

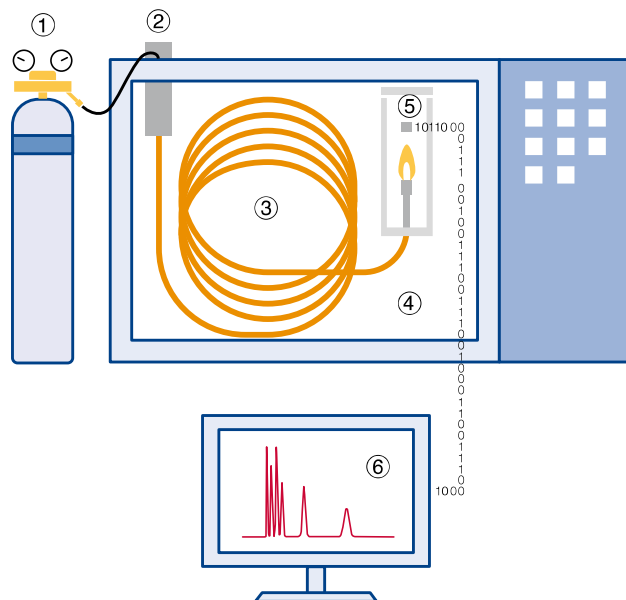


Contents

Basics.....	300
USP listing.....	302
Additional information for GC columns.....	303
Separation properties of OPTIMA® phases.....	305
Summary of MN phases for GC.....	306
OPTIMA® · nonpolar capillary columns.....	310
OPTIMA® · weakly polar capillary columns.....	314
OPTIMA® δ · phases with autoselectivity.....	318
OPTIMA® · medium polar capillary columns.....	321
OPTIMA® · polar capillary columns.....	328
PERMABOND® capillary columns.....	336
Special GC columns overview.....	339
Capillary columns for Fast GC.....	340
Capillary columns for enantiomer separation.....	342
Capillary columns for biodiesel analysis.....	346
Capillary columns for triglyceride analysis.....	348
Capillary columns for high temperature GC.....	349
Capillary columns for amine separation.....	350
Capillary columns for hydrocarbons.....	352
Capillary columns for silane · DEG.....	354
Fused silica capillaries.....	355
Reagents / methods for derivatization.....	357
Reagents / methods for acylation.....	359
Reagents / methods for alkylation / methylation.....	361
Reagents / methods for silylation.....	362
Derivatization procedures.....	367
Test mixtures for GC capillary columns.....	368
Ferrules for capillary columns.....	370
Septa for capillary column.....	371
Accessories for capillary columns.....	372
General accessories.....	373



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:

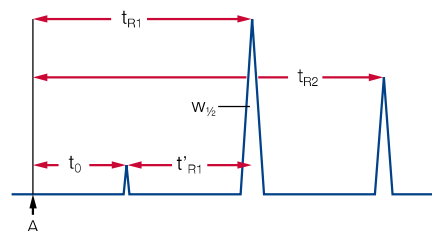
In GC, the mobile phase is always a gas, mostly either He, N₂ or H₂.

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.

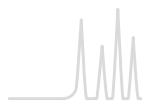
Other terms characterizing a separation:

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.

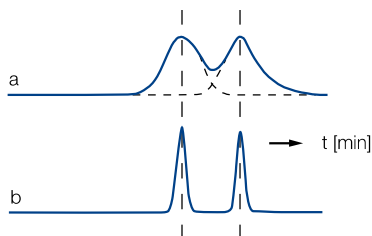
$$k'_i = \frac{t_{Ri} - t_0}{t_0}$$

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:

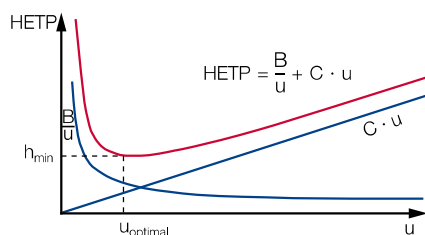
$$R = 1.18 \cdot \frac{t_{R2} - t_{R1}}{(w_{1/2})_2 + (w_{1/2})_1}$$

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.

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

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 x	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 340).

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 of MN GC phases

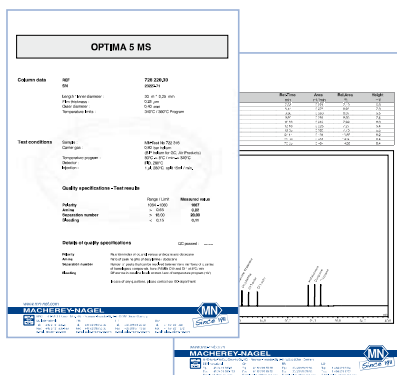
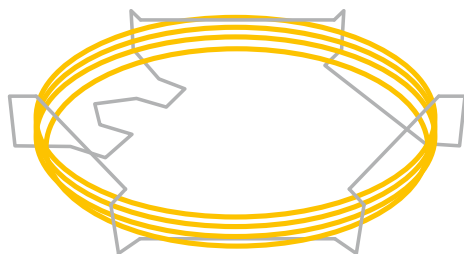
Code	Specifications	MN GC phases	Page
USP G1 / G2	dimethylpolysiloxane oil	OPTIMA® 1	310
		OPTIMA® 1 MS	312
		OPTIMA® 1 MS Accent	312
		OPTIMA® 1-TG	348
		PERMABOND® SE-30	336
		PERMABOND® P-100	352
USP G3	50 % phenyl - 50 % methylpolysiloxane	OPTIMA® 17	327
		OPTIMA® 17 MS	328
		OPTIMA® 17-TG	348
USP G6	trifluoropropylmethylpolysiloxane	OPTIMA® 210	329
USP G7	50 % 3-cyanopropyl - 50 % phenylmethylpolysiloxane	OPTIMA® 225	330
USP G16	polyethylene glycol (average molecular weight ~ 15 000); high molecular weight compound of polyethylene glycol and diepoxide	OPTIMA® WAX	332
		OPTIMA WAXplus®	333
		PERMABOND® CW 20 M	337
		PERMABOND® CW 20 M-DEG	354
		FS-CW 20 M-AM	351
USP G19	25 % phenyl – 25 % cyanopropyl – 50 % methylsiloxane	OPTIMA® 225	330
USP G25	high molecular weight compound of polyethylene glycol and diepoxide, which is esterified with terephthalic acid	OPTIMA® FFAP	334
		OPTIMA® FFAPplus	335
		PERMABOND® FFAP	338
USP G27	5 % phenyl – 95 % methylpolysiloxane	OPTIMA® 5	314
		OPTIMA® 5 Amine	350
		OPTIMA® 5 HT	349
		OPTIMA® 5 MS	315
		OPTIMA® 5 MS Accent	316
		PERMABOND® SE-52	336
USP G28	25 % phenyl – 75 % methylpolysiloxane	OPTIMA® 35 MS	326
USP G32	20 % phenylmethyl – 80 % dimethylpolysiloxane	OPTIMA® 35 MS	326
USP G35	high molecular weight compound of polyethylene glycol and diepoxide, which is esterified with nitroterephthalic acid	OPTIMA® FFAP	334
		OPTIMA® FFAPplus	335
		PERMABOND® FFAP	338
USP G36	1 % vinyl – 5 % phenylmethylpolysiloxane	OPTIMA® 5	314
		OPTIMA® 5 Amine	350
		OPTIMA® 5 HT	349
		OPTIMA® 5 MS	315
		OPTIMA® 5 MS Accent	316
		PERMABOND® SE-54 HKW	352
USP G38	dimethylpolysiloxane oil	OPTIMA® 1	310
		OPTIMA® 1 MS	312
		OPTIMA® 1 MS Accent	312
		OPTIMA® 1-TG	348
		PERMABOND® SE-30	336
		PERMABOND® P-100	352
USP G42	35 % phenyl – 65 % dimethylpolysiloxane	OPTIMA® 35 MS	326
USP G43	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	OPTIMA® 1301	321
		OPTIMA® 1301 MS	322
		OPTIMA® 624	323
		OPTIMA® 624 LB	323
USP G46	14 % cyanopropylphenyl – 86 % methylpolysiloxane	OPTIMA® 1701	324
		OPTIMA® 1701 MS	325
USP G49	proprietary derivatized phenyl groups on a polysiloxane backbone	OPTIMA® δ-3	319



Additional information for GC columns

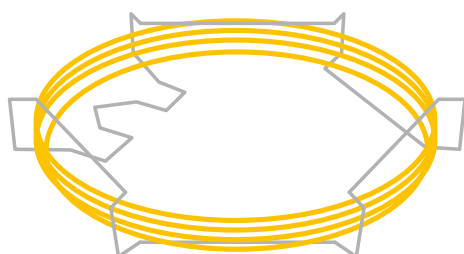
Scope of delivery

Each column is individually tested and supplied with test certificate and test chromatogram, but without 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.

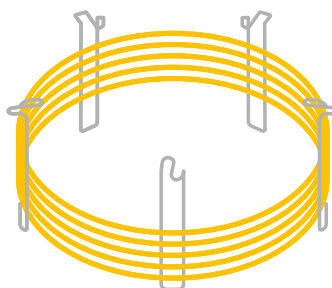


GC cages

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)



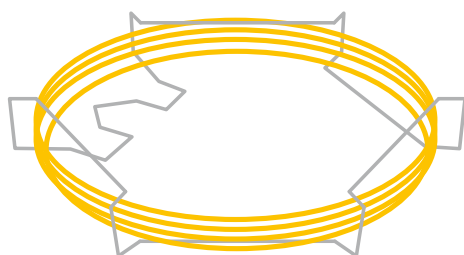
7 inches standard size e.g., REF 726600.30



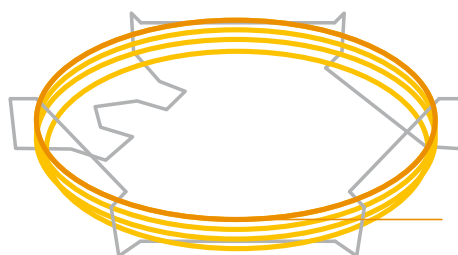
5 inches special cage e.g., REF 726600.30E

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

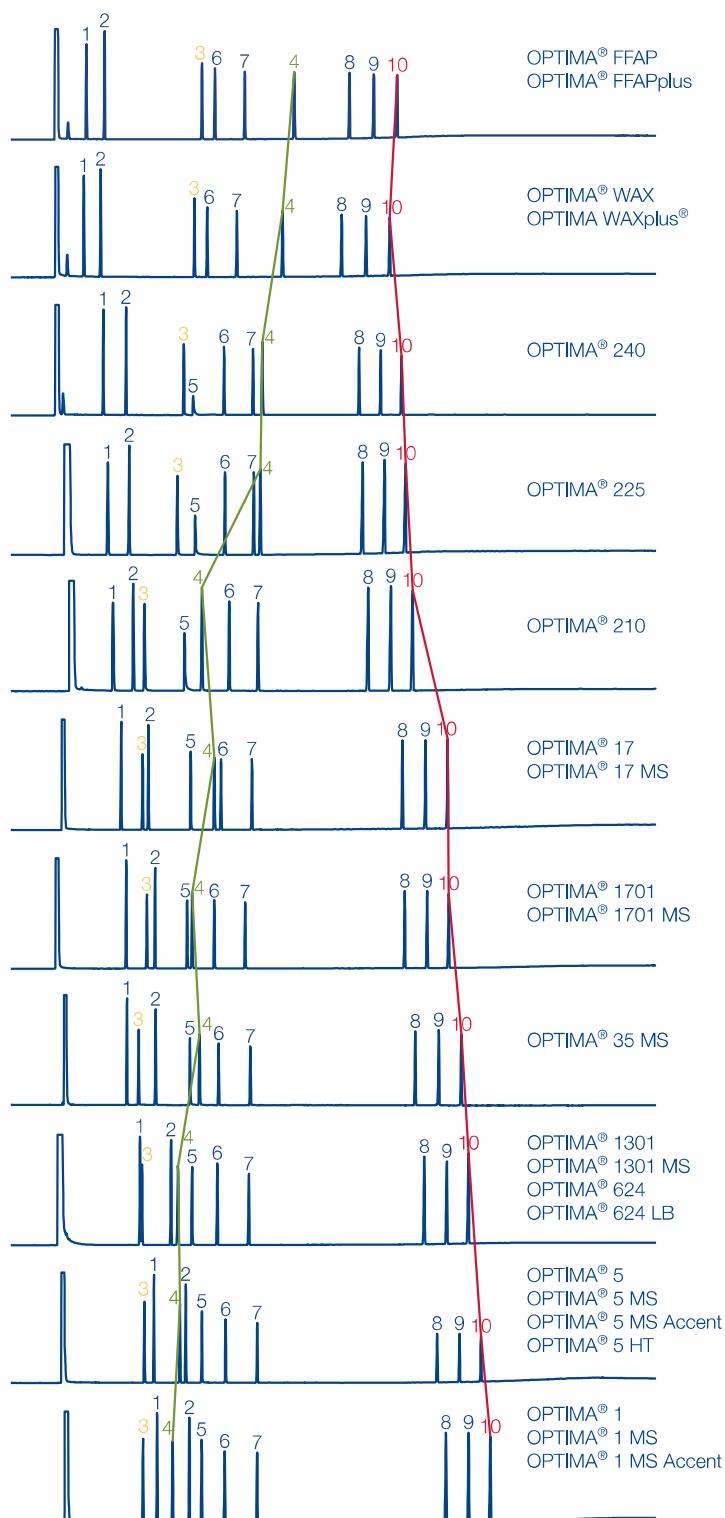
Purpose of derivatization

- 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)
 - Acylation
- For 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also as screw neck vial
- Product range from page 357 onwards





Separation properties of OPTIMA® phases



Peaks:

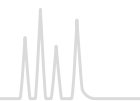
- | | |
|--------------------|-----------------------|
| 1. Undecane | 6. Methyl decanoate |
| 2. Dodecane | 7. Methyl undecanoate |
| 3. Octanol | 8. Henicosane |
| 4. Dimethylaniline | 9. Docosane |
| 5. Decylamine | 10. Tricosane |

All columns:

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



Summary of MN phases for GC



Overview of OPTIMA® MN phases

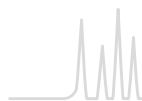
Phase	Composition	Page	Relative polarity ^①	Maximum temperature ^②
OPTIMA® 1		310		
OPTIMA® 1 MS	100 % dimethylpolysiloxane	312		340 / 360 °C
OPTIMA® 1 MS Accent		312		
OPTIMA® 5	5 % phenyl – 95 % methylpolysiloxane	314		340 / 360 °C
OPTIMA® 5 MS	5 % diphenyl – 95 % dimethylpolysiloxane	315		340 / 360 °C
OPTIMA® 5 MS Accent	silarylene phase with selectivity similar to 5 % diphenyl – 95 % dimethylpolysiloxane	316		340 / 360 °C
OPTIMA® XLB	silarylene phase like above, optimized silarylene content for low bleeding	317		340 / 360 °C
OPTIMA® δ-3	phase with autoselectivity ^④	319		340 / 360 °C
OPTIMA® δ-6	phase with autoselectivity ^④	320		340 / 360 °C
OPTIMA® 1301	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	321		300 / 320 °C
OPTIMA® 1301 MS	silarylene phase with low bleeding: polarity similar to 6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	322		300 / 320 °C
OPTIMA® 624	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	323		
OPTIMA® 624 LB	like above, phase with low bleeding	323		280 / 300 °C
OPTIMA® 1701	14 % cyanopropylphenyl – 86 % dimethylpolysiloxane	324		280 / 300 °C
OPTIMA® 1701 MS	silarylene phase with low bleeding: polarity similar to 14 % cyanopropylphenyl – 86 % dimethylpolysiloxane	325		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 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 318

GC columns for special separations can be found from page 339 onwards.



Summary of MN phases for GC

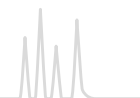


Structure	USP	Similar phases ^③
$\left[\begin{array}{c} \text{CH}_3 \\ \\ \text{O}-\text{Si} \\ \\ \text{CH}_3 \end{array} \right]_n$	G1 / G2 / G38	PERMABOND® SE-30, OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101 5 % diphenyl – 95 % dimethylpolysiloxane
$\left[\begin{array}{c} \text{CH}_3 \\ \\ \text{O}-\text{Si} \\ \\ \text{C}_6\text{H}_5 \end{array} \right]_m \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{O}-\text{Si} \\ \\ \text{CH}_3 \end{array} \right]_n$	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
$\left[\begin{array}{c} \text{C}_6\text{H}_5 \\ \\ \text{O}-\text{Si} \\ \\ \text{C}_6\text{H}_5 \end{array} \right]_m \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{O}-\text{Si} \\ \\ \text{CH}_3 \end{array} \right]_n$	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
$\left[\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \quad \\ \text{Si}-\text{C}_6\text{H}_4-\text{Si}-\text{O} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array} \right]_n \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{Si}-\text{O} \\ \\ \text{CH}_3 \end{array} \right]_o$	G27 / G36	
$\left[\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \quad \\ \text{Si}-\text{C}_6\text{H}_4-\text{Si}-\text{O} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array} \right]_n \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{Si}-\text{O} \\ \\ \text{CH}_3 \end{array} \right]_o$	-	DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS
see description page 318	G49	no similar phases
see description page 318	-	no similar phases
$\left[\begin{array}{c} \text{C}_6\text{H}_5 \\ \\ \text{O}-\text{Si} \\ \\ \text{NC}-(\text{CH}_2)_3 \end{array} \right]_m \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{O}-\text{Si} \\ \\ \text{CH}_3 \end{array} \right]_n$	G43	HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301
$\left[\begin{array}{c} \text{NC}-(\text{CH}_2)_3 \\ \\ \text{Si}-\text{O} \\ \\ \text{NC}-(\text{CH}_2)_3 \end{array} \right]_m \left[\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \quad \\ \text{Si}-\text{C}_6\text{H}_4-\text{Si}-\text{O} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array} \right]_{2m} \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{Si}-\text{O} \\ \\ \text{CH}_3 \end{array} \right]_n$	G43	VF-1301ms, Rxi®-1301SIL MS, TG-1301MS
$\left[\begin{array}{c} \text{C}_6\text{H}_5 \\ \\ \text{O}-\text{Si} \\ \\ \text{NC}-(\text{CH}_2)_3 \end{array} \right]_m \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{O}-\text{Si} \\ \\ \text{CH}_3 \end{array} \right]_n$	G43	HP-624, HP-VOC, DB-624, DB-VRX, SPB™-624, CP-624, Rtx®-624, Rtx®-Volatiles, 007-624, BP624, VOCOL
$\left[\begin{array}{c} \text{C}_6\text{H}_5 \\ \\ \text{O}-\text{Si} \\ \\ \text{NC}-(\text{CH}_2)_3 \end{array} \right]_m \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{O}-\text{Si} \\ \\ \text{CH}_3 \end{array} \right]_n$	G46	OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007-1701, BP10, ZB-1701
$\left[\begin{array}{c} \text{NC}-(\text{CH}_2)_3 \\ \\ \text{Si}-\text{O} \\ \\ \text{NC}-(\text{CH}_2)_3 \end{array} \right]_m \left[\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \quad \\ \text{Si}-\text{C}_6\text{H}_4-\text{Si}-\text{O} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array} \right]_{2m} \left[\begin{array}{c} \text{CH}_3 \\ \\ \text{Si}-\text{O} \\ \\ \text{CH}_3 \end{array} \right]_n$	G46	VF-1701ms, TG-1701MS, OV-1701, DB-1701, HP-1701, Rtx®-1701, SPB™-1701, CP Sil 19 CB, 007-1701, BP10, ZB-1701

at for columns with 0,53 mm ID and for columns with thicker films temperature limits are generally lower.



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	326		360/370 °C
OPTIMA® 17	phenylmethylpolysiloxane, 50 % phenyl	327		320/340 °C
OPTIMA® 17 MS	silarylene phase with selectivity similar to 50 % phenyl – 50 % methylpolysiloxane	328		340/360 °C
OPTIMA® 210	trifluoropropylmethylpolysiloxane (50 % trifluoropropyl)	329		260/280 °C
OPTIMA® 225	50 % cyanopropylmethyl – 50 % phenylmethylpolysiloxane	330		260/280 °C
OPTIMA® 240	33 % cyanopropylmethyl – 67 % dimethylpolysiloxane	331		260/280 °C
OPTIMA® WAX	polyethylene glycol 20 000 Da	332		240/250 °C
OPTIMA WAXplus®	polyethylene glycol with optimized cross-linking	333		260/270 °C
OPTIMA® FFAP	polyethylene glycol 2-nitroterephthalate	334		250/260 °C
OPTIMA® FFAPplus	polyethylene glycol 2-nitroterephthalate with optimized cross-linking	335		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 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 339 onwards.



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 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 DB-FFAP, HP-FFAP, CP-SIL 58 CB, 007-FFAP, CP-FFAP CB, Nukol™

that for columns with 0.53 mm ID and for columns with thicker films temperature limits are generally lower.



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

★ Key features

- Nonpolar phase
- Structure see page 307

✓ Recommended application

- Separation of components according to boiling points
- Thick film columns $\geq 3 \mu\text{m}$ film are especially recommended for solvent analysis.

✍ Temperature

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

Similar phases

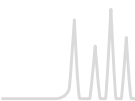
- PERMABOND® SE-30 (see page 336), OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101

Ordering information

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 303.



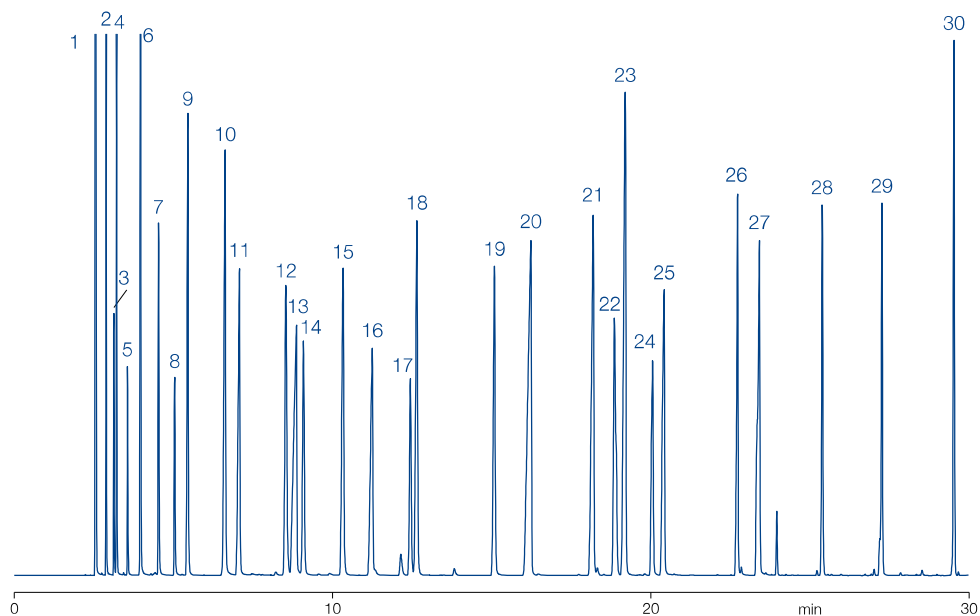
Solvent analysis

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: H₂, 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 | 26. Heptanol |
| 2. Ethanol | 27. Ethyl diglycol |
| 3. Acetone | 28. Butyl diglycol |
| 4. 2-Propanol | 29. Butyl glycol acetate |
| 5. Methyl acetate | 30. Butyl diglycol acetate |
| 6. <i>n</i> -Propanol | |
| 7. Methyl ethyl ketone | |
| 8. Ethyl acetate | |
| 9. Isobutanol | |
| 10. <i>n</i> -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 | |





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 307



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

Ordering information

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 303.

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 307



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

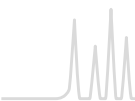


Temperature

- 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



OPTIMA® · nonpolar capillary columns



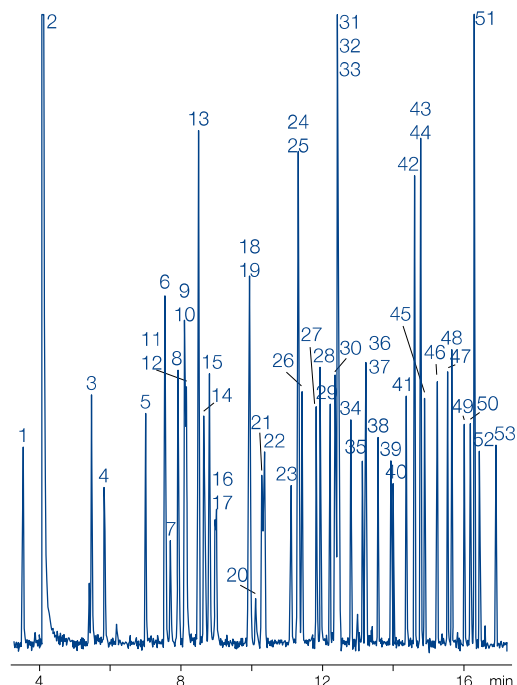
EPA 8140/8141/8141 A Organophosphorus pesticides

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



Ordering information

OPTIMA® 1 MS Accent

Length →				
	15 m	25 m	30 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 303.



OPTIMA® · weakly polar capillary columns



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



Key features

- Nonpolar phase
- Structure see page 307



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-52 (see page 336), SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007-5, BP5, MDN-5, AT™-5, ZB-5

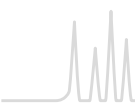
Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



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

★ Key features

- Selectivity identical to OPTIMA® 5
- Phase with low bleeding
- Structure see page 307

✓ 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

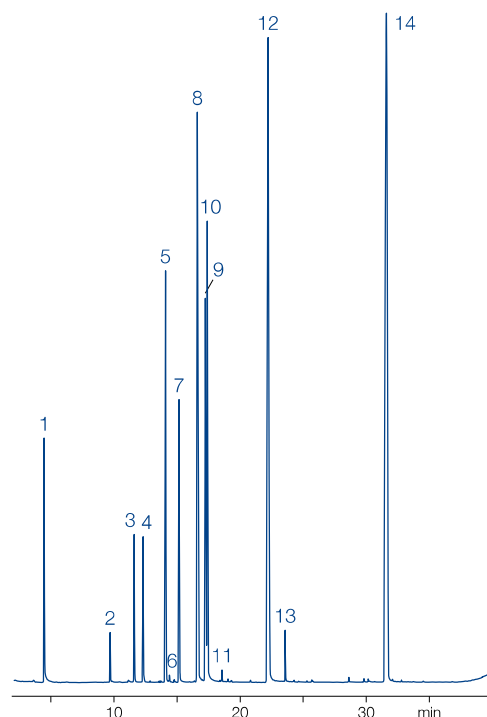
Analysis of various phenols

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-D₈
2. Phenol
3. 2-Methylphenol (o-Cresol)
4. Nitrobenzene-D₅
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

Ordering information

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 303.



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 307

✓ 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

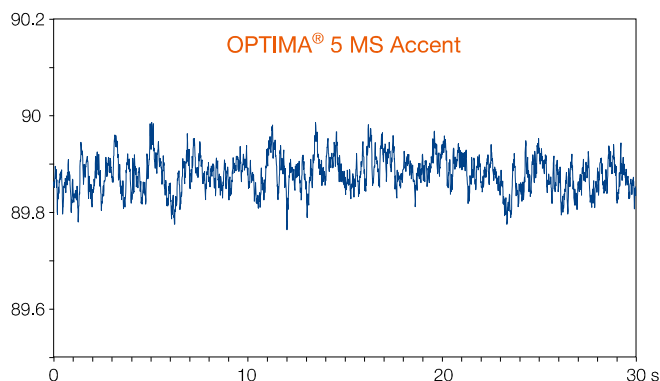
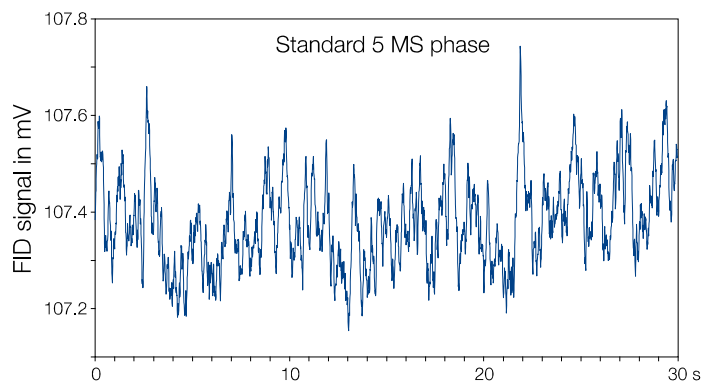
- DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS

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, which is approximately three times lower compared to a 5 MS brand column, provides significantly increased sensitivity and allows its application in trace analysis particularly of high-boiling compounds.

Background noise at 340 °C

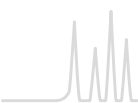


Ordering information

OPTIMA® 5 MS Accent

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			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 303.



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 307

✓ 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

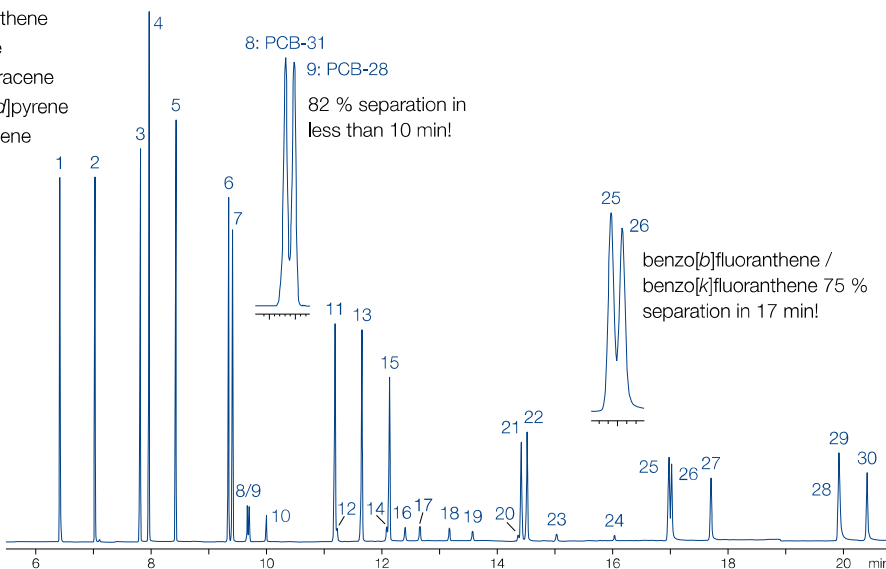
- DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS

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 | 21. Benz[a]anthracene |
| 2. 2-Methylnaphthalene | 22. Chrysene |
| 3. Acenaphthylene | 23. PCB-169 |
| 4. Acenaphthene | 24. PCB-194 |
| 5. Fluorene | 25. Benzo[b]fluoranthene |
| 6. Phenanthrene | 26. Benzo[k]fluoranthene |
| 7. Anthracene | 27. Benzo[a]pyrene |
| 8. PCB-31 | 28. Dibenz[ah]anthracene |
| 9. PCB-28 | 29. Indeno[1,2,3-cd]pyrene |
| 10. PCB-52 | 30. Benzo[ghi]perylene |
| 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 | |



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

Ordering information

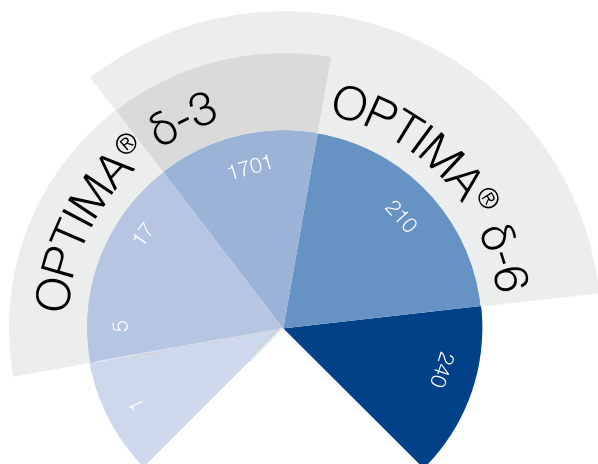
OPTIMA® XLB

	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 303.



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

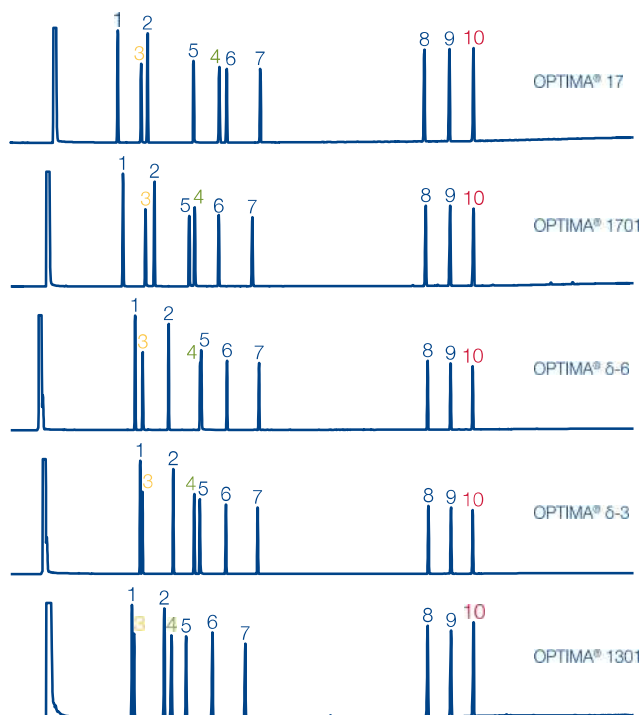
with the polarity of said analyte. We call this phenomenon “Autoselectivity”, because the column adjusts itself to the polarity of the analyte. The implemented polymers consist of cross-linked polysiloxanes with a defined composition and an extremely narrow distribution of molecular weight.

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 319).

Separation characteristics of OPTIMA[®] δ phases

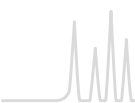


Conditions and peaks (see page 305)

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 319 and page 320.



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 318)
- 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

- Exclusive from MN

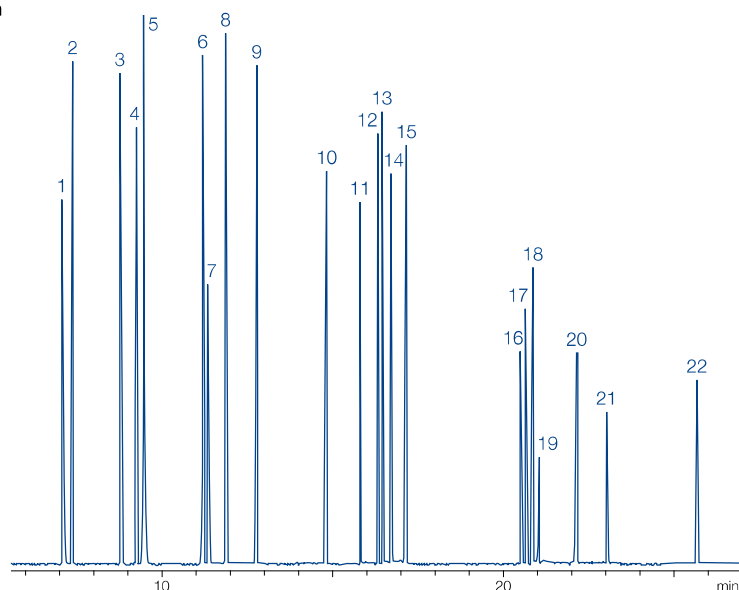
Analysis of isomeric phenols

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



Ordering information

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 303.



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 318)
- 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

- Exclusive from MN

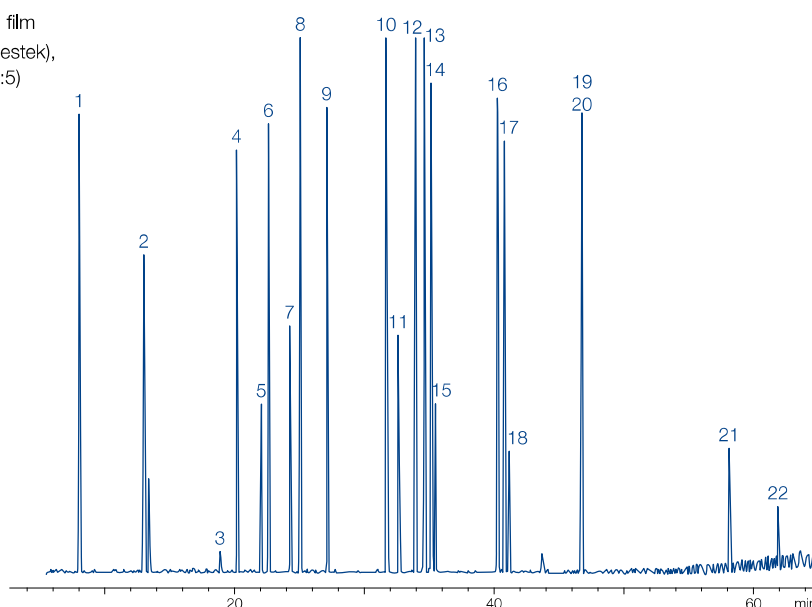
Separation of organophosphorus pesticides (EPA 8140 / 8141)

MN Appl. No. 250420

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

Peaks:

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

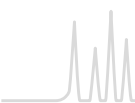


Ordering information

OPTIMA[®] δ -6

	Length $\rightarrow$				
	10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 μ m film	726490.10				
0.2 mm ID (0.4 mm OD)					
0.20 μ m film		726465.25		726465.50	
0.25 mm ID (0.4 mm OD)					
0.25 μ m film			726470.30		726470.60
0.32 mm ID (0.5 mm OD)					
0.25 μ m film			726480.30		726480.60
0.35 μ m film			726481.30		726481.60
1.00 μ m film			726482.30		726482.60
0.53 mm ID (0.8 mm OD)					
1.00 μ m 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 303.



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

★ Key features

- Midpolar phase
- Structure see page 307

✓ 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, SPBTM-1301, Rtx[®]-1301, CP-1301, 007-1301

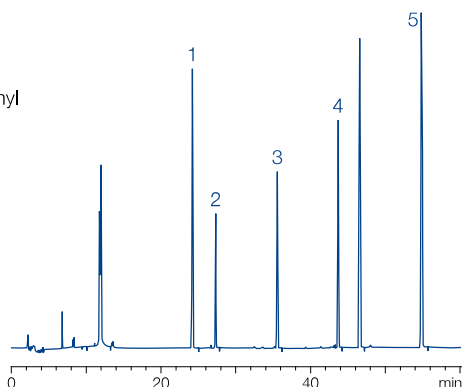
Analysis of a pesticide mixture

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. Bromopropylate



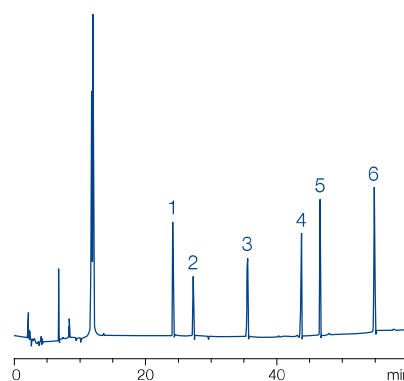
Analysis of a PCB mixture

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



Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



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 307

✓ Recommended application

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

✎ Temperature

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

Similar phases

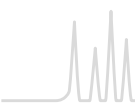
- VF-1301ms, Rxi®-1301Sil MS, TG-1301MS

Ordering information

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 303.



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

★ Key features

- Midpolar phase
- Structure see page 307

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

★ Key features

- Midpolar phase with low bleeding
- Structure see page 307

✓ Recommended application

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

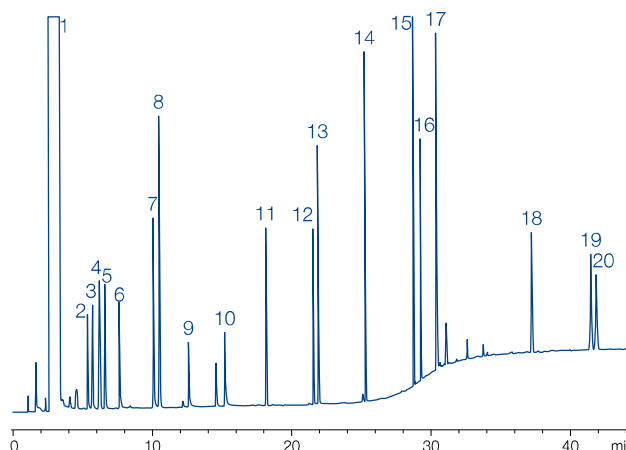
Solvents and semi-volatiles

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



Ordering information

	Length →			
	25 m	30 m	50 m	60 m
OPTIMA® 624				
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				
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 303.



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 307

✓ Recommended application

- Reference column for structure identification, e.g., in combination with OPTIMA® 5
- Film thickness $\geq 1 \mu\text{m}$ 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

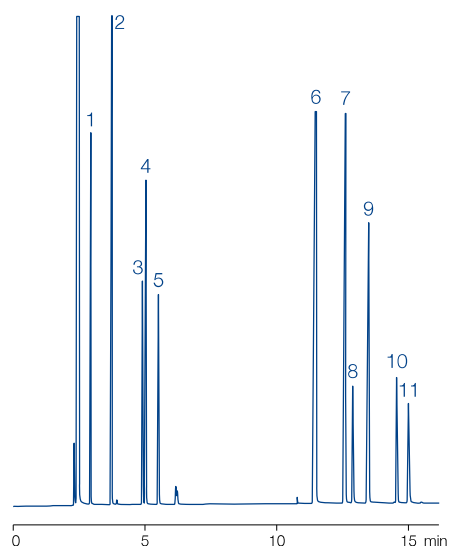
Analysis of aromatic hydrocarbons

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 $\rightarrow$ 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



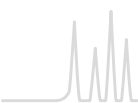
Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



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 307



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

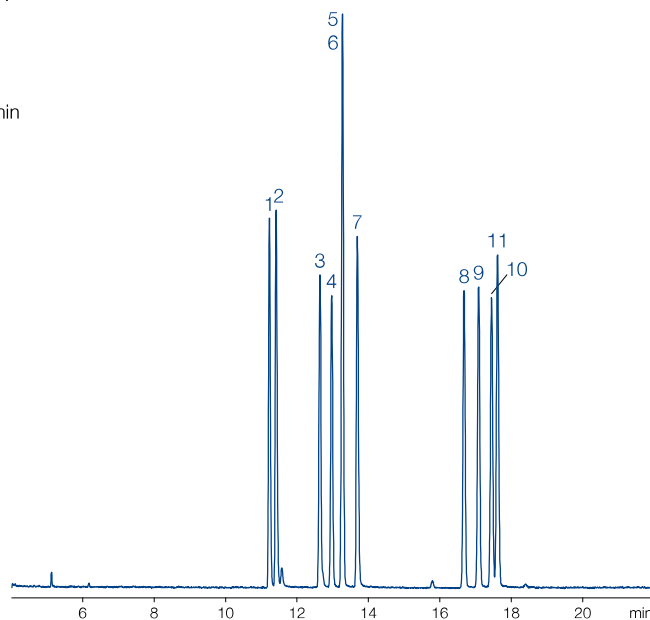
Separation of triazine pesticides (EPA 619)

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. Terbutylazine
7. Secbumeton
8. Prometryn
9. Ametryn
10. Simetryn
11. Terbutryn



Ordering information

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
1.00 µm film	726632.30	726632.60
0.32 mm ID (0.5 mm OD)		
0.25 µm film	726633.30	726633.60
0.50 µm film	726634.30	726634.60
1.00 µm film	726635.30	726635.60

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 303.



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 309

✓ 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

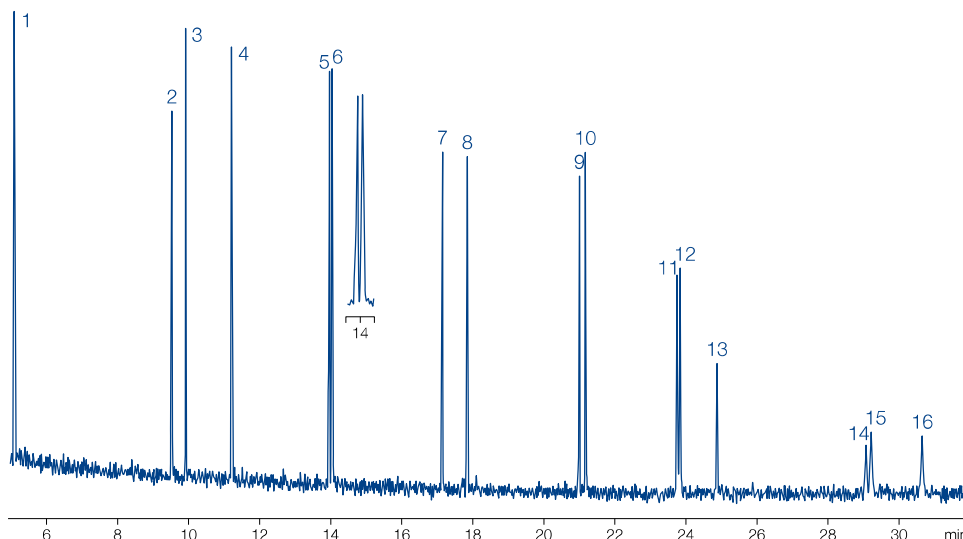
PAH in accordance with EPA 610

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 H₂
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. Dibenzo[a,h]anthracene
16. Benzo[ghi]perylene



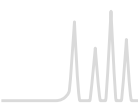
Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



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

★ Key features

- Midpolar phase
- Structure see page 309

✓ 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

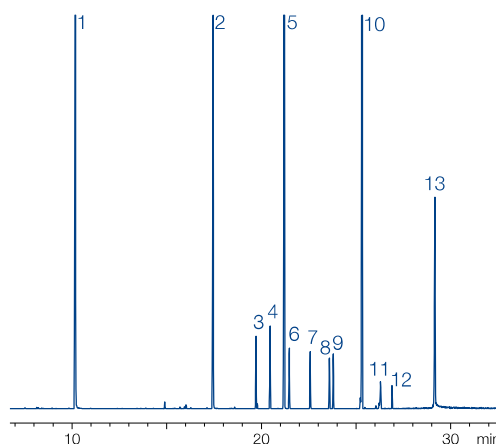
Analysis of pesticides

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 | 8. Captan |
| 2. Naled | 9. Folpet |
| 3. Vinclozolin | 10. Carbophenothion |
| 4. Chlorthalonil | 11. Iprodion |
| 5. Chlorpyrifos | 12. Captafol |
| 6. Dichlofuanid | 13. Coumaphos |
| 7. Procymidon | |



Ordering information

OPTIMA® 17

	Length →					
	10 m	12 m	15 m	25 m	30 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
0.25 µm film			726022.15	726022.25	726022.30	726022.50
0.50 µm film				726067.25	726067.30	726067.50
0.32 mm ID (0.5 mm OD)						
0.15 µm film					726755.30	
0.25 µm film				726351.25	726351.30	726351.50
0.35 µm film				726757.25	726757.30	726757.50
0.50 µm film				726744.25	726744.30	726744.50
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 303.



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 309

✓ 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

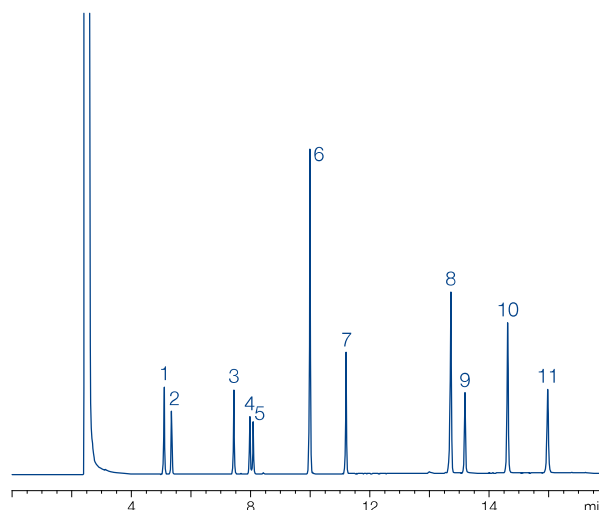
Analysis of phenols

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



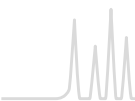
Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps

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

★ Key features

- Midpolar phase
- Structure see page 309

✓ 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

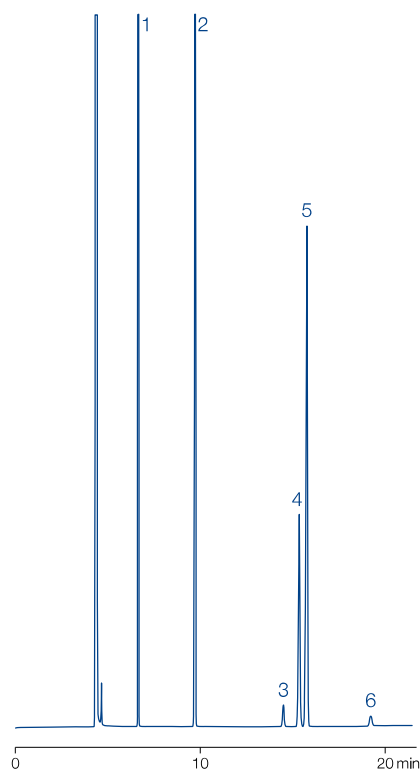
Aromatic hydrocarbons (BTX)

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 N₂ (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



Ordering information

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 303.



OPTIMA® · polar capillary columns



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

★ Key features

- Midpolar phase
- Structure see page 309

✓ 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 H₂

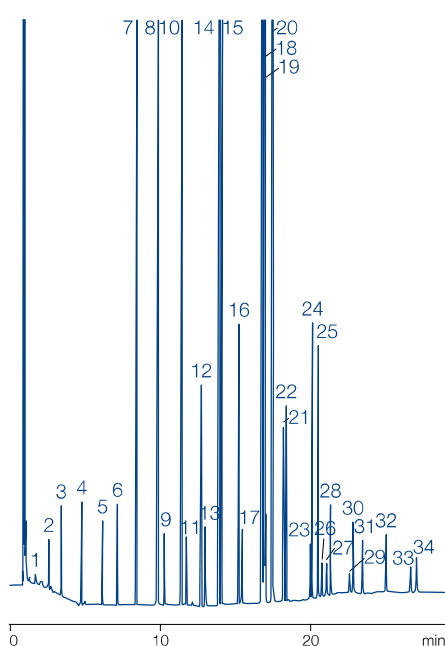
Temperature: 50 °C (2 min) → 125 °C, 30 °C/min → 160 °C, 5 °C/min → 180 °C, 20 °C/min → 200 °C, 3 °C/min → 220 °C, 20 °C/min (10 min)

Detector: FID 260 °C

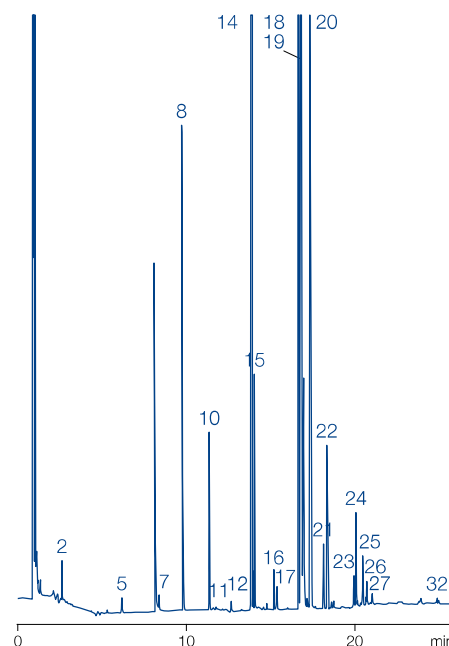
Peaks:

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

FAME Standard



FAME in porcine fat



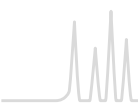
Courtesy of Dr. Bantleon, Mr. Leusche, Mr. Hagemann, VFG-Labor, Versmold, Germany

Ordering information

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 303.

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

★ Key features

- Midpolar phase
- Structure see page 309

✓ Recommended application

- FAMES, dioxins

✎ Temperature

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

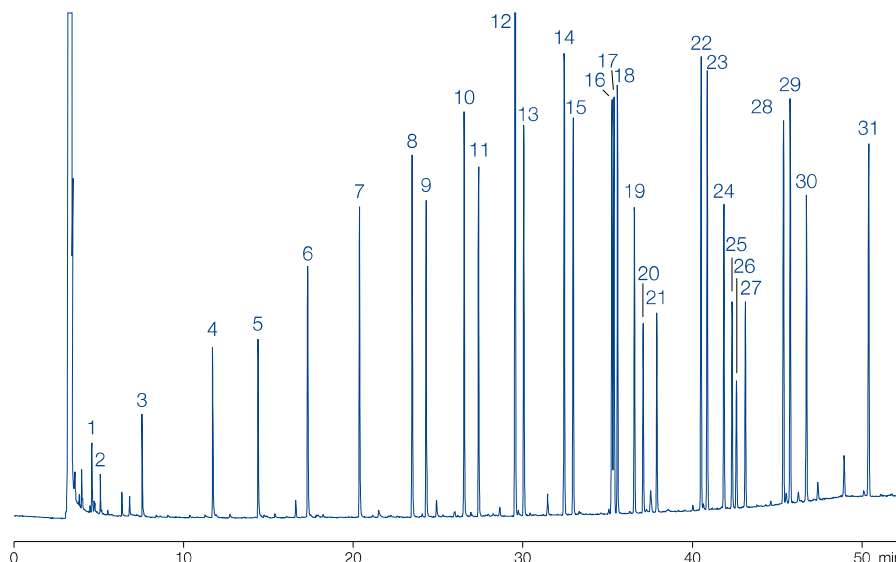
Fatty acid methyl esters *cis/trans* C18:1 (FAME)

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 H₂
Temperature: 80 °C → 120 °C, 20 °C/min → 260 °C (10 min), 3 °C/min
Detector: FID 280 °C

Peaks:

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



Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



OPTIMA® WAX polyethylene glycol 20 000 Da · USP G16

★ Key features

- Polar phase
- Structure see page 309

✓ 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 337), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

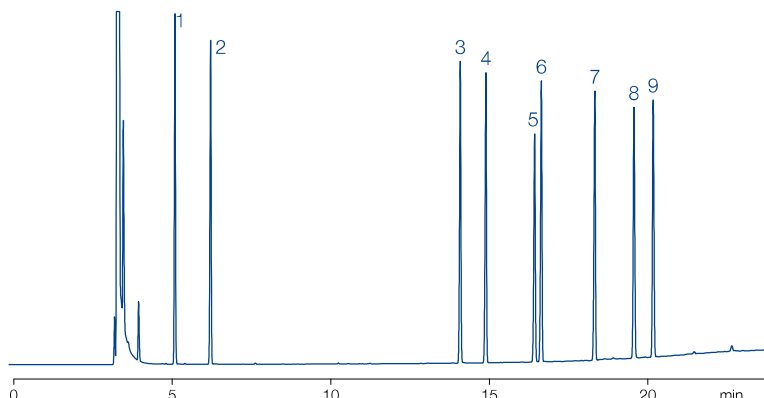
Modified Grob test

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



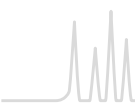
Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps

**OPTIMA WAXplus[®]** cross-linked polyethylene glycol · USP G16★ **Key features**

- Polar phase with improved cross-linking for lower column bleed and better temperature stability
- Structure see page 309

✓ **Recommended application**

- Broad range of application, e.g., for solvents and alcohols, suitable for aqueous solutions

✍ **Temperature**

- T_{max} 260 °C (long-term temperature),
T_{max} 270 °C (short-term max. temperature in a temperature program)

Similar phases

- DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

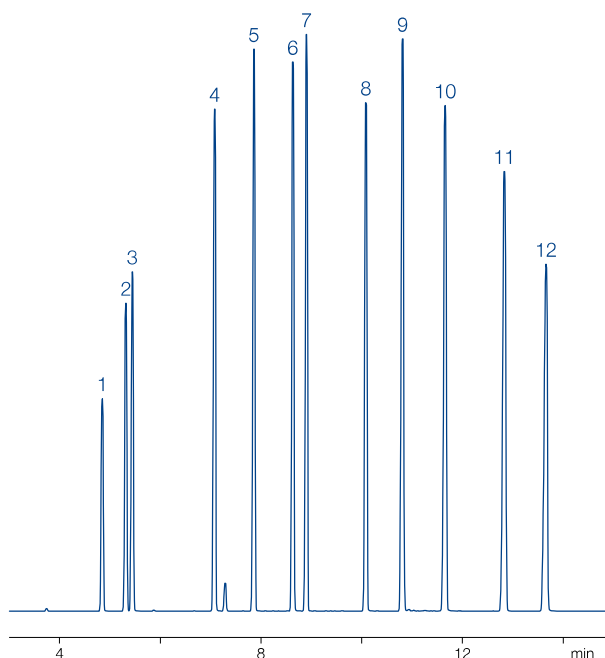
Alcohols

MN Appl. No. 214160

Column: OPTIMA WAXplus[®], 30 m x 0.25 mm ID, 0.5 µm film
Injection: 0.1 µL, split 1:80
Carrier gas: 1.3 bar He
Temperature: 40 °C → 260 °C, 12 °C/min (15 min)
Detector: FID 260 °C

Peaks:

1. Methanol
2. 2-Propanol
3. Ethanol
4. 1-Propanol
5. 2-Methyl-1-propanol
6. 1-Butanol
7. 4-Methyl-2-pentanol
8. 1-Pentanol
9. 2-Methyl-1-pentanol
10. 1-Hexanol
11. Cyclohexanol
12. 1-Heptanol

**Ordering information****OPTIMA WAXplus[®]**

	Length → 30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	726380.30	726380.60
0.50 µm film	726381.30	726381.60
0.32 mm ID (0.5 mm OD)		
0.25 µm film	726382.30	726382.60
0.50 µm film	726383.30	726383.60

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 303.



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 309



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 338), DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™, AT-1000, SPB-1000, BP21, OV-351

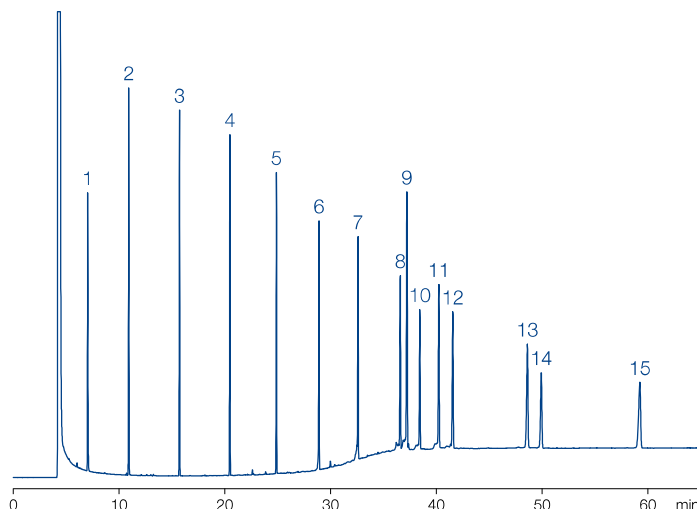
FAME test

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

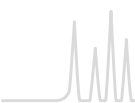


Ordering information

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 303.

OPTIMA[®] FFAPplus polyethylene glycol 2-nitroterephthalate · USP G35 / close equivalent to G25

★ Key features

- Polar phase
- Structure see page 309

✓ Recommended application

- FAMES, free carboxylic acids

✎ Temperature

- T_{max} 250 °C (long-term temperature),
T_{max} 260 °C (short-term max. temperature in a temperature program)

Similar phases

- DB-FFAP, HP-FFAP, CP-SIL 58 CB, 007-FFAP, CP-FFAP CB, Nukol[™]

FAMES from biodiesel

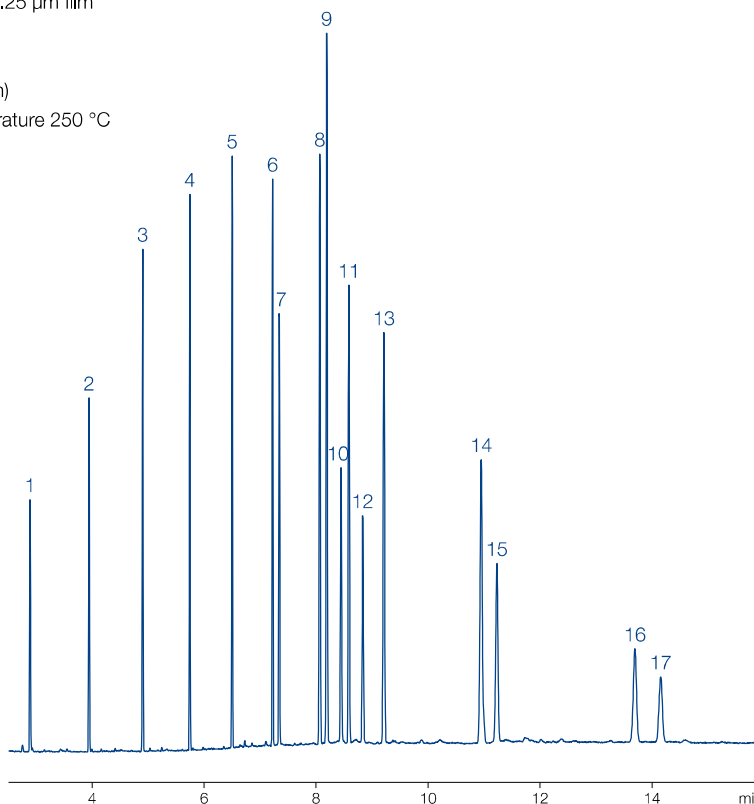
MN Appl. No. 214590

Column: OPTIMA[®] FFAPplus, 30 m x 0.25 mm ID, 0.25 µm film
Injection: 1 µL, 260 °C, split 1:15
Carrier gas: 40 cm/s He
Temperature: 70 °C (1 min) → 240 °C, 30 °C/min (10 min)
Detector: MS-EI, ion source 200 °C, interface temperature 250 °C

Peaks:

Methyl esters of:

1. Caproic acid (C6:0)
2. Caprylic acid (C8:0)
3. Capric acid (C10:0)
4. Lauric acid (C12:0)
5. Myristic acid (C14:0)
6. Palmitic acid (C16:0)
7. Palmitoleic acid (C16:1)
8. Stearic acid (C18:0)
9. Oleic acid (C18:1 *cis*)
10. Linoleic acid (C18:2 *cis*)
11. Nonadecanoic acid (C19:0)
12. Linolenic acid (C18:3)
13. Arachidic acid (C20:0)
14. Behenic acid (C22:0)
15. Erucic acid (C22:1 *cis*)
16. Lignoceric acid (C24:0)
17. Nervonic acid (C24:1 *cis*)



Ordering information

OPTIMA[®] FFAPplus

	Length → 30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	726241.30	726241.60
0.50 µm film	726242.30	726242.60
0.32 mm ID (0.5 mm OD)		
0.25 µm film	726243.30	726243.60
0.50 µm film	726246.30	726246.60

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



PERMABOND[®] SE-30 100 % dimethylpolysiloxane · USP G1 / G2 / G38

★ Key features

- Nonpolar phase

✎ Temperature

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

Similar phases

- OPTIMA[®] 1 (see page 310)

Ordering information

PERMABOND[®] SE-30

	Length → 25 m	50 m
0,25 mm ID (0,4 mm OD)		
0,25 µm film	723052,25	723052,50
0,32 mm ID (0,5 mm OD)		
0,25 µm film	723306,25	
0,50 µm film		723308,50

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 303.

PERMABOND[®] SE-52 5 % phenyl – 95 % dimethylpolysiloxane · USP G27

★ Key features

- Nonpolar phase

✎ Temperature

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

Similar phases

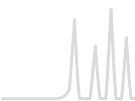
- OPTIMA[®] 5 (see page 314)

Ordering information

PERMABOND[®] SE-52

	Length → 25 m
0,25 mm ID (0,4 mm OD)	
0,25 µm film	723054,25
0,32 mm ID (0,5 mm OD)	
0,25 µm film	723310,25
0,50 µm film	723312,25

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 303.



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 332)

Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



PERMABOND[®] capillary columns



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 334)

Ordering information

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 303.

Further applications can be found online in our application database at www.mn-net.com/apps



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	340
Enantiomer separation cyclodextrin phases	FS-LIPODEX® A, FS-LIPODEX® B, FS-LIPODEX® C FS-LIPODEX® D, FS-LIPODEX® E, FS-LIPODEX® G	342
	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	344
Biodiesel		
Methanol analysis	OPTIMA® BioDiesel M	346
FAME analysis	OPTIMA® BioDiesel F	346
Glycerol and triglycerides	OPTIMA® BioDiesel G	346
Triglycerides		
	OPTIMA® 1-TG	348
	OPTIMA® 17-TG	348
High temperature GC		
	OPTIMA® 5 HT	349
Amines		
Polyfunctional amines	OPTIMA® 5 Amine	350
Amine separations	FS-CW 20 M-AM	351
Petrochemical products (complex hydrocarbon mixtures)		
	PERMABOND® P-100	352
Environmental analysis of volatile halogenated hydrocarbons		
	PERMABOND® SE-54 HKW	352
Silanes (monomeric, e.g., chlorosilanes)		
	PERMABOND® Silane	354
Diethylene glycol, e.g., for the quality control of wine		
	PERMABOND® CW 20 M-DEG	354



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

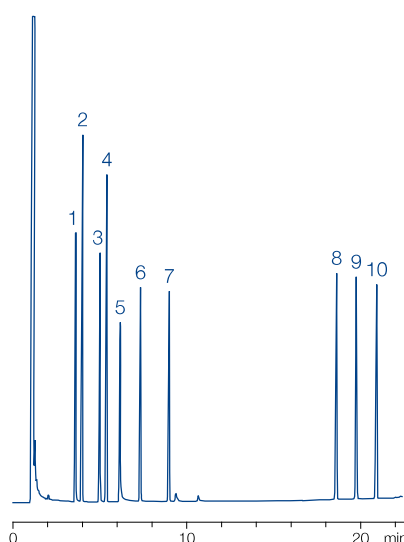
Comparison of a separation on a 50 m standard capillary with separation on a 10 m fast GC column
MN Appl. No. 211260

Peaks:

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

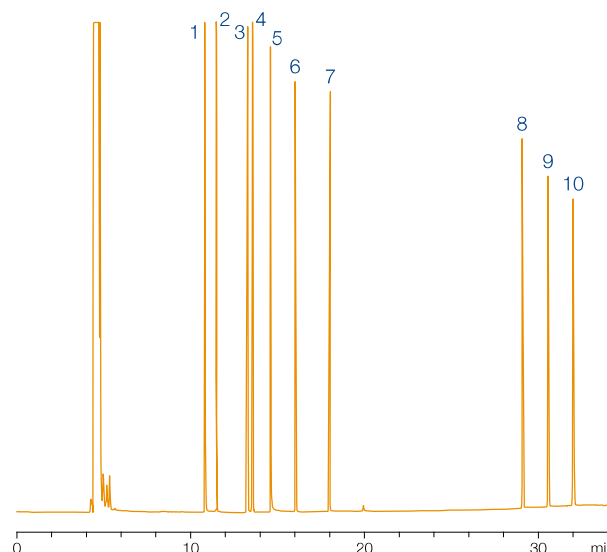
A) Fast GC column

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



Ordering information

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
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					

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 www.mn-net.com/apps



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 61)
- 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

Ordering information

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)

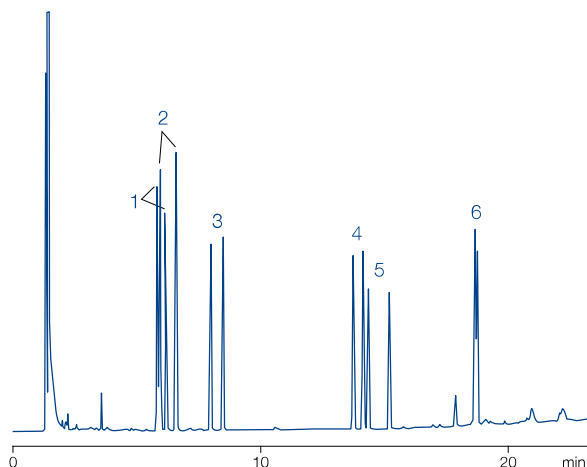
MN Appl. No. 202592

Column: FS-LIPODEX® E, 25 m x 0.25 mm ID
Injection: 1 µL, split ~ 1: 100
Carrier gas: 60 kPa H₂
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



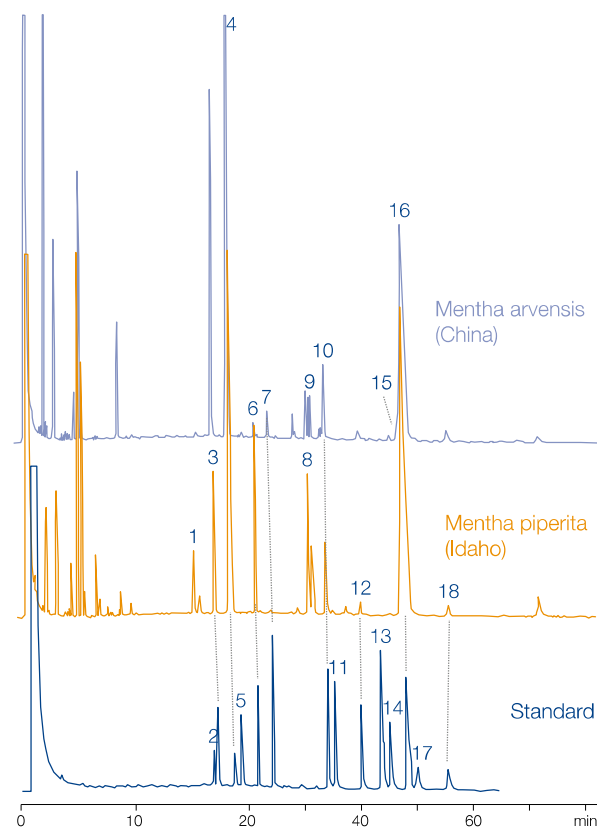
Separation of chiral constituents of peppermint oil

MN Appl. No. 250410

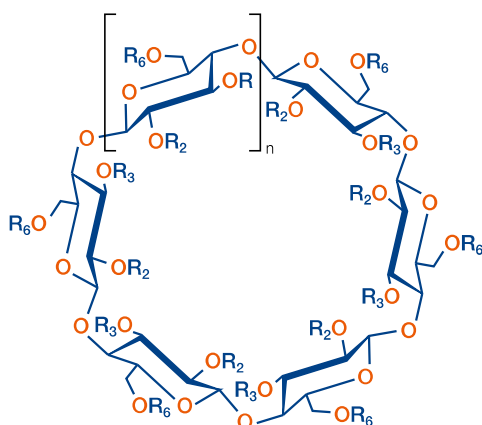
W.A. König et al., High Resol. Chromatogr. 20 (1997) 55–61
Column: FS-LIPODEX® G, 25 m x 0.25 mm ID
Carrier gas: 50 kPa H₂
Temperature: 75 °C, isothermal
Detector: FID

Peaks:

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



Cyclodextrin derivatives



Further applications can be found online in our application database at www.mn-net.com/apps



HYDRODEX cyclodextrin phases for enantiomer separation

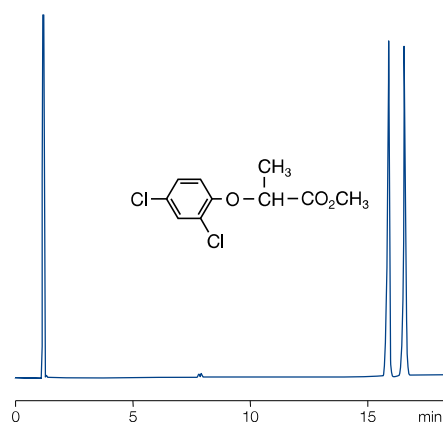
✓ Recommended application

- Cyclodextrin derivatives (see page 343) 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 μ L (~1 % in CH_2Cl_2), split 130 mL/min
Carrier gas: 60 kPa H_2 (1.9 mL/min)
Temperature: 160 $^\circ\text{C}$
Detector: FID 250 $^\circ\text{C}$



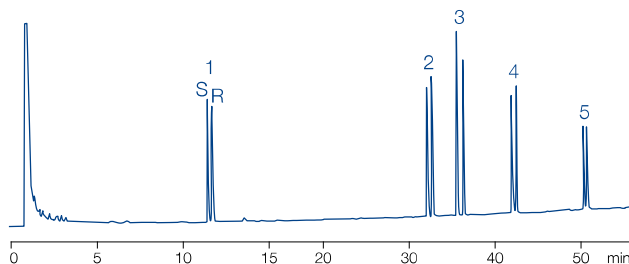
Separation of isomeric antiinflammatory drugs

MN Appl. No. 210150

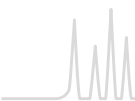
Courtesy of Prof. W.A. König, Hamburg, Germany
Column: FS-HYDRODEX β -6TBDM, 25 m x 0.25 mm ID
Carrier gas: He
Temperature: 135 $^\circ\text{C}$ $\rightarrow$ 200 $^\circ\text{C}$, 1 $^\circ\text{C}/\text{min}$
Detector: FID

Peaks:

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



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



Capillary columns for enantiomer separation



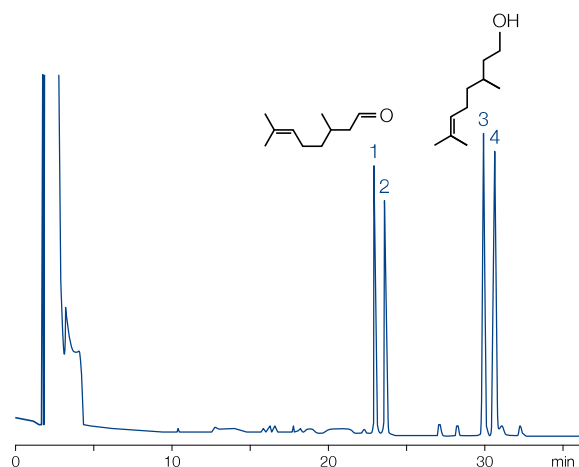
Separation of (R/S) citronellol + citronellal

MN Appl. No. 212440

Column: FS-HYDRODEX β -TBDAC, 50 m x 0.25 mm ID
 Injection: 1 μ L, 1:1000 in CH₂Cl₂, split 25 mL/min
 Carrier gas: 1.5 bar H₂
 Temperature: 100 °C
 Detector: FID 220 °C

Peaks:

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



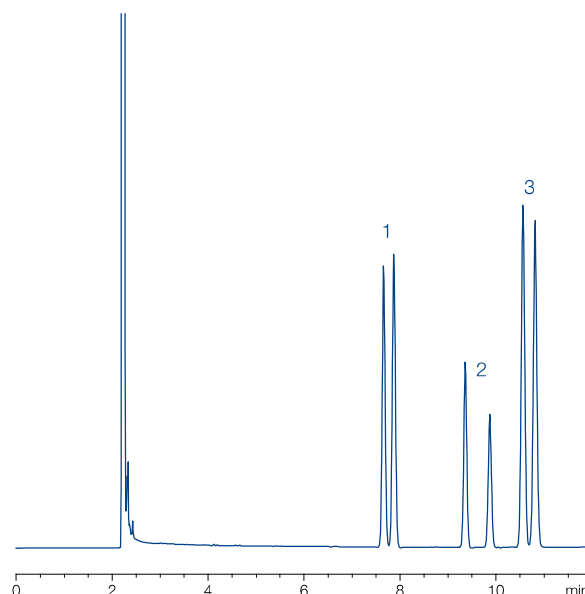
Separation of essential oils

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 H₂
 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)



Ordering information

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 www.mn-net.com/apps



Capillary columns for biodiesel analysis



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 (C₁₄) 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 C₆ (see application 214510 on opposite page). Change of the internal standard from C₁₇ to C₁₉ 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 363).

✎ 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 biodiesel analysis

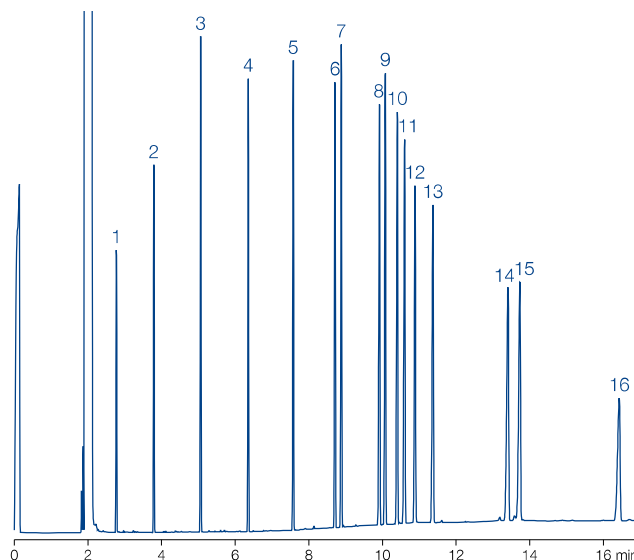
Analysis of FAMES from biodiesel in accordance with DIN EN 14103:2011

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



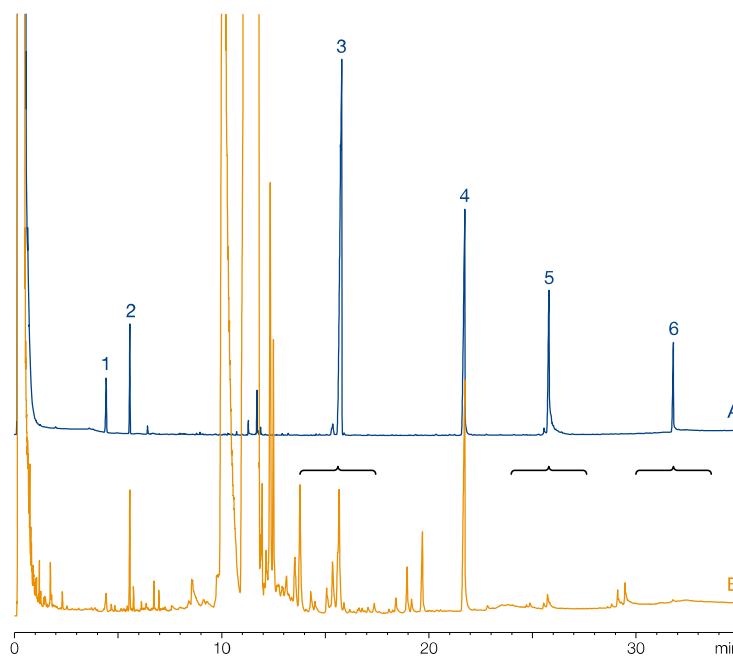
Analysis of glycerol and glycerides from biodiesel

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 H₂, 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 tricaprinate), IS |
| 5. Diolein = glycerol dioleate (TMS)
+ diacylglycerides |
| 6. Triolein = glycerol trioate (TMS)
+ triacylglycerides |



Ordering information

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

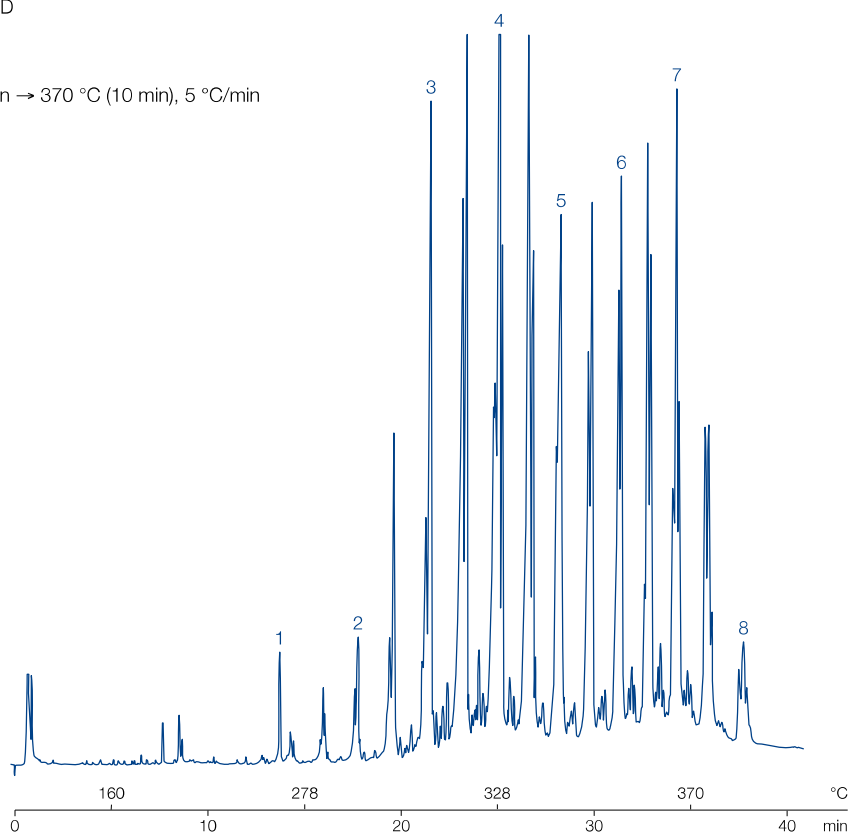
Triglycerides (from butter)

MN Appl. No. 201790

Column: OPTIMA® 1-TG, 25 m x 0.32 mm ID
Injection: 0.5 µL
Carrier gas: 80 kPa H₂
Temperature: 80 °C (1 min) → 250 °C, 20 °C/min → 370 °C (10 min), 5 °C/min
Detector: FID 380 °C

Peaks:

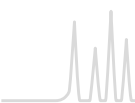
1. Cholesterol
2. T-30
3. T-34
4. T-38
5. T-42
6. T-46
7. T-50
8. T-54



Ordering information

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

✓ 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)

Similar phases

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

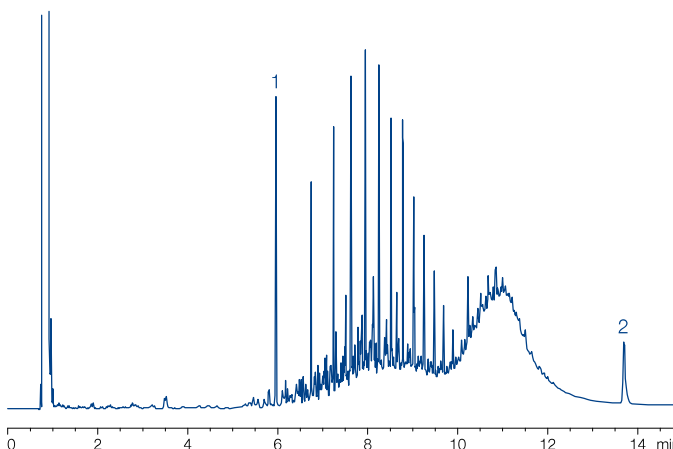
Separation of motor oil / mineral oil (type A + B), rapid determination in accordance with DIN H-53 / ISO DIS

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)



Ordering information

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 www.mn-net.com/apps



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)

✓ Recommended application

- Especially deactivated for the analysis of polyfunctional amines such as ethanalamines, 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)

Similar phases

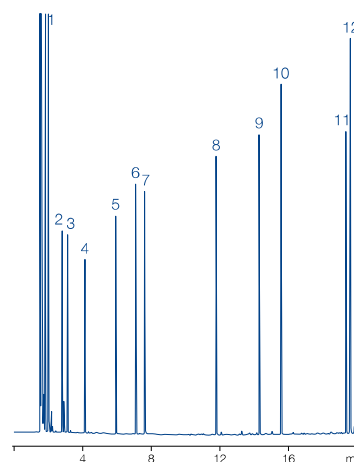
- Rtx®-5 Amine, PTA-5

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 H₂
Temperature: 100 °C (3 min) → 280 °C, 10 °C/min
Detector: FID 280 °C

Peaks:

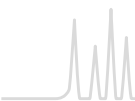
- | | |
|-------------------------------|-------------------------------|
| 1. Diethylamine | 7. Di-isobutylamine |
| 2. Di-isopropylamine | 8. Tri- <i>n</i> -butylamine |
| 3. Triethylamine | 9. Di-isohexylamine |
| 4. Di- <i>n</i> -propylamine | 10. Dicyclohexylamine |
| 5. Di- <i>n</i> -butylamine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



Ordering information

OPTIMA® 5 Amine

	Length →	
	10 m	25 m
0.1 mm ID (0.4 mm OD)		30 m
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

Ordering information

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 www.mn-net.com/apps



MACHEREY-NAGEL CHROMAFIL® syringe filters

Ideal for the filtration of GC, HPLC and UHPLC sample solutions

- Diverse membrane types and filter sizes for a variety of applications
- Optimal flow geometry because of star-shaped distribution device
- Lowest content of extractable substances
- Luer lock inlet, Luer outlet
- Prefiltration of solvents protects sensitive instrument parts and chromatography columns from solid contamination and increases their lifetime.

Find CHROMAFIL® products from page 81 onwards.





Capillary columns for hydrocarbons



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)

Ordering information

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

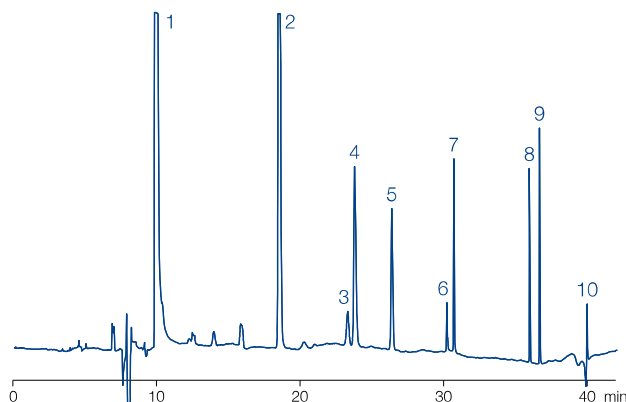
Volatile halogenated hydrocarbons

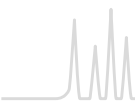
MN Appl. No. 212480

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

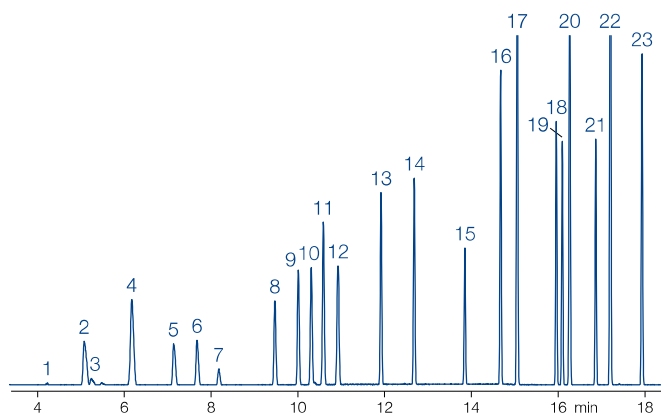
Carrier gas: 0.9 mL/min He (constant flow)

Temperature: 40 °C (5 min) → 160 °C, 10 °C/min

Detector: MSD 5971

Peaks:

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



Ordering information

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 www.mn-net.com/apps



Capillary columns for silane · DEG



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.

Ordering information

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	

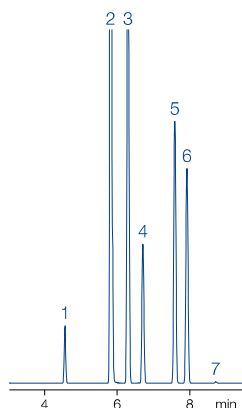
Chloromethylsilanes

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



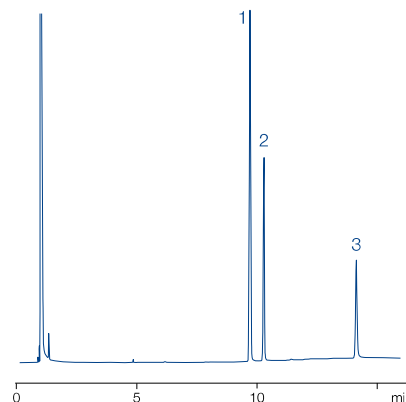
Diethylene glycol standard in wine

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 N₂
 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

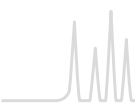
- $T_{\max}$ 220 °C (long-term temperature), $T_{\max}$ 240 °C (short-term max. temperature in a temperature program)

Ordering information

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 www.mn-net.com/apps



Untreated capillaries

✓ Recommended application

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

Ordering information

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

Ordering information

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:

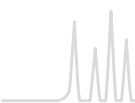
- Calculation example: length of flooded zone ~ 20–30 cm/μL, retention gap 10 m x 0.32 mm ID, capillary column: 25 m x 0.32 mm ID, max. injection volume ~ 30–50 μL
- A retention gap must be inert without any noticeable retention: Me-Sil retention gaps are more inert than Phe-Sil, while Phe-Sil is less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

Ordering information

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.



Derivatization reagents

★ Key features

- Derivatization reagents:
To improve volatility, increase thermal stability or to achieve 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, allow the specific detection in an ECD with the advantage of high sensitivity.
- Specific derivatizations may influence elution orders and fragmentation patterns in a MS
- We provide reagents for
 - acylation
 - alkylation (methylation)
 - silylation
- For 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure

Ordering information

Derivatization method development kits*

Designation	Contents of the kit	REF
Which type of derivatization is suited best for your sample (alkylation, acylation or silylation)?	2 x 1 mL each of TMSH, MSTFA, MBTFA	701952
Acylation kit		
Which is the proper reagent for acylation?	2 x 1 mL each of MBTFA, TFAA, MBHFBA	701950
Alkylation kit		
Which is the proper reagent for methylation?	3 x 1 mL each of TMSH, DMF-DMA	701951
Silylation kit		
Which is the proper reagent for silylation?	2 x 1 mL each of MSTFA, BSTFA, TSIM, MSHFBA	701953

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

Selection guide for derivatization of important functional groups in GC

Function	Method	Derivative	Recommended reagents
alcohols, phenols R'OH	silylation	R'O-TMS	BSA, MSTFA, MSHFBA, TSIM, SILYL-2110, SILYL-21, SILYL-1139
	acylation	R'O-CO-R	TFAA, HFBA, MBTFA, MBHFBA
	alkylation	R'O-R	TMSH
sterically hindered	silylation	R'O-TMS	TSIM, BSTFA, SILYL-991
amines primary, secondary	silylation	R'-NR''-TMS	BSA, MSTFA, MSHFBA, SILYL-991
hydrochlorides	acylation	R'-NR''-CO-R	TFAA, HFBA, MBTFA, MBHFBA
	silylation	R'-NR''-TMS	MSTFA
amides	silylation	not stable	
	acylation	R'-CO-NH-CO-R	TFAA, MBTFA, HFBA, MBHFBA
amino acids	silylation	R'-CH(NH-TMS)-CO-O-TMS	BSA, BSTFA, MSTFA, MSHFBA
	alkylation (a)	R'-CH(NH-CO-R)-CO-O-R	a) MeOH/TMCS, TMSH
	+ acylation (b)		b) TFAA, HFBA, MBTFA, MBHFBA
Carboxylic acids (fatty acids)	silylation	R'-CO-O-TMS	BSA, MSTFA, MSHFBA, TMCS, TSIM, SILYL-2110, SILYL-21, Silyl-1139
	alkylation	R'-CO-O-R	DMF-DMA, MeOH/TMCS (1 M), TMSH
salts	silylation	R'-CO-O-TMS	TMCS
		susceptible to hydrolysis	
carbohydrates	silylation		MSTFA, TSIM, HMDS, SILYL-1139
	acylation		TFAA, MBTFA
steroids	silylation		BSA, TSIM
	acylation		TFAA, MBTFA, HFBA, MBHFBA

These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

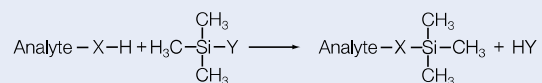
Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps (exception DMCS and TMCS with screw closure). Vials with pierced sealing disks have limited stability and should be used soon.

The derivatization procedures can be found on page 367.



General reaction mechanisms

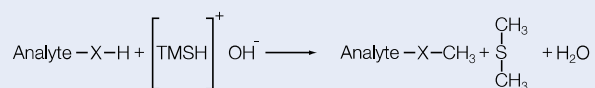
Silylation



X = e.g., O, S, COO, etc.

Y = rest of silylation reagents

Alkylation (Methylation) · example TMSH



X = e.g., O, S, COO, etc.

Acylation



X = e.g., O, S, NH, etc.

Y = rest of acylation reagents

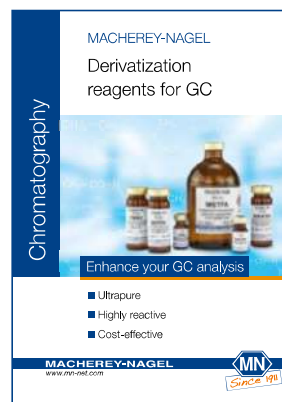


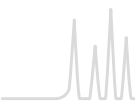
MACHEREY-NAGEL derivatization reagents for GC

Content of brochure

- Product range for acylation, alkylation and silylation reagents
- Protocols for derivatization
- Diverse tips and hints

Order now your derivatization brochure KATEN200144





Acylation reagents

Acyl halides

★ Key features

- By-product of acylation with acyl halides: corresponding hydrohalic acids excess of reagent and acid have to be removed or trapped by a suitable base (e.g., pyridine)
- Pentafluorobenzoyl chloride
PFBC: $\text{C}_6\text{F}_5-\text{CO}-\text{Cl}$
M 230.52 g/mol, Bp 158–159 °C (760 mm Hg),
Density $d_{20^\circ/4^\circ} = 1.601$

Anhydrides

★ Key features

- By-products of acylation with anhydrides: corresponding acids excess reagent and the acid formed are to be removed
- Trifluoroacetic acid anhydride TFAA: $\text{CF}_3-\text{CO}-\text{O}-\text{CO}-\text{CF}_3$
M 210.04 g/mol, Bp 39.5–40.5 °C (760 mm Hg),
Density $d_{20^\circ/4^\circ} = 1.490$
- Heptafluorobutyric acid anhydride
HFBA: $\text{C}_3\text{F}_7-\text{CO}-\text{O}-\text{CO}-\text{C}_3\text{F}_7$
M 410.06 g/mol, Bp 106–107 °C (760 mm Hg),
Density $d_{20^\circ/4^\circ} = 1.665$

Bisacylamides

★ Key features

- By-products: corresponding neutral acylamides: high volatility
- Easily removed; due to the neutral conditions and their favorable chromatographic characteristics, the removal of surplus bisacylamides and their by-products is often not necessary. Therefore, the sample preparation is much easier.
- *N*-methyl-bis(trifluoroacetamide)
MBTFA: $\text{CF}_3-\text{CO}-\text{N}(\text{CH}_3)-\text{CO}-\text{CF}_3$
M 223.08 g/mol, Kp 123–124 °C (760 mm Hg),
Density $d_{20^\circ/4^\circ} = 1.55$
- *N*-methyl-bis(heptafluorobutyramide)
MBHFBA: $\text{C}_3\text{F}_7-\text{CO}-\text{N}(\text{CH}_3)-\text{CO}-\text{C}_3\text{F}_7$
M 423.1 g/mol, Kp 165–166 °C (760 mm Hg),
Density $d_{20^\circ/4^\circ} = 1.673$



Methods for acylation

Acylation with fluorinated acid anhydrides (TFAA, HFBA)

- Applicable for alcohols, phenols, carboxylic acids, amines, amino acids and steroids, stable derivatives for FID or ECD detection
- Procedure see page 367 or online at www.mn-net.com/apps
TFAA: MN Appl. Nr. 213041
HFBA: MN Appl. Nr. 213042

Acylation with fluorinated acid amides (MBTFA, MBHFBA)

- Recommended for alcohols, primary and secondary amines as well as for thiols under mild, neutral conditions
- MBTFA also forms very volatile derivatives with carbohydrates [17].
- Procedure see page 367 or online at www.mn-net.com/apps
MBTFA: MN Appl. Nr. 213051
MBHFBA: MN Appl. Nr. 21305

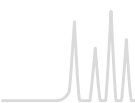
Ordering information

Acylation reagents*

Substance	Packing unit			
	10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL
HFBA		701110.201	701110.110	701110.510
MBTFA		701410.201	701410.110	701410.510
MBHFBA	701420.101	701420.201		
PFBC	701120.101			
TFAA			701130.110	701130.510

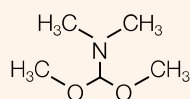
* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.



Alkylation / methylation reagents

DMF-DMA *N,N*-dimethylformamide dimethylacetal

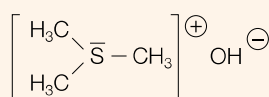


- M 119.17 g/mol,
Kp 106–107 °C (760 mm Hg),
Density d_{20°/4°} = 0.897

★ Key features

- Methylation reagents

TMSH (0.2 mol/L in methanol) Trimethylsulfonium hydroxide



- M 94.06 g/mol

★ Key features

- Methylation reagents

Methods for alkylation / methylation

Methylation with TMSH

- Suited for free acids, chlorophenoxy-carboxylic acids, their salts and derivatives as well as for phenols and chlorophenols [18]
- The great advantage is the simplification of the sample preparation. Lipids or triglycerides can be converted to the corresponding fatty acid methyl esters (FAMES) by simple transesterification.
- This reaction is very elegant and convenient, because it is only necessary to add the reagent (0.2 mol/L in methanol) to the sample solution. Removal of surplus reagent is not required, since at 250 °C inside the injector of the gas chromatograph, TMSH will pyrolyze solely to volatile methanol and dimethylsulfide. Due to high reactivity, a complete conversion is usually obtained at ambient temperature. Heating (e.g., 10 min at 100 °C) in a closed sample vial may be necessary, however.
- Procedure see page 367 or online at www.mn-net.com/apps
MN Appl. Nr. 213060

Methylation with DMF-DMA

- Applicable for fatty acids, primary amines and (partially) amino acids, under formation of *N*-dimethyl-aminomethylene amino acid methyl esters [19]
- Since DMF-DMA is a poor solvent, it is essential to use a mixture of DMF-DMA with pyridine, THF, acetone (barbiturates) or another solvent.
- Procedure see page 367 or online at www.mn-net.com/apps
MN Appl. Nr. 213070

Methylation with methanol – TMCS (1 M)

- Suited for the esterification of free carboxylic acids and the transesterification of glycerides. Formation of HCl catalyzes the reaction. TMCS, resp. silyl ethers remove the water and thus drive the reaction to completion. The mixture should be freshly prepared.
- Procedure see page 367 or online at www.mn-net.com/apps
MN Appl. Nr. 213080

For GC separation of FAMES from natural butter fat after derivatization with TMSH see Appl. 201680 at www.mn-net.com/apps

Ordering information

Alkylation reagents*

Substance	Packing unit			
	10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL
DMF-DMA		701430.201	701430.110	
TMSH	701520.101	701520.201	701520.110	701520.510

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.



Silylation reagents

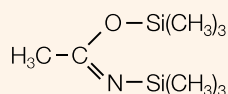
The most common form of silylation in GC is the replacing of active hydrogen atoms with a trimethylsilyl group (TMS derivative). Less frequently, trialkylsilyl groups or dimethylsilyl groups with longer alkyl chains are also in use. The alkylsilyl group increases volatility and enhances thermal stability of the sample.

Silylation can be catalyzed either acidic by addition of TMCS or basic by addition of pyridine or TSIM (e.g., for sterically hindered functionalities like tert. alcohols).

Reactivity of silylation reagents (acc. to M. Donike): TMS amide (e.g., BSA, MSTFA) > TMS amine = TSIM > Enol-O-TMS ether > S-TMS ether > O-TMS ether > TMS-O-TMS

Stability of the TMS derivatives: O-TMS ether > S-TMS ether > Enol-O-TMS ether > TMS amine > TMS amide

BSA *N,O*-bis-trimethylsilyl-acetamide



• M 203.4 g/mol,
Bp 71–73 °C (35 mm Hg),
Density $d_{20^\circ/4^\circ} = 0.832$

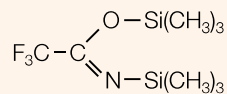
★ Key features

- Strong silylation reagent
- Not recommended for use with carbohydrates or very low molecular weight compounds
- Good solvent for polar compounds, but frequently used in combination with a solvent (pyridine, DMF etc.) or with other silylation reagents. Dissolved in DMF, BSA is the prime derivatization reagent for phenols.

✓ Recommended application

- Alcohols, amines, carboxylic acids, phenols, steroids, biogenic amines and alkaloids are derivatized to stable TMS derivatives

BSTFA *N,O*-bis-trimethylsilyl-trifluoroacetamide



• M 257.4 g/mol,
Bp 40 °C (12 mm Hg),
Density $d_{20^\circ/4^\circ} = 0.961$

★ Key features

- Powerful trimethylsilyl donor with approx. the same donor strength as the nonfluorinated analog BSA
- Advantage of BSTFA over BSA: greater volatility of its reaction products, particularly useful for GC analysis of low boiling TMS amino acids

- BSTFA is nonpolar (less polar than MSTFA) and can be mixed with acetonitrile for improved solubility. For the silylation of fatty acid amides, hindered hydroxyl groups and other difficult to silylate compounds, e.g., secondary alcohols and amines, we recommend BSTFA + 1 % trimethylchlorosilane (TMCS), available under the designation Silyl-991 (see page 366).

Silylation with BSA, BSTFA or Silyl-991 (BSTFA + 1 % TMCS)

- Procedure see page 367 or online at www.mn-net.com/apps
BSA MN Appl. Nr. 213091
BSTFA MN Appl. Nr. 213092
Silyl-991 MN Appl. Nr. 213093

Silylation with BSA in combination with other silylation reagents

- Procedure see page 367 or online at www.mn-net.com/apps
MN Appl. Nr. 213100



Reagents / methods for silylation

Ordering information

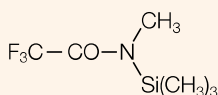
Silylation reagents*

Substance	Packing unit				
	20 x 1 mL	1 x 10 mL	5 x 10 mL	1 x 50 mL	1 x 100 mL
BSA		701210.110	701210.510	701210.150	
BSTFA					
	701220.201	701220.110	701220.510		
SILYL-991 – (BSTFA – TMCS (99:1))					
	701490.201			701490.150	701490.1100

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

MSTFA *N*-methyl-*N*-trimethylsilyl-trifluoroacetamide



- M 199.1 g/mol,
Bp 70 °C (75 mm Hg),
Density d_{20°/4°} = 1.11

★ Key features

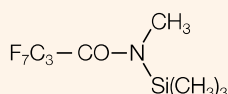
- The most volatile trimethylsilyl amide available, very strong TMS donor which does not cause noticeable FID fouling even during long-time measuring series

✓ Recommended application

- Carboxylic acids, hydroxy and ketocarboxylic acids, amino acids, amines, alcohols, polyalcohols, sugars, mercaptans and similar compounds with active hydrogen atoms. Even amine hydrochlorides can be silylated directly.

- The addition of protic solvents in submolar quantities, e.g., TFA for extremely polar compounds (hydrochlorides) or pyridine for carbohydrates, can improve the already good dissolving power of MSTFA.
- Advantages: complete conversion with high reaction rates, even without a catalyst (1–2 % TMCS or TSIM); the by-product of the reaction (*N*-methyltrifluoroacetamide) shows a high volatility and a short retention time

MSHFBA *N*-methyl-*N*-trimethylsilyl-heptafluorobutyramide



- M 299.1 g/mol,
Bp 148 °C (760 mm Hg)

★ Key features

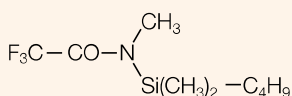
- Similar to MSTFA in reactivity and chromatography
- Either applied alone or in combination with a catalyst (TMCS, TSIM) or another silylation reagent with or without solvent; the by-product *N*-methylheptafluorobutyric amide has a lower retention time than the silylating reagent

✓ Recommended application

- Carboxylic acids, alcohols, phenols, primary and secondary amines and amino acids

- Especially useful for flame ionization detection due to the large ratio of fluorine to silicon of 7:1, since degradation of the surplus MSHFBA does not produce SiO₂ but volatile, non-corrosive silicon compounds

MBDSTFA *N*-methyl-*N*-*tert*-butyldimethylsilyl-trifluoroacetamide

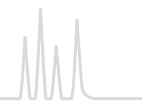


- M 241.3 g/mol,
Bp 170 °C (760 mm Hg),
Density d_{20°/4°} = 1.121

★ Key features

- Silylation reagent that donates a *tert*-butyldimethylsilyl group (TBDMS) for derivatizing active hydrogen atoms in hydroxyl, carboxyl and thiol groups as well as primary and secondary amines
- Fast reactions (typically 5–20 min) with high yields (> 96 %), by-products are neutral volatiles

- TBDMS ethers are 10⁴ times more stable than the corresponding TMS ethers
- Due to the large protecting group, chromatographic retention times are longer. This may have a beneficial impact on some separations. The high concentration of M⁺-57 ions is an interesting topic for GC/MS.



Silylation with MSTFA, MSHFBA or MBDSTFA

• Procedure see page 367 or online at www.mn-net.com/apps

MSTFA MN Appl. Nr. 213111 • MSHFBA MN Appl. Nr. 213112 • MBDSTFA MN Appl. Nr. 213113

Ordering information

Silylation reagents*

Substance	Packing unit						
	10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL	1 x 100 mL	6 x 50 mL	6 x 100 mL
MSTFA		701270.201	701270.110	701270.510	701270.1100	701270.650	701270.6100
MSHFBA		701260.201	701260.110	701260.510	701260.1100		701260.6100
MBDSTFA	701440.101	701440.201					

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

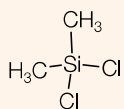


Ultrapure derivatization reagents for acylation, alkylation and silylation.



Reagents / methods for silylation

DMCS Dimethyldichlorosilane

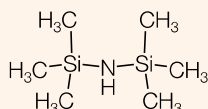


- M 129.06 g/mol,
Bp 70 °C (760 mm Hg),
Density d_{20°/4°} = 1.07

★ Key features

- Used to form dimethylsilyl (DMS) derivatives
- DMS derivatives are much more susceptible to hydrolysis than TMS derivatives, it is therefore vital to have strictly anhydrous conditions during the conversion.

HMDS Hexamethyldisilazane

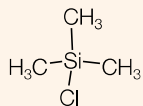


- M 161.4 g/mol,
Bp 126 °C (760 mm Hg),
Density d_{20°/4°} = 0.7742

★ Key features

- Weak TMS donor; used as a sole reagent, it is slow and not very effective.
- Aprotic solvents like acetonitrile, pyridine, dimethylformamide, carbon disulfide and dimethylacetamide recommend themselves for use with HMDS.
- With catalytic quantities, e.g., 1 % of, or as a mixture with TMCS (2:1, v/v; SILYL-21 and SILYL-2110) it is perfectly suited for a quick and quantitative trimethylsilylation of organic compounds.

TMCS Trimethylchlorosilane

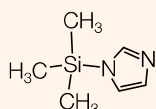


- M 108.7 g/mol,
Bp 57 °C (760 mm Hg),
Density d_{20°/4°} = 0.8580

★ Key features

- Often used as a catalyst with other trimethylsilyl reagents
- As a sole reagent, it can be used to prepare TMS derivatives of organic acids.

TSIM N-trimethylsilyl-imidazole



- M 140.3 g/mol,
Bp 94–96 °C (760 mm Hg),
Density d_{20°/4°} = 0.961

★ Key features

- Strongest hydroxyl silylator
- It is remarkable that TSIM reacts quickly and smooth with hydroxyl (even tert. OH) and carboxyl groups, but not with amines. Hence it is especially suited for multiple derivatizations, when compounds with various functional groups are to be derivatized in different ways (e.g., -O-TMS, -N-HFB derivatives of catecholamines).

✓ Recommended application

- Alcohols, phenols, organic acids, steroids, hormones, glycols, nucleotides, narcotics
- Reagent of choice for carbohydrates and most steroids (even strongly hindered steroids)

Silylation with TSIM or SILYL-1139 (TSIM – pyridine 11:39)

- Procedure see page 367 or online at www.mn-net.com/apps
TSIM: MN Appl. Nr. 213121
SILYL-1139: MN Appl. Nr. 213122



Reagents / methods for silylation



Ordering information

Silylation reagents*

Substance	Packing unit			
	20 x 1 mL	1 x 10 mL	5 x 10 mL	6 x 50 mL
DMCS				701230,650
HMDS			701240,510	701240,650
TMCS	701280,201			701280,650
TSIM	701310,201	701310,110	701310,510	

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

Ordering information

Reagent mixtures for silylation*

Mixture	Composition	Packing unit				
		20 x 1 mL	1 x 10 mL	5 x 10 mL	1 x 50 mL	1 x 100 mL
SILYL-271	BSA - HMDS - TSIM (2:7:1)	701450,201	701450,110	701450,510		
SILYL-1139	TSIM - Pyridine (11:39)	701460,201				
SILYL-21	HMDS - TMCS (2:1)	701470,201				
SILYL-2110	HMDS - TMCS - Pyridine (2:1:10)	701480,201				
SILYL-991	BSTFA - TMCS (99:1)	701490,201			701490,150	701490,1100

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

On request for 1 x 10 mL, 1 x 50 mL and 6 x 50 mL also available with screw closure.

Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps (exception DMCS and TMCS with screw closure). Vials with pierced sealing disks have limited stability and should be used soon.

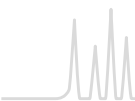
Silylation with SILYL-21 or SILYL-2110

- Recommended applications: sugars, glycols, sterically unhindered alcohols, carboxylic acids, acids in urine, hydroxy fatty acids, nucleotides, steroids, vitamin D, xanthone derivatives
 - Procedure see page 367 or online at www.mn-net.com/apps
- SILYL-21 MN Appl. Nr. 213131
SILYL-2110 MN Appl. Nr. 213132

O-trimethylsilylation with MSTFA followed by N-trifluoroacetylation with MBTF

- Procedure see page 367 or online at www.mn-net.com/apps
- MSTFA/MBTFA MN Appl. Nr. 213140





Acylation

with fluorinated acid anhydrides · TFAA MN Appl. No. 213041 · HFBA MN Appl. No. 213042

Dissolve 0.1 to 1 mg sample in 0.1 mL solvent, add 0.1 mL of the anhydride and heat to 60–70 °C for 1–2 h. If the sample needs not be concentrated prior to the analysis and if there is no danger of catalytically induced side reactions, pyridine is used as solvent. The reaction solution can be injected directly into the gas chromatograph. Otherwise, use a volatile solvent and evaporate solvent, excess reagent and free acid in a stream of nitrogen. Dissolve residue in 50 µL hexane, chloroform etc. and inject aliquot portions.

with fluorinated acid amides · MBTFA MN Appl. No. 213051 · MBHFBA MN Appl. No. 213052

Add 0.5 mL MBTFA or MBHFBA to about 2 mg sample. If there is no reaction at ambient temperature, heat the reaction mixture to 120 °C. Compounds difficult to dissolve, can be trifluoroacetylated in suitable solvent mixtures. It is recommended to use a ratio of solvent to MBTFA or MBHFBA of 4:1. The reaction mixture is chromatographed directly.

Alkylation (Methylation)

with TMSH · MN Appl. No. 213060

Dissolve 100 mg sample (e.g., butter) in 5 mL of a solvent (e.g., *tert.*-butyl methyl ether). Add 50 µL reagent to 100 µL of this solution. The mixture is injected directly. The temperature of the injector must be at least 250 °C.

with DMF-DMA · MN Appl. No. 213070

Add 1 mL of a mixture of DMF-DMA and pyridine (1:1) to 1–50 mg fatty acids. The sample can be injected as soon as a clear solution has formed. It is recommended, however, to heat the solution to 60–100 °C for 10–15 min.

with methanol – TMCS · MN Appl. No. 213080

Add 1 mL methanol – TMCS to about 50 mg carboxylic acid or glyceride and heat. Then evaporate in a stream of nitrogen and dissolve again for injection in, e.g., *n*-heptane.

Silylation

with BSA, BSTFA oder Silyl-991 (BSTFA + 1 % TMCS)

BSA MN Appl. No. 213091 · BSTFA MN Appl. No. 213092 Silyl-991 MN Appl. No. 213093

Add 0.5 mL of the silylation reagent to 1–10 mg sample; if necessary, add some solvent (normally pyridine or DMF [dimethylformamide]). Heat to 60–80 °C for 20 min to increase the reaction rate. 1–2 drops of TMCS (trimethylchlorosilane) or TSM will also speed up the reaction.

with BSA in combination with other silylation reagents · MN Appl. No. 213100

BSA alone silylates all sterically unhindered hydroxyl groups of the steroid skeleton; addition of TMCS will enable reaction of moderately hindered OH groups (reaction time 3–6 h at 60 °C). After addition of TSM even strongly hindered hydroxyl groups will react (reaction time 6–24 h at 60 °C).

with MSTFA, MSHFBA or MBDSTFA

MSTFA MN Appl. No. 213111 · MSHFBA MN Appl. No. 213112 · MBDSTFA MN Appl. No. 213113

Dissolve 10–15 mg sample in 0.8 mL solvent, then add 0.2 mL of the silylation reagent. The reaction mixture can be heated to 60–70 °C for up to 1 h and can be analyzed directly. If TFA is used as a solvent, proceed as follows [20]: dissolve 1–2 mg sample in 100 µL TFA. Dropwise add 0.9 mL of the silylating reagent. After cooling the sample can be chromatographed directly.

with TSM or Silyl-1139 (TSM – pyridine 11:39) · TSM MN Appl. No. 213121 · Silyl-1139 MN Appl. No. 213122

Dissolve 10–15 mg sample in 0.8 mL solvent, then add 0.2 mL of the silylation reagent. The reaction mixture can be heated to 60–70 °C for up to 1 hour and can be analyzed directly. Recommended solvent pyridine. When using Silyl-1139, the presence of water does not interfere.

with Silyl-21 or Silyl-2110 · Silyl-21 MN Appl. No. 213131 · Silyl-2110 MN Appl. No. 213132

Carefully add Silyl-21 or Silyl-2110 to 1–10 mg of the sample. Precipitated ammonium chloride does not interfere. If the sample should not dissolve within 5 min, heat to 75–85 °C. If no mutarotation is to be expected, you may dissolve the sugar in warm pyridine first and then add the silylation reagent. In some cases it may be advantageous to use a different solvent instead of pyridine. For derivatization of 3-ketosteroids we recommend to use DMF (dimethylformamide)

O-trimethylsilylation with MSTFA followed by N-trifluoroacetylation with MBTFA · MN Appl. No. 213140

Completely silylate 2 mg of the sample with 0.3 mL MSTFA, e.g., as described on page 363. After addition of 0.3 mL MBTFA the *N*-trimethylsilyl group is replaced by the *N*-trifluoroacetyl group. The mixture can be analyzed directly.



Test mixtures for GC capillary columns



Test mixtures

★ Key features

- Test mixtures for GC capillary columns to control the performance of fused silica capillary columns and the GC system

Ordering information

Test mixtures*

Designation		Pack of	REF
Activity test mixture (FA-TMS test according to Donike) in MSTFA/ <i>n</i> -hexane (1 + 4)	1 mg/mL each of TMS capric acid (C10), TMS myristic acid (C14), TMS stearic acid (C18), TMS behenic acid (C22), hexadecane (C16), eicosane (C20), tetracosane (C24), octacosane (C28)	1 mL	722307
Grob test mixture (modified) in <i>n</i> -hexane	(in mg/mL) <i>n</i> -decane (~ 2.8), <i>n</i> -undecane (~ 2.9), <i>n</i> -octanol (~ 3.6), 2,6-dimethylphenol (~ 3.2), 2,6-dimethylaniline (~ 3.2), methyl decanoate (~ 4.2), dicyclohexylamine (~ 3.1), methyl undecanoate (~ 4.2), methyl dodecanoate (~ 4.1)	1 mL	722310
MN OPTIMA® test mixture in pentane	0.1 % each of undecane, dodecane, octanol, dimethylaniline, decylamine, methyl decanoate, methyl undecanoate, heneicosane, docosane, tricosane (chromatograms see page 305)	1 mL	722316
MN OPTIMA® amine test mixture in ethanol	0.2 % diisobutylamine, 1 % diethanolamine, 0.2 % 2,6-dimethylaniline, 0.2 % <i>o</i> -propanol-pyridine, 0.2 % dicyclohexylamine, 0.2 % dibenzylamine	1 mL	722317
FAME test mixture in hexane	0.1 % each of FAMES C4, C6, C8, C10, C12, C14, C16, C18, C18:1 cis, C18:1 trans, C18:2, C18:3, C20, C22, C22:1, C24 (chromatogram see page 334)	1 mL	722320

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see SDS.

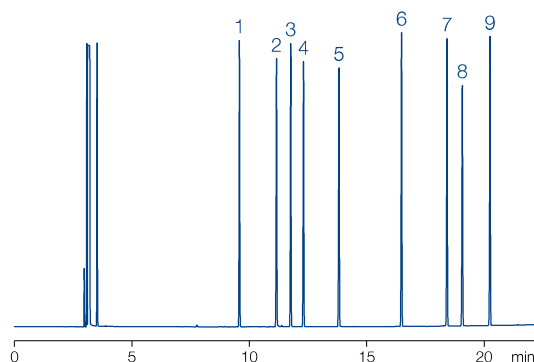
Grob test mixture (modified) (REF 722310)

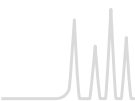
MN Appl. No. 211250

Column: OPTIMA® 5, 50 m x 0.25 mm ID, 1.0 µm film
Injection: 1 µL, split 1:40, 280 °C
Carrier gas: 1.5 bar H₂
Temperature: 80 °C → 280 °C (10 min), 8 °C/min
Detector: FID 280 °C

Peaks:

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





Test mixtures for GC capillary columns



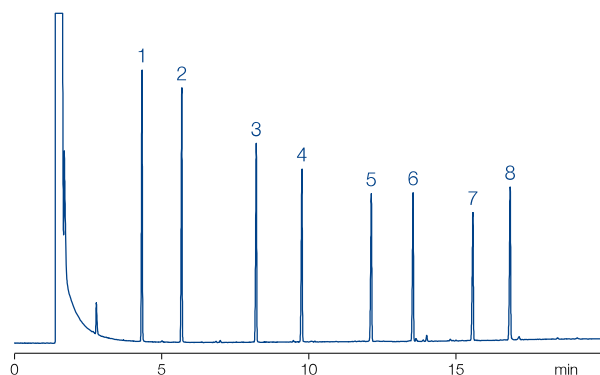
Activity test mixture (REF 722307)

MN Appl. No. 211240

Column: OPTIMA® 5, 25 m x 0.32 mm ID, 1.0 µm film
Injection: 1 µL, split 1:40, 300 °C
Carrier gas: 0.6 bar H₂
Temperature: 150 °C → 300 °C (8 min), 10 °C/min
Detector: FID 300 °C

Peaks:

1. TMS capric acid (C₁₀)
2. Hexadecane (C₁₆)
3. TMS myristic acid (C₁₄)
4. Eicosane (C₂₀)
5. TMS stearic acid (C₁₈)
6. Tetracosane (C₂₄)
7. TMS behenic acid (C₂₂)
8. Octacosane (C₂₈)



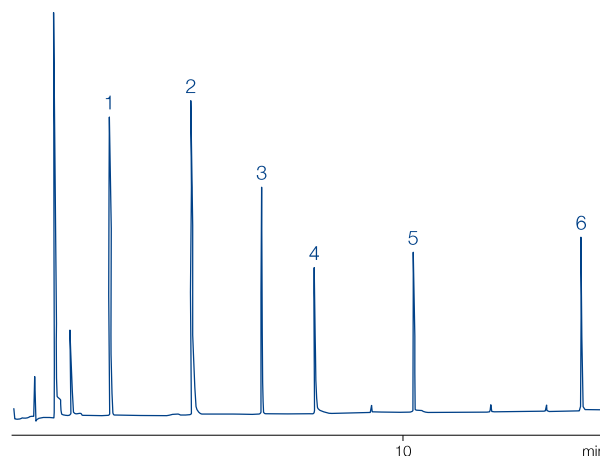
OPTIMA® Amine test mixture (REF 722317)

MN Appl. No. 250020

Column: OPTIMA® 5 Amine, 30 m x 0.32 mm ID, 1.5 µm film
Injection: 1 µL, split 1:40
Carrier gas: 0.6 bar H₂
Temperature: 100 °C → 280 °C, 10 °C/min
Detector: FID 280 °C

Peaks:

1. Diisobutylamine
2. Diethanolamine
3. 2,6-Dimethylaniline
4. o-Propanol-pyridine
5. Dicyclohexylamine
6. Dibenzylamine





Ferrules for capillary columns



Ferrules



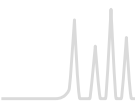
Key features

- Graphite ferrules provide the highest temperature stability (up to 450 °C). They are reusable, if handled with care. We also offer 1/16" graphite ferrules specially designed for Carlo Erba / Fisons or for Agilent gas chromatographs.
- Vespel ferrules with 40 % graphite. Temperature-stable up to 400 °C and reusable.

Ordering information

Ferrules

Bore (= column OD)	Graphite	Vespel +40 % Graphite
T _{max} →	450 °C	400 °C
1/16" ferrules		
0,4 mm		706246
0,5 mm	708308	
1/16" ferrules for Carlo Erba (Fisons) instruments		
0,8 mm	708340	
1/16" ferrules for Hewlett-Packard (Agilent) instruments		
0,4 mm	708353	
0,5 mm	708354	
0,8 mm	708355	
1/8" ferrules		
no bore	708341	
1/4" ferrules		
no bore	708344	
0,4 mm	708345	
0,5 mm	708346	



Injection Port Septa blister pack for cleanliness and easily handling

★ Key features

- BTO septa
for highest demands in GC and GC-MS
– pierced, soft – CenterGuide™
- AG3 septa
with higher durability than BTO
– pierced, hard – CenterGuide™
- Marathon Septa
with extreme durability for > 400 injections
– pierced – CenterGuide™

Ordering information

Injection port septa

Septum grade		BTO septa	AG3 septa	Marathon septa
				
OD	T _{max}			
9 mm	400 °C	702646	702656	702660
11 mm	400 °C	702647	702657	702661
11.5 mm	400 °C	702648	702658	702662
Shimadzu®	300 °C	702649	702659	702663
	Pack of	25	25	25

Standard Septa in classical plastic container

★ Key features

- Standard septa (ST)
beige silicone, 60° shore A, 4 mm
- High temperature septa (HT)
red non-bleeding silicone, 60° shore A, 3 mm
(320 °C max.)
- Silicone septa
soft, transparent
- Silicone / PTFE septa
white silicone, one side coated with grey PTFE, 3 mm

Ordering information

Classical septa

Septum grade	Standard septa (ST)	High temperature septa (HT)	Silicone septa	Silicone septa / PTFE
				
OD				
9 mm	702609	702619	702602	
10 mm	702610	702620		702625
11 mm	702611	702621	702604	702626
12 mm	702612	702622	702605	702627
13 mm	702613	702623	702606	702628
17 mm		702632		
	Pack of	50	50	50



Connectors for capillary GC columns

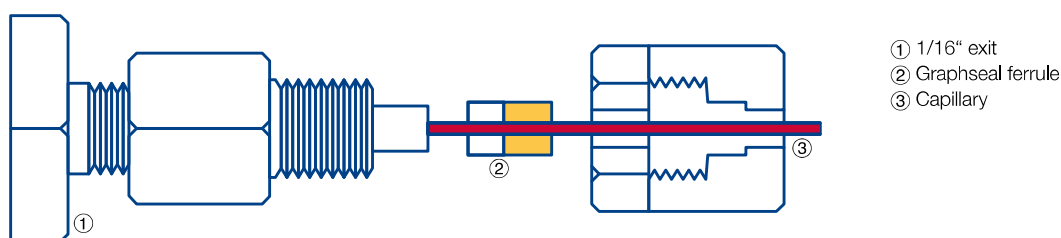
★ Key features

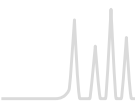
- Glass connectors for fused silica capillary columns from 0.2 to 0.53 mm ID: manufactured from deactivated glass with slightly tapered inner diameter; used to join two fused silica capillaries of equal or different diameters. Advantages compared to stainless steel fittings are easy connection without tools, optical control during connection, negligible heat capacity and no dead volume.
- Graphseal ferrules for capillary columns: a stainless steel ferrule filled with graphite – the ideal sealing material for capillaries. The capillary is mounted on a 1/16" exit (detector, injector etc.), with the appropriate ferrule, a nut (with slit) and an adapter (see table below).

Ordering information

Connectors for capillary GC columns

Description	Pack of	REF
Graphseal ferrules for capillary columns		
0,4 mm bore	10 ferrules	708337
0,5 mm bore	10 ferrules	708318
0,8 mm bore	10 ferrules	708319
Universal capillary glass connectors		
linear	5 connectors	707971
linear	10 connectors	707972
Y splitter	1 connector	707973





Tools and general accessories for GC



Key features

- Magnifying lens with scale: an essential tool for any laboratory. In capillary GC it is often important to inspect column integrity or check cut ends of capillaries. When closing a column by melting the magnifying lens can be used to check whether the column is really closed or whether an open channel has been formed in the sealed end. Our lens provides 8fold magnification and is supplied with a scale as pictured in the figure below. The space between lines is equivalent to 1/10 mm.
- Diamond file: a useful tool for cutting capillaries and smoothing ends of capillaries. Square capillary ends are especially important for butt connections (e.g., in Valco unions).
- Glass wool, quartz wool and glass fiber wadding are used for, e.g., GC liners, packed GC columns etc.

Ordering information

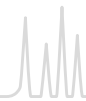
Tools and general accessories

Description	Pack of	REF
Tools for capillary GC		
Diamond file for cutting capillaries and straightening capillary ends	1	708300
Magnifying lens with scale magnification 8x	1	706296
PTFE tape for sealing, reels 12 m long, 12 mm wide, 0.1 mm thick	1 reel	706512
Glass wool		
Glass wool, long fibers, DMCS treated, for packed GC columns	50 g	706201
Glass fiber wadding silanized, very fine fibers	25 g	718002
Quartz wool, very fine fibers	25 g	718587

Index of reference numbers



REF	Page	REF	Page	REF	Page	REF	Page
531011	295	702001	111	702054	124	702128	130
701110.110	360	702002	101	702055	125	702129	130
701110.201	360	702004	102, 120	702056	129	70213	102, 120
701110.510	360	702005	102, 109	702057	130	70213.2	102, 120
701120.101	360	702006	105	702058	132	702130	132
701130.110	360	702007	105	702059	132	702131	131
701130.510	360	702008	105	70206.36	127	702132	131
701210.110	363	702009	105	702060	132	702133	131
701210.150	363	702010	105	702061	132	702134	111, 114
701210.510	363	702011	108	702062	132	702135	105
701220.110	363	702012	108	702063	115	702136	125
701220.201	363	702013	108	702063.2080	115	702141	111
701220.510	363	702014	111	702064	115	702144	130
701230.650	366	702015	111	702065	112	702145	129
701240.510	366	702016	111	702066	103, 120	702146	112
701240.650	366	702017	124	702067	103	702147	106
701260.110	364	702018	124	702068	103, 120	702148	107
701260.1100	364	702019	123	702069	103	702155	106
701260.201	364	70201CG	109	702070	103	70214CG	109
701260.510	364	70201HP	110	702071	129	70215.36	126
701260.6100	364	70201HP.2	110	702072	125	702158	106
701270.110	364	70202.1	124	702073	132	702159	106
701270.1100	364	702020	126	702074	131	70216.36	126
701270.12100	364	702021	131	702075	110	702160	106
701270.201	364	702022	131	702076	110	702161	106
701270.510	364	702023	131	702077	104, 108, 110, 114	702162	106
701270.6100	364	702024	131	702078	104, 120	702163	106
701270.650	364	702025	101	702079	104, 120	702164	106
701280.201	366	702026	105	70208.36	128	702165	106
701280.650	366	702027	105	702080	106	702168	132
701310.110	366	702028	105	702081	106	70217.36	127
701310.201	366	702029	106	702082	106	702170	115
701310.510	366	70203	118	702083	106	702172	105
701410.110	360	702030	106	702084	106	702173	111, 114
701410.201	360	702031	106	702085	106	702174	111, 114
701410.510	360	702032	106, 120	702086	127	702175	112
701420.101	360	702033	106, 120	702088	105	702176	115
701420.201	360	702034	106, 120	702089.1	128	702177	105
701430.110	361	702035	106	702091	129	702178	105
701430.201	361	702036	106	702093	129	702179	105
701440.101	364	702037	106	702094	129	702180	121
701440.201	364	702038	106	702096	121	702181	122
701450.110	366	702039	106	702097	121	702201	107
701450.201	366	70204.36	126	702098	122	702202	107
701450.510	366	702040	106	702099	122	702203	107
701460.201	366	702041	107	70210.36	128	702204	107
701470.201	366	702042	107	702100	128	702205	107
701480.201	366	702043	107	702101	130	702206	107
701490.1100	363, 366	702044	108	702101HP	113	702207	107
701490.150	363, 366	702045	108	702102	132	702208	107
701490.201	363, 366	702046	108	702103	119, 121	702209	107
701520.101	361	702047	108	702104	121	702211	107
701520.110	361	702048	108	702105	122	702212	107
701520.201	361	702049	108	702106	122	702213	107
701520.510	361	70205.36	126	702107	106	702214	107
701950	357	702050	119	702109	106	702215	112
701951	357	702051	119, 121	702110	125	702216	112
701952	357	702052	119, 121	702112	129	702217	112
701953	357	702053	119			702218	112



Index of reference numbers

REF	Page	REF	Page	REF	Page	REF	Page
702219	112	70240	130	70267	130	702827	125
702221	112	702401	111, 115	70269	130	702829	129
702222	112	70242	130	702709	114	70283	101
702223	112	702437	103	70271	123	702833	129
702224	112	70245	103	702710	115	702834	129
702225	115	70248	103	702710.1	115	702835	129
702226	107	702481	103	702710.2080	115	702836	129
702227	115	70249	103	702712	114	702837	129
702228	115	70250	103	702713	114	702838	129
702229	115	702500	104	702714	114	70284	112
702231	115	702502	116, 133	702716	104, 108, 110, 114	70285	121
702232	115	702504	118, 133	702717.2	115	702857	107
702233	115	70251	101	702717.2080	115	702858	107
702234	115	702514	116, 133	702718	115	702859	113
702235	115	702515	118, 133	702718.1	115	70286	101
702236	115	702516	125, 126, 133	702718.2080	115	702860	102
702237	115	702517	131, 133	702719	115	702863	107
702238	103	70252.1	101	70272	123	702864	107
702244	107	70254	127	702723	123	702865	132
702246	103	702540	127	702730	111	702866	125
702247	103	702541	127	702730.1	111	702867	113
702248	103	70256	111	702730.2	111	702873	107
702249	103	70257	118	702730.3	111	702874	107
702251	103	70260	119	702731	115	702877	132
702253	112	702602	371	702732	106	702878	101
702254	112	702604	371	70274	123	702879	112
702261	127	702605	371	70275	123	70288	111
702263	127	702606	371	70277	130	70288.1	111
702263.2	127	702609	371	702773	129	70288.2	111
702282	104, 120	70261	103	702774	129	70288.3	111
702283	104, 120	702610	371	702775	129	702881	113
702284	104, 120	702611	371	702778	130	702885	110
702286	106	702612	371	702780	130	702888	111
702287	106	702613	371	70279	130	70289	101
702287.1	106	702619	371	702791	132	702891	111
702288	106	70262	112	702799	129	702892	110
702288.1	106	702620	371	702800	101	702893	102, 120
702292	119	702621	371	702801	112	702904	130
702293	104, 120	702622	371	702802	118	702917	126
70231	111	702623	371	702803	118	702918	126
70231.1	111	702625	371	702804	129	702924	126
70231.2	111	702626	371	702805	130	702926	119
70231.3	111	702627	371	702807	124	702927	129
70231.4	111	702628	371	702808	129	702928	129
702311	121	702632	371	702809	111, 114	702928.9	129
70232	118	702646	371	702813	104, 108, 110, 114	702929	129
70233	130	702647	371	702818	104, 108, 110, 114	702931	130
702334	111, 114	702648	371	702818.1	104, 108, 110, 114	702931.1	130
702335	105	702649	371	70282	101	702962	119, 121
70234	129	702656	371	702823	111	702963	119
70234.8	129	702657	371	702824	102, 109	702966	119
70234.9	129	702658	371	702825	104, 108, 110, 114	702968	102, 109
70234.10	129	70266	130	702826	125	702968.1	102, 109
70235	130	702660	371	702826.2	125	702972	119
70236	130	702661	371			702973	119, 121
70236.1	130	702662	371			702974	119
70237	129	702663	371			702974.1	102
70238	130					702981	125
70239	111					702995	112

Index of reference numbers



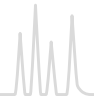
REF	Page	REF	Page	REF	Page	REF	Page
702995.1	112	711018.100	258	711350.100	257	711890.10	257
702995.2	112	711018.1000	258	711360.10	257	711890.100	257
702995.3	112	711019.100	258	711360.100	257	711991.10	257
702D20TB	130	711019.1000	258	711370.10	257	711991.100	257
706201	373	711020.10	257	711370.100	257	711992.10	257
706246	370	711020.100	257	711380.10	257	711992.100	257
706290	254	711021.100	258	711380.100	257	713550.0100	256
706296	373	711021.1000	258	711390.10	257	713550.1	256
706512	373	711022.100	258	711390.100	257	713551.0100	256
707971	372	711022.1000	258	711420.10	257	713551.1	256
707972	372	711023.100	258	711420.100	257	713600.0100	256
707973	372	711023.1000	258	711430.10	257	713600.1	256
708300	373	711024.100	258	711430.100	257	713601.0100	256
708308	370	711024.1000	258	711470.100	258	713601.1	256
708318	372	711025.100	258	711470.1000	258	713610.0100	256
708319	372	711025.1000	258	711480.100	258	713610.1	256
708337	372	711026.100	258	711480.1000	258	713611.0100	256
708340	370	711026.1000	258	711490.100	258	713611.1	256
708341	370	711027.100	258	711490.1000	258	713615.0100	256
708344	370	711027.1000	258	711500.100	258	713615.1	256
708345	370	711028.100	258	711500.1000	258	713618.0100	256
708346	370	711028.1000	258	711510.10	257	713618.1	256
708353	370	711029.100	258	711510.100	257	713620.0100	256
708354	370	711029.1000	258	711520.10	257	713620.1	256
708355	370	711031.100	258	711520.100	257	713621.0100	256
711001.1000	259	711031.1000	258	711530.10	257	713621.1	256
711001.5000	259	711032.100	258	711530.100	257	713630.0100	256
711002.1000	259	711032.1000	258	711540.1000	259	713630.1	256
711002.5000	259	711033.1000	259	711540.5000	259	713631.0100	256
711003.1000	259	711033.5000	259	711550.1000	259	713631.1	256
711003.5000	259	711034.1000	259	711550.5000	259	713831.0100	256
711004.100	259	711034.5000	259	711560.10	257	713831.1	256
711004.1000	259	711035.100	259	711560.100	257	713832.0100	256
711005.100	259	711035.1000	259	711570.10	257	713832.1	256
711005.1000	259	711036.100	259	711570.100	257	718002	79, 373
711006.100	259	711036.1000	259	711580.10	257	718582	254
711006.1000	259	711037.1000	259	711580.100	257	718583	254
711007.100	258	711037.5000	259	711590.100	258	718584	254
711007.1000	258	711240.1000	259	711590.1000	258	718587	373
711008.100	258	711240.5000	259	711600.10	257	718637	254
711008.1000	258	711250.1000	259	711600.100	257	718755	255
711009.100	258	711250.5000	259	711610.100	259	718760	255
711009.1000	258	711260.1000	259	711610.1000	259	718761	255
711010.10	257	711260.5000	259	711620.100	259	718762	255
711010.100	257	711270.1000	259	711620.1000	259	718763	255
711011.100	258	711270.5000	259	711630.100	259	718765	255
711011.1000	258	711280.10	257	711630.1000	259	718766	255
711012.100	258	711280.100	257	711680.10	257	718767	255
711012.1000	258	711300.10	257	711680.100	257	718768	255
711013.100	258	711300.100	257	711690.100	258	718769	255
711013.1000	258	711310.10	257	711690.1000	258	718770	255
711014.100	258	711310.100	257	711700.100	258	718771	255
711014.1000	258	711320.10	257	711700.1000	258	718772	255
711015.100	258	711320.100	257	711710.10	257	718775	255
711015.1000	258	711330.10	257	711710.100	257	718966	251
711016.100	258	711330.100	257	711720.100	258	718967	251
711016.1000	258	711340.10	257	711720.1000	258	718968	251
711017.100	258	711340.100	257	711730.100	258	718969	251
711017.1000	258	711350.10	257	711730.1000	258	718970	251



Index of reference numbers

REF	Page	REF	Page	REF	Page	REF	Page
718971	251	720018.46	215	720120.46	214	720841.46	214
718975	253	720019.40	220	720124.40	232	720905.40	246
718976	253	720019.46	220	720125.40	232	720923.30	229
718977	253	720022.40	217	720127.40	232	720923.40	229
718978	253	720022.46	217	720133.40	214	720935.40	215
719402	249	720023.40	215	720133.46	214	720935.46	215
719403	249	720023.46	215	720140.46	215	720936.40	215
719404	249	720024.40	222	720141.40	214	720936.46	215
719405	249	720024.46	222	720141.46	214	720949.46	214
719406	249	720025.46	221	720143.46	220	720951.46	215
719409	249	720028.46	223	720149.40	215	720956.46	220
719410	249	720029.46	223	720149.46	215	720989.46	223
719411	249	720040.40	215	720150.40	214	720990.46	217
719412	249	720040.46	215	720150.46	214	720994.46	221
719413	249	720041.40	215	720165.46	217	720996.40	223
719414	249	720041.46	215	720170.40	216	720996.46	223
719418	249	720042.40	215	720170.46	216	721020.30	221
719454	245	720043.40	215	720174.46	216	721022.30	214
719455	245	720043.46	215	720175.40	216	721024.30	223
719456	245	720046.40	234	720175.46	216	721025.30	223
719459	245	720050.40	217	720182.46	223	721030.30	219
719460	245	720050.46	217	720183.46	223	721039.30	222
719469	240	720051.40	215	720191.40	215	721061.30	217
719475	240	720051.46	215	720191.46	215	721070.30	215
719489	254	720052.40	217	720193.46	215	721071.30	218
719501	248	720052.46	217	720194.46	218	721072.30	215
719520	245	720055.40	215	720196.40	218	721073.30	215
719530	248	720055.46	215	720196.46	218	721074.20	214
719531	248	720057.40	222	720205.40	222	721074.30	214
719532	248	720057.46	222	720205.46	222	721075.30	215
719533	230	720059.40	219	720214.46	217	721078.30	222
719534	248	720059.46	219	720231.40	243	721083.30	219
719535	248	720062.46	217	720245.40	243	721085.30	216
719536	248	720065.40	216	720252.40	244	721093.30	217
719537	248	720065.46	216	720258.40	244	721095.30	217
719538	250	720071.40	217	720280.40	215	721096.30	217
719539	250	720071.46	217	720280.46	215	721119.30	243
719540	240	720074.46	216	720294.46	215	721133.30	215
719542	245	720077.46	216	720296.40	215	721137.30	220
719543	230	720081.40	235	720296.46	215	721142.30	220
719570	247	720088.40	236	720305.46	215	721155.30	221
719571	247	720089.46	219	720350.40	236	721157.30	216
719574	247	720090.40	222	720430.40	215	721158.30	221
719575	247	720090.46	222	720430.46	215	721167.30	224
719600	240	720093.46	224	720431.40	215	721168.20	229
720001.40	217	720094.40	230	720431.46	215	721168.30	229
720001.46	217	720095.46	221	720432.46	215	721169.30	230
720002.20	214	720095.46RP	221	720445.46	233	721170.30	246
720002.30	214	720096.46	219	720450.46	233	721171.30	232
720002.40	214	720097.40	223	720451.46	233	721176.30	232
720002.46	214	720097.46	223	720471.46	215	721178.30	232
720013.40	217	720098.46	214	720472.40	215	721185.30	233
720013.46	217	720099.46	224	720472.46	215	721186.30	233
720014.20	214	720110.46	215	720701.46	215	721188.30	235
720014.30	214	720117.20	229	720709.46	223	721190.30	236
720014.40	214	720117.30	229	720730.46	215	721194.30	217
720014.46	214	720117.40	229	720735.46	217	721196.30	215
720017.46	217	720117.46	229	720740.46	215	721402.30	234
720018.40	215	720120.40	214	720752.40	232	721469.30	232

Index of reference numbers



REF	Page	REF	Page	REF	Page	REF	Page
721473.30	214	723327.25	354	723555.50	338	725812.25	316
721518.30	224	723341.25	338	723558.10	355	725812.60	316
721567.30	244	723341.30	338	723558.25	355	725813.30	316
721649.30	215	723341.50	338	723560.10	355	725815.12	316
721823	247	723341.60	338	723560.25	355	725815.50	316
721916.30	219	723344.10	338	723562.10	355	725820.15	316
721920	232	723344.25	338	723562.25	355	725820.30	316
721924.30	244	723344.30	338	723706.10	356	725820.60	316
722307	368	723344.50	338	723706.25	356	725825.30	316
722310	368	723344.60	338	723707.10	356	725825.60	316
722316	368	723346.10	355	723707.25	356	725826.30	316
722317	368	723346.25	355	723708.10	356	725826.60	316
722320	368	723348.10	355	723708.25	356	725850.30	317
722393	229	723348.25	355	723709.10	356	725850.60	317
722394	147	723349.10	355	723709.25	356	726022.15	327
723052.25	336	723349.25	355	723710.10	356	726022.25	327
723052.50	336	723356.25	338	723710.25	356	726022.30	327
723054.25	336	723356.50	338	723711.10	356	726022.50	327
723060.10	337	723358.25	345	723711.25	356	726022.60	327
723060.25	337	723358.50	345	723712.10	356	726024.10	310, 341
723060.30	337	723360.25	342	723712.25	356	726024.20	310, 341
723060.50	337	723360.50	342	723713.10	356	726025.20	310, 341
723060.60	337	723362.25	342	723713.25	356	726038.10	310
723063.25	354	723362.50	342	723714.10	356	726038.15	310
723064.10	337, 341	723364.25	342	723714.25	356	726038.25	310
723101.10	355	723364.50	342	723790.1	355	726038.30	310
723101.25	355	723366.25	342	723790.2	355	726038.60	310
723105.10	355	723366.50	342	723791.1	355	726050.10	310
723105.25	355	723368.25	342	723791.2	355	726050.15	310
723106.10	355	723368.50	342	723792.1	355	726050.25	310
723106.25	355	723370.25	345	723792.2	355	726050.30	310
723108.10	355	723370.50	345	723793.1	355	726050.50	310
723108.25	355	723379.25	342	723793.2	355	726050.60	310
723116.10	338	723379.50	342	723827.10	337	726056.10	314
723116.25	338	723381.25	345	723827.25	337	726056.15	314
723116.30	338	723381.50	345	723827.50	337	726056.25	314
723116.50	338	723382.10	341, 342	723830.10	338	726056.30	314
723116.60	338	723383.10	341, 345	723830.25	338	726056.50	314
723148.10	355	723384.25	345	723830.50	338	726056.60	314
723148.25	355	723384.50	345	723890.100	352	726058.10	324
723151.10	355	723386.25	345	723936.25	338	726058.15	324
723151.25	355	723387.25	345	723936.50	338	726058.25	324
723180.10	338, 341	723387.50	345	723945.25	353	726058.30	324
723180.20	338, 341	723388.25	345	723945.50	353	726058.50	324
723181.10	338, 341	723388.50	345	725801.25	313	726058.60	324
723296.10	337	723409.50	354	725801.50	313	726064.30	324
723296.25	337	723411.25	354	725802.30	313	726064.60	324
723296.30	337	723501.10	355	725802.60	313	726065.12	327
723296.50	337	723501.25	355	725805.15	313	726065.25	327
723296.60	337	723515.10	337	725805.30	313	726065.50	327
723306.25	336	723515.25	337	725805.60	313, 315	726066.25	327
723308.50	336	723517.10	337	725806.30	313	726066.50	327
723310.25	336	723517.25	337	725806.60	313	726067.25	327
723312.25	336	723517.30	337	725807.30	313	726067.30	327
723321.10	337	723549.10	337	725807.60	313	726067.50	327
723321.25	337	723549.25	337	725810.25	316	726067.60	327
723321.30	337	723549.30	337	725810.50	316	726080.10	330, 341
723321.50	337	723555.10	338	725811.30	316	726081.10	310
723321.60	337	723555.25	338	725811.60	316	726081.25	310



Index of reference numbers

REF	Page	REF	Page	REF	Page	REF	Page
726081.30	310	726205.60	312	726316.30	314	726382.60	333
726081.50	310	726210.12	315	726316.50	314	726383.30	333
726081.60	310	726210.25	315	726316.60	314	726383.60	333
726089.30	331	726210.50	315	726318.10	324	726400.25	319
726089.50	331	726211.30	315	726318.15	324	726400.50	319
726089.60	331	726212.25	315	726318.25	324	726410.10	319, 341
726090.30	331	726212.50	315	726318.30	324	726410.20	319, 341
726090.60	331	726212.60	315	726318.50	324	726420.30	319
726091.25	331	726213.30	315	726318.60	324	726420.60	319
726091.30	331	726215.12	315	726320.25	324	726421.30	319
726091.50	331	726215.25	315	726320.30	324	726440.30	319
726091.60	331	726215.50	315	726320.50	324	726440.60	319
726095.30	331	726220.15	315	726320.60	324	726441.30	319
726095.60	331	726220.30	315	726321.25	332	726441.60	319
726096.30	331	726220.60	315	726321.30	332	726442.30	319
726096.60	331	726225.30	315	726321.50	332	726442.60	319
726099.25	314	726225.60	315	726321.60	332	726443.30	319
726099.30	314	726226.30	315	726323.10	310	726465.25	320
726099.50	314	726226.60	315	726323.15	310	726465.50	320
726099.60	314	726241.30	335	726323.25	310	726470.30	320
726102.15	349	726241.60	335	726323.30	310	726470.60	320
726102.30	349	726242.30	335	726323.50	310	726480.30	320
726104.15	349	726242.60	335	726323.60	310	726480.60	320
726104.30	349	726243.30	335	726325.15	314	726481.30	320
726106.15	349	726243.60	335	726325.25	314	726481.60	320
726106.30	349	726246.30	335	726325.30	314	726482.30	320
726108.15	349	726246.60	335	726325.50	314	726482.60	320
726108.30	349	726296.25	332	726325.60	314	726483.30	320
726116.25	334	726296.30	332	726341.25	334	726490.10	320, 341
726116.30	334	726296.50	332	726341.30	334	726519.15	310
726116.50	334	726296.60	332	726341.50	334	726519.25	310
726116.60	334	726301.10	310	726341.60	334	726519.30	310
726118.15	330	726301.25	310	726344.25	334	726521.10	310
726118.25	330	726301.30	310	726344.30	334	726521.25	310
726118.30	330	726301.50	310	726344.50	334	726521.30	310
726118.50	330	726301.60	310	726345.30	334	726521.50	310
726118.60	330	726302.10	310	726346.25	334	726523.10	314
726131.10	348	726302.15	310	726351.25	327	726523.25	314
726131.25	348	726302.25	310	726351.30	327	726523.30	314
726132.10	348	726302.30	310	726351.50	327	726525.10	314
726132.25	348	726302.50	310	726351.60	327	726525.25	314
726133.10	348	726302.60	310	726352.25	330	726525.30	314
726133.25	348	726304.10	310	726352.30	330	726525.50	314
726154.30	326	726304.25	310	726352.50	330	726525.60	314
726154.60	326	726304.30	310	726352.60	330	726529.10	310
726157.30	326	726304.50	310	726353.30	350	726529.15	310
726157.60	326	726304.60	310	726354.30	350	726529.25	310
726162.30	328	726313.10	314	726355.25	350	726529.30	310
726162.60	328	726313.15	314	726356.30	350	726541.10	314
726165.30	328	726313.25	314	726357.30	350	726541.15	314
726165.60	328	726313.30	314	726358.30	350	726541.25	314
726180.10	334, 341	726313.50	314	726359.30	350	726541.30	314
726201.25	312	726313.60	314	726360.30	350	726545.10	324
726201.50	312	726314.15	314	726361.10	341, 350	726545.15	324
726202.30	312	726314.25	314	726380.30	333	726545.25	324
726202.60	312	726314.30	314	726380.60	333	726545.30	324
726203.12	312	726314.50	314	726381.30	333	726548.30	332
726205.15	312	726314.60	314	726381.60	333	726549.25	332
726205.30	312	726316.25	314	726382.30	333	726549.30	332

Index of reference numbers



REF	Page	REF	Page	REF	Page	REF	Page
726600.25	332	726777.60	321	726863.25	314	727450	79
726600.30	332	726780.30	321	726863.50	314	727451	79
726600.50	332	726780.50	321	726871.15	329	728031.20	225
726600.60	332	726780.60	321	726871.25	329	728031.30	225
726623.25	314	726783.25	321	726871.30	329	728031.40	225
726623.30	314	726784.25	323	726871.50	329	728031.46	225
726623.50	314	726785.25	323	726871.60	329	728032.20	225
726623.60	314	726785.30	323	726874.30	329	728032.30	225
726628.25	314	726785.50	323	726874.50	329	728032.40	225
726628.30	314	726785.60	323	726874.60	329	728032.46	225
726628.50	314	726786.30	323	726877.15	329	728033.46	225
726628.60	314	726786.50	323	726877.30	329	728034.20	225
726630.30	325	726787.25	323	726877.50	329	728034.30	225
726630.60	325	726787.30	323	726877.60	329	728034.40	225
726631.30	325	726787.50	323	726880.25	329	728034.46	225
726631.60	325	726787.60	323	726880.30	329	728035.20	225
726632.30	325	726789.25	323	726880.50	329	728035.30	225
726632.60	325	726789.30	323	726880.60	329	728035.40	225
726633.30	325	726802.25	310	726900.30	347	728035.46	225
726633.60	325	726802.30	310	726903.10	347	728036.46	225
726634.30	325	726802.50	310	726905.30	347	728037.20	225
726634.60	325	726802.60	310	726911.25	314	728037.30	225
726635.30	325	726805.25	310	726911.30	314	728037.40	225
726635.60	325	726805.30	310	726911.50	314	728037.46	225
726640.30	322	726805.50	310	726911.60	314	728038.20	225
726640.60	322	726805.60	310	726916.10	314	728038.30	225
726641.30	322	726807.25	314	726916.25	314	728038.40	225
726641.60	322	726807.30	314	726916.30	314	728038.46	225
726642.30	322	726807.50	314	726916.50	314	728039.46	225
726642.60	322	726807.60	314	726926.10	310	728053.30	225
726643.30	322	726809.25	314	726926.25	310	728053.40	225
726643.60	322	726809.30	314	726926.30	310	728054.30	225
726735.15	324	726809.50	314	726926.50	310	728054.40	225
726735.25	324	726809.60	314	726929.25	324	728055.30	225
726735.30	324	726821.25	310	726929.30	324	728055.40	225
726735.50	324	726821.30	310	726929.50	324	728777.20	251
726742.25	327	726821.50	310	726929.60	324	728777.30	251
726742.30	327	726821.60	310	726931.10	310	728778.20	251
726742.50	327	726824.25	324	726931.25	310	728778.30	251
726742.60	327	726824.30	324	726931.30	310	729004	89
726744.25	327	726824.50	324	726931.50	310	729004.400	89
726744.30	327	726824.60	324	726934.15	314	729006	89
726744.50	327	726832.25	310	726934.25	314	729006.400	89
726744.60	327	726834.12	310	726934.30	314	729007	88
726747.10	327	726834.25	310	726934.50	314	729007.400	88
726747.15	327	726834.50	310	726965.30	324	729008	88
726747.25	327	726837.12	310	727400	79	729009	88
726747.30	327	726837.25	310	727401	79	729010	90
726755.30	327	726837.50	310	727402	79	729011	90
726757.25	327	726839.50	310	727403	79	729012	90
726757.30	327	726841.25	324	727404	79	729012.400	90
726757.50	327	726841.50	324	727405	79	729013	90
726757.60	327	726846.10	314, 341	727406	79	729013.400	90
726771.25	321	726848.10	327, 341	727407	79	729014	88
726771.30	321	726854.25	314	727420	79	729015	88
726771.50	321	726857.25	314	727421	79	729020	86
726771.60	321	726857.50	314	727422	79	729020.400	86
726777.25	321	726860.25	314	727423	79	729021	86
726777.30	321	726860.50	314	727424	79	729021.400	86



Index of reference numbers

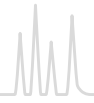
REF	Page
729022	86
729023	86
729024	89
729025	89
729026	89
729026.400	89
729027	89
729027.400	89
729028	91
729028.400	91
729030	87
729030.400	87
729031	87
729031.400	87
729032	85
729032.400	85
729033	85
729033.400	85
729034	91
729036	87
729037	87
729039	85
729039.400	85
729043	91
729044	91
729048	90
729049	90
729050	85
729050.400	85
729051	85
729051.400	85
729054	89
729055	89
729100	92
729101	92
729102	92
729204	89
729204.400	89
729205	88
729205.400	88
729206	89
729207	88
729207.400	88
729208	88
729209	88
729212	90
729212.400	90
729213	90
729213.400	90
729218	91
729218.400	91
729219	91
729219.400	91
729220	86
729220.400	86
729221	86
729221.400	86
729222	86
729223	86

REF	Page
729226	89
729226.400	89
729227	89
729227.400	89
729228	91
729228.400	91
729229	86
729229.400	86
729230	87
729230.400	87
729231	87
729231.400	87
729234	91
729236	87
729237	87
729240	90
729241	90
729241.400	90
729242	90
729243	91
729244	91
729245	88
729246	88
729246.400	88
729247	88
729248	90
729249	90
729254	89
729255	89
729256	88
729257	88
729258	92
730001	33
730002	33
730003	33
730003.250	33
730003G	33
730004	33
730004.250	33
730004G	33
730005	33
730005.250	33
730005G	33
730007	44
730008	33
730009	33
730010	32
730011	32
730011ASP	68
730011MPS	68
730012	32
730012G	32
730012MPS	68
730013	32
730013.250	32
730013ASP	68
730013G	32
730013MPS	68
730014	32

REF	Page
730014.250	32
730014G	32
730015	32
730015.250	32
730015ASP	68
730015G	32
730016	32
730017	43
730018	32
730020	43
730020G	43
730021	35
730022	35
730023	35
730024	35
730024G	35
730026	67
730028	33
730031	40
730033	40
730033.250	40
730033G	40
730034	67
730049	25
730049P45	25
730051	41
730053	41
730061	41
730063	41
730068.320	94
730068.345	94
730068.620	94
730068.645	94
730070	39
730070G	39
730071	39
730071ASP	68
730072	39
730073	39
730073.250	39
730073ASP	68
730073G	39
730073MPS	68
730075	39
730075.250	39
730075ASP	68
730075G	39
730075MPS	68
730076	45
730077	45
730077.250	45
730078	46
730079	46
730079.250	46
730081	44
730082	44
730082.250	44
730082G	44
730083	38

REF	Page
730084	38
730085	56
730085.250	56
730085G	56
730100.4	67
730101	67
730102	67
730103	67
730104.4	67
730105	67
730106	66
730107	39
730107.250	39
730107G	39
730108	30
730108.250	30
730108G	30
730109	54
730111	30
730111.AOX	51
730111G	30
730112	52
730117	30
730118	30
730118G	30
730119	30
730119.AOX	51
730125	56
730126	44
730127	44
730130	33
730132	55
730132.250	55
730134	35
730135	52
730135.250	52
730135G	52
730139	43
730139G	43
730141	32
730149	54
730149.250	54
730149G	54
730150	65
730151	65
730152	66
730153	66
730154	66
730157	66
730158	67
730159	67
730160	67
730161	67
730162	67
730163	67
730164	67
730165	60
730166	51
730166G	51

Index of reference numbers



REF	Page	REF	Page	REF	Page	REF	Page
730167	60	730295	34	730444	37	730595.50000	64
730168	48	730296	34	730446	43	730596	42
730168.250	48	730296G	34	730447	43	730601	35
730169	36	730297	34	730452	43	730602	33
730171	67	730297G	34	730453	43	730603	40
730172	67	730298	34	730455	43	730605	41
730173	65	730298G	34	730457	44	730606	38
730174	65	730299	34	730460	47	730607	41
730175	65	730299G	34	730462	47	730608	39
730176	65	730300	34	730464	47	730609	45
730177	65	730300G	34	730466	43	730610	46
730178	65	730301	34	730467	43	730611	32
730179	66	730302	34	730473	39	730612	33
730180	40	730310	31	730474	67	730613	32
730180G	40	730315	50	730475	67	730615	30
730183.12	66	730322	46	730482	47	730616	51
730184.12	66	730323	46	730483	47	730618	52
730185	66	730344	31	730484	47	730618G	52
730187	66	730349	18	730487	64	730619	54
730188	66	730350.4	67	730487.250	64	730620	52
730189.1	66	730351	67	730489	64	730620G	52
730189.12	66	730355	67	730490	18	730622	44
730191	67	730356	67	730491	18	730626	40
730192	67	730360	65	730494	18	730626G	40
730194	66	730365	65	730496	18	730628	34
730197	18	730366	66	730501	64	730629	47
730199	18	730376	31	730502	64	730630	47
730205	18	730377	31	730505	64	730631	37
730206	18	730378	31	730506	64	730640	43
730207	18	730380	67	730507	64	730641	43
730208	18	730381	67	730507.100	64	730642	43
730209	18	730382	67	730508	64	730643	42
730212	45	730384	44	730509	64	730648	59
730214	39	730385	67	730517.3100	94	730651	36
730214G	39	730386	66	730517.6100	94	730652	36
730214MPS	68	730387	66	730533	60	730653	59
730217	39	730388	67	730561	59	730653.20	59
730221	36	730389	67	730562	59	730657	59
730225	36	730394	31	730564	66	730658	59
730227	36	730396	31	730566	67	730660	44
730230	67	730400	33	730570.320	94	730661	29
730233	66	730402	33	730570.345	94	730666	77
730235	55	730403	33	730570.620	94	730667	77
730238	44	730404	32	730570.645	94	730680	49
730238G	44	730405	32	730578.320	94	730681	48
730239	44	730406	39	730578.345	94	730682	48
730239G	44	730409	36	730578.620	94	730683	49
730243	66	730410	36	730578.645	94	730684	48
730249	53	730411	38	730579.320	94	730685	49
730249G	53	730413	40	730579.345	94	730686	49
730249G.250	53	730417	41	730579.620	94	730690	31
730250	43	730418	41	730579.645	94	730692	31
730259	32	730420	41	730585	64	730693	31
730261	33	730421	41	730586	64	730703	61
730269	32	730425	45	730593	42	730710	62
730275	45	730426	46	730594	42	730712	62
730280	30	730429	43	730595.500	64	730714	62
730288	18	730442	37	730595.1000	64	730716	62
730294	34	730443	37	730595.5000	64	730718	62

Index of reference numbers

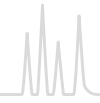
REF	Page
730720	62
730722	62
730723	18
730724	62
730726	18
730727	26
730727P45	26
730728	28
730728P45	28
730729	28
730729P45	28
730730	62
730731	27
730731P45	27
730732	62
730733	27
730733P45	27
730734	62
730735	27
730735P45	27
730736	62
730737	27
730738	62
730739	27
730739P45	27
730740	62
730741	27
730742	62
730743	27
730744	28
730745	28
730747	28
730747P45	28
730748	28
730748P45	28
730749	28
730751	29
730752	29
730753	29
730754	29
730754.250	29
730755	29
730755.250	29
730756	29
730757	29
730758	29
730759	29
730765	31
730798	78
730880	77
730881	77
730884	77
730885	77
730886	77
730887	77
730888	77
730890	77
730891	77
730892	77

REF	Page
730915	77
730931	24
730931.250	24
730931MPS	68
730931P45	24
730934	24
730934P45	24
730935	24
730935MPS	68
730935P45	24
730936	24
730936P45	24
730937	24
730938	24
730938.250	24
730939	24
730939.250	24
730939MPS	68
730940	24
730941	24
730950	26
730950P45	26
730951	26
730951P45	26
730952	25
730952P45	25
730953	25
730954	26
730955	25
730956	25
730956P45	25
730957	25
730958	26
730966	26
730968	26
730968P45	26
730969	25
730969P45	25
730970	59
730971	59
730972	59
730973	59
730974	59
730975	59
730990	66
730996.2	59
731730	34
731731	34
731732	34
731740	36
731741	36
731755	25
731756	25
731757	25
731768	26
731769	26
731770	26
731771	28
731772	28

REF	Page
731773	28
731774	27
731775	27
731776	27
731801	33
731802	33
731803	33
731804	32
731805	32
731806	32
731808	35
731813	40
731828	39
731829	39
731830	39
731831	45
731832	45
731833	45
731834	46
731835	46
731836	46
731839	30
731840	30
731841	30
731844	43
731845	43
731848	44
731849	44
731851	44
731852	61
731853	61
731854	61
731860	31
731861	31
731862	31
731863	31
731865	31
731866	31
731867	31
731868	31
731870	31
731871	31
731875	31
731877	31
731883	18
731884	18
731885	18
731886	18
731888	18
731909	31
732002	33
732012	32
732013	32
732019	67
732020	67
732023	35
732033	40
732072	39
732073	39

REF	Page
732083	45
732088	46
732091	43
732108	30
732130	24
732131	24
732132	24
732168	48
732205	43
732210	43
732295	34
732472	29
732482	47
732500	67
732501	67
732681	49
732800	75
732801	75
732802	75
732803	75
732804	75
732805	75
732806	75
732807	75
732808	75
732809	75
732810	75
732811	75
732812	75
732813	75
732814	75
732815	75
732816	75
732817	75
732818	75
732819	75
732850	75
732903	78
732960	76
732961	76
732962	76
732963	76
732964	76
732965	76
732966	76
732967	76
732980	76
732980FE	76
732981	76
732981FE	76
732982	76
732982FE	76
732983	76
732983FE	76
732984	76
732984FE	76
732985	76
732985FE	76
732986	76

Index of reference numbers



REF	Page	REF	Page	REF	Page	REF	Page
732986FE	76	738141.100M	45	760035.46	183	760081.30	160
732987	76	738161.100M	48	760046.46	182	760081.40	160
732987FE	76	738251.100M	43	760050.20	182	760081.46	160
733110.25	351	738252.100M	43	760050.30	182	760082.20	160
733110.50	351	738253.100M	43	760050.40	182	760082.30	160
733111.10	341, 351	738294.100M	34	760050.46	182	760082.40	160
733299.25	351	738520.025M	29	760051.20	182	760082.46	160
733299.50	351	738520.050M	29	760051.30	182	760083.20	160
733442.50	351	738520.100M	29	760051.40	182	760083.30	160
733551.25	351	738530.010M	24	760051.46	182	760083.40	160
735111	113, 134	738530.025M	24	760052.20	182	760083.46	160
735113	118, 134	738530.050M	24	760052.30	182	760084.20	160
735120	128, 134	738530.100M	24	760052.40	182	760084.30	160
735126	101, 134	738630.M	70, 95	760052.46	182	760084.40	160
735132	128, 134	738637	70	760053.20	182	760084.46	160
735133	118, 134	738638	70	760053.30	182	760086.46	160
735208	101, 134	738639.M	70	760053.40	182	760100.20	161
735211	113, 134	738645	70	760053.46	182	760100.30	161
735220	128, 134	738650.5	70	760054.20	182	760100.40	161
735311	113, 134	738651	70	760054.30	182	760100.46	161
735320	128, 134	738652	70	760054.40	182	760101.20	161
735408	101, 134	738655.2M	95	760054.46	182	760101.30	161
735500	113, 128, 135	738655.M	95	760059.20	183	760101.40	161
735501	113, 128, 135	738656.M	95	760059.30	183	760101.46	161
735511	113, 135	738657.M	95	760059.40	183	760102.20	161
735520	128, 135	738658.M	95	760059.46	183	760102.30	161
735611	113, 135	738659.M	95	760060.20	183	760102.40	161
735620	128, 135	738660.M	95	760060.30	183	760102.46	161
735700	113, 128, 135	738661.M	95	760060.40	183	760103.20	161
735711	113, 135	738662.M	95	760060.46	183	760103.30	161
735720	128, 135	738663.M	95	760061.46	183	760103.40	161
735811	113, 135	738680.100M	49	760062.20	183	760103.46	161
735820	128, 135	738702.030M	61	760062.30	183	760104.20	161
735911	113, 134	738770.M	95	760062.40	183	760104.30	161
735911.20	113, 128, 134	738771.M	95	760062.46	183	760104.40	161
735913	118, 134	760001.20	183	760063.20	183	760104.46	161
735920	128, 134	760001.30	183	760063.30	183	760106.46	161
736400.40	239	760001.40	183	760063.40	183	760149.40	187
736596.40	239	760001.46	183	760063.46	183	760149.46	187
736597.100	239	760002.20	183	760064.46	183	760150.40	187
736598	239	760002.30	183	760071.20	160	760150.46	187
736599.100	239	760002.40	183	760075.20	160	760151.40	187
736601	239	760002.46	183	760076.20	160	760151.46	187
736602.100	239	760004.20	183	760076.30	160	760152.40	187
738001.025M	33	760004.30	183	760076.40	160	760152.46	187
738001.100M	33	760004.40	183	760076.46	160	760153.40	187
738011.025M	32	760004.46	183	760078.20	160	760153.46	187
738011.050M	32	760007.40	190	760078.30	160	760154.46	187
738011.100M	32	760007.46	190	760078.40	160	760156.40	187
738021.100M	35	760008.20	183	760078.46	160	760156.46	187
738031.100M	40	760008.30	183	760079.20	160	760157.20	187
738071.100M	39	760008.40	183	760079.30	160	760157.30	187
738101.100M	46	760008.46	183	760079.40	160	760159.20	187
738111.100M	30	760012.46	190	760079.46	160	760170.46	190
738131.150M	64	760013.20	183	760080.20	160	760172.46	190
		760013.30	183	760080.30	160	760173.46	190
		760013.40	183	760080.40	160	760183.20	242
		760013.46	183	760080.46	160	760183.30	242
		760023.46	190	760081.20	160	760183.40	242



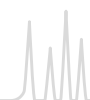
Index of reference numbers

REF	Page	REF	Page	REF	Page	REF	Page
760183.46	242	760262.20	167	760316.40	180	760410.30	165
760184.20	242	760262.30	167	760316.46	180	760410.40	165
760184.30	242	760262.40	167	760321.20	179	760410.46	165
760184.40	242	760262.46	167	760321.30	179	760412.20	165
760184.46	242	760263.20	167	760321.40	179	760412.30	165
760185.20	242	760263.30	167	760321.46	179	760412.40	165
760185.30	242	760263.40	167	760322.46	179	760412.46	165
760185.40	242	760263.46	167	760323.20	179	760413.20	165
760185.46	242	760264.20	167	760323.30	179	760413.30	165
760186.20	242	760264.30	167	760323.40	179	760413.40	165
760186.30	242	760264.40	167	760323.46	179	760413.46	165
760186.40	242	760264.46	167	760324.20	179	760414.20	165
760186.46	242	760271.20	167	760324.30	179	760414.30	165
760193.20	242	760271.30	167	760324.40	179	760414.40	165
760193.30	242	760271.40	167	760324.46	179	760414.46	165
760193.40	242	760271.46	167	760325.20	179	760415.20	165
760193.46	242	760272.20	167	760325.30	179	760415.30	165
760194.20	242	760272.30	167	760325.40	179	760415.40	165
760194.30	242	760272.40	167	760325.46	179	760415.46	165
760194.40	242	760272.46	167	760326.20	179	760416.46	165
760194.46	242	760273.20	167	760326.30	179	760431.20	175
760195.20	242	760273.30	167	760326.40	179	760431.30	175
760195.30	242	760273.40	167	760326.46	179	760431.40	175
760195.40	242	760273.46	167	760396.20	165	760431.46	175
760195.46	242	760274.20	167	760397.46	165	760433.20	175
760196.20	242	760275.20	167	760400.20	165	760433.30	175
760196.30	242	760301.20	179	760400.30	165	760433.40	175
760196.40	242	760301.30	179	760400.40	165	760433.46	175
760196.46	242	760301.40	179	760400.46	165	760435.20	175
760200.20	167	760301.46	179	760401.20	165	760436.20	175
760200.30	167	760304.20	179	760401.30	165	760436.30	175
760200.40	167	760305.20	179	760401.40	165	760436.40	175
760200.46	167	760305.30	179	760401.46	165	760436.46	175
760201.20	167	760305.40	179	760402.20	165	760438.20	175
760201.30	167	760305.46	179	760402.30	165	760443.20	175
760201.40	167	760306.20	179	760402.40	165	760443.30	175
760201.46	167	760306.30	179	760402.46	165	760443.40	175
760202.20	167	760306.40	179	760403.20	165	760443.46	175
760202.30	167	760306.46	179	760403.30	165	760445.46	175
760202.40	167	760308.20	179	760403.40	165	760446.20	175
760202.46	167	760311.20	180	760403.46	165	760446.30	175
760203.20	167	760311.30	180	760404.20	165	760446.40	175
760203.30	167	760311.40	180	760404.30	165	760446.46	175
760203.40	167	760311.46	180	760404.40	165	760447.20	175
760203.46	167	760312.46	180	760404.46	165	760447.30	175
760204.20	167	760313.20	180	760405.20	165	760447.40	175
760204.30	167	760313.30	180	760405.30	165	760447.46	175
760204.40	167	760313.40	180	760405.40	165	760448.20	175
760204.46	167	760313.46	180	760405.46	165	760448.30	175
760205.46	167	760314.20	180	760406.20	165	760448.40	175
760259.46	167	760314.30	180	760406.30	165	760448.46	175
760260.20	167	760314.40	180	760406.40	165	760449.20	175
760260.30	167	760314.46	180	760406.46	165	760449.30	175
760260.40	167	760315.20	180	760407.20	165	760449.40	175
760260.46	167	760315.30	180	760407.30	165	760449.46	175
760261.20	167	760315.40	180	760407.40	165	760453.20	175
760261.30	167	760315.46	180	760407.46	165	760453.30	175
760261.40	167	760316.20	180	760409.20	165	760453.40	175
760261.46	167	760316.30	180	760410.20	165	760453.46	175

Index of reference numbers



REF	Page	REF	Page	REF	Page	REF	Page
760455.46	175	760486.40	169	760552.46	185	760588.40	171
760456.20	175	760486.46	169	760553.20	185	760588.46	171
760456.30	175	760487.20	169	760553.30	185	760589.20	171
760456.40	175	760487.30	169	760553.40	185	760589.30	171
760456.46	175	760487.40	169	760553.46	185	760589.40	171
760457.20	175	760487.46	169	760554.20	185	760589.46	171
760457.30	175	760488.20	169	760554.30	185	760591.20	163
760457.40	175	760488.30	169	760554.40	185	760591.30	163
760457.46	175	760488.40	169	760554.46	185	760591.40	163
760458.20	175	760488.46	169	760561.20	171	760591.46	163
760458.30	175	760489.20	169	760561.30	171	760593.20	163
760458.40	175	760489.30	169	760561.40	171	760593.30	163
760458.46	175	760489.40	169	760561.46	171	760593.40	163
760459.20	175	760489.46	169	760563.20	171	760593.46	163
760459.30	175	760521.20	185	760563.30	171	760595.20	163
760459.40	175	760521.30	185	760563.40	171	760596.20	163
760459.46	175	760521.40	185	760563.46	171	760596.30	163
760461.20	169	760521.46	185	760565.20	171	760596.40	163
760461.30	169	760523.20	185	760566.20	171	760596.46	163
760461.40	169	760523.30	185	760566.30	171	760598.20	163
760461.46	169	760523.40	185	760566.40	171	760603.20	163
760463.20	169	760523.46	185	760566.46	171	760603.30	163
760463.30	169	760525.20	185	760568.20	171	760603.40	163
760463.40	169	760526.20	185	760573.20	171	760603.46	163
760463.46	169	760526.30	185	760573.30	171	760605.46	163
760465.20	169	760526.40	185	760573.40	171	760606.20	163
760466.20	169	760526.46	185	760573.46	171	760606.30	163
760466.30	169	760528.20	185	760575.46	171	760606.40	163
760466.40	169	760530.20	185	760576.20	171	760606.46	163
760466.46	169	760530.30	185	760576.30	171	760607.20	163
760468.20	169	760530.40	185	760576.40	171	760607.30	163
760473.20	169	760530.46	185	760576.46	171	760607.40	163
760473.30	169	760531.20	185	760577.20	171	760607.46	163
760473.40	169	760531.30	185	760577.30	171	760608.20	163
760473.46	169	760531.40	185	760577.40	171	760608.30	163
760475.46	169	760531.46	185	760577.46	171	760608.40	163
760476.20	169	760532.20	185	760578.20	171	760608.46	163
760476.30	169	760532.30	185	760578.30	171	760609.20	163
760476.40	169	760532.40	185	760578.40	171	760609.30	163
760476.46	169	760532.46	185	760578.46	171	760609.40	163
760477.20	169	760533.20	185	760579.20	171	760609.46	163
760477.30	169	760533.30	185	760579.30	171	760613.20	163
760477.40	169	760533.40	185	760579.40	171	760613.30	163
760477.46	169	760533.46	185	760579.46	171	760613.40	163
760478.20	169	760534.20	185	760583.20	171	760613.46	163
760478.30	169	760534.30	185	760583.30	171	760615.46	163
760478.40	169	760534.40	185	760583.40	171	760616.20	163
760478.46	169	760534.46	185	760583.46	171	760616.30	163
760479.20	169	760550.20	185	760585.46	171	760616.40	163
760479.30	169	760550.30	185	760586.20	171	760616.46	163
760479.40	169	760550.40	185	760586.30	171	760617.20	163
760479.46	169	760550.46	185	760586.40	171	760617.30	163
760483.20	169	760551.20	185	760586.46	171	760617.40	163
760483.30	169	760551.30	185	760587.20	171	760617.46	163
760483.40	169	760551.40	185	760587.30	171	760618.20	163
760483.46	169	760551.46	185	760587.40	171	760618.30	163
760485.46	169	760552.20	185	760587.46	171	760618.40	163
760486.20	169	760552.30	185	760588.20	171	760618.46	163
760486.30	169	760552.40	185	760588.30	171	760619.20	163



Index of reference numbers

REF	Page	REF	Page	REF	Page	REF	Page
760619.30	163	760739.46	189	760802.30	177	761910.20	165
760619.40	163	760740.20	189	760802.40	177	761910.30	165
760619.46	163	760741.20	189	760802.46	177	761911.20	165
760620.20	173	760742.46	189	760803.20	177	761911.30	165
760620.30	173	760749.46	161	760803.30	177	761912.20	165
760620.40	173	760750.20	161	760803.40	177	761912.30	165
760620.46	173	760750.30	161	760803.46	177	761915.20	167
760621.20	173	760750.40	161	760805.20	177	761915.30	167
760621.30	173	760750.46	161	760805.30	177	761916.20	167
760621.40	173	760751.20	161	760805.40	177	761916.30	167
760621.46	173	760751.30	161	760805.46	177	761917.20	167
760622.20	173	760751.40	161	760806.20	177	761917.30	167
760622.30	173	760751.46	161	760806.30	177	761920.20	177
760622.40	173	760752.20	161	760806.40	177	761920.30	177
760622.46	173	760752.30	161	760806.46	177	761921.20	177
760623.20	173	760752.40	161	760807.20	177	761921.30	177
760623.30	173	760752.46	161	760807.30	177	761922.20	177
760623.40	173	760753.20	161	760807.40	177	761922.30	177
760623.46	173	760753.30	161	760807.46	177	761925.20	179
760624.20	173	760753.40	161	760808.20	177	761925.30	179
760624.30	173	760753.46	161	760808.30	177	761926.20	179
760624.40	173	760754.20	161	760808.40	177	761926.30	179
760624.46	173	760754.30	161	760808.46	177	761927.20	180
760625.20	173	760754.40	161	760809.20	177	761927.30	180
760625.30	173	760754.46	161	760809.30	177	761931.20	182
760625.40	173	760755.20	161	760809.40	177	761931.30	182
760625.46	173	760755.30	161	760809.46	177	761932.20	183
760700.20	183	760755.40	161	760812.20	177	761932.30	183
760700.30	183	760755.46	161	760812.30	177	761936.20	183
760700.40	183	760756.20	161	760812.40	177	761936.30	183
760700.46	183	760756.30	161	760812.46	177	761937.20	183
760701.20	183	760756.40	161	760813.46	177	761937.30	183
760701.30	183	760756.46	161	760815.46	177	761941.20	187
760701.40	183	760757.20	161	760821.20	177	761941.30	187
760701.46	183	760757.30	161	760821.30	177	761943.30	187
760702.46	183	760757.40	161	760821.40	177	761944.30	187
760703.20	183	760757.46	161	760821.46	177	761951.20	189
760703.30	183	760759.20	161	760822.20	177	761951.30	189
760703.40	183	760760.20	161	760822.30	177	761952.30	189
760703.46	183	760773.20	227	760822.40	177	761953.20	189
760704.20	183	760773.30	227	760822.46	177	761953.30	189
760704.30	183	760773.40	227	760823.20	177	761960.20	185
760704.40	183	760783.30	227	760823.30	177	761960.30	185
760704.46	183	760783.40	227	760823.40	177	761961.20	185
760706.46	183	760784.30	227	760823.46	177	761961.30	185
760720.40	189	760784.40	227	760824.20	177	761962.20	185
760720.46	189	760785.30	227	760825.20	177	761962.30	185
760721.46	189	760785.40	227	761810.20	173	761966.30	190
760722.40	189	760786.30	227	761810.30	173	761967.30	190
760722.46	189	760786.40	227	761901.20	160	761970.20	227
760730.20	189	760800.20	177	761901.30	160	761970.30	227
760730.30	189	760800.30	177	761902.20	160	761971.30	227
760730.40	189	760800.40	177	761902.30	160	761975.20	175
760730.46	189	760800.46	177	761903.20	161	761975.30	175
760731.46	189	760801.20	177	761903.30	161	761976.20	175
760732.20	189	760801.30	177	761905.20	161	761976.30	175
760732.30	189	760801.40	177	761905.30	161	761977.20	175
760732.40	189	760801.46	177	761907.20	161	761977.30	175
760732.46	189	760802.20	177	761907.30	161	761980.20	169

Index of reference numbers



REF	Page	REF	Page	REF	Page	REF	Page
761980.30	169	762081.210	161	762273.210	167	762556.320	180
761981.20	169	762082.210	161	762291.160	167	762556.400	180
761981.30	169	762090.160	183	762291.80	167	762556.500	180
761982.20	169	762090.80	183	762293.320	167	762561.100	180
761982.30	169	762092.160	183	762302.100	183	762561.210	180
761985.20	171	762092.80	183	762302.210	183	762563.210	180
761985.30	171	762094.160	190	762303.400	183	762563.320	180
761986.20	171	762094.80	190	762311.320	183	762563.500	180
761986.30	171	762097.160	161	762311.500	183	762564.100	180
761987.20	171	762097.80	161	762321.320	183	762564.210	180
761987.30	171	762100.400	161	762330.320	190	762565.320	180
761988.20	242	762103.100	161	762350.100	163	762565.400	180
761988.30	242	762103.210	161	762350.210	163	762565.500	180
761989.20	242	762109.100	161	762351.100	163	762566.100	180
761989.30	242	762109.210	161	762351.210	163	762566.210	180
761990.20	163	762113.100	161	762352.400	163	762566.320	180
761990.30	163	762113.210	161	762353.100	163	762566.400	180
761991.20	163	762113.320	161	762353.210	163	762566.500	180
761991.30	163	762113.400	161	762353.320	163	762571.100	180
761992.20	163	762160.160	161	762353.400	163	762571.210	180
761992.30	163	762160.80	161	762354.160	163	762573.210	180
762003.100	183	762163.320	161	762354.80	163	762573.320	180
762003.210	183	762210.100	171, 175	762355.320	163	762573.500	180
762007.100	190	762210.210	171, 175	762371.400	177	762574.100	180
762007.210	190	762211.100	171, 175	762372.100	177	762574.210	180
762007.400	190	762211.210	171, 175	762372.210	177	762575.320	180
762010.100	183	762212.400	171, 175	762373.100	177	762575.400	180
762010.210	183	762213.100	171, 175	762373.210	177	762575.500	180
762010.320	183	762213.210	171, 175	762373.320	177	762576.100	180
762010.400	183	762213.320	171, 175	762373.400	177	762576.210	180
762010.500	183	762213.400	171, 175	762375.100	177	762576.320	180
762011.100	183	762214.160	175	762375.210	177	762576.400	180
762011.210	183	762214.80	175	762390.160	177	762576.500	180
762022.100	183	762216.320	175	762390.80	177	762591.160	180
762022.210	183	762220.100	169	762392.320	177	762591.80	180
762022.320	183	762220.210	169	762403.100	165	762592.320	180
762022.400	183	762221.100	169	762403.210	165	762592.500	180
762027.400	183	762221.210	169	762403.320	165	763132.20	201
762029.100	183	762222.400	169	762403.400	165	763132.30	201
762029.210	183	762223.100	169	762404.100	165	763132.40	201
762061.100	183	762223.210	169	762404.210	165	763132.46	201
762061.210	183	762223.320	169	762405.100	165	763134.20	201
762062.100	183	762223.400	169	762405.210	165	763134.30	201
762062.210	183	762224.160	169	762406.400	165	763134.40	201
762062.320	183	762224.80	169	762420.160	165	763134.46	201
762062.400	183	762226.320	169	762420.80	165	763136.20	201
762070.100	161	762234.160	171	762422.320	165	763136.30	201
762070.210	161	762234.80	171	762551.100	180	763136.40	201
762071.100	161	762236.320	171	762551.210	180	763136.46	201
762071.210	161	762250.210	161	762553.210	180	763138.20	201
762072.100	183	762250.400	161	762553.320	180	763138.30	201
762072.210	183	762269.400	167	762553.500	180	763152.20	201
762075.400	190	762271.100	167	762554.100	180	763152.30	201
762077.100	190	762271.210	167	762554.210	180	763152.40	201
762077.210	190	762272.100	167	762555.320	180	763152.46	201
762078.100	190	762272.210	167	762555.400	180	763154.20	201
762078.210	190	762272.320	167	762555.500	180	763154.30	201
762079.400	183	762272.400	167	762556.100	180	763154.40	201
762081.100	161	762273.100	167	762556.210	180	763154.46	201



Index of reference numbers

REF	Page	REF	Page	REF	Page	REF	Page
763156.20	201	763532.46	207	808013	289	811073	284
763156.30	201	763534.20	207	808023	289	811074	284
763156.40	201	763534.30	207	808033	289	811075	284
763156.46	201	763534.40	207	808043	289	811081	284
763157.20	201	763534.46	207	808053	289	811082	284
763157.30	201	763536.20	207	808063	289	811111	286
763157.40	201	763536.30	207	808072	289	811112	286
763157.46	201	763536.40	207	808073	289	811115	285
763158.20	201	763536.46	207	809011	276	811116	285
763158.30	201	763538.20	207	809012	276	811120	287
763232.20	203	763538.30	207	809013	276	812003	277
763232.30	203	763732.20	205	809017	276	812004	277
763232.40	203	763732.30	205	809017.200	276	812005	277
763232.46	203	763732.40	205	809020	276	812005.200	277
763234.20	203	763732.46	205	809021	276	812006	277
763234.30	203	763734.20	205	809022	276	812007	277
763234.40	203	763734.30	205	809023	276	812008	277
763234.46	203	763734.40	205	809027	276	812010	282
763236.20	203	763734.46	205	809027.200	276	812011	282
763236.30	203	763736.20	205	809028.100	276	812013	282
763236.40	203	763736.30	205	809033	292	812014	282
763236.46	203	763736.40	205	809043	292	814000	269
763238.20	203	763736.46	205	809051	276	814001	269
763238.30	203	763738.20	205	809053	276	814002	269
763252.20	203	763738.30	205	809061	276	814003	269
763252.30	203	801011	289	809063	276	814011	269
763252.40	203	801013	289	809073	276	814012	269
763252.46	203	801022	289	809083	276	814013	269
763254.20	203	801023	289	809121	276	814018	295
763254.30	203	801033	290	809122	276	814019	295
763254.40	203	801053	290	809123	276	814021	295
763254.46	203	801063	290	810012	279	814022	295
763256.20	203	801113	289	810013	279	814023	295
763256.30	203	801123	289	810022	279	814024	295
763256.40	203	802021	288	810023	279	814025	271
763256.46	203	802022	288	810043	293	814026	271
763257.20	203	802023	288	810053	293	814027	271
763257.30	203	803012	290	810063	292	814028	271
763257.40	203	803013	290	810123	279	814029	269
763257.46	203	803022	290	811011	281	814030	295
763258.20	203	803023	290	811012	281	814100	271
763258.30	203	804022	291	811013	281	814101	295
763332.20	209	804023	291	811021	281	814102	295
763332.30	209	805012	276	811022	281	814103	295
763332.40	209	805013	276	811023	281	814104	295
763332.46	209	805014	276	811032	279	814200	271
763334.20	209	805017	276	811042	279	814201	271
763334.30	209	805021	276	811051	292	814202	271
763334.40	209	805022	276	811052	283	814203	296
763334.46	209	805023	276	811054	283	814204	271
763336.20	209	805024	276	811055	291	814205	271
763336.30	209	805032	276	811056	291	814206	296
763336.40	209	805901	276	811057	291	814300	271
763336.46	209	805902	276	811058	291	814301	271
763338.20	209	806013	293	811059	291	814302	296
763338.30	209	806023	293	811062	283	814400	271
763532.20	207	807021	288	811064	283	814401	296
763532.30	207	807023	288	811071	284	814402	296
763532.40	207	807033	288	811072	284	814403	296