USP listing

USP specification of MN HPLC phases

Code	Specification	MN HPLC Phases	Page
USP L1	octadecyl silane chemically bonded to porous silica particles 1.5 to 10 µm diameter, or monolithic silica gel	NUCLEODUR® C_{18} ec	181
		NUCLEODUR® C_{18} Gravity	158
		NUCLEODUR® C_{18} Gravity-SB	162
		NUCLEODUR® C_{18} HTec	178
		NUCLEODUR® C_{18} Isis	164
		NUCLEODUR® C_{18} Pyramid	166
		NUCLEODUR® PolarTec	168
		NUCLEODUR® Sphinx RP	176
		NUCLEOSHELL® RP 18	200
		NUCLEOSHELL® RP 18plus	202
		NUCLEOSIL® C_{18}	220
		NUCLEOSIL® C_{18} AB	220
		NUCLEOSIL® C_{18} HD	220
		NUCLEOSIL® Nautilus	221
		NUCLEOSIL® C_{18} MPN	250
		NUCLEOSIL® C_{18} PPN	251
USP L3	porous silica particles, 1.5 to 10 µm diameter, or monolithic silica gel	NUCLEODUR® SiOH	190
		NUCLEOSIL® SiOH	230
USP L7	octyl silane chemically bonded to totally porous silica particles, 1.8 to 10 µm diameter	NUCLEODUR® C_8 ec	181
		NUCLEODUR® C_8 Gravity	158
		NUCLEOSIL® C_8	224
		NUCLEOSIL® C_8 HD	224
USP L8	an essentially monomolecular layer of aminopropyl silane chemically bonded to totally porous silica gel support, 1.5 to 10 µm diameter	NUCLEODUR® NH_2 / NH_2-RP	188
		NUCLEOSIL® Carbohydrate	254
		NUCLEOSIL® NH_2 / NH_2-RP	227
USP L9	irregular or spherical, totally porous silica gel having a chemically bonded, strongly acidic cation-exchange coating, 3 to 10 µm diameter	NUCLEOSIL® SA	229
USP L10	nitrile groups chemically bonded to porous silica particles, 1.5 to 10 µm diameter	NUCLEODUR® CN / CN-RP	186
		NUCLEOSIL® CN / CN-RP	228
USP L11	phenyl groups chemically bonded to porous silica particles, 1.5 to 10 µm diameter	NUCLEODUR® Phenyl-Hexyl	170
		NUCLEODUR® π^2	172
		NUCLEOSHELL® Phenyl-Hexyl	207
		NUCLEODUR® Sphinx RP	176
		NUCLEOSIL® C_6H_5	226
USP L14	silica gel having a chemically bonded, strongly basic quaternary ammonium anion-exchange coating, 5 to 10 µm diameter	NUCLEOSIL® SB	229
USP L16	dimethylsilane chemically bonded to porous silica particles, 5 to 10 µm diameter	NUCLEOSIL® C_2	225
USP L17	strong cation-exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the H form, 6 to 12 µm diameter	NUCLEOGEL® ION 300 OA	256
		NUCLEOGEL® SUGAR 810 H	255
USP L19	strong cation-exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the Ca form, 5 to 15 µm particle size	NUCLEOGEL® SUGAR 810 Ca	255
		NUCLEOGEL® SUGAR Ca	256
USP L20	dihydroxypropane groups chemically bonded to porous silica particles, 5 to 10 µm diameter	NUCLEOSIL® OH (Diol)	226
USP L21	a rigid, spherical styrene-divinylbenzene copolymer, 5 to 10 µm diameter	NUCLEOGEL® RP	252
USP L22	a cation-exchange resin made of porous polystyrene gel with sulfonic acid groups, about 10 µm in size	NUCLEOGEL® SCX	247
USP L23	an anion-exchange resin made of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, about 10 µm in size	NUCLEOGEL® SAX	247
USP L26	butyl silane chemically bonded to totally porous silica particles, 5 to 10 µm diameter	NUCLEODUR® C_4 ec	248
		NUCLEOSIL® C_4	225
		NUCLEOSIL® C_4 MPN	250
USP L32	a chiral ligand-exchange resin packing · L-proline copper complex covalently bonded to irregular shaped silica particles, 5 to 10 µm diameter	NUCLEOSIL® CHIRAL-1	242
USP L34	strong cation-exchange resin consisting of sulfonated cross-linked PS-DVB copolymer in the Pb form, 5 to 7 µm particle size	NUCLEOGEL® SUGAR Pb	256
USP L36	a 3,5-dinitrobenzoyl derivative of L-phenylglycine covalently bonded to 5 µm aminopropyl silica	NUCLEOSIL® CHIRAL-3	243
USP L40	cellulose tris-(3,5-dimethylphenylcarbamate) coated porous silica particles, 5 to 20 µm diameter	NUCLEOCEL *DELTA*	240

USP listing

USP specification of MN HPLC phases

Code	Specification	MN HPLC Phases	Page
USP L43	pentafluorophenyl groups chemically bonded to silica particles by a propyl spacer, 1.5 to 10 µm diameter	NUCLEODUR® PFP	174
		NUCLEOSHELL® PFP	212
USP L45	beta-cyclodextrin bonded to porous silica particles, R,S-hydroxypropyl ether derivative, 3 to 10 µm diameter	NUCLEODEX β-OH, β-PM	238
USP L58	strong cation-exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the Na form, 6 to 30 µm diameter	NUCLEOGEL® SUGAR Na	256
USP L60	spherical porous silica gel, particle size of 10 µm diameter or smaller, the surface of which has been covalently modified with alkyl amide groups and endcapped	NUCLEODUR® PolarTec	168
		NUCLEOSIL® C_{18} Nautilus	220
USP L75	A chiral-recognition protein, bovine serum albumin (BSA), chemically bonded to silica particles, about 7 µm in diameter, with a pore size of 300 Angstrom	RESOLVOSIL BSA-7	241
USP L118	Aqueous polymerized C_{18} groups on silica particles, 1.2 to 5 µm in diameter	NUCLEODUR® C_{18} PAH	234
		NUCLEOSIL® C_{18} PAH	236

Phase overview for special separations

Overview

Separation / mechanism	Recommended column	Specification of the phase	Page
Environmental analysis			
Anion exchange chromatography of inorganic anions	NUCLEOSIL® Anion I	Strongly basic silica-based anion exchanger	237
RP chromatography of PAHs	NUCLEODUR® C_{18} PAH	NUCLEODUR® polymer-coated with C_{18} groups USP L1	234
	NUCLEOSIL® 100-5 C_{18} PAH	NUCLEOSIL® 100 polymer-coated with C_{18} groups USP L1	236
RP chromatography of PFAS	NUCLEODUR® PFAS	Silica-based column for PFAS analysis	232
Enantiomer separation			
Polar and π-π interactions	NUCLEOCEL *DELTA*	Silica-based modified cellulose phases USP L40	240
Formation of inclusion complexes	NUCLEODEX α-PM, β-PM, γ-PM and β-OH	Silica-based permethylated and underivatized cyclodextrin phases USP L45	238
Enantioselective binding to chiral protein surface structures	RESOLVOSIL BSA-7	Silica-based protein phase (BSA)	241
Ligand exchange	NUCLEOSIL® CHIRAL-1	Covalently bonded amino acid – Cu(II) complexes USP L32	242
Charge-transfer, dipole-dipole interactions and others	NUCLEOSIL® CHIRAL-2 NUCLEOSIL® CHIRAL-3	Silica-based brush type phases USP L36	243
Separation of biological macromolecules			
Anion exchange chromatography of oligonucleotides and nucleic acids	NUCLEOGEN® DEAE	Silica-based DEAE anion exchanger	244
Anion exchange chromatography of peptides, large proteins and oligonucleotides	NUCLEOGEL® SAX	Polymer-based strongly basic anion exchanger USP L23	247
Cation exchange chromatography of proteins, peptides and carbohydrates	NUCLEOGEL® SCX	Polymer-based strong cation exchanger USP L22	247
Reversed phase chromatography of proteins, peptides and oligonucleotides	NUCLEOSIL® MPN	Monomerically bonded alkyl chains on silica USP L1 / USP L26	250
	NUCLEOSIL® PPN	Polymerically bonded alkyl chains on silica USP L1	251
	NUCLEOGEL® RP 300	Polystyrene – divinylbenzene polymer USP L21	252
Reversed phase chromatography of small molecules	NUCLEOGEL® RP 100	Small pore macroporous PS-DVB polymer USP L21	252
Food analysis · sugars and organic acids			
RP chromatography of organic acids	NUCLEODUR® C_{18} OA	Reversed phase with polar selectivity for organic acid analysis	253
RP chromatography of mono- and oligosaccharides	NUCLEOSIL® Carbohydrate	Silica-based special amino phase USP L8	254
Separation of sugars, alcohols, org. acids based on ion exclusion, ion exchange, size exclusion, ligand exchange, NP and RP effects	NUCLEOGEL® SUGAR 810 H, Ca	Resins with sulfonic acid modification in different ionic forms H form USP L17 / Ca form L19 / Pb form L34 / Na form L58	255
Separation of sugars, alcohols, org. acids based on steric exclusion, ligand exchange and partition effects	NUCLEOGEL® SUGAR Ca, Na, Pb NUCLEOGEL® ION 300 OA		256
Gel permeation chromatography (GPC)			
Water-insoluble compounds	NUCLEOGEL® GPC	Polystyrene – divinylbenzene polymer	257

NUCLEODUR® PFAS special reversed phase for PFAS analysis

Technical data

- Base material NUCLEODUR® silica, particle size 3 µm, pore size 110 Å; pH stability 1.0 – 9.0

Recommended application

- Analysis of PFAS

PFAS analysis according to EPA 533

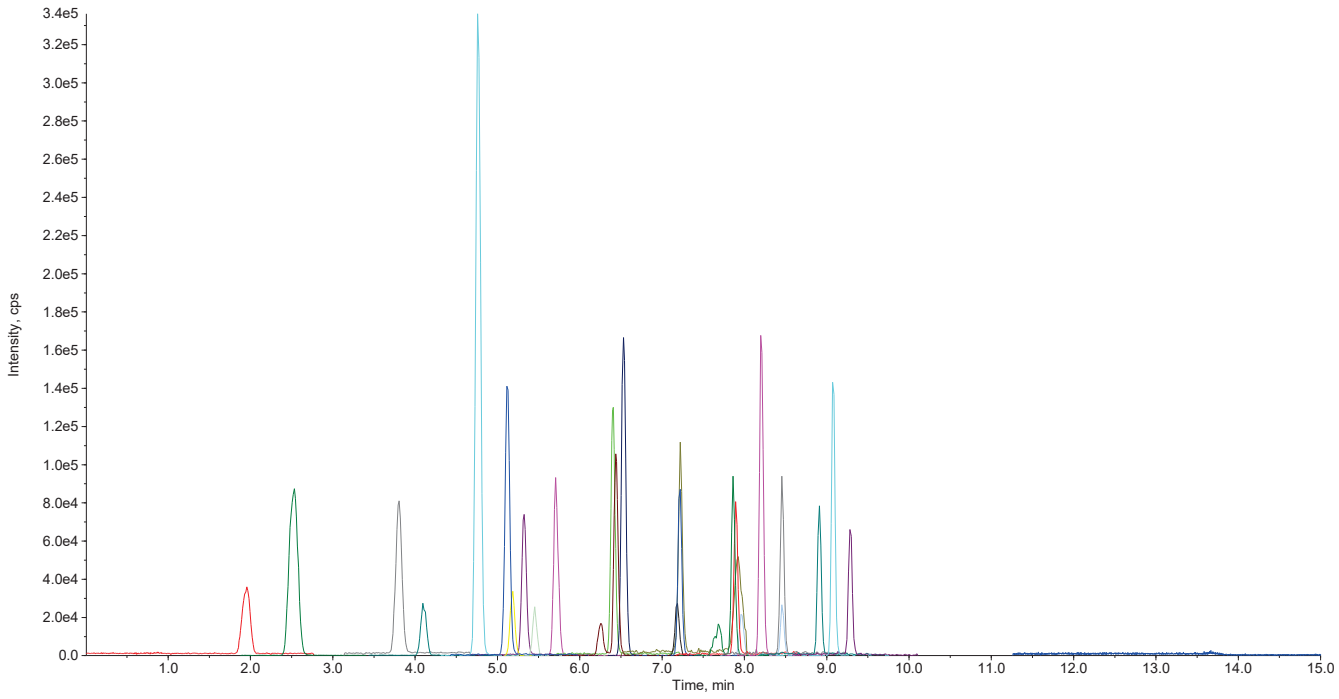
MN Appl. No. 129090

Delay Column: EC 50/2 NUCLEODUR® PFAS Delay , 5 µm (REF 760673.20)
Analytical Column: EC 100/2 NUCLEODUR® PFAS, 3 µm (REF 760666.20)
Eluent:
A) 5 mM ammonium acetate in water
B) 5 mM ammonium acetate in methanol
Gradient: hold 40 % B for 1.0 min, in 8 min from 40 % B to 95 % B, hold 95 % B for 3.0 min, in 0.1 min to 40 % B, hold 40 % B for 2.9 min
Flow rate: 0.3 mL/min, temperature 40 °C
MS conditions: AB Sciex QTRAP 5500
Acquisition mode: SRM

Interface: ESI
Polarity: negative
Curtain gas: 30 psig
Collision Gas: medium
Ion spray voltage: -4500 V
Temperature: 400 °C
Ion source gas 1: 50 psig
Ion source gas 2: 60 psig
Detection window: 60 s

Peaks:

1. PFBA
2. PFMPA
3. PFPeA
4. PFBS
5. PFEESA
6. NFDHA
7. 4:2-FTS
8. PFHxA
9. PFPeS
10. HFPO-DA
11. PFHpA
12. PFHxS
13. ADONA
14. 6:2-FTS
15. PFOA
16. PFHpS
17. PFOS
18. PFNA
19. PFMBA
20. 9Cl-PF_3ONS
21. PFDA
22. 8:2-FTS
23. PFUnA
24. 11-Cl-PF_3OUdS
25. PFDoA



Chromatogram of PFAS according to EPA 533 on NUCLEODUR® PFAS EC 100/2 mm column (β = 1.0 ng/mL for each compound)

Eluent in column acetonitrile – water (70:30, v/v)

ID	Length → 50 mm	100 mm
NUCLEODUR® PFAS, 3 µm; particle size 3 µm		
Analytical EC columns		
2 mm	760663.20	760666.20
NUCLEODUR® PFAS Delay, 5 µm; particle size 5 µm		
Delay column		
2 mm	760673.20	

HPLC columns for environmental analyses

Analysis of per- and polyfluoroalkyl substances (PFAS) by HPLC

PFAS are organic compounds with a carbon chain in which hydrogen is substituted by fluorine. The carbon-fluorine bond is very strong which makes them “virtually indestructable“, so that these chemicals are very persistent in the environment and in the human body.

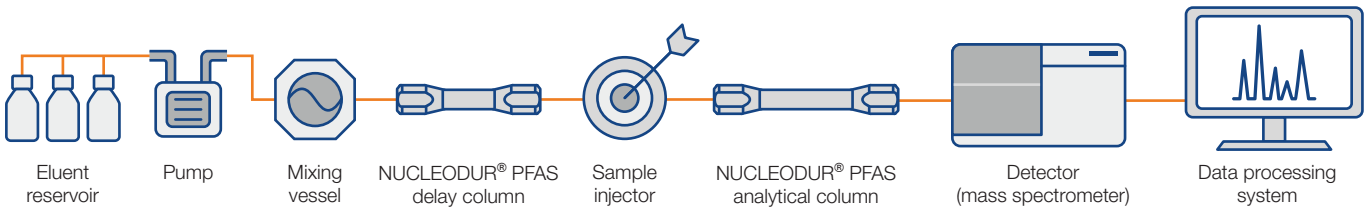
The molecular structure of the PFAS provides them with non-sticky and tensid-like characteristics (because of their hydrophobic, lipophilic chain + hydrophilic head). There are thousands of different compounds which are commonly used for more than 80 years for various prposes in daily life, e. g. textiles, fire extinguisher foams, food packing or cookware. Health effects were neglected for a long time. In September 2020, the European Food Safety Authority (EFSA) published a new health risk assessment related to the pres-ence of PFAS in food. Many institutions worldwide are working on global regulation and monitoring of PFAS. As toxicological information and additional PFAS compounds become identified in the future, further directives, restrictions, and regulations will be issued over time. Chromatographic analysis will help us quantify the impact and make monitoring possible.

The special HPLC columns for PFAS analysis: NUCLEODUR® PFAS and NUCLEODUR® PFAS Delay

NUCLEODUR® PFAS, 3 µm HPLC columns provide a solution for analyzing PFAS substances.

These columns show a high batch-to-batch reproducibility, are specially batch tested for PFAS analyses and are very well suited for LC-MS due to a low bleeding characteristics.

The NUCLEODUR® PFAS Delay column provide high retention for PFAS compounds and are used to retain PFAS contaminants from the HPLC system, which could otherwise falsify the sample to be analyzed. For this purpose the NUCLEODUR® PFAS Delay column is connected in flow direction between the mixing vessel and the sample injector.



HPLC columns for environmental analyses

NUCLEODUR® C_{18} PAH special octadecyl phase for PAH analysis · USP L1

Technical data

- Base material NUCLEODUR® silica, particle sizes 1.8 and 3 µm, pore size 110 Å; polymeric coating

Recommended application

- Allows efficient gradient separation of the 16 PAHs according to EPA

Analysis of 16 EPA PAHs with or without acetonitrile

MN Appl. Nos. 123820 / 123830

Separation with acetonitrile

Column: 100 × 4 mm NUCLEODUR® C_{18} PAH, 3 µm

Eluent: A) methanol – water (80:20, v/v) B) acetonitrile 2 – 20 % B in 1.2 min, 20 – 100 % B in 0.5 min, 100 % B for 2.5 min, 100 – 2 % B in 0.4 min

Flow rate: 2.5 mL/min, temperature 35 °C

Detection: UV, 254 nm fluorescence (see chromatogram)

Separation without acetonitrile

Column: 125 × 4 mm NUCLEODUR® C_{18} PAH, 3 µm

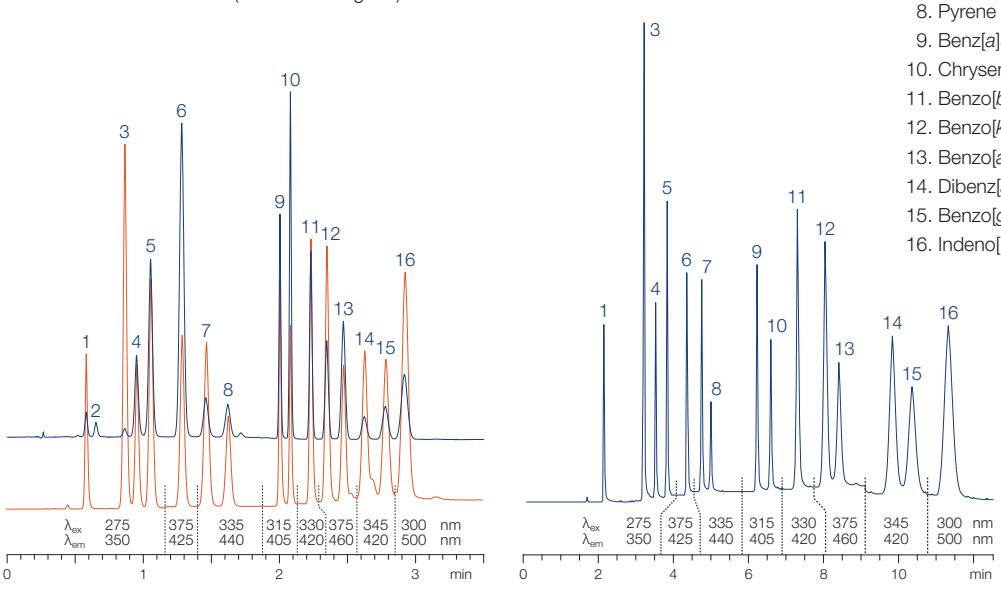
Eluent: A) water B) methanol 65 – 97 % B in 6 min, 97 % B for 5 min, 97 – 65 % B in 0.5 min

Flow rate: 2 mL/min, temperature 35 °C

Detection: fluorescence (see chromatogram)

Peaks:

1. Naphthalene
2. Acenaphthylene (not detectable by fluorescence)
3. Acenaphthene
4. Fluorene
5. Phenantrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[*a*]anthracene
10. Chrysene
11. Benzo[*b*]fluoranthene
12. Benzo[*k*]fluoranthene
13. Benzo[*a*]pyrene
14. Dibenz[*ah*]anthracene
15. Benzo[*ghi*]perylene
16. Indeno[1,2,3-*cd*]pyrene



Detection of separated PAHs with UV (250 – 280 nm), diode array or fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analyzed with fluorescence detection).

Eluent in column acetonitrile – water (70:30, v/v)

	ID	Length → 100 mm	125 mm	150 mm	250 mm	EC guard columns*
NUCLEODUR® C_{18} PAH, 1.8 µm; particle size 1.8 µm · UHPLC						
Analytical EC columns						
	2 mm	760773.20				761970.20
	3 mm	760773.30				761970.30
	4 mm	760773.40				761970.30
NUCLEODUR® C_{18} PAH, 3 µm; particle size 3 µm						
Analytical EC columns						
	3 mm	760783.30	760784.30	760785.30	760786.30	761971.30
	4 mm	760783.40	760784.40	760785.40	760786.40	761971.30

Guard column system

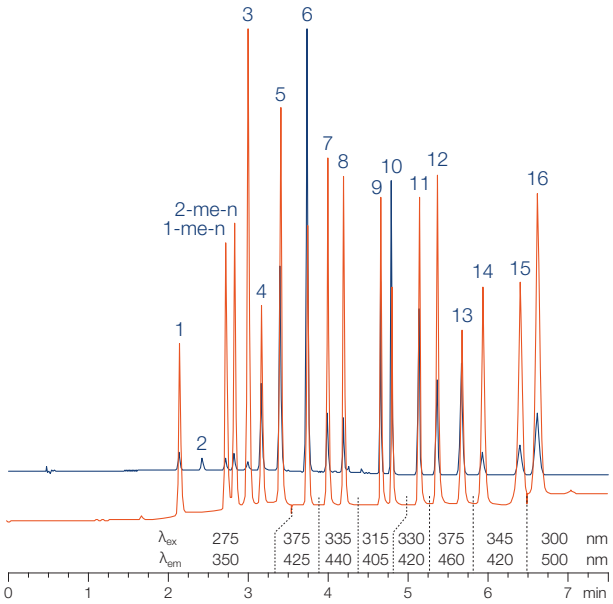
Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966

Separation of 18 PAHs on NUCLEODUR® C_{18} PAH

MN Appl. No. 123840

Column:	125 × 4 mm NUCLEODUR® C_{18} PAH, 3 µm
Eluent:	A) methanol – water (70:30, v/v); B) acetonitrile 0 – 20 % B in 1.5 min, 20 – 50 % B in 1.5 min, 50 – 100 % B in 1.0 min, 100 % B for 3 min, 100 – 0 % B in 0.5 min
Flow rate:	1.5 mL/min
Temperature:	35 °C
Injection:	UV: 1 µL,
Fluorescence:	0.5 µL
Detection:	UV, 254 nm fluorescence (see chromatogram)

Peaks:
(concentrations 10 ng/µL per compound)
1.–16. see page 227
1-me-n: 1-methylnaphthalene
2-me-n: 2-methylnaphthalene

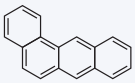


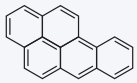
Analysis of polycyclic aromatic hydrocarbons (PAHs) by HPLC

Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds that consist of fused aromatic rings and do not contain heteroatoms or carry substituents. As a pollutant, they are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. PAHs are natural components of coal or gas. They are delivered to our environment by pyrolysis (incomplete burning) of organic materials like coal, oil, fuel, wood, tobacco, … and hence can be found globally. Today most PAHs accrue from anthropogenic processes – but also natural origins (forest fire) are possible. Regarding to past pollutions an important impact had production of coke and gas from black coal. Waste products (e. g., tar) from coking or gas plants are often origin of serious ground water pollutions.

Since a number of PAHs (e. g., benzo[a]pyrene, 3-methylcholanthrene and benzanthracene) have been proven to be carcinogenic, control of the PAH content of food, water and soil is an important task for routine analysis. For choice and limiting values of the polycyclics we refer to the governmental regulations, which exist in many countries (e. g., EPA method 610 of the United States Environmental Protection Agency).

PAHs can be determined by different chromatographic techniques (TLC, GC, HPLC). Thus the 6 PAHs according to German drinking water specification (TVO) can, e. g., be analyzed by TLC (see German Standard DIN 38409), while a much larger number of polycyclic aromatics can be determined by GC or HPLC.


Benzo[a]anthracen


Benzo[a]pyren

HPLC columns for PAH analysis

For PAH analyses we have developed specially modified C_{18} phases based on NUCLEODUR® and NUCLEOSIL® which allow efficient gradient separation of 16 PAHs according to EPA. Detection of the separated PAHs can be achieved by UV (250 – 280 nm), with diode array or with fluorescence detection at different wavelengths for excitation and emission. Acenaphthylene cannot be analyzed with fluorescence detection. For cost-effective routine PAH analysis we recommend applications using methanol instead of acetonitrile as eluent. For rapid analysis NUCLEODUR® C_{18} PAH (3 µm) in short columns (100 mm) provides excellent results at high flow rates. Hereby separation of 16 PAHs according to EPA can be achieved in less than 3 min.

Tightened regulations require determination of 2 additional PAHs (1- and 2-methylnaphthalene) – so we developed highly efficient methods for 18 PAHs on the NUCLEODUR® C_{18} PAH.

HPLC columns for environmental analyses

NUCLEOSIL® 100-5 C_{18} PAH special octadecyl phase for PAH analysis · USP L1

Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å; polymeric coating
- Detection of the separated PAH with UV (250 – 280 nm), diode array or fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analyzed with fluorescence detection)

Recommended application

- Efficient gradient separation of the 16 PAHs according to EPA

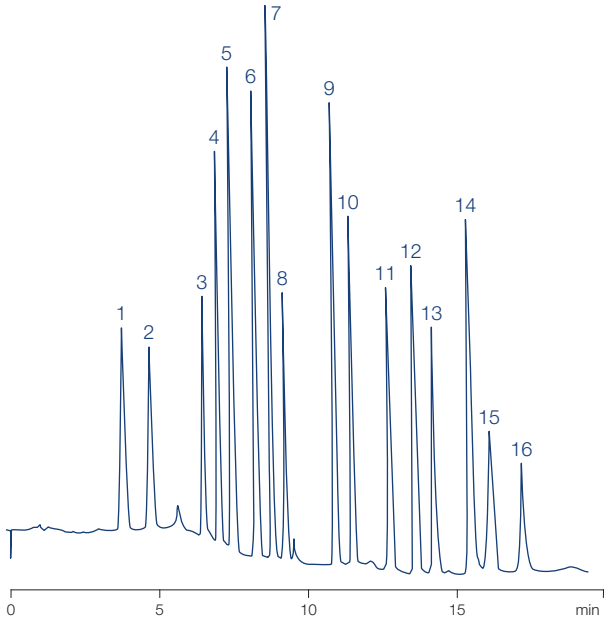
Separation of the PAH standard according to EPA (REF 722393)

MN Appl. No. 115040

Column: 150 x 4 mm NUCLEOSIL® 100-5 C_{18} PAH
Eluent: A) methanol – water (80:20)
B) acetonitrile – tetrahydrofuran (93:7)
0–100 % B in 10 min, 5 min 100 % B
Flow rate: 1 mL/min
Pressure: 140 bar
Temperature: 20 °C
Detection: UV, 260 nm

Peaks: (10 µg/mL each in acetonitrile)

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



Eluent in column acetonitrile – water 70:30

ID		Length → 150 mm	250 mm	EC guard columns*
NUCLEOSIL® 100-5 C_{18} PAH; particle size 5 µm, pore size 100 Å				
Analytical EC columns				
	2 mm		720117.20	721168.20
	3 mm	720923.30	720117.30	721168.30
	4 mm	720923.40	720117.40	721168.30
	4.6 mm		720117.46	721168.30
PAH standard according to EPA for HPLC				
Analytical EC columns				
PAH standard for HPLC	16 PAH according to EPA method 610 in acetonitrile (1 mL) for composition see chromatogram above			722393

Guard column system

Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966

EC columns in packs of 1, guard columns in packs of 3. For details of our column systems see page 258.

Anion columns for analysis of inorganic anions

NUCLEOSIL® Anion II

Technical data

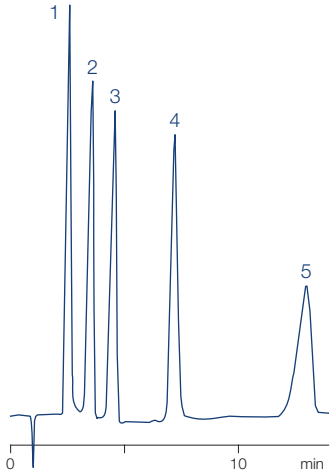
- Base material NUCLEOSIL® silica, particle size 10 µm, pore size 300 Å strongly basic anion exchanger, exchange capacity 50 µeq/g, pH stability 2 – 7.5
- Eluent in column 0.15 mol/L $(NH_4)_2HPO_4$ buffer pH 5.2 recommended buffer concentration for separation of inorganic anions: 2 mmol/L phthalate
- Preferred method of detection: conductivity or negative UV detection

Separation of an anion standard

MN Appl. No. 106440

Column: 250 x 4 mm NUCLEOSIL® Anion II
Eluent: 2 mmol/L potassium hydrogen phthalate, pH 5.7
Flow rate: 2 mL/min
Detection: UV, 280 nm

Peaks:
1. H_2PO^{4-}
2. Cl^-
3. NO^{2-}
4. NO^{3-}
5. SO_4^{2-}



ID	Length → 120 mm	250 mm	Guard columns*
NUCLEOSIL® Anion II; eluent 0.15 mol/L $(NH_4)_2HPO_4$ buffer pH 5.2			
Analytical EC columns			
4 mm		720094.40	721169.30

NUCLEOSIL® Anion II guard columns are used with the Column Protection System (REF 718966, see page 259).

HPLC columns for enantiomer separations

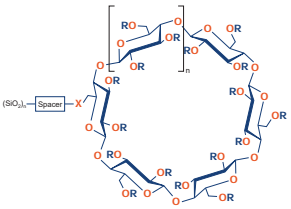
NUCLEODEX columns enantiomer separation based on cyclodextrins

NUCLEODEX β-OH β-cyclodextrin (R = H; n = 2) · USP L45

Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Separation based on hydrogen bonds and dipole interactions between functional groups of the analyte and hydroxyl groups of the cyclodextrin
- Examples for successful enantiomer separations: chlorthalidone and other compounds, which require free hydroxyl groups for enantioselective interactions
- Eluent in column CH_3OH – 0.1 % TEAA pH 4 (55:45)

NUCLEODEX α-PM permethylated α-cyclodextrin (R = CH_3; n = 1)



Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Examples for successful enantiomer separations: mecoprop and dichlorprop as free carboxylic acids, *trans*-stilbene oxide, styrene oxide
- Eluent in column CH_3OH – 50 mmol/L phosphate pH 3 (70:30)

NUCLEODEX β-PM permethylated β-cyclodextrin (R = CH_3; n = 2) · USP L45

Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Examples for successful enantiomer separations: mephobarbital (prominal), pesticide derivatives mecoprop methyl and dichlorprop methyl
- Eluent in column CH_3OH – 0.1 % TEAA pH 4 (65:35)

NUCLEODEX γ-PM permethylated γ-cyclodextrin (R = CH_3; n = 3)

Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å modified cyclodextrins as chiral selectors
- Examples for successful enantiomer separations: steroids or other larger molecules
- Eluent in column CH_3OH – 0.1 % TEAA pH 4 (55:45)

Recommended application

- NUCLEODEX phases are especially suited for the control of optical purity, but also for semipreparative separations and for the analysis of positional and *cis*-trans isomers.
- For numerous separations on NUCLEODEX phases please visit our website: *https://chromaappdb.mn-net.com/*

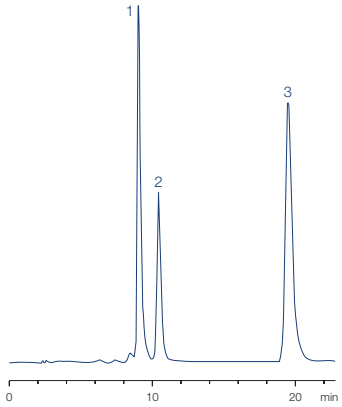
HPLC columns for enantiomer separations

Separation of the positional isomers of nitroaniline

MN Appl. No. 101420

Column:	200 x 4 mm NUCLEODEX β-OH
Eluent:	methanol – 0.1 % triethylammonium acetate pH 4.0 (50:50, v/v)
Flow rate:	0.7 mL/min
Pressure:	180 bar
Detection:	UV, 254 nm
Injection:	1 µL

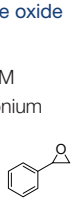
Peaks:
1. *m*-Nitroaniline
2. *o*-Nitroaniline
3. *p*-Nitroaniline



Enantiomer separation of styrene oxide

MN Appl. No. 106160

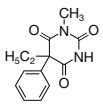
Column:	200 x 4 mm NUCLEODEX α-PM
Eluent:	methanol – 0.1 % triethylammonium acetate pH 4.0 (60:40, v/v)
Flow rate:	0.7 mL/min
Pressure:	160 bar
Detection:	UV, 230 nm
Injection:	2 µL



Enantiomer separation of mephobarbital

MN Appl. No. 105800

Column:	200 x 4 mm NUCLEODEX β-PM
Eluent:	methanol – 0.1 % triethylammonium acetate pH 4.0 (55:45, v/v)
Flow rate:	0.7 mL/min
Pressure:	180 bar
Detection:	UV, 254 nm
Injection:	1 µL

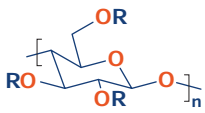


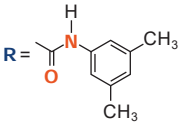
ID	Length → 200 mm	EC guard columns*
NUCLEODEX β-OH; eluent methanol – 0.1 % TEAA pH 4 (55:45)		
Analytical EC columns		
4 mm	720124.40	721171.30
NUCLEODEX α-PM; eluent methanol – 50 mmol/L phosphate pH 3 (70:30)		
Analytical EC columns		
4 mm	720127.40	721469.30
NUCLEODEX β-PM; eluent methanol – 0.1 % TEAA pH 4 (65:35)		
Analytical EC columns		
4 mm	720125.40	721176.30
NUCLEODEX γ-PM; eluent methanol – 0.1 % TEAA pH 4 (55:45)		
Analytical EC columns		
4 mm	720752.40	721178.30
NUCLEODEX CC screening kit		
contains one CC 30/4 each with NUCLEODEX β-OH, α-PM, β-PM and γ-PM as well as one CC column holder 30 mm	721920	

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 259). Columns and guard columns in packs of 1.

HPLC columns for enantiomer separations

NUCLEOCEL *DELTA* enantiomer separation based on a cellulose derivative · USP L40





Technical data

- Base material silica, chiral selector cellulose tris-(3,5-dimethylphenylcarbamate) High resolution type (S) with 5 µm particle size, allows use of shorter columns (150 mm) for faster separations, pressure stability up to ~150 bar (2,000 psi), pH stability 1 – 9
- NUCLEOCEL *DELTA* for normal phase applications: eluent in column *n*-heptane – 2-propanol (90:10, v/v) typical eluents are heptane – propanol mixtures
- NUCLEOCEL *DELTA*-RP for reversed phase applications: eluent in column acetonitrile – water (40:60, v/v) designed for use either in polar organic mode or with eluents containing high concentrations of chaotropic salts such as perchlorate

Recommended application

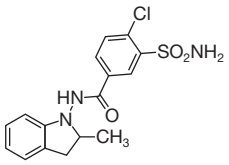
- Pharmaceutically active compounds, chiral pollutants (e. g., herbicides, PCB), chiral compounds in food (dyes, preservatives), chiral catalysts and bioorganic compounds

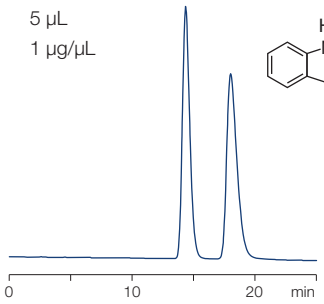
Similar phases: Chiralcel® OD, Kromasil® CelluCoat™, Eurocel® 01, Lux™ Cellulose-1

Enantiomer separation of indapamide

MN Appl. No. 121230

Column:	250 x 4,6 mm NUCLEOCEL *DELTA-RP S*
Eluent:	acetonitrile – water (40:60, v/v)
Flow rate:	0.5 mL/min
Temperature:	40 °C
Detection:	UV, 254 nm
Injection:	5 µL
Concentration:	1 µg/µL
α = 1.3	
R_s = 2.6	

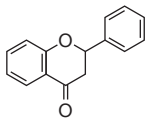


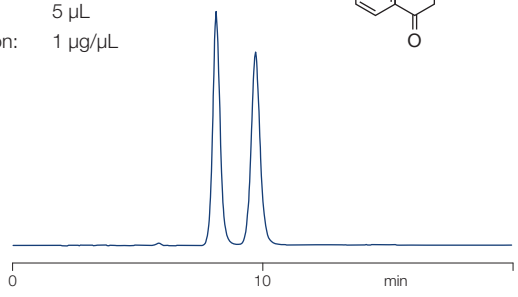


Enantiomer separation of flavanone

MN Appl. No. 121260

Column:	250 x 4,6 mm NUCLEOCEL *DELTA S*
Eluent:	*n*-heptane – 2-propanol (90:10, v/v)
Flow rate:	1 mL/min
Temperature:	25 °C
Detection:	UV, 254 nm
Injection:	5 µL
Concentration:	1 µg/µL
α = 1.29	
R_s = 2.6	





ID	Length → 150 mm	250 mm	EC guard columns*
NUCLEOCEL *DELTA S*, 5 µm; eluent *n*-heptane – 2-propanol (90:10, v/v)			
Analytical EC columns			
4.6 mm		720445.46	721185.30
NUCLEOCEL *DELTA-RP S*, 5 µm; eluent acetonitrile – water (40:60, v/v)			
Analytical EC columns			
4.6 mm	720451.46	720450.46	721186.30

* EC 4/3 guard column cartridges are used for EC columns of 4.6 mm ID with the Column Protection System guard column holder (REF 718966, see page 259). Columns and guard columns in packs of 1.

HPLC columns for enantiomer separations

RESOLVOSIL BSA-7 protein phase for enantiomer separation · USP L75

Technical data

- Base material NUCLEOSIL® silica, particle size 7 µm, pore size 300 Å chiral selector bovine serum albumin (BSA)
- Separation based on selective interaction of proteins with low molecular compounds, i. e. principles of bioaffinity, including hydrophobic interactions (similar to a true reversed phase), interactions of polar groups and steric effects

Recommended application

- Amino acid derivatives, aromatic amino acids, aromatic sulfoxides, barbiturates, benzodiazepinones, benzoin and benzoin derivatives, β-blockers, coumarin derivatives, and for monitoring stereoselective microbial and enzymatic conversions

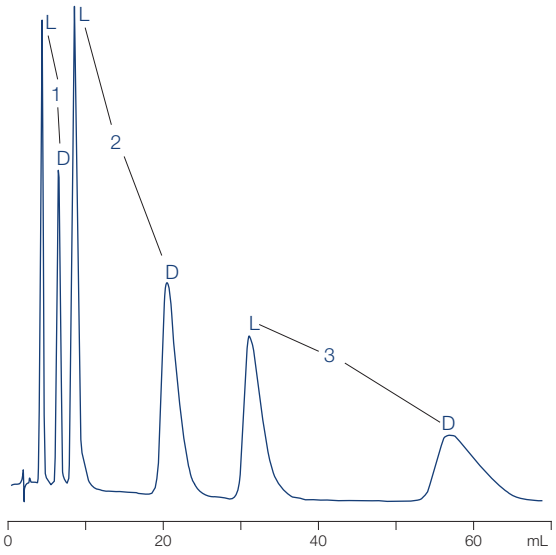
Enantiomer separation of *N*-benzoyl-*D*,*L*-amino acids

MN Appl. No. 105450

S. Allenmark et al. in "Affinity chromatography and biological recognition" (I. Chaiken, M. Wilchek, and I. Parikh. Eds.), Academic Press, New York, 1983, 259 – 260

Column: 150 × 4 mm RESOLVOSIL BSA-7
Eluent: 50 mmol/L phosphate buffer pH 6.5 + 1 % 1-propanol
Flow rate: 0.70 mL/min
Detection: UV, 225 nm

Peaks:
1. Serine
2. Alanine
3. Phenylalanine



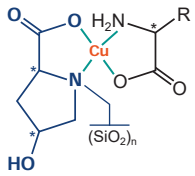
Eluent in column 0.1 mol/L phosphate buffer pH 7.5, 2 % 1-propanol

ID	Length → 150 mm	EC guard columns*
RESOLVOSIL BSA-7		
Analytical EC columns		
4 mm	720046.40	721402.30

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 259). Columns and guard columns in packs of 1.

HPLC columns for enantiomer separations

NUCLEOSIL® CHIRAL-1 enantiomer separation based on ligand exchange · USP L32



Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 120 Å chiral selector *L*-hydroxyproline – Cu^{2+} complexes
- Principal interaction mode:
- formation of ternary mixed-ligand complexes with Cu(II) ions; differences in the stability of the diastereomeric complexes cause chromatographic separation

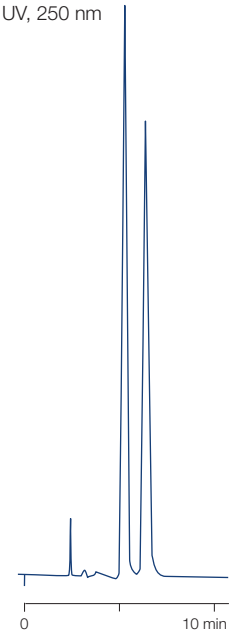
Recommended application

- Enantiomers with two polar functional groups with the correct spacing such as α-amino acids, α-hydroxycarboxylic acids (e.g., lactic acid), *N*-alkyl-α-amino acids etc.

D,*L*-alanine enantiomers

MN Appl. No. 105410

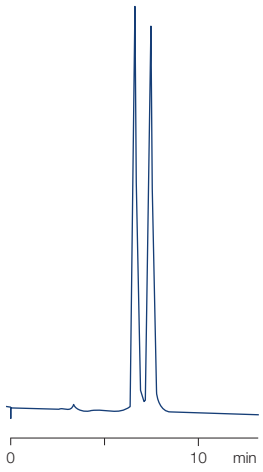
Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.5 mmol/L $CuSO_4$
Flow rate:	1 mL/min
Pressure:	60 bar
Temperature:	60 °C
Detection:	UV, 250 nm



D,*L*-threonine enantiomers

MN Appl. No. 105410

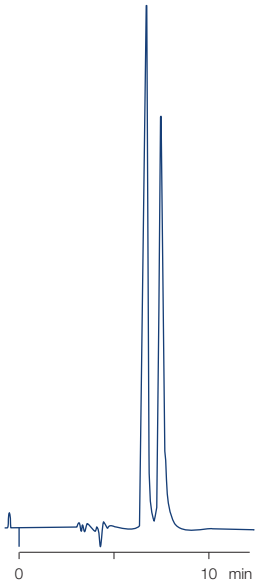
Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.25 mmol/L $CuSO_4$
Flow rate:	0.8 mL/min
Pressure:	65 bar
Temperature:	60 °C
Detection:	UV, 240 nm



Lactic acid enantiomers

MN Appl. No. 105560

Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.5 mmol/L $CuSO_4$
Flow rate:	0.8 mL/min
Temperature:	60 °C
Detection:	UV, 240 nm
Injection:	1 µL



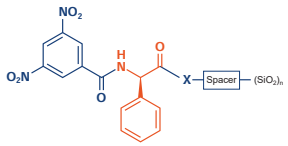
Eluent in column 0.5 mmol/L copper sulfate solution

ID		Length → 250 mm	EC guard columns*
NUCLEOSIL® CHIRAL-1			
Analytical EC columns			
	4 mm	720081.40	721188.30

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 259). Columns and guard columns in packs of 1.

HPLC columns for enantiomer separations

NUCLEOSIL® CHIRAL-2 · CHIRAL-3 enantiomer separation in organic eluent systems · USP L36



Technical data

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å chiral selector for NUCLEOSIL® CHIRAL-2 is *N*-(3,5-dinitrobenzoyl)-*D*-phenylglycine, for CHIRAL-3 the optical antipode is used, "brush type" phases
- Principle interaction modes: charge-transfer interactions, hydrogen bonds, dipole-dipole interactions and steric effects

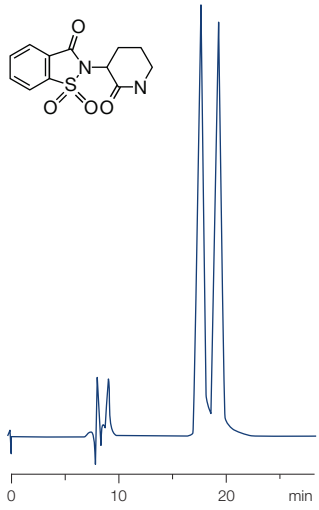
Recommended application

- analysis of stereoisomers such as separation of enantiomers and diastereomers, control of optical purity of plant protectives (pesticides, e. g., propionic acid derived herbicides) pharmaceuticals etc. and for product control in chiral organic syntheses
- For control of optical purity of a substance, the columns NUCLEOSIL® CHIRAL-2 and NUCLEOSIL® CHIRAL-3 allow to select conditions such that the minor enantiomer, present as an impurity, is eluted before the main peak. Overlapping peaks are avoided. This makes an exact quantification of the impurity much easier.

Enantiomer separation of *D*,*L*-supidimide

MN Appl. No. 105690

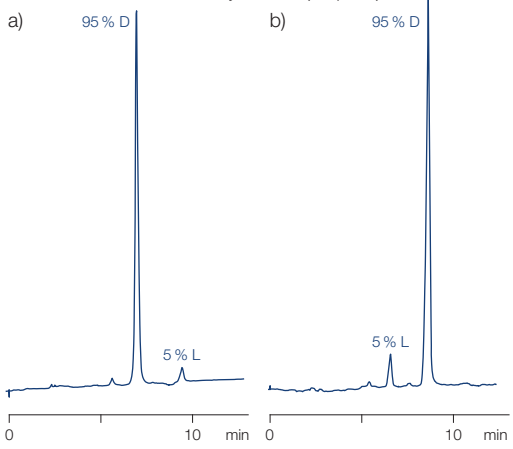
Column:	250 x 4 mm NUCLEOSIL® CHIRAL-2
Eluent:	tetrahydrofuran – *n*-heptane (10:3, v/v)
Flow rate:	1.0 mL/min
Detection:	UV, 220 nm



Control of optical purity of mecoprop methyl

MN Appl. No. 111360

Columns:	a) 250 x 4 mm NUCLEOSIL® CHIRAL-2
	b) 250 x 4 mm NUCLEOSIL® CHIRAL-3
Eluent:	*n*-heptane – 2-propanol – TFA (100:0.05:0.05, v/v/v)
Flow rate:	1 mL/min, ambient temperature
Detection:	UV, 230 nm, injection 1 µL (sample with 90 % ee)



Eluent in column *n*-heptane – 2-propanol – TFAA (100:0.05:0.05, v/v/v)

ID		Length → 250 mm	EC guard columns*
NUCLEOSIL® CHIRAL-2			
Analytical EC columns			
	4 mm	720088.40	721190.30
NUCLEOSIL® CHIRAL-3			
Analytical EC columns			
	4 mm	720350.40	721190.30

Guard columns for NUCLEOSIL® CHIRAL-2 and CHIRAL-3 are identical.
* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 259). EC columns and EC guard columns in packs of 1.

HPLC columns for biochemical separations

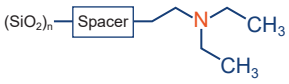
NUCLEOGEN® columns anion exchange chromatography of nucleic acids

NUCLEOGEN® 60-7 DEAE pore size 60 Å

Technical data

- Base material silica, particle size 7 µm; DEAE anion exchanger
- For the separation of oligonucleotides up to chain lengths of 40 bases with recoveries > 95 % capacity 200 A_{260}/mL (~ 300 A_{260} for a 125 × 4 mm ID column, 1875 A_{260} for a 125 × 10 mm ID column)
- Preparative separations possible when using higher flow rates and longer gradient times

NUCLEOGEN® 500-7 DEAE pore size 500 Å



Technical data

- Base material silica, particle size 7 µm; DEAE anion exchanger
- For the separation of tRNA, 5S RNA, viroids and messenger RNA in the intermediate molecular weight range (25 – 1,000 kDa) with recoveries > 95 %
- Capacity 730 A_{260} for a 125 × 6 mm ID column, 1940 A_{260} for a 125 × 10 mm ID column

NUCLEOGEN® 4000-7 DEAE pore size 4000 Å

Technical data

- Base material silica, particle size 7 µm; DEAE anion exchanger
- For the separation of plasmids, DNA restriction fragments, ribosomal RNA, messenger RNA and viral RNA, i. e. very high molecular weight nucleic acids (e. g., 1 – 50 MDa)
- Capacity 120 A_{260} for a 125 × 6 mm ID column, 350 A_{260} for a 125 × 10 mm ID column

For more separations of deoxyoligonucleotides, plasmids and DNA restriction fragments visit our website *https://chromaappdb.mn-net.com/*

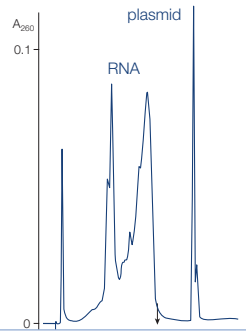
Separation of plasmid pBR 322

MN Appl. No. 107480

M. Colpan, D. Riesner, private communication

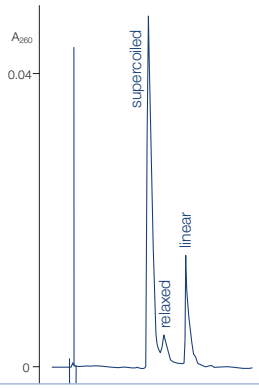
A) isolation of plasmid DNA from a crude cell lysate

Sample:	5 µg plasmid pBR 322 containing cleared lysate from *E. coli*
Column:	125 × 6 mm NUCLEOGEN® 4000 – 7 DEAE
Eluent:	A) 20 mmol/L K phosphate buffer pH 6.9; 5 mol/L urea B) eluent A + 1.5 mol/L KCl 20 – 100 % B in 50 min; arrow = ionic strength of 850 mmol/L
Flow rate:	1.0 mL/min, 70 bar
Temperature:	ambient
Detection:	UV, 260 nm



B) separation of supercoiled plasmid from relaxed and linear forms

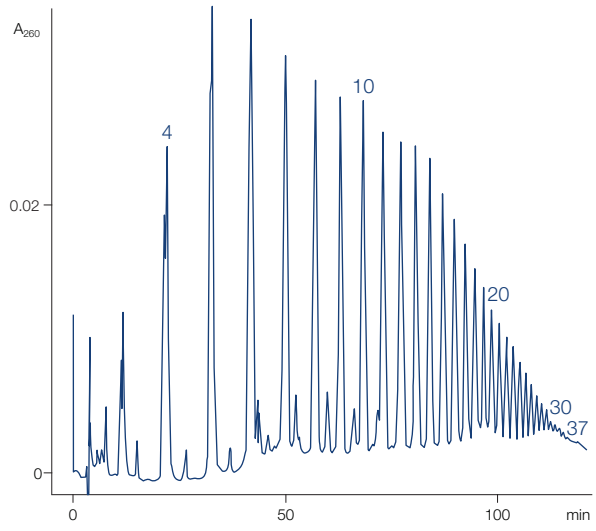
Sample:	plasmid pBR 322, supercoiled, relaxed and linear
Column:	125 × 6 mm NUCLEOGEN® 4000 – 7 DEAE
Eluent:	A) 20 mmol/L K phosphate buffer pH 6.8; 6 mol/L urea B) eluent A + 2 mol/L KCl 42 – 100 % B in 230 min
Flow rate:	1.5 mL/min, 45 bar
Temperature:	ambient



Separation of oligo(rA)$_n$

MN Appl. No. 115180

Column:	125 x 4 mm NUCLEOGEN® 60-7 DEAE
Eluent:	A) 20 mmol/L phosphate buffer, pH 5.5, 5 mol/L urea B) buffer A + 1 mol/L KCl 0–100 % B in 200 min
Flow rate:	2 mL/min
Pressure:	110 bar
Temperature:	ambient
Detection:	UV, 260 nm

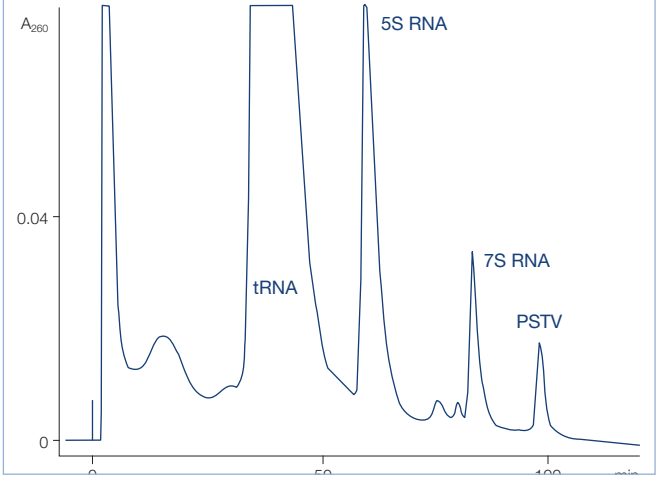


Preparative separation of a crude RNA extract of viroid (PSTV) infected tomato plants

MN Appl. No. 107490

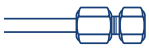
D. Riesner, BioEngineering 1 (1988) 42 – 48

Column:	125 × 6 mm NUCLEOGEN® 500 – 7 DEAE
Eluent:	A) ’250 mmol/L KCl, 20 mmol/L phosphate buffer, pH 6.6, 5 mol/L urea B) 1 mol/L KCl, 20 mmol/L phosphate buffer, pH 6.6, 5 mol/L urea 0 – 50 % B in 120 min, 50 – 100 % B in 250 min
Flow rate:	3 mL/min
Pressure:	40 bar
Temperature:	ambient
Detection:	260 nm



HPLC columns for biochemical separations

Eluent in column methanol

ID	Length → 125 mm	Guard columns*
NUCLEOGEN® 60-7 DEAE; particle size 7 µm, pore size 60 Å		
Analytical EC columns		
 4 mm	736596.40	736400.40
Preparative VarioPrep columns		
 10 mm	736597.100	736400.40
NUCLEOGEN® 500-7 DEAE; particle size 7 µm, pore size 500 Å		
Analytical Valco type columns		
 6 mm	736598	736400.40
Preparative VarioPrep columns		
 10 mm	736599.100	736400.40
NUCLEOGEN® 4000-7 DEAE; particle size 7 µm, pore size 4000 Å		
Analytical Valco type columns		
 6 mm	736601	736400.40
Preparative VarioPrep columns		
 10 mm	736602.100	736400.40

* NUCLEOGEN® guard columns are 30 mm long and require the CC column holder 30 mm (REF 721823).
Columns in packs of 1, guard columns in packs of 2.

HPLC columns for biochemical separations

NUCLEOGEL® SAX anion exchange of biological macromolecules · USP L23

Technical data

- Polymer-based strongly basic anion exchanger – $N^+(CH_3)_3$, gel matrix quaternized PEI; particle size 8 µm, pore size 1000 Å
- pH working range 1 – 13, max. working pressure 200 bar

Recommended application

- Purification of peptides, large proteins and oligonucleotides, high capacity for proteins even at pH 10

NUCLEOGEL® SCX cation exchange of biological macromolecules · USP L22

Technical data

- Polymer-based strongly acidic cation exchanger – SO_3^-, hydrophilic gel matrix; particle size 8 µm, pore size 1000 Å
- pH working range 1 – 13, max. working pressure 200 bar

Recommended application

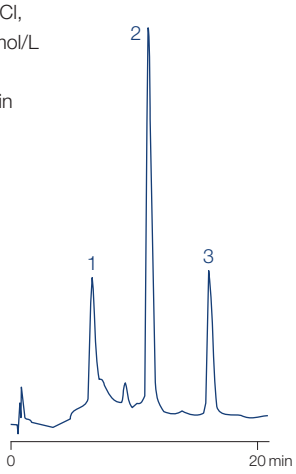
- Proteins, peptides and carbohydrates with high isoelectric point

Separation of hen's egg white

MN Appl. No. 115200

Sample:	frozen egg white was thawed, filtered and diluted 1:8 with eluent A
Column:	50 × 4.6 mm NUCLEOGEL® SAX 1000-8
Eluent:	A) 0.01 mol/L Tris-HCl, pH 7.5; B) A + 0.5 mol/L NaAc, pH 7.5; 0 – 100 % B in 20 min
Flow rate:	1 mL/min
Inj.volumen:	50 µL
Detection:	UV, 280 nm

Peaks:
1. Conalbumin
2. Ovalbumin
3. Not identified

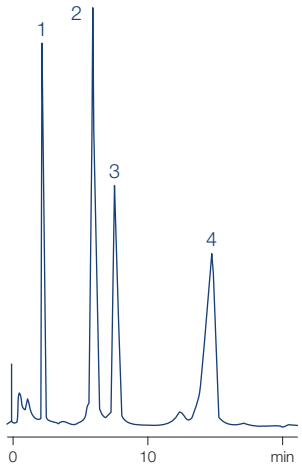


Separation of protein standards

MN Appl. No. 108261

Column:	50 × 4.6 mm NUCLEOGEL® SCX 1000-8
Eluent:	A) 0.02 mol/L KH_2PO_4, pH 6.0 B) A + 0,5 mol/L NaCl, pH 6.0 0 – 100 % B in 20 min
Flow rate:	1 mL/min
Detection:	UV, 280 nm

Peaks:
1. Myoglobin
2. α-Chymotrypsinogen A
3. Cytochrome C
4. Lysozyme



Eluent in column 0.1 mol/L Na_2SO_4 + 0.2 % NaN_3

ID		Length → 50 mm	Guard columns*
NUCLEOGEL® SAX; pore size 1000 Å			
Analytical Valco type columns			
	4.6 mm	719469	719600
NUCLEOGEL® SCX; pore size 1000 Å			
Analytical Valco type columns			
	4.6 mm	719475	719540

* NUCLEOGEL® SAX and SCX Valco type guard columns measure 5 × 3 mm and require the guard column holder B, REF 719539 (see page 258)
Columns in packs of 1, guard columns in packs of 2.

HPLC columns for biochemical separations

NUCLEODUR® 300 C_{18} ec · C_4 ec wide pore silica for biochromatography · USP L1 (C_{18}) · USP L26 (C_4)

Key feature

- Reliable wide pore RP phases for daily routine analysis
- Medium density octadecyl or butyl modification with exhaustive endcapping
- Ideal phases for separation of biomolecules

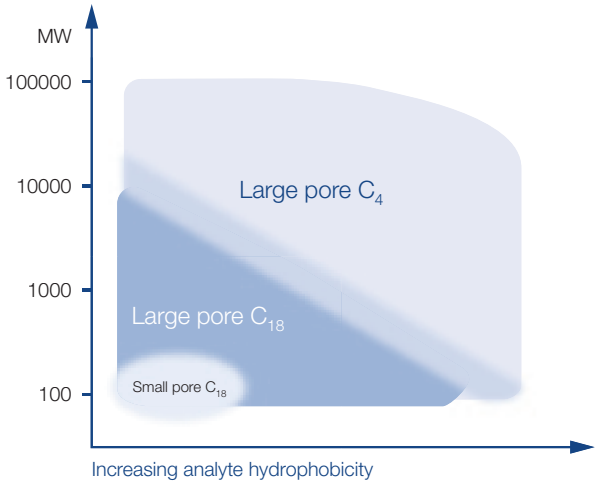
Technical data

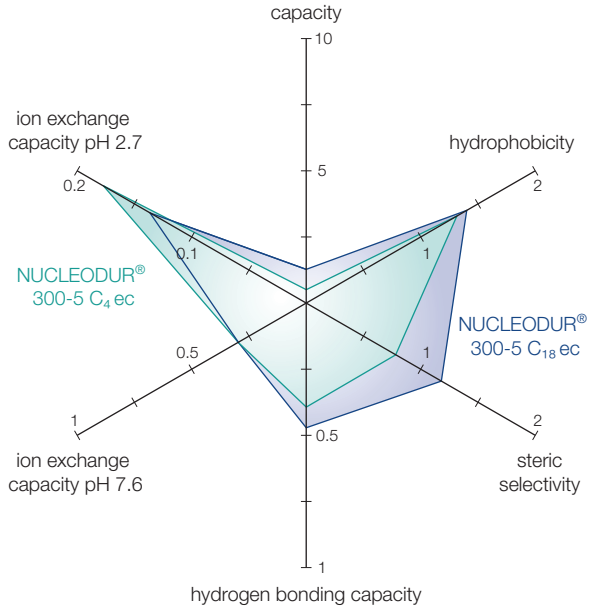
- Pore size 300 Å; particle size 5 µm, carbon content 4 % for C_{18}, 2.5 % for C_4; pH stability 1 – 9; high reproducibility from lot to lot

Recommended application

- Biological macromolecules like proteins or peptides

Column selection by analyte characteristics





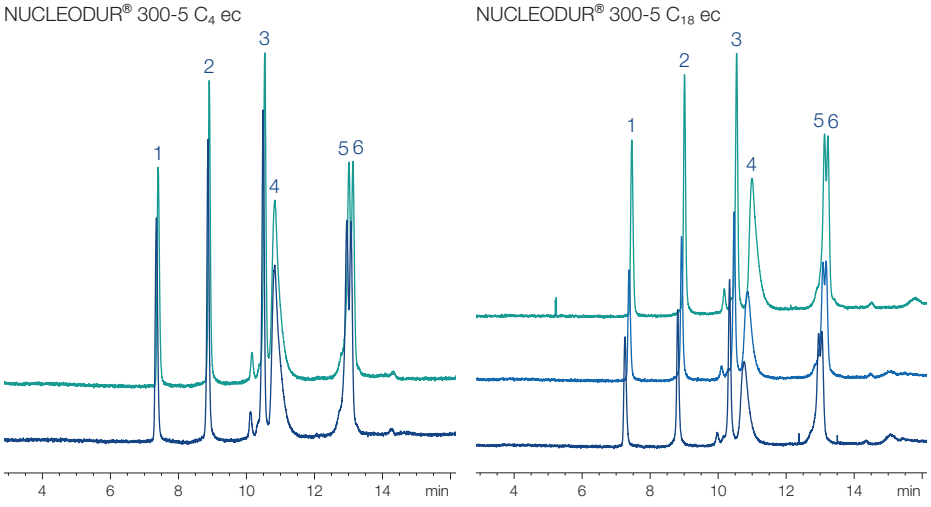
Tanaka plots of NUCLEODUR® wide pore phases

Batch-to-batch reproducibility of NUCLEODUR® 300-5 C_4 ec and NUCLEODUR® 300-5 C_{18} ec

MN Appl. Nos. 126551 / 126552

Columns:	250 × 4 mm
Eluent:	A) 0.1 % TFA in water
	B) 0.08 % TFA in acetonitrilel
	20 – 60 % B in 15 min
Flow rate:	1 mL/min
Temperature:	25 °C
Detection:	UV, 280 nm

Peaks:
1. Ribonuclease A
2. Cytochrome C
3. Lysozyme
4. BSA
5. β-Lactoglobulin
6. β-Lactoglobulin 2



HPLC columns for biochemical separations

Comparison of narrow and wide pore NUCLEODUR® for the separation of proteins

MN Appl. No. 126590

Columns: 250 × 4,6 mm NUCLEODUR® 300-5 C_{18} ec
250 × 4,6 mm NUCLEODUR® C_{18} Gravity, 5 µm

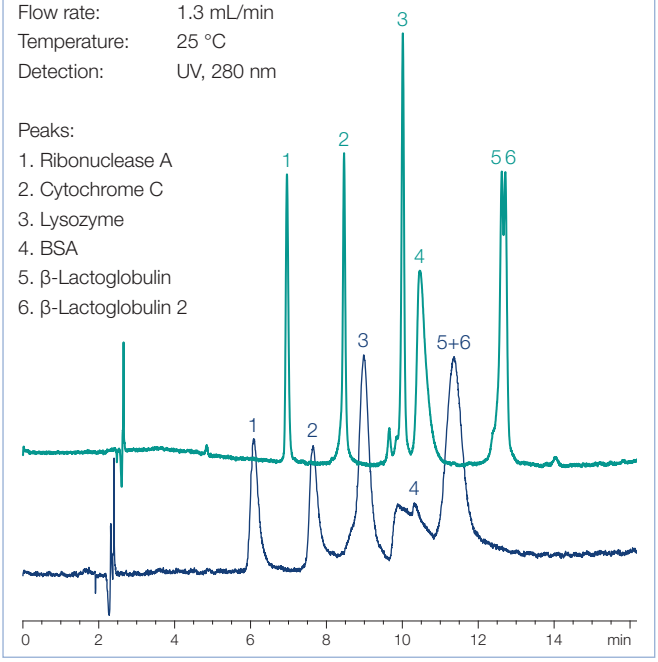
Eluent: A) 0.1 % TFA in water
B) 0.08 % TFA in acetonitrile
20 – 65 % B in 15 min
(3 min 65 % B)

Flow rate: 1.3 mL/min

Temperature: 25 °C

Detection: UV, 280 nm

Peaks:
1. Ribonuclease A
2. Cytochrome C
3. Lysozyme
4. BSA
5. β-Lactoglobulin
6. β-Lactoglobulin 2



Sharper peaks of larger molecules on wide pore material

Tryptic digest of cytochrome C

MN Appl. No. 126600

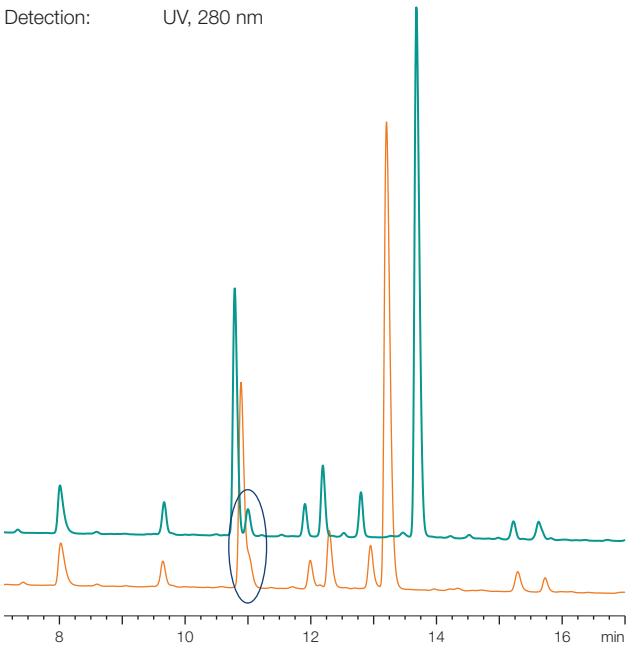
Columns: 250 × 4.6 mm NUCLEODUR® 300-5 C_{18} ec
250 × 4.6 mm Jupiter® C_{18}, 5 µm

Eluent: A) 0.1 % TFA in water
B) 0.08 % TFA in acetonitrile
5 – 40 % B in 15 min (1 min 40 % B)

Flow rate: 1.3 mL/min

Temperature: 30 °C

Detection: UV, 280 nm



Less tailing and better separation on NUCLEODUR® 300 C_{18} ec

Eluent in column acetonitrile – water

	ID	Length → 100 mm	125 mm	150 mm	250 mm	EC guard columns*
NUCLEODUR® 30-5 C_{18} ec; octadecyl phase, particle size 5 µm, pore size 300 Å, endcapped, 4 % C						
Analytical EC columns						
	2 mm	760183.20	760184.20	760185.20	760186.20	761988.20
	3 mm	760183.30	760184.30	760185.30	760186.30	761988.30
	4 mm	760183.40	760184.40	760185.40	760186.40	761988.30
	4.6 mm	760183.46	760184.46	760185.46	760186.46	761988.30
NUCLEODUR® 300-5 C_4 ec; butyl phase, particle size 5 µm, pore size 300 Å, endcapped, 2.5 % C						
Analytical EC columns						
	2 mm	760193.20	760194.20	760195.20	760196.20	761989.20
	3 mm	760193.30	760194.30	760195.30	760196.30	761989.30
	4 mm	760193.40	760194.40	760195.40	760196.40	761989.30
	4.6 mm	760193.46	760194.46	760195.46	760196.46	761989.30

* EC guard columns require the Column Protection System guard column holder (REF 718966, see page 259).
EC columns in packs of 1, guard columns in packs of 3.

HPLC columns for biochemical separations

NUCLEOSIL® MPN RP chromatography of biological macromolecules

NUCLEOSIL® 100-5 C_{18} MPN · USP L1

Key feature

- Octadecyl phase, particle size 5 µm; pore size 100 Å
- Dynamic protein binding capacity per g packing: 6 mg BSA, 110 mg cytochrome C
- pH working range 2 – 8, max. working pressure 250 bar

Technical data

- Silica-based reversed phase materials with monomerically bonded alkyl chains, brush type structure predominantly hydrophobic forces with a small portion of hydrophilic interactions
- Maximum separation efficiency can be achieved when the injected protein mass does not exceed 1 – 2 % of the maximum protein loading capacity.

NUCLEOSIL® 300-5 C_4 MPN · USP L26

Key feature

- Butyl phase, particle size 5 µm, pore size 300 Å
- Dynamic protein binding capacity per g packing: 14 mg BSA, 27 mg cytochrome C especially suited for the purification of larger, hydrophobic peptides and very different proteins
- pH working range 2 – 8, max. working pressure 250 bar

Technical data

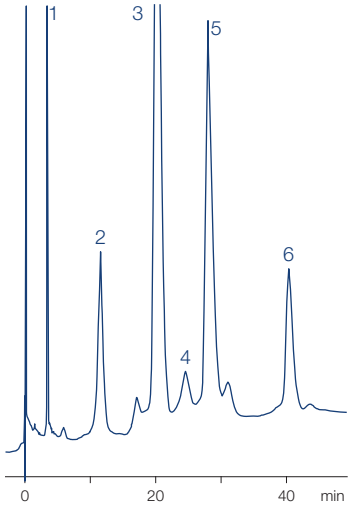
- Silica-based reversed phase materials with monomerically bonded alkyl chains, brush type structure predominantly hydrophobic forces with a small portion of hydrophilic interactions
- Maximum separation efficiency can be achieved when the injected protein mass does not exceed 1 – 2 % of the maximum protein loading capacity.

Separation of haemoglobin chains

MN Appl. No. 108240

Column:	250 x 4 mm NUCLEOSIL® 300-5 C_4 MPN
Eluent:	A) 20 % acetonitrile, 80 % water, 0.1 % TFA
	B) 60 % acetonitrile, 40 % water, 0.1 % TFA
	40–60 % B in 60 min
Flow rate:	1 mL/min
Detection:	UV, 220 nm

Peaks:
1. Hem
2. β-globin
3. α-globin
4. $^{A}\gamma^{T}$-globin
5. $^{G}\gamma$-globin
6. $^{A}\gamma^{I}$-globin



Eluent in column methanol

ID	Length → 250 mm	EC guard columns*
NUCLEOSIL® 100-5 C_{18} MPN		
Analytical EC columns		
4 mm	720231.40	
NUCLEOSIL® 300-5 C_4 MPN		
Analytical EC columns		
4 mm	720245.40	721119.30

* EC guard columns require the Column Protection System guard column holder (REF 718966, see page 259). Columns in packs of 1, guard columns in packs of 2.

NUCLEOSIL® PPN RP chromatography of biological macromolecules

NUCLEOSIL® 100-5 C_{18} PPN · USP L1

Key feature

- Octadecyl phase, particle size 5 µm, pore size 100 Å, dynamic protein binding capacity per g packing: 8 mg BSA, 64 mg cytochrome C; suited for the separation of peptides and proteins up to about 40 kD, also suited for basic peptides

Technical data

- Silica-based reversed phase materials with polymerically bonded alkyl chains; exclusively hydrophobic interactions
- pH working range 1 – 9, max. working pressure 250 bar

NUCLEOSIL® 500-5 C_{18} PPN · USP L1

Key feature

- Octadecyl phase, particle size 5 µm, pore size 500 Å, dynamic protein binding capacity per g packing: 22 mg BSA, 40 mg cytochrome C; especially suited for large peptides and medium-size hydrophilic proteins

Technical data

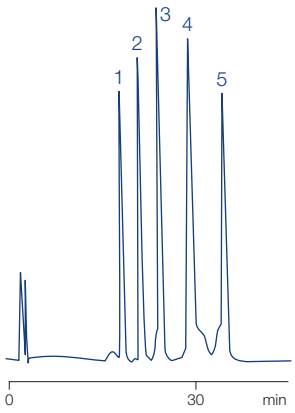
- Silica-based reversed phase materials with polymerically bonded alkyl chains; exclusively hydrophobic interactions
- pH working range 1 – 9, max. working pressure 250 bar

Separation of a protein standard

MN Appl. No. 108220

Column: 125 × 4 mm NUCLEOSIL® 100-5 C_{18} PPN
Eluent: A) 0.1 % TFA in H_2O
B) 0.08 % TFA in CH_3CN
20 – 60 % B in 10 min
Flow rate: 1.0 mL/min
Detection: UV, 280 nm

Peaks:
1. Ribonuclease
2. Cytochrome C
3. Lysozyme
4. β-Lactoglobulin
5. Ovalbumin

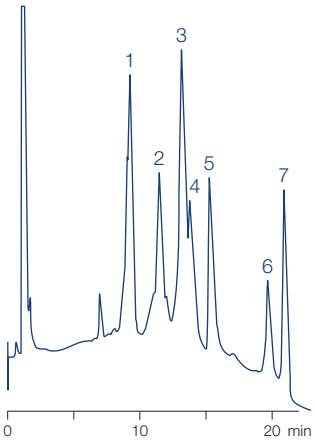


Separation of pancreatic secretion of piglets

MN Appl. No. 108280

Column: 125 x 4 mm NUCLEOSIL® 500-5 C_{18} PPN
Eluent: A) 0.1 % TFA in H_2O
B) 0.08 % TFA in CH_3CN
30–50 % B in 14 min, then 50–65 % B in 6 min
Flow rate: 1 mL/min
Detection: UV, 215 nm

Peaks:
1. Trypsin + trypsinogen
2. Proelastase
3. Lipase + α-Chymotrypsin
4. Chymotrypsinogen
5. α-Amylase
6., 7. Procarboxypeptidase



Eluent in column methanol

ID	Length → 250 mm	EC guard columns*
NUCLEOSIL® 100-5 C_{18} PPN; particle size 5 µm, pore size 100 Å		
Analytical EC columns		
4 mm	720252.40	721567.30
NUCLEOSIL® 500-5 C_{18} PPN; particle size 5 µm, pore size 500 Å		
Analytical EC columns		
4 mm	720258.40	721924.30

* EC guard columns require the Column Protection System guard column holder (REF 718966, see page 259).
Columns in packs of 1, guard columns in packs of 2.

HPLC columns for biochemical separations

NUCLEOGEL® RP columns RP columns for biochemical applications · USP L21

Technical data

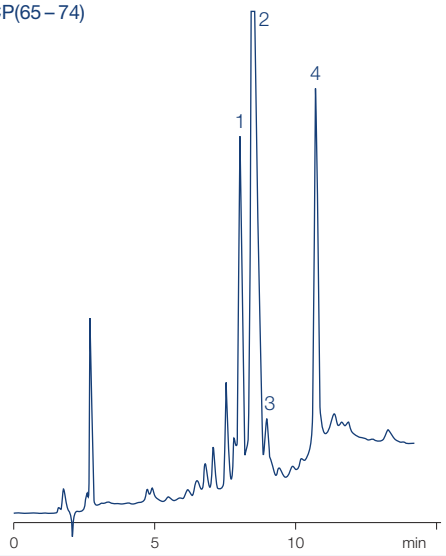
- Polystyrene resin cross-linked with divinylbenzene, available particle sizes 5 µm and 8 µm, available pore sizes 100 Å and 300 Å
- pH working range 1 – 13, max. working pressure 180 bar
- Small pore columns for reversed phase separation of small molecules such as pharmaceuticals with basic properties, e. g., organic heterocycles; also suited for separation of nucleosides and nucleotides up to 5000 Da; allow gradient as well as isocratic elution
- Wide pore columns are especially recommended for large biomolecules higher background hydrophobicity compared to silica phases

Analysis of the synthetic acyl carrier protein ACP(65 – 74)

MN Appl. No. 108500

Column: 150 × 4.6 mm NUCLEOGEL® RP 100-8
Eluant: A) 0.1 % TFA in acetonitrile – water (1:99, v/v)
B) 0.1 % TFA in acetonitrile – water (99:1, v/v)
10 – 60 % B in 20 min
Flow rate: 1 mL/min
Detection: UV, 220 nm

Peaks:
1. ACP(66 – 74)(H-Gln)
2. ACP(65 – 74)
3. ACP(66 – 74)(Glp)
4. Thioanisole



Eluent in column acetonitrile – water

ID	Length → 50 mm	150 mm	250 mm	Guard columns*
NUCLEOGEL® RP 100-5; particle size 5 µm, pore size 100 Å				
Analytical Valco type columns				
4.6 mm		719454	719455	719542
NUCLEOGEL® RP 100-8; particle size 8 µm, pore size 100 Å				
Analytical Valco type columns				
4.6 mm		719456	719520	719542
NUCLEOGEL® RP 300-5; particle size 5 µm, pore size 300 Å				
Analytical Valco type columns				
4.6 mm	719459			719542
NUCLEOGEL® RP 300-8; particle size 8 µm, pore size 300 Å				
Analytical Valco type columns				
4.6 mm	719460			719542

* Valco type guard columns measure 5 × 3 mm and require Guard column holder B, REF 719539, see page 258.
Columns in packs of 1, guard columns in packs of 2.

NUCLEODUR® C_{18} OA special octadecyl phase for organic acid analysis · USP L1

Technical data

- Base material NUCLEODUR® silica, particle size 5 µm, pore size 110 Å; pH stability 2.0 – 8.0

Recommended application

- Reversed phase with polar selectivity for organic acid analysis; suitable for usage with 100 % aqueous mobile phase

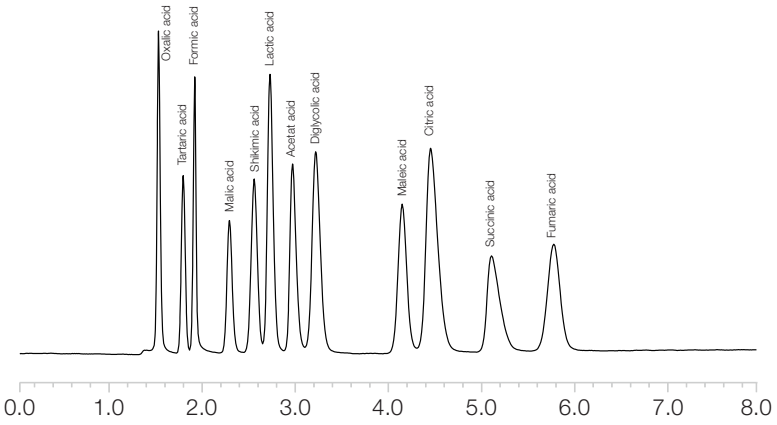
Analysis of organic acids

MN Appl. No. 129180

Analytical Column: EC 150/4.6 NUCLEODUR® C_{18} OA, 5 µm (REF 760688.46)
Eluent: A) 25 mmol KH_2PO_4 in water (pH = 2.5, adjusted with phosphoric acid)
B) methanol
Gradient: 0 % B for 8.0 min, from 0 % to 65 % B in 0.5 min, hold 65 % B for 5.0 min, from 65 % to 0 % B in 0.5 min, hold 0 % B for 6.5 min
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 210 nm

Peaks:

1. Oxalic acid
2. Tartaric acid
3. Formic acid
4. Malic acid
5. Shikimic acid
6. Lactic acid
7. Acetic acid
8. Diglycolic acid
9. Maleic acid
10. Citric acid
11. Succinic acid
12. Fumaric acid



Detection of a standard mixture containing 12 organic acids.

Eluent in column acetonitrile – water

ID		Length → 150 mm	250 mm
NUCLEODUR® C_{18} OA, 5 µm; particle size 5 µm			
Analytical EC columns			
	4.6 mm	760688.46	760689.46

Analysis of organic acids by HPLC

Fruits and fruit juices are globally traded products. Therefore, monitoring of organic acids is an important parameter for quality control in the processing of juices and related products, as well as for the evaluation of the authenticity and purity of juices. In addition, the use of organic acids in foods and beverages is regulated in many countries, though regulations vary widely.

HPLC columns for sugar analyses

NUCLEOSIL® Carbohydrate separation of mono- and disaccharides · USP L8

Technical data

- Matrix: NUCLEOSIL® silica with amino modification, particle size 10 µm

Recommended application

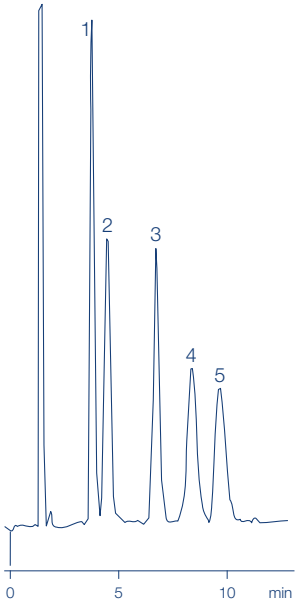
- RP separation of mono- and disaccharides

Separation of sugars

MN Appl. No. 102480

Column: 250 x 4 mm NUCLEOSIL® Carbohydrate
Eluent: acetonitrile – water (79:21, v/v)
Flow rate: 2 mL/min
Temperature: 25 °C
Detection: RI
Injection: 10 µL

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



Eluent in column acetonitrile – water (79:21, v/v)

ID		Length → 250 mm	EC guard columns*
NUCLEOSIL® Carbohydrate			
Analytical EC columns			
	4 mm	720905.40	721170.30

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 259). Columns and guard columns in packs of 1.

HPLC columns for sugar analyses

NUCLEOGEL® SUGAR 810 separation of sugars · USP L17 (H^+ form) · USP L19 (Ca^{2+} form)

Technical data

- Sulfonated polystyrene - divinylbenzene resins in different ionic forms; due to a different selectivity pattern compared to NUCLEOGEL® SUGAR columns, the range of application is considerably enlarged
- Separation mechanism: ion exclusion, ion exchange, size exclusion, ligand exchange, NP and RP chromatography

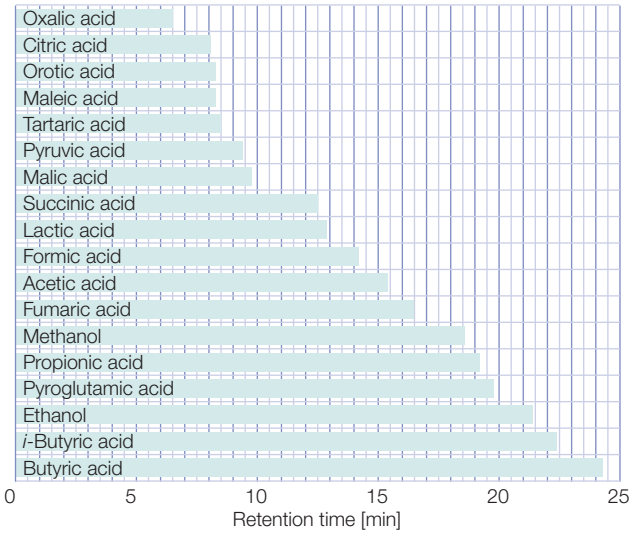
Recommended application

- H+ form:
  Separation of sugars, sugar alcohols and organic acids; eluent in column 5 mmol/L H_2SO_4
- Ca^{2+} form:
  Separation of mono-, di- and oligosaccharides; eluent in column water

Organic acids and alcohols

MN Appl. No. 113870

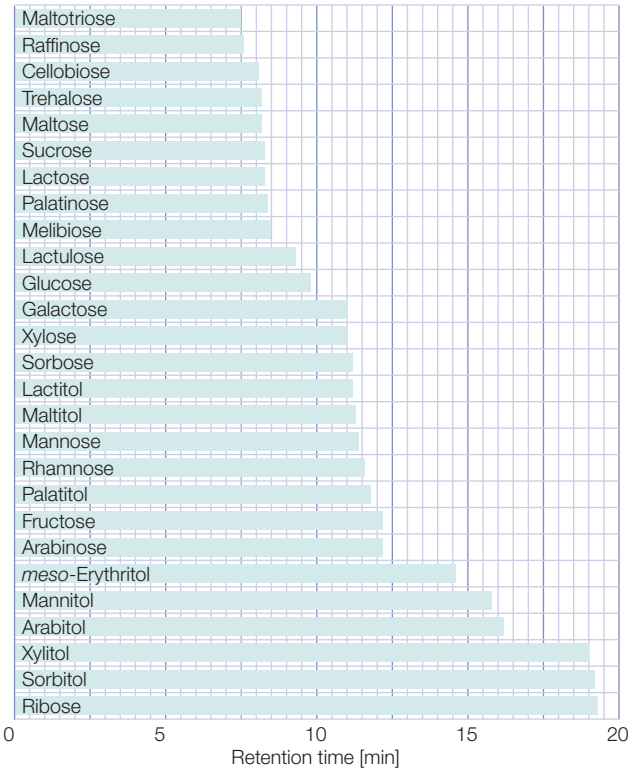
Column:	300 x 7.8 mm NUCLEOGEL® SUGAR 810 H
Eluent:	5 mmol/L H_2SO_4
Flow rate:	0.6 mL/min
Temperature:	35 °C
Detection:	RI
Injection:	5 µL



Sugars and sugar alcohols

MN Appl. No. 114160

Column:	300 x 7.8 mm NUCLEOGEL® SUGAR 810 Ca
Eluent:	water
Flow rate:	0.6 mL/min
Temperature:	85 °C
Detection:	RI



ID	Length → 300 mm	Guard columns*
NUCLEOGEL® SUGAR 810 H; eluent in column 5 mmol/L H_2SO_4		
Analytical Valco type columns		
7.8 mm	719574	719575
NUCLEOGEL® SUGAR 810 Ca; eluent in column water		
Analytical Valco type columns		
7.8 mm	719570	719571

* NUCLEOGEL® SUGAR 810 guard columns measure 30 × 4 mm and require the CC column holder 30 mm (REF 721823)
Columns in packs of 1, guard columns in packs of 2.

HPLC columns for sugar analyses

NUCLEOGEL® ION 300 OA / SUGAR

separation of sugars · USP L17 (H^+ form) · USP L19 (Ca^{2+} form) · USP L34 (Pb^{2+} form) · USP L58 (Na^+ form)

Technical data

- Sulfonated spherical PS/DVB resins in different ionic forms; mean particle size 10 µm, pore size 100 Å
- Separation mechanism includes steric exclusion, ligand exchange and partition effects, ligand exchange being the predominant force, since the hydrated metal ions form strong interactions with the hydroxyl groups of the sample molecules. The intensity of these interactions decreases in the sequence Pb > Ca > Na
- Recommended operating temperatures: 60 – 95 °C; maximum pressure 70 bar

Recommended application

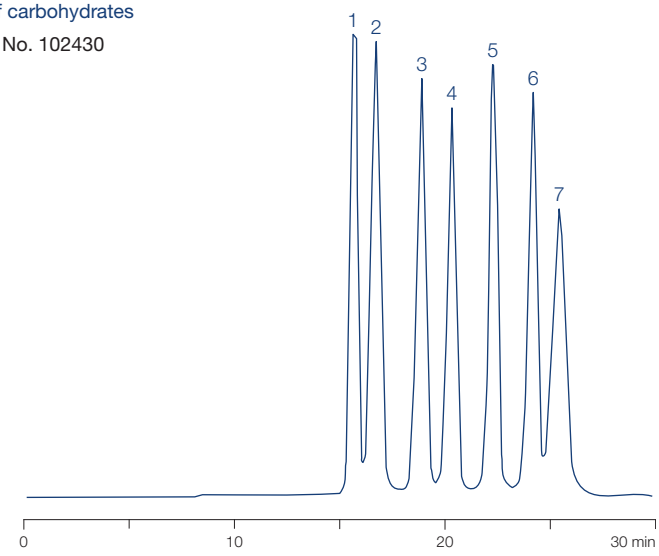
- NUCLEOGEL® ION 300 OA:
  H^+ form for separation of sugars, alcohols and organic acids
- NUCLEOGEL® SUGAR:
  Ca^{2+} form: separation of mono- and oligosaccharides, sugar alcohols
- Pb^{2+} form: separation of mono- and disaccharides from food and biological samples
- Na^+ form: separation of oligosaccharides from starch hydrolysates and food

Separation of carbohydrates

MN Appl. No. 102430

Column: 300 x 7.8 mm NUCLEOGEL® SUGAR Pb
Eluent: deionized water
Flow rate: 0.4 mL/min
Temperature: 80 °C
Detection: RI

Peaks:
1. Sucrose
2. Maltose
3. Glucose
4. Xylose
5. Galactose
6. Arabinose
7. Mannose



ID	Length → 300 mm	Guard columns*
NUCLEOGEL® ION 300 OA; eluent in column 5 mmol/L H_2SO_4 5 mmol/L H2SO4		
Analytical Valco type columns		
7.8 mm	719501	719537
NUCLEOGEL® SUGAR Ca; eluent in column water + 0.02 % azide		
Analytical Valco type columns		
6.5 mm	719531	719535
NUCLEOGEL® SUGAR Pb; eluent in column water + 0.02 % azide		
Analytical Valco type columns		
7.8 mm	719530	719534
NUCLEOGEL® SUGAR Na; eluent in column water + 0.02 % azide		
Analytical Valco type columns		
7.8 mm	719532	719536

* Valco Type guard columns measure 21 × 4 mm and require the guard column holder C, REF 719538, see page 258.
Columns in packs of 1, guard columns in packs of 2.

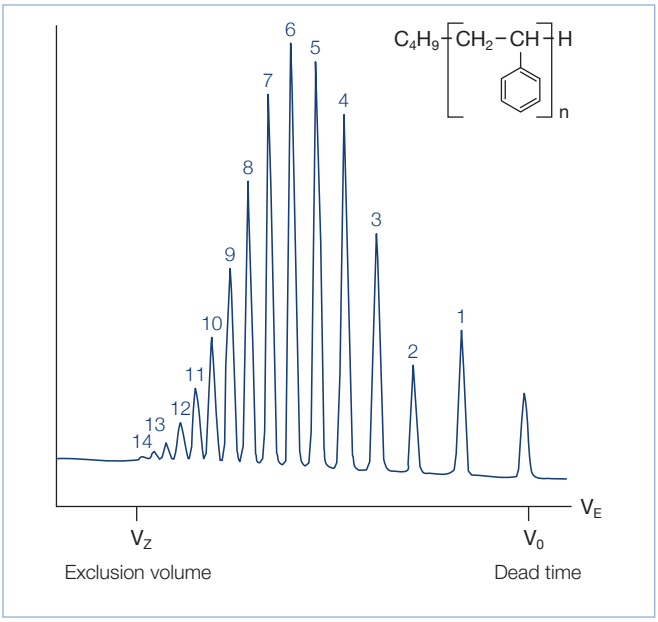
Columns for gel permeation chromatography

NUCLEOGEL® GPC for GPC of water-insoluble substances

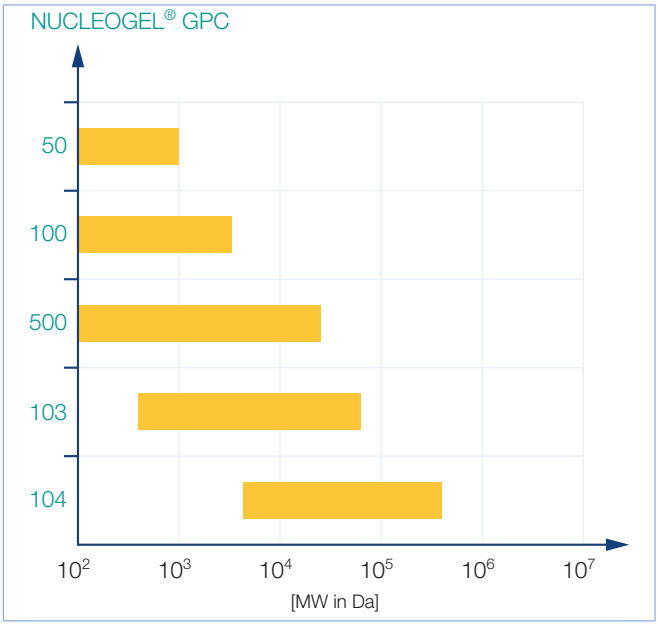
Technical data

- Highly crosslinked macroporous, spherical polystyrene – divinylbenzene polymer matrix with good mechanical stability

Chromatogram of styrene oligomers



Working ranges for polystyrene



Eluent in column toluene

Phase	Exclusion limit [kDalton]	Application	Column 300 × 7.7 mm
5 µm particle size			
Analytical Valco type columns			
NUCLEOGEL® GPC 50	2	low molecular weight organics	719402
NUCLEOGEL® GPC 100	4	oligomers, oils	719403
NUCLEOGEL® GPC 500	25	low molecular weight polymers	719404
NUCLEOGEL® GPC 103	60	low molecular weight polymers	719405
NUCLEOGEL® GPC 104	500	polymers up to 500 kDa	719406
		guard columns 50 × 7.7 mm	719409
10 µm particle size			
Analytical Valco type columns			
NUCLEOGEL® GPC 50	2	low molecular weight organics	719410
NUCLEOGEL® GPC 100	4	oligomers, oils	719411
NUCLEOGEL® GPC 500	25	low molecular weight polymers	719412
NUCLEOGEL® GPC 103	60	low molecular weight polymers	719413
NUCLEOGEL® GPC 104	500	polymers up to 500 kDa	719414
		guard columns 50 × 7.7 mm	719418

Columns and guard columns in packs of 1.