Applications Guide

Environmental

Fuels and Petrochemical

Pharmaceutical

Food, Flavors and Fragrances

Chemical

Forensic

SGE Analytical Science
SGE Analytical Science

Few companies can claim to be able to provide a total solution for analytical science; SGE is one of those few. From sample preparation, to injection, the separation and throughout the chromatographic process in either LC or GC there is a SGE product that has been designed to provide you with the results you need time and again.

This brochure highlights some of SGE’s capabilities in capillary gas chromatography, specifically in the technically demanding area of capillary columns. SGE columns are engineered for consistent separation performance and can be found in many laboratories being tasked to perform everything from routine analyses to the latest R&D challenges.

**forte™ GC Capillary Columns**

With over 30 year's experience, GC capillary columns truly are SGE's strength, its forte.

SGE is the only independent manufacturer of GC capillary columns that has the skill and technology to control all critical processes from producing the fused silica capillary tubing, through the phase synthesis, to the validation of the performance of each column.

SGE offers a comprehensive range of **forte™** GC capillary columns for almost any chromatographic application providing the best possible combination of, Performance, Robustness, Reproducibility, Low Bleed and Inertness.

With this brochure we bring to you a small taste of the applications you might consider running on an SGE GC capillary column. If the application is not in this guide, please visit our website www.sge.com.

**forte™; Now with added capabilities**

SilGuard™ is SGE’s new development for the **forte™** line of GC capillary columns, which further enhances column robustness and endurance adding additional analytical capabilities to the standard GC column. It is a unique integrated guard column system, developed using SGE’s renowned SilTite™ ferrule technology.

SilGuard™ technology stands to benefit chromatographers by reducing the amount of non-volatiles entering the analytical column and as a result, **forte™** columns can now offer enhanced endurance with no loss of sensitivity.

For more information on SilGuard™ contact you local SGE office, distributor or visit [www.sge.com](http://www.sge.com)
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For further information on our full range of products, please visit www.sge.com
Guidelines for Choosing Columns

1. Stationary Phase

- Select the least polar phase that will perform the separation you require.
- Non-polar stationary phases separate analytes predominantly by order of boiling point.
- Increase the amount of phenyl and/or cyanopropyl content in the phase, and the separation is then influenced more by differences in dipole moments or charge distributions (BP10, BPX35, BPX50, BP225 and BPX70).
- To separate compounds that differ more in their hydrogen bonding capacities (for example aldehydes and alcohols), polyethylene glycol type phases are best suited - SolGel-WAX™, BP20 (WAX) and BP21 (FFAP).

2. Internal Diameter

- The smaller the diameter the greater the efficiency, hence better resolution. Fast columns (0.1 mm ID) are used for faster analysis because the same resolution can be achieved in a shorter time.
Effect of Film Thickness.

- For samples with a variation in solute concentration, a thicker film column is recommended. This will reduce the possibility of broad overloaded peaks co-eluting with other compounds of interest. If the separation of two solutes is sufficient and co-elution is still unlikely, even with large differences in concentration, then a thinner film can be used. The greater the film thickness the greater the retention of solutes, therefore the higher the elution temperature. As a rule, doubling the film thickness results in an increase in elution temperature of approximately 15-20° under isothermal conditions. Using a temperature program, the increase in elution temperature is slightly less.

Effect of Length

- Always try to select the shortest column that will provide the required resolution for the application. If the maximum column length available is being used, and resolution of the sample mixture is still inadequate then try changing the stationary phase or internal diameter.
- Resolution is proportional to the square root of the column efficiency. Therefore, doubling the column length will only increase the resolving power of the column by approximately 40%.

Formula to calculate Phase Ratio

\[ \phi = \frac{id}{4d_f} \]

where

- \( \phi \) = ratio
- \( id \) = column internal diameter (µm)
- \( d_f \) = film thickness (µm)

PHASE RATIO

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Above shows the phase ratio (\( \phi \)) available for the SGE range of capillary columns. Keeping a similar phase ratio when changing column internal diameters will ensure that your chromatographic parameters will not need substantial changes.

For further information on our full range of products, please visit [www.sge.com](http://www.sge.com)
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- ● Indicates recommended phases to be used for the application
- ○ Indicates alternative phases that can be used for the application

For further information on our full range of products, please visit [www.sge.com](http://www.sge.com)
The widespread use of GC-MS for Environmental analyses requires both low bleed and inertness. The broad range of compounds of interest means that medium polarity phases become more useful. BPX5, BPX35, and BPX50 provide a range of polarities, all with low bleed, high temperature limits, and robustness. The inclusion of SilGuard™ integrated guard column technology with every forte™ BPX5 capillary GC column provides additional protection by reducing the amount of non volatiles entering the analytical column.

For specialized applications such as PCBs, SGE’s HT8 delivers unique separation capabilities.

Applications

• Analysis of PCB’S, PCDT’S, and other complex mixtures using BPX5 and SolGel-1ms
• HT8: The Perfect PCB Column
• Fast Pesticide Screening Using a BPX5 GC Capillary Column
• Analysis of Polychlorinated Dibenzodioxins and Furans on BPX5
• Analysis of Polynuclear Aromatic Hydrocarbons on BPX35
• Analysis of Polynuclear Aromatic Hydrocarbons on BPX5
• Analysis of Volatile Organic Pollutants on BPX-Volatiles
• Applications using BPX90
• Analysis of Volatiles in Drinking Water on 25 m BP624 Column
• Polychlorinated Biphenyls PCB Analysis

For further information on our full range of products, please visit [www.sge.com](http://www.sge.com)
ANALYSIS OF PCB’S, PCDT’S, AND OTHER COMPLEX MIXTURES USING BPX5 AND SOLGEL-1ms

SIM 7-Group Analysis of 44 mono- to deca-PBDE’s via cool-on-column (3-µL). Deca-PBDE 209 at 310 °C, PBDEs 33/28 and 138/166 partially resolved, PBDE 85 coeluted with 155.

- 44 Mono-Deca-PBDEs
- 6890 GC/Autospec HRMS
- Cool-on-column inlet
- (No liner but 0.53 mm retention gap)
- 12.5 m BPX5 0.15 mm ID 0.1 µm
- 0.25 m 0.53 mm ID plus
- 2 m 0.25 mm retention gaps
- He programmed 245-415 kPa
- 150 °C-315 °C @ 3 °C/min

SIM 2-Group Analysis for non-o-PCBs. Tetra-PCB’s 77 and 81 (A) are resolved from residual o-PCB’s (97, 87, 110, and 136). Penta-126 (B), and hexa-169 (C) also detected in eluate 2-basic alumina of DX-3 QC sediment extract (5 of 500 µL) Ion chromatograms (not smoothed). PBDE’s are in same eluate (Peterman et al., 2006). Tetra-PBDE 47 from (M-2 Br)+ incidentally detected (B); 0.3 ng/g near lab background.

- Dioxin-like non-ortho PCBs
- HP 5890A GC/VG 70S HRMS
- Heated (275 ºC) Direct inlet
- 4 mm Siltek Cyclo-Uniliner
- 30 m SolGel-1ms 0.15 mm ID 0.1 µm
- 2.5 m x 0.25 mm ID retention gap
- He constant at 415 kPa
- 155 ºC (1 min) - 205 ºC @ 1.8 ºC/min then to 310 ºC @ 3.6 ºC/min

ACKNOWLEDGEMENT
Paul H. Peterman, US Geological Survey, Columbia Environmental Research Center. For additional information see SGE application note AN-0030-C.

SGE liners undergo a high temperature deactivation process making them ideal for using with active compounds
Chromatogram on the left demonstrates clearly the significant difference in selectivity of the HTB column. By GC/MS, quantitation of CB28 using a standard 5% phenylpolysiloxane column is impossible as coelution with CB31 (with the same number of chlorines) occurs. HTB separates the two congeners by a full minute allowing quantitation to be performed with ease.

**AROCOR 1242**
- **Phase:** HTB, 0.25 µm film
- **Column:** 50 m x 0.22 mm ID
- **Initial Temp:** 80 °C, 2 min
- **Rate 1:** 30 °C/min
- **Temp 2:** 170 °C
- **Rate 2:** 3 °C/min
- **Final Temp:** Split, 300 °C
- **Carrier Gas:** He, 40 psi
- **Detector:** ECD, 330 °C

**Separation of CB31 and CB28**

**Standard 5% Phenylsiloxane**

**AROCOR 1260**
- **Phase:** HTB, 0.25 µm film
- **Column:** 50 m x 0.22 mm ID
- **Initial Temp:** 80 °C, 2 min
- **Rate 1:** 30 °C/min
- **Temp 2:** 170 °C
- **Rate 2:** 3 °C/min
- **Final Temp:** Split, 300 °C
- **Carrier Gas:** He, 40 psi
- **Detector:** ECD, 330 °C

**AROCOR 1260**

**AROCOR 1260**

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FAST PESTICIDE SCREENING USING A BPX5 GC CAPILLARY COLUMN

Phase: SGE forte BPXSDX
Column: 40 m x 0.18 mm ID x 0.18 µm
Initial Temp: 80 °C, 1 min
Rate 1: 25 °C/min to 300 °C
Final Temp: 300 °C, 7 min
Detector Type: LECO™ TOF Mass spectrometer
Carrier Gas: He
Carrier Gas Flow: constant flow mode at 1 mL/min
~75 cm/sec
Injection Mode: splitless
Injection Temperature: 270 °C
Total run time: 16.8 min
Detector voltage: 1700 V
Data acquisition speed: 10 Hz
Column Part Number: 054229

ACKNOWLEDGEMENT
SGE would like to thank Prof Jana Hajšlová and Jakub Schurek from VSCHT (Prague, CZ) for providing these chromatograms.
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<th>Name</th>
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The list of some pesticides used in the sample, and their retention times

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**ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS ON BPX35**

**Components**
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Pyrene
8. Fluoranthene
9. Benzo (a) anthracene
10. Chrysene
11. Benzo (b) fluoranthene
12. Benzo (k) fluoranthene
13. Benzo (a) pyrene
14. Indeno (1,2,3-c,d)pyrene
15. Dibenzo (a,h) anthracene
16. Benzo (g,h,i) perylene

**Phase:** BPX35, 0.25 µm
**Column:** 30 m x 0.22 mm ID
**Initial Temp:** 100 °C, 1 min
**Rate:** 10 °C/min
**Temp 1:** 240 °C
**Rate 2:** 2 °C/min
**Temp 2:** 280 °C
**Rate 3:** 10 °C/min
**Final Temp:** 320 °C
**Detector:** Mass Spectrometer
**Column Part Number:** 054714

**ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS ON BPX5**

**Components**
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Pyrene
8. Fluoranthene
9. Benzo (a) anthracene
10. Chrysene
11. Benzo (b) fluoranthene
12. Benzo (k) fluoranthene
13. Benzo (a) pyrene
14. Indeno (1,2,3-c,d)pyrene
15. Dibenzo (a,h) anthracene
16. Benzo (g,h,i) perylene

**Phase:** BPX5, 0.25 µm
**Column:** 50 m x 0.22 mm ID
**Initial Temp:** 80 °C
**Rate 1:** 10 °C/min
**Temp 1:** 240 °C
**Rate 2:** 2 °C/min
**Temp 2:** 280 °C
**Rate 3:** 10 °C/min
**Final Temp:** 320 °C
**Detector:** Mass Spectrometer
**Column Part Number:** 054114

---

**ANALYSIS OF POLYCHLORINATED DIBENZODIOXINS AND FURANS ON BPX5**

**Single Ion Chromatograms of TCDF Isomers**

- m/z 305.8987
- m/z 317.9389

**Single Ion Chromatograms of TCDD Isomers**

- m/z 321.8936
- m/z 333.9339

---

**EXPERT TIP**
Remember: the lower the temperature, the longer your column will last.
**ANALYSIS OF VOLATILE ORGANIC POLLUTANTS ON BPX-VOLATILES**

**Components**

1. Dichlorodifluoromethane  
2. Chloromethane  
3. Vinyl Chloride  
4. Bromomethane  
5. Chloromethane  
6. Trichlorofluoromethane  
7. 1,1-Dichloroethane  
8. Dichloromethane  
9. trans-1,2-Dichloroethene  
10. 1,1-Dichloroethene  
11. 2,2-Dichloropropane  
12. cis-1,2-Dichloroethane  
13. Bromochloromethane  
14. Chloroform  
15. 1,1,1-Trichloroethane  
16. 1,1-Dichloroethene  
17. Carbon Tetra Chloride  
18. Benzene  
19. 1,2-Dichloroethane  
20. Trichloroethene  
21. 1,2-Dichloropropane  
22. Dibromomethane  
23. Bromomethylketone  
24. cis-1,3-Dichloropropene  
25. Toluene  
26. trans-1,3-Dichloropropene  
27. 1,1,2-Trichloroethene  
28. Tetrachloroethene  
29. 1,3-Dichloropropane  
30. Dibromochloromethane  
31. 1,2-Dibromoethane  
32. Chlorobenzene  
33. Ethylbenzene  
34. 1,2-Dibromoethane  
35. p-Xylene  
36. m-Xylene  
37. o-Xylene  
38. Styrene  
39. Bromoform  
40. Iodopropylene  
41. Bromobenzene  
42. 1,1,2,2-Tetrachloroethane  
43. 1,3-Trichloropropane  
44. n-Propyl benzene  
45. 2,3-Dichloro-2,3-trifluorobutane  
46. 1,3,3-Trifluoro-2-propanone  
47. 4-Chlorotoluene  
48. tert-Butylbenzene  
49. 1,2,4-Trimethylbenzene  
50. sec-Butylbenzene  
51. 1,3-Dichlorobenzene  
52. p-Xylene  
53. 1,2-Dichlorobenzene  
54. n-Octylbenzene  
55. m-Xylene  
56. 1,2-Dichlorobenzene  
57. 1,2-Dibromo-3-chloropropane  
58. Hexachlorobutadiene  
59. Naphthalene  
60. 1,2,3-Trichlorobenzene

**Phase:**

BPX-Volatiles 1 μm film
502.2 mix:
200 ppm in Methanol
Initial Temp: 40 °C , 0 min
Rate 1: 6 °C to 210 °C
Rate 2: 15 °C to 240 °C
Final Temp: 240 °C, 5 min
Detector Type: Mass Spectrometer
Carrier Gas: He, 40.3 psi
Carrier Gas Flow: 1.2 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 40 °C
Injection Mode: Split
Split Ratio: 50:1
Injection Volume: 1 µL
Injection Temperature: 250 °C
Autosampler: No
Liner Type: ms-NoVent™ Part No: 113409
Full scan:
0.00 - 60.00 m/z
1000000 - 1200000 - 800000 - 400000 - 0
1.60 2.00 2.40 2.80 3.20 3.60 4.00 4.40
14.00 15.00 16.00 17.00 18.00 19.00 20.00

Chromatogram showing analysis of commonly screened volatile organic pollutants

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ANALYSIS OF VOLATILES IN DRINKING WATER ON 25 M BP624 COLUMN

**Components**
1. Difluorobenzene
2. Benzene
3. Toluene - (d8)
4. Toluene
5. Chlorobenzene - (d5)
6. Ethyl benzene
7. p and m-Xylene
8. o-Xylene
9. Bromofluorobenzene

**VOLATILES IN DRINKING WATER**
Phase: BP624, 1.2 µm
Column: 25 m x 0.22 mm ID
Initial Temp: 50 °C, 2 min
Rate: 15 °C/min
Final Temp: 170 °C
Detector: HP5970 MSD
Injection Mode: Hexadecane extract
Carrier Gas: He, 15 psi
Column Part Number: 054826

**EXPERT TIP**
Condition column at either 20 ° above the maximum method temperature or the recommended maximum column temperature (whichever is lower).
### POLYCHLORINATED BIPHENYLS PCB ANALYSIS

#### Components

|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|

#### Phase: HTB, 0.25 μm

- **Column:** 25 m x 0.22 mm ID
- **Initial Temp:** 60 °C, 2 min
- **Rate:** 12 °C/min
- **Final Temp:** 360 °C, 10 min
- **Detector:** Ion Trap MS
- **Injection Mode:** PTV
- **Carrier Gas:** He, 15 psi

#### Performance Specifications

- HTB 8% Phenyl (Equiv) Polycarborane - Siloxane
- Minimum Operating Temp.: -20 °C
- Maximum Cycling Temp.: 370 °C (Polyimide)

#### PCB ANALYSIS

#### Phase: HTB, 0.25 μm film

- **Column:** 50 m x 0.22 mm ID
- **Initial Temp:** 90 °C, 2 min
- **Rate:** 2 °C/min
- **Final Temp:** 170 °C, 7.5 min
- **Rate:** 3.5 °C/min
- **Temp 2:** 285 °C
- **Rate:** 20 °C/min
- **Temp 3:** 320 °C
- **Carrier Gas:** He, 40 psi
- **Detector:** ECD

#### Components

|------------|---------|----------|----------|----------|---------|---------|---------|---------|---------|----------|---------|---------|---------|

#### Environmental

- **Carrier gas:** He, 43 cm/sec
- **Part Number:** 054676

---

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GC analysis in the Food, Flavors and Fragrances area covers a diverse range of compounds that vary in both polarity and boiling point. As a consequence a range of different columns are often required. Chromatograms are often complex, and any single column may not give enough separation of all of the compounds that may be present. Pairs of columns such as BPX5 and SolGel-WAX™ may be used to overcome this problem.

For specific classes of compounds such as fatty acids, specialized columns are often necessary. Short chain fatty acids may be analyzed as free acids on the Nitrotetraphalic acid (TPA) modified Polyethylene Glycol BP21 phase. Longer chain fatty acids are usually analyzed as fatty acid methyl esters on wax phases such as BP20 and SolGel-WAX™, or for more demanding applications, BPX70 or BPX90.

Applications

- Comparison of Geranium Oils on SolGel-WAX™
- Analysis of Eucalyptus Oil on SolGel-WAX™
- Analysis of Lavender Oil on Cydex-B
- Analysis of Lavender Oil on BPX-5
- Analysis of Tasmanian Lavender Oil on SolGel-WAX™
- Analysis of Wine on BP20
- Analysis of Scotch Whisky on BP20
- Analysis of Teatree Oil on BPX5
- Analysis of Omega-3 Fatty Acids using BPX70
- BPX90 – a Highly Polar Phase for FAME Analysis
- Analysis of PUFA-1 Marine FAME on BPX70
- Analysis of PUFA-2 Animal FAME on BPX70
- Analysis of PUFA-1 Marine FAME on BPX70
ANALYSIS OF EUCALYPTUS OIL ON SOLGEL-WAX™

Components
1. α-Pinene
2. β-Pinene
3. Sabinene
4. Limonene
5. 1,8-Cineole
6. p-Cymene
7. Linalool L
8. Terpinen-4-ol
9. α-Terpinyl acetate
10. α-Terpinyl acetate
11. d-Carvoene

EXPERIMENTAL CONDITIONS

Column: SGE forte SolGel-WAX™, 30 m x 0.25 mm x 0.25 μm (SGE P/N 054796)
Temperature Program:
- 60 °C for 3 min,
- then 4 °C/min to 220 °C
Carrier Gas: He
Flow: 0.6 mL/min
Injection Volume
0.3 μL split ratio 30:1
Injection temp: 250 °C
Liner: SGE P/N 092019 single tapered with quartz wool

ACKNOWLEDGEMENT

We thank M. Bernet and M. Didtsch of the ISIPCA Group, Research and Studies Centre for Fragrance, Cosmetics and Food Flavors, France, for providing these chromatograms. For more information see SGE application note AN-0020-C.
Components
1. 3-Octanone
2. Octenyl acetate
3. Octanol
4. cis Linalool oxide
5. trans Linalool oxide
6. Linalool L
7. Linalyl acetate
8. Terpinen-4-ol
9. Lavandulyl acetate
10. Borneol L
11. Caryophyllene oxide

LAVENDER OIL
Phase: CYDEX-B, 0.25 µm film
Column: 50 m x 0.22 mm ID
Initial Temp: Isothermal at 90 °C
Final Temp: FID
Detector: 32 x 10^{-12}AFS
Injection Mode: Split
Column Part Number: 054901

Components
1. (+) Linalool
2. (-) Linalool

ANALYSIS OF LAVENDER OIL ON BPX5
Phase: BPX5, 0.25 µm film
Lavender Oil: Lavender Oil in ethanol
Column: 30 m x 0.25 mm ID
Initial Temp: 40 °C, 1 min
Rate 1: 5 °C/min to 260 °C
Final Temp: 260 °C
Detector Type: Mass Spectrometer
Carrier Gas: He, 7.0 psi
Carrier Gas Flow: 1.0 mL/min
Constant Flow: On
Average Linear Velocity: 36 cm/sec at 40 °C
Injection Mode: Split
Split Ratio: 200:1
Purge on (Split) Vent Flow: 200 mL/min
Injection Volume: 0.2 µL
Injection Temperature: 250 °C
Autosampler: No
Liner Type: 4 mm ID Double Taper Liner
Liner Part Number: 092018
Column Part Number: 054101

Components
1. ß- Pinene
2. 1-Octen-3-ol
3. 3-Octanol
4. p-Cymene
5. Limonene
6. cis-Damodane
7. cis-Linalool oxide
8. trans-Linalool oxide
9. Linalool L
10. Octenyl acetate
11. Camphor
12. Lavandulol
13. Borneol L
14. Terpinen-4-ol
15. α-Terpineol
16. α-Cadinene
17. Linalool
18. α-Cryophyllene
19. Geranyl Acetate
20. α-Santalene
21. ß-Caryophyllene
22. α-Cadinene
23. α-Cryophyllene oxide

ANALYSIS OF TASSMANIAN LAVENDER OIL SOLGEL-WAX™
Phase: SolGel-WAX™, 0.25 µm film
Sample: Neat
Column: 30 m x 0.25 mm ID
Initial Temp: 40 °C, 1 min
Rate 1: 8 °C/min to 220 °C
Final Temp: 220 °C, 5 min
Detector Type: Mass Spectrometer
Carrier Gas: He, 25.7 psi
Carrier Gas Flow: 1.8 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 40 °C
Injection Mode: Split
Split Ratio: 100:1
Injection Volume: 0.2 µL
Injection Temperature: 250 °C
Autosampler: No
Liner Type: 4 mm ID Single Taper Liner
Liner Part Number: 054796
Column Part Number: 113400
HP5973 restrictor: 113409
Full Scan/SIM: 45-450 m/z

EXPERT TIP
Better resolution is often obtained from chiral columns by using lower temperatures and higher carrier gas velocities than for conventional columns.

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ANALYSIS OF WINE ON BP20

**Components**
1. Acetaldehyde
2. Ethyl Acetate
3. Methanol
4. Ethanol
5. Propanol
6. Isopropanol
7. Isobutanol
8. Isoamyl Alcohol
9. Acetic Acid
10. Unknown

**Phase:** BP20, 1.0 µm
**Column:** 25 m x 0.32 mm ID
**Initial Temp:** 40 °C, 2 min
**Rate 1:** 5 °C/min
**Final Temp:** 200 °C
**Rate 2:** 15 °C/min
**Carrier Gas:** He, 6 psi
**Injection Mode:** Split
**Split Ratio:** 200:1
**Injection Volume:** 0.2 µL
**Injection Temperature:** 250 °C
**Detector Type:** Mass Spectrometer

**EXPERT TIP**
For extended life of polar columns, always use an oxygen trap in the carrier gas line.

ANALYSIS OF SCOTCH WHISKY ON BP20

**Components**
1. Acetaldehyde
2. Ethyl Acetate
3. Methanol
4. Ethanol
5. Propan-1-ol
6. 2-Methylpropan-1-ol
7. 2-Methylbutan-1-ol

**Phase:** BP20, 1.0 µm
**Column:** 12 m x 0.53 mm ID
**Initial Temp:** 55 °C, 3 min
**Rate:** 10 °C/min
**Final Temp:** 120 °C, 0 min
**Carrier Gas:** He, 7.0 psi
**Detector:** FID
**Sensitivity:** 128 x 10^-12 AFS
**Injection Mode:** Split

**ANALYSIS OF TEATREE OIL ON BPX5**

**Components**
1. Terpinolene
2. α-Pinene
3. Sabinene
4. 3-Octanol
5. 1,8-Cineole
6. α-Humulene
7. α-Pinene
8. α-Cymene
9. Limonene
10. 1,8-Cineole
11. γ-Terpinene
12. Terpinolene
13. Terpin-4-ol
14. α-Terpineol
15. n-Geraniol
16. Trans-β-Caryophyllene
17. Aromadendrene
18. Aboromadendrene
19. Ledene
20. Germacrene B
21. α-Cadinene
22. 4α-8α-Calaminene
23. Globulol

**Phase:** BP20, 0.25 µm film
**Column:** 30 m x 0.25 mm ID
**Initial Temp:** 40 °C, 1 min
**Rate 1:** 5 °C/min to 200 °C
**Final Temp:** 200 °C
**Carrier Gas:** He, 7.0 psi
**Detectors:** Mass Spectrometer, 36 cm/sec at 40 °C
**Injection Mode:** Split
**Split Ratio:** 200:1
**Injection Volume:** 0.2 µL
**Injection Temperature:** 250 °C
**Autosampler:** No
**Liner Type:** 4 mm ID Double Taper Liner
**Liner Part Number:** 092018
**Column Part Number:** 054101
ANALYSIS OF OMEGA-3 FATTY ACIDS USING A BPX70

The chromatogram shows the excellent separation of a complex mixture of FAME compounds. Note the excellent peak shape and separation of the Omega-1,2 and 3 fatty acid isomers both structural and cis and trans.

BPX90 – A HIGHLY POLAR PHASE FOR FAME ANALYSIS

WHAT IS DIFFERENT?

- BPX90 is a highly polar phase of the poly (biscyanopropylsiloxane) type.
- The phase has excellent thermal stability and a wide operating range (70 - 280 °C).
- The separation mechanisms give short retention times relative to other polar phases. BPX90 shows low selectivity for non-polar analytes and saturated FAME.
- BPX90 shows enhanced selectivity for polyunsaturated FAME and the selectivity can be tuned with film thickness.
- BPX90 is effective for the separation of cis and trans isomers and positional isomers of FAME analytes.

For further information on our full range of products, please visit www.sge.com
ANALYSIS OF PUFA-1 MARINE FAME ON BPX70

Phase: BPX70, 0.25 µm film
Column: 25 m x 0.22 mm ID
Initial Temp: 150 °C, 0 min
Program Rate: 2 °C/min
Final Temp: 210 °C, 5 min
Carrier Gas: He, 15 psi
Detector: FID, 280 °C
Sensitivity: 32 x 10⁻¹²AFS
Injection Mode: Split, 50:1
Column Part Number: 054602

Components
1. C14:0
2. C16:0
3. C16:1n7
4. C18:1n9
5. C18:1n7
6. C18:2n6
7. C18:3n3
8. C18:4n3
9. C20:0
10. C20:1n9
11. C20:4n6
12. C20:5n3
13. C20:6n3
14. C22:4n6
15. C22:5n3
16. C22:6n3

ANALYSIS OF PUFA-2 ANIMAL FAME ON BPX70

Phase: BPX70, 0.25 µm film
Column: 25 m x 0.22 mm ID
Initial Temp: 150 °C, 0 min
Program Rate: 2 °C/min
Final Temp: 210 °C, 5 min
Carrier Gas: He, 15 psi
Detector: FID, 280 °C
Sensitivity: 32 x 10⁻¹²AFS
Injection Mode: Split, 50:1
Column Part Number: 054602

Components
1. C14:0
2. C16:0
3. C16:1n7
4. C18:1n9
5. C18:1n7
6. C18:2n6
7. C18:3n3
8. C18:4n3
9. C20:0
10. C20:1n9
11. C20:4n6
12. C20:5n3
13. C20:6n3
14. C22:4n6
15. C22:5n3
16. C22:6n3

ANALYSIS OF PUFA-1 MARINE FAME ON BPX70

Phase: BPX70, 0.25 µm film
Column: 50 m x 0.22 mm ID
Initial Temp: 150 °C, 0 min
Program Rate: 2 °C/min
Final Temp: 210 °C, 5 min
Carrier Gas: He, 15 psi
Detector: FID, 280 °C
Sensitivity: 32 x 10⁻¹²AFS
Injection Mode: Split, 50:1
Column Part Number: 054603

Components
1. C18:1n9
2. C18:1n7
3. C18:2n6
4. C18:3n3
5. C18:4n3
6. C20:0
7. C20:1n9
8. C20:4n6
9. C20:5n3
10. C20:6n3
11. C22:1n11
12. C22:4n6
13. C22:5n3
14. C22:6n3

EXPERT TIP

To fully utilize the high thermal stability of BPX70 columns SGE recommend the use of helium when operating above 220/230 °C for extended periods.

For further information on our full range of products, please visit www.sge.com
For Fuels and Petrochemical analysis by GC, one of the main considerations is the thermal stability of the column, both physical and chemical. Phases must have high temperature limits to allow the analysis of high boiling point compounds and columns must be able to physically withstand repeated cycling to extreme temperatures. Columns such as SGE’s BPX1 and HT5 have been created with these demands in mind.

Where higher polarity is required, such as the separation of aromatic compounds, SolGel-WAX™ and BPX90 provide enhanced selectivity without the unnecessary sacrifice of maximum temperature limits.

**Applications**

- Total Recoverable Petroleum Hydrocarbons (TRPH) Analysis on Standard and Fast BPX5
- Analysis of Polywax 655 and Refinery Lubrication Oil on HT5
- The Separation of Aromatics from Olefins in Petroleum Samples using BPX90
- Unleaded Gasoline on BPX5
- Fast GC For TPH Analysis
- Simulated Distillation using BPX1-SimD

For further information on our full range of products, please visit [www.sge.com](http://www.sge.com)
TOTAL RECOVERABLE PETROLEUM HYDROCARBONS (TRPH) ANALYSIS ON STANDARD AND FAST BPX5

Chromatogram showing separation of Total Recoverable Petroleum Hydrocarbons using a conventional 30 m x 0.25 mm ID BPX5 column with a 0.25 micron film.

Chromatogram showing separation of Total Recoverable Petroleum Hydrocarbon using a FAST BPX5 column.

Phase: BPX5, 0.25 µm film
TRPH (C8-C40): 5 ng/µL in dichloromethane
Column: 30 m x 0.25 mm ID
Initial Temp: 40 °C , 2 min
Rate 1: 30 °C/min to 330 °C
Rate 2: NA
Final Temp: 330 °C, 9 min
Detector Type: FID, 350 °C
Carrier Gas: He, 14.4 psi
Carrier Gas Flow : 1.29 mL/min
Constant Flow: On
Average Linear Velocity: 40 cm/sec at 40 °C
Injection Mode: Split, 120:1
Injection Volume: 1µL
Injection Temperature: 250 °C
Autosampler: Yes
Liner Type : 4 mm ID FocusLiner™
with single taper
Liner Part Number: 092003
Column Part Number: 054101

Phase: BPX5, 0.10 µm film
TRPH (C8-C40) Standard: 5 ng/µL in dichloromethane
Column: 10 m x 0.10 mm ID
Initial Temp: 40 °C , 1 min
Rate 1: 30 °C/min to 330 °C
Rate 2: NA
Final Temp: 330 °C, 0 min
Detector Type: FID, 350 °C
Carrier Gas: He, 28 psi
Carrier Gas Flow : 0.52 mL/min
Constant Flow: On
Average Linear Velocity: 55 cm/sec at 40 °C
Injection Mode: Split, 120:1
Injection Volume: 1 µL
Injection Temperature: 250 °C
Autosampler: Yes
Liner Type : 2.3 mm ID FocusLiner™
Liner Part Number: 092005
Column Part Number: 054099

ANALYSIS OF POLYWAX 655 AND REFINERY LUBRICATION OIL ON HT5

POLYWAX 655

Phase: HT5, 0.1 µm
Column: 6 m x 0.53 mm ID
Initial Temp: 50 °C
Rate: 10 °C/min
Final Temp: 480 °C, 15 min
Detector: FID
Sensitivity: 40 x 10^-12 AFS
Injection Mode: On-Column
Carrier Gas: H2, 20 mL/min
Solvent: CS2
Column Part Number: 054661

REFINERY LUBRICATION OIL

For further information on our full range of products, please visit www.sge.com
THE SEPARATION OF AROMATICS FROM OLEFINS IN PETROLEUM SAMPLES USING BPX90

The separation of a petroleum sample using a BPX90 column (30 m x 0.25 mm ID, 250 micron film) showing the resolution of aromatic families and the separation from more abundant alkanes.

UNLEADED GASOLINE ON BPX5

Phase: BPX5, 0.25 µm film
Column: 30 m x 0.25 mm ID

Column Part Number: 054101

Sample Introduction:
Injector Temp: 240 °C
Injection Volume: 0.1 µL
Autosampler Syringe: 0.5 µL Removable Needle
Part No. 000410

Septas: Auto-Sep T™
Part No. 041882

Injection Type: Split
Purge On Time: NA
Purge On (Split) Vent: 200 mL/min
Split Ratio: 149:1
Liner Type: FocusLiner™
single taper
Part No. 092003

Pressure/Flow Values:
Carrier Gas: He
Constant Flow: On
Pressure: 13.6 psi
Column Flow: 1.34 mL/min
Linear Velocity: 30 cm/sec @ 25 °C

Oven Parameters:
Initial Temp: 25 °C
Initial Time: 1 min
Rate 1: 30 °C/min
Final Temp 1: 240 °C
Hold Time: 1 min
Run Time: 9.17 min

Detector Parameters:
Detector Type: FID @ 280 °C

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FAST GC FOR TPH ANALYSIS

Phase: BPX5, 0.1 µm
Column: 5 m x 0.1 mm ID
Initial Temp: 50 °C
Rate 1: 45 °C/min
Final Temp: 300 °C, 0 min
Detector Temp: 270 °C
Detector: FID
Carrier: He, Inlet pressure 40 psi (constant flow mode, linear velocity of 75 cm/sec)

Chromatogram of TPH standards from C8 to C32

Chromatogram showing elution of BTEX in under one minute

SIMULATED DISTILLATION USING BPX1-SIMD

Phase: BPX1, 0.1 µm
Column: 5 m x 0.53 mm ID
Initial Temp: 40 °C
Rate: 15 °C
Final Temp: 420 °C, 5 min
Detector Temp: 440 °C
Carrier Gas: He, 10 mL/min
Instrument: HP 6890
Column Part Number: 054800

Separation Systems Injector
Initial Temp: 40 °C
Rate: 15 °C
Final Temp: 420 °C, 5 min

A portion of the previous chromatogram from C40 to the end of the analysis (expanded vertically) shows excellent resolution and the ability to see beyond C110.

All of the data presented was produced by Dr. Lubkowitz and the staff at Separation Systems Inc. on a system using the Separation System programmed temperature vaporization injector (PTV) and the SIMDIS EXPERT® software.
For general chemical analysis, a good rule of thumb is to use the lowest polarity column that provides sufficient separation. Particular classes of compounds, such as alcohols, amines, or organic acids, may require thicker film phases, or specific phases such as the BPX35 or BP21 to avoid undue peak tailing.

**Applications**

- Analysis of 18 Alcohols on BP20
- Analysis of Aliphatic Alcohols on BP1
- Analysis of 15 Organic Acids on BP20
- US EPA 625 Phenols Mix on BPX50
- Analysis of Organic Acids in Water on BP21
- Analysis of Amines on BP1
- Analysis of Aromatic Amines on BP5
- Analysis of Aromatic Amines from Diazo Dyes on BPX35
- Analysis of Ketones on Thick Film BPX5
- Analysis of Triethylamine and Triethanolamine on SolGel-1ms™
ANALYSIS OF 18 ALCOHOLS ON BP20

Components
1. Methanol
2. Propan-2-ol
3. Ethanol
4. n-Butan-1-ol
5. n-Propanol + 2-Methyl-3-Buten-2-ol
6. L-3-Methyl-2-Butan-1-ol
7. Pentan-3-ol
8. L-2-Pentan-1-ol
9. n-Butanol
10. 2,4-Dimethyl Pentan-3-ol
11. Hexan-3-ol
12. 2-Methyl Prop-2-en-1-ol
13. Crotyl Alcohol (2-Butan-1-ol)
14. Hexan-2-ol
15. Pentan-1-ol
16. 2-Methyl Pentan-1-ol
17. 2-Ethyl Butan-1-ol
18. Hexan-1-ol

ALCOHOLS
Phase: BP20, 0.25 µm film
Column: 30 m x 0.32 mm ID
Initial Temp: 45 °C, 2 min
Rate: 3 °C/min
Final Temp: 80 °C, 0 min
Detector: FID
Sensitivity: 128 x 10⁻¹² AFS
Injection Mode: Split
Column Part Number: 054427

EXPERT TIP
After installing a new column purge with oxygen free carrier gas for at least 30 minutes before heating GC oven.

ANALYSIS OF ALIPHATIC ALCOHOLS ON BP1

Components
1. Octanol
2. Decanol
3. Undecanol
4. Dodecanol
5. Tetradecanol
6. Hexadecanol
7. Eicosanol

ALCOHOLS
Phase: BP1, 3.0 µm film
Column: 12 m x 0.53 mm ID
Initial Temp: 100 °C
Rate: 10 °C/min
Final Temp: 260 °C
Carrier Gas: N₂
Injection Volume: 0.1 µL
Column Part Number: 054097

ANALYSIS OF 15 ORGANIC ACIDS ON BP20

Components
1. Valeric Acid
2. Caproic Acid
3. Heptanoic Acid
4. Octanoic Acid
5. Nonanoic Acid
6. Decanoic Acid
7. Undecanoic Acid
8. Dodecanoic Acid
9. Tridecanoic Acid
10. Tetradecanoic Acid
11. Pentadecanoic Acid
12. Hexadecanoic Acid
13. Heptadecanoic Acid
14. Octadecanoic Acid
15. Arachidic Acid

ORGANIC ACIDS
Phase: BP20, 0.25 µm
Column: 30 m x 0.32 mm ID
Initial Temp: 70 °C
Rate: 10 °C/min
Final Temp: 260 °C, 5 min
Detector: FID
Injection Mode: Split
Carrier Gas: H₂, 6 psi
Column Part Number: 054433

For further information on our full range of products, please visit www.sge.com
## Analysis of Amines on BP1

<table>
<thead>
<tr>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aniline</td>
</tr>
<tr>
<td>2. Decylamine</td>
</tr>
<tr>
<td>3. Dicyclohexylamine</td>
</tr>
<tr>
<td>4. Dodecylamine</td>
</tr>
<tr>
<td>5. Tetradecylamine</td>
</tr>
</tbody>
</table>

### Analysis of Amines

**Phase:** BP1, 3.0 µm film  
**Column:** 12 m x 0.53 mm ID  
**Initial Temp:** 70 °C  
**Rate:** 10 °C/min  
**Final Temp:** 250 °C  
**Carrier Gas:** N₂  
**Injection Volume:** 0.1 µL  
**Column Part Number:** 054097

## Analysis of Phenols Mix on BPX50

**US EPA 625 Phenols Mix**

<table>
<thead>
<tr>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 2-Chlorophenol</td>
</tr>
<tr>
<td>2. 2-Nitrophenol</td>
</tr>
<tr>
<td>3. 2,4-Dimethylphenol</td>
</tr>
<tr>
<td>4. 2,4-Dichlorophenol</td>
</tr>
<tr>
<td>5. 4-Chloro-3-methylphenol</td>
</tr>
<tr>
<td>6. 2,4-Dinitrophenol</td>
</tr>
<tr>
<td>8. 4-Nitrophenol</td>
</tr>
<tr>
<td>9. 2-Methyl-4,6-dinitrophenol</td>
</tr>
<tr>
<td>10. Pentachlorophenol</td>
</tr>
</tbody>
</table>

**US EPA 625 Phenols Mix**

- **Phase:** BPX50, 0.25 µm  
- **Column:** 30 m x 0.25 mm ID  
- **Injector Mode:** Split, 40:1  
- **Initial Oven Temp:** 50°C, 1 min  
- **Rate:** 8 °C/min  
- **Final Temp:** 300 °C, 10 min  
- **Detector:** HP 5973 MSD  
- **Column Part Number:** 054751

**Organic Acids in Water**

- **Phase:** BP21, 0.5 µm film  
- **Column:** 30 m x 0.53 mm ID  
- **Initial Temp:** 85 °C, 0 min  
- **Rate:** 6 °C/min  
- **Final Temp:** 180 °C, 5 min  
- **Detector:** FID  
- **Injection Mode:** On-Column  
- **Column Part Number:** 054477

---

**EXPERT TIP**

On-column injection and the addition of a 0.03M Oxalic acid (2%) to the injection solution increases the acidity of the column to allow lactic acid to be detected.
ANALYSIS OF AROMATIC AMINES ON BP5

Phase: BP5, 1.0 µm film
Column: 12 m x 0.53 mm ID
Initial Temp: 60 °C, 0 min
Rate: 10 °C/min
Final Temp: 190 °C, 0 min
Detector: FID
Sensitivity: 128 x 10⁻¹²AFS
Injection Mode: Split
Column Part Number: 054197

Components
1. Pyridine
2. o-Toluidine
3. gamma - BHC
4. Aniline
5. 2-Methylpyridine
6. m-Toluidine
7. 2,6-Dimethylaniline
8. 1,4-Phenyldiamine
9. Nicotine
10. Biphenylamine
11. 2-Naphtylamine
12. 4-Aminodiphenyl
13. 4,4'-Diaminodiphenyl
14. Benzidine
15. 3,3'-Dimethyl-4,4'-diaminodiphenylmethane
16. 3,3'-Dichlorobenzidine
17. 4,4'-Thiodianiline
18. 3,3'-Dimethoxybenzidine
19. 4,4'-Methylenebis(2chloraniline)
20. 3,3'-Dimethylbenzidine
21. 4,4'-Diaminodiphenylmethane

EXPERT TIP
SilTite™ ferrules eliminate the need for re-tightening following temperature cycling and reduce oxygen levels within the system improving performance.

For further information on our full range of products, please visit www.sge.com
ANALYSIS OF KETONES ON THICK FILM BPX5

Phase: BPX5, 1.0 µm film
Sample: 300 ppm in dichloromethane
Column: 60 m x 0.25 mm ID
Initial Temp: 40 °C, 5 min
Rate 1: 10 °C/min to 80 °C
Rate 2: 30 °C/min to 260 °C
Final Temp: 260 °C, 4 min
Detector Type: FID
Detector Temp: 360 °C
Carrier Gas: He, 2.76 psi
Carrier Gas Flow: 1.9 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 40 °C
Injection Mode: Split
Split Ratio: 100:1
Injection Volume: 0.4 µL
Injection Temperature: 250 °C
Autosampler: No
Liner Type: 4 mm ID Single Taper Liner
Liner Part Number: 092017
Column Part Number: 054123

Components
1. Ethanol
2. Acetone
3. 2-Butanone
4. 3-Methyl-2-butane
5. 2-Pentanone
6. 3-pentanone
7. 4-Methyl-2-pentanone
8. 3-Methyl-2-pentanone
9. 3-Hexanone
10. 2-Hexanone
11. Methyl oxide
12. Cyclopentanone
13. 2-Methyl-3-hexanone
14. 4-Methyl-2-hexanone
15. 5-Methyl-2-hexanone
16. 3-Heptanone
17. 2-Heptanone
18. Cyclohexanone
19. 2-Octanone
20. 2-Norbornone
21. 2-Deconane
22. 2-Lindeconane
23. 2-Dodecanone

ANALYSIS OF TRIETHYLAMINE AND TRIETHANOLAMINE ON SOLGEL-1ms™

Phase: SolGel-1ms, 0.25 µm film
Amine mix: 10 ng/µL in dichloromethane
Column: 30 m x 0.32 mm ID
Initial Temp: 40 °C, 5 min
Rate 1: 20 °C/min to 200 °C
Final Temp: 200 °C, 7 min
Detector Type: FID
Detector Temp: 300 °C
Carrier Gas: He, 9.9 psi
Carrier Gas Flow: 2.2 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 100 °C
Mode of Injection: Split
Split Ratio: 50:1
Injection Volume: 0.3 µL
Injection Temperature: 250 °C
Autosampler: No
Column Part Number: 054798

Components
Solvant
Triethylamine
Triethanolamine

EXPERT TIP
To prevent decreasing retention times in your chromatography, replace the septum daily.

For further information on our full range of products, please visit www.sge.com
GC analysis of Pharmaceuticals covers a wide range of compounds that can vary greatly in their molecular weight, reactivity, and pH. From the analysis of low molecular weight residual solvents on a G43 (BPX-Volatiles) to higher molecular weight compounds on a G42 (BPX35), a wide range of GC columns are often specified in the test methods.

Proper deactivation of GC consumables such as liners and columns becomes increasingly important where system inertness has to be demonstrated. SGE's unique, high temperature gas phase deactivation ensures maximum inertness and minimal activity from our columns and consumables.

Applications

- USP Methods
- Analysis of Tricyclic Antidepressants on BPX35
- Analysis of Dioxane Impurities on BP20
- Analysis of a Common Solvent Mixture on a Thick Film BPX5
- Analysis of a Common Pharmaceutical Solvent on BPX-Volatiles
- Analysis of a Common Pharmaceutical Solvent on BPX-Volatiles
- Analysis of Class I Solvents on BPX-Volatiles
- Analysis of the Separation of the Class III Solvents on BPX-Volatiles

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<table>
<thead>
<tr>
<th>Method</th>
<th>Phase Composition</th>
<th>SGE Phase Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>Dimethylpolysiloxane oil</td>
<td>BP1, SOLGEL-1ms™</td>
</tr>
<tr>
<td>G2</td>
<td>Dimethylpolysiloxane gum</td>
<td>BP1, SOLGEL-1ms</td>
</tr>
<tr>
<td>G3</td>
<td>50% Phenyl - 50% Methylpolysiloxane</td>
<td>BPX50</td>
</tr>
<tr>
<td>G5</td>
<td>3-Cyanopropylpolysiloxane</td>
<td>BPX70</td>
</tr>
<tr>
<td>G7</td>
<td>50% 3-Cyanopropyl - 50% Phenylmethylsilicone</td>
<td>BP225</td>
</tr>
<tr>
<td>G14</td>
<td>Polyethylene glycol (average molecular weight of 950-1,050)</td>
<td>BP20(WAX), SOLGEL-WAX™</td>
</tr>
<tr>
<td>G15</td>
<td>Polyethylene glycol (average molecular weight of 3,000-3,700)</td>
<td>BP20(WAX), SOLGEL-WAX</td>
</tr>
<tr>
<td>G16</td>
<td>Polyethylene glycol (average molecular weight of 15,000)</td>
<td>BP20(WAX), SOLGEL-WAX</td>
</tr>
<tr>
<td>G17</td>
<td>75% Phenyl - 25% Methylpolysiloxane</td>
<td>BPX50</td>
</tr>
<tr>
<td>G19</td>
<td>25% Phenyl - 25% Cyanopropylmethylsilicone</td>
<td>BP225</td>
</tr>
<tr>
<td>G20</td>
<td>Polyethylene glycol (average molecular weight of 380-420)</td>
<td>BP20(WAX), SOLGEL-WAX</td>
</tr>
<tr>
<td>G25</td>
<td>Polyethylene glycol TPA (Carbowax 20M terephthalic acid)</td>
<td>BP21(FFAP)</td>
</tr>
<tr>
<td>G27</td>
<td>5% Phenyl - 95% Methylpolysiloxane BP5,</td>
<td>BPX5</td>
</tr>
<tr>
<td>G28</td>
<td>25% Phenyl - 75% Methylpolysiloxane</td>
<td>BPX35</td>
</tr>
<tr>
<td>G32</td>
<td>20% Phenylmethyl - 80% Dimethylpolysiloxane</td>
<td>BPX35</td>
</tr>
<tr>
<td>G35</td>
<td>Polyethylene glycol &amp; diepoxide esterified with nitroterephthalic acid</td>
<td>BP21(FFAP)</td>
</tr>
<tr>
<td>G36</td>
<td>1% Vinyl - 5% Phenylmethylpolysiloxane</td>
<td>BP5, BPX5</td>
</tr>
<tr>
<td>G38</td>
<td>Phase G1 plus a tailing inhibitor</td>
<td>BP1, SOLGEL-1ms</td>
</tr>
<tr>
<td>G39</td>
<td>Polyethylene glycol (average molecular weight of 1,500)</td>
<td>BP20(WAX), SOLGEL-WAX</td>
</tr>
<tr>
<td>G41</td>
<td>Phenylmethyldimethylsiloxane (10% phenyl substituted)</td>
<td>BP5, BPX5</td>
</tr>
<tr>
<td>G42</td>
<td>35% Phenyl - 65% Dimethylvinylsiloxane</td>
<td>BPX35</td>
</tr>
<tr>
<td>G43</td>
<td>6% Cyanopropylphenyl - 94% Dimethylpolysiloxane</td>
<td>BP624</td>
</tr>
<tr>
<td>G46</td>
<td>14% Cyanopropylphenyl - 86% methylpolysiloxane</td>
<td>BP10 (1701)</td>
</tr>
</tbody>
</table>

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**Fused Silica Tubing**

- Quality guaranteed
- Chemically inert and thermally stable
- Suitable for organic and aqueous solvents
- Ideal for biotechnology applications
- Custom-made tubing available upon request
- Available deactivated for guard column material
- Tubing protected with a high temperature Polyimide resin (+400 °C)

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**ETP multiplier**

- Air stable
- 2 year shelf life guarantee
- Discrete dynode design results in extend operating life
- Total compatibility with all major quadrupole, magnetic sector and TOF instruments
**ANALYSIS OF TRICYCLIC ANTIDEPRESSANTS ON BPX35**

- **Phase:** BPX35, 0.25 µm
- **Column:** 25 m x 0.22 mm ID
- **Initial Temp.:** 210 °C, 1 min
- **Rate:** 5 °C/min
- **Final Temp.:** 280 °C
- **Carrier Gas:** Helium, 150 kpa
- **Injection Mode:** Split (20:1)
- **Detector:** FID, 380 °C
- **Column Part Number:** 054711

Components
1. Amitriptyline
2. Trimipramine
3. Nortriptyline
4. Doxepin
5. Desipramine

**TRICYCLIC ANTIDEPRESSANTS**

**Phase:** BPX35, 0.25 µm
**Column:** 25 m x 0.22 mm ID
**Initial Temp.:** 210 °C, 1 min
**Rate:** 5 °C/min
**Final Temp.:** 280 °C
**Carrier Gas:** Helium, 150 kpa
**Injection Mode:** Split (20:1)
**Detector:** FID, 380 °C
**Column Part Number:** 054711

**ANALYSIS OF DIOXANE IMPURITIES ON BP20**

- **Phase:** BP20, 1.0 µm
- **Column:** 25 m x 0.53 mm ID
- **Initial Temp.:** 40 °C, 2 min
- **Rate:** 10 °C/min
- **Final Temp.:** 120 °C
- **Detector:** FID, 280 °C
- **Injector Mode:** Split, 30:1
- **Carrier Gas:** Hydrogen, 2 psi
- **Injection Volume:** 0.2 µL
- **Column Part Number.:** 054448

Components
1. Methanol
2. Dichloromethane
3. Ethanol
4. Dioxane impurity
5. Dioxane

**ANALYSIS OF A COMMON SOLVENT MIXTURE ON A THICK FILM BPX5**

- **Phase:** BPX5, 1.0 µm film
- **Sample:** neat
- **Column:** 60 m x 0.25 mm ID
- **Initial Temp:** 32 °C, 5 min.
- **Rate:** 10 °C/min to 190 °C, 190°C, 2 min.
- **Final Temp.:** 190°C, 2 min.
- **Detector Type:** FID
- **Detector Temp.:** 360 °C
- **Carrier Gas:** He, 26.9 psi
- **Carrier Gas Flow:** 1.9 mL/min.
- **Constant Flow:** On
- **Average Linear Velocity:** 35 cm/sec at 40 °C
- **Injection Mode:** Split
- **Split Ratio:** 100:1
- **Injection Volume:** 0.3 µL
- **Injection Temperature:** 250 °C
- **Autosampler:** No
- **Liner Type:** 4 mm ID Single Taper Liner
- **Liner Part Number:** 092017
- **Column Part Number:** 054123

Components
1. Methanol
2. Ethanol
3. Acetone
4. Isopropyl alcohol
5. Acetonitrile
6. Dichloromethane
7. 2-Butanone
8. Ethyl acetate
9. Benzene

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ANALYSIS OF COMMON PHARMACEUTICAL SOLVENT ON BPX-VOLATILES

Components
1. Methanol
2. Ethanol
3. Ethyl ether
4. Acetone
5. n-Propyl alcohol
6. Acetonitrile
7. Methylene chloride
8. 1-Butanol
9. Hexane
10. Propanol
11. 2-Butanone
12. Ethyl acetate
13. 2-Butanol
14. Tetrahydrofuran
15. Chloroform
16. Cyclohexane
17. Benzene
18. n-Hexane
19. 1,2-Dichloroethane
20. 1,4-Dioxane
21. Pyrrole
22. Toluen
23. Dimethylformamide

Phase: BPX-Volatiles, 1.4 µm film
Sample: 30 m x 0.25 mm ID
Initial Temp: 35 °C, 15 min
Rate 1: 5 °C/min to 100 °C
Final Temp: 100 °C, 2 min
Detector Type: Mass Spectrometer
Carrier Gas: He, 25.7 psi
Carrier Gas Flow: 1.8 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 35 °C
Injection Mode: Split
Split Ratio: 100:1
Injection Volume: 0.5 µL
Injection Temp: 250 °C
Autosampler: No
Liner Type: 4 mm ID Single Taper Liner
Liner Part Number: 092017
Column Part No: 054980
Full Scan / SIM: Full scan 25-450

ANALYSIS OF COMMON PHARMACEUTICAL SOLVENT ON BPX-VOLATILES

Components
1. Dichlorodifluoromethane
2. Chloromethane
3. Vinyl chloride
4. Bromoform
5. Chloroform
6. Trichlorofluoromethane
7. 1,1-Dichloroethene
8. Dichloromethane
9. trans-1,2-Dichloroethene
10. 1,1-Dichloroethane
11. 2,2-Dichloropropane
12. cis-1,2-Dichloroethene
13. Bromochloromethane
14. Chloroform
15. 1,1,1-Trichloroethane
16. 1,1-Dichloropropene
17. Carbon tetrachloride
18. Benzene
19. 1,2-Dichloroethane
20. Trichloroethene
21. 1,2-Dichloropropane
22. Dibromomethane
23. Bromochloromethane
24. cis-1,3-Dichloropropene
25. Toluene
26. trans-1,3- Dichloropropene
27. 1,1,3-Trichloroethane
28. Tetrachloroethene
29. 1,3-Dichloropropane
30. Dibromochloromethane
31. 1,2-Dibromoethane
32. Chlorobenzene
33. Ethylbenzene
34. 1,1,2-Tetrachloroethane
35. m-Xylene
36. o-Xylene
37. 1,2-Dichloroethane
38. trans-1,3-Dichloropropene
39. Bromochloromethane
40. Isopropylbenzene
41. Bromobenzene
42. 1,2,2-Tetrachloroethane
43. 1,2,3-Trichloropropane
44. 1,2-Propanoate
45. 1,3,5-Trichlorobenzene
46. 4-Chlorostilbene
47. 1,3,5-Trichlorobenzene
48. tert-Butylbenzene
49. 1,2,4-Trimethylbenzene
50. n-Butylbenzene
51. 1,3-Dichlorobenzene
52. p-Isopropyltoluene
53. 1,2-Dichlorobenzene
54. n-Butylbenzene
55. 1,4-Dichlorobenzene
56. 1,2-Dibromo-3chloropropane
57. 1,2,4-Trichlorobenzene
58. Hexachlorobutadiene
59. Naphthalene
60. 1,2,3-Trichlorobenzene

Phase: BPX-Volatiles 1.4 µm film
Sample: USEPA 502.2 mix:
Column: 30 m x 0.25 mm ID
Initial Temp: 40 °C, 0 min
Rate 1: 6 °C to 210 °C
Rate 2: 15 °C to 240 °C
Final Temp: 240 °C, 5 min
Detector Type: Mass Spectrometer
Carrier Gas: He, 22.8 psi
Carrier Gas Flow: 1.3 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 40 °C
Injection Mode: Split
Split Ratio: 50:1
Injection Volume: 1 mL
Injection Temp: 250 °C
Autosampler: No
Liner Type: 4 mm ID Single Taper Liner
Liner Part Number: 092017
Column Part No: 054980
Full Scan / SIM: Full scan 45-450
ANALYSIS OF CLASS I SOLVENTS ON BPX-VOLATILES

Phase: BPX-Volatiles 1.4 µm film
Sample: 30 m x 0.25 mm ID
Column: 200 ppm in methanol
Initial Temp: 40 °C, 1 min
Rate 1: 6 °C/min to 80 °C
Rate 1: Final Temp: 80 °C
Rate 2: Detector Type: Mass Spectrometer
Carrier Gas: He, 6.7 psi
Carrier Gas Flow: 0.9 mL/min
Constant Flow: On
Averages Linear Velocity: 35 cm/sec at 50 °C
Injection Mode: Split
Split Ratio: 100:1
Injection Volume: 0.4 µL
Injection Temp: 250 °C
Autosampler: No
Liner Type: 4 mm ID Single Taper Liner
Liner Part Number: 092017
Column Part No: 054980
Full Scan / SIM: Full scan 30-450

Components
1. 1,1-Dichloroethene
2. 1,1,1-Trichloroethane
3. Carbon tetrachloride
4. Benzene
5. 1,2-Dichloroethane

ANALYSIS OF THE SEPARATION OF THE CLASS III SOLVENTS ON BPX-VOLATILES

Phase: BPX-Volatiles 1.4 µm film
Sample: 200 ppm in methanol
Column: 30 m x 0.25 mm ID
Initial Temp: 50 °C, 5 min
Rate 1: 10 °C/min to 85 °C, 1 min
Rate 2: 15 °C/min to 170 °C,
Final Temp: 170 °C
Detector Type: Mass Spectrometer
Carrier Gas: He, 6.7 psi
Carrier Gas Flow: 0.9 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 50 °C
Injection Mode: Split
Split Ratio: 100:1
Injection Volume: 0.4 µL
Injection Temp: 250 °C
Autosampler: No
Liner Type: 4 mm ID Single Taper Liner
Liner Part Number: 092017
Column Part No: 054980

Components
1. Pentane
2. Ethanol
3. Ethyl ether
4. Acetone
5. iso-Propyl alcohol
6. Ethyl formate
7. Methyl acetate
8. Dichloromethane
9. Methyl-butyl ether
10. n-Propanol
11. Ethyl acetate
12. 2-Butanone (MEK)
13. Tetrahydrofuran
14. iso-Butanol
15. iso-Butanol
16. iso-Propyl acetate
17. Heptane
18. Acetic acid
19. n-Butanol
20. Propyl acetate
21. 4-Methyl-2-pentanone
22. iso-Propyl alcohol
23. iso-Butyl acetate
24. n-Butyl alcohol
25. Butyl acetate
26. Dimethyl sulfoxide
Forensic and Toxicology analyses face similar challenges as those found in pharmaceutical assays. These methods are often very challenging due to the analysis of very active compounds as well as coming from samples that are detrimental to GC systems. These compounds are generally basic in nature that makes inertness of the system components critical to successful determinations.

The robustness is another critical aspect of clinical analyses. The natures of sample compounds and matrices are extremely arduous on the analytical system. SGE’s columns are designed to withstand these ordeals and provide excellent lifetimes in difficult analyses.

**Applications**

- Analysis of Acid/Neutral Drugs on BPX35
- Analysis of Basic Drugs on BPX35
- Analysis of Underivatized Barbiturates on BP5
- Analysis of Various Drugs on BPX50
- Analysis of a Variety of Antidepressant and Anticonvulsant Drugs on BPX50
ANALYSIS OF ACID/NEUTRAL DRUGS ON BPX35

Components
1. Ethosuximide
2. Barbital
3. Aprobarbital
4. Butabarbital
5. Amobarbital
6. Pentobarbital
7. Secobarbital
8. Meperprobamate
9. Carisoprodol
10. Glutethimide
11. Phenobarbital
12. Methaqualone
13. Primidone

ACID/NEUTRAL DRUGS
Phase: BPX35, 0.25 µm
Column: 25 m x 0.22 mm ID
Initial Temp: 100 °C, 1min
Rate: 10 °C/min
Final Temp: 300 °C, 5 min
Carrier Gas: He, 150 kpa
Injection Mode: Split, (20:1)
Detector: FID, 380 °C
Column Part Number: 054711

ANALYSIS OF BASIC DRUGS ON BPX35

Components
1. Benzocaine
2. Unknown
3. Meperidine
4. Diphenhydramine
5. Lidocaine
6. Tripelennamine
7. Amitriptyline
8. Tetracaine
9. Pyrimazine
10. Unknown
11. Diazepam
12. Flurazepam
13. Papaverine
14. Triazolam

BASIC DRUGS
Phase: BPX35, 0.25 µm
Column: 25m x 0.22 mm ID
Initial Temp: 100 °C
Rate: 5 °C/min
Final Temp.: 325 °C, 5 min
Carrier Gas: Helium 150 kpa
Injection Mode: Split, 0.5 µL (20:1)
Detector: FID, 380 °C
Column Part Number: 054711
ANALYSIS OF UNDERIVATIZED BARBITURATES ON BP5

UNDERIVATIZED BARBITURATES
Phase: BP5, 1.0 µm
Column: 12m x 0.53 mm I.D.
Temp: 195 °C
Carrier Gas: Hydrogen
Carrier Flow: 10 mL/min
Injection Volume: 0.1 µL
Column Part Number: 054197

Components
1. Barbital
2. Butabarbital
3. Amylobarbital
4. Pentobarbital
5. Secobarbital
6. Hexabarbital

ANALYSIS OF VARIOUS DRUGS ON BPX50

Phase: BPX50, 0.25 µm film
Sample: 5-10 ppm in methanol
Column: 30 m x 0.25 mm ID
Initial Temp: 150 °C, 0.5 min.
Rate 1: 10 °C/min to 180 °C
Rate 2: 1.5 °C/min to 220 °C
Rate 3: 30 °C/min to 250 °C
Final Temp: 260 °C, 5 min.
Detector Type: FID
Detector Temp.: 320 °C
Carrier Gas: He, 25.7 psi
Carrier Gas Flow: 1.8 mL/min
Constant Flow: On
Average Linear Velocity: 35 cm/sec at 40 °C
Injection Mode: Splitless
Purge on Time: 0.5 min
Purge on (Split) Vent Flow: 60 mL/min
Injection Volume: 1 µL
Injection Temperature: 250 °C
Autosampler: No
Liner Type: 4 mm ID Single Taper Liner
Liner Part Number: 092017
Column Part Number: 054751
Full Scan / SIM: Full scan 45-450
ANALYSIS OF A VARIETY OF ANTIDEPRESSANT AND ANTICONVULSANT DRUGS ON BPX50

**Components**
1. Benzothiazole
2. Selegeline
3. Methsuximide
4. Ketamine
5. Unknown
6. Brompheniramine
7. Mianserin
8. Carbamazepine
9. Pholcodine
10. Clobazam
11. Diltiazem
12. Atropine
13. Pholcodine

**Phase:** BPX50, 0.25 µm film
**Sample:** 5-10 ppm in methanol
**Column:** 30 m x 0.25 mm ID
**Initial Temp:** 150 °C, 0.5 min.
**Rate 1:** 10 °C/min to 180 °C
**Rate 2:** 1.5 °C/min to 220 °C
**Final Temp:** 260 °C, 5 min.
**Detector Type:** FID
**Detector Temp.:** 320 °C
**Carrier Gas:** He, 25.7 psi
**Carrier Gas Flow:** 1.8 mL/min.
**Constant Flow:** On
**Average Linear Velocity:** 35 cm/sec at 40 °C
**Injection Mode:** Splitless
**Purge on Time:** 0.5 min
**Purge on (Split) Vent Flow:** 60 mL/min
**Injection Volume:** 1 µL
**Injection Temperature:** 250 °C
**Autosampler:** No
**Liner Type:** 4 mm ID Single Taper Liner
**Column Part Number:** 092017
**Liner Part Number:** 054751
**Full Scan / SIM:** Full scan 45-450

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**FocusLiner™ improves reproducibility by:**

- Promoting uniform sample vaporization
- Maximizing sample vaporization on an inert surface
- Acting as a particulate filter for dirty samples
- Improving injection reproducibility 10-fold
- Wiping needle tip during injection through fixed quartz wool
- Liner deactivated at high temperatures with wool in situ using SGE’s high quality deactivation processes

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SGE Capillary Column Part Number Listing

**Unique highly polar phase**
- 90% Cyanopropyl Polysilphenylene-siloxane DB-624, HP-VOC, Rtx Volatiles, VOCOL, VB-624, ZB-624
- 50% Cyanopropylphenyl Polysiloxane HP-225, DB-225, Rtx-225
- 5% Phenyl Polycarborane-siloxane DB-HT Sim Dist, HT-SimDist, DistCB, MXT-500

**Unique highly inert phase**
- SolGel + Polyethylene Glycol DB-Wax, Rtx-Wax, Stabilwax, HP220M, HP-Wax, HP-INNOWax, Supelcowax-10, AT-Wax, Nukol, CP Wax 2CB, VB-WAX, ZB-WAX
- 50% Phenyl Polycarborane-siloxane DB-20, DB-21, DB-22, DB-23, DB-24, DB-25

**GC Column Replacement Guide**

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<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Solution</th>
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<tbody>
<tr>
<td>High baseline level</td>
<td>Septum bleed and/or contaminated liner Poor carrier gas quality causing phase decomposition</td>
<td>Replace septa and insert a new inlet liner. Ensure gas traps are installed correctly to remove moisture, organics and oxygen. Ensure high purity carrier gas is used.</td>
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<tr>
<td>Maximum temperature of the phase has been exceeded</td>
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<td>Lower maximum program temperature.</td>
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<tr>
<td>Highly acid or alkaline samples</td>
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<td>Neutralize sample before injecting.</td>
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<tr>
<td>Dirty samples</td>
<td></td>
<td>Filter sample. Use a FocusLiner™.</td>
</tr>
<tr>
<td>Contaminated solvent</td>
<td></td>
<td>Use a high purity solvent.</td>
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<tr>
<td>Split peaks</td>
<td>Poor manual injection technique</td>
<td>Increase the plunger depression speed.</td>
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<td></td>
<td>Mixed solvent</td>
<td>Change to a single solvent.</td>
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<tr>
<td></td>
<td>Compound degradation</td>
<td>Can happen with some pesticides. Lower injector temperature. Recondition capillary column and re-inject sample.</td>
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<tr>
<td></td>
<td>Column inserted too far into injector</td>
<td>Reposition column according to manufacturer's instructions.</td>
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<td>Fronting peaks</td>
<td>Too much sample injected on to column</td>
<td>Dilute sample. Use a thicker film. Increase the split ratio.</td>
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<td>Tailing peaks</td>
<td>Column contamination</td>
<td>Cut 50cm off the front of the column and re-install in the injector.</td>
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<td></td>
<td>Sample not suitable for phase polarity</td>
<td>Choose a more polar column.</td>
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<td>Poorly deactivated inlet liner</td>
<td>Replace with a new fully deactivated inlet liner.</td>
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<td></td>
<td>Graphite ferrule contamination in the start of the column</td>
<td>Cuts 5cm off the front of the column and re-install in the injector.</td>
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<td>Broad peaks</td>
<td>Make-up gas flow rate for atmospheric detectors is low</td>
<td>Increase make up gas flow according to manufacturer's instructions.</td>
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<td>Carrier gas flow is low</td>
<td>Check carrier gas flow.</td>
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<td>Split gas flow is too low</td>
<td>Increase split flow or use the ‘solvent effect’ to focus peaks.</td>
</tr>
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<td>Column contamination</td>
<td>Cut 50cm off the front of the column and re-install in the injector.</td>
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<tr>
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<td>Co-elution of peaks</td>
<td>Change column polarity or lower temp. program ramp rate to separate peaks.</td>
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<td>Change in sample concentration</td>
<td>Check injector conditions are reproducible e.g. temperature and split ratio.</td>
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<tr>
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<td>Mass spectrometer sampling rate is too low causing triangular-looking peaks</td>
<td>Increase sampling rate or reduce number of ions detected in SIM mode.</td>
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<tr>
<td>Shifting retention times</td>
<td>Leaking septum</td>
<td>Tighten septum cap or replace with new septum.</td>
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<td>Carrier gas velocity has changed</td>
<td>Verify carrier gas flow rate.</td>
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<td>Method temperature has changed</td>
<td>Check inlet pressure on GC. Ensure pressure in gas line and gas cylinder is OK.</td>
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<td>Column dimensions and film thickness have changed after installing a new column</td>
<td>Re-check dimensions on column tag against column description.</td>
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<tr>
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<td>Sample concentration has changed — more has been injected on column</td>
<td>Dilute sample or increase split ratio.</td>
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<td>Dirty column. Extra non-volatile material deposited on the column has caused a change in column polarity</td>
<td>Cut 50cm off the front of the column and re-install in the injector.</td>
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<td>Loss of peak resolution</td>
<td>Aging column has resulted in a substantial loss of phase causing a loss in column resolving power</td>
<td>Replace column.</td>
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<tr>
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<td>Carrier gas velocity has changed</td>
<td>Re-check temperature method conditions.</td>
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<td>Dirty column. Extra non-volatile material deposited on the column has caused a change in column polarity</td>
<td>Cut 50cm off the front of the column and re-install in the injector.</td>
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<td>Manual injection technique or operator has changed</td>
<td>Ensure technique is consistent.</td>
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<td>No peaks</td>
<td>GC incorrectly wired</td>
<td>Check all connections from GC to computer / integrator.</td>
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<td>Wrong detector is being monitored</td>
<td>Check injector number is consistent with detector number being monitored.</td>
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<td>FID flame is out</td>
<td>If using water, reduce injection volume. Water can extinguish the flame.</td>
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<td>Syringe is blocked or leaking around plunger</td>
<td>Check flame gas pressures.</td>
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<tr>
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<td>Massive leak in system</td>
<td>Check all column and injector connections.</td>
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<tr>
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<td>Column is blocked</td>
<td>Check column for breakage. This can sometimes be difficult to locate as the fused silica can break leaving the polyimide outer coating intact.</td>
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<td>System has become active</td>
<td>Re-install liner with a new deactivated liner.</td>
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<tr>
<td>Loss of sensitivity</td>
<td>Concentration of sample has changed</td>
<td>Re-confirm with a standard concentration injection.</td>
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<td>Flame gas flow rates and/or make-up gas flow have changed</td>
<td>Check flame gas pressures.</td>
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<tr>
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<td>System has become active</td>
<td>Re-check solvent and method temperatures.</td>
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<td>Splitless conditions have changed</td>
<td>Cut 50cm off the front of the column, re-install in the injector and re-condition the column.</td>
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<td>Ghost peaks</td>
<td>Syringe has become contaminated from previous sample</td>
<td>Ensure syringe has been thoroughly washed with solvent between injections. Sometimes this can involve 20 solvent rinses.</td>
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<td>New standards have impurities</td>
<td>Confirm by using a different source of primary standards.</td>
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<tr>
<td></td>
<td>Impurities in solvent</td>
<td>Use a different type of solvent or confirm by using a different source of the same solvent.</td>
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<td>Septum bleed</td>
<td>Can appear as discrete peaks in temperature program runs. Will disappear with isothermal analysis. Replace septum. Could also be from sample vial septa.</td>
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<tr>
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<td>Peaks are still eluting from previous run</td>
<td>Peaks will appear broader for that part of the chromatogram.</td>
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<td>Flashback has happened</td>
<td>Inject twice the amount of pure solvent (this may need to be repeated). Carrier gas lines may also need to be cleaned</td>
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</tbody>
</table>

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