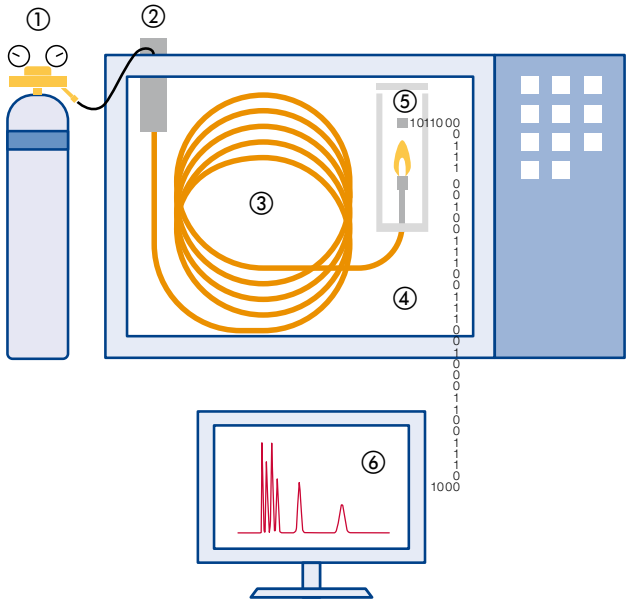
Contents

The GC system



Configuration of a gas chromatograph

① Gas supply: carrier gas and – if necessary – detector gases e.g., for FID detector

② Sample injector: During direct injection, the sample is applied to the column without touching any other parts made from glass or metal (on-column injection). During indirect injection, the sample is brought into an evaporator and is then transferred onto the column either completely, or partially (split technique). Both techniques allow working at low temperatures, high temperatures and the use of temperature programming.

③ Capillary column: the heart of the GC system

④ Temperature-controlled oven

⑤ Detector: indicates a substance by generating an electrical signal (response). Some detectors are specific for certain classes of substances or for certain elements (e.g., P, N).

⑥ Data station for configuration of a gas chromatograph

The separation process

Chromatographic separation is achieved through continuous distribution of each sample component between the mobile and the stationary phase:

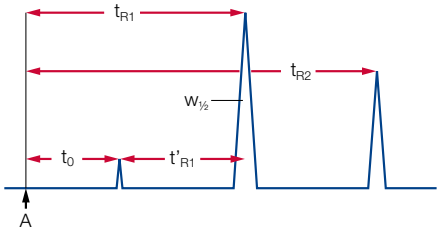
In GC, the mobile phase is always a gas, mostly either He, N_2 or H_2.

The stationary phase is often a viscous, gum-like liquid adhered to the inner wall of a capillary column (WCOT = Wall Coated Open Tubular).

Transport of the components occurs exclusively in the mobile phase, while separation only takes place in the stationary phase. The quality of a separation (resolution) depends on the residence time of the components within the stationary phase and on the rate of interactions. The type of interaction between component and phase (selectivity) is determined by the functional groups of the stationary phase. The polarity of the phase is a function of its substituents.

The chromatogram

A chromatogram consists of a base line and a number of peaks. The area of a peak allows quantitative determinations:



A: starting point of a chromatogram; time of injection of a dissolved solute

A component can be identified by its retention time (qualitative determination):

$$t_{Ri} = t_0 + t'_{Ri}$$

t_0: dead time; residence time of a solute in the mobile phase (time required by a component to migrate through the chromatographic system without any interaction with the stationary phase)

t_{Ri}: retention time; time interval between peak i and the point of injection

t'_{Ri}: net retention time; difference between total retention time and dead time t_0. It indicates how long a substance stays in the stationary phase.

Other terms characterizing a separation:

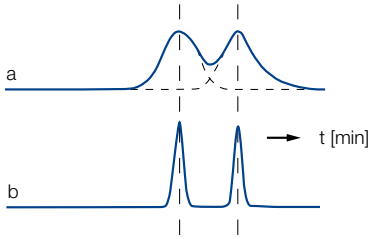
k': retention factor; a measure for the position of a sample peak in the chromatogram. The retention factor is specific for a given compound and constant under constant conditions.

$$k'_i = \frac{t_{Ri} - t_0}{t_0}$$

α: relative retention; also called separation factor or selectivity coefficient, is the ratio of two capacity factors. The reference substance is always in the denominator.

$$\alpha = \frac{k'_2}{k'_1}$$

The relative retention does not provide any information on the quality of a separation. For equal values of α two very broad peaks may overlap (as shown in a), or may be completely resolved (as in b), if they are accordingly narrow.



R: resolution; a measure for the quality of a separation, taking ($w_{1/2}$) into account according to:

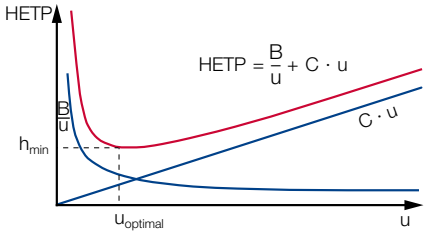
$$R = 1.18 \cdot \frac{t_{R2} - t_{R1}}{(w_{1/2})_2 + (w_{1/2})_1}$$

N: number of theoretical plates; characterizes the quality of a column (should be determined for k' > 5). The height equivalent to a theoretical plate (h, HETP) is calculated by dividing the length L of the column by the number of theoretical plates N. The smaller this value the more efficient the column.

$$N = 5.54 \cdot \frac{(t_{Ri})}{(w_{1/2})} \qquad h = HETP = \frac{L}{N}$$

The Golay equation shows how the plate height h depends on the flow velocity u:

B: molecular axial diffusion; B is a function of the diffusion coefficient of the component in the respective carrier gas



C: resistance to mass transfer

In practice often higher velocities than $u_{opt.}$ are chosen, if separation efficiency is sufficient. Higher carrier velocities mean shorter retention times.

Parameters characterizing a capillary column

OPTIMA® 5	1.0 µm film	30 m ×	0.32 mm ID
A	B	C	D

A: Stationary phase

Different chemical structures of stationary phases are responsible for the type of interaction (selectivity) between the phase and the analytes. The stationary phase also limits the temperature range for chromatography. For a detailed summary of MN phases for GC please see the following chapter.

B: Film thickness

MACHEREY-NAGEL offers ranges from 0.1 to 5.0 µm. The standard film thickness is 0.25 µm. Thin films (0.1 – 0.2 µm) are very well suited for high-boiling, temperature-sensitive or almost contemporaneously eluting substances.

Increasing the film thickness will increase the capacity, the retention for low-boiling substances and the inertness of the column. This is especially helpful for samples with a broad range of concentrations, or the separation of volatile polar substances.

A better coverage of the column wall by a thicker film and a reduced column surface due to a shorter column have a positive impact on the separation of very active substrates, that may cause noticeable tailing when they come in contact with non-coated spots of the column wall.

Thick films, however, always mean more stationary phase in the column, hence increased column bleeding. Therefore, maximum operating temperatures for thick-film columns are reduced. In addition, thick-film columns may have a lesser separating capacity.

C: Column length

The separating efficiency (better the number of plates N) of a column is directly proportional to its length. Most routine separations are carried out on 25 or 30 m columns, while more complex samples may require 50 or 60 m. 10 m columns are common for Fast GC (see page 345).

D: Inner diameter (ID)

The lower the ID, the higher is the theoretically possible number of plates per meter.

0.1 – 0.2 mm ID:
for high resolution and short retention times at low carrier gas flow

0.25 mm ID:
for analysis of complex mixtures

0.32 mm ID:
for routine analysis with short retention times, but increased capacity

0.53 mm ID:
for rapid separations with inert surface and highest capacity

USP listing

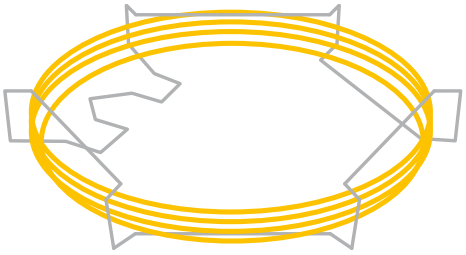
USP listing of MN GC phases

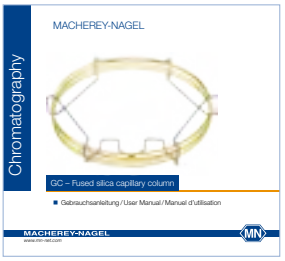
Code	Specifications	MN GC phases	Page
USP G1 / G2	dimethylpolysiloxane oil	OPTIMA® 1	318
		OPTIMA® 1 MS	320
		OPTIMA® 1 MS Accent	320
		OPTIMA® 1-TG	353
		PERMABOND® SE-30	342
		PERMABOND® P-100	357
USP G3	50 % phenyl - 50 % methylpolysiloxane	OPTIMA® 17	335
		OPTIMA® 17 MS	336
		OPTIMA® 17-TG	353
USP G6	trifluoropropylmethylpolysiloxane	OPTIMA® 210	337
USP G7	50 % 3-cyanopropyl – 50 % phenylmethylpolysiloxane	OPTIMA® 225	338
USP G16	polyethylene glycol (average molecular weight ~ 15 000); high molecular weight compound of polyethylene glycol and diepoxide	OPTIMA® WAX	340
		PERMABOND® CW 20 M	342
		PERMABOND® CW 20 M-DEG	359
		FS-CW 20 M-AM	356
USP G19	25 % phenyl – 25 % cyanopropyl – 50 % methylsiloxane	OPTIMA® 225	338
USP G25	high molecular weight compound of polyethylene glycol and diepoxide, which is esterified with terephthalic acid	OPTIMA® FFAP	341
		PERMABOND® FFAP	343
USP G27	5 % phenyl – 95 % methylpolysiloxane	OPTIMA® 5	322
		OPTIMA® 5 Amine	355
		OPTIMA® 5 HT	354
		OPTIMA® 5 MS	323
		OPTIMA® 5 MS Accent	324
USP G28	25 % phenyl – 75 % methylpolysiloxane	OPTIMA® 35 MS	334
USP G32	20 % phenylmethyl – 80 % dimethylpolysiloxane	OPTIMA® 35 MS	334
USP G35	high molecular weight compound of polyethylene glycol and diepoxide, which is esterified with nitroterephthalic acid	OPTIMA® FFAP	341
		PERMABOND® FFAP	343
USP G36	1 % vinyl – 5 % phenylmethylpolysiloxane	OPTIMA® 5	322
		OPTIMA® 5 Amine	355
		OPTIMA® 5 HT	354
		OPTIMA® 5 MS	323
		OPTIMA® 5 MS Accent	324
		PERMABOND® SE-54 HKW	357
USP G38	dimethylpolysiloxane oil	OPTIMA® 1	318
		OPTIMA® 1 MS	320
		OPTIMA® 1 MS Accent	320
		OPTIMA® 1-TG	353
		PERMABOND® SE-30	342
		PERMABOND® P-100	357
USP G42	35 % phenyl – 65 % dimethylpolysiloxane	OPTIMA® 35 MS	334
USP G43	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	OPTIMA® 1301	329
		OPTIMA® 1301 MS	330
		OPTIMA® 624	330
		OPTIMA® 624 LB	331
USP G46	14 % cyanopropylphenyl – 86 % methylpolysiloxane	OPTIMA® 1701	332
		OPTIMA® 1701 MS	333
USP G49	proprietary derivatized phenyl groups on a polysiloxane backbone	OPTIMA® δ-3	327

Additional information for GC columns

Scope of delivery

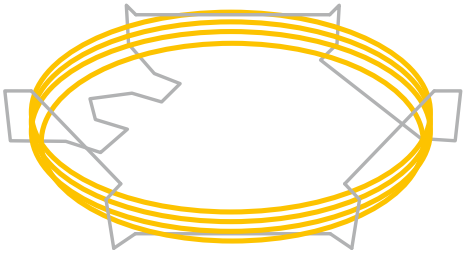
Each column is individually tested and supplied with a test certificate and test chromatogram, but does not include fittings or ferrules. Columns have fused ends or are sealed with septa to protect them from atmospheric oxygen. Further more an instruction leaflet is enclosed.



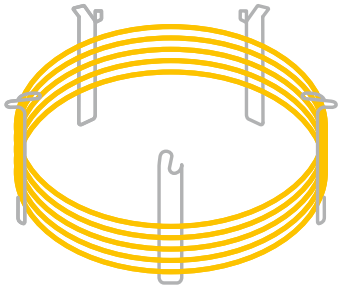


GC cages

The standard size of a GC cage is 7 inches. On request, all columns can be supplied on a 5 inch (13 cm) cage e.g., for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)



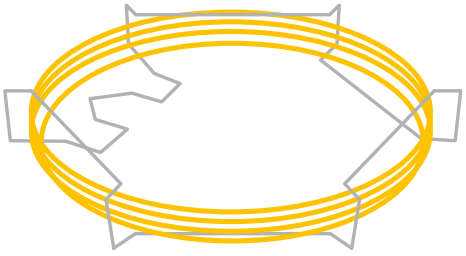
7 inches standard size e.g., REF 726600.30



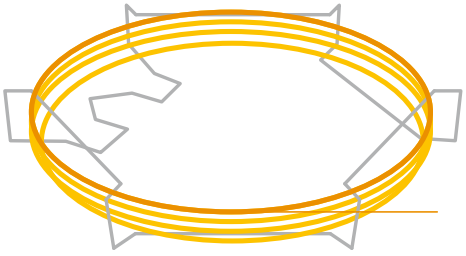
5 inches special cage e.g., REF 726600.30E

Integrated guard column

To prolong column life, even at highly contaminated or matrix-containing samples, MN offers the option to add an integrated guard column. All capillary columns are available with a 10 m guard column with respective deactivation. To order, please add V1 at the end of the REF number (e.g., 726600.30V1). Guard column combinations with other lengths, IDs or different deactivation are available on request.



Without integrated guard column e.g., REF 726600.30



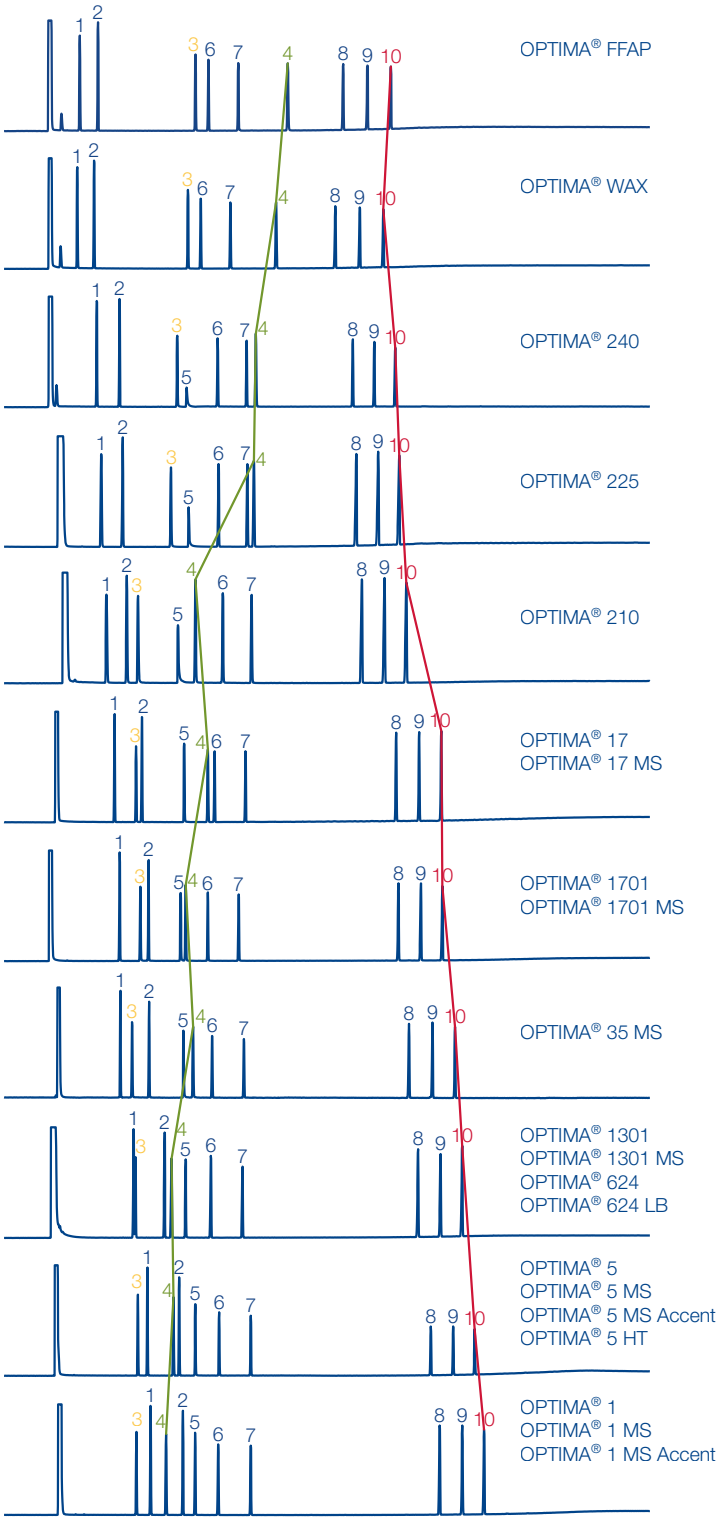
With integrated guard column e.g., REF 726600.30V1

MACHEREY-NAGEL derivatization reagents

Purpose of derivatization

- Improved volatility, better thermal stability or a lower limit of detection in gas chromatography
- Prerequisite: quantitative, rapid and reproducible formation of only one derivative
- Halogen atoms inserted by derivatization (e.g., trifluoroacetates) for specific detection (ECD) with the advantage of high sensitivity
- Influence of elution orders and fragmentation patterns in MS by a specific derivatization
- We provide reagents for
  - Silylation
  - Alkylation (methylation)
  - Acylaction
- For 1 × 10 mL, 1 × 50 mL and 6 × 50 mL also as screw neck vial
- Product range from page 362 onwards

Separation properties of OPTIMA® phases



Peaks:

1. Undecane
2. Dodecane
3. Octanol
4. Dimethylaniline
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane

All columns:	0.25 µm film, 30 m × 0.25 mm ID
Sample:	MN OPTIMA® test mixture (REF 722316)
Injection:	1.0 µL, split 15 mL/min
Carrier gas:	0.80 bar He
Temperature:	80 °C T_{max} (isothermal), 8 °C/min (20 min T_{max})
Detector:	FID 260 – 280 °C

Summary of MN phases for GC

Overview of OPTIMA® MN phases

Phase	Composition	Page	Relative polarity [1]	Maximum temperature [2]
OPTIMA® 1	100 % dimethylpolysiloxane	318		340 / 360 °C
OPTIMA® 1 MS	100 % dimethylpolysiloxane	320		
OPTIMA® 1 MS Accent	100 % dimethylpolysiloxane	320		
OPTIMA® 5	5 % phenyl – 95 % methylpolysiloxane	322		340 / 360 °C
OPTIMA® 5 MS	5 % diphenyl – 95 % dimethylpolysiloxane	323		340 / 360 °C
OPTIMA® 5 MS Accent	silarylene phase with selectivity similar to 5 % diphenyl – 95 % dimethylpolysiloxane	324		340 / 360 °C
OPTIMA® XLB	silarylene phase like above, optimized silarylene content for low bleeding	325		340 / 360 °C
OPTIMA® δ-3	phase with autoselectivity [4]	327		340 / 360 °C
OPTIMA® δ-6	phase with autoselectivity [4]	328		340 / 360 °C
OPTIMA® 1301	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	329		300 / 320 °C
OPTIMA® 1301 MS	silarylene phase with low bleeding: polarity similar to 6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	330		300 / 320 °C
OPTIMA® 624	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	330		280 / 300 °C
OPTIMA® 624 LB	like above, phase with low bleeding	331		
OPTIMA® 1701	14 % cyanopropylphenyl – 86 % dimethylpolysiloxane	332		280 / 300 °C
OPTIMA® 1701 MS	silarylene phase with low bleeding: polarity similar to 14 % cyanopropylphenyl – 86 % dimethylpolysiloxane	333		280 / 300 °C

[1] = nonpolar, = polar

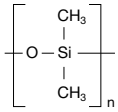
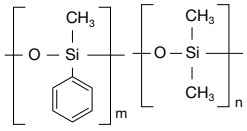
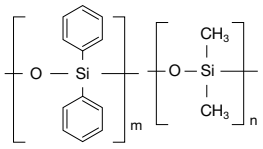
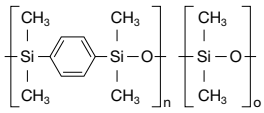
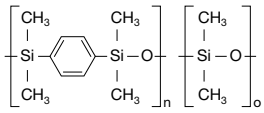
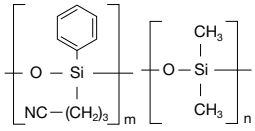
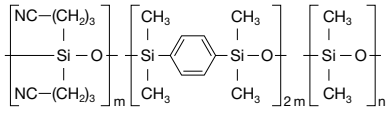
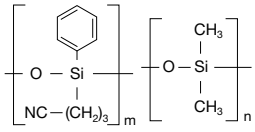
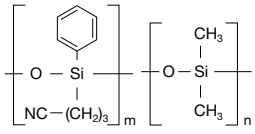
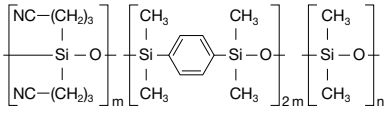
[2] First temperature (long term temperature) for isothermal operation, second value for the max. temperature (short term temperature) in a temperature program. Please note that for columns with 0.53 mm ID and for columns with thicker films temperature limits are generally lower. For details refer to the description of individual phases.

[3] Phases which provide a similar selectivity based on chemical and physical properties

[4] See description on page 326

GC columns for special separations can be found from page 344 onwards.

Summary of MN phases for GC

Structure	USP	Similar phases [3]
	G1 / G2 / G38	PERMABOND® SE-30, OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101
		5 % diphenyl – 95 % dimethylpolysiloxane
	G27 / G36	PERMABOND® SE-52, SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007 – 5, BP5, MDN-5, AT™-5, ZB-5
	G27 / G36	DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007 – 5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS
	G27 / G36	
	–	DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS
see description page 326	G49	no similar phases
see description page 326	–	no similar phases
	G43	HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007 – 1301
	G43	VF-1301ms, Rxi®-1301Sil MS, TG-1301MS
	G43	HP-624, HP-VOC, DB-624, DB-VRX, SPB™-624, CP-624, Rtx®-624, Rtx®-Volatiles, 007 – 624, BP624, VOCOL
	G46	OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007 – 1701, BP10, ZB-1701
	G46	VF-1701ms, TG-1701MS, OV-1701, DB-1701, HP-1701, Rtx®-1701, SPB™-1701, CP Sil 19 CB, 007 – 1701, BP10, ZB-1701

Summary of MN phases for GC

Phase	Composition	Page	Relative polarity [1]	Maximum temperature [2]
OPTIMA® 35 MS	silarylene phase with selectivity similar to 35 % diphenyl – 65 % dimethylpolysiloxane	334		360 / 370 °C
OPTIMA® 17	phenylmethylpolysiloxane, 50 % phenyl	335		320 / 340 °C
OPTIMA® 17 MS	silarylene phase with selectivity similar to 50 % phenyl – 50 % methylpolysiloxane	336		340 / 360 °C
OPTIMA® 210	trifluoropropylmethylpolysiloxane (50 % trifluoropropyl)	337		260 / 280 °C
OPTIMA® 225	50 % cyanopropylmethyl – 50 % phenylmethylpolysiloxane	338		260 / 280 °C
OPTIMA® 240	33 % cyanopropylmethyl – 67 % dimethylpolysiloxan	339		260 / 280 °C
OPTIMA® WAX	polyethylene glycol 20 000 Da	340		240 / 250 °C
OPTIMA® FFAP	polyethylene glycol 2-nitroterephthalate	341		250 / 260 °C

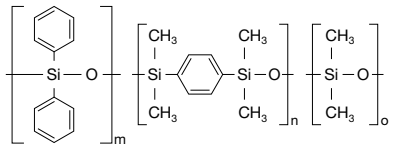
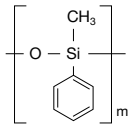
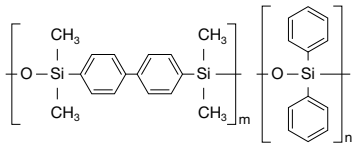
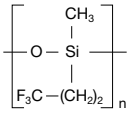
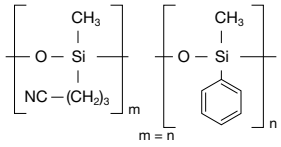
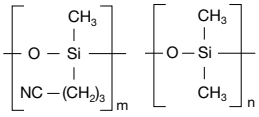
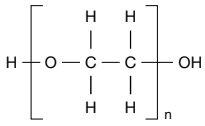
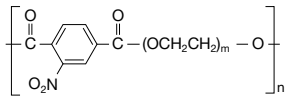
[1] = nonpolar, = polar

[2] First temperature (long term temperature) for isothermal operation, second value for the max. temperature (short term temperature) in a temperature program. Please note that for columns with 0.53 mm ID and for columns with thicker films temperature limits are generally lower. For details refer to the description of individual phases.

[3] Phases which provide a similar selectivity based on chemical and physical properties

GC columns for special separations can be found from page 344 onwards.

Summary of MN phases for GC

Structure	USP	Similar phases [3]
	G28 / G32 / G42	DB-35 MS, HP-35, SPB™-35, Rxi®-35SIL MS, Rtx-35, 007 – 35, BPX™-35, MDN-35, AT™-35 MS, ZB-35, OV-11, VF-35 MS
	G3	OV-17, DB-17, HP-50+, HP-17, SPB™-50, SP-2250, Rxi®-17, Rtx®-50, CP-Sil 24 CB, 007 – 17, ZB-50
	G3	OV-17, AT™-50, BPX™-50, DB-17, DB-17ms, HP-50+, HP-17, SPB™-50, SPB™-17, SP-2250, Rtx®-50, CP-Sil 24 CB, 007 – 17, VF-17ms, ZB-50
	G6	OV-210, DB-210, Rtx®-200, 007-210
	G7 / G19	DB-225, HP-225, OV-225, Rtx®-225, CP-Sil 43, 007 – 225, BP225
	–	no similar phases
	G16	PERMABOND® CW 20 M, DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax
	G35 / G25	PERMABOND® FFAP, DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™, AT-1000, SPB-1000, BP21, OV-351

OPTIMA® · nonpolar capillary columns

OPTIMA® 1 100 % dimethylpolysiloxane · USP G1 / G2 / G38

Key features
- Nonpolar phase
- Structure see page 315

Recommended application
- Separation of components according to boiling points
- Thick film columns ≥ 3 µm film are especially recommended for solvent analysis.

Temperature
- Columns with 0.1 – 0.32 mm ID and films < 3 µm: T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID, films < 3 µm: T_{max} 320 and 340 °C, resp.
- Thick film columns with films ≥ 3 µm: max. temperatures 300 and 320 °C, resp.

Similar phases
- PERMABOND® SE-30 (see page 342), OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101

OPTIMA® 1

	Length → 10 m	12 m	15 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)								
0.10 µm film	726024.10			726024.20				
0.40 µm film				726025.20				
0.2 mm ID (0.4 mm OD)								
0.10 µm film					726832.25			
0.20 µm film		726834.12			726834.25		726834.50	
0.35 µm film		726837.12			726837.25		726837.50	
0.50 µm film							726839.50	
0.25 mm ID (0.4 mm OD)								
0.10 µm film	726038.10		726038.15		726038.25	726038.30		726038.60
0.25 µm film	726050.10		726050.15		726050.25	726050.30	726050.50	726050.60
0.50 µm film	726081.10				726081.25	726081.30	726081.50	726081.60
1.00 µm film					726802.25	726802.30	726802.50	726802.60
0.32 mm ID (0.5 mm OD)								
0.10 µm film	726301.10				726301.25	726301.30	726301.50	726301.60
0.25 µm film	726302.10		726302.15		726302.25	726302.30	726302.50	726302.60
0.35 µm film					726821.25	726821.30	726821.50	726821.60
0.50 µm film	726304.10				726304.25	726304.30	726304.50	726304.60
1.00 µm film	726323.10		726323.15		726323.25	726323.30	726323.50	726323.60
3.00 µm film					726805.25	726805.30	726805.50	726805.60
5.00 µm film	726931.10				726931.25	726931.30	726931.50	
0.53 mm ID (0.8 mm OD)								
0.50 µm film			726519.15		726519.25	726519.30		
1.00 µm film	726529.10		726529.15		726529.25	726529.30		
2.00 µm film	726521.10				726521.25	726521.30	726521.50	
5.00 µm film	726926.10				726926.25	726926.30	726926.50	

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

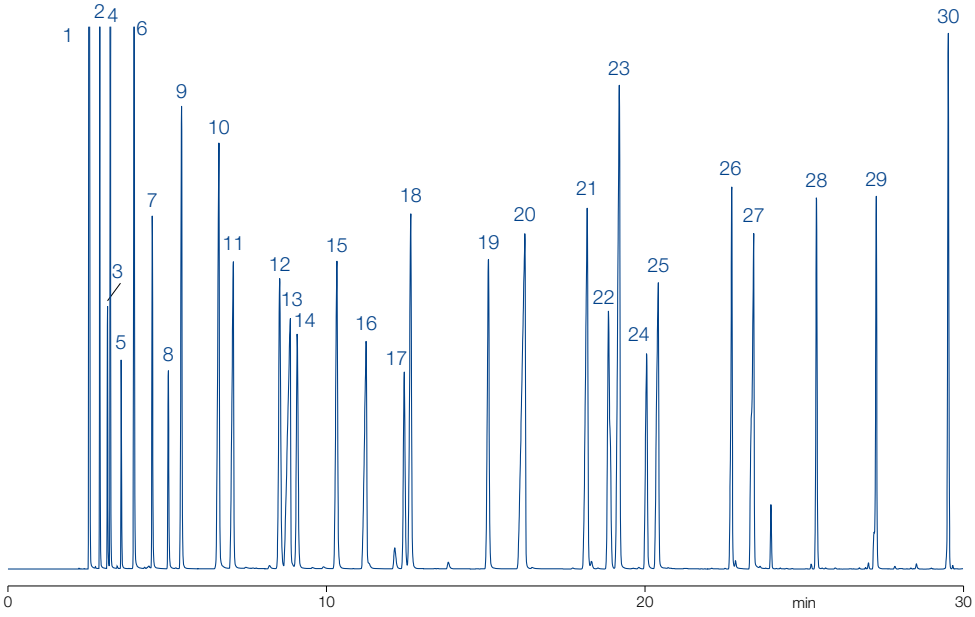
Solvent analysis

MN Appl. No. 201390

Column:	OPTIMA® 1, 60 m x 0.32 mm ID, 1.0 µm film
Sample:	solvent mixture, courtesy of J. Lutz, Alcan Rorschach, Switzerland
Injection:	0.4 µL, split 1:60
Carrier gas:	H_2, 120 kPa
Temperature:	50 °C (9 min) → 90 °C, 4 °C/min → 280 °C (2 min), 14 °C/min
Detector:	FID 300 °C

Peaks:

1. Methanol
2. Ethanol
3. Acetone
4. 2-Propanol
5. Methyl acetate
6. *n*-Propanol
7. Methyl ethyl ketone
8. Ethyl acetate
9. Isobutanol
10. *n*-Butanol
11. 1-Methoxy-2-propanol
12. Isooctane
13. Ethyl glycol
14. Isoheptane
15. Methyl isobutyl ketone
16. 1-Ethoxy-2-propanol
17. Toluene
18. Isobutyl acetate
19. Butyl acetate
20. 4-Hydroxy-4-methyl-2-pentanone
21. 1-Methoxy-2-propyl acetate
22. Xylene
23. Cyclohexanone
24. Ethyl glycol acetate
25. Butyl glycol
26. Heptanol
27. Ethyl diglycol
28. Butyl diglycol
29. Butyl glycol acetate
30. Butyl diglycol acetate



OPTIMA® · nonpolar capillary columns

OPTIMA® 1 MS 100 % dimethylpolysiloxane · USP G1 / G2 / G38

Key features
- Selectivity identical to OPTIMA® 1,
- Phase with low bleeding
- Structure see page 315

Recommended application
- GC/MS and ECD, general analysis at trace level

Temperature
- T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)

Similar phases
- Ultra-1, DB-1MS, HP-1MS, Rxi®-1MS, Rtx®-1MS, Equity™-1, AT™-1MS, VF-1MS, CP-Sil 5 CB MS

OPTIMA® 1 MS

Length → 12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)					
0.20 µm film		726201.25		726201.50	
0.35 µm film 726203.12					
0.25 mm ID (0.4 mm OD)					
0.25 µm film	726205.15		726205.30		726205.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film			726202.30		726202.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® 1 MS Accent 100 % dimethylpolysiloxane · USP G1 / G2 / G38

Key features
- Selectivity identical to OPTIMA® 1,
- Nonpolar phase
- Lowest column bleed
- Solvent rinsing for removal of impurities applicable
- Increased sensitivity due to an unmatched low background level
- Structure see page 315

Recommended application
- Ideal for ion trap and quadrupole MS detectors
- Perfect inertness for basic compounds
- All-round phase for environmental analysis, trace analysis, EPA methods, pesticides, PCB, food and drug analysis

Temperature
- T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)

Similar phases
- Ultra-1, DB-1MS, HP-1MS, Rxi®-1MS, Rtx®-1MS, Equity™-1, AT™-1MS, VF-1MS, CP-Sil 5 CB MS

EPA 8140 / 8141 / 8141 A Organophosphorus pesticides

MN Appl. No. 213030

Column: OPTIMA® 1 MS Accent, 30 m x 0.32 mm ID, 0.50 µm film

Sample: 0.2 µg/mL in hexane,
8140 / 8141 OP pesticides calibration mix A
and 8141 OP pesticides calibration mix B;
IS triphenyl phosphate and tributyl phosphate

Injection: 250 °C, splitless (hold 1 min)

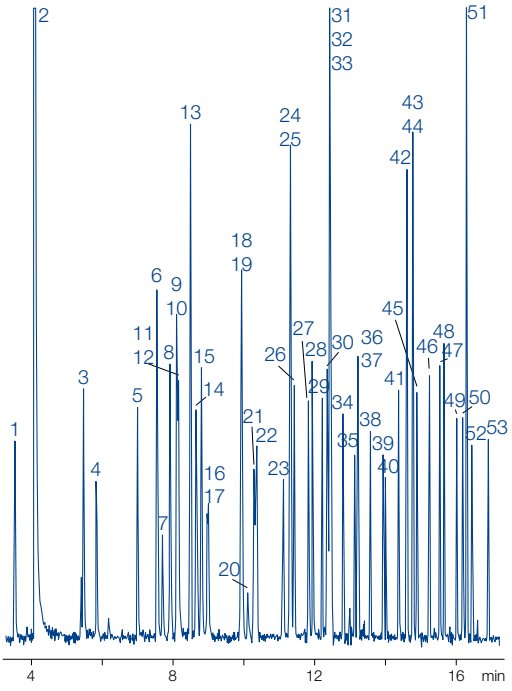
Carrier gas: He, 1 mL/min, constant pressure

Temperature: 100 °C → 180 °C, 10 °C/min (2 min) → 300 °C, 18 °C/min (3 min)

Detector: FPD (Flame Photometric Detector), 280 °C

Peaks:

1. Dichlorvos
2. Hexamethylphosphoramide
3. Mevinphos
4. Trichlorfon
5. TEPP
6. Thionazin
7. Demeton-O
8. Ethoprop
9. Tributyl phosphate (IS)
10. Dicrotophos
11. Monocrotophos
12. Naled
13. Sulfotepp
14. Phorate
15. Dimethoate
16. Demeton-S
17. Dioxathion
18. Terbufos
19. Fonophos
20. Phosphamidon isomer
21. Diazinon
22. Disulfoton
23. Phosphamidon
24. Dichlorofenthion
25. Parathion-methyl
26. Chlorpyrifos-methyl
27. Ronnel
28. Fenitrothion
29. Malathion
30. Fenthion
31. Aspon
32. Parathion-ethyl
33. Chlorpyrifos
34. Trichloronate
35. Chlorfenvinphos
36. Merphos
37. Crotoxyphos
38. Stirofos
39. Tokuthion
40. Merphos oxidation product
41. Fensulfothion
42. Famphur
43. Ethion
44. Bolstar
45. Carbophenothion
46. Triphenyl phosphate (IS)
47. Phosmet
48. EPN
49. Azinphos-methyl
50. Leptophos
51. Tri-*o*-cresyl phosphate
52. Azinphos-ethyl
53. Coumaphos



OPTIMA® 1 MS Accent

Length →	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)					
0.20 µm film		725801.25		725801.50	
0.25 mm ID (0.4 mm OD)					
0.25 µm film	725805.15		725805.30		725805.60
0.50 µm film			725806.30		725806.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film			725802.30		725802.60
0.50 µm film			725807.30		725807.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · weakly polar capillary columns

OPTIMA® 5 5 % phenyl – 95 % methylpolysiloxane · USP G27 / G36

Key features
- Nonpolar phase
- Structure see page 315

Recommended application
- Standard phase with large range of application

Temperature
- Columns with 0.1 – 0.32 mm ID and films < 3 µm: T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID, films < 3 µm: T_{max} 320 and 340 °C, resp.
- Thick film columns with films ≥ 3 µm: max. temperatures 300 and 320 °C, resp.

Similar phases
- PERMABOND® SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007 – 5, BP5, MDN-5, AT™-5, ZB-5

OPTIMA® 5

	Length → 10 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	726846.10					
0.2 mm ID (0.4 mm OD)						
0.10 µm film			726854.25			
0.20 µm film			726857.25		726857.50	
0.35 µm film			726860.25		726860.50	
0.50 µm film			726863.25		726863.50	
0.25 mm ID (0.4 mm OD)						
0.10 µm film			726911.25	726911.30	726911.50	726911.60
0.25 µm film	726056.10	726056.15	726056.25	726056.30	726056.50	726056.60
0.35 µm film			726623.25	726623.30	726623.50	726623.60
0.50 µm film			726099.25	726099.30	726099.50	726099.60
1.00 µm film			726807.25	726807.30	726807.50	726807.60
0.32 mm ID (0.5 mm OD)						
0.10 µm film	726313.10	726313.15	726313.25	726313.30	726313.50	726313.60
0.25 µm film		726314.15	726314.25	726314.30	726314.50	726314.60
0.35 µm film			726628.25	726628.30	726628.50	726628.60
0.50 µm film			726316.25	726316.30	726316.50	726316.60
1.00 µm film		726325.15	726325.25	726325.30	726325.50	726325.60
3.00 µm film			726809.25	726809.30	726809.50	726809.60
5.00 µm film		726934.15	726934.25	726934.30	726934.50	
0.53 mm ID (0.8 mm OD)						
0.50 µm film	726523.10		726523.25	726523.30		
1.00 µm film	726541.10	726541.15	726541.25	726541.30		
2.00 µm film	726525.10		726525.25	726525.30	726525.50	726525.60
5.00 µm film	726916.10		726916.25	726916.30	726916.50	

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® · weakly polar capillary columns

OPTIMA® 5 MS 5 % diphenyl – 95 % dimethylpolysiloxane · USP G27 / G36

Key features
- Selectivity identical to OPTIMA® 5
- Phase with low bleeding
- Structure see page 315

Recommended application
- GC/MS and ECD, applications and general analysis at trace level
- Perfect inertness for basic compounds

Temperature
- T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)

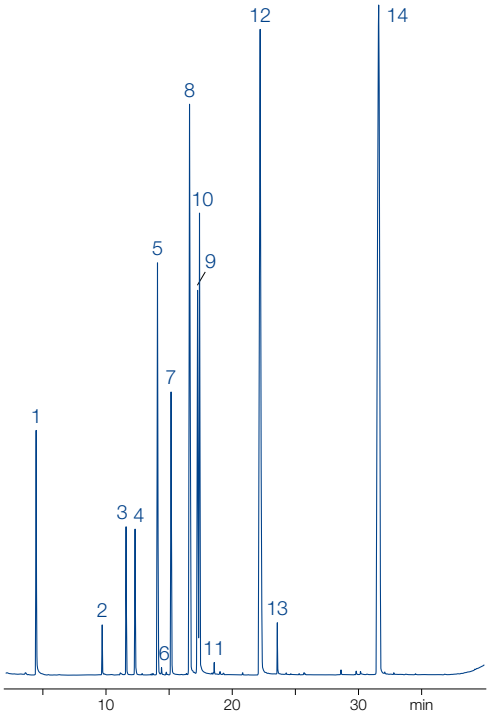
Similar phases
- DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007 – 5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS

Analysis of various phenols

MN Appl. No. 210110

Column: OPTIMA® 5 MS, 30 m x 0.25 mm ID, 0.25 µm film
Sample: 5 ppm of each compound except *N-i*-propylaniline (9.4 ppm)
Methode: SPME
Temperature: 40 °C (2 min) → 240 °C, 6 °C/min → 320 °C, 20 °C/min
Detector: MSD

Peaks:
1. Toluene-D_8
2. Phenol
3. 2-Methylphenol (o-Cresol)
4. Nitrobenzene-D_5
5. *N-i*-Propylaniline
6. 2,4-Dichlorophenol
7. 4-Chlorophenol
8. 4-Bromo-2-chlorophenol
9. 3-Bromophenol
10. 4-Chloro-3-methylphenol
11. 2,4-Dibromophenol
12. 2-Hydroxybiphenyl
13. 2-Cyclohexylphenol
14. Hexafluorobisphenol A



Courtesy of Riedel-de-Haën, Seelze, Germany

OPTIMA® 5 MS

Length → 12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)					
0.20 µm film 726210.12		726210.25		726210.50	
0.35 µm film 726215.12		726215.25		726215.50	
0.25 mm ID (0.4 mm OD)					
0.25 µm film	726220.15		726220.30		726220.60
0.50 µm film			726225.30		726225.60
1.00 µm film			726226.30		726226.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film			726211.30		
0.50 µm film			726213.30		
1.00 µm film		726212.25		726212.50	726212.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · weakly polar capillary columns

OPTIMA® 5 MS Accent silarylene phase · USP G27 / G36

Key features

- Chemically bonded, cross-linked silarylene phase with polarity similar to a 5 % diphenyl – 95 % dimethylpolysiloxane phase
- Lowest column bleed, nonpolar phase, solvent rinsing for removal of impurities applicable
- Structure see page 315

Recommended application

- Ideal for ion trap and quadrupole MS detectors
- Perfect inertness for basic compounds
- All-round phase for environmental analysis, trace analysis, EPA methods, pesticides, PCB, food and drug analysis

Temperature

- T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)
- Film thickness > 0.5 µm: T_{max} 320 and 340 °C, resp.

Similar phases

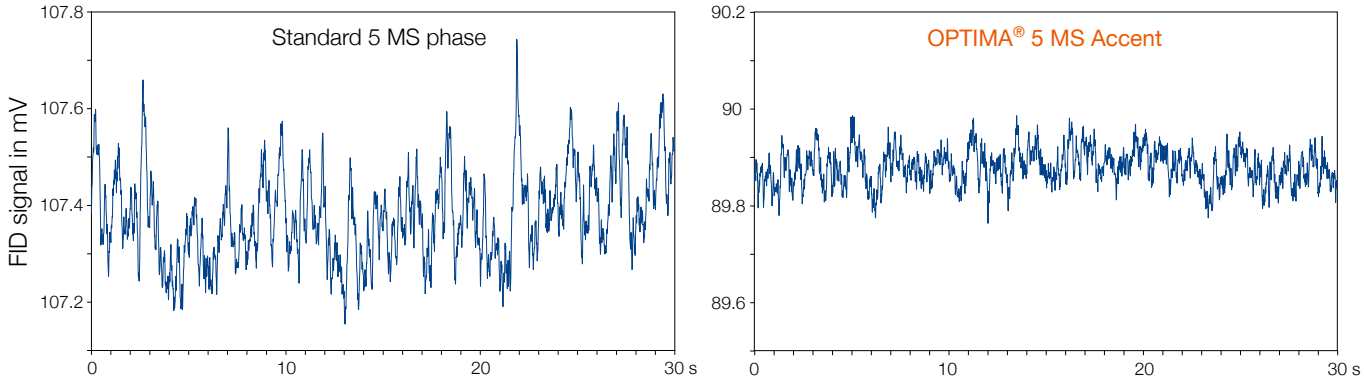
- DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS

Increased sensitivity due to an unmatched low background level

The bleed comparison test of OPTIMA® 5 MS Accent with a conventional 5 MS phase shows the outstanding performance of the silarylene phase.

The unmatched low background level of the OPTIMA® 5 MS Accent (approximately three times lower compared to a 5 MS brand column) provides significantly increased sensitivity, allowing its application in trace analysis of particularly high-boiling compounds.

Background noise at 340 °C



OPTIMA® 5 MS Accent

Length → 12 m	15 m	25 m	30 m	50 m	60 m
0.20 mm ID (0.4 mm OD)					
0.20 µm film		725810.25		725810.50	
0.35 µm film 725815.12				725815.50	
0.25 mm ID (0.4 mm OD)					
0.25 µm film	725820.15		725820.30		725820.60
0.50 µm film			725825.30		725825.60
1.00 µm film			725826.30		725826.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film			725811.30		725811.60
0.50 µm film			725813.30		
1.00 µm film		725812.25			725812.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® XLB silarylene phase

Key features

- Chemically bonded, cross-linked silarylene phase, optimized silarylene content for lowest column bleed, nonpolar phase, perfect inertness for basic compounds, solvent rinsing for removal of impurities applicable
- Structure see page 315

Recommended application

- Ideal for ion trap and quadrupole MS detectors, ultra low bleed phase, highly selective for environmental and trace analysis, pesticides, recommended phase for PCB separations

Temperature

- T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)

Similar phases

- DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS

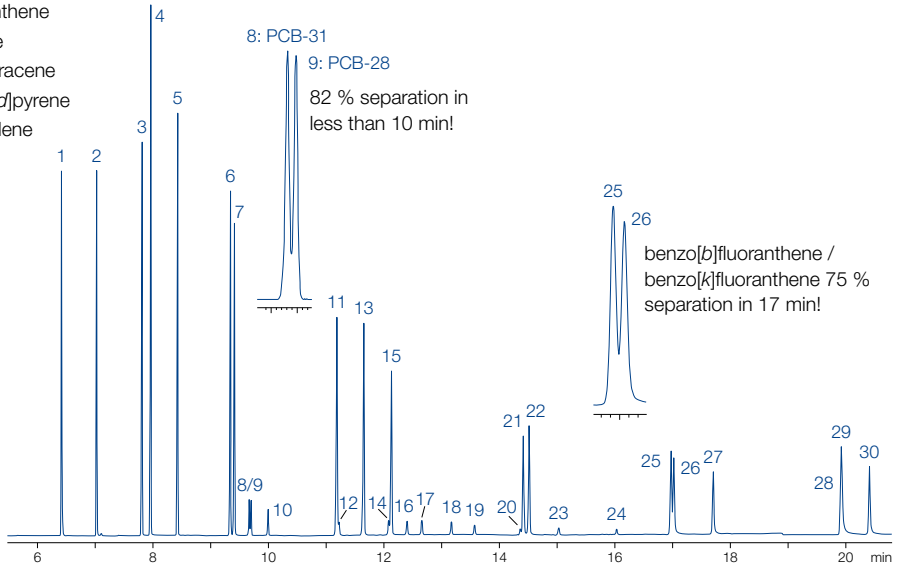
Rapid separation of PCB and PAH

MN Appl. No. 212920

Column:	OPTIMA® XLB, 30 m x 0.25 mm ID, 0.25 µm film
Injection:	1 µL, Standard 0.005 ng/µL, 250 °C, pulsed, splitless, pulse 1.38 bar in 1 min
Carrier gas:	60 mL/min He
Temperature:	40 °C (2 min) → 240 °C (2 min), 30 °C/min → 340 °C (5 min), 10 °C/min
Detektion:	MS source 230 °C, interface 280 °C, quadrupole 150 °C

Peaks:

1. Naphthalene
2. 2-Methylnaphthalene
3. Acenaphthylene
4. Acenaphthene
5. Fluorene
6. Phenanthrene
7. Anthracene
8. PCB-31
9. PCB-28
10. PCB-52
11. Fluoranthene
12. PCB-101
13. Pyrene
14. PCB-77
15. 2-Methylfluoranthene
16. PCB-118
17. PCB-153
18. PCB-138
19. PCB-126
20. PCB-180
21. Benz[*a*]anthracene
22. Chrysene
23. PCB-169
24. PCB-194
25. Benzo[*b*]fluoranthene
26. Benzo[*k*]fluoranthene
27. Benzo[*a*]pyrene
28. Dibenz[*ah*]anthracene
29. Indeno[1,2,3-*cd*]pyrene
30. Benzo[*ghi*]perylene



Courtesy of Centre d'Analyses de Recherche, Lab. d'Hydrologie, 65400 Illkirch, France

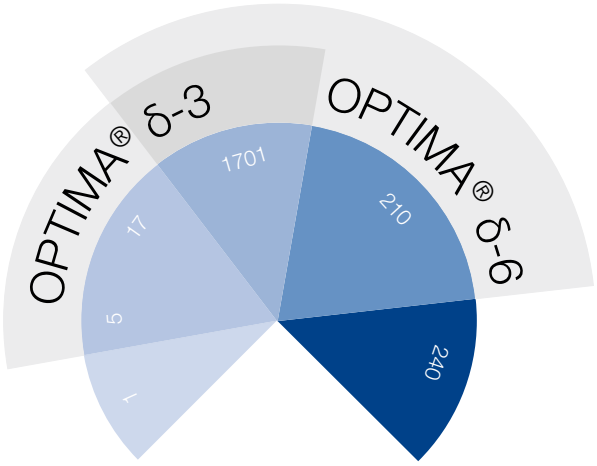
OPTIMA® XLB

	Length → 30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	725850.30	725850.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® δ · phases with autoselectivity

Range of polarities covered by OPTIMA® δ phases



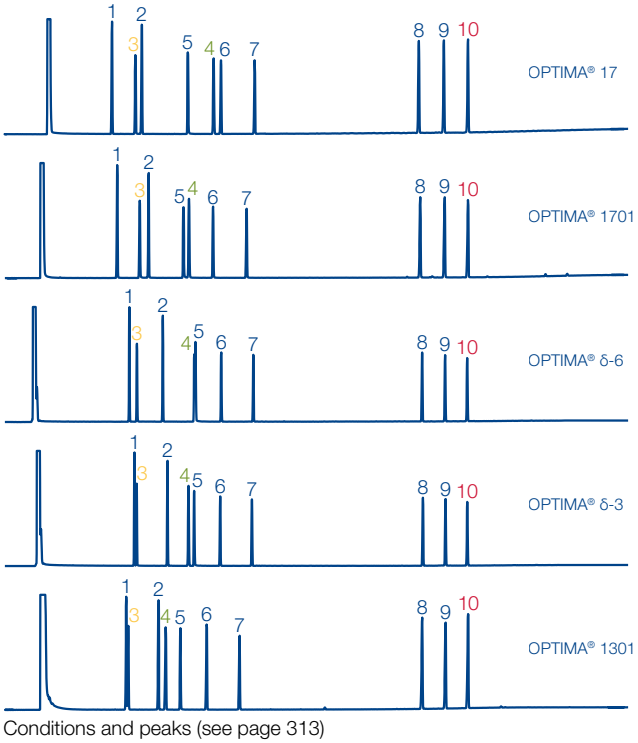
All stationary GC phases can be classified by their polarities. While the selectivity of common GC phases is generally determined by permanent dipole-dipole interactions, OPTIMA® δ-3 and OPTIMA® δ-6 show an additional feature. Large, polarizable groups in the polymer chain of the stationary phase enable the analyte to induce a further dipole moment that increases with the polarity of said analyte. We call this phenomenon "Autoselectivity", because the column adjusts itself to the polarity of the analyte. The implemented polymers consist of cross-linked polysiloxanes with a defined composition and an extremely narrow distribution of molecular weight.

OPTIMA® δ phases cover broad ranges of polarities. Compared with conventional phases, OPTIMA® δ-3 polarity ranges from approximately the nonpolar OPTIMA® 5 to the midpolar OPTIMA® 1701, while for OPTIMA® δ-6 the polarity covers a range from about the midpolar OPTIMA® 17 to the polar OPTIMA® 210.

OPTIMA® δ phases show high temperature limits (340 / 360 °C), as well as low bleed levels, which makes them ideal for the use with mass selective (MSD) or phosphorus/nitrogen detectors (PND) in the field of environmental trace analysis.

Isomeric phenols, such as chloro- and nitrophenols, are difficult to analyze with standard GC phases (e.g., OPTIMA® 5 or OPTIMA® 17) because of co-elutions. The autoselective OPTIMA® δ-3 is able to separate all 22 phenols due to stronger interactions occurring with more polar molecules, because polar analytes induce a dipole moment in the phase of the OPTIMA® δ-3 (see chromatogram page 327).

Separation characteristics of OPTIMA® δ phases



Conditions and peaks (see page 313)

Key features of OPTIMA® δ phases

- Wide range of application due to autoselectivity
- Outstanding thermal stability similar to nonpolar phases
- Low bleed levels
- Medium polar without CN groups

Ordering information about OPTIMA® δ phases can be found on page 327 and page 328.

OPTIMA® δ · phases with autoselectivity

OPTIMA® δ-3 polysiloxane phase with autoselectivity · USP G49

Key features

- Medium polar without CN groups
- Autoselectivity resulting in a polarity range from approximately the nonpolar OPTIMA® 5 to the midpolar OPTIMA® 1701 (see page 326)
- Analytes determine the polarity of the phase

Similar phases

- Exclusively from MN

Recommended application

- Ideal for MSD and PND detectors

Temperature

- 0.1 – 0.32 mm ID:
  T_{max} 340 °C (long-term temperature),
  T_{max} 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID:
  T_{max} 320 and 340 °C, resp.

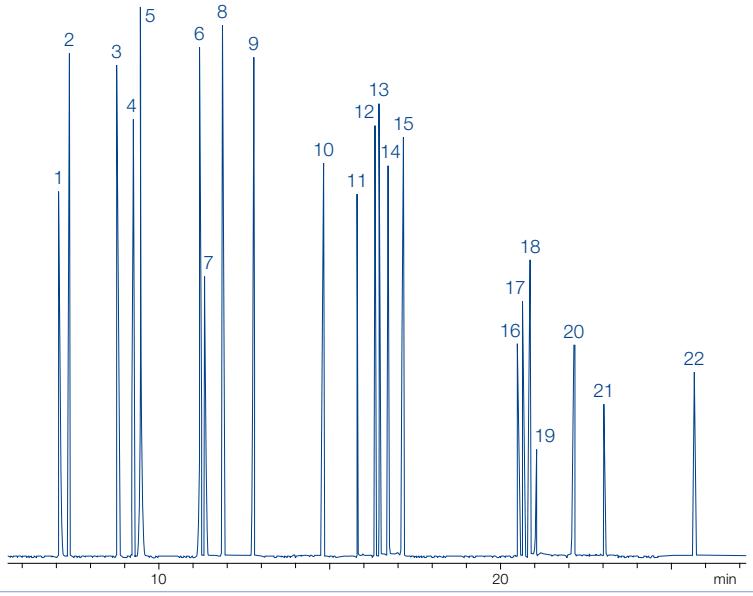
Analysis of isomeric phenols

MN Appl. No. 250060

Column: OPTIMA® δ-3, 60 m x 0.25 mm ID, 0.25 µm film
Injection: 1.0 µL, split 1:80
Carrier gas: He, 1.3 bar
Temperature: 60 °C (3 min) → 320 °C, 6 °C/min
Detector: MSD HP 5971

Peaks:

1. Phenol
2. 2-Chlorophenol
3. 2-Methylphenol
4. 4-Methylphenol
5. 3-Methylphenol
6. 2,4-Dimethylphenol
7. 2-Nitrophenol
8. 2,4-Dichlorophenol
9. 2,6-Dichlorophenol
10. 4-Chloro-3-methylphenol
11. 2,3,5-Trichlorophenol
12. 2,4,6-Trichlorophenol
13. 2,4,5-Trichlorophenol
14. 2,3,4-Trichlorophenol
15. 2,3,6-Trichlorophenol
16. 2,3,5,6-Tetrachlorophenol
17. 2,3,4,5-Tetrachlorophenol
18. 2,3,4,6-Tetrachlorophenol
19. 2,4-Dinitrophenol
20. 3,4,5-Trichlorophenol
21. 2-Methyl-4,6-dinitrophenol
22. 2-Isopropyl-4,6-dinitrophenol



OPTIMA® δ-3

Length → 10 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film 726410.10	726410.20				
0.2 mm ID (0.4 mm OD)					
0.20 µm film		726400.25		726400.50	
0.25 mm ID (0.4 mm OD)					
0.25 µm film			726420.30		726420.60
0.50 µm film			726421.30		
0.32 mm ID (0.5 mm OD)					
0.25 µm film			726440.30		726440.60
0.35 µm film			726441.30		726441.60
1.00 µm film			726442.30		726442.60
0.53 mm ID (0.8 mm OD)					
1.00 µm film			726443.30		

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® δ · phases with autoselectivity

OPTIMA® δ-6 polysiloxane phase with autoselectivity

Key features

- Medium polar without CN groups Autoselectivity resulting in a polarity range from approximately the midpolar OPTIMA® 17 to the polar OPTIMA® 210 (see page 326)
- Analytes determine the polarity of the phase

Recommended application

- Ideal for MSD and PND detectors

Temperature

- 0.1 – 0.32 mm ID: T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 320 and 340 °C, resp.

Similar phases

- Exclusively from MN

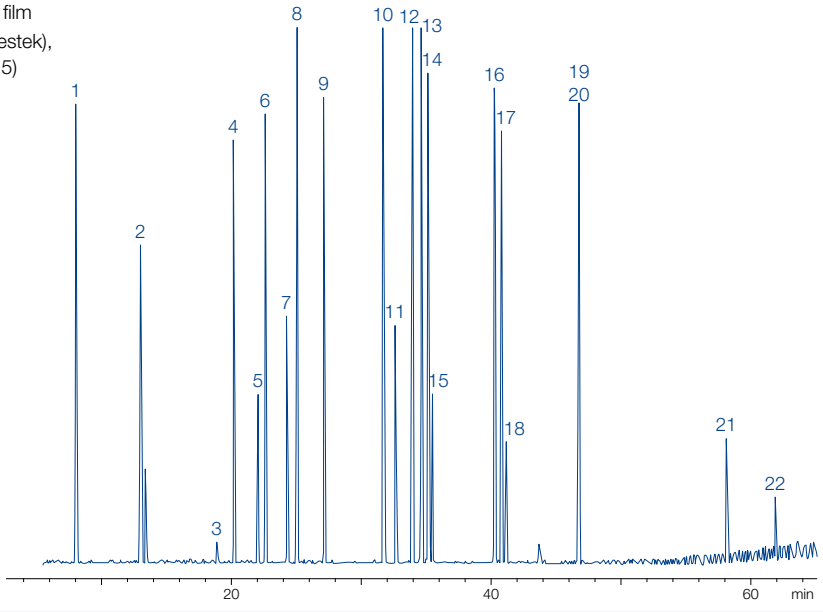
Separation of organophosphorus pesticides (EPA 8140 / 8141)

MN Appl. No. 250420

Column:	OPTIMA® δ-6, 50 m x 0.2 mm ID, 0.2 µm film
Sample:	EPA 8140 OP pesticide calibration mix (Restek), 200 µg/mL each in hexane – acetone (95:5)
Injection:	1 µL, split 1:30
Carrier gas:	2.0 bar He
Temperature:	150 °C → 300 °C (10 min), 2.5 °C/min
Detector:	MSD HP 5971

Peaks:

1. Dichlorvos
2. Mevinphos
3. Demeton-S
4. Ethoprop
5. Naled
6. Phorate
7. Demeton-O
8. Diazinon
9. Disulfoton
10. Ronnel
11. Parathion-methyl
12. Chlorpyrifos
13. Trichloronate
14. Fenthion
15. Merphos
16. Stirofos
17. Tokuthion
18. Merphos oxidation product
19. Fensulfothion
20. Bolstar
21. Azinphos-methyl
22. Coumaphos



OPTIMA® δ-6

	Length → 10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film	726490.10				
0.2 mm ID (0.4 mm OD)					
0.20 µm film		726465.25		726465.50	
0.25 mm ID (0.4 mm OD)					
0.25 µm film			726470.30		726470.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film			726480.30		726480.60
0.35 µm film			726481.30		726481.60
1.00 µm film			726482.30		726482.60
0.53 mm ID (0.8 mm OD)					
1.00 µm film			726483.30		

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · medium polar capillary columns

OPTIMA® 1301 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane · USP G43

Key features
- Midpolar phase
- Structure see page 315

Recommended application
- Pesticide analysis
- For corresponding columns with higher film thickness see OPTIMA® 624

Temperature
- T_{max} 300 °C (long-term temperature), T_{max} 320 °C (short-term max. temperature in a temperature program)

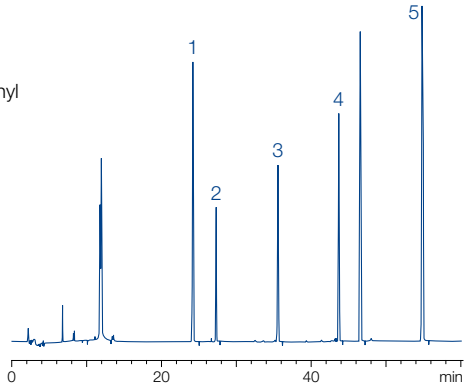
Similar phases
- HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301

Analysis of a pesticide mixture

MN Appl. No. 210620

Column:	OPTIMA® 1301, 60 m x 0.25 mm ID, 0.25 µm film
Injection:	3 µL (0.1 ng/µL), 80 °C (1 min) → 250 °C (1 min) pulsed splitless
Carrier gas:	He, 54 mL/min
Temperature:	80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min)
Detector:	ECD

Peaks :
1. Propyzamide
2. Vinclozolin
3. Bromophos-ethyl
4. 2,4-DDT
5. Brompropylate

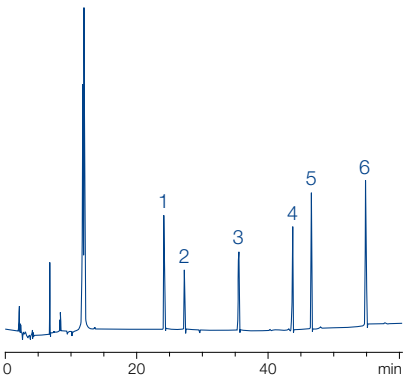


Analysis of a PCB mixture

MN Appl. No. 210650

Column:	OPTIMA® 1301, 60 m x 0.25 mm ID, 0.25 µm film
Injection:	3 µL (0.1 ng/µL), 80 °C (1 min) → 250 °C (1 min) pulsed splitless
Carrier gas:	He, 54 mL/min
Temperature:	80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min)
Detector:	ECD

Peaks :
1. PCB-28
2. PCB-52
3. PCB-128
4. PCB-153
5. PCB-138
6. PCB-180



OPTIMA® 1301

	Length → 25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film	726771.25	726771.30	726771.50	726771.60
0.32 mm ID (0.5 mm OD)				
0.25 µm film	726777.25	726777.30		726777.60
1.00 µm film		726780.30	726780.50	726780.60
0.53 mm ID (0.8 mm OD)				
1.00 µm film	726783.25			

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® · medium polar capillary columns

OPTIMA® 1301 MS 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane · USP G43

Key features
- Chemically bonded, cross-linked silarylene phase with selectivity similar to 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane, symmetric substituted cyanopropylsilanes and integrated phenyl rings (silarylene)
- Midpolar phase with very low bleed
- Perfect deactivation
- Structure see page 315

Recommended application
- Specially suitable for sophisticated environmental analysis (e.g., EPA methods for PAHs, PCBs and pesticides)
- 100 % ion trap and quadrupole MS compatibility

Temperature
- T_{max} 300 °C (long-term temperature), T_{max} 320 °C (short-term max. temperature in a temperature program)

Similar phases
- VF-1301ms, Rxi®-1301Sil MS, TG-1301MS

OPTIMA® 1301 MS

	Length → 30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	726640.30	726640.60
0.32 mm ID (0.5 mm OD)		
0.25 µm film	726641.30	726641.60
1.00 µm film	726642.30	726642.60
0.53 mm ID (0.8 mm OD)		
1.00 µm film	726643.30	726643.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® 624 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane · USP G43

Key features
- Midpolar phase
- Structure see page 315

Recommended application
- Environmental analysis
- For corresponding columns with lower film thickness see OPTIMA® 1301

Temperature
- T_{max} 280 °C (long-term temperature), T_{max} 300 °C (short-term max. temperature in a temperature program)

Similar phases
- HP-624, HP-VOC, DB-624, DB-VRX, SPB™-624, CP-624, Rtx®-624, Rtx®-Volatiles, 007-624, BP624, VOCOL

OPTIMA® · medium polar capillary columns

OPTIMA® 624 LB 6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane

Key features

- Midpolar phase with low bleeding
- Structure see page 315

Recommended application

- Halogenated hydrocarbons, volatiles, aromatic compounds, solvents etc.

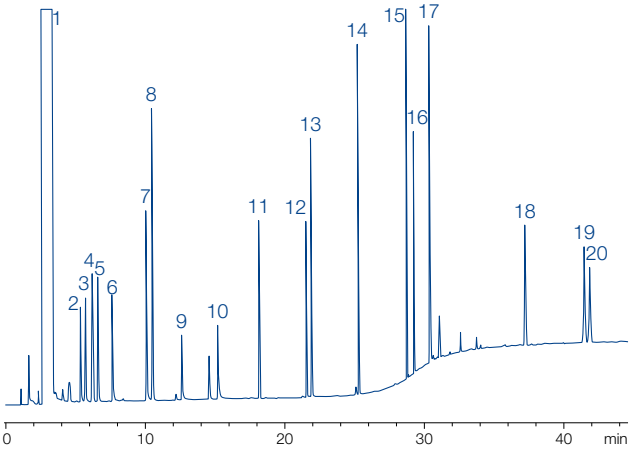
Solvents and semi-volatiles

MN Appl. No. 212520

Column: OPTIMA® 624 LB, 30 m x 0.32 mm ID, 1.8 µm film; retention gap Phe-Sil 0.5 m x 0.53 mm
Injection: 1 µL (10 ppm per substance in acetone), cold on-column
Carrier gas: 1.1 bar He
Temperature: 45 °C (3 min) → 150 °C (6 °C/min) → 300 °C (18 °C/min), 20 min 300 °C
Detector: FID 280 °C

Peaks:

1. Acetone
2. Ethyl acetate
3. Tetrahydrofuran
4. Cyclohexane
5. 2-Methyl-2-butanol
6. 1-Butanol
7. Pyridine
8. Toluene
9. Dimethylformamide
10. Dimethylsulfoxide
11. Decane
12. 1-Octanol
13. Acetophenone
14. Butyrophenone
15. Heptanophenone
16. 5-Methoxyindole
17. Dibenzylamine
18. Methyl eicosanoate
19. Methyl *cis*-13-docosenoate
20. Methyl docosanoate



OPTIMA® 624

	Length → 25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)				
1.10 µm film	726784.25			
0.25 mm ID (0.4 mm OD)				
1.40 µm film	726785.25	726785.30	726785.50	726785.60
0.32 mm ID (0.5 mm OD)				
1.80 µm film	726787.25	726787.30	726787.50	726787.60
0.53 mm ID (0.8 mm OD)				
3.00 µm film	726789.25	726789.30		

OPTIMA® 624 LB

	Length → 25 m	30 m	50 m	60 m
0.32 mm ID (0.5 mm OD)				
1.80 µm film		726786.30	726786.50	

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · medium polar capillary columns

OPTIMA® 1701 14 % cyanopropyl-phenyl – 86 % dimethylpolysiloxane · USP G46

Key features

- Midpolar phase, special selectivity due to high cyanopropyl content
- Structure see page 315

Recommended application

- Reference column for structure identification, e.g., in combination with OPTIMA® 5
- Film thickness ≥ 1 µm for solvent analysis

Temperature

- T_{max} 280 °C (long-term temperature), T_{max} 300 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 280 and 300 °C, resp.

Similar phases

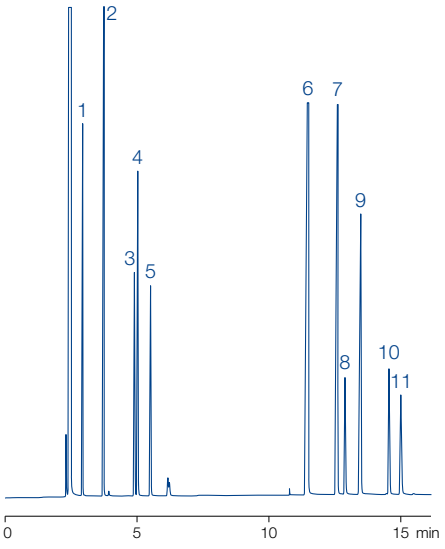
- OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007-1701, BP10, ZB-1701

Analysis of aromatic hydrocarbons

MN Appl. No. 200400

Column: OPTIMA® 1701, 25 m x 0.32 mm ID, 0.25 µm film
Injection: 1 µL, split 1:40
Carrier gas: 0.6 bar N_2
Temperature: 60 °C → 120 °C, 4 °C/min
Detector: FID 260 °C

Peaks:
1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *o*-Xylene
6. Phenol
7. 2-Methylphenol
8. 2,6-Dimethylphenol
9. 4-Methylphenol
10. 2,4-Dimethylphenol
11. 2,4,6-Trimethylphenol



OPTIMA® 1701

Length →	10 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film			726841.25		726841.50	
0.25 mm ID (0.4 mm OD)						
0.25 µm film	726058.10	726058.15	726058.25	726058.30	726058.50	726058.60
0.50 µm film				726064.30		726064.60
1.00 µm film				726965.30		
0.32 mm ID (0.5 mm OD)						
0.25 µm film	726318.10	726318.15	726318.25	726318.30	726318.50	726318.60
0.35 µm film			726824.25	726824.30	726824.50	726824.60
0.50 µm film			726320.25	726320.30	726320.50	726320.60
1.00 µm film			726929.25	726929.30	726929.50	726929.60
0.53 mm ID (0.8 mm OD)						
1.00 µm film	726545.10	726545.15	726545.25	726545.30		
2.00 µm film		726735.15	726735.25	726735.30	726735.50	

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® 1701 MS silarylene phase · USP G46

Key features

- Chemically bonded, cross-linked silarylene phase with selectivity similar to 14 % cyanopropyl-phenyl – 86 % dimethylpolysiloxane, symmetric substituted cyanopropylsilanes and integrated phenyl rings (silarylene)
- Midpolar phase with very low bleed
- Perfect deactivation
- Structure see page 315

Recommended application

- Environmental analysis (e.g., PAHs, PCBs, pesticides)
- Reference column for structure identification, e.g., in combination with OPTIMA® 5 MS
- 100 % ion trap and quadrupole MS compatibility

Temperature

- T_{max} 280 °C (long-term temperature), T_{max} 300 °C (short-term max. temperature in a temperature program)

Similar phases

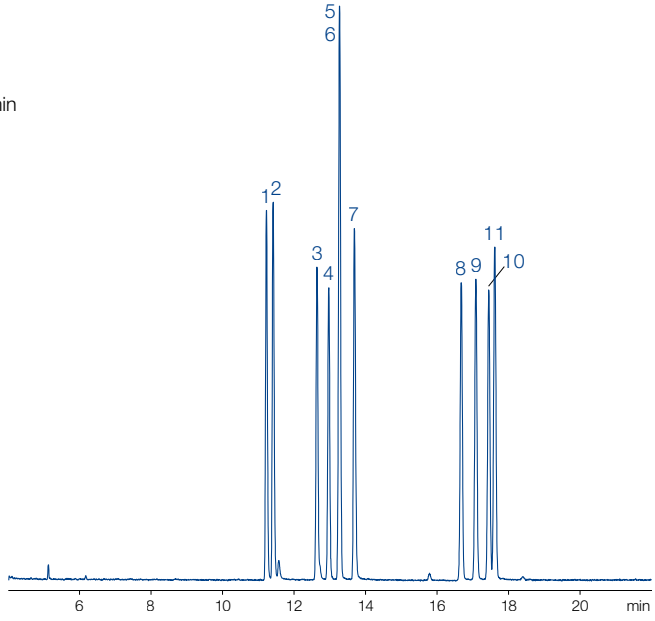
- VF-1701ms, TG-1701MS, OV-1701, DB-1701, HP-1701, Rtx®-1701, SPB™-1701, CP Sil 19 CB, 007-1701, BP10, ZB-1701

Separation of triazine pesticides (EPA 619)

MN Appl. No. 215080

Column: OPTIMA® 1701 MS, 30 m x 0.25 mm ID, 0.25 µm film
Injection: 1 µL, 250 °C, split 1:100
Carrier gas: 42 cm/s He
Temperature: 160 °C (1 min) → 180 °C, 15 °C/min → 220 °C, 2 °C/min
Detector: MSD

Peaks:
1. Prometon
2. Atraton
3. Propazine
4. Atrazine
5. Simazine
6. Terbuthylazine
7. Secbumeton
8. Prometryn
9. Ametryn
10. Simetryn
11. Terbutryn



OPTIMA® 1701 MS

	Length → 30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	726630.30	726630.60
0.50 µm film	726631.30	726631.60
0.32 mm ID (0.5 mm OD)		
0.25 µm film	726633.30	726633.60
0.50 µm film	726634.30	726634.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · medium polar capillary columns

OPTIMA® 35 MS silarylene phase · USP G42 / close equivalent to USP G28 / G32

Key features
- Chemically bonded cross-linked silarylene phase with selectivity similar to 35 % phenyl – 65 % methyl polysiloxane, midpolar phase, polymer without CN groups
- Very low column bleeding
- Structure see page 317

Recommended application
- Ideal for ion trap detectors
- Optimum column for confirmation of analytical results in combination with a 1 MS or 5 MS
- All-round phase for environmental analysis, ultra trace analysis, EPA methods, pesticides, PCB, food and drug analysis

Temperature
- T_{max} 360 °C (long-term temperature), T_{max} 370 °C (short-term max. temperature in a temperature program)

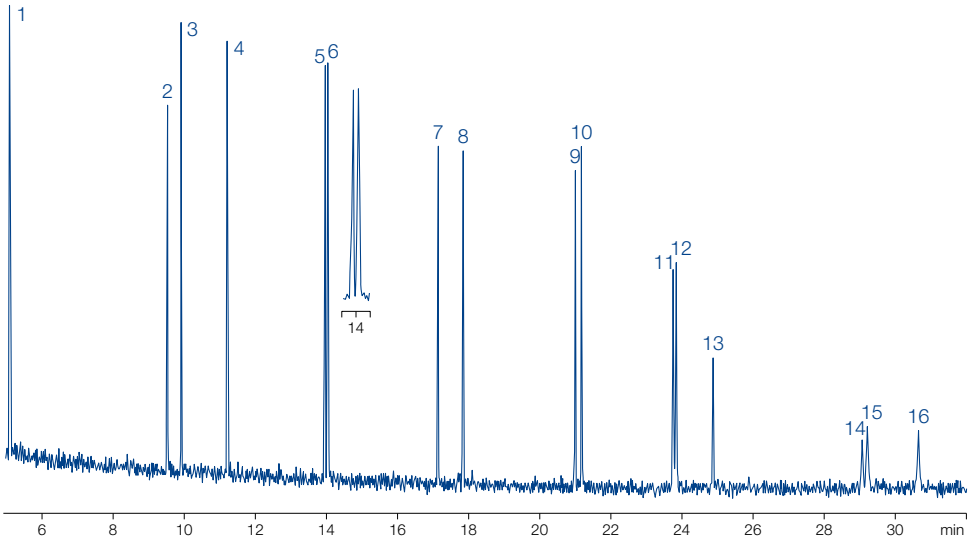
Similar phases
- DB-35 MS, HP-35, SPB™-35, Rxi®-35SIL MS, Rtx-35, 007-35, BPX™-35, MDN-35, AT™-35 MS, ZB-35, OV-11, VF-35 MS

PAH in accordance with EPA 610

MN Appl. No. 213190

Column: OPTIMA® 35 MS, 30 m x 0.25 mm ID, 0.25 µm film
Injection: 1 µL, split 1:10
Carrier gas: 0.6 bar H_2
Temperature: 100 °C (3 min) → 300 °C (10 min), 6 °C/min
Detector: MSD

Peaks
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. Indeno[1,2,3-*cd*]pyrene
15. Dibenz[*ah*]anthracene
16. Benzo[*ghi*]perylene



OPTIMA® 35 MS

	Length → 30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	726154.30	726154.60
0.32 mm ID (0.5 mm OD)		
0.25 µm film	726157.30	726157.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® · medium polar capillary columns

OPTIMA® 17 phenylmethylpolysiloxane (50 % phenyl) · USP G3

Key features
- Midpolar phase
- Structure see page 317

Recommended application
- Steroids, pesticide, drug analysis

Temperature
- T_{max} 320 °C (long-term temperature), T_{max} 340 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 300 and 320 °C resp.

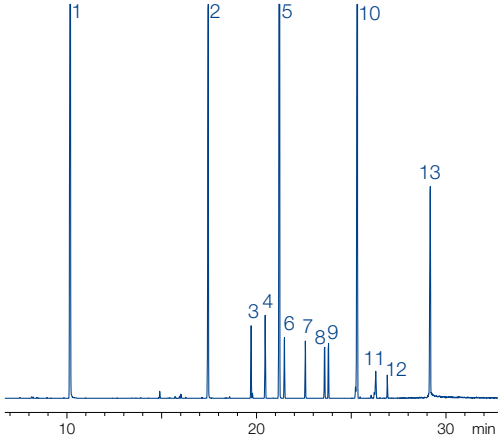
Similar phases
- OV-17, DB-17, HP-50+, HP-17, SPB™-50, SP-2250, Rxi®-17, Rtx®-50, CP-Sil 24 CB, 007-17, ZB-50

Analysis of pesticides

MN Appl. No. 200930

Column: OPTIMA® 17, 25 m x 0.2 mm ID, 0.20 µm film
Sample: pesticides, standard of the cantonal laboratory Schaffhausen (Switzerland), 0.1 mg/mL or 0.01 mg/mL each
Injection: 1.0 µL, 3 s without split
Carrier gas: He, 25 cm/s
Temperature: 100 °C (3 min), 8 °C/min → 250 °C, 10 °C/min → 320 °C
Detector: MSD HP 5971

Peaks:
1. Dichlorphos
2. Naled
3. Vinclozolin
4. Chlorthalonil
5. Chlorpyrifos
6. Dichlofluanid
7. Procymidon
8. Captan
9. Folpet
10. Carbophenothion
11. Iprodion
12. Captafol
13. Coumaphos



OPTIMA® 17

	Length → 10 m	12 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)							
0.10 µm film	726848.10						
0.2 mm ID (0.4 mm OD)							
0.20 µm film		726065.12		726065.25		726065.50	
0.50 µm film				726066.25		726066.50	
0.25 mm ID (0.4 mm OD)							
0.15 µm film				726742.25	726742.30	726742.50	726742.60
0.25 µm film			726022.15	726022.25	726022.30	726022.50	726022.60
0.50 µm film				726067.25	726067.30	726067.50	726067.60
0.32 mm ID (0.5 mm OD)							
0.15 µm film					726755.30		
0.25 µm film				726351.25	726351.30	726351.50	726351.60
0.35 µm film				726757.25	726757.30	726757.50	726757.60
0.50 µm film				726744.25	726744.30	726744.50	726744.60
0.53 mm ID (0.8 mm OD)							
1.00 µm film	726747.10		726747.15	726747.25	726747.30		

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · medium polar capillary columns

OPTIMA® 17 MS silarylene phase · USP G3

Key features

- Medium polar silarylene phase with selectivity analogue to 50 % phenyl – 50 % methylpolysiloxane, no CN groups in the polymer
- Structure see page 317

Recommended application

- Ideal for ion trap detectors
- Optimum reference column in combination with a 1 MS or 5 MS
- All-round phase for environmental analysis, ultra-trace analysis, EPA methods, pesticide, PCBs, food and drug analysis

Temperature

- T_{max} 340 °C (long-term temperature),
- T_{max} 360 °C (short-term max. temperature in a temperature program)

Similar phases

- OV-17, AT™-50, BPX™-50, DB-17, DB-17ms, HP-50+, HP-17, SPB™-50, SPB™-17, SP-2250, Rtx®-50, CP-Sil 24 CB, 007-17, VF-17ms, ZB-50

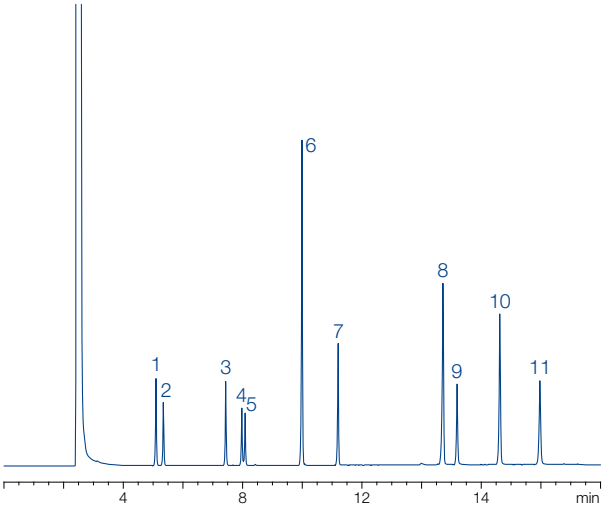
Analysis of phenols

MN Appl. No. 213600

Column:	OPTIMA® 17 MS, 30 m x 0.25 mm ID, 0.25 µm film
Sample:	phenol mix 604
Injection:	1.0 µL, 230 °C, split 1:30
Carrier gas:	0.8 bar He
Temperature:	100 °C, 10 °C/min → 250 °C
Detector:	FID 280 °C

Peaks:

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



OPTIMA® 17 MS

	Length → 30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	726162.30	726162.60
0.32 mm ID (0.5 mm OD)		
0.25 µm film	726165.30	726165.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® · medium polar capillary columns

OPTIMA® 210 trifluoropropyl-methylpolysiloxane (50 % trifluoropropyl) · close equivalent to USP G6

Key features
- Midpolar phase
- Structure see page 317

Recommended application
- Environmental analysis, especially for *o*-, *m*- and *p*-substituted aromatic hydrocarbons

Temperature
- T_{max} 260 °C (long-term temperature), T_{max} 280 °C (short-term max. temperature in a temperature program)

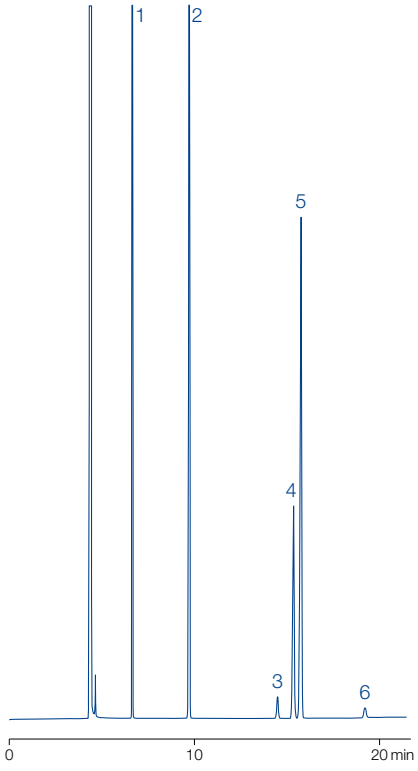
Similar phases
- OV-210, DB-210, Rtx®-200, 007-210

Aromatic hydrocarbons (BTX)

MN Appl. No. 200230

Column: OPTIMA® 210, 50 m x 0.25 mm ID, 0.5 µm film
Injection: 0.5 µL, split 105 mL/min
Carrier gas: 130 kPa N_2 (1.1 mL/min)
Temperature: 50 °C
Detector: FID 250 °C

Peaks:
1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *m*-Xylene
6. *o*-Xylene



OPTIMA® 210

	Length → 15 m	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)					
0.25 µm film	726871.15	726871.25	726871.30	726871.50	726871.60
0.50 µm film			726874.30	726874.50	726874.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film	726877.15		726877.30	726877.50	726877.60
0.50 µm film		726880.25	726880.30	726880.50	726880.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · medium polar capillary columns

OPTIMA® 225 50 % cyanopropyl-methyl – 50 % phenylmethylpolysiloxane · close equivalent to USP G7 / G19

Key features
- Midpolar phase
- Structure see page 317

Recommended application
- Fatty acid analysis

Temperature
- T_{max} 260 °C (long-term temperature), T_{max} 280 °C (short-term max. temperature in a temperature program)

Similar phases
- OV-210, DB-210, Rtx®-200, 007-210

Analysis of FAME in porcine fat

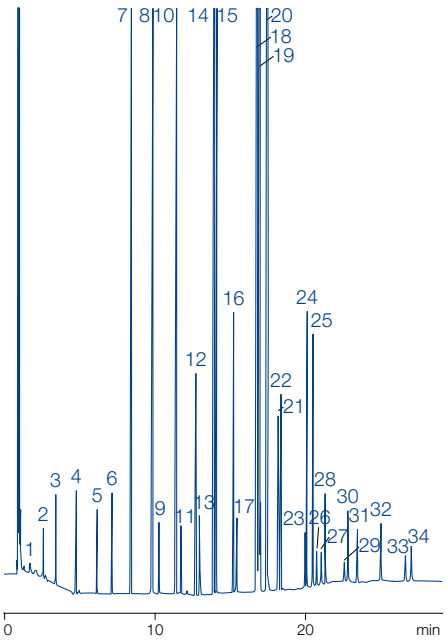
MN Appl. No. 210060

Column: OPTIMA® 225, 25 m x 0.32 mm ID, 0.25 µm film
Injection: 1 µL, split 1:40
Carrier gas: 60 kPa H_2
Temperature: 50 °C (2 min) → 125 °C, 30 °C/min → 160 °C, 5 °C/min → 180 °C, 20 °C/min → 200 °C, 3 °C/min → 220 °C, 20 °C/min (10 min)
Detector: FID 260 °C

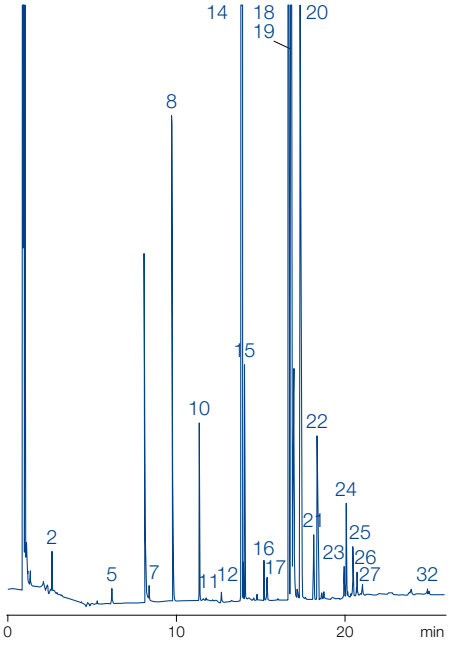
Peaks:

1. C4:0
2. C5:0
3. C6:0
4. C8:0
5. C10:0
6. C11:0
7. C12:0
8. C13:0
9. C13:1
10. C14:0
11. C14:1
12. C15:0
13. C15:1
14. C16:0
15. C16:1
16. C17:0
17. C17:1
18. C18:0
19. C18:1
20. C18:2
21. C18:3
22. C19:0
23. C20:0
24. C20:1
25. C20:2
26. C20:4
27. C20:3
28. C20:5
29. C22:0
30. C22:1
31. C22:2
32. C22:6
33. C24:0
34. C24:1

FAME Standard



FAME in porcine fat



Courtesy of Dr. Bantleon, Mr. Leusche, Mr. Hagemann, VFG-Labor, Versmold, Germany

OPTIMA® 225

	Length → 10 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	726080.10					
0.25 mm ID (0.4 mm OD)						
0.25 µm film		726118.15	726118.25	726118.30	726118.50	726118.60
0.32 mm ID (0.5 mm OD)						
0.25 µm film			726352.25	726352.30	726352.50	726352.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

OPTIMA® · medium polar capillary columns

OPTIMA® 240 33 % cyanopropyl-methyl – 67 % dimethylpolysiloxane

Key features
- Midpolar phase
- Structure see page 317

Recommended application
- FAMEs, dioxins

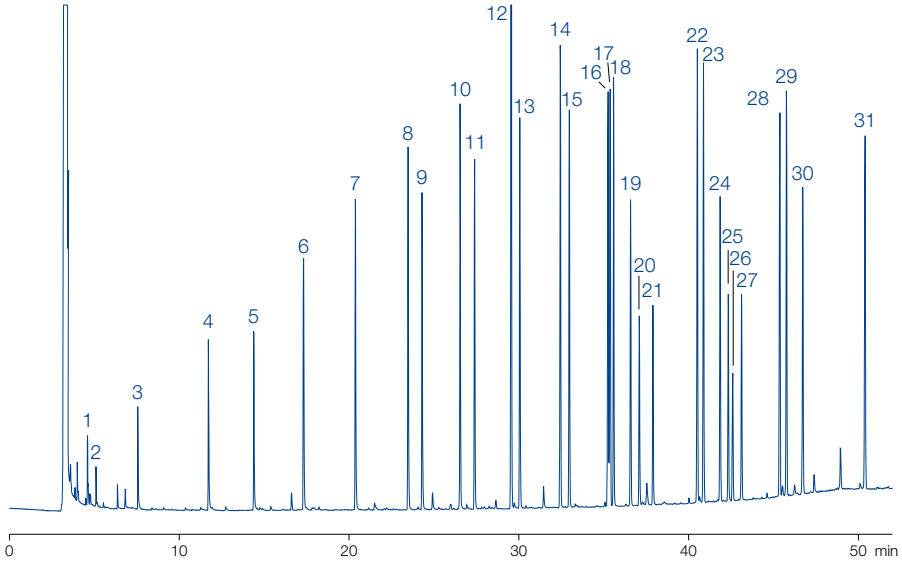
Temperature
- T_{max} 260 °C (long-term temperature), T_{max} 280 °C (short-term max. temperature in a temperature program)

Fatty acid methyl esters *cis/trans* C18:1 (FAME)

MN Appl. No. 201620

Column: OPTIMA® 240, 60 m x 0.25 mm ID, 0.25 µm film
Sample: FAME mixture
Injection: 1.0 µL, split 1:25
Carrier gas: 150 kPa H_2
Temperature: 80 °C → 120 °C, 20 °C/min → 260 °C (10 min), 3 °C/min
Detector: FID 280 °C

Peaks:
1. C4:0
2. C5:0
3. C8:0
4. C10:0
5. C11:0
6. C12:0
7. C13:0
8. C14:0
9. C14:1
10. C15:0
11. C15:1
12. C16:0
13. C16:1
14. C17:0
15. C17:1
16. C18:0
17. *trans*-C18:1
18. *cis*-C18:1
19. C18:2
20. C18:3
21. C18:3
22. C20:0
23. C20:1
24. C20:2
25. C20:3
26. C20:4
27. C20:3
28. C22:0
29. C22:1
30. C22:3
31. C24:1



OPTIMA® 240

	Length → 25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film		726089.30	726089.50	726089.60
0.50 µm film		726090.30		726090.60
0.32 mm ID (0.5 mm OD)				
0.25 µm film	726091.25	726091.30	726091.50	726091.60
0.35 µm film		726095.30		726095.60
0.50 µm film		726096.30		726096.60

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® · polar capillary columns

OPTIMA® WAX polyethylene glycol 20 000 Da · USP G16

Key features
- Polar phase
- Structure see page 317

Recommended application
- Solvent analysis and alcohols, suitable for aqueous solutions

Temperature
- T_{max} 240 °C (long-term temperature), T_{max} 250 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 220 and 240 °C resp.

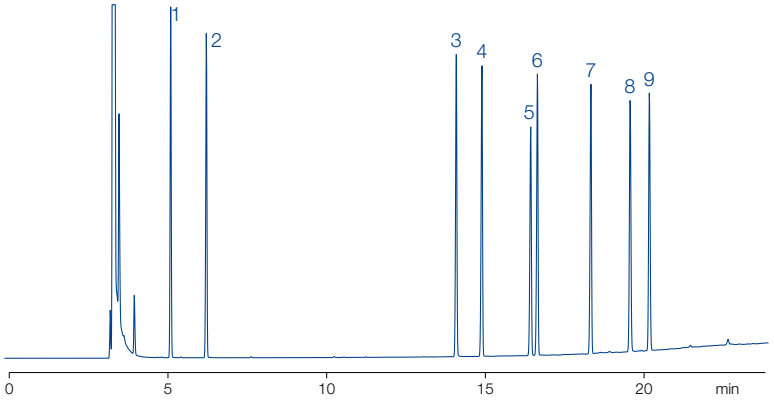
Similar phases
- PERMABOND® CW 20 M (see page 342), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

Modified Grob test

MN Appl. No. 211170

Column: OPTIMA® WAX, 50 m x 0.32 mm ID, 0.5 µm film
Injection: 1 µL, split 1:20
Carrier gas: 1,2 bar He
Temperature: 80 °C → 250 °C, 8 °C/min
Detector: FID 250 °C

Peaks:
1. Decane
2. Undecane
3. Octanol
4. Methyl decanoate
5. Dicyclohexylamine
6. Methyl undecanoate
7. Methyl dodecanoate
8. 2,6-Dimethylaniline
9. 2,6-Dimethylphenol



OPTIMA® WAX

Length →	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film	726600.25	726600.30	726600.50	726600.60
0.32 mm ID (0.5 mm OD)				
0.25 µm film	726321.25	726321.30	726321.50	726321.60
0.50 µm film	726296.25	726296.30	726296.50	726296.60
0.53 mm ID (0.8 mm OD)				
1.00 µm film	726549.25	726549.30		
2.00 µm film		726548.30		

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® FFAP polyethylene glycol 2-nitroterephthalate · USP G35 / close equivalent to USP G25

Key features
- Polar phase (FFAP = Free Fatty Acid Phase)
- Structure see page 317

Recommended application
- Fatty acid methyl esters (FAMEs), free carboxylic acids

Temperature
- 0.10 – 0.32 mm ID: T_{max} 250 °C (long-term temperature), T_{max} 260 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 220 and 240 °C, resp.

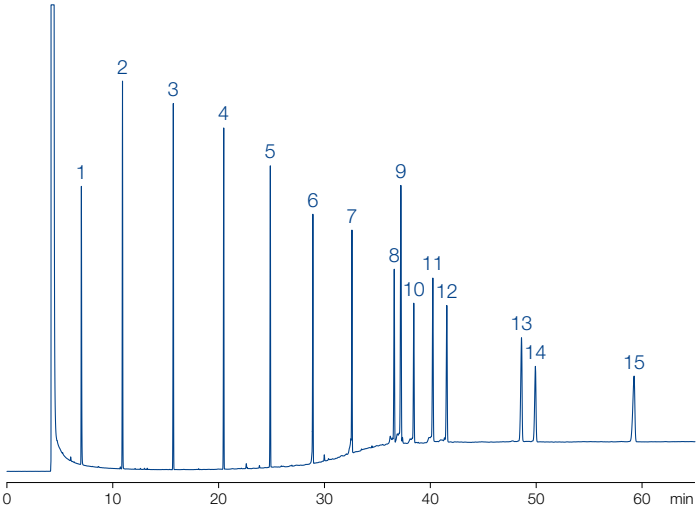
Similar phases
- PERMABOND® FFAP (see page 343), DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™, AT-1000, SPB-1000, BP21, OV-351

FAME test

MN Appl. No. 211140

Column: OPTIMA® FFAP, 60 m x 0.32 mm ID, 0.25 µm film
Injection: 1.0 µL, 220 °C, split 1:40
Carrier gas: 1.2 bar He
Temperature: 55 °C → 250 °C, 6 °C/min
Detector: FID 220 °C

Peaks:
1. C4
2. C6
3. C8
4. C10
5. C12
6. C14
7. C16
8. C18
9. C18:1 *cis/trans*
10. C18:2
11. C18:3
12. C20
13. C22
14. C22:1
15. C24



OPTIMA® FFAP

	Length → 10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film	726180.10				
0.25 mm ID (0.4 mm OD)					
0.25 µm film		726116.25	726116.30	726116.50	726116.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film		726341.25	726341.30	726341.50	726341.60
0.50 µm film		726344.25	726344.30	726344.50	
0.53 mm ID (0.8 mm OD)					
0.50 µm film			726345.30		
1.00 µm film		726346.25			

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

PERMABOND® capillary columns

PERMABOND® CW 20 M polyethylene glycol 20 000 Dalton · USP G16

Key features
- Polar phase

Recommended application
- Solvent analysis and alcohols, suitable for aqueous solutions

Temperature
- 0.1 – 0.32 mm ID: T_{max} 220 °C (long-term temperature), T_{max} 240 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 200 and 220 °C, resp.

Similar phases
- See OPTIMA® WAX (see page 340)

PERMABOND® CW 20 M

	Length → 10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film	723064.10				
0.25 mm ID (0.4 mm OD)					
0.25 µm film	723060.10	723060.25	723060.30	723060.50	723060.60
0.32 mm ID (0.5 mm OD)					
0.25 µm film	723321.10	723321.25	723321.30	723321.50	723321.60
0.35 µm film	723827.10	723827.25		723827.50	
0.50 µm film	723296.10	723296.25	723296.30	723296.50	723296.60
0.53 mm ID (0.8 mm OD)					
0.50 µm film	723515.10	723515.25			
1.00 µm film	723549.10	723549.25	723549.30		
2.00 µm film	723517.10	723517.25	723517.30		

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

PERMABOND® FFAP polyethylene glycol 2-nitroterephthalate · USP G35 / close equivalent to G25

Key features
- Polar phase

Recommended application
- FAMEs, free carboxylic acids

Temperature
- 0.1 – 0.32 mm ID: T_{max} 220 °C (long-term temperature), T_{max} 240 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 200 and 220 °C, resp.

Similar phases
- See OPTIMA® FFAP (see page 341)

PERMABOND® FFAP

	Length → 10 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	723180.10	723180.20				
0.25 µm film	723181.10					
0.25 mm ID (0.4 mm OD)						
0.10 µm film			723936.25		723936.50	
0.25 µm film	723116.10		723116.25	723116.30	723116.50	723116.60
0.32 mm ID (0.5 mm OD)						
0.10 µm film			723356.25		723356.50	
0.25 µm film			723341.25	723341.30	723341.50	723341.60
0.35 µm film	723830.10		723830.25		723830.50	
0.50 µm film	723344.10		723344.25	723344.30	723344.50	723344.60
0.53 mm ID (0.8 mm OD)						
1.00 µm film	723555.10		723555.25		723555.50	

In addition to this standard program we will be happy to supply columns custom-made to your specifications. Information about scope of delivery, special cages and integrated guard columns see additional information for GC columns on page 311.

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

Special GC columns overview

Capillary columns for special GC separations

Certain analytical separations can be accomplished more easily with chromatographic columns, that have been especially developed for that task, compared with standard columns. The following table summarizes our program of GC speciality capillaries, the individual columns will be described in detail on the following pages.

Overview

Separation/special application	Recommended capillary column	Page
Fast GC column with 0.10 mm ID		
	OPTIMA® 1, OPTIMA® 5, OPTIMA® δ-3, OPTIMA® δ-6 OPTIMA® 17, OPTIMA® 225, OPTIMA® FFAP PERMABOND® CW 20 M, PERMABOND® FFAP	345
Enantiomer separation cyclodextrin phases		
	FS-LIPODEX® A, FS-LIPODEX® B, FS-LIPODEX® C FS-LIPODEX® D, FS-LIPODEX® E, FS-LIPODEX® G	347
	FS-HYDRODEX β-PM, FS-HYDRODEX β-3 P, FS-HYDRODEX β-6TBDM, FS-HYDRODEX β-6TBDE, FS-HYDRODEX β-6TBDE, FS-HYDRODEX β-TBDAc, FS-HYDRODEX γ-DiMOM	349
Biodiesel		
Methanol analysis	OPTIMA® BioDiesel M	351
FAME analysis	OPTIMA® BioDiesel F	351
Glycerol and triglycerides	OPTIMA® BioDiesel G	351
Triglycerides		
	OPTIMA® 1-TG	353
	OPTIMA® 17-TG	353
High temperature GC		
	OPTIMA® 5 HT	354
Amines		
Polyfunctional amines	OPTIMA® 5 Amine	355
Amine separations	FS-CW 20 M-AM	356
Petrochemical products (complex hydrocarbon mixtures)		
	PERMABOND® P-100	357
Environmental analysis of volatile halogenated hydrocarbons		
	PERMABOND® SE-54 HKW	357
Silanes (monomeric, e.g., chlorosilanes)		
	PERMABOND® Silane	359
Diethylene glycol, e.g., for the quality control of wine		
	PERMABOND® CW 20 M-DEG	359

Fast GC

Key features

- Decreased column diameters, high heating rates and decreased column lengths for faster GC separations with high resolution efficiency
- Small inner diameters combined with very fast temperature programs can reduce the analysis time by up to 80 %
- High sensitivity detectors with small volume and very short response time, as well as very rapid data acquisition and processing
- Small inner diameters result in high column inlet pressures and a lower volume flow of the mobile phase: very fast injection of very small samples against a high pressure
- Amount of sample, which can be injected, is limited by the inner diameter and the thin film

Temperature

- High heating rates place special demands on stationary phases. OPTIMA® columns meet exactly this requirement: very low bleeding, long lifetimes – even for continuous high heating rates

Comparison of a separation on a 50 m standard capillary with separation on a 10 m fast GC column

MN Appl. No. 211260

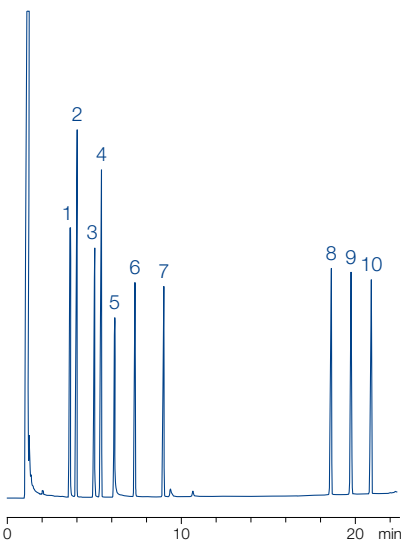
Peaks:

1. Octanol
2. Undecane
3. Dimethylaniline
4. Dodecane
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane

A) Fast GC column

Column: OPTIMA® 5, 10 m x 0.1 mm ID, 0.1 µm film

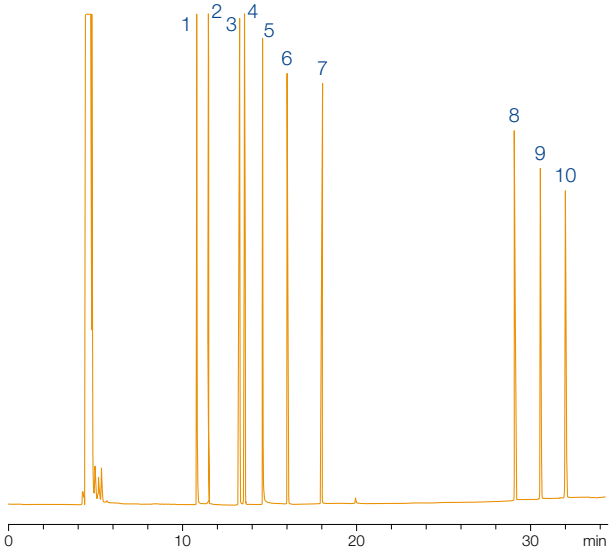
injection 1 µL, split 1:40, carrier gas 0.75 bar He



B) standard GC column

Column: OPTIMA® 5, 50 m x 0.25 mm ID, 0.25 µm film

injection 1 µL, split 1:35, carrier gas 1.5 bar He



Both separations:

Temperature: 80 °C → 320 °C (10 min), 8 °C/min

Detector: FID

While maintaining the temperature program and halving the pressure a time saving of 30 % results with identical separation efficiency.

Capillary columns for Fast GC

Columns for Fast GC

Phase	Maximum temperature	ID [mm]	Film thickness [µm]	REF (10 m)	REF (20 m)
OPTIMA® 1					
	340 / 360 °C	0.10	0.10	726024.10	726024.20
		0.10	0.40		726025.20
OPTIMA® 5					
	340 / 360 °C	0.10	0.10	726846.10	
OPTIMA® δ-3					
	340 / 360 °C	0.10	0.10	726410.10	726410.20
OPTIMA® δ-6					
	340 / 360 °C	0.10	0.10	726490.10	
OPTIMA® 17					
	320 / 340 °C	0.10	0.10	726848.10	
OPTIMA® 225					
	260 / 280 °C	0.10	0.10	726080.10	
OPTIMA® FFAP					
	250 / 260 °C	0.10	0.10	726180.10	
PERMABOND® CW 20 M					
	220 / 240 °C	0.10	0.10	723064.10	
PERMABOND® FFAP					
	220 / 240 °C	0.10	0.10	723180.10	723180.20
		0.10	0.25	723181.10	
OPTIMA® 5 Amine					
	300 / 320 °C	0.10	0.40	726361.10	
FS-CW 20 M-AM					
	220 / 240 °C	0.10	0.25	733111.10	
FS-LIPODEX® E					
	200 / 220 °C	0.10	0.10	723382.10	
FS-HYDRODEX β-6TBDM					
	230 / 250 °C	0.10	0.10	723383.10	
In addition to this standard program, all MN GC phases can be custom-made as fast GC columns					

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

Capillary columns for enantiomer separation

LIPODEX® cyclodextrin phases for enantiomer separation

Key features

- Base material: cyclic oligosaccharides consisting of six (α-cyclodextrin), seven (β-cyclodextrin) or eight (γ-cyclodextrin) glucose units bonded through 1,4-linkages
- Regioselective alkylation and / or acylation of the hydroxyl groups leads to lipophilic phases with varying enantioselectivity, which are well suited for GC enantiomer analysis
- Important advantage: many compounds can be analyzed without derivatization (however, for certain substances enantioselectivity can be favorably influenced by formation of derivatives)

Recommended application

- A large number of separations have been achieved, however, it is not possible to make a general prediction, which phase could solve a given separation task. Even for compounds with small structural differences or within homologous series the enantiodifferentiation can be quite different. The following table shows typical applications.

Note

- Water as solvent is strictly forbidden for all cyclodextrin phases
- Dry the sample with our CHROMAFIX® Dry (Na_2SO_4) cartridges (see page 62)
- Use suitable nonpolar solvent

Phase	Cyclodextrin derivate	T_{max} [°C]	Recommended application
LIPODEX® A			
	hexakis-(2,3,6-tri-O-pentyl)-α-CD	200 / 220	carbohydrates, polyols, diols, hydroxycarboxylic acid esters, (epoxy-) alcohols, glycerol derivatives, spiroacetals, ketones, alkyl halides
LIPODEX® B			
	hexakis-(2,6-di-O-pentyl-3-O-acetyl)-α-CD	200 / 220	lactones, diols (cyclic carbonates), aminols, aldols (O-TFA), glycerol derivatives (cyclic carbonates)
LIPODEX® C			
	heptakis-(2,3,6-tri-O-pentyl)-β-CD	200 / 220	Alcohols, cyanhydrins, olefins, hydroxycarboxylic acid esters, alkyl halides
LIPODEX® D			
	heptakis-(2,6-di-O-pentyl-3-O-acetyl)-β-CD	200 / 220	aminols (TFA), β-amino acid esters, trans-cycloalkane-1,2-diols, trans-cycloalkane-1,2- diols, trans-cycloalkane-1,3-diols (TFA)
LIPODEX® E			
	octakis-(2,6-di-O-pentyl-3-O-butyryl)-γ-CD	200 / 220	α-amino acids, α- and β-hydroxycarboxylic acid esters, alcohols (TFA), diols (TFA), ketones, pheromones (cyclic acetals), amines, alkyl halides, lactones
LIPODEX® G			
	octakis-(2,3-di-O-pentyl-6-O-methyl)-γ-CD	220 / 240	menthol isomers, ketones, alcohols, carboxylic acid esters, terpenes

LIPODEX®

Length →	10 m 0.10 mm ID	25 m 0.25 mm ID	50 m 0.25 mm ID
FS-LIPODEX® A			
		723360.25	723360.50
FS-LIPODEX® B			
		723362.25	723362.50
FS-LIPODEX® C			
		723364.25	723364.50
FS-LIPODEX® D			
		723366.25	723366.50
FS-LIPODEX® E			
	723382.10	723368.25	723368.50
FS-LIPODEX® G			
		723379.25	723379.50
All columns with 0.4 mm OD			

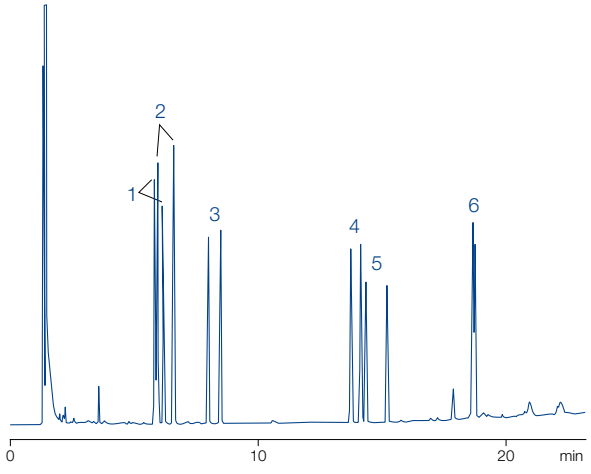
Capillary columns for enantiomer separation

Enantiomer separation of amino acid methyl esters (TFA)

MN Appl. No. 202592

Column:	FS-LIPODEX® E, 25 m x 0.25 mm ID
Injection:	1 µL, split ~ 1: 100
Carrier gas:	60 kPa H_2
Temperature:	90 → 190 °C, 4 °C/min
Detector:	FID 250 °C

Peaks:
(D is eluted before L except for proline: L before D)
1. Alanine
2. Valine
3. Leucine
4. Proline
5. Aspartic acid
6. Phenylalanine



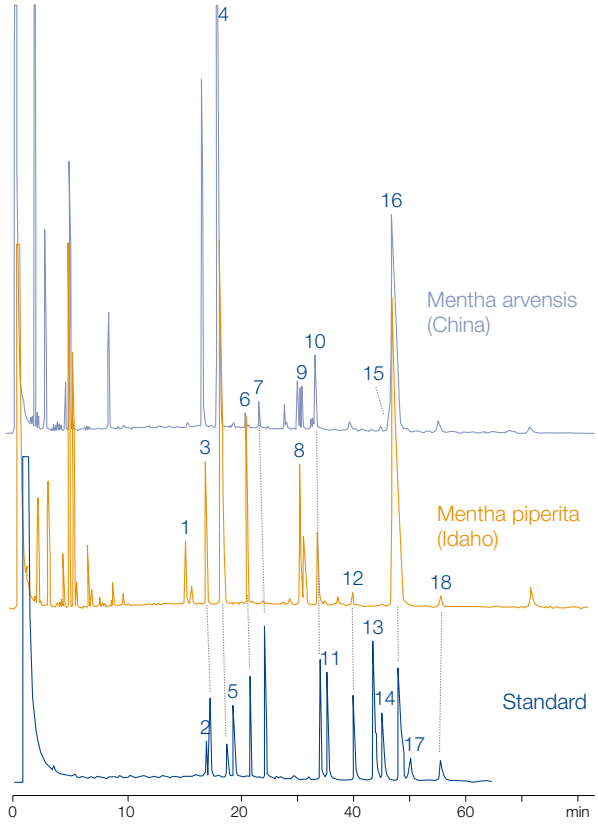
Separation of chiral constituents of peppermint oil

MN Appl. No. 250410

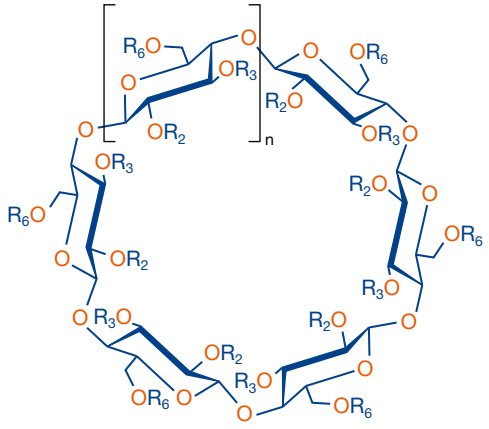
W. A. König et al., High Resol. Chromatogr. 20 (1997) 55–61

Column:	FS-LIPODEX® G, 25 m x 0.25 mm ID
Carrier gas:	50 kPa H_2
Temperature:	75 °C, isothermal
Detector:	FID

Peaks:
1. (+)-trans-Sabinene hydrate
2. (+)-Menthone
3. (+)-Isomenthone
4. (–)-Menthone
5. (–)-Isomenthone
6. (+)-Menthofuran
7. (–)-Isopulegol
8. (–)-Menthyl acetate
9. (+)-Pulegone
10. (+)-Neomenthol
11. (–)-Neomenthol
12. (+)-Neoisomenthol
13. (+)-Menthol
14. (–)-Neoisomenthol
15. (+)-Piperitone
16. (–)-Menthol
17. (+)-Isomenthol
18. (–)-Isomenthol



Cyclodextrin derivates



Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

HYDRODEX cyclodextrin phases for enantiomer separation

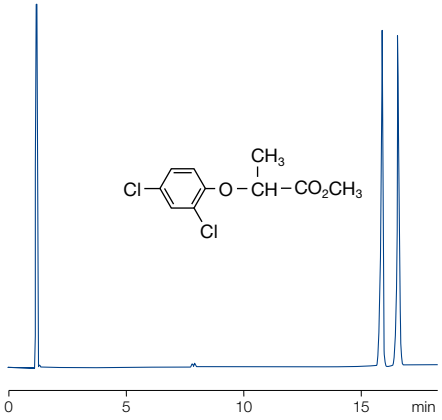
☑ Recommended application

- Cyclodextrin derivatives (see page 348) with high melting point: for GC enantiomer separation diluted with polysiloxanes

Enantiomer separation of dichlorprop methyl ester

MN Appl. No. 202542

Column: FS-HYDRODEX β-3P, 25 m x 0.25 mm ID
Injection: 0.1 µL (~1 % in CH_2Cl_2), split 130 mL/min
Carrier gas: 60 kPa H_2 (1.9 mL/min)
Temperature: 160 °C
Detector: FID 250 °C

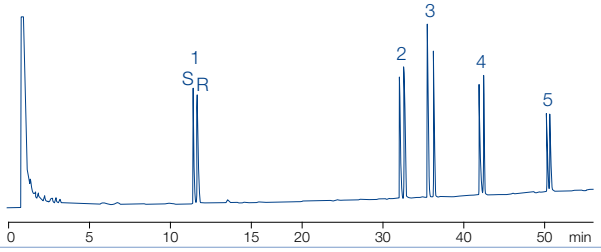


Separation of isomeric antiinflammatory drugs

MN Appl. No. 210150

Courtesy of Prof. W.A. König, Hamburg, Germany
Column: FS-HYDRODEX β-6TBDM, 25 m x 0.25 mm ID
Carrier gas: He
Temperature: 135 °C → 200 °C, 1 °C/min
Detector: FID

Peaks:
1. Ibuprofen
2. Flurbiprofen
3. Fenoprofen
4. Naproxen
5. Ketoprofen



Phase	Cyclodextrin derivative (diluted with optimized polysiloxane)	T_{max} [°C]	Recommended application
HYDRODEX β-PM			
	heptakis-(2,3,6-tri-O-methyl)-β-CD	230 / 250	hydroxycarboxylic acid esters, alcohols, diols, olefins, lactones, acetals
HYDRODEX β-3P			
	heptakis-(2,6-di-O-methyl-3-O-pentyl)-β-CD	230 / 250	terpenes, dienes, allenes, terpene alcohols, 1,2-epoxy-alkanes, carboxylic acids (esters), hydroxycarboxylic acid esters, pharmaceuticals, pesticides
HYDRODEX β-6TBDM			
	heptakis-(2,3-di-O-methyl-6-O-t-butyldimethyl-silyl)-β-CD	230 / 250	γ-lactones, cyclopentanones, terpenes, esters, tartrates
HYDRODEX β-6TBDE			
	heptakis-(2,3-di-O-ethyl-6-O-t-butyldimethyl-silyl)-β-CD	230 / 250	essential oils
HYDRODEX β-TBDAc			
	heptakis-(2,3-di-O-acetyl-6-O-t-butyldimethyl-silyl)-β-CD	220 / 240	alcohols, esters, ketones, aldehydes, δ-lactones
HYDRODEX γ-TBDAc			
	octakis-(2,3-di-O-acetyl-6-O-t-butyldimethyl-silyl)-γ-CD	220 / 240	cyclic ketones, aromatic ketones, oxiranes, aromatic esters, aromatic amides
HYDRODEX γ-DI-MOM			
	octakis-(2,3-di-O-methoxymethyl-6-O-t-butyldimethyl-silyl)-γ-CD	220 / 240	ketones, terpenes, cyclic ethers, alcohols, amines

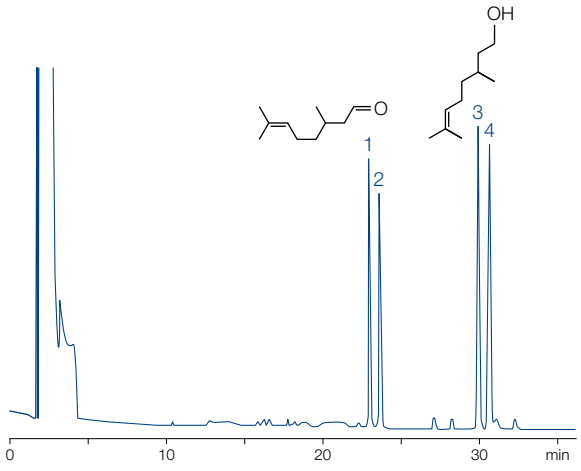
Capillary columns for enantiomer separation

Separation of (R/S) citronellol + citronellal

MN Appl. No. 212440

Column:	FS-HYDRODEX β-TBDAc, 50 m x 0.25 mm ID
Injection:	1 µL, 1:1000 in CH_2Cl_2, split 25 mL/min
Carrier gas:	1.5 bar H_2
Temperature:	100 °C
Detector:	FID 220 °C

Peaks:
1. (R)/(S)-Citronellal
2. (S)/(R)-Citronellal
3. (S)-Citronellol
4. (R)-Citronellol

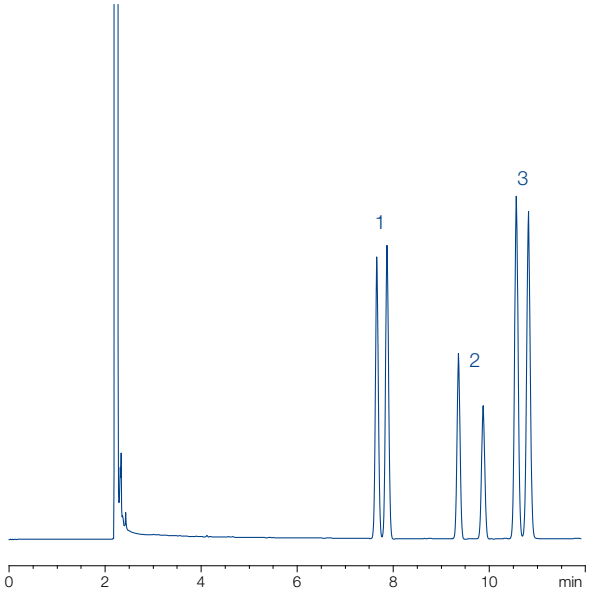


Separation of essential oils

MN Appl. No. 212980/212990/213000

Column:	FS-HYDRODEX γ-TBDAc, 50 m x 0.25 mm ID
Injektor:	220 °C
Carrier gas:	1.2 bar H_2
Temperature:	125 °C
Detector:	FID 220 °C

Peaks:
1. Fenchone (1.5 mg/mL)
2. Menthone (0.5 mg/mL)
3. Menthol (2 mg/mL)



HYDRODEX

Length →	10 m 0.10 mm ID	25 m 0.25 mm ID	50 m 0.25 mm ID
FS-HYDRODEX β-PM			
		723370.25	723370.50
FS-HYDRODEX β-3P			
		723358.25	723358.50
FS-HYDRODEX β-6TBDM			
	723383.10	723381.25	723381.50
FS-HYDRODEX β-6TBDE			
		723386.25	
FS-HYDRODEX β-TBDAc			
		723384.25	723384.50
FS-HYDRODEX γ-TBDAc			
		723387.25	723387.50
FS-HYDRODEX γ-DiMOM			
		723388.25	723388.50
All columns with 0.4 mm OD			

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

OPTIMA® BioDiesel for the analysis of biodiesel (DIN EN 14214 / ASTM D 6751)

OPTIMA® BioDiesel M for analysis of methanol in accordance with DIN EN 14110

Key features

- The methanol content in biodiesel as specified in DIN EN 14110 must not exceed 0.2 %. The column OPTIMA® BioDiesel M allows the GC headspace analysis of the methanol content in biodiesel in the concentration range from 0.01 to 0.5 % with 2-propanol as internal standard.

Temperature

- T_{max} 340 °C (long-term temperature), T_{max} 360 °C (short-term max. temperature in a temperature program)

Similar phases

- Select™ Biodiesel for Methanol, Trace TR-BioDiesel (M)

OPTIMA® BioDiesel F for analysis of FAMEs in accordance with DIN EN 14103:2011

Key features

- The analysis of biodiesel requires separation of typical FAMEs between myristic acid (C_{14}) and nervonic acid (C_{24}:1) methyl esters. This analysis is possible on OPTIMA® BioDiesel F in only 22 min. Additionally, linolenic acid methyl ester can be determined due to the good resolution. The extended standard DIN EN 14103:2011 also covers smaller FAMEs starting from C_6 (see application 214510 on opposite page). Change of the internal standard from C_{17} to C_{19} also allows the analysis of animal fats.

Temperature

- T_{max} 240 °C (long-term temperature), T_{max} 250 °C (short-term max. temperature in a temperature program)

Similar phases

- Select™ Biodiesel for FAME, Trace TR-BioDiesel (F)

OPTIMA® BioDiesel G for analysis of glycerol and glycerides in accordance with DIN EN 14105

Key features

- The capillary column OPTIMA® BioDiesel G allows determination of free glycerol and residues of mono-, di- and triglycerides in FAMEs intended as additives for mineral oils. The procedure can be applied for FAMEs from rapeseed oil, sunflower oil and soy bean oil. Glycerol as well as mono- and diglycerides are derivatized to more volatile substances by addition of MSTFA in the presence of pyridine (see page 368).

Temperature

- T_{max} 380 °C (long-term temperature), T_{max} 400 °C (short-term max. temperature in a temperature program)

Similar phases

- Select™ Biodiesel for Glycerides, Trace TR-BioDiesel (G), MET-Biodiesel

Capillary columns for triglyceride analysis

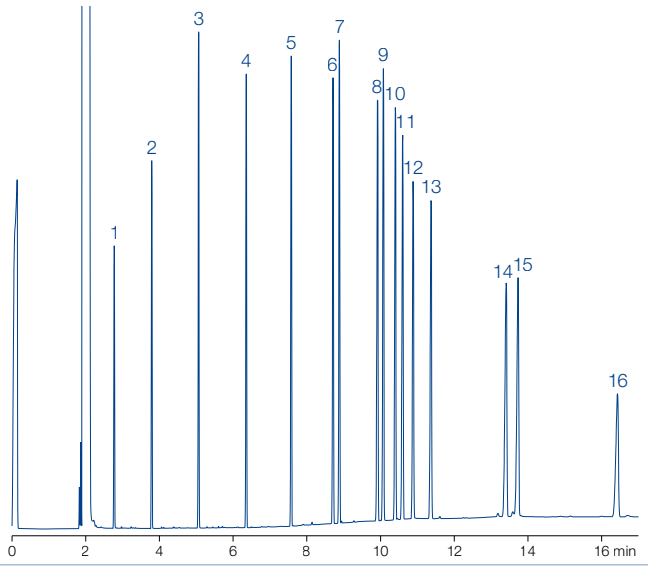
Analysis of FAMEs from biodiesel in accordance with DIN EN 14103:2011

MN Appl. No. 214510

Column: OPTIMA® BioDiesel F, 30 m x 0.25 mm ID
Sample: 50 µg/mL each in dichloromethane
Injection: 10 µL, 250 °C, split 1:20
Carrier gas: 1.2 bar He
Temperature: 80 °C → 250 °C (8.5 min), 20 °C/min
Detector: FID 260 °C

Peaks:

1. C6:0
2. C8:0
3. C10:0
4. C12:0
5. C14:0
6. C16:0
7. C16:1
8. C18:0
9. C18:1
10. C18:2
11. C19:0, int. st.
12. C18:3
13. C20:0
14. C22:0
15. C22:1
16. C24:0



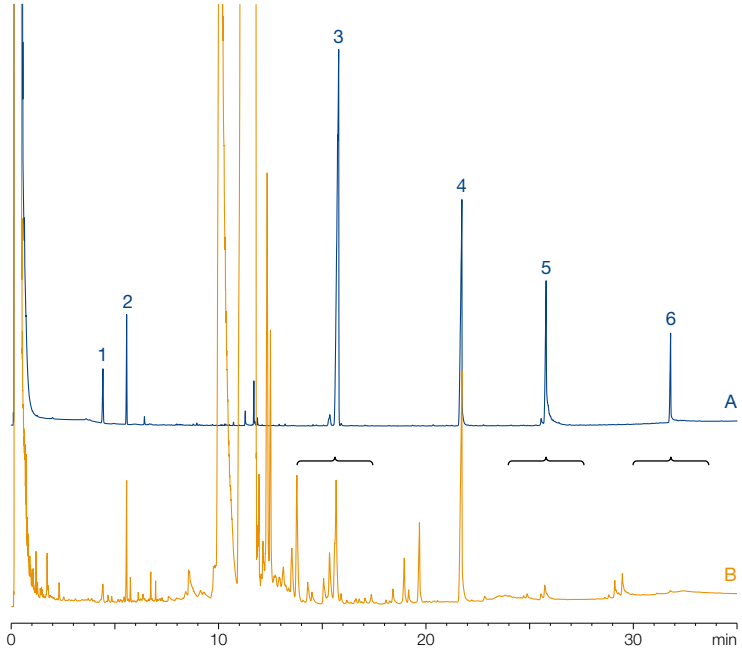
Analysis of glycerol and glycerides from biodiesel

MN Appl. No. 213640

Column: OPTIMA® BioDiesel G, 10 m x 0.25 mm ID
Sample: A) standard in *n*-heptane
B) biodiesel
Injection: 2 µL, 350 °C, CIS (15 °C → 350 °C, 12 °C/s)
Carrier gas: 0.8 bar H_2, split 1: 2.6
Temperature: 50 °C (3.5 min) → 180 °C, 15 °C/min → 280 °C, 7 °C/min → 370 °C (10 min), 10 °C/min
Detector: FID 380 °C

Peaks:

1. Glycerol (TMS)
2. Butanetriol (TMS), IS
3. Monoolein = glycerol monooleate (TMS) + monoacylglycerides
4. Tricaprin (glycerol tricaprate), IS
5. Diolein = glycerol dioleate (TMS) + diacylglycerides
6. Triolein = glycerol trioleate + triacylglycerides



OPTIMA® BioDiesel

	Length → 10 m	30 m
OPTIMA® BioDiesel M		
0.32 mm ID (0.5 mm OD)		726905.30
OPTIMA® BioDiesel F		
0.25 mm ID (0.4 mm OD)		726900.30
OPTIMA® BioDiesel G		
0.25 mm ID (0.4 mm OD)	726903.10	

Capillary columns for triglyceride analysis

OPTIMA® 1-TG · 17-TG for triglyceride analysis · USP G1 / G2 / G38 (1-TG) · USP G3 (17-TG)

Key features

- Short capillary columns (max. 25 m and 0.32 mm ID) with low-bleeding stationary phases thermally stable with optimized deactivation

Recommended application

- OPTIMA® 1-TG
  100 % dimethylpolysiloxane offers separation according to carbon number
- OPTIMA® 17-TG
  phenyl-methyl-polysiloxane (50 % phenyl) for separation according to degree of unsaturation

Temperature

- T_{max} 370 °C (both phases)

Similar phases der OPTIMA® 1-TG:

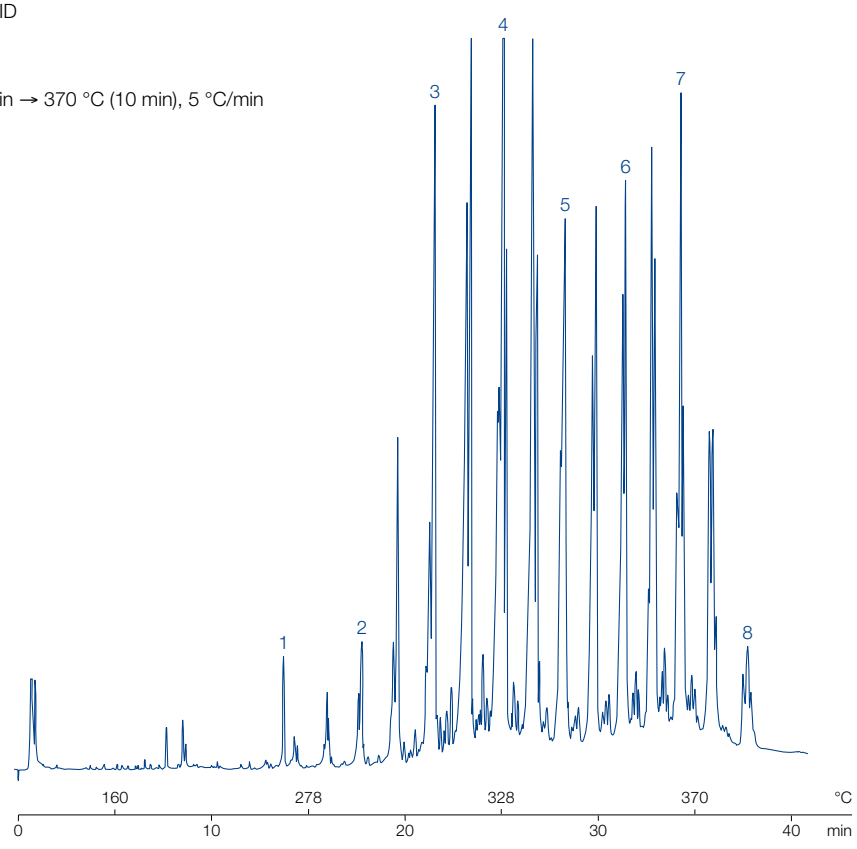
- SPB-1 TG, DB-1 HT, 400-1 HT, HT-5

Triglycerides (from butter)

MN Appl. No. 201790

Column: OPTIMA® 1-TG, 25 m x 0.32 mm ID
Injection: 0.5 µL
Carrier gas: 80 kPa H_2
Temperature: 80 °C (1 min) → 250 °C, 20 °C/min → 370 °C (10 min), 5 °C/min
Detector: FID 380 °C

Peaks:
1. Cholesterol
2. T-30
3. T-34
4. T-38
5. T-42
6. T-46
7. T-50
8. T-54



OPTIMA® 1-TG · OPTIMA® 17-TG

	Length → 10 m	25 m
OPTIMA® 1-TG		
0.25 mm ID (0.4 mm OD)	726133.10	726133.25
0.32 mm ID (0.5 mm OD)	726132.10	726132.25
OPTIMA® 17-TG		
0.32 mm ID (0.5 mm OD)	726131.10	726131.25

Capillary columns for high temperature GC

OPTIMA® 5 HT for high temperature GC · USP G27 / G36

Key features

- Chemically bonded, cross-linked silarylene phase with polarity similar to a 5 % diphenyl – 95 % dimethylpolysiloxane phase
- Nonpolar phase, low bleeding

Similar phases

- DB-5HT, VF-5HT, HT-5, XTI-5HT, ZB-5HT

Recommended application

- Ideal for MS detectors, can be rinsed with solvents
- For simulated distillation, hydrocarbon, fuel and oil analysis, high-boiling analytes

Temperature

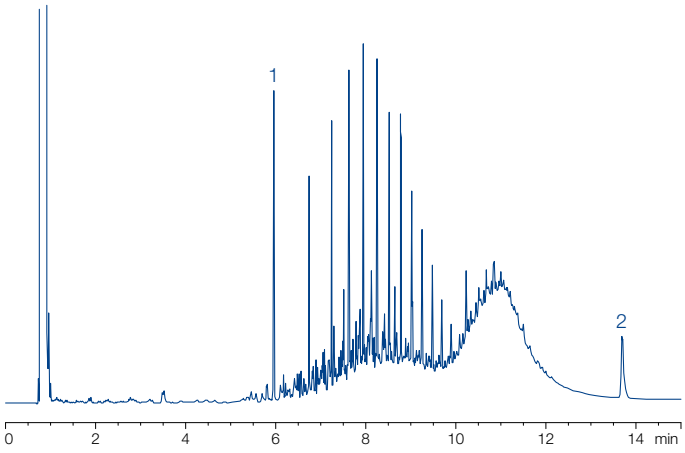
- T_{max} 380 °C (long-term temperature), T_{max} 400 °C (short-term max. temperature in a temperature program)

Separation of motor oil / mineral oil (type A + B), rapid determination in accordance with DIN H-53 / ISO DIS

MN Appl. No. 213400

Column:	OPTIMA® 5 HT, 15 m x 0.32 mm ID, 0.25 µm film
Sample:	mineral oil type A + B (hydrocarbon index kit acc. to EN ISO 9377-2) in hexane
Injection:	1 µL, splitless, 300 °C
Carrier gas:	0.6 bar He
Temperature:	40 °C (5 min) → 390 °C, 50 °C/min
Detector:	FID 280 °C

Peaks:
1. Decane (C10)
2. Tetracontane (C40)



OPTIMA® 5 HT

	Length → 15 m	30 m
0.25 mm ID (0.4 mm OD)		
0.10 µm film	726102.15	726102.30
0.25 µm film	726106.15	726106.30
0.32 mm ID (0.5 mm OD)		
0.10 µm film	726104.15	726104.30
0.25 µm film	726108.15	726108.30

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

Capillary columns for amine separation

OPTIMA® 5 Amine special column for analysis of amines · USP G27 / G36

Key features

- Nonpolar phase
- Improved linearity for analysis of active components at trace levels: no amine absorptions even for aliphatic and aromatic amines at concentrations of 100 pg/peak
- Tested with the OPTIMA® Amine test mixture (REF 722317), which contains, amongst others, diethanolamine and propanol-pyridine (this test mixture is supplied with each column)

Similar phases

- Rtx®-5 Amine, PTA-5

Recommended application

- Especially deactivated for the analysis of polyfunctional amines such as ethanolamines, amino-functionalized diols and similar compounds; which are important base materials in industrial chemistry, and show strong tailing on standard-deactivated columns

Temperature

- T_{max} 300 °C (long-term temperature), T_{max} 320 °C (short-term max. temperature in a temperature program)

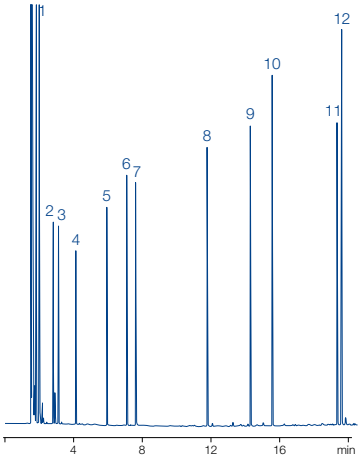
Separation of secondary and tertiary amines

MN Appl. No. 210280

Column:	OPTIMA® 5 Amine, 30 m x 0.25 mm ID, 1.0 µm film
Injection:	1 µL, split 1:100
Carrier gas:	0.6 bar H_2
Temperature:	100 °C (3 min) → 280 °C, 10 °C/min
Detector:	FID 280 °C

Peaks:

1. Diethylamine
2. Di-isopropylamine
3. Triethylamine
4. Di-*n*-propylamine
5. Di-*n*-butylamine
6. Tri-*n*-propylamine
7. Di-isobutylamine
8. Tri-*n*-butylamine
9. Di-isohexylamine
10. Dicyclohexylamine
11. Dibenzylamine
12. Tri-*n*-hexylamine



OPTIMA® 5 Amine

Length → 10 m	25 m	30 m
0.1 mm ID (0.4 mm OD)		
0.40 µm film	726361.10	
0.2 mm ID (0.4 mm OD)		
0.35 µm film	726355.25	
0.25 mm ID (0.4 mm OD)		
0.50 µm film		726354.30
1.00 µm film		726358.30
0.32 mm ID (0.5 mm OD)		
0.25 µm film		726360.30
1.00 µm film		726353.30
1.50 µm film		726356.30
0.53 mm ID (0.8 mm OD)		
1.00 µm film		726359.30
3.00 µm film		726357.30

Capillary columns for amine separation

FS-CW 20 M-AM polyethylene glycol 20 000, non-immobilized · USP G16

Key features

- Polyethylene glycol, basic for amine separations

Temperature

- T_{max} 220 °C (long-term temperature), T_{max} 240 °C (short-term max. temperature in a temperature program)

Similar phases

- Carbowax™ Amine, CP-Wax 51, CAM, Stabilwax® DB

FS-CW 20 M-AM

Length →	10 m	25 m	50 m
0.1 mm ID (0.4 mm OD)			
0.25 µm film	733111.10		
0.25 mm ID (0.4 mm OD)			
0.25 µm film		733110.25	733110.50
0.32 mm ID (0.5 mm OD)			
0.25 µm film		733299.25	733299.50
0.35 µm film			733442.50
0.53 mm ID (0.8 mm OD)			
1.00 µm film		733551.25	

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

PERMABOND® P-100 for analysis of petrochemical products · USP G1 / G2 / G38

Key features
- Extra long column with nonpolar dimethylpolysiloxane phase

Recommended application
- High resolution and sufficient capacity for analysis of complex mixtures of hydrocarbons

Temperature
- T_{max} 300 °C (long-term temperature), T_{max} 320 °C (short-term max. temperature in a temperature program)

PERMABOND® P-100

	Length → 100 m
0.25 mm ID (0.4 mm OD)	
0.50 µm film	723890.100

PERMABOND® SE-54-HKW for volatile halogenated hydrocarbons · USP G36

Recommended application
- SE-54 optimized for volatile halogenated hydrocarbons

Temperature
- T_{max} 300 °C (long-term temperature), T_{max} 320 °C (short-term max. temperature in a temperature program)

For the analysis of halogenated hydrocarbons, we recommend our optimized column PERMABOND® SE-54-HKW at 25 or 50 m length with our approved polysiloxane phase SE-54.

As an alternative, or to verify analytical results, the OPTIMA® 624 has proven itself as advantageous, especially for the determination of 1,1,2-trichlorotrifluoroethane (F 113) along with dichloromethane.

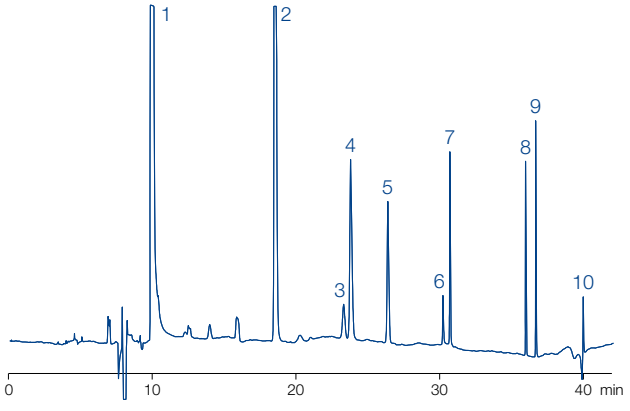
Both phases are also suited for the determination of vinyl chloride as well as for the separation of cis/trans isomers of 1,2-dichloroethene. The high film thickness secures a high capacity and an outstanding resolution. For GC/MS coupling, we recommend OPTIMA® 624 LB or OPTIMA® 624 with 0.2 or 0.25 mm ID.

Volatile halogenated hydrocarbons

MN Appl. No. 212480

Column:	PERMABOND® SE-54-HKW, 50 m x 0.32 mm ID
Injection:	1 µL, split ~ 1:30
Carrier gas:	0.9 bar He
Temperature:	35 °C (25 min) → 160 °C (5 min), 10 °C/min
Detector:	ECD 300 °C

Peaks:
1. Dichloromethane (795 ng/mL)
2. Trichloromethane (75 ng/mL)
3. 1,1,1-Trichloroethane (67 ng/mL)
4. 1,2-Dichloroethane (100 ng/mL)
5. Tetrachloromethane (15.9 ng/mL)
6. Trichloroethene (14.6 ng/mL)
7. Bromodichloromethane (20 ng/mL)
8. Dibromochloromethane (122 ng/mL)
9. Tetrachloroethene (81 ng/mL)
10. Tribromomethane (28.9 ng/mL)



Capillary columns for hydrocarbons

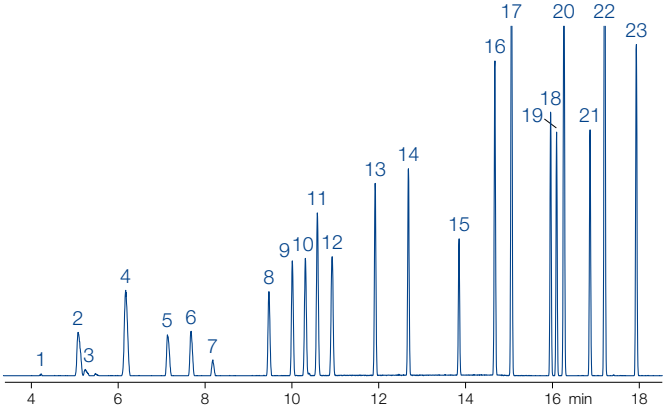
Volatile halogenated hydrocarbons and BTX

MN Appl. No. 200160

Column:	OPTIMA® 624, 50 m x 0.25 mm ID, 1.40 µm film
Injection:	1 µL, split 50 mL/min
Carrier gas:	0.9 mL/min He (constant flow)
Temperature:	40 °C (5 min) → 160 °C, 10 °C/min
Detector:	MSD 5971

Peaks:

1. Vinyl chloride
2. Trichlorofluoromethane (F 11)
3. Pentane
4. 1,1,2-Trichlorotrifluoroethane (F 113)
5. Dichloromethane
6. *trans*-1,2-Dichloroethene
7. Hexane
8. *cis*-1,2-Dichloroethene
9. Trichloromethane
10. 1,1,1-Trichloroethane
11. Tetrachloromethane
12. 1,2-Dichloroethane + benzene
13. Trichloroethene
14. Bromodichloromethane
15. Toluene
16. Tetrachloroethene
17. Dibromochloromethane
18. Chlorobenzene
19. Ethylbenzene
20. *m*- + *p*-Xylene
21. *o*-Xylene
22. Tribromomethane
23. Bromobenzene



PERMABOND® SE-54-HKW

	Length → 25 m	50 m
0.32 mm ID (0.5 mm OD)		
1.80 µm film	723945.25	723945.50

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

PERMABOND® Silane for silane analysis

Recommended application

- Developed especially for the analysis of monomeric silanes and chlorosilanes (not for the separation of trimethylsilyl derivatives)
- Also suited for the separation of dimeric siloxanes and silazanes

Temperature

- 0.32 mm ID: T_{max} 260 °C (long-term temperature), T_{max} 280 °C (short-term max. temperature in a temperature program)
- 0.53 mm ID: T_{max} 240 and 260 °C, resp.

PERMABOND® Silane

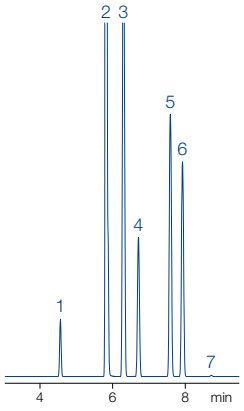
	Length → 25 m	50 m
0.32 mm ID (0.5 mm OD)		723409.50
0.53 mm ID (0.8 mm OD)	723411.25	

Chloromethylsilanes

MN Appl. No. 200090

Column: PERMABOND® Silane, 50 m x 0.32 mm ID
Injection: 0.5 µL gas, split 80 mL/min
Carrier gas: 1 mL/min He (constant flow)
Temperature: 50 °C → 100 °C, 5 °C/min
Detector: MSD 5971

Peaks:
1. Tetramethylsilane
2. Dichloromethane
3. Tetrachlorosilane
4. Chlorotrimethylsilane
5. Methyltrichlorosilane
6. Dichlorodimethylsilane
7. Hexamethyldisiloxane

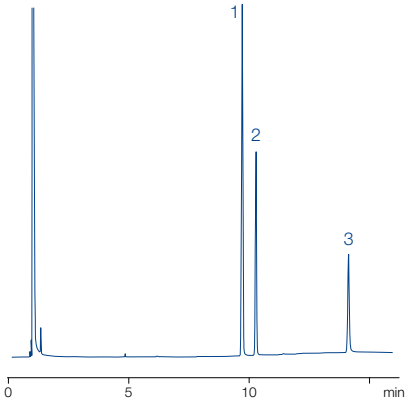


Diethylene glycol standard in wine

MN Appl. No. 201500

Column: PERMABOND® CW 20 M-DEG, 25 m x 0.25 mm ID
Injection: 0.5 µL, split ~1:40
Carrier gas: 1.2 bar N_2
Temperature: 80 °C → 200 °C, 10 °C/min
Detector: FID 260 °C

Peaks:
DEG standard
1. 1,4-Butanediol
2. Diethylene glycol
3. Glycerol



PERMABOND® CW 20 M-DEG for determination of diethylene glycol · USP G16

Key features

- Polyethylene glycol 20,000 (diethylene glycol tested)

Recommended application

- Determination of diethylene glycol (DEG), e.g., for the quality control of wine

Temperature

- T_{max} 220 °C (long-term temperature), T_{max} 240 °C (short-term max. temperature in a temperature program)

PERMABOND® CW 20 M-DEG

	Length → 25 m
0.25 mm ID (0.4 mm OD)	
0.25 µm film	723063.25
0.32 mm ID (0.5 mm OD)	
0.25 µm film	723327.25

Further applications can be found online in our application database at *ChromaAppDB.mn-net.com*

Fused silica capillaries

Untreated capillaries

☑ Recommended application

- Capillary electrophoresis
- Preparation of capillary columns
- Capillary LC applications

Untreated capillaries

	Length → 1 m Pack of 3	10 m Pack of 1	25 m Pack of 1
Capillaries for electrophoresis			
0.025 mm ID (0.4 mm OD)	723793.1	723793.2	
0.05 mm ID (0.4 mm OD)	723790.1	723790.2	
0.075 mm ID (0.4 mm OD)	723791.1	723791.2	
0.10 mm ID (0.4 mm OD)	723792.1	723792.2	
Untreated capillaries			
0.20 mm ID (0.4 mm OD)		723148.10	723148.25
0.25 mm ID (0.4 mm OD)		723101.10	723101.25
0.32 mm ID (0.5 mm OD)		723151.10	723151.25
0.53 mm ID (0.8 mm OD)		723501.10	723501.25
Untreated capillaries are supplied without cage.			

Deactivated capillary columns precolumns / guard columns

☑ Recommended application

- As precolumns / guard columns, whenever a larger contamination capacity is required
- Preparation of capillary columns

Deactivated capillary columns

	Length → 10 m	25 m
Methyl-Sil deactivated (T_{max} 320 °C)		
0.25 mm ID (0.4 mm OD)	723106.10	723106.25
0.32 mm ID (0.5 mm OD)	723346.10	723346.25
0.53 mm ID (0.8 mm OD)	723558.10	723558.25
Phenyl-Sil deactivated (T_{max} 320 °C)		
0.25 mm ID (0.4 mm OD)	723108.10	723108.25
0.32 mm ID (0.5 mm OD)	723348.10	723348.25
0.53 mm ID (0.8 mm OD)	723560.10	723560.25
CW deactivated (T_{max} 250 °C)		
0.25 mm ID (0.4 mm OD)	723105.10	723105.25
0.32 mm ID (0.5 mm OD)	723349.10	723349.25
0.53 mm ID (0.8 mm OD)	723562.10	723562.25
Untreated capillaries are supplied without cage.		

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of integrated precolumns. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

Retention gaps

Key features

- The retention gap technique in combination with on-column injection allows to concentrate a large sample volume in the capillary column.
- Choice of the retention gap depends on the solvent used: the flooded zone after injection should be between 20 – 30 cm/µL
- Me-Sil retention gap:
  only for use with *n*-hexane and diethyl ether
- Phe-Sil retention gap:
  for all solvents except methanol and water
- CW retention gap:
  for all solvents and especially for methanol and water

Temperature

- T_{max} 250 °C (CW retention gaps),
  T_{max} 320 °C (Me-Sil and Phe-Sil retention gaps)

Note:

- Calculation example: length of flooded zone ~ 20 – 30 cm/µL, retention gap 10 m x 0.32 mm ID, capillary column: 25 m x 0.32 mm ID, max. injection volume ~ 30 – 50 µL
- A retention gap must be inert without any noticeable retention: Me-Sil retention gaps are more inert than Phe-Sil, while Phe-Sil is less susceptible to contamination
- Retention gaps can also be used as transfer lines or precolumns (contamination capacity about 5 – 10 µg).

Retention gaps

	Length →	
	10 m	25 m
Me-Sil retention gaps (T_{max} 320 °C)		
0.25 mm ID (0.4 mm OD)	723706.10	723706.25
0.32 mm ID (0.5 mm OD)	723707.10	723707.25
0.53 mm ID (0.8 mm OD)	723708.10	723708.25
Phe-Sil retention gaps (T_{max} 320 °C)		
0.25 mm ID (0.4 mm OD)	723709.10	723709.25
0.32 mm ID (0.5 mm OD)	723710.10	723710.25
0.53 mm ID (0.8 mm OD)	723711.10	723711.25
CW retention gaps (T_{max} 250 °C)		
0.25 mm ID (0.4 mm OD)	723712.10	723712.25
0.32 mm ID (0.5 mm OD)	723713.10	723713.25
0.53 mm ID (0.8 mm OD)	723714.10	723714.25
Retention gaps are supplied without cage.		

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of integrated precolumns. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.