The GC Column

How to Choose the Correct Type and Dimension

Simon Jones
Application Engineer
Things to Consider…
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• Is it Volatile enough to chromatograph by GC?
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- Is it Volatile enough to chromatograph by GC?
- Is it a Gas or a Liquid?
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- What is the sample Matrix?
  - Can we do sample clean up?
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CAPILLARY COLUMN TYPES

Porous Layer Open Tube (PLOT)

Wall Coated Open Tube (WCOT)
Packed Columns

1950 Introduction with the first gas chromatographs

Packed Column Designs and Materials
Packed Column Anatomy

Packed Columns

• 1 – 12 m length
• Internal Diameter 0.5 – 4mm
• Tubing
  – Stainless Steel, Ultimetal™ SS, Glass, Nickel, PTFE
Packed Column Anatomy

Packed Columns

• 1 – 12 m length
• Internal Diameter 0.5 – 4mm
• Tubing
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• Packing
  – Coated packing
    • Inert, solid support (diatomaceous earth) coated with liquid stationary phase (e.g. OV-1, SE-30, Carbowax 20M, FFAP)
  – Porous packing
    • Porous polymers (PoraPak Q, N, HayeSep Q, R, S, etc.)
    • Porous carbons (Carboxens, Carbosieves, Carbotraps)
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    • Porous carbons (Carboxens, Carbosieves, Carbotraps)
STATIONARY PHASE POLYMERS

Siloxane

\[
\begin{array}{c}
\text{Si} \\
\text{O} \\
\text{Si} \\
\text{R} \\
\end{array}
\]_n

R=methyl, phenyl, cyanopropyl, trifluoropropyl

Siarylene backbone

\[
\begin{array}{c}
\text{Si} \\
\text{O} \\
\text{Si} \\
\text{R} \\
\end{array}
\]_n
\[
\begin{array}{c}
\text{Si} \\
\text{Si} \\
\text{Si} \\
\text{Si} \\
\text{Si} \\
\text{O} \\
\end{array}
\]_m

Polyethylene Glycol

\[
\begin{array}{c}
\text{HO} \\
\text{CH}_2 \\
\text{CH}_2 \\
\text{O} \\
\end{array}
\]_n
Stationary Phase
% Substitution -- polysiloxanes

% = # of sites on silicon atoms occupied

Balance is methyl

\[
\text{Siloxane} \quad R=\text{methyl, phenyl, cyanopropyl, trifluoropropyl}
\]
Stationary Phase
Poly(ethylene) Glycol

100% PEG (DB-WAX)
Less stable than polysiloxanes
Unique separation characteristics

HO \(\left(\text{CH}_2-\text{CH}_2-\text{O}\right)\text{H}\)
Poly(Ethylene) Glycol Modified

• Base deactivated (CAM)

• Acid Modified (DB-FFAP)

• Extended Temperature Range
WCOT Column Types

Agilent J&W has **over 50 different stationary phase offerings**

<table>
<thead>
<tr>
<th>Low Polarity</th>
<th>Mid Polarity</th>
<th>High Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP-Sil 2</td>
<td>DB-XLB</td>
<td>DB-WAX</td>
</tr>
<tr>
<td>DB-28B7</td>
<td>DB-35ms UI</td>
<td>HP-88</td>
</tr>
<tr>
<td>CP-Sil 8 CB</td>
<td>DB &amp; HP-5ms</td>
<td>DB-225</td>
</tr>
<tr>
<td>Ultra 1</td>
<td>DB &amp; HP-5mas UI</td>
<td>CP-Sil 19 CB</td>
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<tr>
<td>DB-11t</td>
<td>Ultra 2</td>
<td>DB-1701</td>
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<tr>
<td>CP-Select CB MTBE</td>
<td>DB-255ms</td>
<td>CP-Sil 43 CB</td>
</tr>
<tr>
<td>DB &amp; HP-1</td>
<td>DB &amp; HP-17ms</td>
<td>DB-1701</td>
</tr>
<tr>
<td>CP-Sil 5 CB</td>
<td>DB &amp; HP-5</td>
<td>CP-Sil 19 CB</td>
</tr>
<tr>
<td>CP-Volamine</td>
<td>CP-Si PAH CB</td>
<td>CP-Sil 19 CB</td>
</tr>
<tr>
<td>CP Select Mineral Oil</td>
<td>SE-54</td>
<td>CP-TCEP</td>
</tr>
<tr>
<td>HP-101</td>
<td>DB-17</td>
<td>HP-190 Wax</td>
</tr>
<tr>
<td>SE-30</td>
<td>DB-502.2</td>
<td>CP-Select 57 CB</td>
</tr>
<tr>
<td></td>
<td>HP-VOC</td>
<td>DB-608</td>
</tr>
<tr>
<td></td>
<td>DB-VRX</td>
<td>DB-TPH</td>
</tr>
<tr>
<td></td>
<td>DB-624</td>
<td>DB-502.2</td>
</tr>
<tr>
<td></td>
<td>DB-624ms</td>
<td>HP-VOC</td>
</tr>
<tr>
<td></td>
<td>CP-Select</td>
<td>DB-1301</td>
</tr>
<tr>
<td></td>
<td>624 CB</td>
<td>VF-1301ms</td>
</tr>
<tr>
<td></td>
<td>DB-1301</td>
<td>CP-Sil 13 CB</td>
</tr>
<tr>
<td></td>
<td>VF-1301ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CP-Sil 13 CB</td>
<td></td>
</tr>
</tbody>
</table>
PLOT Column Types

PLOT columns are primarily, but not exclusively, used for the analysis of gases and low boiling point solutes (i.e., boiling point of solute is at or below room temperature).

- Agilent J&W PLOT columns begin with the designation of
  - GS (Gas Solid) or
  - HP-PLOT followed by a specific name
  - CP (ChromPack) followed by name
  - 10 stationary phases
    - GS-OxyPLOT / CP-Lowox
    - GS-Alumina
    - HP-PLOT Al₂O₃ “M”
    - HP-PLOT Al₂O₃ “S”
    - HP-PLOT Al₂O₃ “KCl” / CP-AL₂O₃/KCl
    - HP-PLOT MoleSieve / CP-Molsieve 5A
    - GS-CarbonPLOT / CP-CarboBOND
    - HP-PLOT Q / CP PoraBOND Q
    - HP-PLOT U / CP-PoraBOND U
    - GS-GasPro / CP-SilicaPLOT

- GS-OxyPLOT: oxygenates
- HP-PLOT Molesieve: O2, N2, CO, Methane
- HP-PLOT Alumina and GS-Alumina: complex hydrocarbon gas matrices, ethylene and propylene purity, 1,4-butadiene
- HP-PLOT U: C1 to C7 hydrocarbons, CO2, Polar Hydrocarbons
- GS-GasPro: freons, sulfurs, inorganic gases
- GS-CarbonPLOT: inorganic and organic gases
Integrated Particle Trap PLOT Columns

Particle trap is on both ends of the column

On the front end to help facilitate backflushing without blowing particles back into the inlet / valve
Specialty Phases

Columns developed for particular applications

Examples: DB-UI 8270D, DB-624UI <467>, DB-VRX, DB-MTBE, DB-TPH, DB-ALC1, DB-ALC2, DB-HTSimDis, DB-Dioxin, Select Low Sulfur, CP-Volamine, Select PAH, DB-EUPAH, DB-CLP1 & 2, DB-Select 624 UI 467, CP-LowOx, Select Permanent Gases……….
Ultra Inert Phases

DB-1msUI
HP-1msUI
DB-5msUI
HP-5msUI
DB-17msUI
DB-624UI
DB-Select 624UI 467
DB-WAXUI

Same Selectivity, more Inertness!
Three Types Of Low Bleed Phases

• Phases tailored to “mimic” currently existing polymers
  Examples: DB-5ms, DB-35ms, DB-17ms, VF-1701ms

• New phases unrelated to any previously existing polymers
  Examples: DB-XLB

• Optimized manufacturing processes
  DB-1ms, HP-1ms, HP-5ms, VF-5ms

Siarylene backbone
What is Column Bleed???
“Back Biting” Mechanism of Product Formation

Cyclic products are thermodynamically more stable!
DB-5ms Structure

DB-5 Structure

DB-5ms Structure

1. Increased stability
2. Different selectivity
3. Optimized to match DB-5

5% Phenyl
DB-35MS VS STANDARD 35% PHENYL
Benzo[g,h,i]perylene, 1ng

Standard 35% Phenyl

DB-35ms
Solid line: DB-5ms 30 m x .25 mm I.D. x .25 μm
Dashed line: DB-5 30 m x .25 mm I.D. x .25 μm
Oven: 60°C isothermal
Carrier gas: H₂ at 40 cm/sec

1: Ethylbenzene
2: m-Xylene
3: p-Xylene
4: o-Xylene

Chromatograms are offset on x-axis for easier viewing
Why is stationary phase type important?

\[ R_s = \frac{\sqrt{N}}{4} \left( \frac{k}{k+1} \right) \left( \frac{\alpha - 1}{\alpha} \right) \]

Influence on \( \alpha \)

\[ \alpha = \frac{k_2}{k_1} \]

- \( k_2 \) = partition ratio of 2\textsuperscript{nd} peak
- \( k_1 \) = partition ratio of 1\textsuperscript{st} peak
Selectivity

• Relative spacing of the chromatographic peaks

• The result of all non-polar, polarizable and polar interactions that cause a stationary phase to be more or less retentive to one analyte than another
Optimizing Selectivity ($\alpha$)

Match analyte polarity to stationary phase polarity

- ‘like dissolves like’

Take advantage of unique interactions between analyte and stationary phase functional groups
Analyte Polarity

**Nonpolar Molecules** - generally composed of only carbon and hydrogen and exhibit no dipole moment (Straight-chained hydrocarbons (n-alkanes))

**Polar Molecules** - primarily composed of carbon and hydrogen but also contain atoms of nitrogen, oxygen, phosphorus, sulfur, or a halogen (Alcohols, amines, thiols, ketones, nitriles, organo-halides, etc. Includes dipole-dipole interactions and H-bonding)

**Polarizable Molecules** - primarily composed of carbon and hydrogen, but also contain unsaturated bonds (Alkenes, alkynes and aromatic compounds)
Selectivity Interactions

• Dispersion
• Dipole
• Hydrogen bonding
Dispersion Interaction

\[ \Delta H_{\text{vap}} \]

- Separation by differences in analyte heat of vaporizations ( \( \Delta H_{\text{vap}} \) )

- Heat necessary to convert a liquid into a gas (at the same temperature)
Dispersion Interaction
Solubility And Retention

30 m x 0.32 mm ID, 0.25 µm
He at 35 cm/sec
50-170°C at 15°/min

Hexanol 158°C
Decane 174°C
Dodecane 216°C

100% Methyl (non-polar)
100% PEG (polar)
Dispersion Interaction

$\Delta H_{\text{vap}}$

Vapor pressure: good approximation

Boiling point: poor approximation
Dipole Interaction

C18:1 (Methyl \textit{trans}-9-octadecenoate)
B.Pt. 186°C

C18:1 (Methyl \textit{cis}-9-octadecenoate)
B.Pt. 186°C

Smaller differences require a stronger dipole phase
Fames – 37 Component Standard

Column: DB-23
60 m X 0.25 mm X 0.15 µm
Agilent P/N 122-2361
Carrier: He, 33 cm/sec @ 50°C
Oven: 50°C for 1 min
25°C/min to 175 (no hold)
4°C/min to 230°C hold 5 min
Injector: 250°C, Split 50:1, 1uL
Detector: FID, 250°C

1 C18:1 (Methyl trans-9-octadecenoate)
2 C18:1 (Methyl cis-9-octadecenoate)
Hydrogen Bonding Interaction

Dipole-Dipole interaction with H bound to O or N interacting with an O or N
NONPOLAR PHASES

Typified by 100% polydimethylsiloxanes such as HP-1, DB-1, DB-1ms, HP-1ms, VF-1ms, CP-Sil 5 CB

Separation Mechanisms:
- Dispersion only
POLARIZABLE PHASES

Typified by phenyl substituted siloxanes, substituted at 5-50% (HP-5, HP-5ms, DB-35, DB-35ms, DB-17, DB-17ms)

Separation Mechanisms:
- Dispersion
- Inducible dipole at phenyl groups
STRONG DIPOLE PHASES

Typified by cyanopropyl or trifluoropropyl substituted siloxanes, substituted 6-50% (DB-1701, DB-1301, DB-200, DB-23, DB-225)

\[
\begin{array}{ccc}
R & \text{Si} & O \\
\text{R'} & \text{m} & \text{Me} \\
\end{array}
\]

R = cyanopropyl or trifluoropropyl
R' = phenyl or methyl

Separation Mechanisms:
- Dispersion
- Inducible dipole at phenyl groups
- Strong permanent dipole
- Hydrogen bonding
HYDROGEN BONDING PHASES

Typified by polyethylene glycol polymers (Carbowax, HP-INNOWax, DB-WAX, DB-FFAP, VF-WAXms, CP-WAX52CB….)

Separation Mechanisms:
- Dispersion
- Strong permanent dipole
- Hydrogen bonding
<table>
<thead>
<tr>
<th>Phase</th>
<th>Dispersion</th>
<th>Dipole</th>
<th>H Bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl</td>
<td>Strong</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Phenyl</td>
<td>Strong</td>
<td>None</td>
<td>Weak</td>
</tr>
<tr>
<td>Cyanopropyl</td>
<td>Strong</td>
<td>Very Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>Trifluoropropyl</td>
<td>Strong</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>PEG</td>
<td>Strong</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Polarity

Polarity

Stability

Temperature Range
## Compounds & Properties

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Polar</th>
<th>Aromatic</th>
<th>Hydrogen Bonding</th>
<th>Dipole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toluene</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>induced</td>
</tr>
<tr>
<td>Hexanol</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Phenol</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Decane</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>induced</td>
</tr>
<tr>
<td>Dodecane</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>
100% Methyl Polysiloxane

1. Toluene $110^\circ C$
2. Hexanol $158^\circ C$
3. Phenol $181^\circ C$
4. Decane (C10) $174^\circ C$
5. Naphthalene $218^\circ C$
6. Dodecane (C12) $216^\circ C$

Strong Dispersion
No Dipole
No H Bonding
100% Methyl Polysiloxane

Strong Dispersion
No Dipole
No H Bonding

1. Toluene 110°C
2. Hexanol 158°C
3. Phenol 181°C
4. Decane (C10) 174°C
5. Naphthalene 218°C
6. Dodecane (C12) 216°C
5% Phenyl

1. Toluene 110°C
2. Hexanol 158°C
3. Phenol 181°C
4. Decane (C10) 174°C
5. Naphthalene 218°C
6. Dodecane (C12) 216°C

Strong Dispersion
No Dipole
Weak H Bonding
50% Phenyl

50% Phenyl

1. Toluene 110°C
2. Hexanol 158°C
3. Phenol 181°C
4. Decane (C10) 174°C
5. Naphthalene 218°C
6. Dodecane (C12) 216°C

Strong Dispersion
No Dipole
Weak H Bonding
50% Cyanopropyl

Strong Dispersion
Strong Dipole
Moderate H Bonding

1. Toluene 110°C
2. Hexanol 158°C
3. Phenol 181°C
4. Decane (C10) 174°C
5. Naphthalene 218°C
6. Dodecane (C12) 216°C
14% Cyanopropylphenyl

1. Toluene 110°C
2. Hexanol 158°C
3. Phenol 181°C
4. Decane (C10) 174°C
5. Naphthalene 218°C
6. Dodecane (C12) 216°C

Strong Dispersion
None/Strong Dipole (Ph/CNPr)
Weak/Moderate H Bonding (Ph/CNPr)
50% Cyanopropylphenyl

1. Toluene
2. Hexanol
3. Phenol
4. Decane (C10)
5. Naphthalene
6. Dodecane (C12)

Strong Dispersion
None/Strong Dipole (Ph/CNPr)
Weak/Moderate H Bonding (Ph/CNPr)
100% Polyethylene Glycol

1. Toluene
2. Hexanol
3. Phenol
4. Decane (C10)
5. Naphthalene
6. Dodecane (C12)

Strong Dispersion
Strong Dipole
Moderate H Bonding
Stationary Phase Selection
Part 1

• Existing information
• Selectivity
• Polarity
• Critical separations
• Temperature limits
Stationary Phase Selection
Part 2

• Capacity
• Analysis time
• Bleed
• Versatility
• Selective detectors
Column Dimensions

- Inner diameter
- Length
- Film Thickness
## Column Diameter

### Capillary Columns

<table>
<thead>
<tr>
<th>I.D. (mm)</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.53</td>
<td>Megabore</td>
</tr>
<tr>
<td>0.45</td>
<td>High speed Megabore</td>
</tr>
<tr>
<td>0.32</td>
<td>Wide</td>
</tr>
<tr>
<td>0.20-0.25</td>
<td>Narrow</td>
</tr>
<tr>
<td>0.18</td>
<td>Minibore</td>
</tr>
</tbody>
</table>
## Column Diameter
### Theoretical Efficiency

<table>
<thead>
<tr>
<th>I.D. (mm)</th>
<th>N/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>11905</td>
</tr>
<tr>
<td>0.18</td>
<td>6666</td>
</tr>
<tr>
<td>0.20</td>
<td>5941</td>
</tr>
<tr>
<td>0.25</td>
<td>4762</td>
</tr>
<tr>
<td>0.32</td>
<td>3717</td>
</tr>
<tr>
<td>0.53</td>
<td>2242</td>
</tr>
</tbody>
</table>

$k = 5$
Efficiency and Resolution

Relationship

\[ \sqrt{N} \propto R_s \]

Efficiency \( \times 4 \) = Resolution \( \times 2 \)
Square root of resolution is inversely proportional to column diameter.
## Column Diameter

**Inlet Head Pressures**

**Helium**

<table>
<thead>
<tr>
<th>I.D (mm)</th>
<th>Pressure (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>225-250</td>
</tr>
<tr>
<td>0.20</td>
<td>25-35</td>
</tr>
<tr>
<td>0.25</td>
<td>15-25</td>
</tr>
<tr>
<td>0.32</td>
<td>10-20</td>
</tr>
<tr>
<td>0.53</td>
<td>2-4</td>
</tr>
</tbody>
</table>

30 meters

Hydrogen pressures x 1/2
## Column Diameter

<table>
<thead>
<tr>
<th>I.D. (mm)</th>
<th>Capacity (ng)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>50-100</td>
</tr>
<tr>
<td>0.25</td>
<td>75-150</td>
</tr>
<tr>
<td>0.32</td>
<td>125-250</td>
</tr>
<tr>
<td>0.53</td>
<td>200-400</td>
</tr>
</tbody>
</table>

0.25 µm film thickness
Column Diameter
Carrier Gas Flow Rate

Smaller diameters for low flow situations
(e.g., GC/MS)

Larger diameters for high flow situations
(e.g., purge & trap, headspace, gas sample valve)
Column Length

Most common: 15-60 meters

Available: 5-200 meters
Column Length
Resolution and Retention
210°C isothermal

Resolution is proportional to the square root of column length
Isothermal: Retention is proportional to length
Temperature program: 1/3-1/2 of isothermal values
Column Length
Cost

15m  30m  60m

$ $ $ $
Film Thickness

Most common: 0.1-3.0 μm
Available: 0.1-10.0 μm
Film Thickness
Retention
100°C Isothermal

 Isothermal: Retention is proportional to film thickness
Temperature program: 1/3-1/2 of isothermal values
Film Thickness
Equal Retention: Isothermal

100°C

137°C

DB-1, 30 m x 0.32 mm ID
He at 37 cm/sec
C10, C11, C12
Film Thickness
Resolution

When solute $k < 5$

When solute $k > 5$
**Film Thickness**

**Resolution at Low k**

- **0.25 µm**
  - 2.0 min

- **1.00 µm**
  - 3.5 min

- **3.00 µm**
  - 6.5 min

DB-1, 30 m x 0.32 mm ID
40°C isothermal, He at 35 cm/sec
Solvent mixture
Film Thickness
Resolution at High k

DB-1, 30 m x 0.32 mm ID
40°C isothermal, He at 35 cm/sec
Solvent mixture

0.25 µm

R = 0
k = 0.09
2.2 min

1.00 µm

R = 0.81
k = 2.55
5.0 min

5.00 µm

R = 0.72
k = 13.46
18.0 min
<table>
<thead>
<tr>
<th>Thickness (um)</th>
<th>Capacity (ng)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>50-100</td>
</tr>
<tr>
<td>0.25</td>
<td>125-250</td>
</tr>
<tr>
<td>1.0</td>
<td>500-1000</td>
</tr>
<tr>
<td>3.0</td>
<td>1500-3000</td>
</tr>
<tr>
<td>5.0</td>
<td>2500-5000</td>
</tr>
</tbody>
</table>

0.32 mm I.D.
More stationary phase = More degradation products
Film Thickness
Inertness Summary

0.25
active inactive

1.0
active inactive

3.0
active inactive
## Column Dimensions

**Diameter Summary**

<table>
<thead>
<tr>
<th>To Increase</th>
<th>Make Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>Smaller</td>
</tr>
<tr>
<td>Retention</td>
<td>Smaller</td>
</tr>
<tr>
<td>Pressure</td>
<td>Smaller</td>
</tr>
<tr>
<td>Flow rate</td>
<td>Larger</td>
</tr>
<tr>
<td>Capacity</td>
<td>Larger</td>
</tr>
</tbody>
</table>
## Column Dimensions

### Length Summary

<table>
<thead>
<tr>
<th>To Increase</th>
<th>Make Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>Longer</td>
</tr>
<tr>
<td>Retention</td>
<td>Longer</td>
</tr>
<tr>
<td>Pressure</td>
<td>Longer</td>
</tr>
<tr>
<td>Cost</td>
<td>Longer</td>
</tr>
</tbody>
</table>
## Column Dimensions

**Film Thickness Summary**

<table>
<thead>
<tr>
<th>To Increase</th>
<th>Make Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retention</td>
<td>Thicker</td>
</tr>
<tr>
<td>Resolution (k&lt;5)</td>
<td>Thicker</td>
</tr>
<tr>
<td>Resolution (k&gt;5)</td>
<td>Thinner</td>
</tr>
<tr>
<td>Capacity</td>
<td>Thicker</td>
</tr>
<tr>
<td>Inertness</td>
<td>Thicker</td>
</tr>
<tr>
<td>Bleed</td>
<td>Thicker</td>
</tr>
</tbody>
</table>
**Column: DB-WAX 30 m X 0.25 mm X 0.25 µm**

**Carrier:** Helium at 25.4 cm/sec measured at 45°C

**Oven:**
- 45°C for 2 min
- 45 to 250°C at 3°C/min
- 250°C for 34 min

**Injector:** Split 1:30, 250°C
- 1µL of 1:35 Oil in Acetone

**Detector:** MSD full scan at m/z 40-500
- 250°C transfer line
**Column:** DB-WAX 20m X 0.18mm X 0.18um

**Carrier:** Helium at 26.3 cm/sec measured at 45°C

**Oven:**
- 45°C for 1.28 min
- 45 to 250°C at 4.67°C/min
- 250°C for 21.81 min

**Injector:**
- Split 1:30, 250°C
  - 1µL of 1:35 Oil in Acetone

**Detector:**
- MSD full scan at m/z 40-500
  - 250°C transfer line
Column: **DB-WAX 20m X 0.18mm X 0.18um**

Carrier:  Helium at 26.3 cm/sec measured at 45°C

Oven:  45°C for 1.28 min  
        45 to 250°C at 4.67°C/min  
        250°C for 21.81 min

Injector:  Split 1:30, 250°C  
           1µL of 1:35 Oil in Acetone

Detector:  MSD full scan at m/z 40-500  
           250°C transfer line
Conclusions:

Understand the Sample
Is it volatile and thermally stable enough to chromatograph by GC?
Try to match polarity – **oil and water don’t mix!**
Look for unique characteristics of compounds and match them to a phase
If you have the correct selectivity, change the dimensions to improve resolution – **consider a smaller ID**
If you need better peak shape for difficult compounds, try the ‘UI’ version
Look for available information for a particular application

**Call Tech Support!**
References:

GC Column Selection Guide: 5990-9867EN

Integrated Particle Trap PLOT columns: 5991-1174EN

ScanView: Application Database
https://community.agilent.com/docs/DOC-2118-software-supported-method-development-the-scanview-program
Contact Agilent Chemistries and Supplies Technical Support

1-800-227-9770 Option 3, Option 3:
Option 1 for GC/GCMS Columns and Supplies
Option 2 for LC/LCMS Columns and Supplies
Option 3 for Sample Preparation, Filtration and QuEChERS
Option 4 for Spectroscopy Supplies

Available in the USA 8-5 all time zones

gc-column-support@Agilent.com
lc-column-support@agilent.com
spp-support@agilent.com
spectro-supplies-support@agilent.com