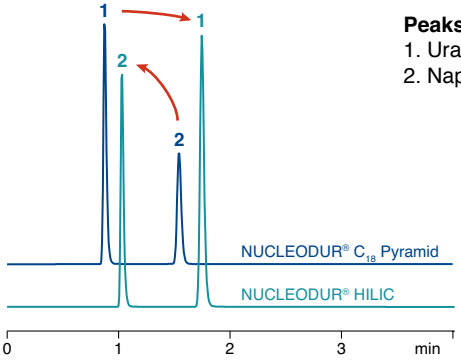
Commonly HILIC is described as partition chromatography or liquid/liquid extraction system between the mobile and stationary phase. Versus a water-poor mobile phase a water-rich layer on the surface of the polar stationary phase is formed. Thus, a distribution of the analytes between these two layers 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® 100-3 HILIC
Eluent: acetonitrile – water (90:10, v/v)
Flow rate: 1.0 ml/min, temperature 25 °C
Detection: UV, 254 nm



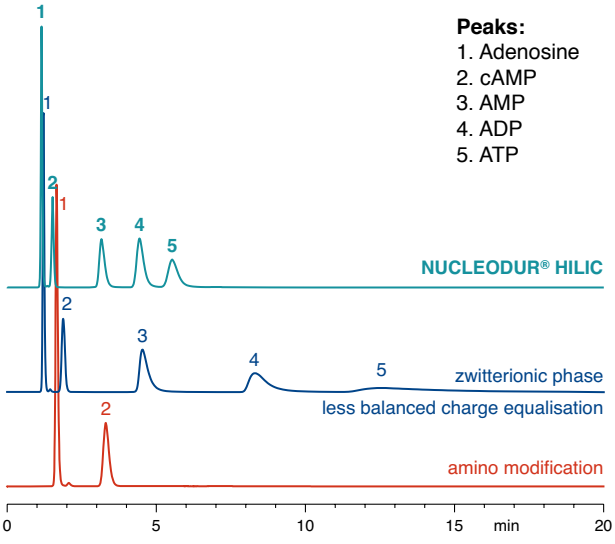
Peaks:
1. Uracil
2. Naphthalene

MN Appl. No. 122911/122912

In comparison with medium polar aminopropyl phases or modification with less balanced charge equalisation 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® 100-5 HILIC
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



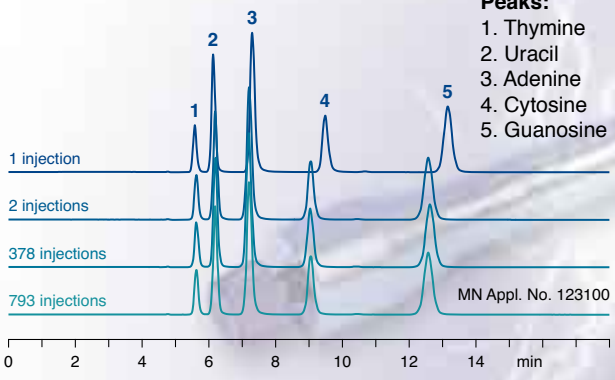
Peaks:
1. Adenosine
2. cAMP
3. AMP
4. ADP
5. ATP

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

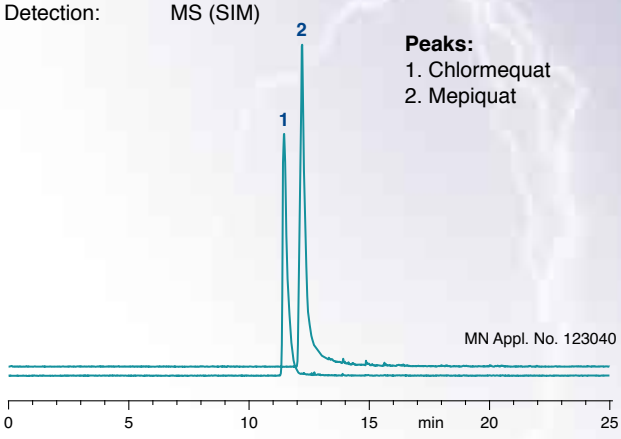
Column: 250 x 4 mm NUCLEODUR® 100-5 HILIC
Eluent: acetonitrile – 5 mM ammonium acetate (80:20, v/v)
Flow rate: 0.6 ml/min
Temperature: 25 °C
Detection: UV, 254 nm



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

Separation of growth regulators

Columns: 125 x 2 mm NUCLEODUR® 100-3 HILIC
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; 7 % C; 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.

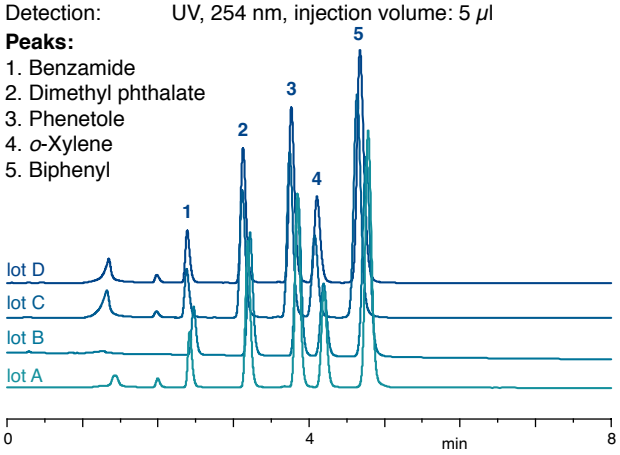
The fully endcapped and highly reproducible (see figure top right) NUCLEODUR® 100-5 CN-RP phase has cyanopropyl groups on the surface able to generate a clearly recognizable different retention behavior compared to purely alkyl-functionalized surface modifications (see figure down right).

The polarity of the NUCLEODUR® 100-5 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

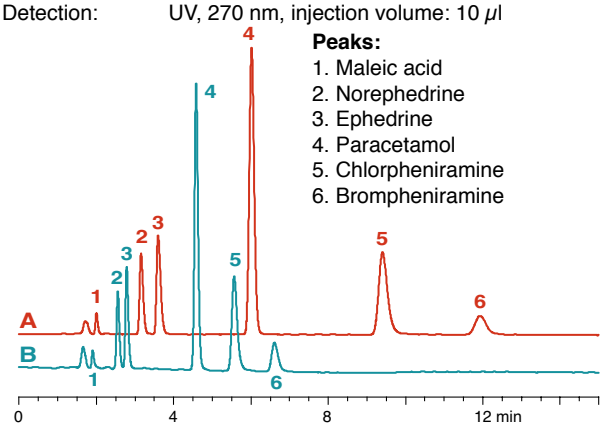


MN Appl. No. 120380

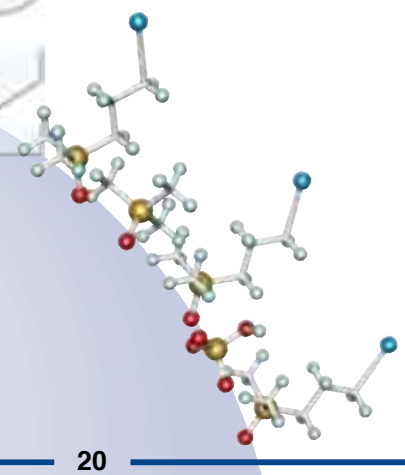
Separation of cold medicine ingredients on two different NUCLEODUR® phases

Column: A) 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
B) 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

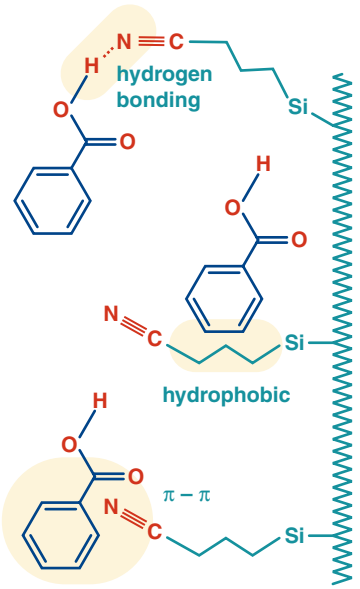


MN Appl. No. 119340



CN / CN-RP

Interactions on cyano-modified silica

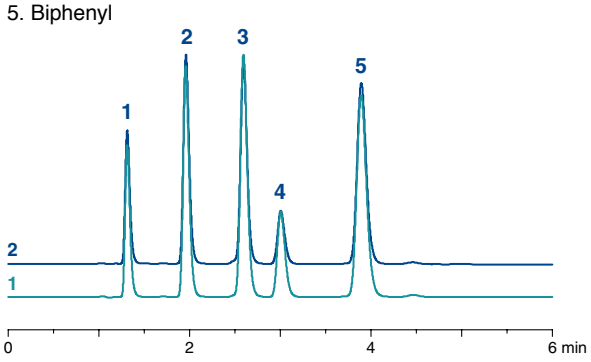


Short-chain bonded phases are sometimes suspected of revealing shortcomings in stability towards hydrolysis at low pH [J. J. Kirkland, LCGC 14 (1996) 486 – 500]. The following chromatograms show that even after 100 sample injections and four weeks storage at pH 1 (curve 2), neither a considerable shift in retention, nor a visible change in peak symmetry could be noticed (curve 1 = 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

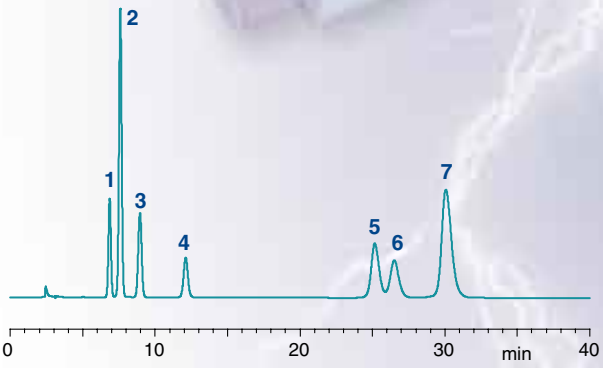
Due to the exceptional polarity features the cyano phase can also be run in the normal phase mode. NUCLEODUR® CN columns for normal phase applications are shipped in *n*-heptane. The drastic change in selectivity and order of elution for a mixture of various steroids in normal and reversed phase mode 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

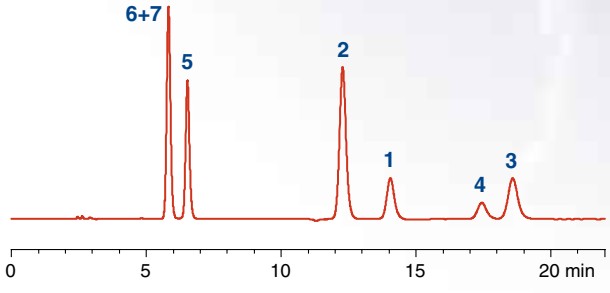
Column: 250 x 4 mm NUCLEODUR® 100-5 CN
Eluent: *n*-heptane – 2-propanol (90:10, v/v)
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 10 µl

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; 2.5 % C; 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

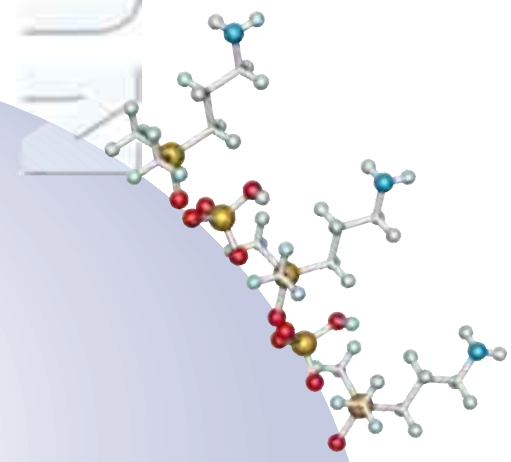
Some compounds, especially polar substances, cannot be sufficiently resolved on C_{18} phases. Polar-modified silica phases offer alternative selectivities such expanding the spectrum of analytical HPLC into the polar range.

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® Amino, 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® Amino is the separation of simple and complex sugars, sugar alcohols and other hydroxy compounds under RP conditions as well as hydrocarbons under NP conditions.

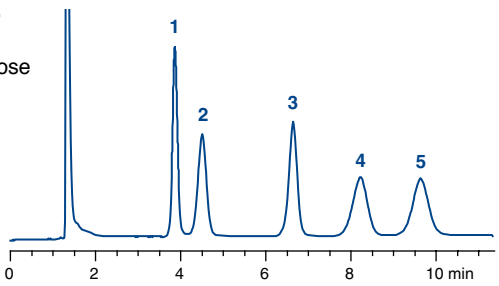


NH_2 / NH_2-RP

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

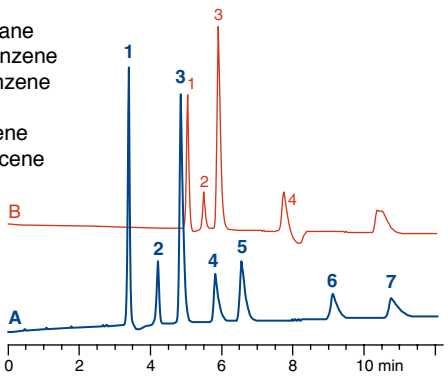


MN Appl. No. 122160

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

Columns: **A) 250 x 4 mm NUCLEODUR® 100-5 NH_2**
B) 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



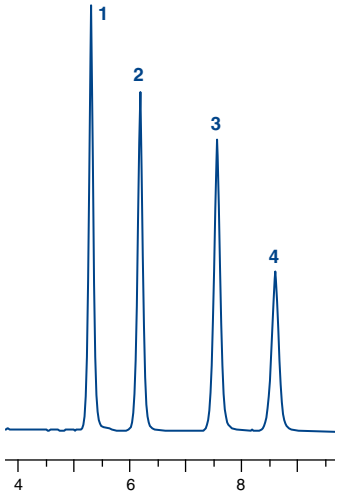
MN Appl. No. 122180

Even at lower flow rates than for C_{18} phases, NUCLEODUR® Amino 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

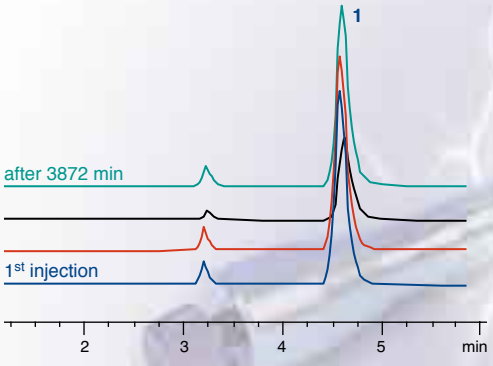
One of the main problems with conventional amino phases is insufficient resistance towards hydrolysis. Due to a special method of surface modification NUCLEODUR® NH_2 features a pronounced stability at higher as well as at lower pH values. The figure at right shows, that even after several days of exposure 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 in our online application data base under *www.mn-net.com*.

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 800 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 midpolar compounds under normal phase conditions

USP L3

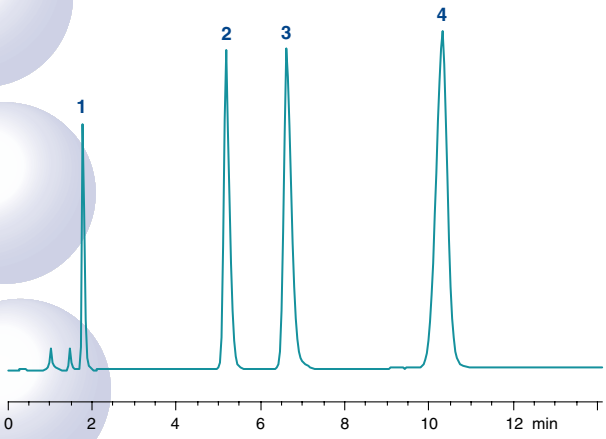
Applications

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

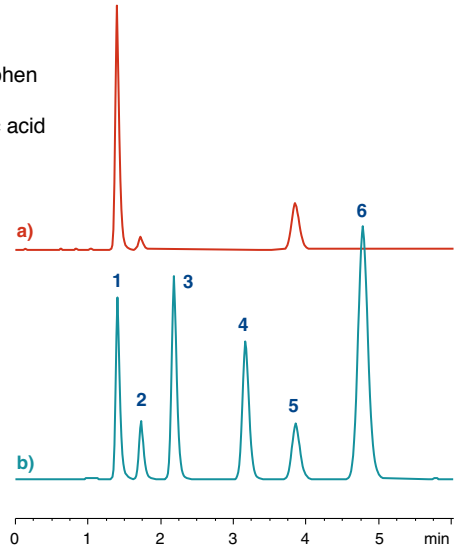


Analgesics

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

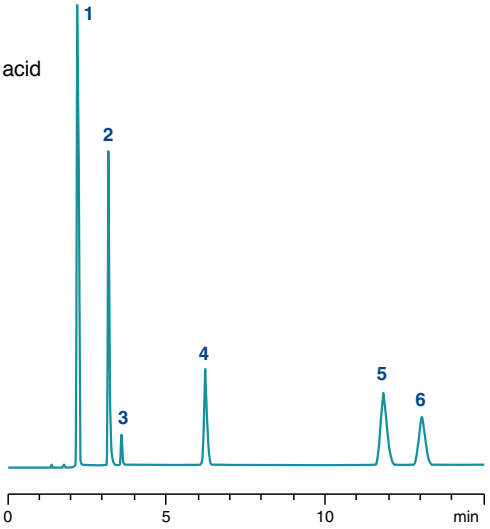


Analgesics

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



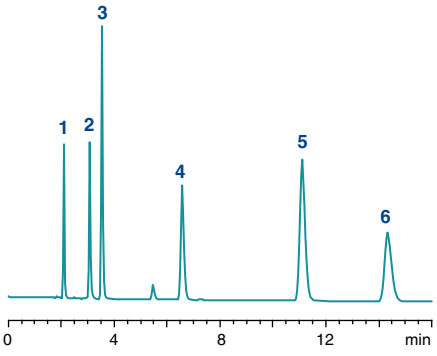
For a fast separation (< 1 min) of acetylsalicylic acid and salicylic acid on NUCLEODUR® 100-5 C_{18} ec see application 117780 at *www.mn-net.com.*

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

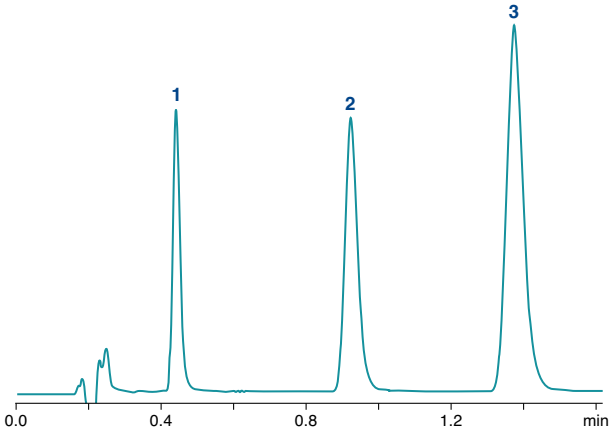


Antiinflammatory drugs

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

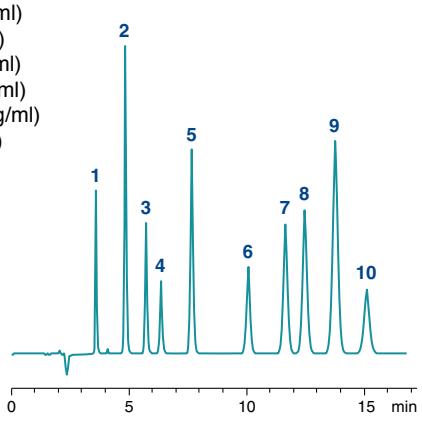


Analgesic and antiinflammatory drugs

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)

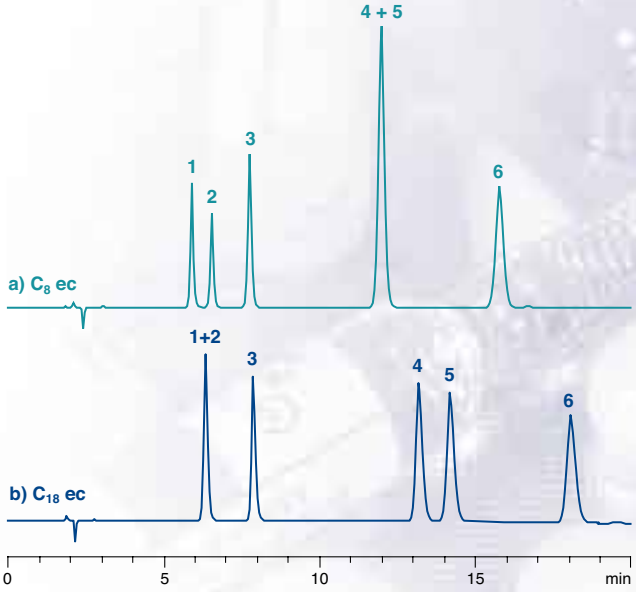


Antiinflammatory drugs

MN Appl. No. 120880/120881

Column: a) 250 x 4 mm NUCLEODUR® 100-5 C_8 ec
b) 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 nonsteroidal 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.

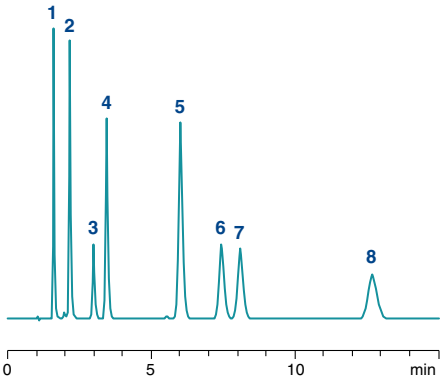
Applications

Antiinflammatory drugs

MN Appl. No. 117830

Column: 250 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

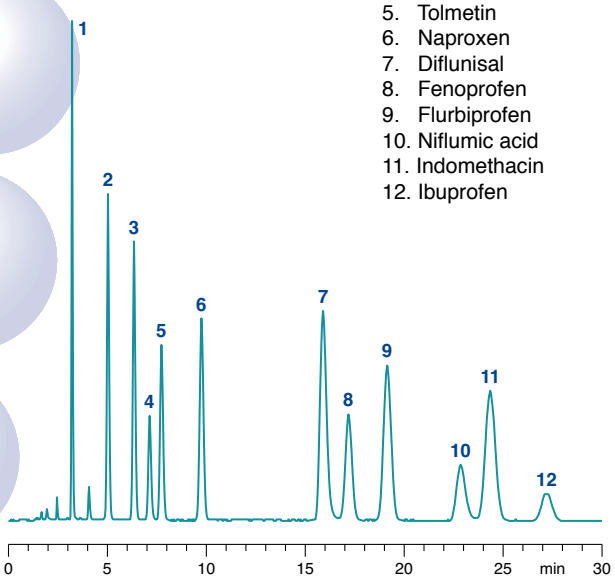
Peaks:
1. Acetylsalicylic acid
2. Sulindac
3. Tolmetin
4. Ketoprofen
5. Flurbiprofen
6. Diclofenac
7. Ibuprofen
8. Meclofenamic acid



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

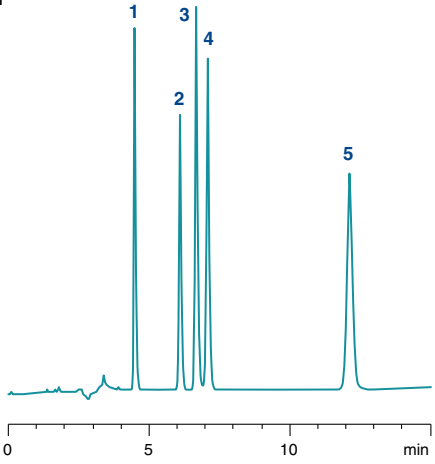


Barbiturates

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

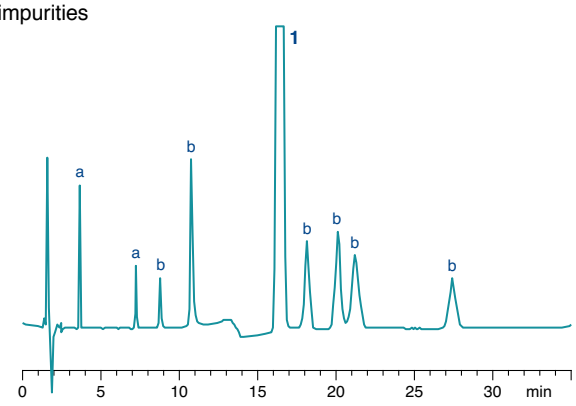


Neuroleptics

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



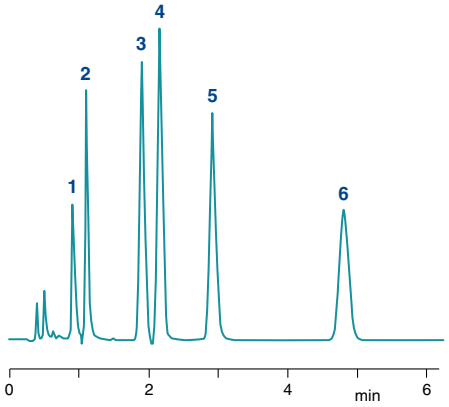
For separation on NUCLEODUR® C_{18} Gravity see application 121611 at *www.mn-net.com.*

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

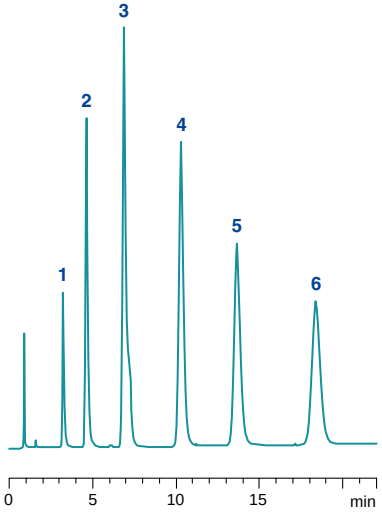
Peaks:
1. Protriptyline
2. Nortriptyline
3. Doxepin
4. Imipramine
5. Amitriptyline
6. Trimipramine



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

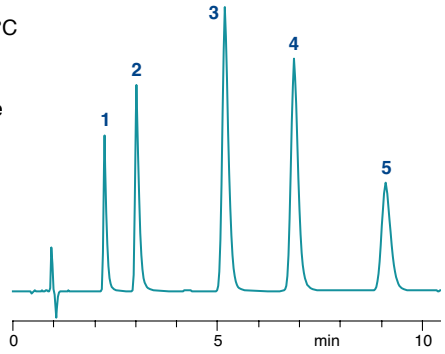
Peaks and other conditions as above



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

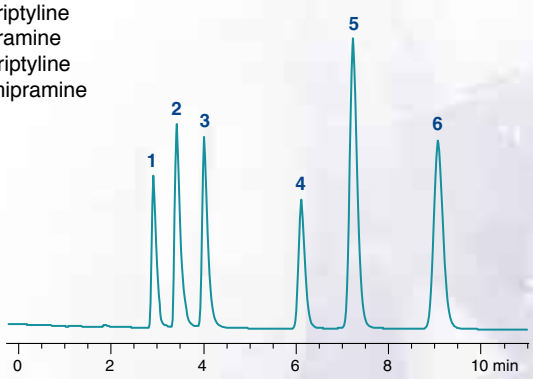


Tricyclic antidepressants

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

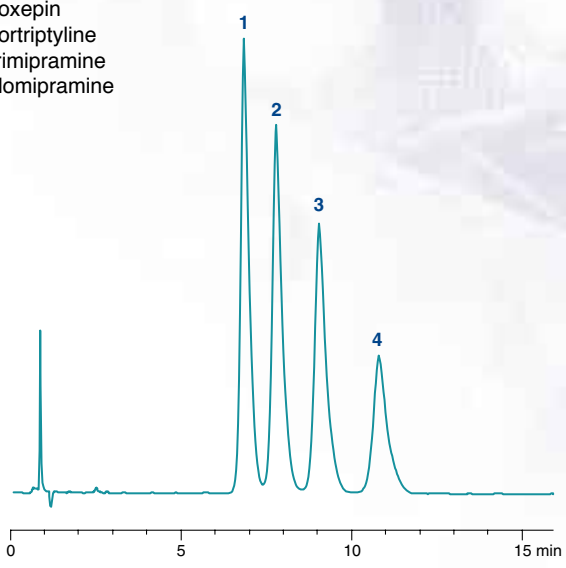


Peak symmetry at 10 % of peak height:
A_s (imipramine): 1.29
A_s (amitriptyline): 1.26
A_s (clomipramine): 1.16

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



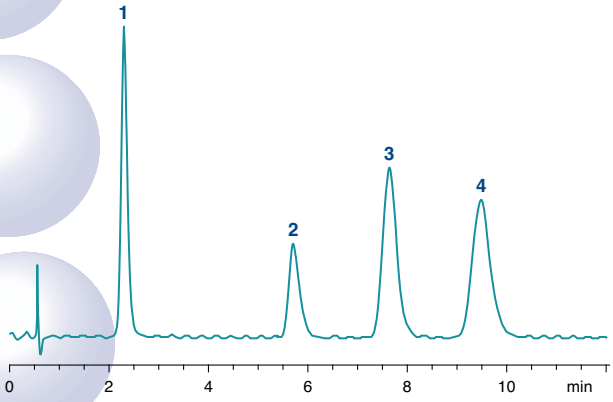
Applications

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

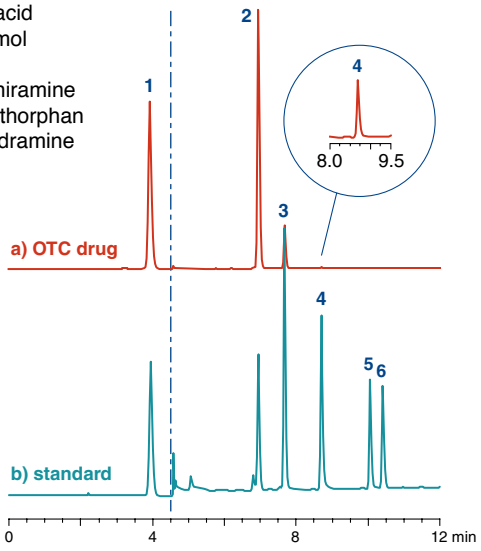


Cold medicine ingredients

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 – 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

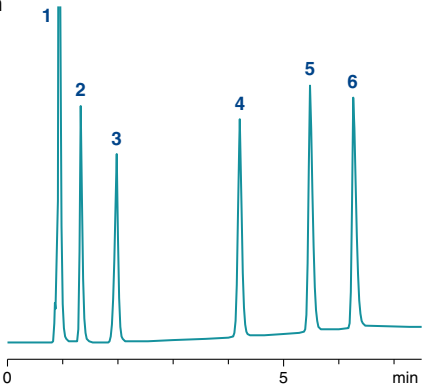


Cold medicine

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 – 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

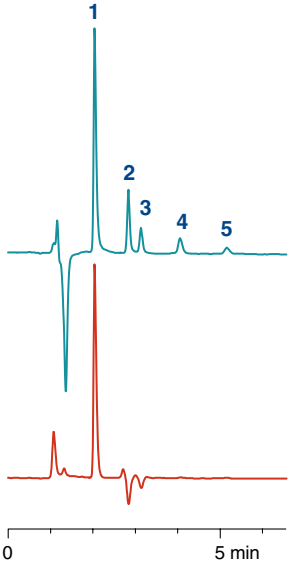


Xylometazoline in nasal spray

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})

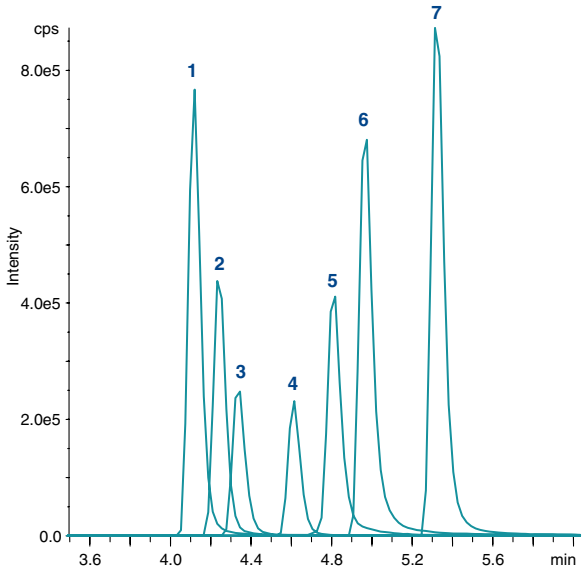


β_2-Agonists in human urine by LC-MS/MS

MN Appl. No. 119760

Column: 70 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 – 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)
7. Mapenterol (5.32 min)
6. Bambuterol (4.97 min)



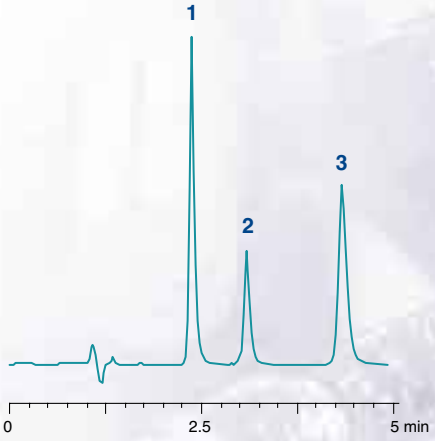
Courtesy of M. Thevis and W. Schänzer, Institute of Biochemistry, German Sport University, Cologne, Germany.

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

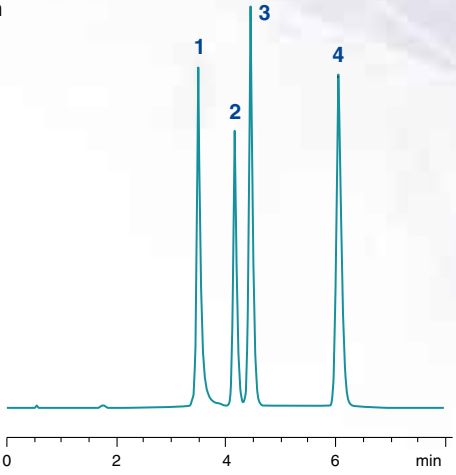


Benzodiazepines

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



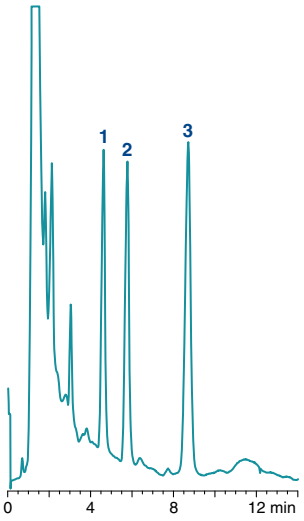
Applications

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. int. std.



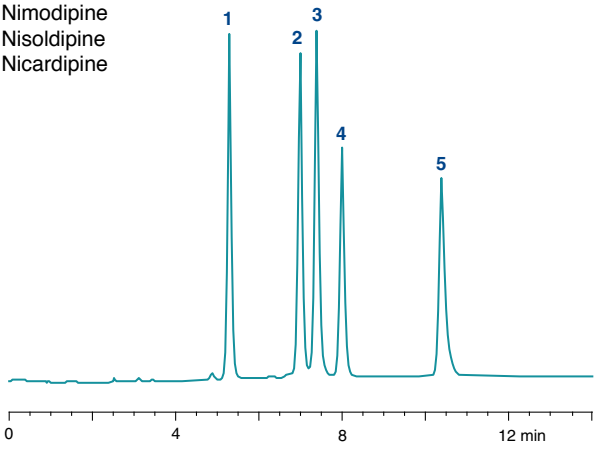
Courtesy of Mrs. Richter, Institute of Anesthetics, Biochemical Laboratory, University of Erlangen, Germany

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 – 50 % B in 7.5 min, then 7.5 min 50 % B
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

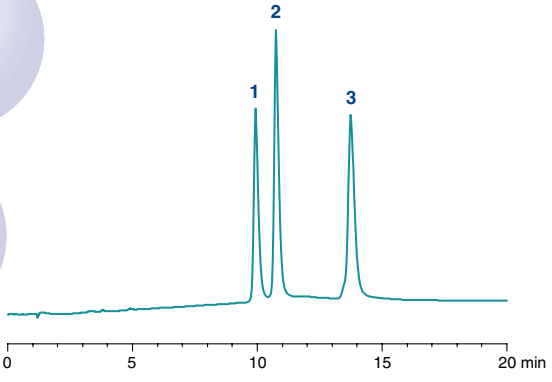


Sedative drugs

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 – 50 % B in 10 min, then 10 min 50 % B
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

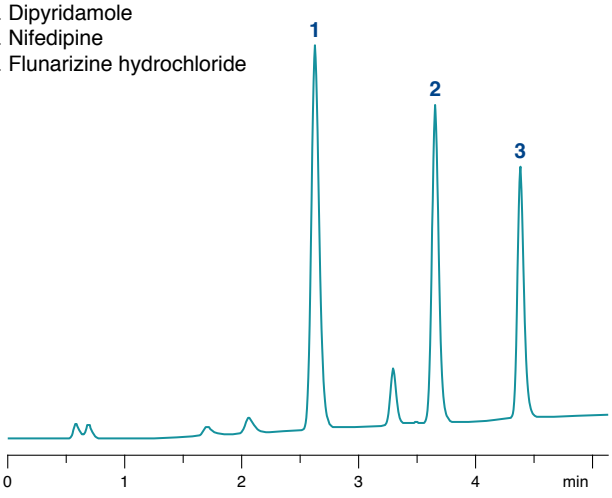


Cardiovascular drugs

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 – 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

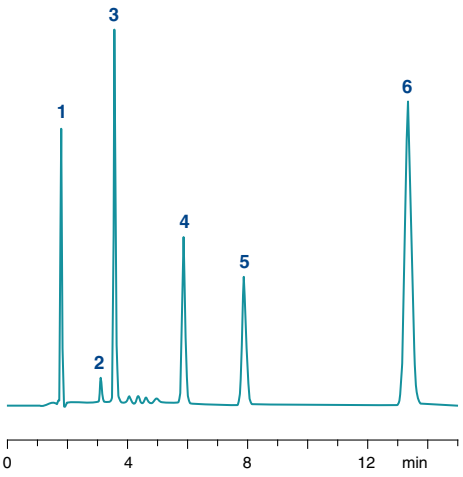


Antibacterial drugs

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

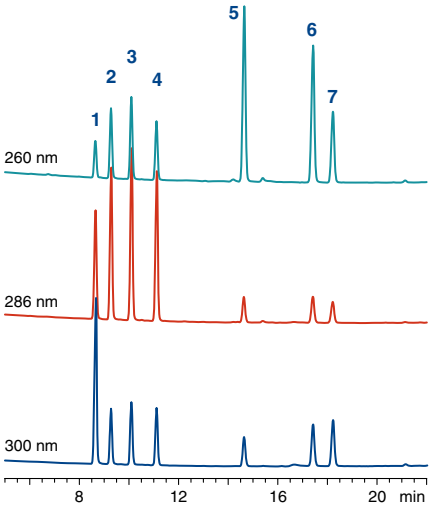


Gyrase inhibitors

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 – 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



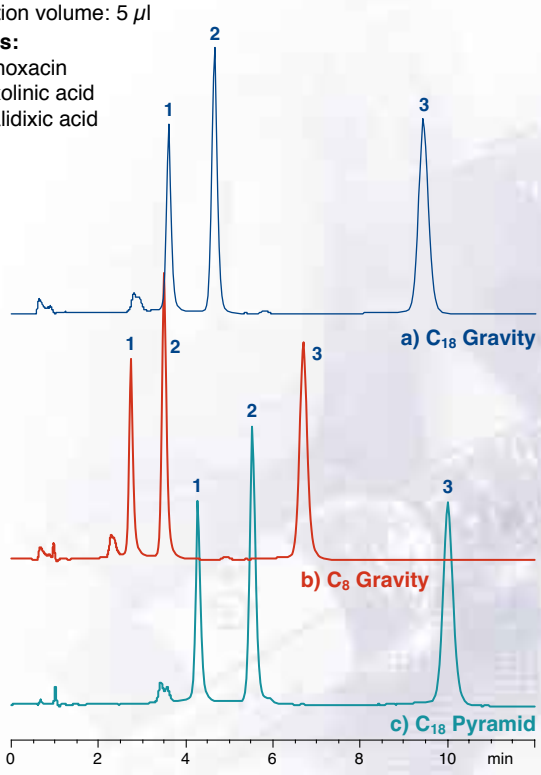
Courtesy of R. Lippold, Chemical and Veterinary Research Agency, Freiburg, Germany.

Quinolone antibiotics

MN Appl. No. 120460/120470

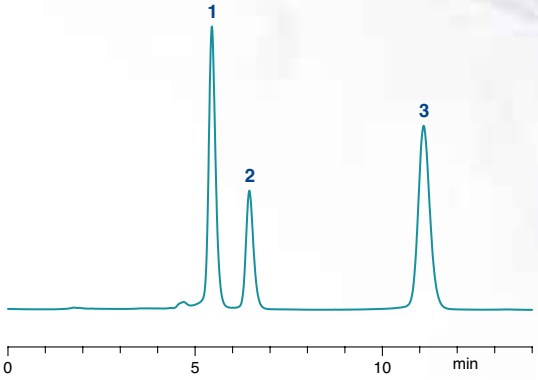
Columns: a) 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
b) 125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
c) 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: methanol – 0.2 % formic acid (40:60, v/v)
Flow rate: 1.0 ml/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 5 µl

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)
Temperature: 22 °C
Peaks and other conditions as above



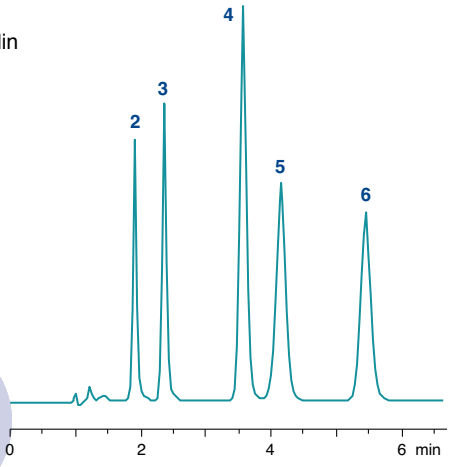
Applications

Penicillin antibiotics

MN Appl. No. 117860

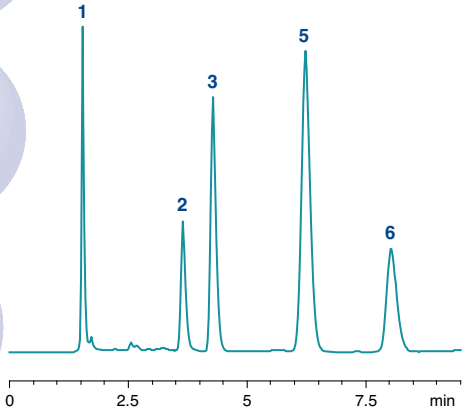
Column: 125 x 4 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – 20 mM KH_2PO_4, pH 3.0 (40:60, v/v)
Flow rate: 1.0 ml/min
Temperature: 22 °C
Detection: UV, 254 nm
Injection volume: 5 µl

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)
Temperature: 25 °C
Injection volume: 1 µl
Peaks and other conditions as above

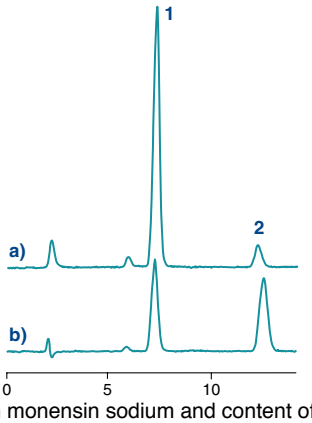


Anticoccidial drugs (polyether antibiotics)

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

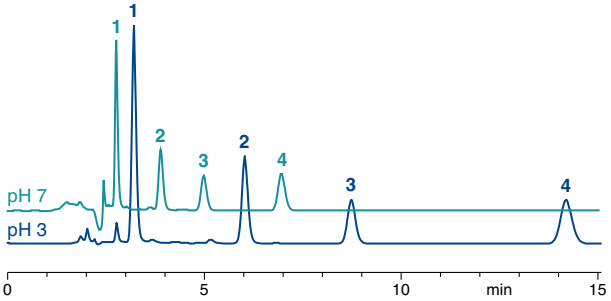
Courtesy of J. Schönherr, Saxon State Institute for Agriculture, Leipzig, Germany

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)
a) pH 3 with H_3PO_4, b) 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



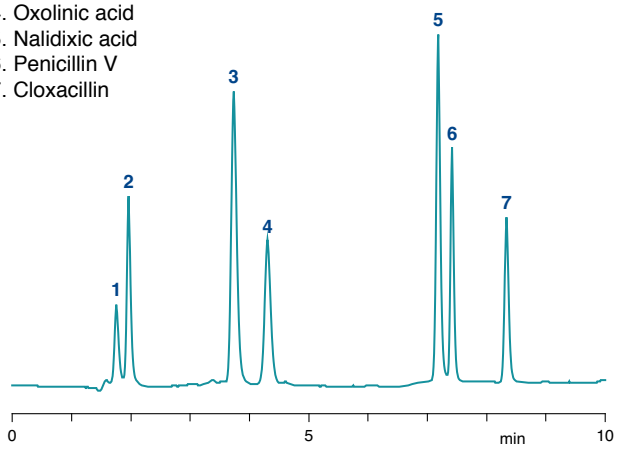
Protonation causes a drastic increase in retention time, but an improved peak symmetry.

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
4 min 60 % B, then 60 – 40 % B in 1 min, finally 40 % B
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

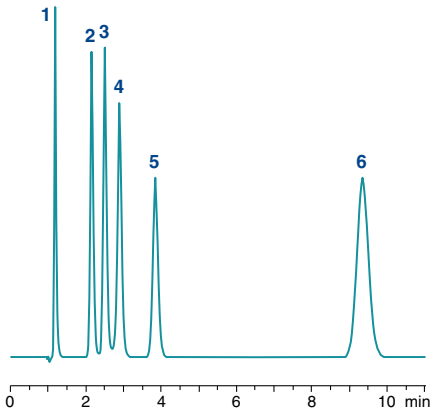


Sulfonamides

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

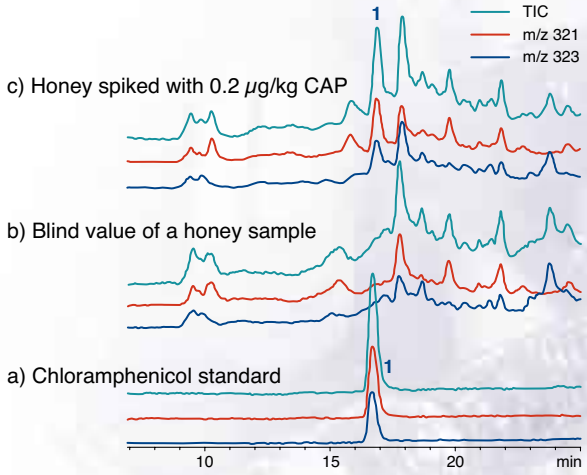


Determination of chloramphenicol residues in honey by microbore HPLC

MN Appl. No. 119810

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

Peaks
1. Chloramphenicol (CAP)



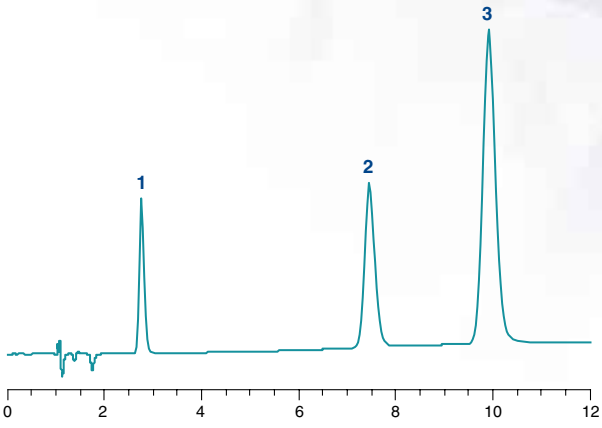
S. Oepkemeier, H.D. Winkler, GIT **46** (2002) 982 – 985.

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



Applications

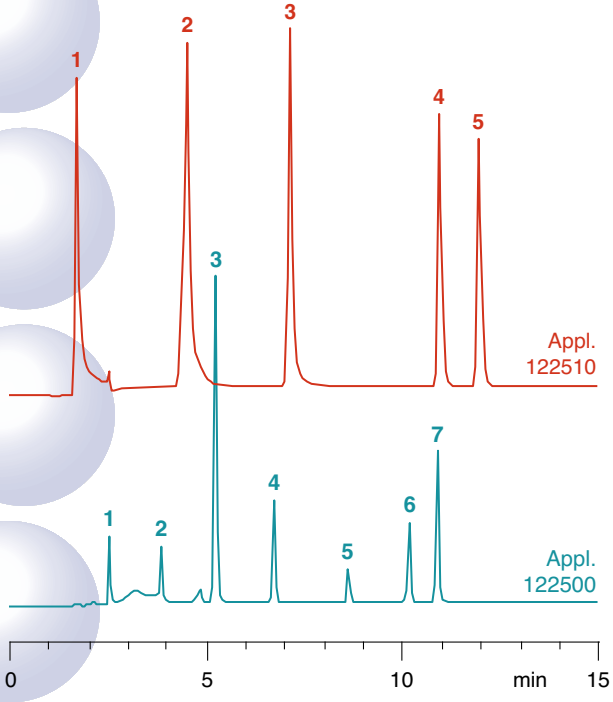
Food dyes

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 – 50 % B in 20 min, then 50 – 20 % B in 5 min
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 5 µl

Peaks application 122510
1. Ponceau 6R (E126)
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)

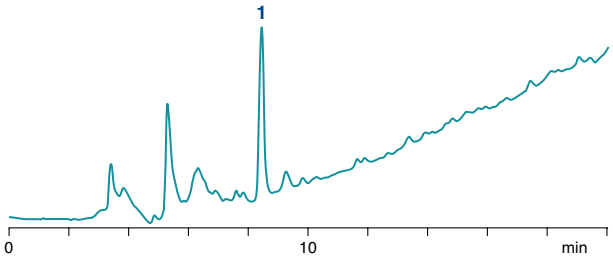


Alkaline tannic acid mixture

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 – 25 % B in 15 min, 25 % B for 5 min, 25 – 5 % B in 2 min, 5 % B for 3 min
Flow rate: 0.8 ml/min
Detection: UV, 275 nm (optimized for gallic acid)
Injection volume: 10 µl

Peaks:
1. Gallic acid



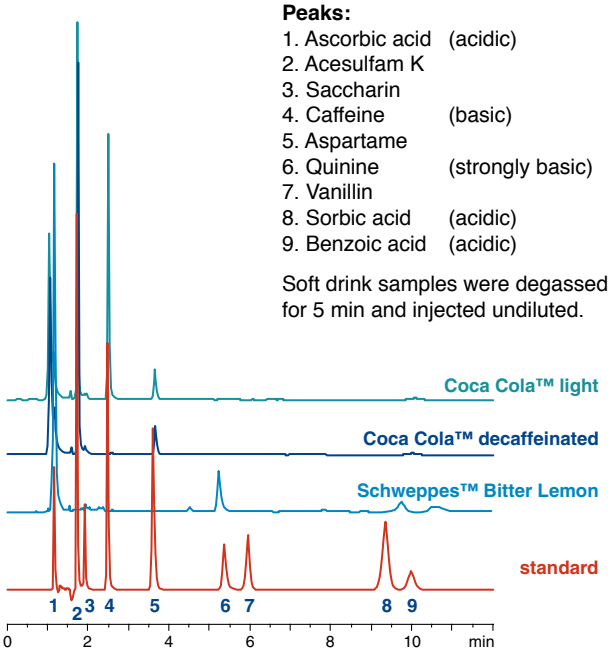
Soft drink additives

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: 1.2 ml/min
Temperature: 25 °C
Detection: UV, 220 nm
Injection volume: 10 µl

Peaks:
1. Ascorbic acid (acidic)
2. Acesulfam 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.



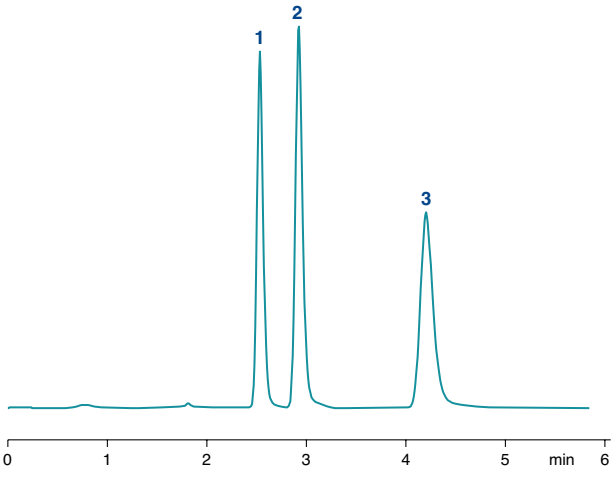
For fast separation of sweeteners on NUCLEODUR® 100-5 C_{18} ec see appl. 117940 at *www.mn-net.com.*

Acrylamide, methacrylamide and methacrylic acid

MN Appl. No. 123010

Column: 125 x 4 mm NUCLEODUR® 100-5 HILIC
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

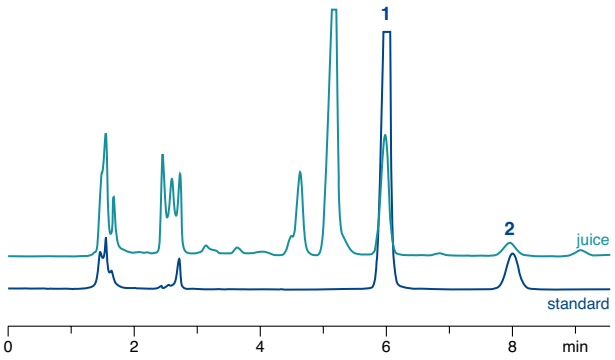


Patulin and hydroxymethylfurfural in apple juice

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



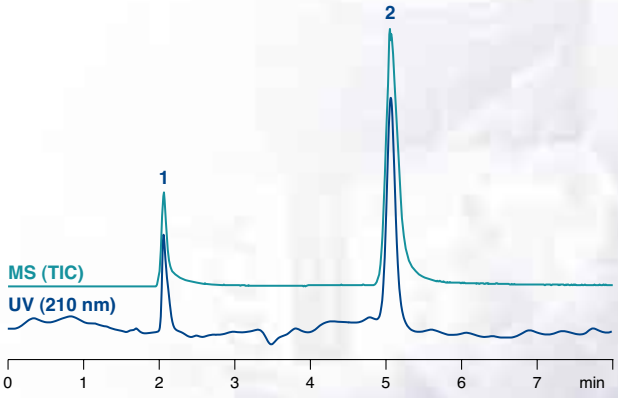
Courtesy of A. Gessler, Wesergold Getränkeindustrie GmbH & Co. KG, Rinteln, Germany.

Melamine and cyanuric acid

MN Appl. No. 123070

Column: 125 x 2 mm NUCLEODUR® 100-5 HILIC
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

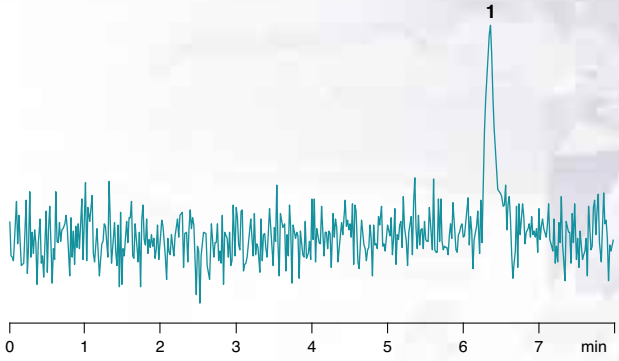
Peaks:
1. Melamine (10 µg/ml)
2. Cyanuric acid (490 µg/ml)



MN Appl. No. 123090

Column: 125 x 4 mm NUCLEODUR® 100-5 HILIC
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)

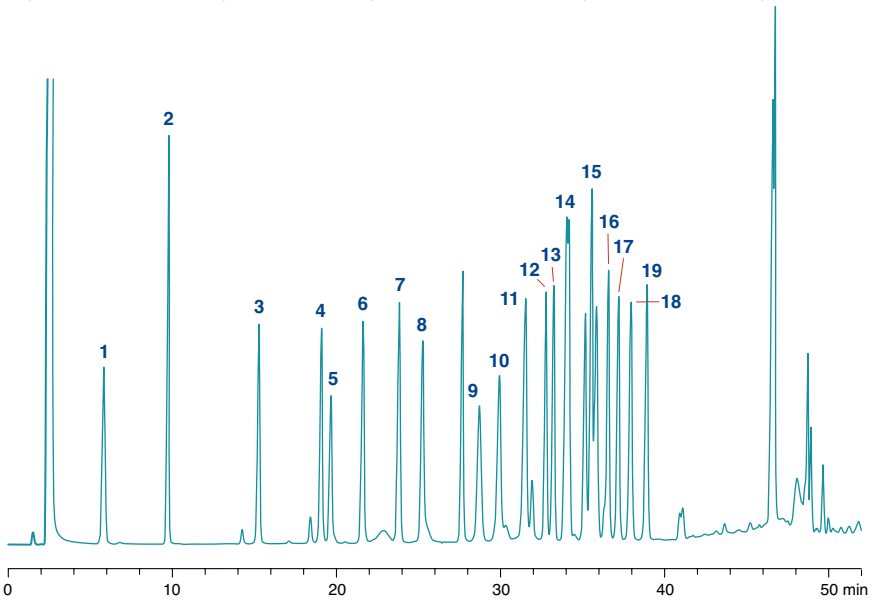


Amino acids as OPA derivatives

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)
2.9 min 100 % B, then 100 – 95 % B in 3.1 min, 95 – 85 % B in 11 min, 85 – 83 % B in 3 min, 83 – 70 % B in 10 min, 70 – 62 % B in 8 min, 62 – 35 % B in 7 min, 35 – 0 % B in 1 min, 2 min at 0 % B, 0 – 80 % B in 0.5 min, 2.5 min at 80 % B, 80 – 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

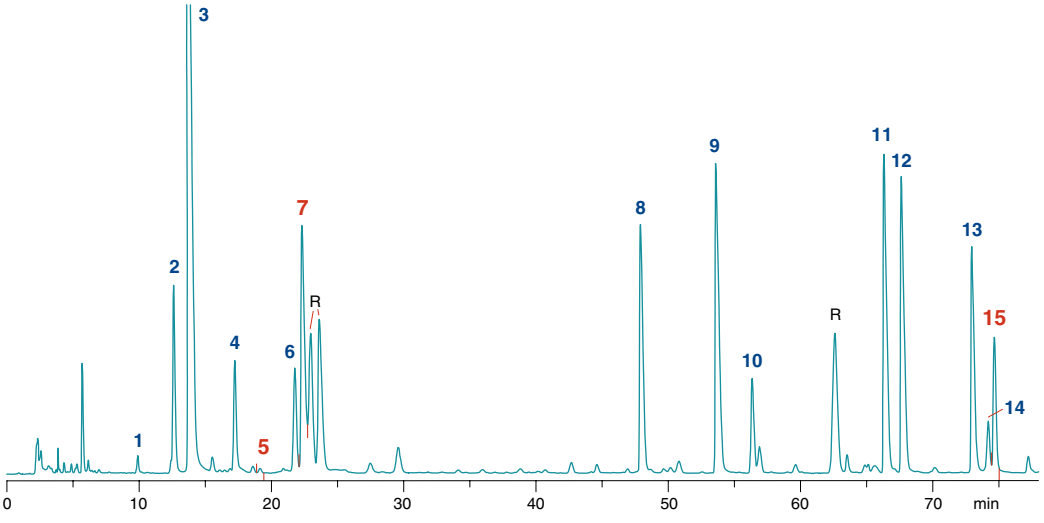
MN Appl. No. 118980

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 for 2 min, 3 – 7.5 % B in 16 min, 7.5 % B for 8 min, 7.5 – 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.



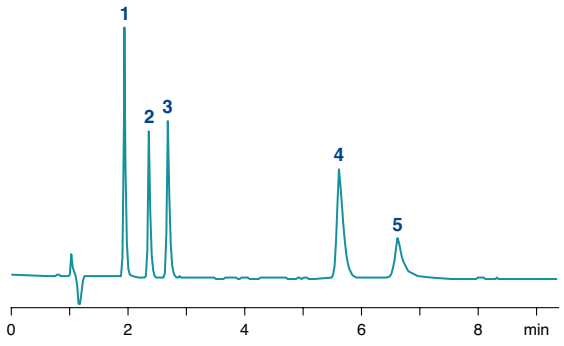
Courtesy of Dr. J. Weinreich, Center for Medical Research, Clinic for General Surgery, University Clinical Center, Tübingen, Germany.

Aromatic amino acids and histamine

MN Appl. No. 122980

Column: 125 x 4 mm NUCLEODUR® 100-3 HILIC
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

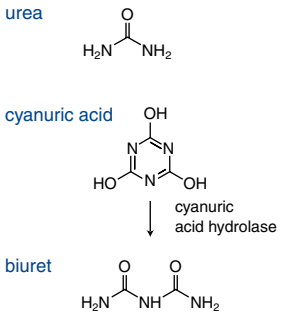


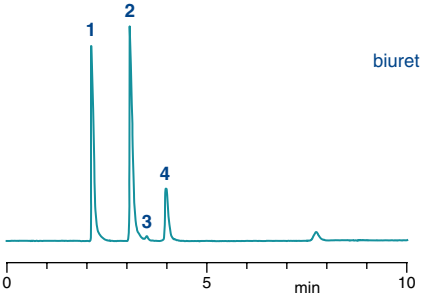
Separation of urea, biuret and cyanuric acid

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)





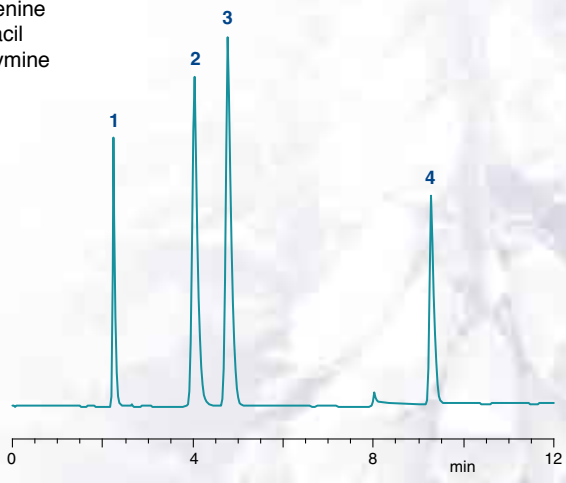
Courtesy of C. Greve, Institute of Chemical Engineering, University of Clausthal, Germany.

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
2.5 min 100 % A, then to 90 % A in 10 min
Flow rate: 1.0 ml/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection volume: 3 µl

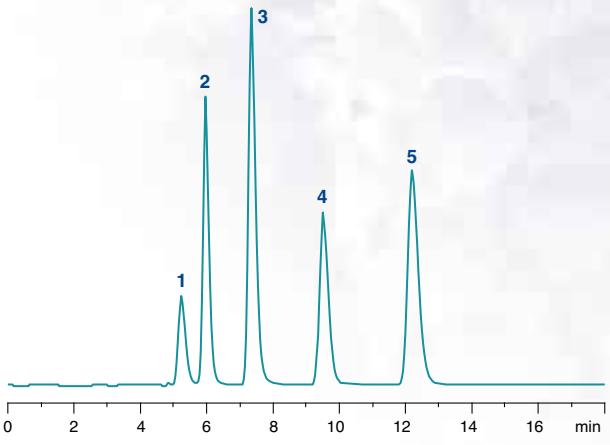
Peaks:
1. Cytosine
2. Adenine
3. Uracil
4. Thymine



MN Appl. No. 122950

Column: 125 x 4 mm NUCLEODUR® 100-5 HILIC
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



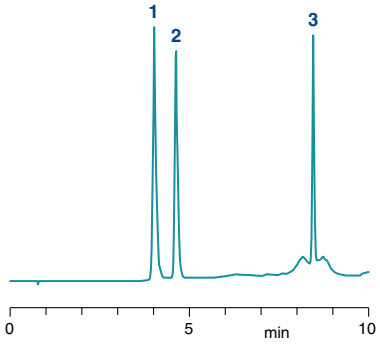
Applications

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 – 70 % B in 4 min, then 70 – 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

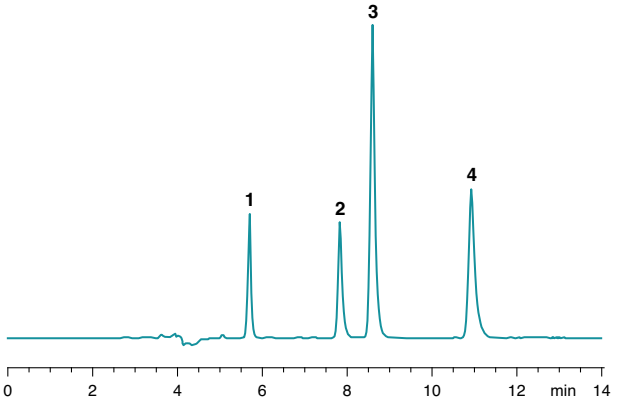


Catecholamines

MN Appl. No. 123030

Column:	250 x 4 mm NUCLEODUR® 100-3 HILIC
Eluent:	acetonitrile – 25 mM ammonium acetate (75:25, v/v)
Flow rate:	0.8 ml/min
Temperature:	25 °C
Detection:	UV, 210 nm
Injection:	5 µl, 30 ng/µl

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

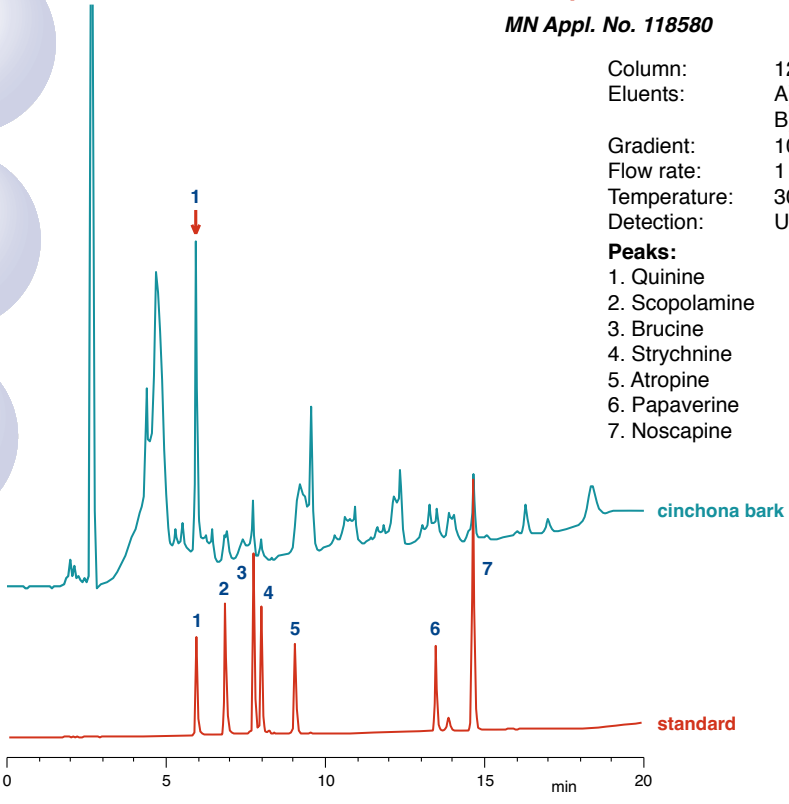


Determination of quinine in cinchona bark

MN Appl. No. 118580

Column:	125 x 4 mm NUCLEODUR® C_8 Gravity, 5 µm
Eluents:	A) 20 mM $NH_4H_2PO_4$, pH 2 B) acetonitrile
Gradient:	10 – 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

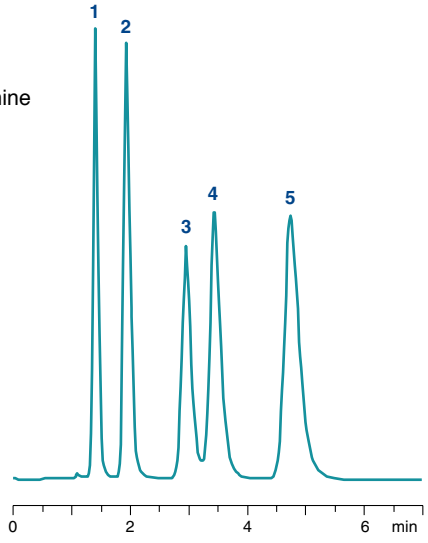


Catecholamines

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

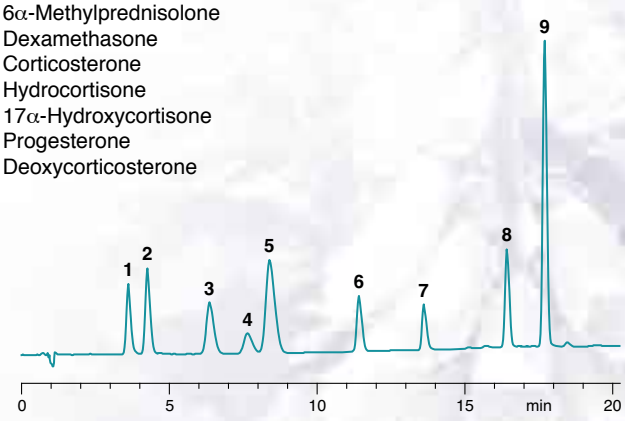


Steroids

MN Appl. No. 122530

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile, B) water
7 min 70 % B, in 16 min to 20 % B, then in 2 min to 70 % B
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

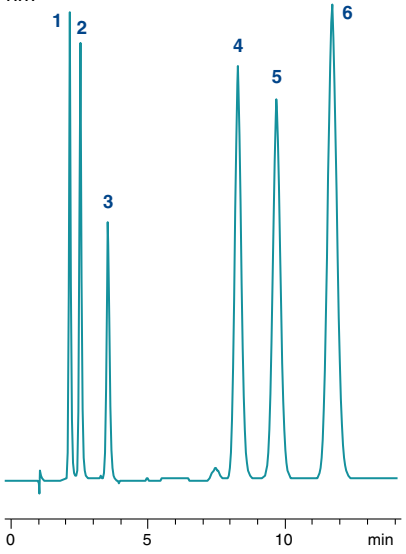


Steroids

MN Appl. No. 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

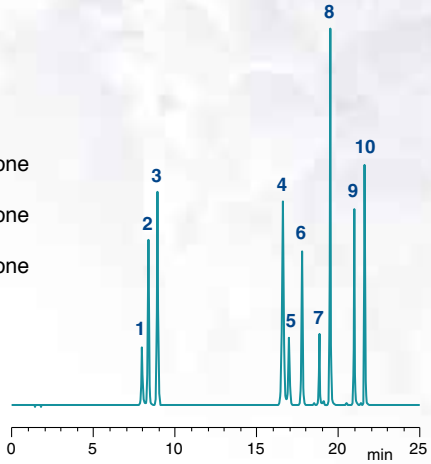


Steroids

MN Appl. No. 118550

Column: 125 x 4 mm NUCLEODUR® 100-5 C_8 ec
Eluent: A) water, B) methanol
1 min 20 % B, 20 – 35 % B in 10 min, 3 min 35 % B, 35 – 60 % B in 6 min, 5 min 60 % B
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



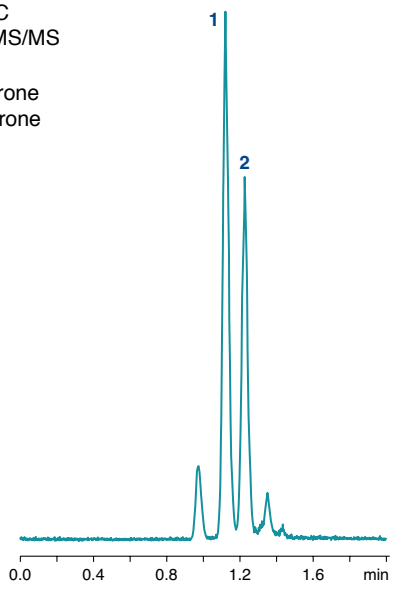
Applications

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 – 60 % A in 1.1 min, 60 – 0 % A in 0.05 min, 0 – 75 % A in 0.05 min, 75 % A for 0.95 min
Flow rate: 0.9 ml/min
Temperature: 70 °C
Detection: LC-MS/MS

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

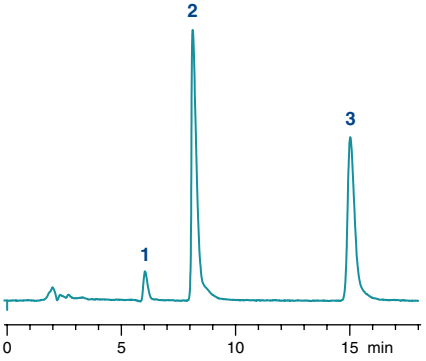


Analysis of mycotoxins

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



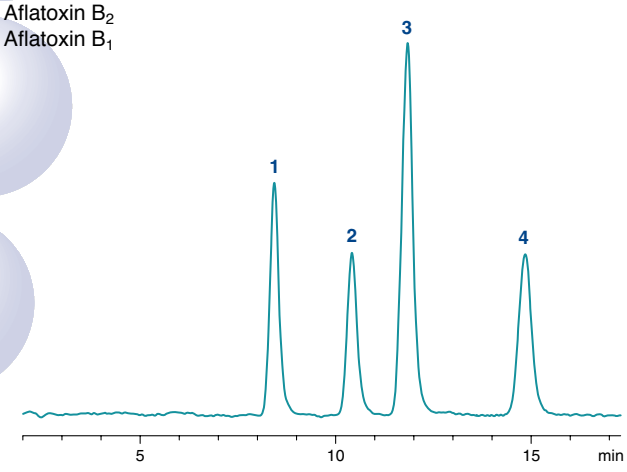
Courtesy of K.H. Ueberschär, Federal Agricultural Research Centre, Institute of Animal Feed, Celle, Germany.

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

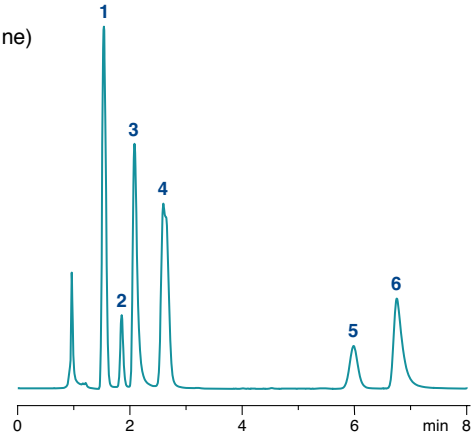


Water-soluble vitamins

MN Appl. No. 122970

Column: 125 x 4 mm NUCLEODUR® 100-3 HILIC
Eluent: A) acetonitrile, B) 25 mM ammonium acetate, pH 4
1 min 80 % A, 80 – 70 % A in 1 min, 11 min 70 % A
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

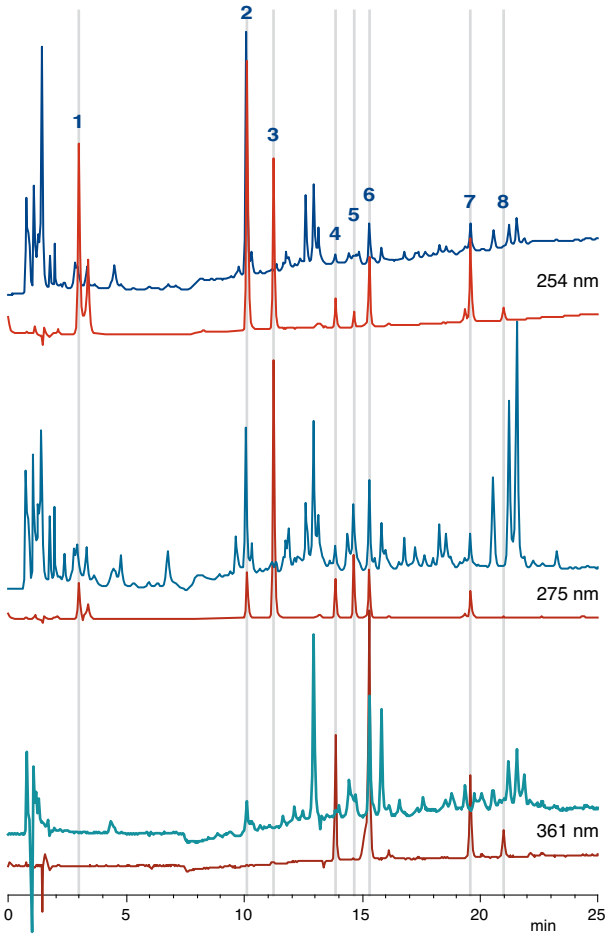
MN Appl. No. 119770

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:
5 min 0 % B, 0 – 10 % B in 2.5 min, 10 – 25 % B in 2.5 min, 25 – 50 % B in 8 min, 50 – 70 % B in 7 min, 70 – 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)

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



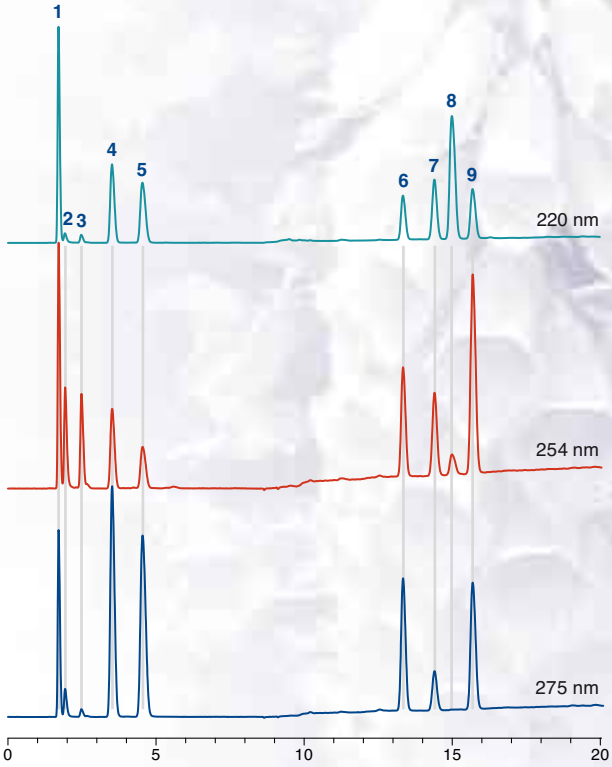
Water-soluble vitamins

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)
6 min 0 % B, 0 – 15 % B in 2 min, 15 – 35 % B in 10 min, 35 % B for 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)



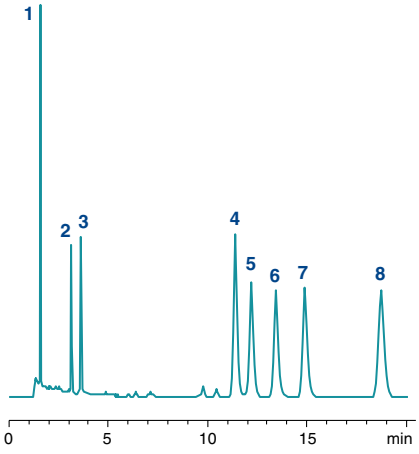
Applications

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

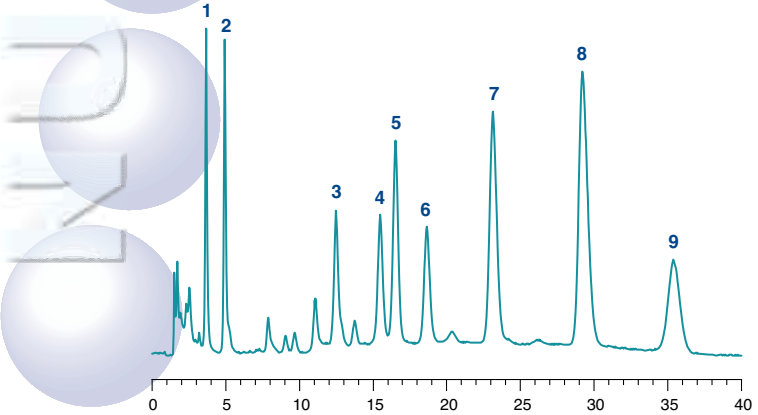
Peaks:
1. Vitamin K_3
2. Vitamin A
3. Vitamin A acetate
4. Vitamin D_2
5. Vitamin D_3
6. Vitamin E (α-tocopherol)
7. Vitamin E acetate (α-tocopherol acetate)
8. Vitamin K_1



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



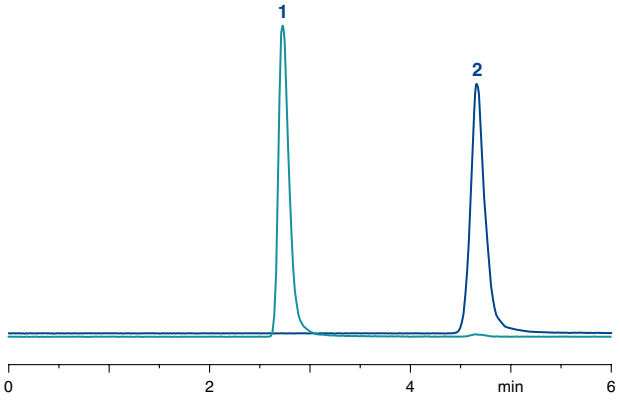
For separation of tocopherols on NUCLEODUR® 100-5 C_{18} ec see appl. 117910 at *www.mn-net.com.*

Creatinine and creatine

MN Appl. No. 122300

Column: 125 x 2 mm NUCLEODUR® 100-3 HILIC
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



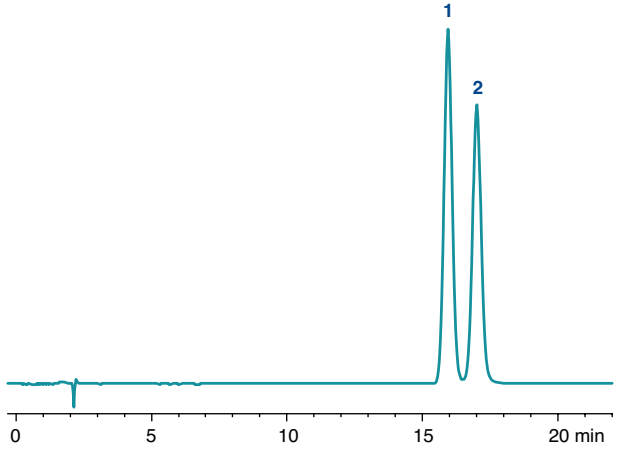
For UV detection see appl. 122990 at *www.mn-net.com.*

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

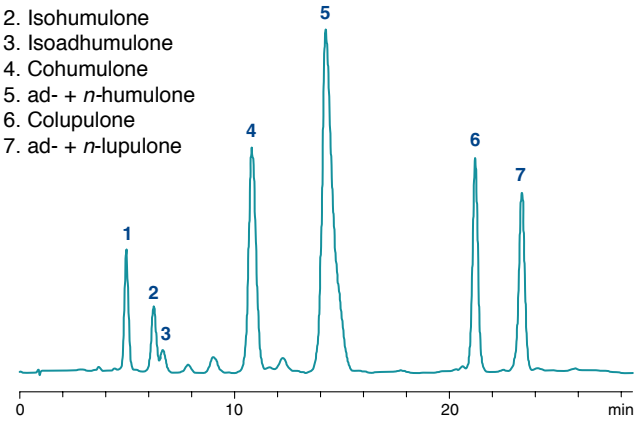


Determination of iso-alpha-acids, alpha- and beta-acids in isomerized hop pellets

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 for 17 min, 100 – 65 % B in 8 min, 65 – 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

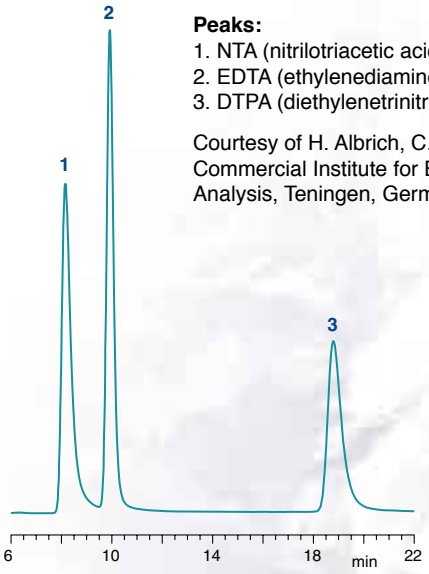


M. Biendl et al., European Brewery Convention, J. of the Institute of Brewing **110** (2004) 242 – 243.

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)

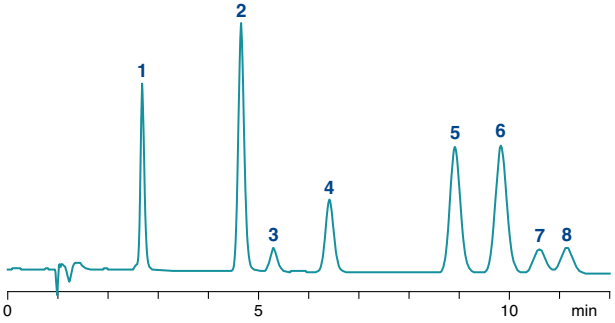
Courtesy of H. Albrich, C. Geis, GIU; Commercial Institute for Environmental Analysis, Teningen, Germany.

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 *p*-aminobenzoic acid
6. Ethylhexyl methoxycinnamate
7. Butyl methoxydibenzoylmethane (BMDBM)
8. Ethylhexyl salicylate



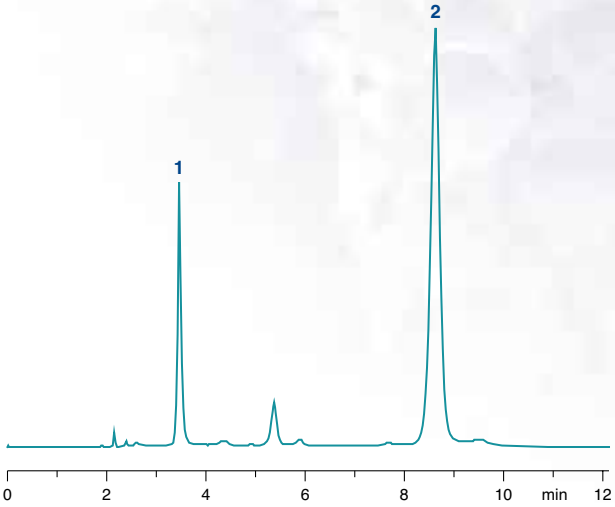
For separation on C_{18} Gravity see appl. 122660 at *www.mn-net.com.*

Ascorbic acid and dehydroascorbic acid

MN Appl. No. 122940

Column: 250 x 4 mm NUCLEODUR® 100-5 HILIC
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



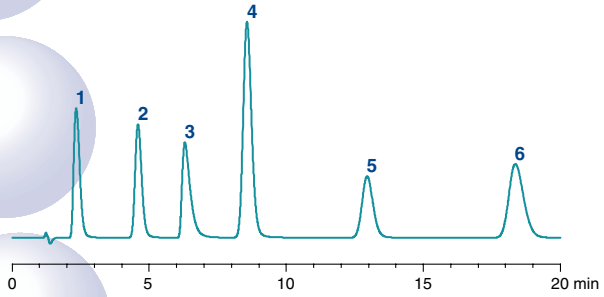
Applications

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

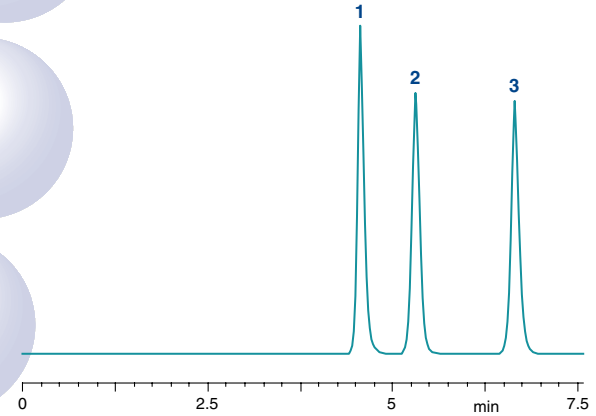


Organic acids

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

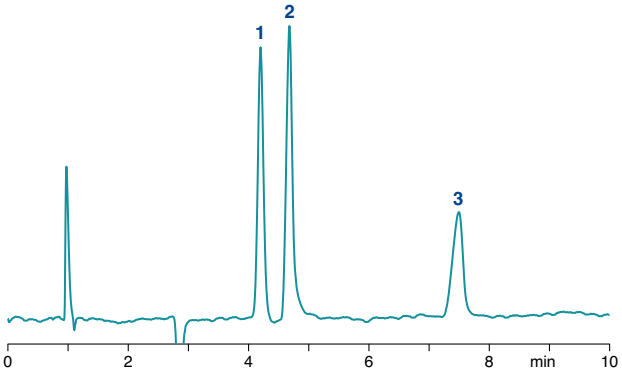


Organic acids

MN Appl. No. 122930

Column: 125 x 4 mm NUCLEODUR® 100-3 HILIC
Eluent: acetonitrile – 200 mM ammonium acetate, pH 6.8 (70:30, v/v)
Flow rate: 0.25 ml/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection volume: 5 µl

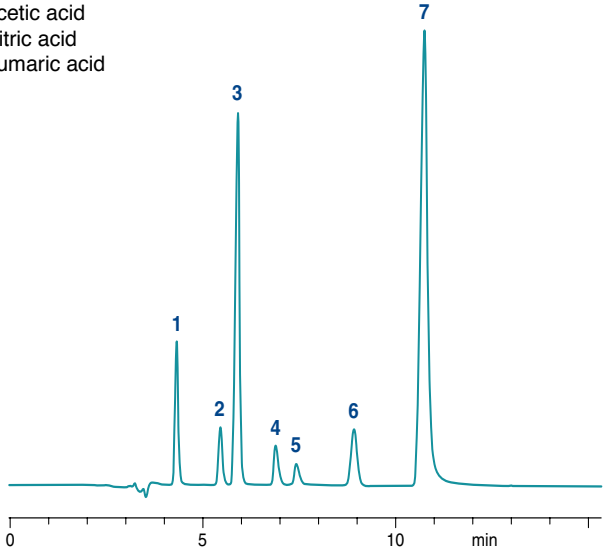
Peaks:
1. Fumaric acid
2. Oxalic acid
3. Citric acid



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, 250 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



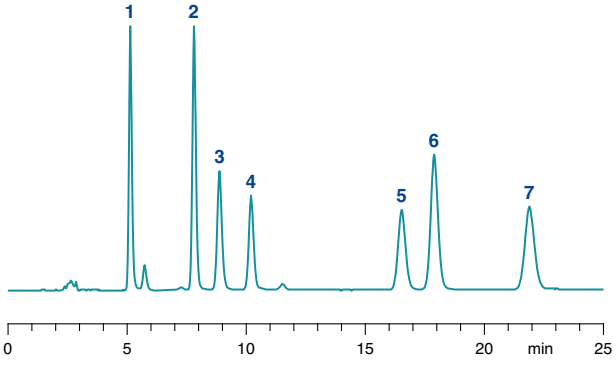
Also see application 119180 at *www.mn-net.com.*

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

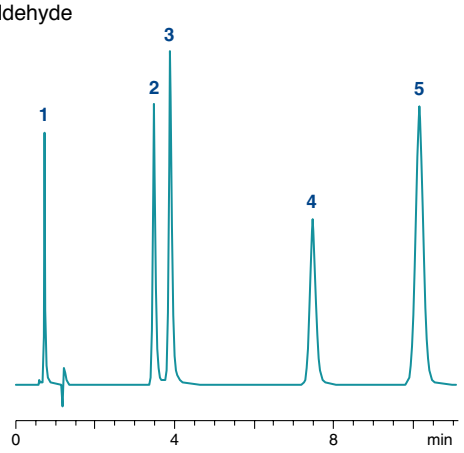


Aromatic aldehydes

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

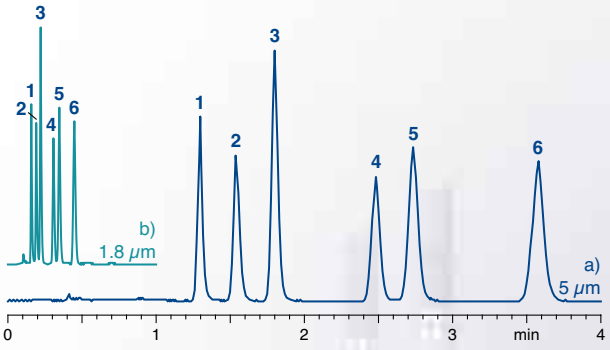


Aromatic ketones

MN Appl. No. 122720 / 122730

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

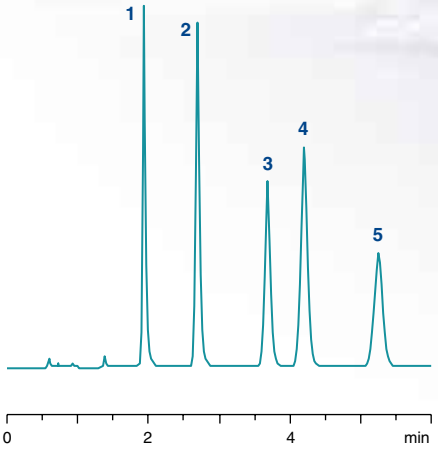
Peaks:
1. Acetophenone
2. Eugenol
3. Propiophenone
4. Butyrophenone
5. Benzophenone
6. Valerophenone



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

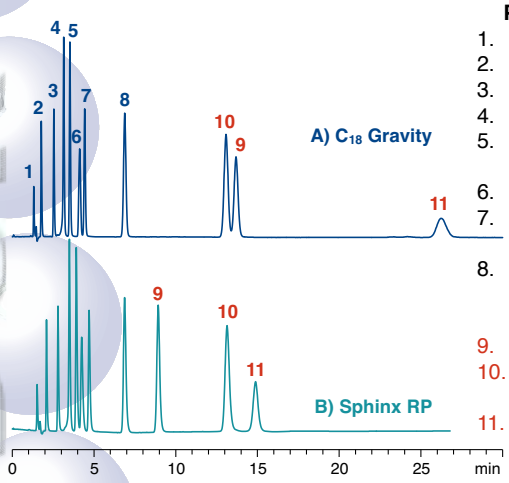


Applications

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

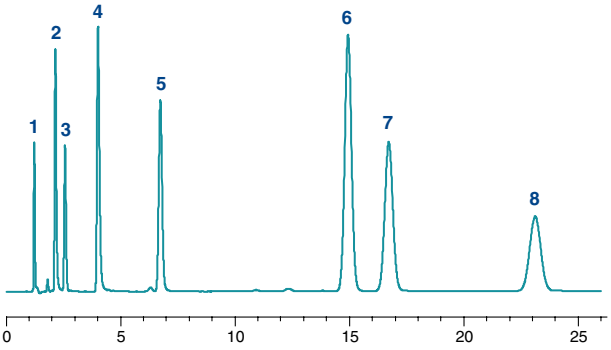
Selectivity comparison of NUCLEODUR® C_{18} Gravity and Sphinx RP shows lower hydrophobicity and retention of Sphinx RP for substituted aromatics like toluene and xylene.

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

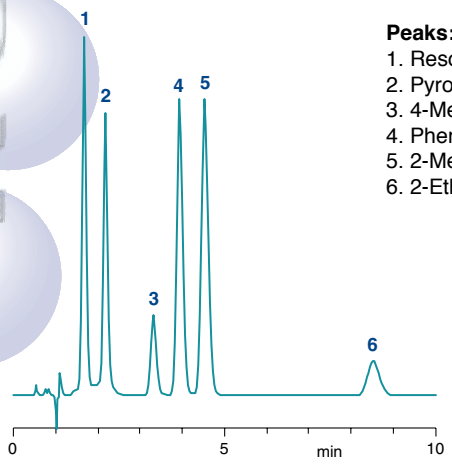
Peaks:
1. Uracil
2. Pyridine
3. Desethylatrazine
4. 4-Acetylpyridine
5. 4-Ethylaniline
6. *N,N*-Dimethylaniline
7. 4-Aminoanthraquinone
8. 3,5-Dinitro-(1-phenylethylbenzamide)



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



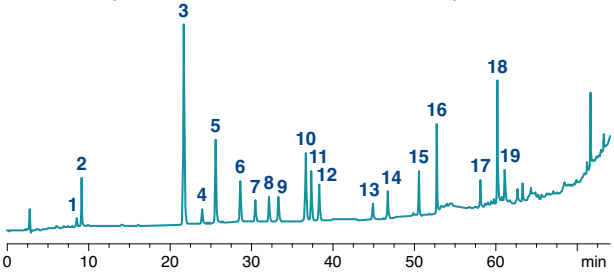
Peaks:
1. Resorcinol
2. Pyrocatechol
3. 4-Methoxyphenol
4. Phenol
5. 2-Methoxyphenol
6. 2-Ethoxyphenol

Amines from aqueous solution

MN Appl. No. 122220

Column: 250 x 4 mm NUCLEODUR® Sphinx RP, 5 µm
Sample prep.: SPE see Appl. 304750 at *www.mn-net.com*
Eluent: A) methanol, B) 0.575 g $NH_4H_2PO_4$ + 0.7 g Na_2HPO_4 + 100 ml methanol in 1 l water, pH 6.9
10 – 50 % A in 40 min, 50 – 100 % A in 32 min
Flow rate: 1.0 ml/min; temperature 30 °C
Detection: UV, 240 nm

Peaks:
1. 4-Methoxy-*m*-phenylenediamine
2. 4-Methyl-*m*-phenylenediamine
3. *o*-Anisidine
4. Benzidine
5. 4,4'-Oxydianiline
6. 4-Chloroaniline
7. 5-Nitro-*o*-toluidine
8. *p*-Cresidine
9. 4,4'-Methylenediamine
10. 2-Naphthylamine
11. 4,4'-Thiodianiline
12. 4-Chloro-*o*-toluidine
13. 4,4'-Methylenedi-*o*-toluidine
14. Xenylamine
15. 4-Aminoazobenzene
16. 3,3'-Dichlorobenzidine
17. 4,4'-Methylene-bis-(2-chloroaniline)
18. *o*-Aminoazotoluene
19. 2,4,5-Trimethylaniline



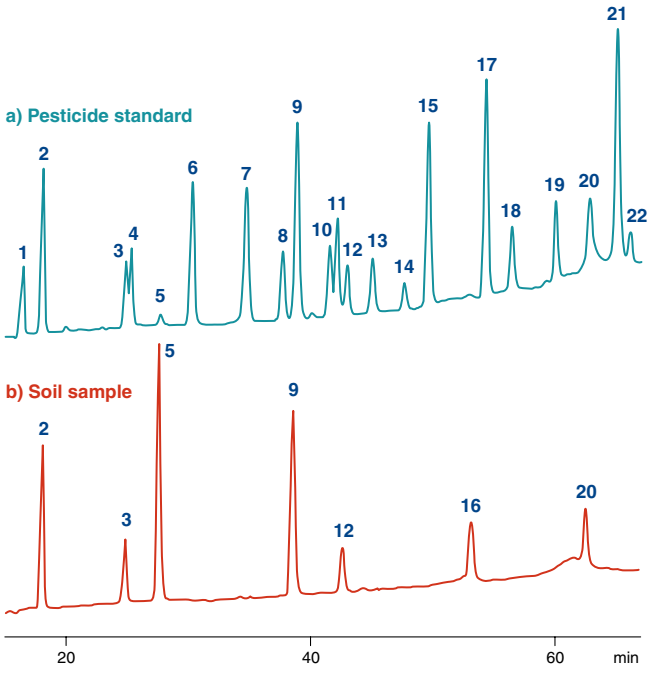
Pesticides from soil

MN Appl. No. 119890

Column:	250 x 4 mm NUCLEODUR® 100-3 C_8 ec
Eluent:	A) water, B) acetonitrile, 10 – 25 % B in 10 min, 25 – 30 % B in 10 min, 5 min at 30 % B, 30 – 40 % B in 20 min, 40 – 50 % B in 20 min, 10 min at 50 % B
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 application 118010 at *www.mn-net.com*.

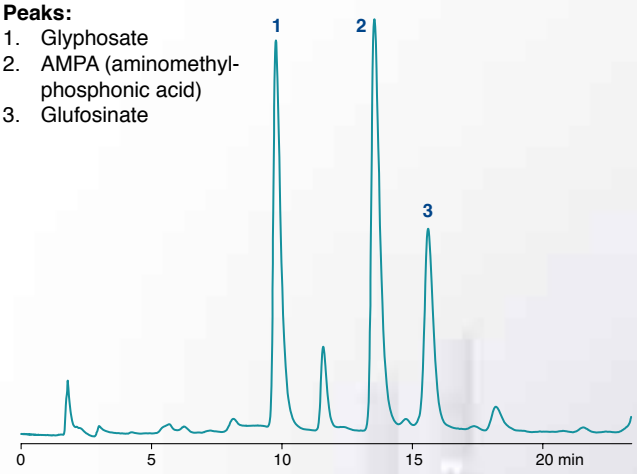
Organophosphorus herbicides

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 – 35 % A in 27 min, 6 min at 90 % A, 90 – 30 % A in 2 min, 7 min at 30 % A
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



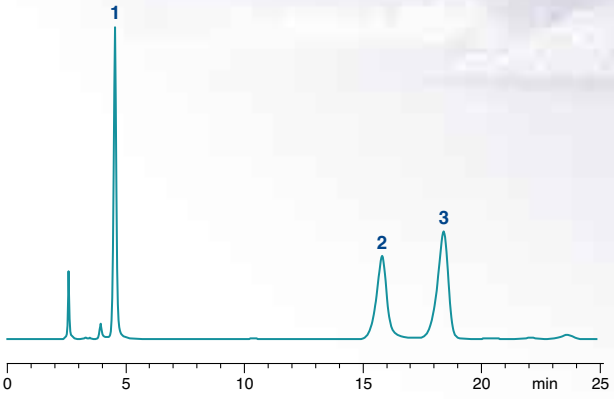
Courtesy of Mr. Schüssler, Mrs. Mikler, Bavarian State Agency for Water Management, Munich.

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

MN Appl. No. 120481: triazines

MN Appl. No. 120482: phenylurea derivatives

MN Appl. No. 120483: phenoxycarboxylic acids

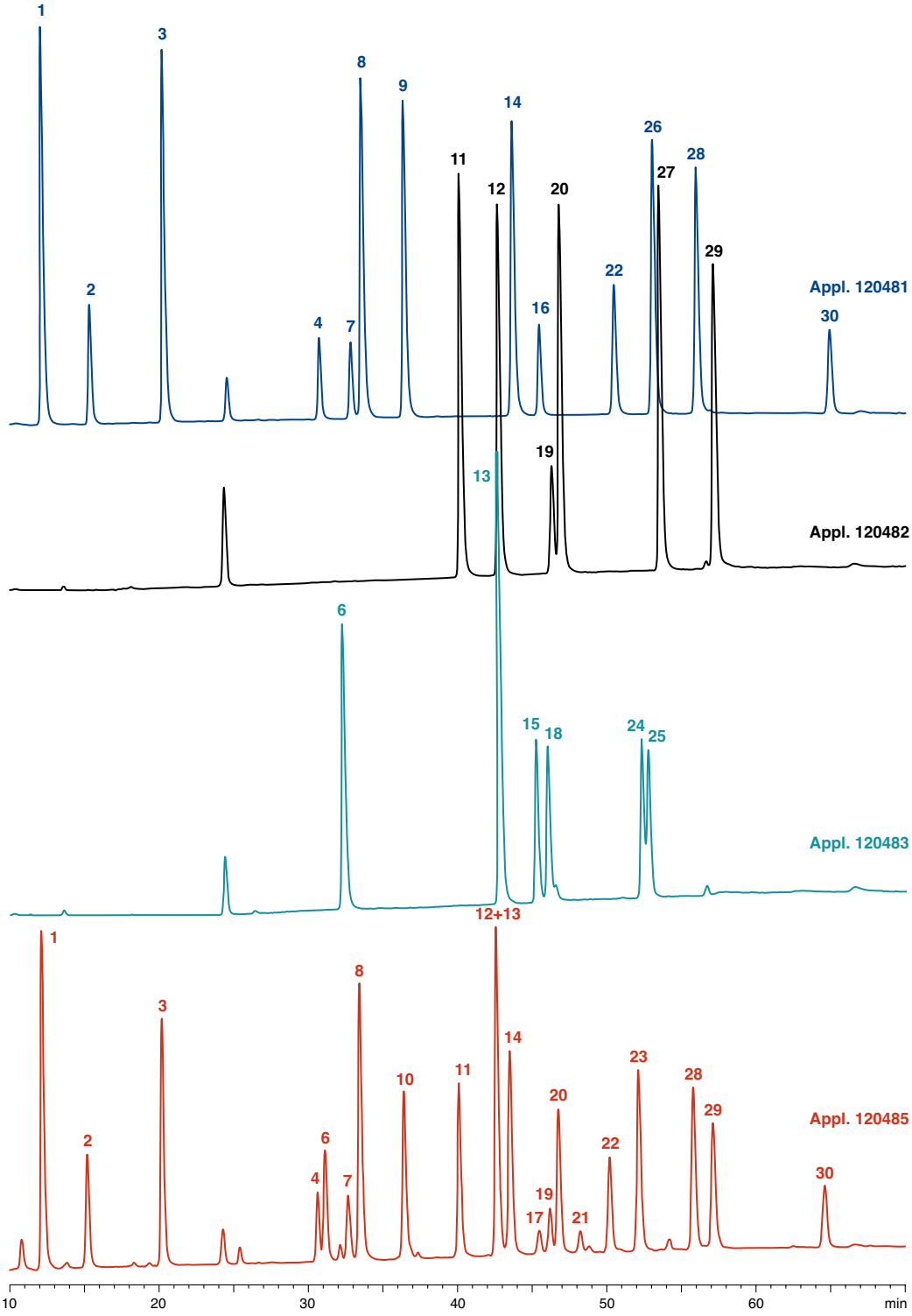
MN Appl. No. 120485: 21 pesticides

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, 5 min at 85 % B, then 85 – 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
22. Metazachlor
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.

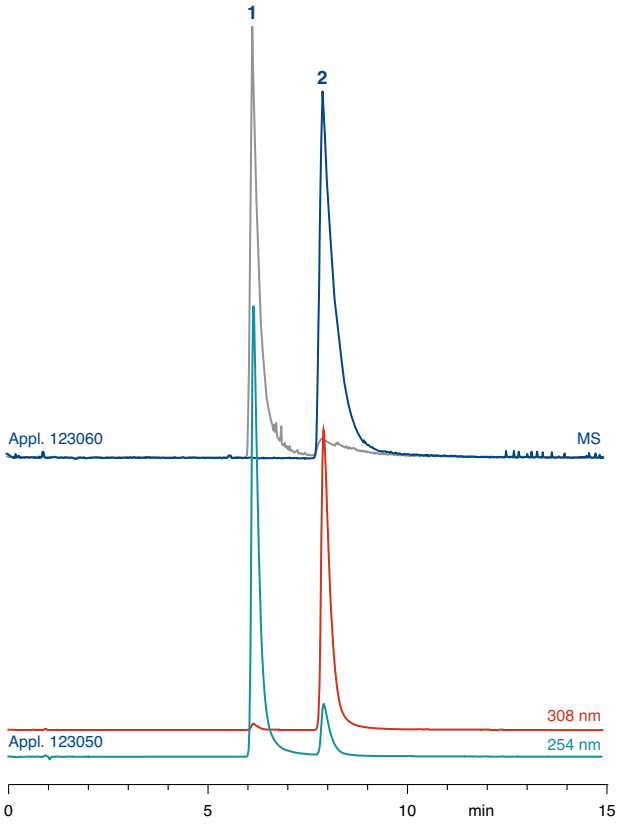


Herbicides

MN Appl. No. 123050 / 123060

Column: 125 x 2 mm NUCLEODUR® 100-3 HILIC
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

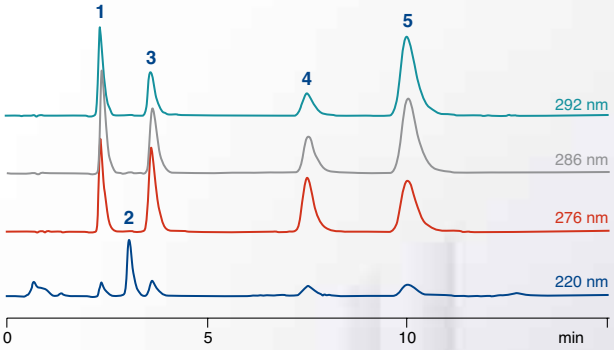


Furfurol and related compounds in transformer oil in accordance with DIN EN 61198-B

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



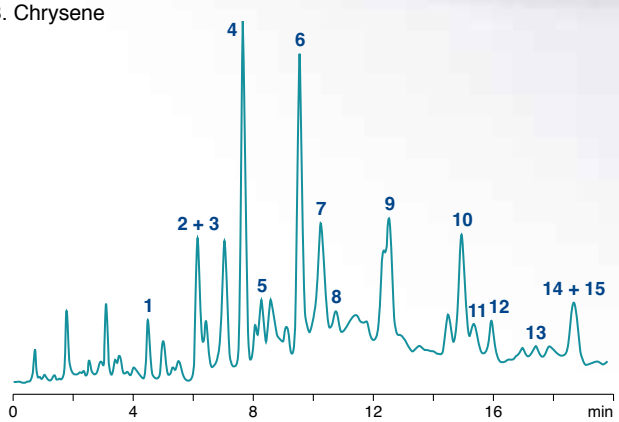
A. Heiseler et al., GIT (2004) 504 – 505

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 for 3 min, 60 – 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

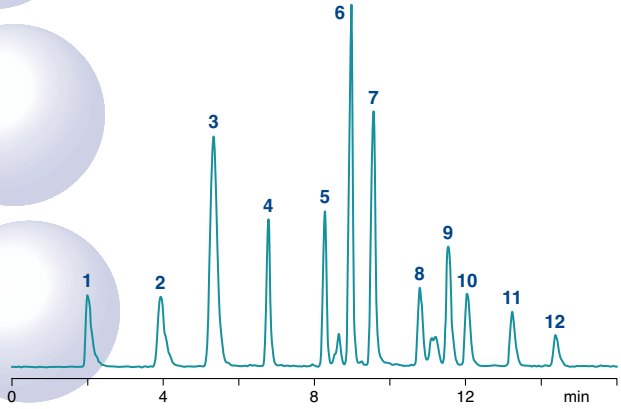
Perfluorinated surfactants in water

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 – 30 % B in 3 min, 30 – 55 % B in 8 min, 55 – 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

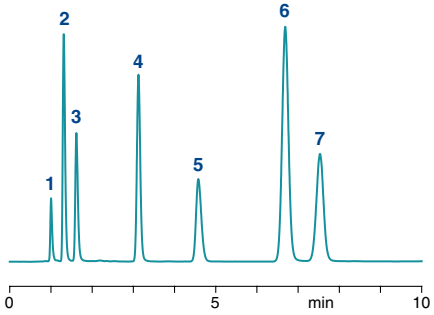
Selectivity test

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



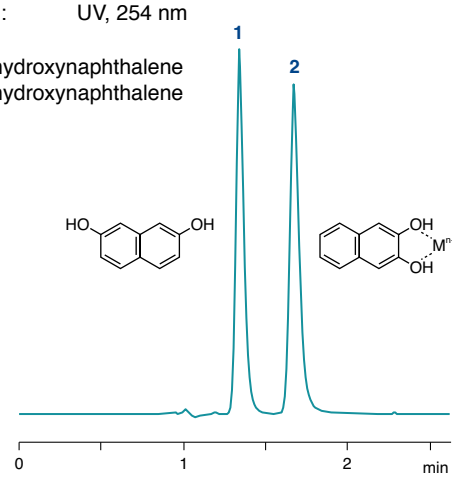
Test for metal ions in silica adsorbent

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.

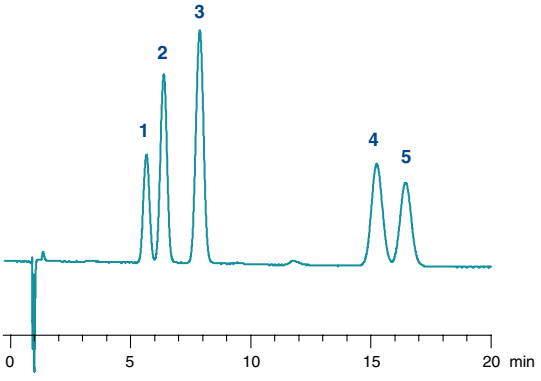
Dihydroxynaphthalenes

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



Alphabetical Index of Analytes

A

Acenaphthene	C_{18} Gravity, 5 µm	7
	C_{18} Pyramid, C_{18} Gravity, C_8 Gravity	13
	Sphinx RP, 5 µm	50
Acenaphthylene	C_{18} Gravity, 5 µm	49
Acesulfam K	100-5 C_8 ec	34
2-Acetamidophen	C_8 Gravity, 5 µm	24
Acetaminophen see Paracetamol		
Acetanilide	C_8 Gravity, 5 µm	24
Acetic acid	C_{18} Pyramid, 5 µm	12, 13, 44
Acetophenone	100-5 C_{18} ec	45
	C_{18} Gravity, 1.8 vs 3 µm	45
	C_{18} Gravity, Sphinx RP, 5 µm	46
2-Acetylfuran	100-5 C_{18} ec	49
4-Acetylpyridine	C_{18} Isis, 5 µm	46
Acetylsalicylic acid	100-5 C_8 ec	25
	100-5 C_{18} ec	24, 26
	C_8 Gravity, 5 µm	24
	C_{18} Gravity, 5 µm	26
	C_{18} Pyramid, 5 µm	24
Acrylamide	100-5 HILIC	35
Adenine	100-5 HILIC	19, 37
	100-5 NH_2-RP	23
	C_{18} Pyramid, 5 µm	37
Adhumulone, adlupulone	100-5 C_{18} ec	43
Adrenaline	100-3 HILIC	38
	C_{18} Gravity, 5 µm	39
Aflatoxins	100-5 C_{18} ec	40
Alanine	100-5 C_{18} ec	36
4-Aminoanthraquinone	C_{18} Isis, 5 µm	46
4-Aminoazobenzene	Sphinx RP, 5 µm	46
o-Aminoazotoluene	Sphinx RP, 5 µm	46
4-Aminobenzoic acid	C_{18} Pyramid, 5 µm	41
γ-Aminobutyric acid	100-5 C_{18} ec	36
Aminomethylphosphonic acid see AMPA		
Amitriptyline	C_8 Gravity, 5 µm	27
	C_{18} Gravity, 5 µm	7, 27
	C_{18} Isis, 5 µm	27
	C_{18} Pyramid, 5 µm	27
Amoxicillin	C_{18} Gravity, 5 µm	33
	C_{18} Pyramid, 5 µm	32
AMPA	100-5 NH_2-RP	23, 47
	C_{18} Gravity, 5 µm	47
o-Anisidine	Sphinx RP, 5 µm	46
Anthracene	C_{18} Gravity, 5 µm	49
Arginine	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Ascorbic acid	100-3 HILIC	40
	100-5 C_8 ec	34
	100-5 HILIC	43
	C_{18} Pyramid, 5 µm	28, 41
Asparagine	100-5 C_{18} ec	36
Aspartame	100-5 C_8 ec	34
Aspartic acid	100-5 C_{18} ec	36
	100-5 CN-RP	44
Atrazine	100-3 C_8 ec	47, 48
Atropine	C_8 Gravity, 5 µm	38
Azorubine	C_{18} Gravity, 5 µm	34

B

Bambuterol	C_{18} Pyramid, 5 µm	29
Beclometasone dipropionate		
	C_{18} Pyramid, 1.8 µm	25
Bentazone	100-3 C_8 ec	48
Benzaldehyde	100-5 C_{18} ec	45
	C_{18} Gravity, Sphinx RP, 5 µm	46
Benzalkonium chlorides	100-5 CN-RP	28
Benzamide	100-5 CN-RP	20, 21
	C_{18} Gravity, 5 µm	8, 13, 46
	C_{18} Pyramid, C_8 Gravity, 5 µm	13
	Sphinx RP, 5 µm	46
Benz[a]anthracene	C_{18} Gravity, 5 µm	49
Benzidine	Sphinx RP, 5 µm	46
Benzocaine	C_{18} Pyramid, 5 µm	24
Benzo[b]fluoranthene	C_{18} Gravity, 5 µm	49
Benzo[k]fluoranthene	C_{18} Gravity, 5 µm	49
Benzoic acid	100-5 C_8 ec	34
	C_{18} Gravity, 5 µm	28
Benzo[ghi]perylene	C_{18} Gravity, 5 µm	49
Benzophenone	100-5 C_{18} ec	45
	C_{18} Gravity, 1.8 vs 3 µm	45
	C_{18} Gravity, 5 µm	13, 46
	C_{18} Pyramid, C_8 Gravity, 5 µm	13
	Sphinx RP, 5 µm	46
Benzophenone-3	100-5 C_{18} ec	43
Benzo[a]pyrene	C_{18} Gravity, 5 µm	49
Betamethasone	C_{18} Isis, 5 µm	42
Biotin	100-3 HILIC	40
	C_{18} Pyramid, 5 µm	41
Biphenyl	100-5 CN-RP	20, 21
	C_{18} Pyramid, C_{18} Gravity, C_8 Gravity	13
	Sphinx RP, 5 µm	50
Biphenyl-2-ol	100-5 C_8 ec / C_{18} ec	17
Biuret	C_{18} Pyramid, 5 µm	37
Bromacil	100-3 C_8 ec	48
Bromazepam	100-5 C_{18} ec	29
Brompheniramine	100-5 C_{18} ec / 100-5 CN-RP	20
Brucine	C_8 Gravity, 5 µm	38
Butacaine	C_{18} Pyramid, 5 µm	24
Butyl methoxydibenzoylmethane		
	100-5 C_{18} ec	43
Butyrophenone	100-5 C_{18} ec	45
	C_{18} Gravity, 1.8 vs 3 µm	45

C

Caffeine	100-5 C_8 ec	34
	100-5 C_{18} ec	16
	C_8 Gravity, 5 µm	24
	C_{18} Gravity, 5 µm	9
	C_{18} Isis, 5 µm	11
	C_{18} Pyramid, 5 µm	28
	Sphinx RP, 5 µm	14, 33
4-Carboxybenzaldehyde	100-5 C_{18} ec	45
Carprofen	100-5 C_8 ec / C_{18} ec	25
Catechin	Sphinx RP, C_{18} Gravity, C_8 Gravity	15
Cefamandole	C_{18} Gravity, 5 µm	32
Cefotaxime	C_{18} Gravity, 5 µm	32
Cefoxitin	C_{18} Gravity, 5 µm	32
Cephalothin	C_{18} Gravity, 5 µm	32
Chloramphenicol	C_{18} Gravity, 5 µm	33
Chlormequat	100-3 HILIC	19
4-Chloroaniline	Sphinx RP, 5 µm	46
Chlorocresol	C_{18} Pyramid, 1.8 µm	25
Chloroprothixene · HCl	C_8 Gravity, 5 µm	26
Chloroquine	C_{18} Gravity, 5 µm	38
4-Chloro-*o*-toluidine	Sphinx RP, 5 µm	46
Chloroxuron	100-3 C_8 ec	47
Chlorpheniramine	100-5 C_{18} ec / 100-5 CN-RP	20
	C_8 Gravity, 5 µm	13
	C_{18} Gravity, 5 µm	13, 28
	C_{18} Pyramid, 5 µm	13, 28
Chlorpromazine	100-5 CN-RP	30
Chlortoluron	100-3 C_8 ec	47, 48
Chrysene	C_{18} Gravity, 5 µm	49
Cimetidine	C_{18} Gravity, 3 µm	28

Substance Index

Cinoxacin	100-5 C_{18} ec	31
	C_{18} Gravity, 5 µm	33
	C_{18} Gravity, C_8 Gravity, C_{18} Pyramid	31
	Sphinx RP, 5 µm	31
Ciprofloxacin	100-5 C_{18} ec	31
	Sphinx RP, 5 µm	31
Citric acid	100-3 HILIC	44
	C_{18} Pyramid, 5 µm	44
Citrulline	C_{18} Gravity, 3 µm	36
Clenbuterol	100-5 CN-RP	29
	C_{18} Pyramid, 5 µm	29
Clobetasol 17-propionate	C_{18} Pyramid, 1.8 µm	25
Clomipramine	100-5 CN-RP	27
	C_{18} Isis, 5 µm	27
Clonidin	100-5 CN-RP	29
Cloxacillin	100-5 C_{18} ec	31, 32
	C_{18} Gravity, 5 µm	33
Cohumulone, colupulone	100-5 C_{18} ec	43
Corticosterone	C_{18} Gravity, 5 µm	39
Cortisone	100-5 C_8 ec	39
	100-5 CN / CN-RP	21
	C_8 Gravity, 5 µm	39
	C_{18} Gravity, 5 µm	39
Creatine, Creatinine	100-3 HILIC	42
p-Cresidine	Sphinx RP, 5 µm	46
Cyanazine	100-3 C_8 ec	47, 48
Cyanocobalamine	100-3 HILIC	40
	C_{18} Pyramid, 5 µm	41
Cyanuric acid	100-5 HILIC	35
	C_{18} Pyramid, 5 µm	37
Cyclohexane	100-5 NH_2	22
Cytosine	100-5 HILIC	19, 37
	100-5 NH_2-RP	23
	C_{18} Pyramid, 5 µm	37

D

2,4-D	100-3 C_8 ec	48
Dehydroascorbic acid	100-5 HILIC	43
Deoxycorticosterone	C_{18} Gravity, 5 µm	39
Desethylatrazine	100-3 C_8 ec	47, 48
	C_{18} Isis, 5 µm	46
Desethylterbuthylazine	100-3 C_8 ec	48
Desisopropylatrazine	100-3 C_8 ec	48
Dexamethasone	C_{18} Gravity, 5 µm	39
	C_{18} Isis, 5 µm	42
Dextromethorphan	C_{18} Gravity, 5 µm	28
	C_{18} Pyramid, 5 µm	28
Dibenz[ah]anthracene	C_{18} Gravity, 5 µm	49
Dibenzothiophene	100-5 NH_2	22
Dibutyl phthalate	C_{18} Gravity, 5 µm	7
Dicamba	100-3 C_8 ec	48
Dichlobenil	100-3 C_8 ec	47
2,4-Dichlorobenzamide	100-3 C_8 ec	48
3,3'-Dichlorobenzidine	Sphinx RP, 5 µm	46
Dichlorprop	100-3 C_8 ec	48
Diclofenac	100-5 C_8 ec	25
	100-5 C_{18} ec	24 – 26
Dicloxacillin	100-5 C_{18} ec, C_{18} Pyramid, 5 µm	32
Diethylenetrinitrilopentaacetic acid		
	C_{18} Pyramid, 5 µm	43
Diflunisal	100-5 C_8 ec	25
	C_{18} Gravity, 5 µm	26
Dihydroxybenzoic acid isomers		
	C_{18} Isis, 5 µm	44
Dihydroxynaphthalene isomers		
	C_8 Gravity, 5 µm	50
	C_{18} Isis, 5 µm	50
	Sphinx RP, 5 µm	50
Dihydroxyphenylalanine	C_{18} Gravity, 5 µm	39
Dimefuron	100-3 C_8 ec	48
N,N-Dimethylaniline	C_{18} Isis, 5 µm	46
1,2-Dimethylbenzene	100-5 NH_2	22
Dimethyl phthalate	100-5 CN-RP	20, 21
	C_{18} Pyramid, C_{18} Gravity, C_8 Gravity	13
3,5-Dinitro-(1-phenylethylbenzamide)		
	C_{18} Isis, 5 µm	46
Diphenhydramine	C_{18} Gravity, 5 µm	8
	C_{18} Pyramid, 5 µm	28
Dipyridamole	C_{18} Gravity, 3 µm	30
Diquat	100-3 HILIC	49
Diuron	100-3 C_8 ec	47, 48
L-DOPA	100-3 HILIC	38
Dopamine	100-3 HILIC	38
Doxepin	100-5 CN-RP	27
	C_8 Gravity, 5 µm	27
	C_{18} Gravity, 5 µm	27
	C_{18} Pyramid, 5 µm	27
DTPA	C_{18} Pyramid, 5 µm	43

E

EDTA	C_{18} Pyramid, 5 µm	43
Enrofloxacin	C_{18} Gravity, 5 µm	33
	Sphinx RP, 5 µm	31
Ephedrine	100-5 C_{18} ec / 100-5 CN-RP	20
Erythrosine	C_{18} Gravity, 5 µm	34
Estradiol, estriol, estrone	100-5 C_8 ec	39
2-Ethoxyphenol	100-5 C_8 ec	17
	100-5 C_{18} ec	17, 46
4-Ethoxyvanillin	100-5 C_{18} ec	45
4-Ethylaniline	C_{18} Isis, 5 µm	46
Ethylbenzene	100-5 C_{18} ec	16
	C_{18} Gravity, 1.8 vs 3 µm	4
	C_{18} Gravity, 5 µm	9
	C_{18} Isis, 5 µm	11
Ethyl benzoate	C_{18} Pyramid, C_{18} Gravity, C_8 Gravity	13
	Sphinx RP, 5 µm	50
Ethylenediaminetetraacetic acid		
	C_{18} Pyramid, 5 µm	43
Ethylhexyldimethyl p-aminobenzoic acid		
	100-5 C_{18} ec	43
Ethylhexyl methoxycinnamate		
	100-5 C_{18} ec	43
Ethylhexyl salicylate	100-5 C_{18} ec	43
Eugenol	C_{18} Gravity, 1.8 vs 3 µm	45

F

Famotidine	C_{18} Gravity, 3 µm	28
Fast Red E	C_{18} Gravity, 5 µm	34
Fast Yellow	C_{18} Gravity, 5 µm	34
Fenoprofen	100-5 C_8 ec	25
	100-5 C_{18} ec	25
	C_{18} Gravity, 5 µm	26
Fenoterol	C_{18} Pyramid, 5 µm	29
Fisetin	Sphinx RP, C_{18} Gravity, C_8 Gravity	15
Flumequine	Sphinx RP, 5 µm	31
Flunarizine · HCl	C_{18} Gravity, 3 µm	30
Fluoranthene	C_{18} Gravity, 5 µm	49
Fluorene	C_{18} Gravity, 5 µm	49
Flurbiprofen	100-5 C_8 ec	25
	100-5 C_{18} ec	26
	C_{18} Gravity, 5 µm	26
	C_{18} Pyramid, 5 µm	24
Folic acid	C_{18} Pyramid, 5 µm	41
Formic acid	C_{18} Pyramid, 5 µm	13
Fructose	100-5 NH_2-RP	22

Fumaric acid	100-3 HILIC	44
	100-5 CN-RP	44
	C_{18} Pyramid, 5 µm	44
2-Furfurol	100-5 C_{18} ec	49
2-Furfuryl alcohol	100-5 C_{18} ec	49

G

Gallic acid	C_{18} Isis, 5 µm	44
	C_{18} Pyramid, 5 µm	34
Glucose	100-5 NH_2-RP	22
Glufosinate	100-5 NH_2-RP	47
	C_{18} Gravity, 5 µm	47
Glutamic acid	100-5 C_{18} ec	36
Glutamine	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Glycine	100-5 C_{18} ec	36
Glyphosate	100-5 NH_2-RP	47
	C_{18} Gravity, 5 µm	47
Guanosine	100-5 HILIC	19, 37

H

Hexamethylbenzene	100-5 NH_2	22
Hexazinone	100-3 C_8 ec	47, 48
Hexobarbital	100-5 C_{18} ec	26
Histamine	100-5 HILIC	37
Histidine	100-5 C_{18} ec	36
	100-5 HILIC	37
	C_{18} Gravity, 3 µm	36
n-Humulone	100-5 C_{18} ec	43
Hydrocortisone	100-5 CN / CN-RP	21
	C_8 Gravity, 5 µm	39
	C_{18} Gravity, 5 µm	39
Hydrocortisone acetate	C_8 Gravity, 5 µm	39
4-Hydroxybenzaldehyde	100-5 C_{18} ec	45
4-Hydroxybenzoic acid	C_{18} Isis, 5 µm	44
17α-Hydroxycortisone	C_{18} Gravity, 5 µm	39
Hydroxymethylfurfural	C_{18} Gravity, 5 µm	35
5-Hydroxymethyl-2-furfurol	100-5 C_{18} ec	49
α-Hydroxymidazolam	C_{18} Gravity, 3 µm	30
4-Hydroxyproline	C_{18} Gravity, 3 µm	36
Hydroxytestosterone isomers		
	C_{18} Isis, 1.8 µm	40
Hydroxytyramine	C_{18} Gravity, 5 µm	39

I

Ibuprofen	100-5 C_8 ec	25
	100-5 C_{18} ec	24, 26
	C_{18} Gravity, 5 µm	26
	C_{18} Pyramid, 5 µm	24
Imipramine	C_8 Gravity, 5 µm	27
	C_{18} Gravity, 5 µm	27
	C_{18} Isis, 5 µm	27
	C_{18} Pyramid, 5 µm	27
Indeno[1,2,3-cd]pyrene	C_{18} Gravity, 5 µm	49
Indomethacin	100-5 C_8 ec	25
	C_{18} Gravity, 5 µm	26
Isoadhumulone	100-5 C_{18} ec	43
Isocohumulone	100-5 C_{18} ec	43
Isohumulone	100-5 C_{18} ec	43
Isoleucine	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Isoproturon	100-3 C_8 ec	47, 48
Isorhamnetin	Sphinx RP, C_{18} Gravity, C_8 Gravity	15

K

Kaempferol	Sphinx RP, C_{18} Gravity, C_8 Gravity	15
Ketoprofen	100-5 C_8 ec	25
	100-5 C_{18} ec	24 – 26
	C_{18} Gravity, 5 µm	8
	C_{18} Pyramid, 5 µm	24

L

Lactic acid	C_{18} Pyramid, 5 µm	44
Lactose	100-5 NH_2-RP	22
Leucine	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Lidocaine	C_8 Gravity, 5 µm	13
	C_{18} Gravity, 5 µm	8, 13
	C_{18} Pyramid, 5 µm	13, 24
	Sphinx RP, 5 µm	50
Linuron	100-3 C_8 ec	47, 48
Lorazepam	100-5 C_{18} ec	29
n-Lupulone	100-5 C_{18} ec	43
Lysine	100-5 C_{18} ec	36

M

Maleic acid	100-5 C_{18} ec	20
	100-5 CN-RP	20, 44
	C_{18} Gravity, 5 µm	28
	C_{18} Pyramid, 5 µm	12
Malic acid	C_{18} Pyramid, 5 µm	44
Maltose	100-5 NH_2-RP	22
Mapenterol	C_{18} Pyramid, 5 µm	29
Maprotiline	C_{18} Isis, 5 µm	27
Marbofloxacin	Sphinx RP, 5 µm	31
MCPA	100-3 C_8 ec	48
Meclofenamic acid	100-5 C_{18} ec	26
Mecoprop	100-3 C_8 ec	48
Medrysone	100-5 CN / CN-RP	21
Mefloquine	C_{18} Gravity, 5 µm	38
Melamine	100-5 HILIC	35
Mephobarbital	100-5 C_{18} ec	26
Mepiquat	100-3 HILIC	19
Metalaxyl	100-3 C_8 ec	48
Metamitron	100-3 C_8 ec	47
Metazachlor	100-3 C_8 ec	47, 48
Methabenzthiazuron	100-3 C_8 ec	47, 48
Methacrylamide	100-5 HILIC	35
Methacrylic acid	100-5 HILIC	35
Methionine	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Methoxyphenol isomers	100-5 C_8 ec	17
	100-5 C_{18} ec	17, 46
4-Methoxy-*m*-phenylenediamine		
	Sphinx RP, 5 µm	46
9-Methylanthracene	100-5 NH_2	22
4-Methylbenzylidine camphor		
	100-5 C_{18} ec	43
4,4'-Methylene-bis-(2-chloroaniline)		
	Sphinx RP, 5 µm	46
4,4'-Methylenediamine	Sphinx RP, 5 µm	46
4,4'-Methylenedi-*o*-toluidine		
	Sphinx RP, 5 µm	46
5-Methyl-2-furfurol	100-5 C_{18} ec	49
Methyl 4-hydroxybenzoate	C_{18} Pyramid, 5 µm	24
6α-Methyl-11β-hydroxyprogesterone		
	100-5 C_8 ec	39
	C_8 Gravity, 5 µm	39
6α-Methyl-17α-hydroxyprogesterone + acetate		
	100-5 C_8 ec	39
	C_8 Gravity, 5 µm	39
4-Methyl-*m*-phenylenediamine		
	Sphinx RP, 5 µm	46
6α-Methylprednisolone	C_{18} Gravity, 5 µm	39

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Methyltestosterone	100-5 CN / CN-RP	21
Metobromuron	100-3 C_8 ec	47, 48
Metolachlor	100-3 C_8 ec	47, 48
Metoxuron	100-3 C_8 ec	47, 48
Midazolam	C_{18} Gravity, 3 µm	30
Monensin sodium	C_{18} Gravity, 3 µm	32
Monolinuron	100-3 C_8 ec	47, 48
N		
Nafcillin	100-5 C_{18} ec, C_{18} Pyramid, 5 µm	32
Nalidixic acid	C_{18} Gravity, 5 µm	33
	C_{18} Gravity, C_8 Gravity, C_{18} Pyramid	31
	Sphinx RP, 5 µm	31
	Sphinx RP, 5 µm	31
Naphthalene	100-3 HILIC	19
	100-5 NH_2	22
	C_{18} Gravity, 1.8 vs 3 µm	4
	C_{18} Gravity, 5 µm	13, 49
	C_{18} Pyramid, C_8 Gravity	13
2-Naphthylamine	Sphinx RP, 5 µm	46
Naproxen	100-5 C_8 ec	25
	C_{18} Gravity, 5 µm	26
Nicardipine	100-5 CN-RP	30
Nicotinamide	100-3 HILIC	40
	C_{18} Pyramid, 5 µm	41
Nicotinic acid	C_{18} Pyramid, 5 µm	41
Nifedipine	100-5 CN-RP	30
	C_{18} Gravity, 3 µm	30
Niflumic acid	C_{18} Gravity, 5 µm	26
Nimodipine	100-5 CN-RP	30
Nisoldipine	100-5 CN-RP	30
Nitrendipine	100-5 CN-RP	30
Nitrilotriacetic acid	C_{18} Pyramid, 5 µm	43
Nitrobenzene	C_{18} Gravity, Sphinx RP, 5 µm	46
Nitrocresol isomers	C_{18} Gravity, 5 µm	45
2-Nitrophenol	C_{18} Gravity, Sphinx RP, 5 µm	46
Nitrophenol isomers	C_{18} Gravity, 5 µm	45
5-Nitro-*o*-toluidine	Sphinx RP, 5 µm	46
Nizatidine	C_{18} Gravity, 3 µm	28
Norephedrine	100-3 HILIC	38
	100-5 C_{18} ec / 100-5 CN-RP	20
	C_{18} Gravity, 5 µm	39
Norgestrel	100-5 CN / CN-RP	21
Nortriptyline	100-5 CN-RP	27
	C_8 Gravity, 5 µm	27
	C_{18} Gravity, 5 µm	27
	C_{18} Isis, 5 µm	27
	C_{18} Pyramid, 5 µm	27
Norvaline	100-5 C_{18} ec	36
Noscapine	C_8 Gravity, 5 µm	38
	C_{18} Gravity, 5 µm	8
NTA	C_{18} Pyramid, 5 µm	43
O		
Octocrylene	100-5 C_{18} ec	43
Ofloxacin	100-5 C_{18} ec	31
Ornithine	C_{18} Gravity, 3 µm	36
Oxalic acid	100-3 HILIC	44
Oxazepam	100-5 C_{18} ec	29
Oxolinic acid	C_{18} Gravity, 5 µm	33
	C_{18} Gravity, C_8 Gravity, C_{18} Pyramid	31
	Sphinx RP, 5 µm	31
4,4'-Oxydianiline	Sphinx RP, 5 µm	46
P		
Papaverine	C_8 Gravity, 5 µm	38
	C_{18} Gravity, 5 µm	8
Paracetamol	100-5 C_{18} ec	20, 24
	100-5 CN-RP	20
	C_8 Gravity, 5 µm	24
	C_{18} Gravity, 5 µm	28
	C_{18} Pyramid, 5 µm	24, 28
Paraquat	100-3 HILIC	49
Patulin	C_{18} Gravity, 5 µm	35
Penicillins G + V	100-5 C_{18} ec	31, 32
	C_{18} Pyramid, 5 µm	32
Penicillin V	C_{18} Gravity, 5 µm	33
Pentobarbital	100-5 C_{18} ec	26
Perfluorinated surfactants	Sphinx RP, 3 µm	50
Phenactin	C_8 Gravity, 5 µm	24
Phenanthrene	C_{18} Gravity, 5 µm	49
Phenetole	100-5 C_8 ec / C_{18} ec	17
	100-5 CN-RP	20, 21
Phenobarbital	100-5 C_{18} ec	26
Phenol	100-5 C_8 ec	17
	100-5 C_{18} ec	17, 46
	C_{18} Gravity, 5 µm	46
	Sphinx RP, 5 µm	15, 46
Phenylalanine	100-5 C_{18} ec	36
	100-5 HILIC	37
	C_{18} Gravity, 3 µm	36
1-Phenyldodecane	100-5 NH_2	22
Phenylglycine	100-5 HILIC	37
Pirenzepine · HCl	C_{18} Gravity, 3 µm	28
Piroxicam	100-5 C_8 ec	25
	100-5 C_{18} ec	25
	C_{18} Gravity, 5 µm	26
Ponceau 4R and 6R	C_{18} Gravity, 5 µm	34
Prednisolone	100-5 C_8 ec	39
	100-5 CN / CN-RP	21
	C_{18} Gravity, 5 µm	39
Procainamide	100-5 CN-RP	29
Progesterone	100-5 C_8 ec	39
	C_{18} Gravity, 5 µm	39
Promazine	100-5 CN-RP	30
Promethazine	100-5 CN-RP	30
Propazine	100-3 C_8 ec	48
Propiophenone	100-5 C_{18} ec	45
	C_{18} Gravity, 1.8 vs 3 µm	45
Propyl 4-hydroxybenzoate	C_{18} Gravity, Sphinx RP, 5 µm	46
Propyzamid	100-3 C_8 ec	47
Protriptyline	C_8 Gravity, 5 µm	27
	C_{18} Gravity, 5 µm	27
	C_{18} Isis, 5 µm	27
	C_{18} Pyramid, 5 µm	27
Pseudoephedrine	C_{18} Gravity, 5 µm	28
Pyrene	C_{18} Gravity, 5 µm	49
Pyridine	C_{18} Gravity, 5 µm	9
	C_{18} Isis, 5 µm	11, 46
	Sphinx RP, 5 µm	15
Pyridoxal	C_{18} Pyramid, 5 µm	41
Pyridoxamine	C_{18} Pyramid, 5 µm	41
Pyridoxine	100-3 HILIC	40
	C_{18} Pyramid, 5 µm	41
Pyridoxine hydrochloride	C_{18} Pyramid, 5 µm	41
Pyrocatechol	100-5 C_8 ec	17
	100-5 C_{18} ec	17, 46
Q		
Quercetin	Sphinx RP, C_{18} Gravity, C_8 Gravity	15
Quinine	100-5 C_8 ec	34
	C_8 Gravity, 5 µm	38
	C_{18} Gravity, 5 µm	38
Quinoline yellow	C_{18} Gravity, 5 µm	34

R

Ractopamine	C_{18} Pyramid, 5 µm	29
Reproterol	C_{18} Pyramid, 5 µm	29
Resorcinol	100-5 C_8 ec	17
	100-5 C_{18} ec	17, 46
Riboflavin	C_{18} Pyramid, 5 µm	41
Ritodrine	C_{18} Pyramid, 5 µm	29
Rutin	C_{18} Pyramid, 5 µm	41
	Sphinx RP, C_{18} Gravity, C_8 Gravity	15

S

Saccharin	100-5 C_8 ec	34
Saccharose	100-5 NH_2-RP	22
Salicylic acid	100-5 C_{18} ec	24
Salinomycin sodium	C_{18} Gravity, 3 µm	32
Sarafloxacin	Sphinx RP, 5 µm	31
Scopolamine	C_8 Gravity, 5 µm	38
Sebuthylazine	100-3 C_8 ec	47, 48
Serine	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Shikimic acid	C_{18} Pyramid, 5 µm	44
Simazine	100-3 C_8 ec	47, 48
Sorbic acid	100-5 C_8 ec	34
Streptomycin	100-5 NH_2-RP	23
Strychnine	C_8 Gravity, 5 µm	38
Succinylsulfathiazole	C_{18} Gravity, 5 µm	33
Sulfadiazine	C_{18} Gravity, 5 µm	33
Sulfadimidine	C_{18} Gravity, 5 µm	33
Sulfamerazine	C_{18} Gravity, 5 µm	33
Sulfanilamide	C_{18} Gravity, 5 µm	33
Sulfathiazole	C_{18} Gravity, 5 µm	33
Sulindac	100-5 C_{18} ec	26
	C_{18} Gravity, 5 µm	26
Sunset yellow CFC	C_{18} Gravity, 5 µm	34
Suprofen	100-5 C_8 ec	25
	100-5 C_{18} ec	25
	C_{18} Gravity, 5 µm	26
Syringic acid	C_{18} Isis, 5 µm	44

T

Tartaric acid	C_{18} Pyramid, 5 µm	12, 44
Tartrazine	C_{18} Gravity, 5 µm	34
Temazepam	100-5 C_{18} ec	29
Terbuthylazine	100-3 C_8 ec	47, 48
Terbutryn	100-3 C_8 ec	47
o-, *m*-, *p*-Terphenyl	C_{18} Isis, 1.8 vs 5 µm	5
	C_{18} Isis, 5 µm	10
o-Terphenyl	C_{18} Isis, 5 µm	11
Testosterone	100-5 C_8 ec	39
	100-5 CN / CN-RP	21
Tetracaine	C_{18} Pyramid, 5 µm	24
Theobromine	Sphinx RP, 5 µm	33
Theophylline	100-5 C_{18} ec	16
	C_{18} Gravity, 5 µm	9
	C_{18} Isis, 5 µm	11
	Sphinx RP, 5 µm	14
Thiamine	100-3 HILIC	40
	C_{18} Pyramid, 5 µm	41
Thiamine · HCl	C_{18} Pyramid, 5 µm	41
Thiamylal	100-5 C_{18} ec	26
4,4'-Thiodianiline	Sphinx RP, 5 µm	46
Threonine	C_{18} Gravity, 3 µm	36
Thymine	100-5 HILIC	19, 37
	100-5 NH_2-RP	23
	C_{18} Pyramid, 5 µm	37
α-Tocopherol see Vitamin E		
Tocopherols	C_{18} Isis, 5 µm	42
Tolmetin	100-5 C_8 ec	25
	100-5 C_{18} ec	26
	C_{18} Gravity, 5 µm	26
Toluene	100-5 C_{18} ec	16
	C_{18} Gravity, 5 µm	9, 46
	C_{18} Isis, 5 µm	11
	Sphinx RP, 5 µm	46
Tribunil see Methabenzthiazuron		
2,4,5-Trimethylaniline	Sphinx RP, 5 µm	46
Trimipramine	100-5 CN-RP	27
	C_8 Gravity, 5 µm	27
	C_{18} Gravity, 5 µm	27
Triphenylene	C_{18} Isis, 1.8 vs 5 µm	5
	C_{18} Isis, 5 µm	10, 11
Tryptophan	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Tyrosine	100-5 C_{18} ec	36
	100-5 HILIC	37
	C_{18} Gravity, 3 µm	36
	C_{18} Gravity, 5 µm	39

U

Uracil	100-3 HILIC	19
	100-5 C_{18} ec	16
	100-5 HILIC	19, 37
	100-5 NH_2-RP	23
	C_{18} Gravity, 5 µm	46
	C_{18} Isis, 5 µm	46
	C_{18} Pyramid, 5 µm	37
	Sphinx RP, 5 µm	46, 50
Urea	C_{18} Pyramid, 5 µm	37

V

Valerophenone	100-5 C_{18} ec	45
	C_{18} Gravity, 1.8 vs 3 µm	45
Valine	100-5 C_{18} ec	36
	C_{18} Gravity, 3 µm	36
Vanillic acid	C_{18} Isis, 5 µm	44
Vanillin	100-5 C_8 ec	34
	100-5 C_{18} ec	45
	Sphinx RP, 5 µm	33
Veratrol	100-5 C_8 ec	17
	100-5 C_{18} ec	16, 17
Vitamin A + acetate	100-5 C_{18} ec	42
	C_{18} Isis, 5 µm	42
Vitamin D_2 / D_3	100-5 C_{18} ec	42
	C_{18} Isis, 5 µm	42
Vitamin E + acetate	100-5 C_{18} ec	42
	C_{18} Isis, 5 µm	42
Vitamin K_1	100-5 C_{18} ec	42
	C_{18} Isis, 5 µm	42
Vitamin K_2	C_{18} Isis, 5 µm	42
Vitamin K_3	100-5 C_{18} ec	42
Vitamins, water-soluble (B_1, B_2, B_6, B_7, B_8, B_9, B_{12}, C, H)		
	100-3 HILIC	40
	C_{18} Pyramid, 5 µm	41

X

Xenylamine	Sphinx RP, 5 µm	46
o-Xylene	100-5 CN-RP	20, 21
Xylene	C_{18} Gravity, Sphinx RP, 5 µm	46
Xylometazoline	100-5 CN-RP	28

Y

Yellow orange S	C_{18} Gravity, 5 µm	34

Z

Zearalenol, Zearalenone	C_{18} Gravity, 5 µm	40

Packed columns

NUCLEODUR® C_{18} Gravity

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® C_{18} Gravity, 1,8 µm								
Particle size 1.8 µm, pore size 110 Å; high density octadecyl phase, endcapped, 18 % C; eluent in column acetonitrile / water								
EC analytical columns								
2 mm ID	760078.20	760079.20	760071.20	760076.20		760075.20		
3 mm ID	760078.30	760079.30						
4 mm ID	760078.40	760079.40						
4.6 mm ID	760078.46	760079.46						
NUCLEODUR® C_{18} Gravity, 3 µm								
Particle size 3 µm, pore size 110 Å; high density octadecyl phase, endcapped, 18 % C; eluent in column acetonitrile / water								
Microbore analytical columns								
1 mm ID				717714.10	717715.10	717716.10	717717.10	
EC analytical columns								
2 mm ID		760080.20			760081.20	760083.20	760082.20	761124.30
3 mm ID		760080.30			760081.30	760083.30	760082.30	761124.30
4 mm ID		760080.40			760081.40	760083.40	760082.40	761124.40
4.6 mm ID		760080.46	760086.46	760084.46	760081.46	760083.46	760082.46	761124.40
NUCLEODUR® C_{18} Gravity, 5 µm								
Particle size 5 µm, pore size 110 Å; high density octadecyl phase, endcapped, 18 % C; eluent in column acetonitrile / water								
Microbore analytical columns								
1 mm ID				717706.10	717707.10	717708.10	717705.10	
EC analytical columns								
2 mm ID		760102.20			760100.20	760103.20	760101.20	761125.30
3 mm ID		760102.30			760100.30	760103.30	760101.30	761125.30
4 mm ID		760102.40			760100.40	760103.40	760101.40	761125.40
4.6 mm ID		760102.46	760106.46	760104.46	760100.46	760103.46	760101.46	761125.40
VarioPrep preparative columns								
10 mm ID		762103.100			762109.100		762113.100	762160.80
21 mm ID		762103.210			762109.210		762113.210	762161.160
32 mm ID							762113.320	
40 mm ID						762100.400	762113.400	
NUCLEODUR® C_{18} Gravity, 10 µm								
Particle size 10 µm, pore size 110 Å; high density octadecyl phase, endcapped, 18 % C; eluent in column acetonitrile / water								
VarioPrep preparative columns								
21 mm ID							762250.210	762161.160
40 mm ID							762250.400	

NUCLEODUR® C_8 Gravity

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *

NUCLEODUR® C_8 Gravity, 1.8 µm

Particle size 1.8 µm, pore size 110 Å; high density octyl phase, endcapped, 11 % C; eluent in column acetonitrile / water

EC analytical columns								
2 mm ID	760756.20	760755.20	760760.20	760757.20		760759.20		
3 mm ID	760756.30	760755.30						
4 mm ID	760756.40	760755.40						
4.6 mm ID	760756.46	760755.46						

NUCLEODUR® C_8 Gravity, 5 µm

Particle size 5 µm, pore size 110 Å; high density octyl phase, endcapped, 11 % C; eluent in column acetonitrile / water

EC analytical columns								
2 mm ID		760750.20			760751.20	760752.20	760753.20	761754.30
3 mm ID		760750.30			760751.30	760752.30	760753.30	761754.30
4 mm ID		760750.40			760751.40	760752.40	760753.40	761754.40
4.6 mm ID		760750.46	760749.46	760754.46	760751.46	760752.46	760753.46	761754.40
VarioPrep preparative columns								
10 mm ID		762081.100			762071.100		762070.100	762097.80
21 mm ID		762081.210			762071.210	762082.210	762070.210	762089.160

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). For 10 mm ID VarioPrep columns 10 x 8 mm ID VP guard columns with VP guard column holder 8 mm (REF 718251) are applied, 21 mm ID VarioPrep columns are used with 20 x 16 mm ID VP guard columns with VP guard column holder 16 mm (REF 718250). ChromCart® guard column cartridges in packs of 3, VP guard columns in packs of 2, all other columns in packs of 1.

Microbore columns with NUCLEODUR® C_8 Gravity on request!

Our HPLC QC policy

- **highest production standard**
  our facilities are EN ISO 9001:2000 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

Packed columns

NUCLEODUR® C_{18} Isis

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® C_{18} Isis, 1.8 µm								
Particle size 1.8 µm, pore size 110 Å; octadecyl phase with high steric selectivity, polymer modification, 20 % C; eluent in column acetonitrile / water								
EC analytical columns								
2 mm ID	760406.20	760405.20	760396.20	760407.20		760409.20		
3 mm ID	760406.30	760405.30						
4 mm ID	760406.40	760405.40						
4.6 mm ID	760406.46	760405.46						
NUCLEODUR® C_{18} Isis, 3 µm								
Particle size 3 µm, pore size 110 Å; octadecyl phase with high steric selectivity, polymer modification, 20 % C; eluent in column acetonitrile / water								
Microbore analytical columns								
1 mm ID		717760.10		717761.10	717762.10			
EC analytical columns								
2 mm ID		760400.20			760402.20	760403.20	760404.20	761300.30
3 mm ID		760400.30			760402.30	760403.30	760404.30	761300.30
4 mm ID		760400.40			760402.40	760403.40	760404.40	761300.40
4.6 mm ID		760400.46	760397.46	760401.46	760402.46	760403.46	760404.46	761300.40
NUCLEODUR® C_{18} Isis, 5 µm								
Particle size 5 µm, pore size 110 Å; octadecyl phase with high steric selectivity, polymer modification, 20 % C; eluent in column acetonitrile / water								
Microbore analytical columns								
1 mm ID		717770.10		717771.10	717772.10			
EC analytical columns								
2 mm ID		760410.20			760412.20	760413.20	760414.20	761310.30
3 mm ID		760410.30			760412.30	760413.30	760414.30	761310.30
4 mm ID		760410.40			760412.40	760413.40	760414.40	761310.40
4.6 mm ID		760410.46	760416.46	760415.46	760412.46	760413.46	760414.46	761310.40
VarioPrep preparative columns								
10 mm ID		762404.100			762405.100		762403.100	762420.80
21 mm ID		762404.210			762405.210		762403.210	762421.160
32 mm ID							762403.320	
40 mm ID						762406.400	762403.400	

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). For 10 mm ID VarioPrep columns 10 x 8 mm ID VP guard columns with VP guard column holder 8 mm (REF 718251) are applied, 21 mm ID VarioPrep columns are used with 20 x 16 mm ID VP guard columns with VP guard column holder 16 mm (REF 718250). ChromCart® guard column cartridges in packs of 3, VP guard columns in packs of 2, all other columns in packs of 1.

NUCLEODUR® C_{18} Pyramid

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® C_{18} Pyramid, 1.8 µm								
Particle size 1.8 µm, pore size 110 Å; octadecyl phase with hydrophilic endcapping, 14 % C; eluent in column acetonitrile / water								
EC analytical columns								
2 mm ID	760271.20	760272.20	760275.20	760273.20		760274.20		
3 mm ID	760271.30	760272.30						
4 mm ID	760271.40	760272.40						
4.6 mm ID	760271.46	760272.46						
NUCLEODUR® C_{18} Pyramid, 3 µm								
Particle size 3 µm, pore size 110 Å; octadecyl phase with hydrophilic endcapping, 14 % C; eluent in column acetonitrile / water								
Microbore analytical columns								
1 mm ID		717740.10		717741.10	717742.10	717743.10	717744.10	
EC analytical columns								
2 mm ID		760263.20			760260.20	760261.20	760262.20	761854.30
3 mm ID		760263.30			760260.30	760261.30	760262.30	761854.30
4 mm ID		760263.40			760260.40	760261.40	760262.40	761854.40
4.6 mm ID		760263.46	760259.46	760264.46	760260.46	760261.46	760262.46	761854.40
NUCLEODUR® C_{18} Pyramid, 5 µm								
Particle size 5 µm, pore size 110 Å; octadecyl phase with hydrophilic endcapping, 14 % C; eluent in column acetonitrile / water								
Microbore analytical columns								
1 mm ID				717722.10	717723.10	717724.10	717725.10	
EC analytical columns								
2 mm ID		760200.20			760201.20	760203.20	760202.20	761800.30
3 mm ID		760200.30			760201.30	760203.30	760202.30	761800.30
4 mm ID		760200.40			760201.40	760203.40	760202.40	761800.40
4.6 mm ID		760200.46	760205.46	760204.46	760201.46	760203.46	760202.46	761800.40
VarioPrep preparative columns								
10 mm ID		762271.100			762273.100		762272.100	762291.80
21 mm ID		762271.210			762273.210		762272.210	762292.160
32 mm ID							762272.320	
40 mm ID						762269.400	762272.400	

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). For 10 mm ID VarioPrep columns 10 x 8 mm ID VP guard columns with VP guard column holder 8 mm (REF 718251) are applied, 21 mm ID VarioPrep columns are used with 20 x 16 mm ID VP guard columns with VP guard column holder 16 mm (REF 718250). ChromCart® guard column cartridges in packs of 3, VP guard columns in packs of 2, all other columns in packs of 1.

Packed columns

NUCLEODUR® Sphinx RP

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *

NUCLEODUR® Sphinx RP, 1.8 µm

Particle size 1.8 µm, pore size 110 Å; special bifunctional RP phase, 14 % C; eluent in column acetonitrile / water

EC analytical columns								
2 mm ID	760821.20	760822.20	760825.20	760823.20		760824.20		
3 mm ID	760821.30	760822.30						
4 mm ID	760821.40	760822.40						
4.6 mm ID	760821.46	760822.46						

NUCLEODUR® Sphinx RP, 3 µm

Particle size 3 µm, pore size 110 Å; special bifunctional RP phase, 14 % C; eluent in column acetonitrile / water

EC analytical columns								
2 mm ID		760806.20			760807.20	760805.20	760808.20	761557.30
3 mm ID		760806.30			760807.30	760805.30	760808.30	761557.30
4 mm ID		760806.40			760807.40	760805.40	760808.40	761557.40
4.6 mm ID		760806.46	760813.46	760812.46	760807.46	760805.46	760808.46	761557.40

NUCLEODUR® Sphinx RP, 5 µm

Particle size 5 µm, pore size 110 Å; special bifunctional RP phase, 14 % C; eluent in column acetonitrile / water

Microbore analytical columns								
1 mm ID		717680.10		717681.10	717682.10	717683.10	717684.10	
EC analytical columns								
2 mm ID		760800.20			760801.20	760802.20	760803.20	761550.30
3 mm ID		760800.30			760801.30	760802.30	760803.30	761550.30
4 mm ID		760800.40			760801.40	760802.40	760803.40	761550.40
4.6 mm ID		760800.46	760815.46	760809.46	760801.46	760802.46	760803.46	761550.40
VarioPrep preparative columns								
10 mm ID		762372.100			762375.100		762373.100	762390.80
21 mm ID		762372.210			762375.210		762373.210	762391.160
32 mm ID							762373.320	
40 mm ID						762371.400	762373.400	

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 64.
VarioPrep columns: axially adjustable endfitting; available dimensions see page 62.

NUCLEODUR® C_{18} ec

Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® 100-3 C_{18} ec							
Particle size 3 µm, pore size 110 Å; octadecyl phase, endcapped, 17.5 % C; eluent in column acetonitrile / water							
EC analytical columns							
2 mm ID	760050.20			760051.20		760052.20	761005.30
3 mm ID	760050.30			760051.30		760052.30	761005.30
4 mm ID	760050.40			760051.40		760052.40	761005.40
4.6 mm ID	760050.46	760046.46	760054.46	760051.46	760053.46	760052.46	761005.40
NUCLEODUR® 100-5 C_{18} ec							
Particle size 5 µm, pore size 110 Å; octadecyl phase, endcapped, 17.5 % C; eluent in column acetonitrile / water							
Microbore analytical columns							
1 mm ID			717701.10	717700.10	717702.10	717703.10	
EC analytical columns							
2 mm ID	760004.20			760001.20		760002.20	761100.30
3 mm ID	760004.30			760001.30		760002.30	761100.30
4 mm ID	760004.40			760001.40		760002.40	761100.40
4.6 mm ID	760004.46	760035.46	760013.46	760001.46	760008.46	760002.46	761100.40
VarioPrep preparative columns							
10 mm ID	762003.100			762029.100		762022.100	762090.80
21 mm ID	762003.210			762029.210		762022.210	762091.160
32 mm ID						762022.320	
40 mm ID					762027.400	762022.400	
NUCLEODUR® 100-10 C_{18} ec							
Particle size 10 µm, pore size 110 Å; octadecyl phase, endcapped, 17.5 % C; eluent in column acetonitrile / water							
VarioPrep preparative columns							
10 mm ID	762011.100			762302.100		762010.100	762090.80
21 mm ID	762011.210			762302.210		762010.210	762091.160
32 mm ID						762010.320	
40 mm ID					762303.400	762010.400	
50 mm ID						762010.500	

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). For 10 mm ID VarioPrep columns 10 x 8 mm ID VP guard columns with VP guard column holder 8 mm (REF 718251) are applied, 21 mm ID VarioPrep columns are used with 20 x 16 mm ID VP guard columns with VP guard column holder 16 mm (REF 718250). ChromCart® guard column cartridges in packs of 3, VP guard columns in packs of 2, all other columns in packs of 1.

Packed columns

NUCLEODUR® C_8 ec

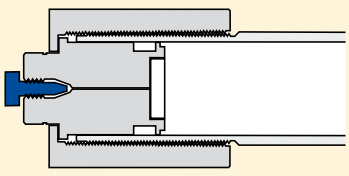
Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® 100-3 C_8 ec							
Particle size 3 µm, pore size 110 Å; octyl phase, endcapped, 10.5 % C; eluent in column acetonitrile / water							
EC analytical columns							
2 mm ID	760063.20			760060.20		760062.20	761012.30
3 mm ID	760063.30			760060.30		760062.30	761012.30
4 mm ID	760063.40			760060.40		760062.40	761012.40
4.6 mm ID	760063.46	760064.46	760059.46	760060.46	760061.46	760062.46	761012.40
NUCLEODUR® 100-5 C_8 ec							
Particle size 5 µm, pore size 110 Å; octyl phase, endcapped, 10.5 % C; eluent in column acetonitrile / water							
EC analytical columns							
2 mm ID	760700.20			760701.20		760703.20	761704.30
3 mm ID	760700.30			760701.30		760703.30	761704.30
4 mm ID	760700.40			760701.40		760703.40	761704.40
4.6 mm ID	760700.46	760706.46	760704.46	760701.46	760702.46	760703.46	761704.40
VarioPrep preparative columns							
10 mm ID	762072.100			762061.100		762062.100	762092.80
21 mm ID	762072.210			762061.210		762062.210	762093.160
32 mm ID						762062.320	
40 mm ID					762079.400	762062.400	

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). For 10 mm ID VarioPrep columns 10 x 8 mm ID VP guard columns with VP guard column holder 8 mm (REF 718251) are applied, 21 mm ID VarioPrep columns are used with 20 x 16 mm ID VP guard columns with VP guard column holder 16 mm (REF 718250). ChromCart® guard column cartridges in packs of 3, VP guard columns in packs of 2, all other columns in packs of 1.

Microbore columns with NUCLEODUR® C_8 ec on request!

VarioPrep column system for preparative HPLC

Standard dimensions of VarioPrep columns with axially adjustable endfitting:

ID [mm]	Length [mm]								Endfitting design
	10*	20*	50	100	125	150	250	500	
8	x		x	x	x		x		
10			x	x	x		x	x	
16		x	x	x	x		x		
21			x	x	x	x	x		
32				x		x	x		
40			x	x	x	x	x	x	
50				x		x	x		
80				x			x	x	

* For 8 and 10 mm ID VarioPrep columns 10 x 8 mm ID guard column cartridges are applied with guard column adapter 8 mm (REF 718251); 16 and 21 mm ID VarioPrep columns are used with 20 x 16 mm ID guard column cartridges with guard column adapter 16 mm (REF 718250).

On request, all VarioPrep column dimensions are available with any NUCLEODUR® or NUCLEOSIL® packing.

NUCLEODUR® HILIC

Length →	50 mm	100 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® 100-3 HILIC						
Particle size 3 µm, pore size 110 Å; zwitterionic phase for HILIC chromatography, 7 % C; eluent in column acetonitrile / water 80:20						
EC columns						
2 mm ID	760532.20		760531.20		760530.20	761580.30
3 mm ID	760532.30		760531.30		760530.30	761580.30
4 mm ID	760532.40		760531.40		760530.40	761580.40
4.6 mm ID	760532.46	760534.46	760531.46	760533.46	760530.46	761580.40
NUCLEODUR® 100-5 HILIC						
Particle size 5 µm, pore size 110 Å; zwitterionic phase for HILIC chromatography, 7 % C; eluent in column acetonitrile / water 80:20						
EC columns						
2 mm ID	760552.20		760551.20		760550.20	761590.30
3 mm ID	760552.30		760551.30		760550.30	761590.30
4 mm ID	760552.40		760551.40		760550.40	761590.40
4.6 mm ID	760552.46	760554.46	760551.46	760553.46	760550.46	761590.40

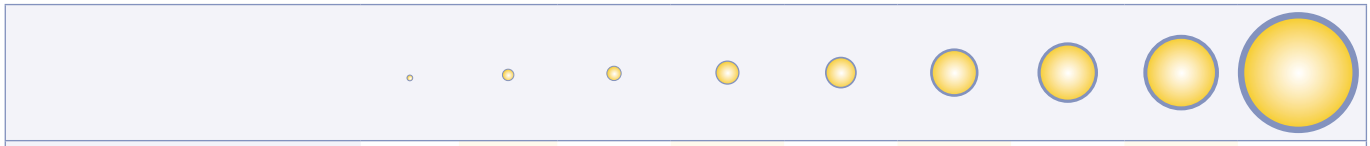
* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). Guard column cartridges in packs of 3, EC columns in packs of 1.

Microbore columns and preparative columns with NUCLEODUR® HILIC on request!

VarioPrep guard column holders and replacement parts · ordering information

Description	Pack of	REF
VP guard column holder 8 mm for VarioPrep columns with 8 and 10 mm ID	1	**718251**
O ring for VP guard column holder 8 mm	2	**718975**
VP guard column holder 16 mm for VarioPrep columns with 16 and 21 mm ID	1	**718250**
O ring for VP guard column holder 16 mm	2	**718976**

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	27.6	64	100	161.3	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® CN and CN-RP

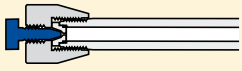
Length →	50 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® 100-3 CN-RP					
Particle size 3 µm, pore size 110 Å; cyano phase (nitrile), 7 % C; eluent in column acetonitrile / water					
EC columns					
2 mm ID	760159.20	760157.20			761430.30
3 mm ID		760157.30			761430.30
4 mm ID			760156.40		761430.40
4.6 mm ID			760156.46		761430.40
NUCLEODUR® 100-5 CN-RP					
Particle size 5 µm, pore size 110 Å; cyano phase (nitrile), 7 % C; eluent in column acetonitrile / water					
EC columns					
4 mm ID		760153.40		760152.40	761420.40
4.6 mm ID		760153.46	760154.46	760152.46	761420.40
NUCLEODUR® 100-5 CN					
Particle size 5 µm, pore size 110 Å; cyano phase (nitrile), 7 % C; eluent in column *n*-heptane					
EC columns					
4 mm ID		760151.40		760150.40	761419.40
4.6 mm ID		760151.46	760149.46	760150.46	761419.40

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). Guard column cartridges in packs of 3, EC columns in packs of 1.

Microbore columns and preparative columns with NUCLEODUR® CN/CN-RP on request!

The EC standard HPLC column system from MACHEREY-NAGEL

Available standard dimensions · please ask for availability of certain phases

ID [mm]	Length [mm]											Endfitting design
	8*	20	30	50	75	100	125	150	200	250	300	
2	-	x	x	x	x	x	x	x	x	x	x	
3	x	x	x	x	x	x	x	x	x	x	x	
4	x	x	x	x	x	x	x	x	x	x	x	
4.6	-	x	x	x	x	x	x	x	x	x	x	

* ChromCart® guard column cartridges for EC columns

EC guard column adaptor · installation and ordering information




Description	Pack	REF
Guard column adapter EC	1	**721359**

NUCLEODUR® NH_2 and NH_2-RP

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® 100-3 NH_2-RP					
Particle size 3 µm, pore size 110 Å; amino phase, 2.5 % C; eluent in column acetonitrile / water					
EC columns					
2 mm ID	760740.20	760741.20			761035.30
4.6 mm ID			760742.46	760739.46	761035.40
NUCLEODUR® 100-5 NH_2-RP					
Particle size 5 µm, pore size 110 Å; amino phase, 2.5 % C; eluent in column acetonitrile / water					
EC columns					
2 mm ID		760730.20		760732.20	761137.30
3 mm ID		760730.30		760732.30	761137.30
4 mm ID		760730.40		760732.40	761137.40
4.6 mm ID		760730.46	760731.46	760732.46	761137.40
NUCLEODUR® 100-5 NH_2					
Particle size 5 µm, pore size 110 Å; amino phase, 2.5 % C; eluent in column *n*-heptane					
EC columns					
4 mm ID		760720.40		760722.40	761130.40
4.6 mm ID		760720.46	760721.46	760722.46	761130.40

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). Guard column cartridges in packs of 3, EC columns in packs of 1.

Microbore columns and preparative columns with NUCLEODUR® CN/CN-RP on request!

Unmodified NUCLEODUR®

Length →	50 mm	125 mm	150 mm	250 mm	Guard columns *
NUCLEODUR® 100-3					
Particle size 3 µm, pore size 110 Å; unmodified; eluent in column *n*-heptane					
EC analytical columns					
4.6 mm ID	760170.46		760172.46	760173.46	761007.40
NUCLEODUR® 100-5					
Particle size 5 µm, pore size 110 Å; unmodified; eluent in column *n*-heptane					
EC analytical columns					
4 mm ID				760007.40	761055.40
4.6 mm ID	760023.46		760012.46	760007.46	761055.40
VarioPrep preparative columns					
10 mm ID	762077.100	762078.100		762007.100	762094.80
21 mm ID	762077.210	762078.210		762007.210	762095.160
40 mm ID			762075.400	762007.400	

* As guard columns for EC columns use 8 mm ChromCart® guard column cartridges with guard column adaptor EC (REF 721359). For 10 mm ID VarioPrep columns 10 x 8 mm ID VP guard columns with VP guard column holder 8 mm (REF 718251) are applied, 21 mm ID VarioPrep columns are used with 20 x 16 mm ID VP guard columns with VP guard column holder 16 mm (REF 718250). ChromCart® guard column cartridges in packs of 3, VP guard columns in packs of 2, all other columns in packs of 1.

Microbore columns with unmodified NUCLEODUR® on request!

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