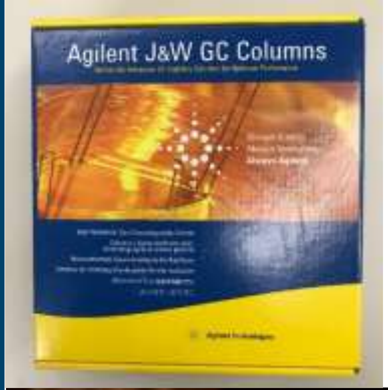
Finding the Perfect Match: Practical Advice on GC Column Selection



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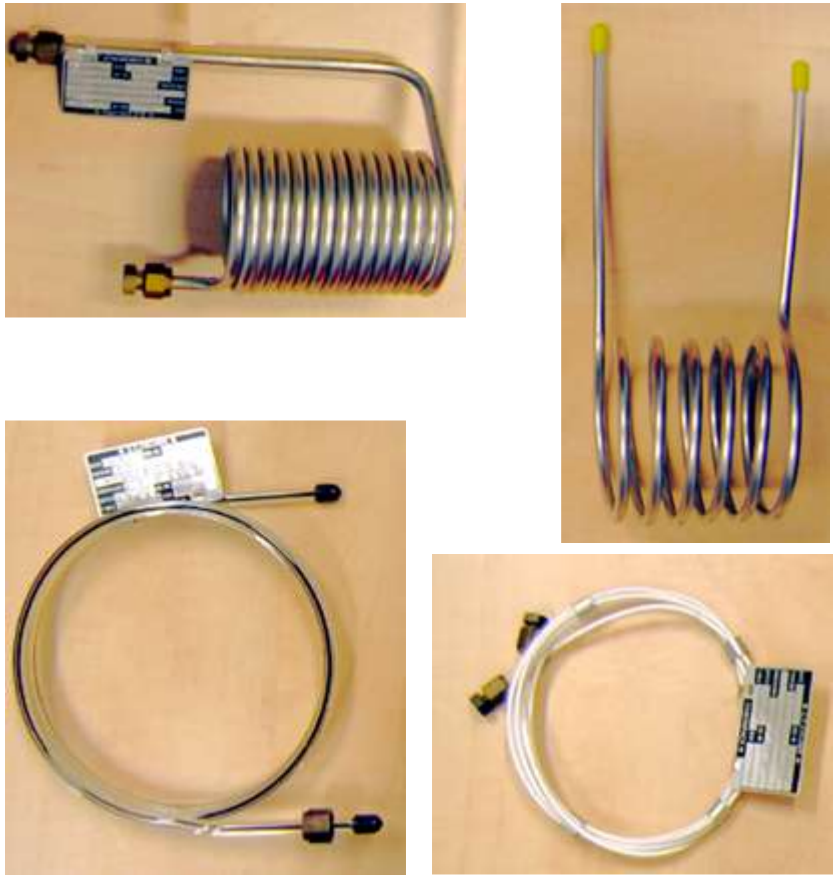
Online Application Engineer
September 12, 2019

Things to Consider when Choosing a Column

- Is it volatile enough to chromatograph by GC?
- Is it a gas or a liquid?
- How are we getting the sample injected?
- What is the sample matrix?
    - -Can we do sample clean up?
- Is it an established method?
- What do we know about the analytes?
- What else *may* be present in the sample?

Some Column History

1969:

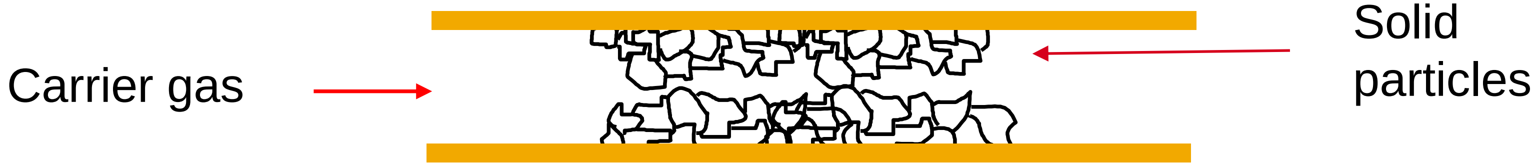


1977: First glass capillary columns

1979: First WCOT fused silica capillary columns

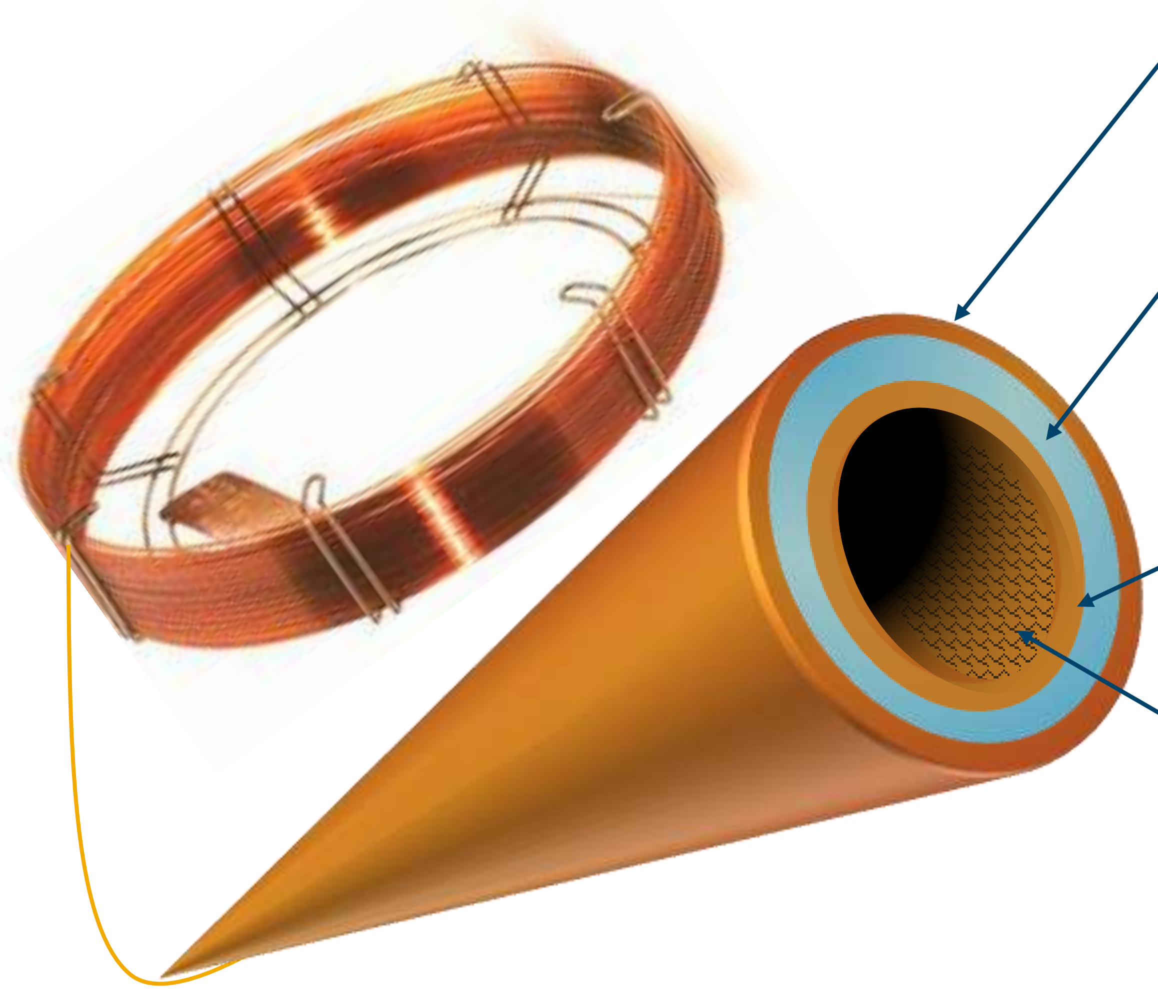
Capillary Column Types

Porous Layer Open Tube (PLOT)



Wall Coated Open Tube (WCOT)

Column Construction



Polyimide coating

Flexible polymeric coating; adds mechanical strength and temperature stability to fused silica

Fused silica

Amorphous glass-like tubing comprised of silicon dioxide; high temperature resistance, low reactivity. May contain rough edges creating active sites.

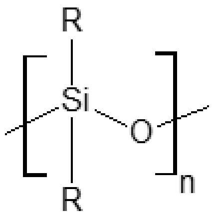
Deactivation

Chemical treatment layer; smooths fused silica surface to enhance inertness

Stationary phase

Polymeric coating atop deactivation layer; commonly comprised of polysiloxane- or polyethyleneglycol-based compounds

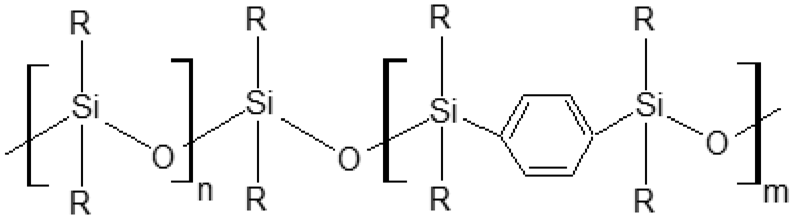
Stationary Phase Polymers



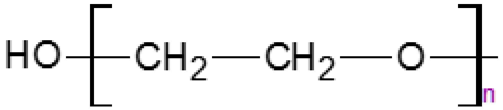
Siloxane

R= methyl, phenyl, cyanopropyl, trifluoropropyl

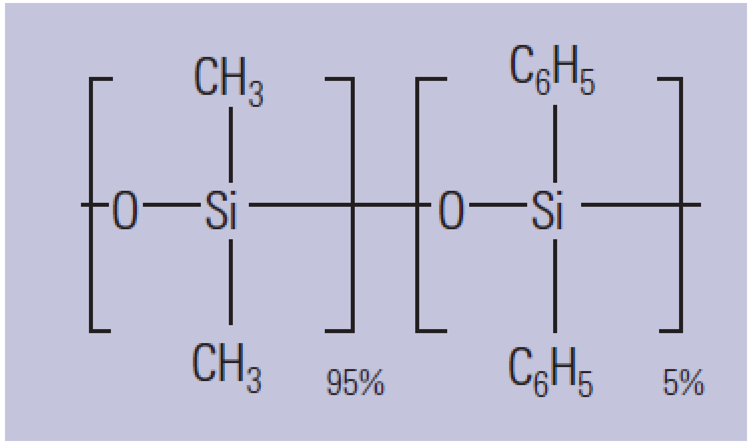
% = number of sites on silicon atoms occupied



Siarylene backbone



Polyethylene glycol



Structure of Agilent J&W HP-5ms

5% phenyl / 95% methyl

Polyethylene Glycol Phases

$$HO \left(CH_2 - CH_2 - O \right) H$$

- Less stable than polysiloxanes
- Unique separation characteristics
- Popular WAX phases from Agilent
  - Most inert: Agilent J&W DB-WAX UI
  - High temperatures: Agilent J&W DB-HeavyWAX
  - Application specific: Agilent J&W DB-FATWAX UI

Another New Column: J&W DB-HeavyWAX

The WAX column you've been waiting for!

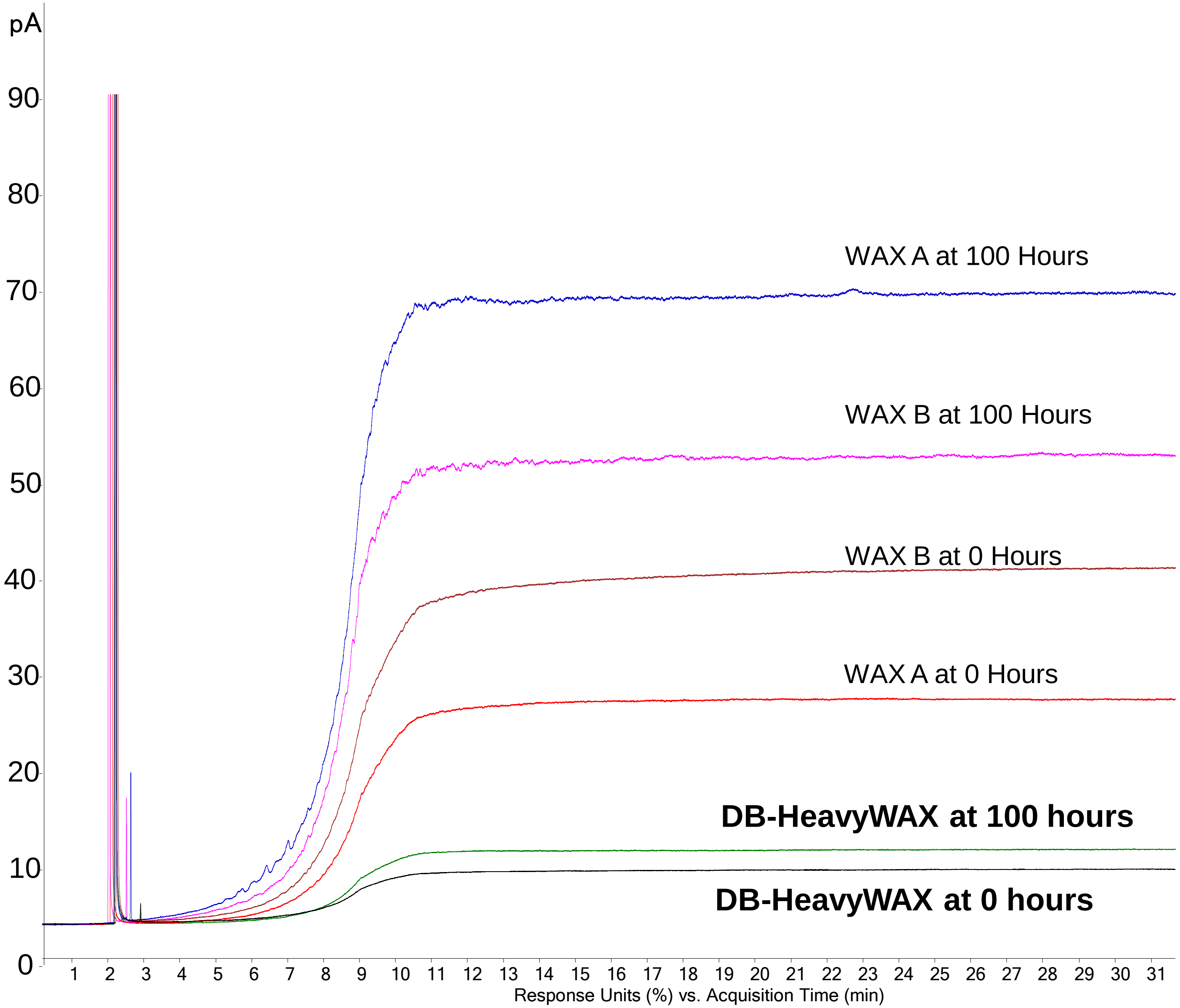
- Increase temperature range
  - 280 °C isothermal
  - 290 °C programmed

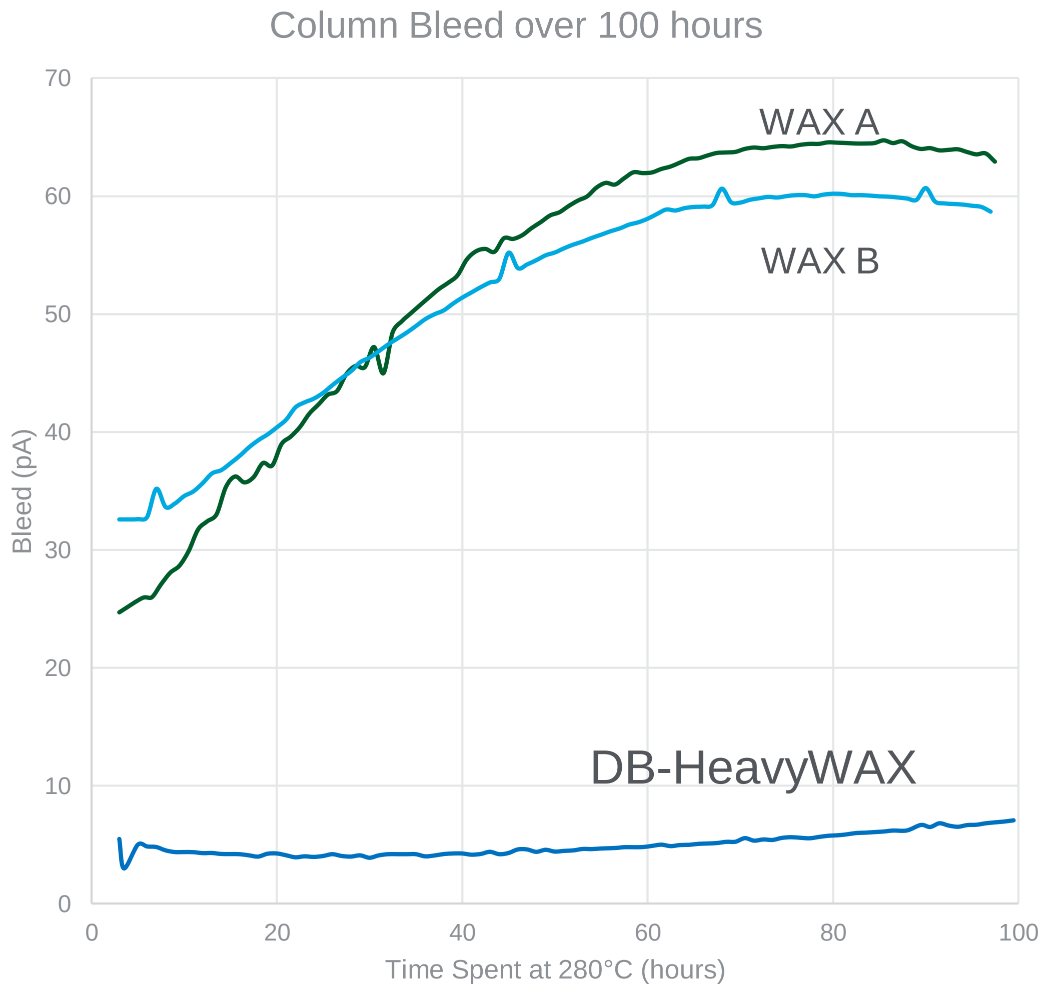
- Increased thermal stability
  - Stable retention times
  - Consistent peak order

- Lower bleed
  - Greater sensitivity for "heavier" compounds
  - Increased analyte range
  - Can decrease analysis time
  - Safely bake out column

www.agilent.com/chem/db-heavywax

Bleed Summary at 280°C Over 100 Hours





JW Column Portfolio- DB, HP, CP, VF

Low Polarity			Mid Polarity			High Polarity		
CP-Sil 2	DB & HP-1MS UI	DB & HP-5MS UI	DB-XLB	DB-225MS	DB-ALC1	HP-88	DB-WAX	DB-WAX UI
DB-MTBE	DB & HP1-MS	DB & HP5-MS	VF-XMS	DB-225	DB-Dioxin	CP-Sil 88	DB-WAX ETR	DB-HeavyWAX
CP-Select CB MTBE	VF-1MS	VF-5MS	DB-35MS UI	CP-Sil 43 CB	DB-200	DB-23	HP-INNOWax	DB-FATWAX UI
	DB & HP-1	DB & HP-5	DB & VF-35MS	VF-1701 MS	VF-200MS	VF-23 MS	VF-WAX MS	
	CP-Sil 5 CB	CP-Sil 8 CB	DB & HP-35	DB-1701	DB-210		CP-WAX 57 CB	
	Ultra 1	Ultra 2	DB & VF-17MS	CP-Sil 19 CB	DX-4		DB & HP-FFAP	
	DB-1HT	VF-DA	DB-17	HP-Blood Alcohol			DB-WAX FF	
	DB-2887	DB-5.625	HP-50+	DB-ALC2			CP-FFAP CB	
	DB-Petro/PONA	DB & VF-5HT	DB-17HT	DX-1			CP-WAX 58 FFAP CB	
	CP-Sil PONA CB	CP-Sil PAH CB	DB-608				CP-WAX 52 CB	
	DB-HT SimDis	Select Biodiesel	DB-TPH				CP-WAX 51	
	CP-SimDis	SE-54	DB-502.2				CP-Carbowax 400	
	CP-Volamine		HP-VOC				Carbowax 20M	
	Select Mineral Oil		DB-VRX				HP-20M	
	HP-101		DB-624				CAM	
	SE-30		VF-624MS				CP-TCEP	
			CP-Select 624 CB					
			DB-1301					
			VF-1301MS					
			CP-Sil 13 CB					

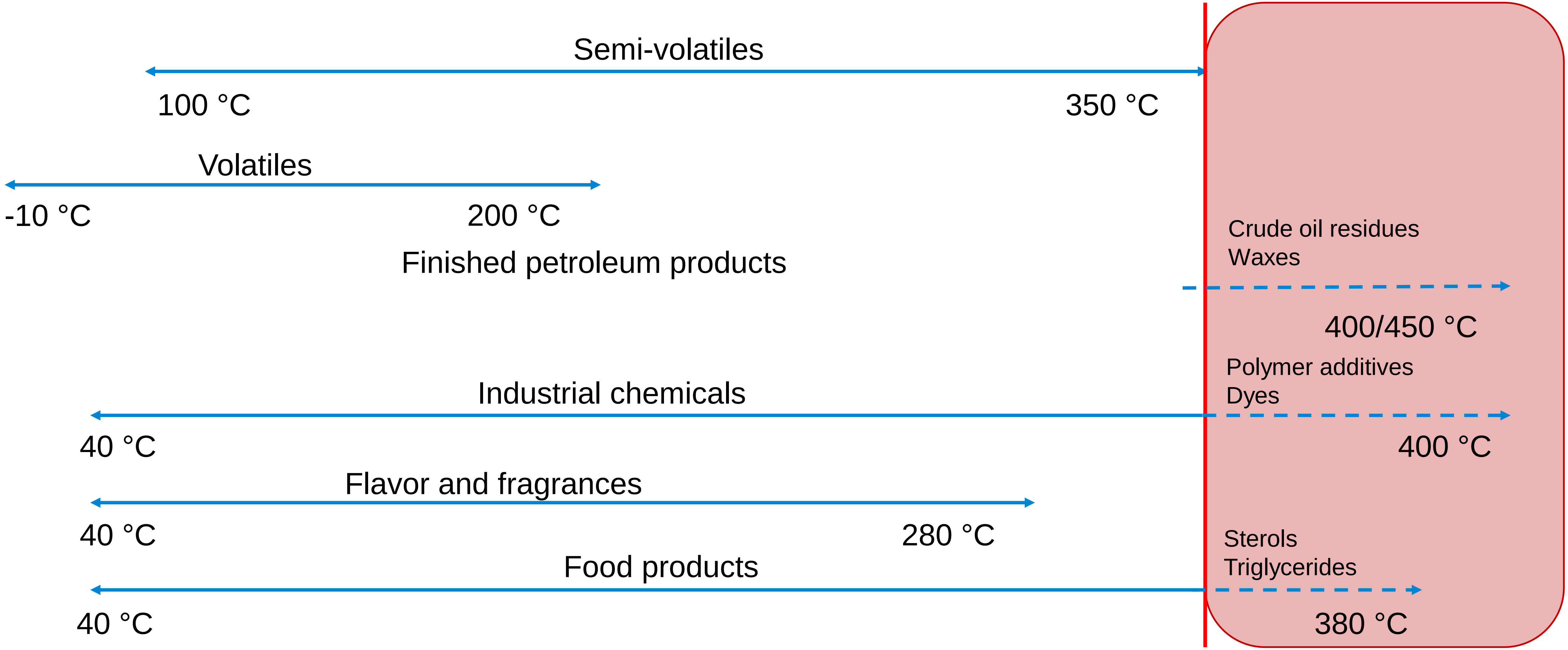
Agilent J&W has <u>over 50 different stationary phase offerings</u>

Specialty Phases

Columns developed for particular applications

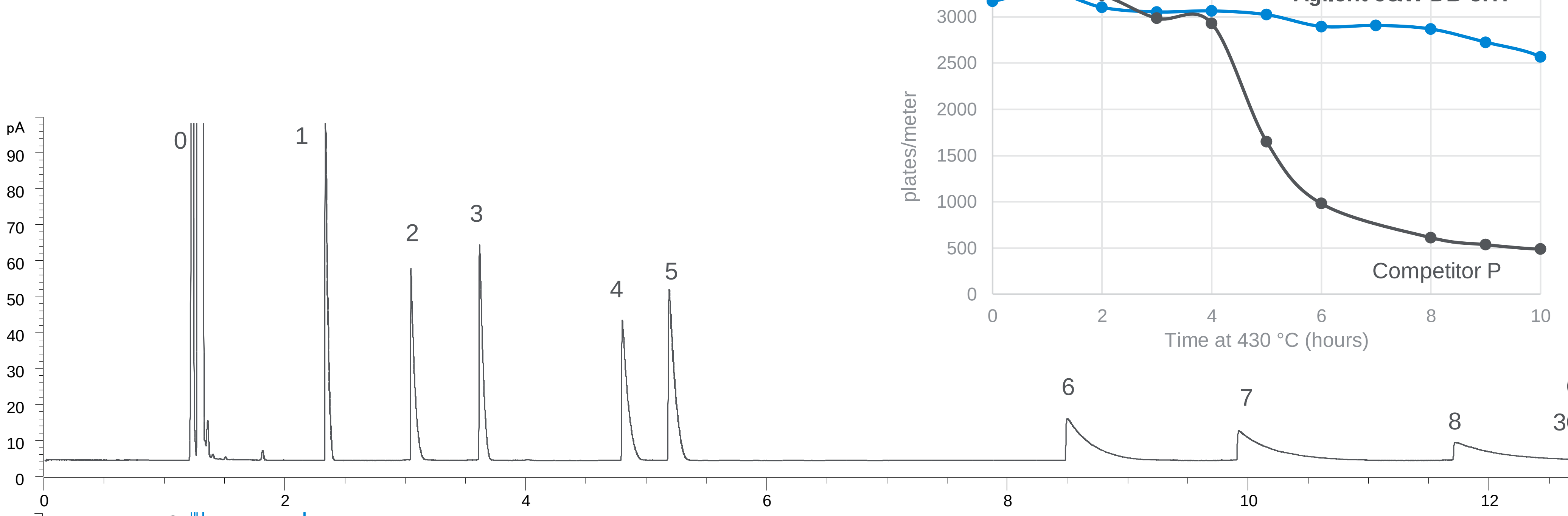
- Examples:
  - DB-8270D UI
  - DB-624 UI <467>
  - DB-MTBE
  - DB-TPH
  - DB-BAC1 UI & DB-BAC2 UI
  - DB-HT SimDis
  - Select Low Sulfur
  - CP-Volamine
  - Select PAH
  - DB-EUPAH
  - DB-CLP1 & DB-CLP2
  - DB-Select 624 UI <467>
  - CP-LowOx
  - Select Permanent Gases
  - And more!

High Temperature Applications

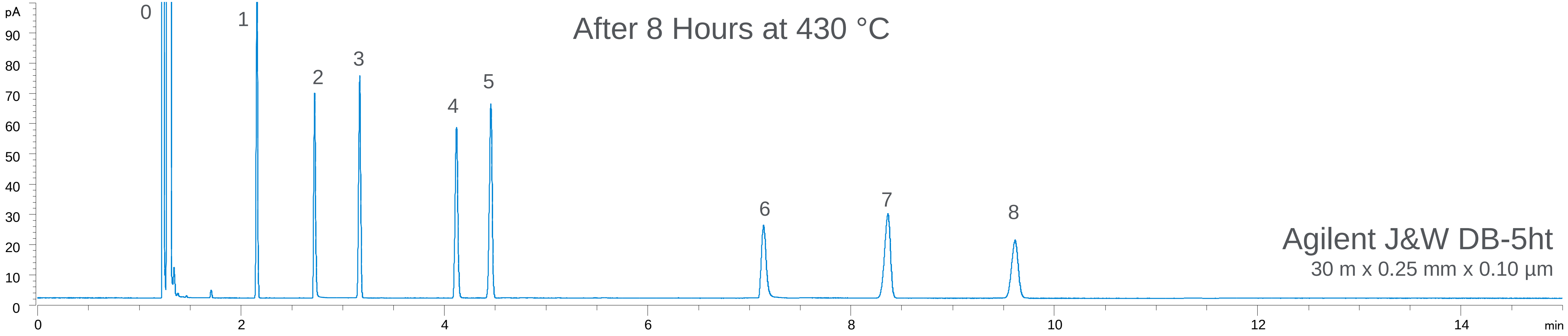


If you aren’t going above 350 °C, you don’t need a high temperature column

Agilent's High Temperature Columns

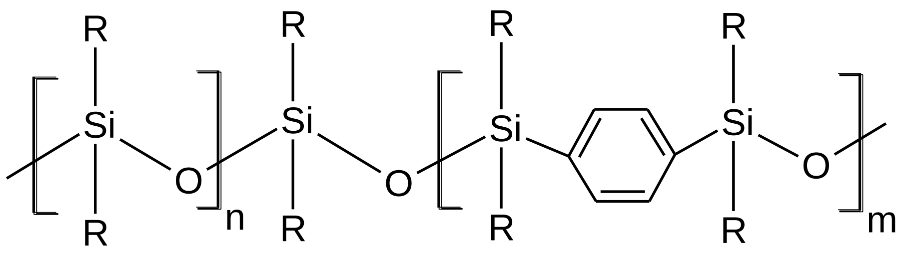


Peak	Name
0	Methane
1	Decane
2	1-Octanol
3	2,6-Dimethylphenol
4	2,6-Dimethylaniline
5	Naphthalene
6	1-Decanol
7	Tridecane
8	Methyl Decanoate



Low Bleed Phases

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



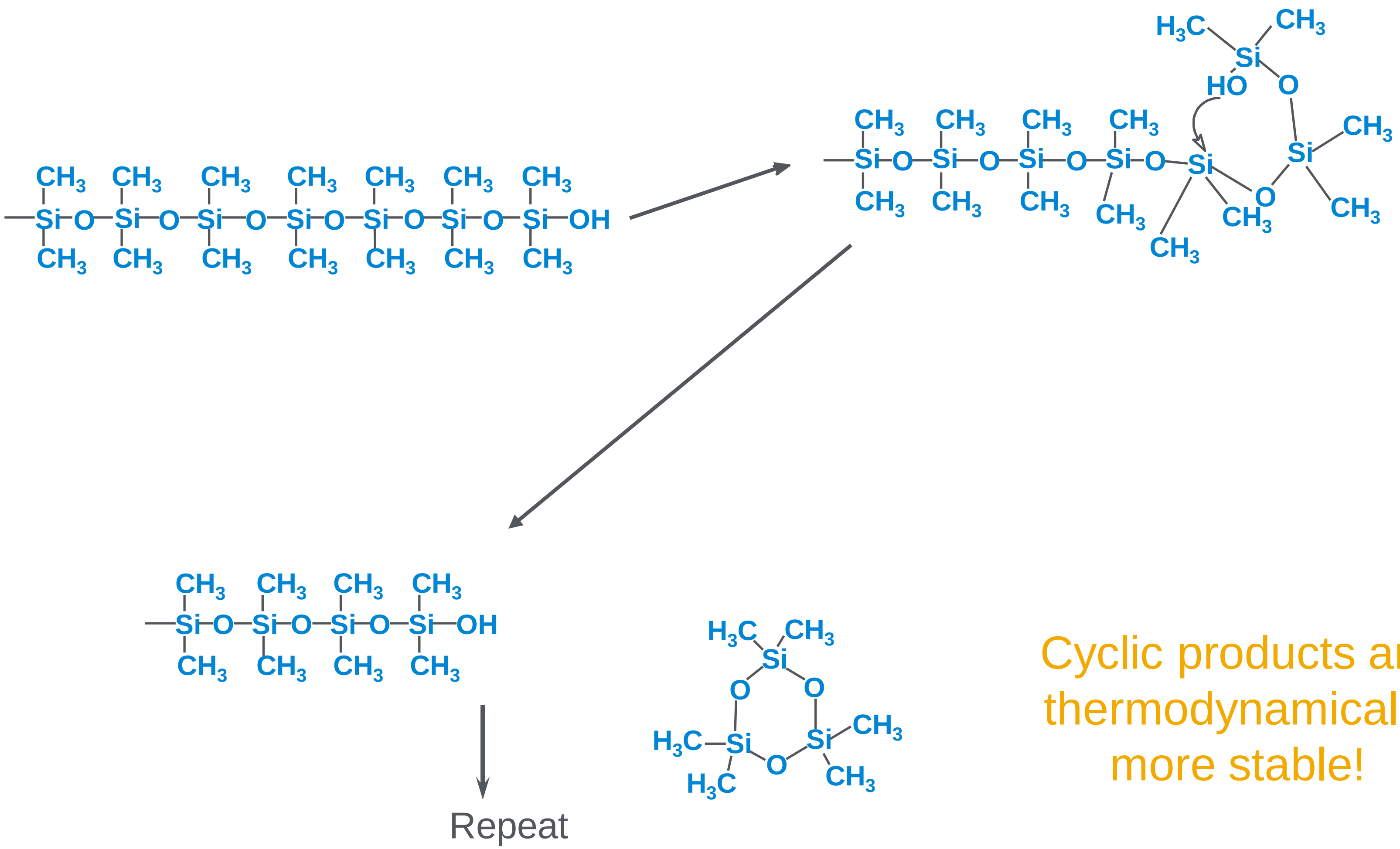
Siarylene backbone

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

- Optimized manufacturing processes
  Examples: DB-1ms, HP-1ms, HP-5ms, VF-5ms

What is Column Bleed?

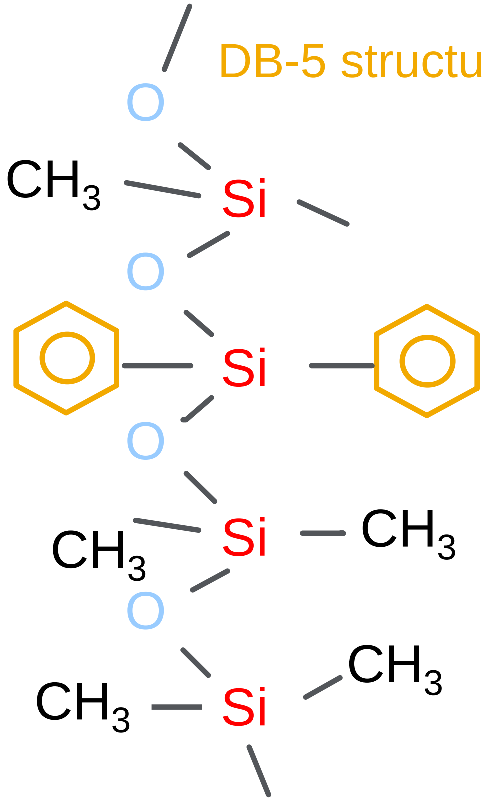
“Back biting” mechanism of product formation



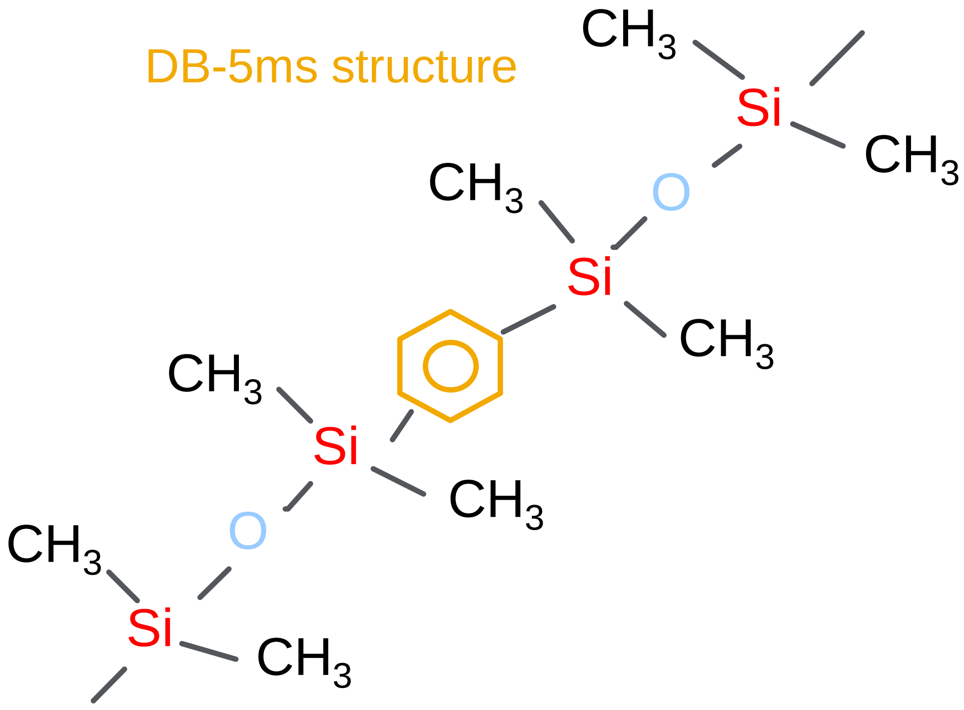
Cyclic products are thermodynamically more stable!

Agilent J&W DB-5ms Structure

DB-5 structure



DB-5ms structure



DB-5ms:

- Increased stability
- Different selectivity
- Optimized to match DB-5 as much as possible

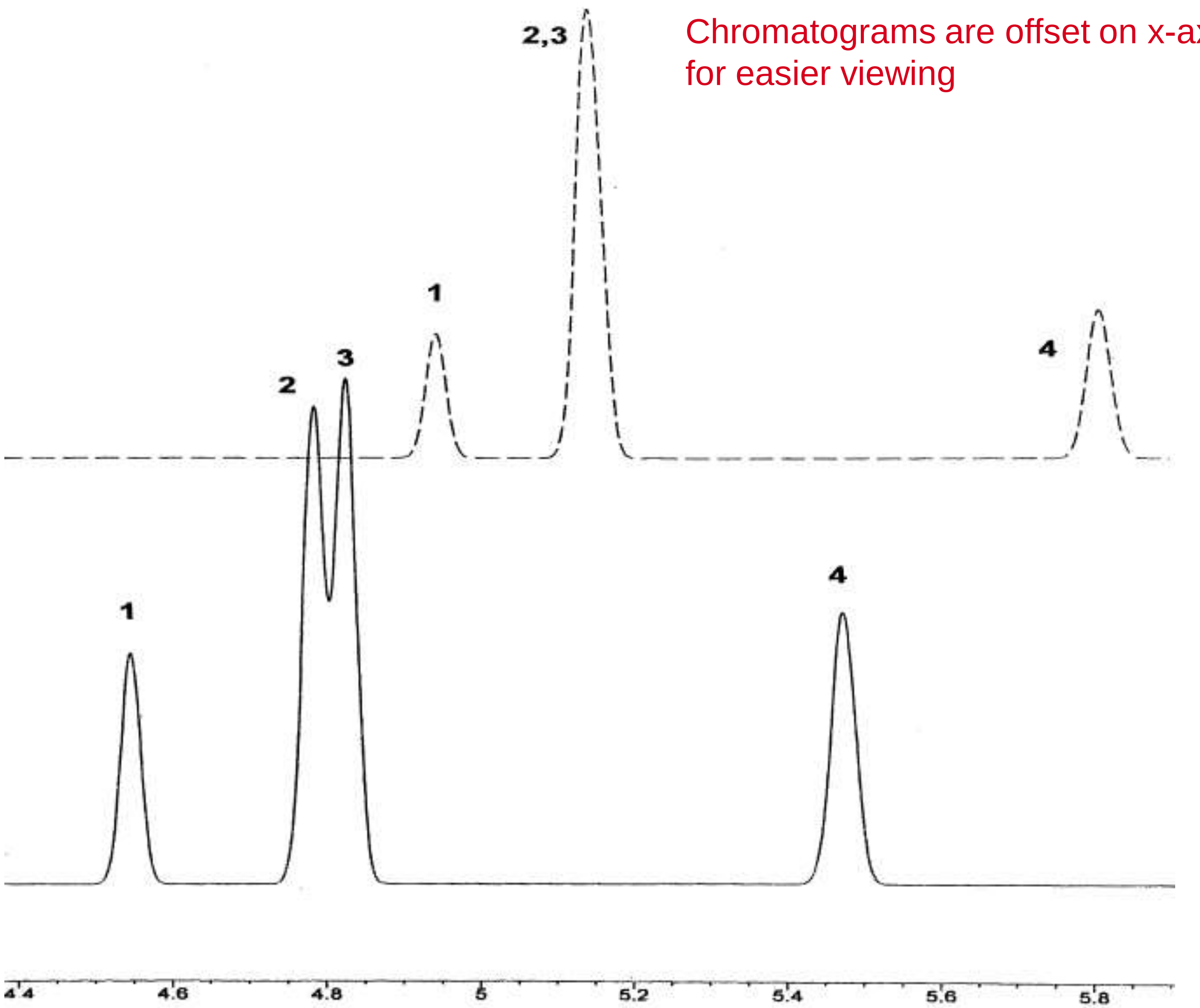
DB-5ms vs. DB-5 Selectivity

Solid line: Agilent J&W **DB-5ms**
30 m x .25 mm id x .25 µm
Dashed line: Agilent J&W **DB-5**
30 m x .25 mm id x .25 µm
Oven: 60 °C isothermal
Carrier gas: H_2 at 40 cm/sec

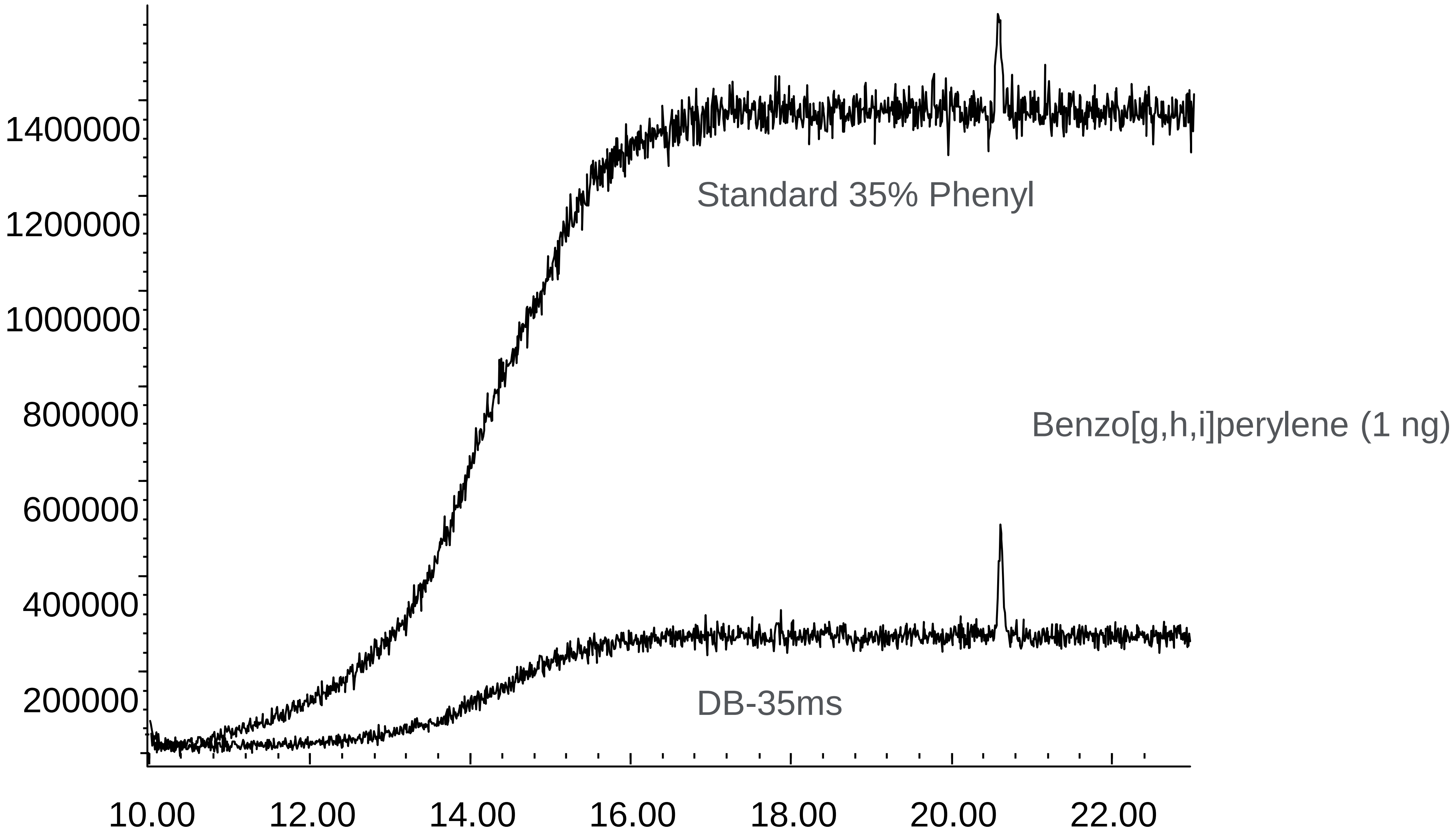
1: Ethylbenzene
2: m-Xylene

3: p-Xylene
4: o-Xylene

Chromatograms are offset on x-axis for easier viewing



Comparison of Agilent J&W DB-35MS vs Standard DB-35



Agilent Ultra Inert GC Columns
Column inertness: what does it mean?

- Easier to describe “lack of inertness”
  - Peak tailing (reversible interaction)
  - Loss of compound all together (irreversible interaction)

- A high level of flow path inertness will produce peaks from active compounds that are not degraded and will look “normal”/symmetrical

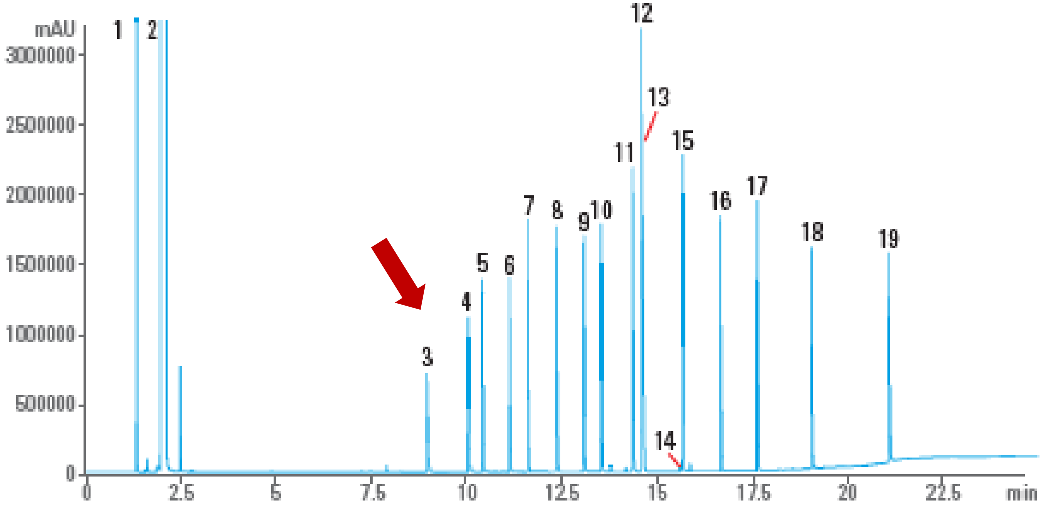
- The negative effects the column has towards challenging compounds
  - Acids
  - Bases
  - Hydrogen bonding
  - i.e. 2,4-DNP, Endrin, etc.

DB-WAX Ultra Inert and Free Fatty Acid

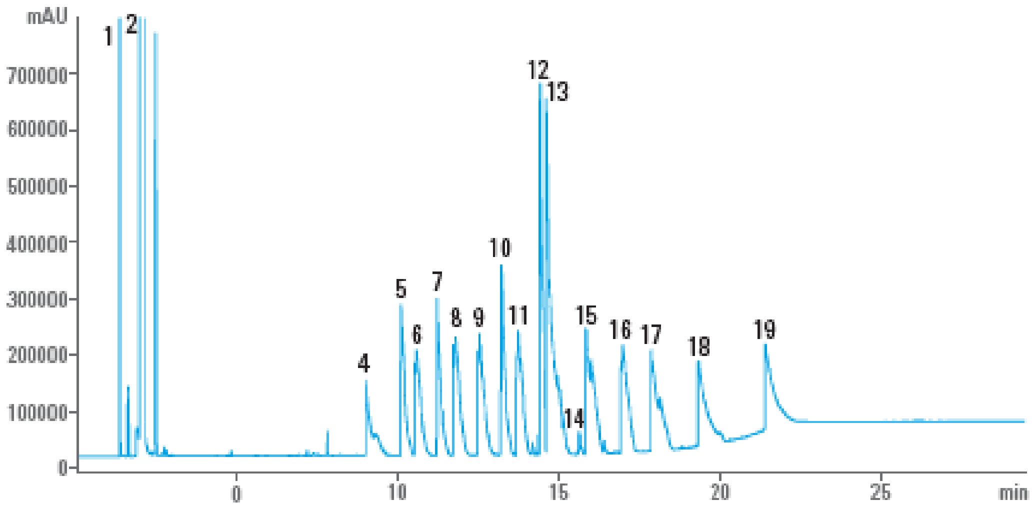
Peak identification:
1. Methane
2. Acetone (solvent)
3. Acetic acid
4. Propionic acid
5. Isobutyric acid
6. Butyric acid
7. Isovaleric acid
8. Valeric acid
9. 4-Methylvaleric acid
10. Hexanoic acid
11. 4-Methylhexanoic acid
12. 2-Ethylhexanoic acid
13. Heptanoic acid
14. Pyruvic acid
15. Octanoic acid
16. Nonanoic acid
17. Decanoic acid
18. Undecylenic acid
19. Myristic acid (Tetradecanoic)

Competitive comparison: free fatty acids

DB-WAX Ultra Inert GC column
30 m x 0.25 mm id, 0.25 µm (p/n 122-7032UI)



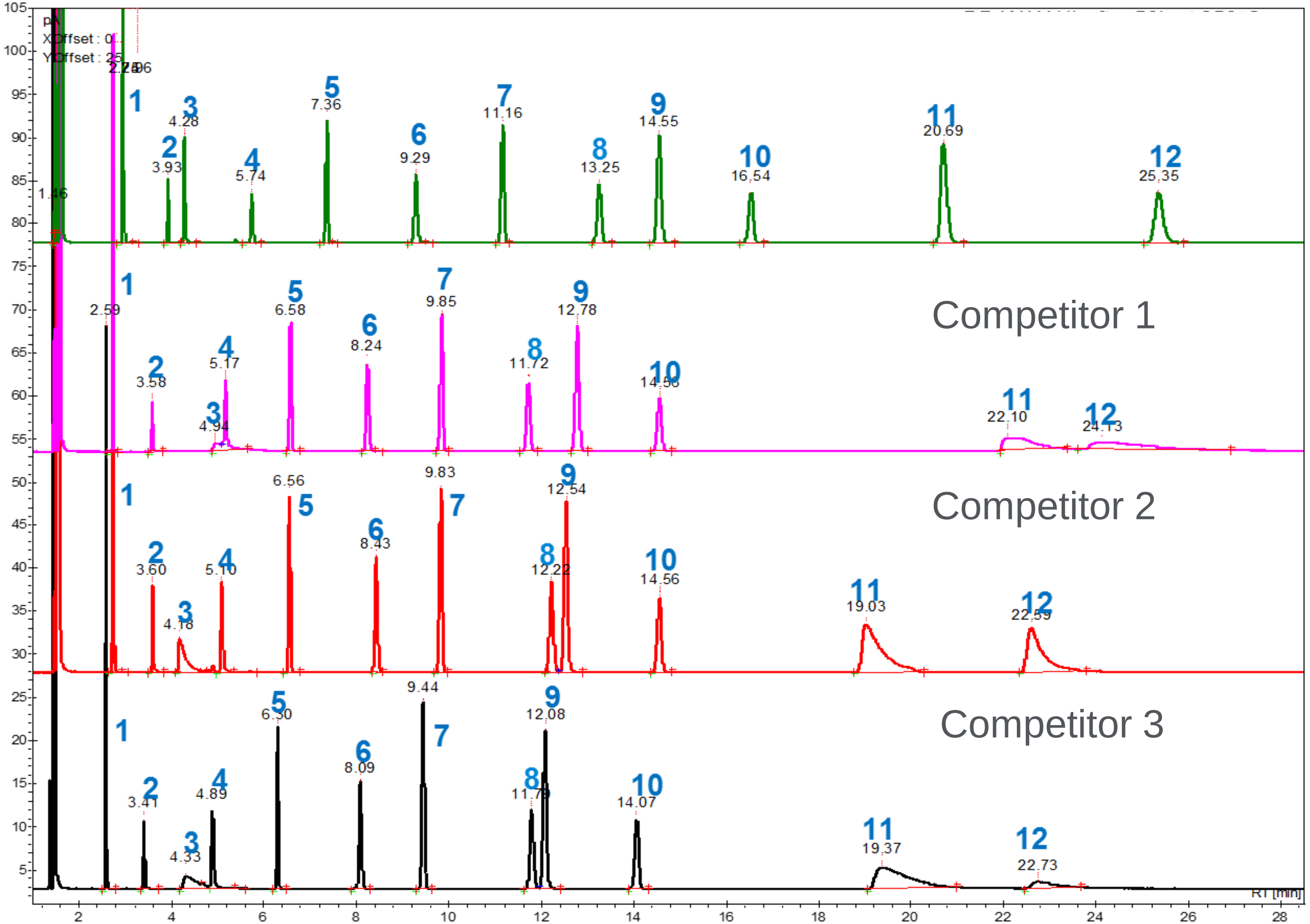
Standard WAX GC column
30 m x 0.25 mm id, 0.25 µm



Application note: 5991-6709EN

Let's Make a Better Wax Column: DB-WAX Ultra Inert

Competitor comparison DB-WAX UI test mix after 50 hours at 250 °C



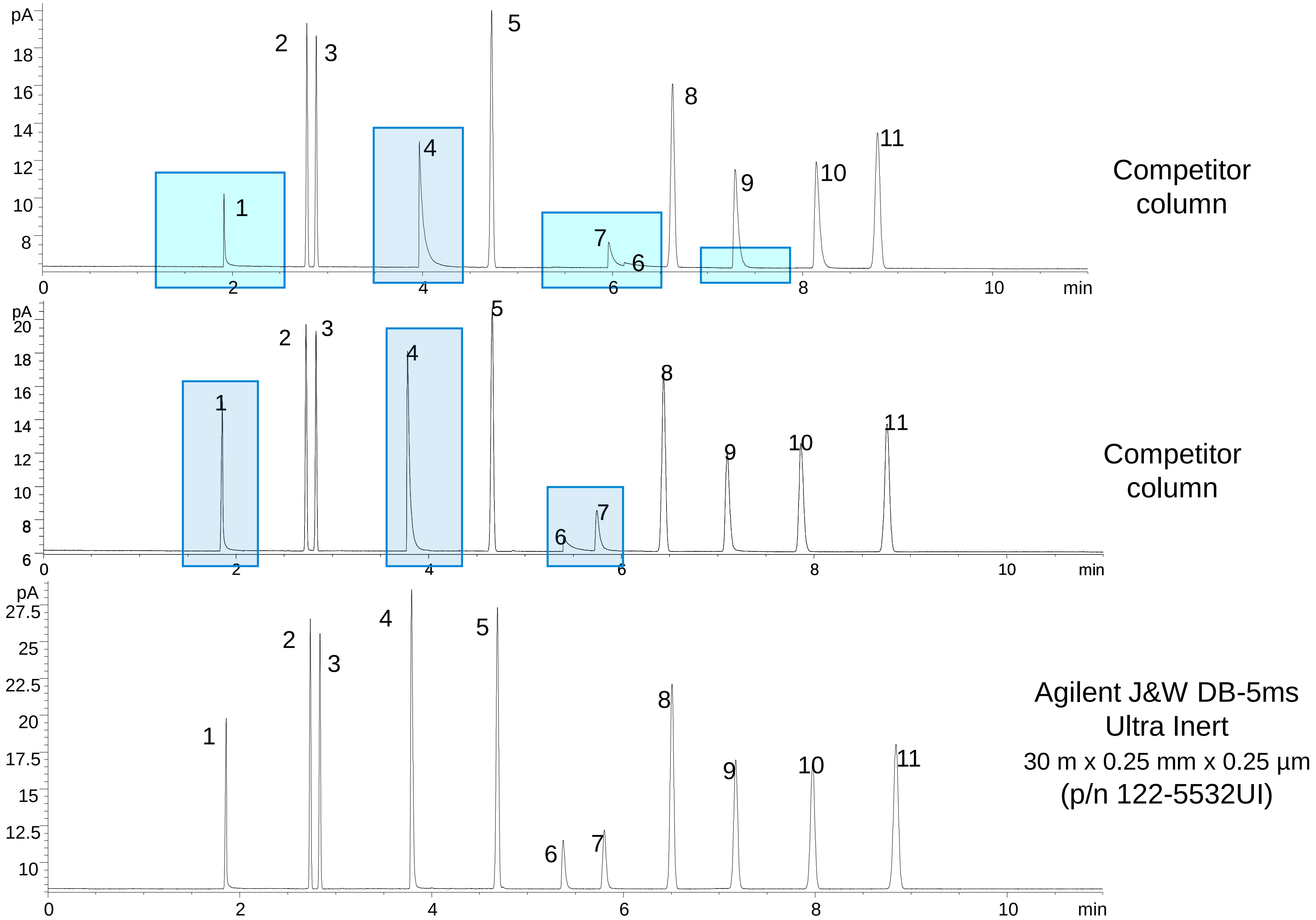
Compound I.D.

*. Methane
1. 5-Nonanone
2. Decanal
3. Propionic Acid
4. Ethylene Glycol
5. Heptadecane
6. Aniline
7. Methyl Dodecanoate
8. 2-Chlorophenol
9. 1-Undecanol
10. Nonadecane
11. 2-Ethylhexanoic Acid
12. Ethyl Maltol

Application Note: 5991-6683EN

Ultra Inert Test Mix – DB-5MS Ultra Inert v. Competitors

1. **1-Propionic acid**
2. **1-Octene**
3. **n-Octane**
4. **4-Picoline**
5. **n-Nonane**
6. **Trimethyl phosphate**
7. **1,2-Pentanediol**
8. **n-Propylbenzene**
9. **1-Heptanol**
10. **3-Octanone**
11. **n-Decane**



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 *α*

$$\alpha = \frac{k_2}{k_1}$$

k_2 = partition ratio of 2nd peak
k_1 = partition ratio of 1st peak

Agilent

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 (α)

- 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

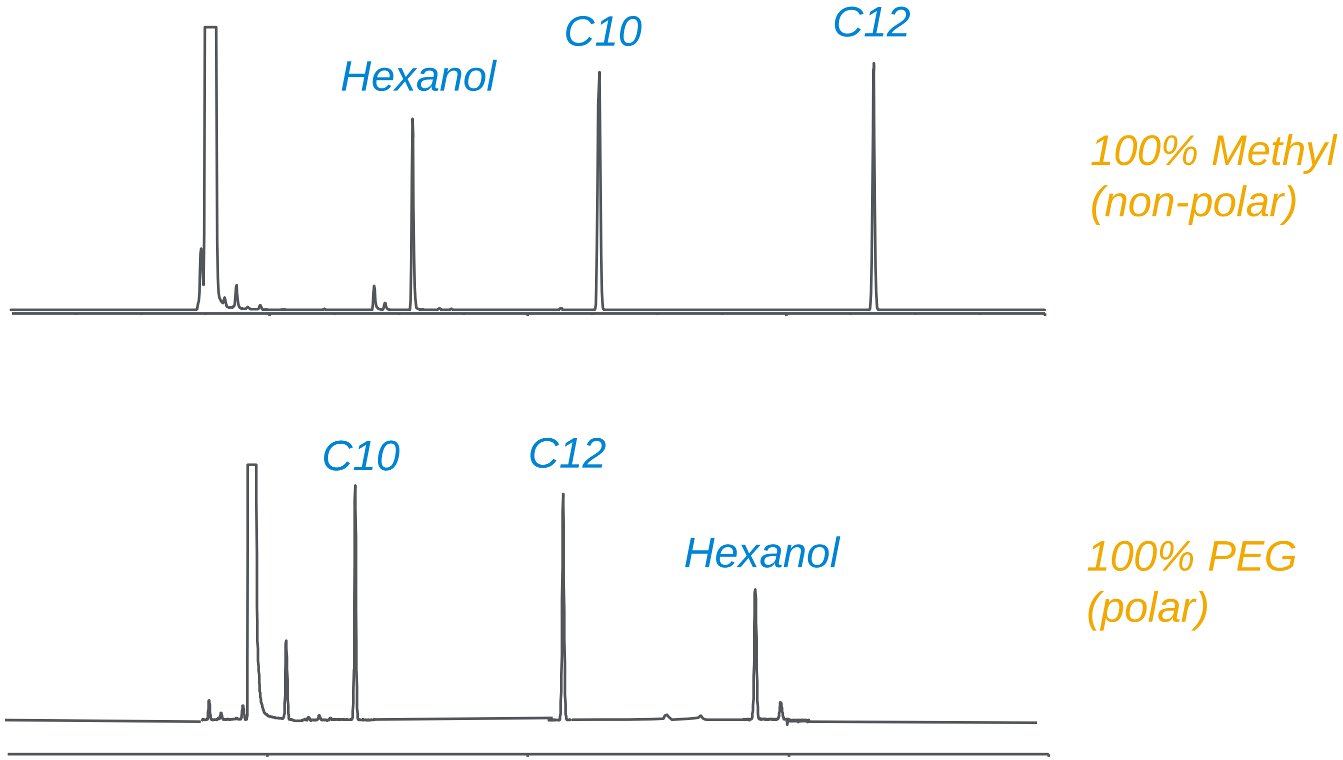
Dispersion Interaction (ΔH_{vap})

- Separation by differences in analyte heat of vaporizations (ΔH_{vap})

- Heat necessary to convert a liquid into a gas
  (at the same temperature)

Dispersion Interaction
Solubility And Retention

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



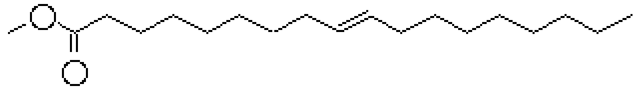
30 m x 0.32 mm id, 0.25 µm
He at 35 cm/sec
50–170 °C at 15 °C/min

Dispersion Interaction (ΔH_{vap})

Vapor pressure: good approximation

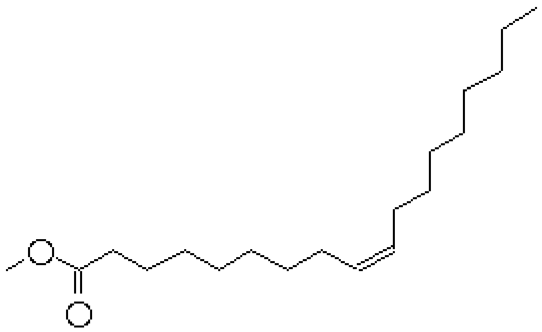
Boiling point: poor approximation

Dipole Interaction



C18:1 (Methyl *trans*-9-octadecenoate)

B.Pt. 186°C



C18:1 (Methyl *cis*-9-octadecenoate)

B.Pt. 186°C

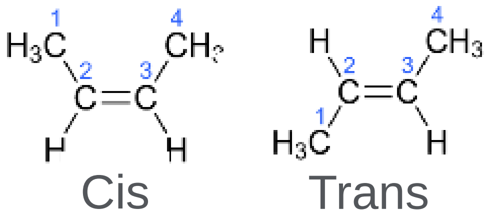
Smaller differences require a stronger dipole phase

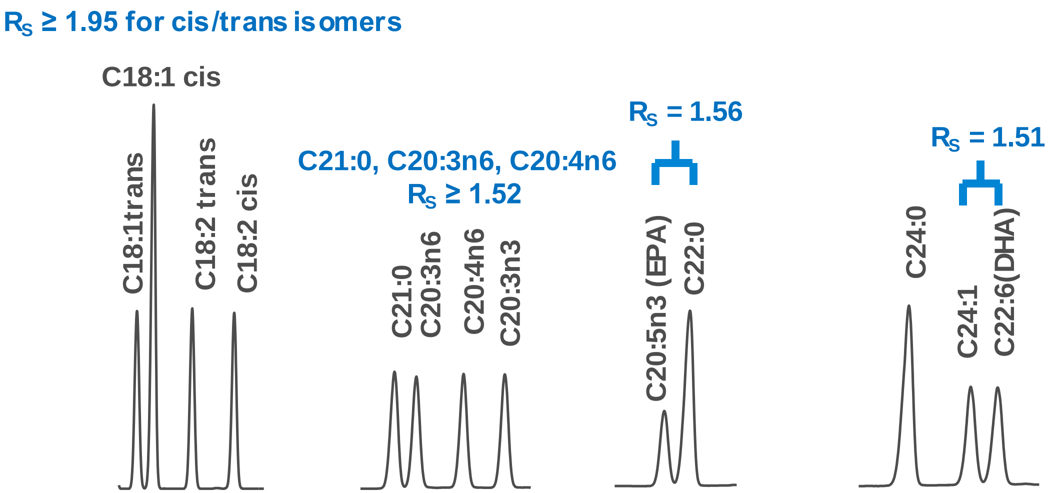
DB-FastFAME

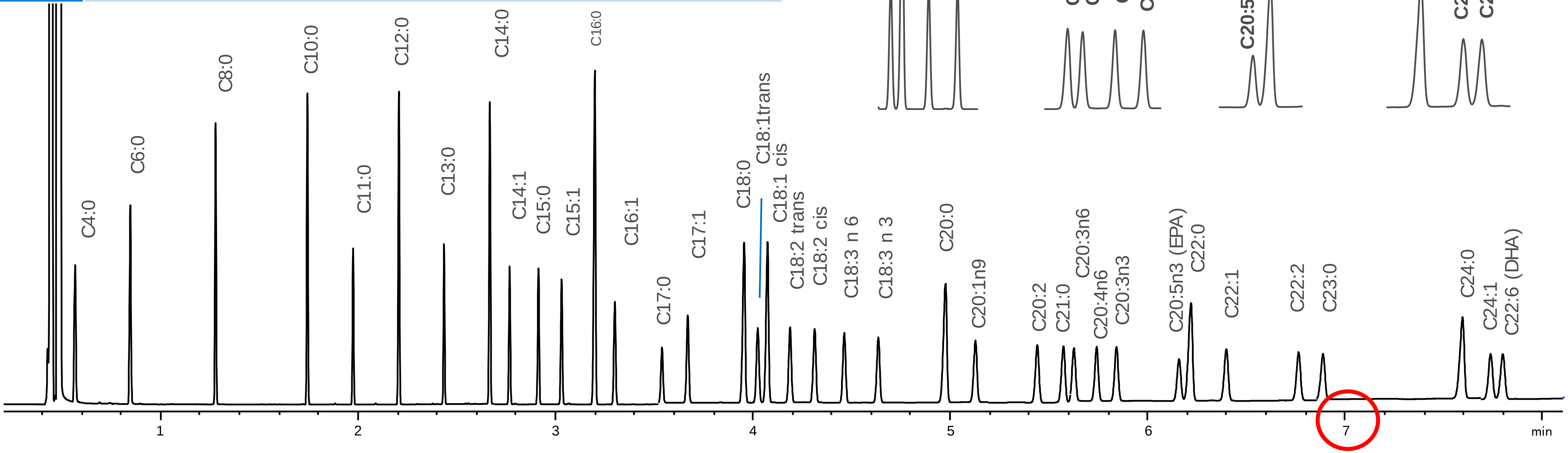
20 m x 0.18 mm x 0.20 µm

Column	**Agilent J&W DB-FastFAME, 20 m x 0.18 mm, 0.20 µm**
Gas	**Hydrogen**, 28 psi, constant pressure mode
Inlet	Split/splitless, 250 °C, split ratio 50:1
Oven	80 °C (0.5 min), 65 °C/min to 175 °C, 10 °C/min to 185 °C (0.5 min), 7 °C/min to 230 °C
FID	280 °C, Hydrogen: 40 mL/min; Air: 400 mL/min; make-up gas: 25 mL/min.
Injection	1 µL

Strong interaction between cis isomers and the dipoles of the cyano propyl ligands. That allows the trans to elute after the cis isomers.



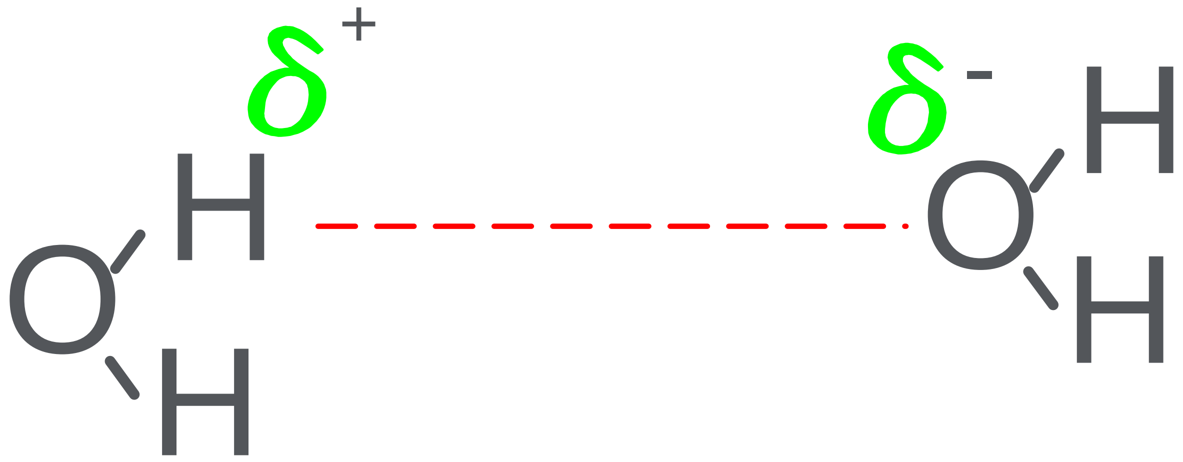




Application note: 5991-8706EN

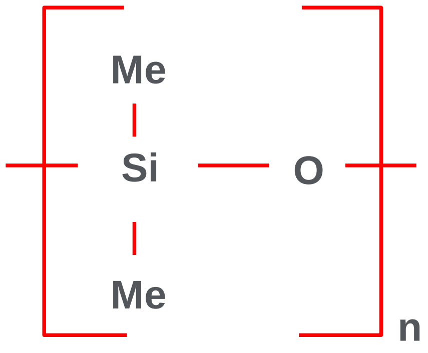
Hydrogen Bonding Interaction

Dipole-Dipole interaction with hydrogen bound to oxygen or nitrogen interacting with an oxygen or nitrogen-atom



Nonpolar Phases

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

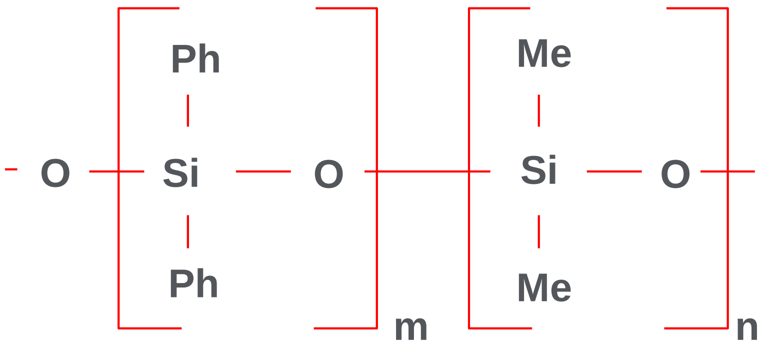


Separation mechanisms:

- 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)



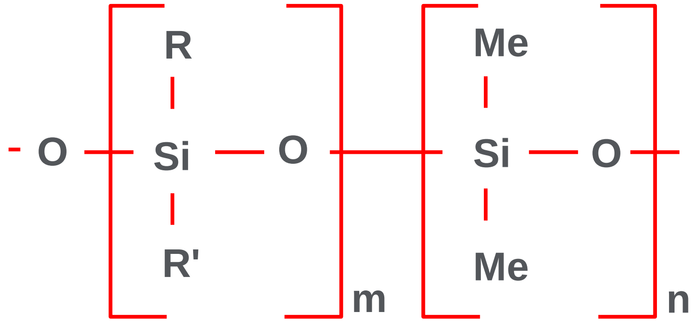
5%--weakly polar,
50%-- mid-polar

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)



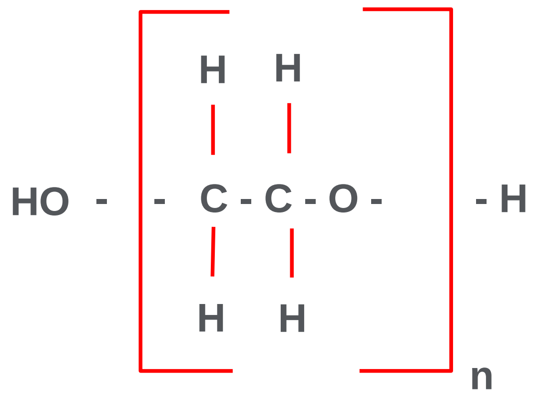
R = cyanopropyl or trifluoropropyl
R′ = phenyl or methyl

Separation mechanisms:

- Dispersion
- Inducible dipole at phenyl groups
- Strong permanent dipole
- Hydrogen bonding

Hydrogen Bonding Phases

Typified by polyethylene glycol polymers (HP-Innowax, DB-WAX UI, DB-HeavyWAX, DB-FFAP, VF-WAXms, CP-WAX52CB…)



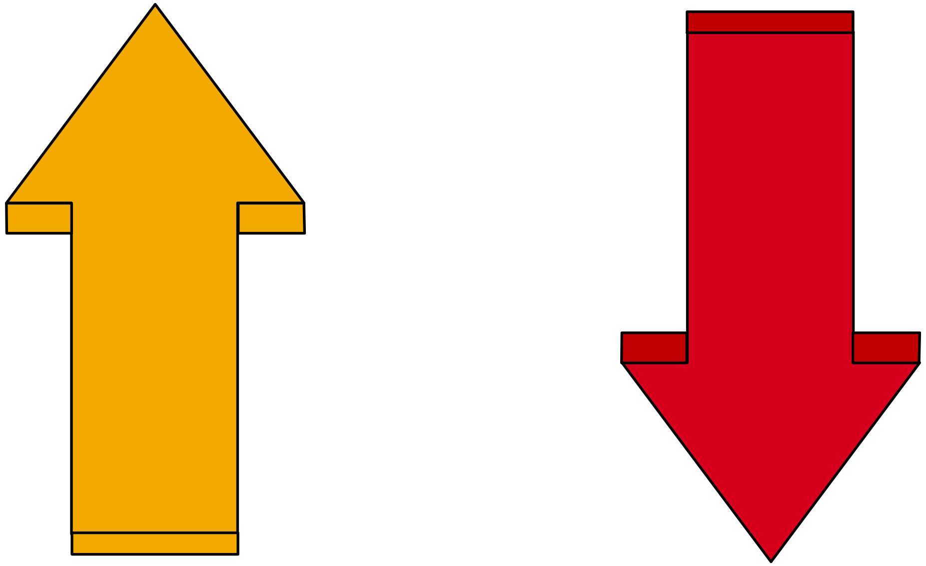
Separation mechanisms:

- Dispersion
- Strong permanent dipole
- Hydrogen bonding

Selectivity
Interaction strengths

Phase	Dispersion	Dipole	H Bonding
Methyl	Strong	None	None
Phenyl	Strong	None	Weak
Cyanopropyl	Strong	Very Strong	Moderate
Trifluoropropyl	Strong	Moderate	Weak
PEG	Strong	Strong	Moderate

Polarity



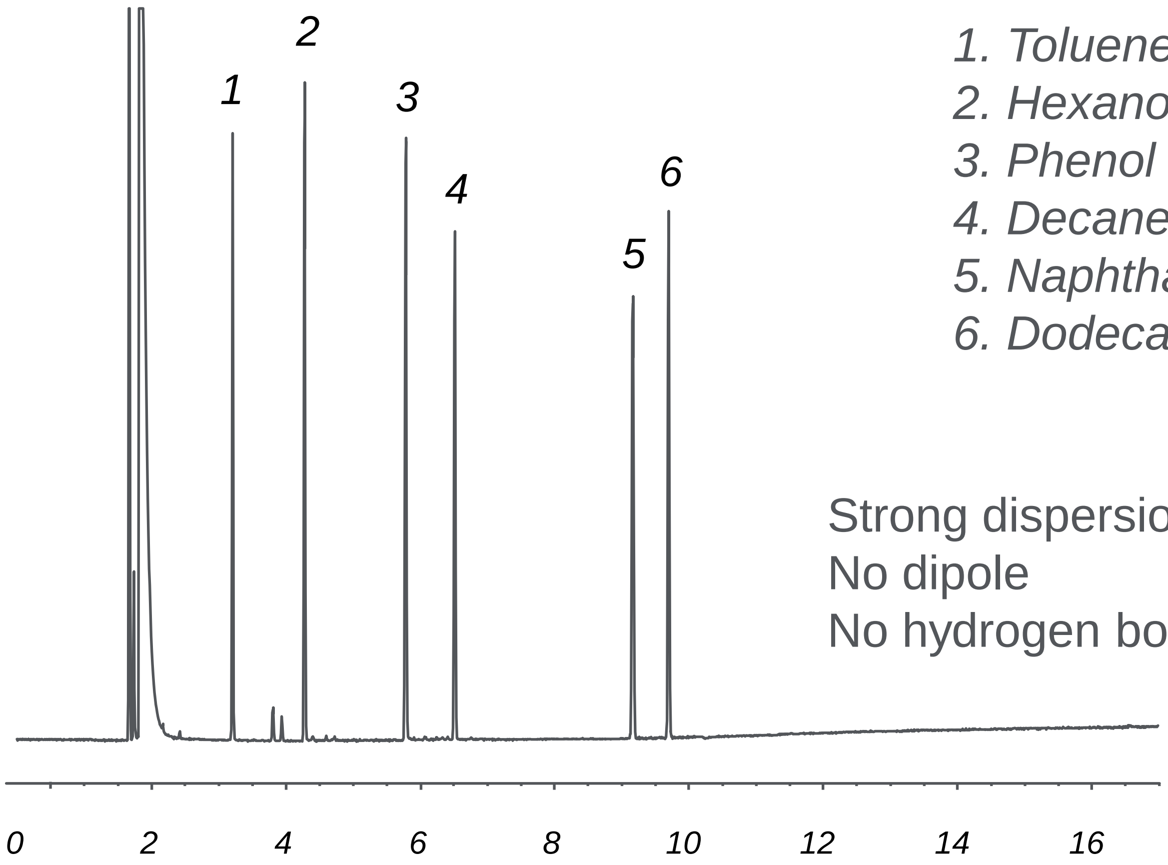
Polarity

Stability
Temperature Range

Compounds & Properties

Compounds	Polar	Aromatic	Hydrogen Bonding	Dipole
Toluene	no	yes	no	induced
Hexanol	yes	no	yes	yes
Phenol	yes	yes	yes	yes
Decane	no	no	no	no
Naphthalene	no	yes	no	induced
Dodecane	no	no	no	no

100% Methyl Polysiloxane



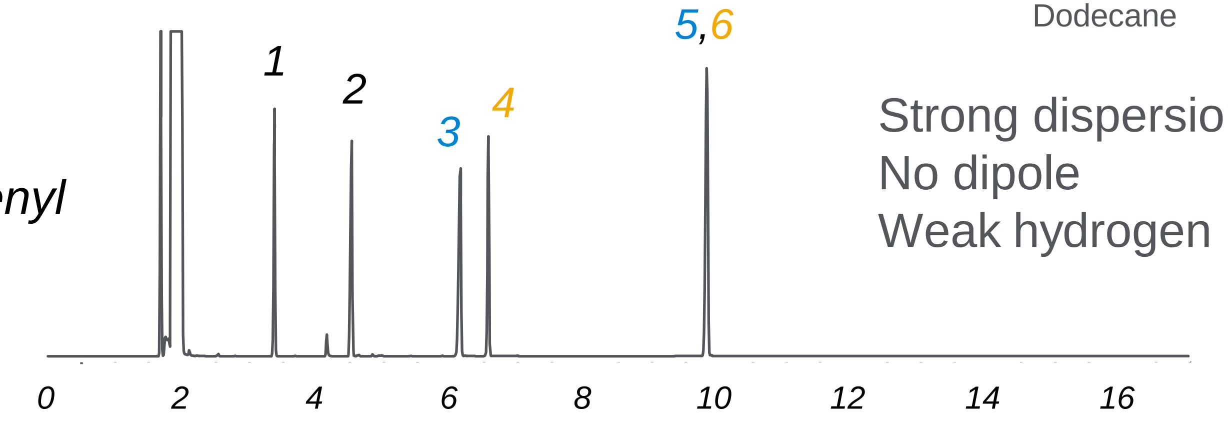
1. Toluene 110 ^oC
2. Hexanol 156 ^oC
3. Phenol 182 ^oC
4. Decane (C10) 174 ^oC
5. Naphthalene 218 ^oC
6. Dodecane (C12) 216 ^oC

Strong dispersion
No dipole
No hydrogen bonding

5% Phenyl

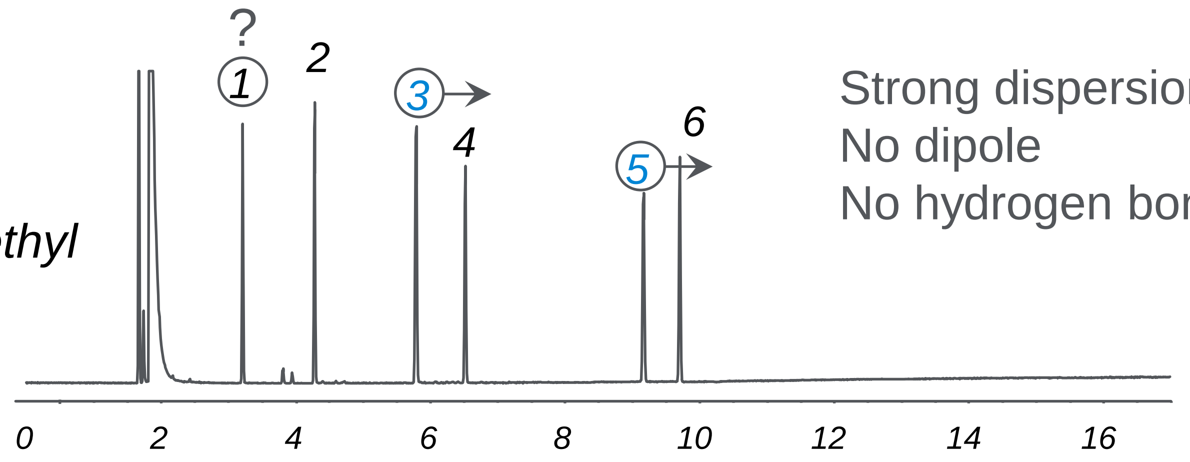
Compounds	Polar	Aromatic	Hydrogen Bonding	Dipole
Toluene	no	yes	no	induced
Hexanol	yes	no	yes	yes
Phenol	yes	**yes**	**yes**	yes
Decane	no	no	no	no
Naphthalene	no	**yes**	no	induced
Dodecane	no	no	no	no

5% Phenyl



Strong dispersion
No dipole
Weak hydrogen bonding

100% Methyl



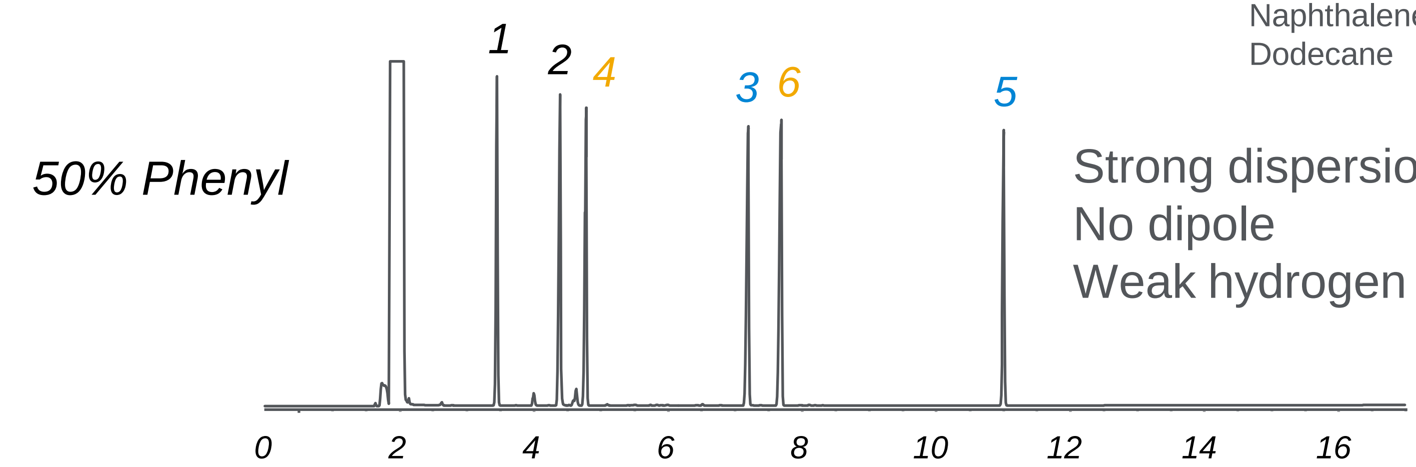
Strong dispersion
No dipole
No hydrogen bonding

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

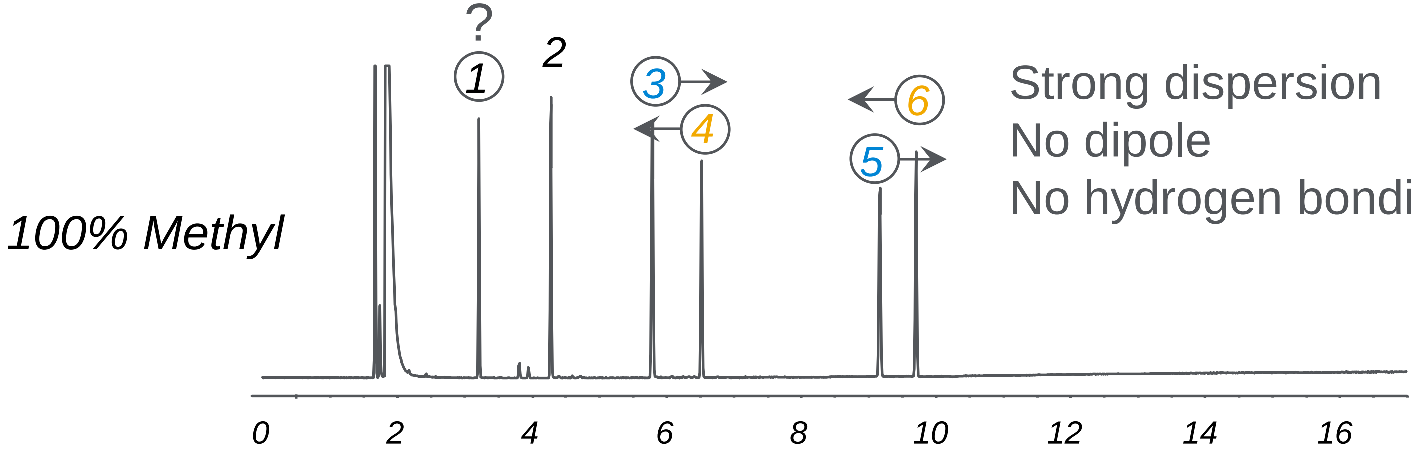
Agilent

50% Phenyl

Compounds	Polar	Aromatic	Hydrogen Bonding	Dipole
Toluene	no	yes	no	induced
Hexanol	yes	no	yes	yes
Phenol	yes	**yes**	**yes**	yes
Decane	**no**	**no**	**no**	no
Naphthalene	no	**yes**	no	induced
Dodecane	**no**	**no**	**no**	no



Strong dispersion
No dipole
Weak hydrogen bonding



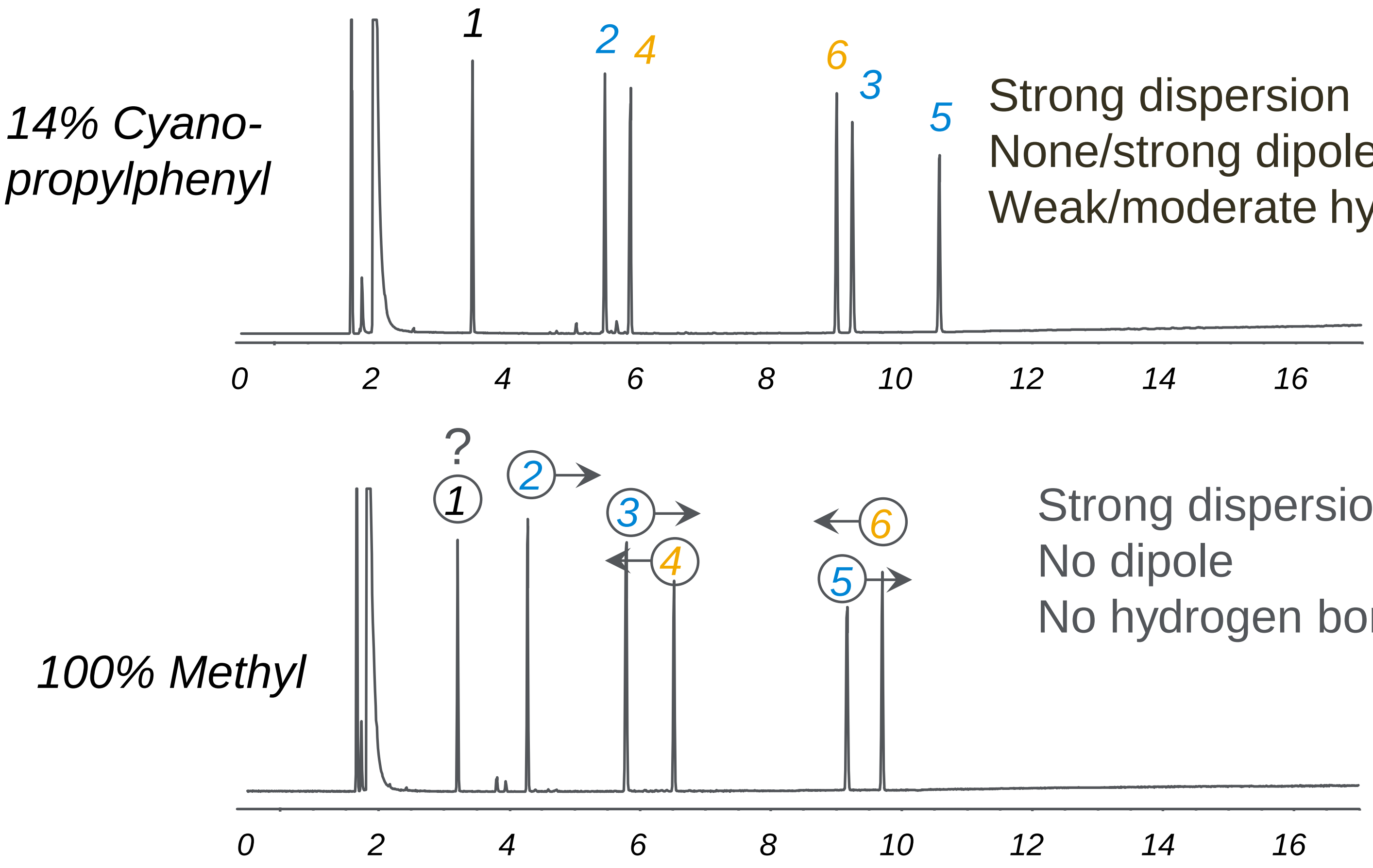
Strong dispersion
No dipole
No hydrogen bonding

1. *Toluene* 110 °C
2. *Hexanol* 156 °C
3. *Phenol* 182 °C
4. *Decane (C10)* 174 °C
5. *Naphthalene* 218 °C
6. *Dodecane (C12)* 216 °C

Agilent Restricted

14% Cyanopropylphenyl

Compounds	Polar	Aromatic	Hydrogen Bonding	Dipole
Toluene	no	yes	no	induced
Hexanol	**yes**	no	**yes**	**yes**
Phenol	**yes**	yes	**yes**	**yes**
Decane	**no**	no	**no**	**no**
Naphthalene	no	**yes**	no	**induced**
Dodecane	**no**	no	**no**	**no**



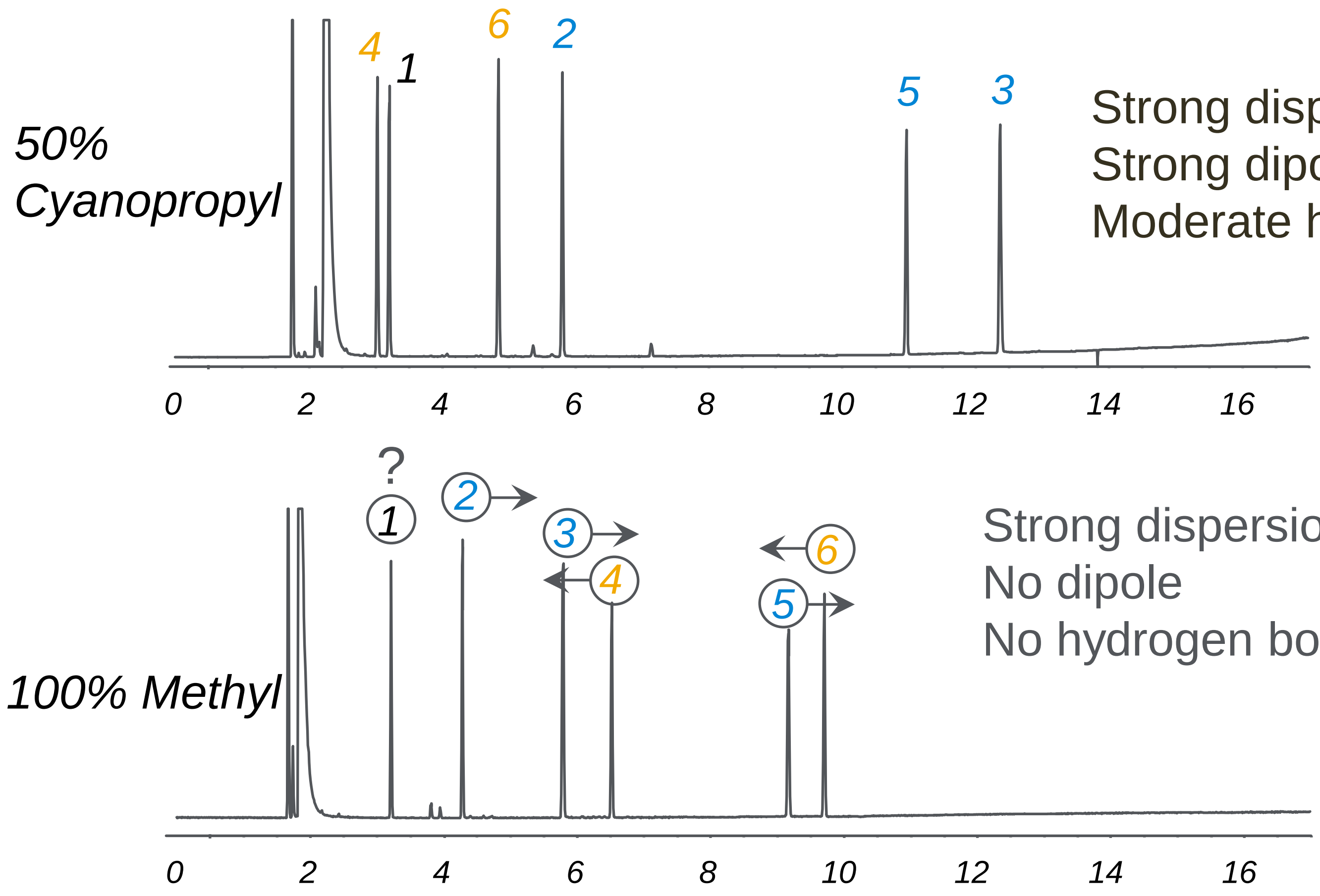
Strong dispersion
None/strong dipole (phenyl/cyanopropyl)
Weak/moderate hydrogen bonding (phenyl/cyanopropyl)

Strong dispersion
No dipole
No hydrogen bonding

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

50% Cyanopropyl

Compounds	Polar	Aromatic	Hydrogen Bonding	Dipole
Toluene	no	yes	no	induced
Hexanol	**yes**	no	**yes**	**yes**
Phenol	**yes**	yes	**yes**	**yes**
Decane	no	no	**no**	**no**
Naphthalene	no	yes	no	induced
Dodecane	no	no	**no**	**no**



Strong dispersion
Strong dipole
Moderate hydrogen bonding

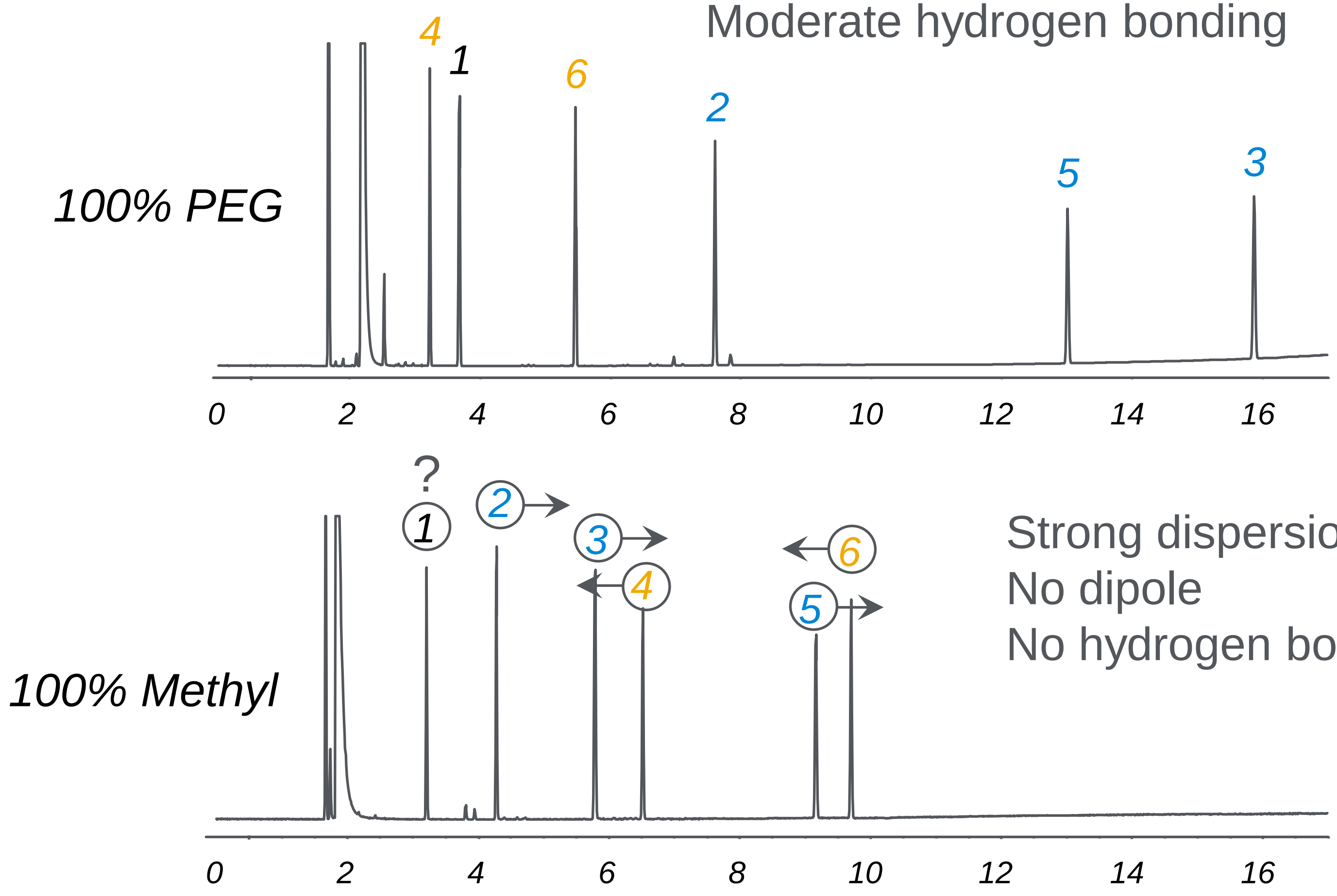
Strong dispersion
No dipole
No hydrogen bonding

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

100% Polyethylene Glycol

Compounds	Polar	Aromatic	Hydrogen Bonding	Dipole
Toluene	no	yes	no	induced
Hexanol	**yes**	no	**yes**	**yes**
Phenol	**yes**	yes	**yes**	**yes**
Decane	**no**	no	**no**	**no**
Naphthalene	no	yes	no	induced
Dodecane	**no**	no	**no**	**no**

Strong dispersion
Strong dipole
Moderate hydrogen bonding



Strong dispersion
No dipole
No hydrogen bonding

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

Agilent Restricted

Stationary Phase Selection
Part 1

- Existing information
- Selectivity
- Polarity
- Critical separations
- Temperature limits

Agilent Bond Elut Sample Cleanup Products

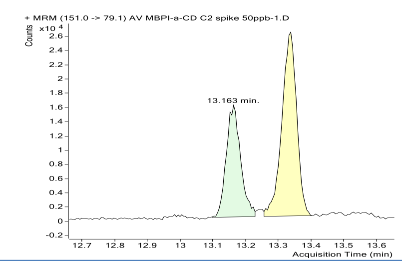
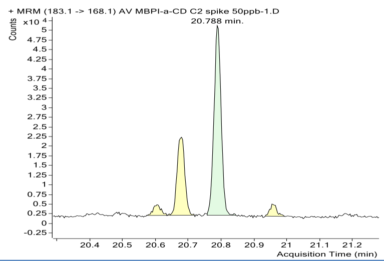
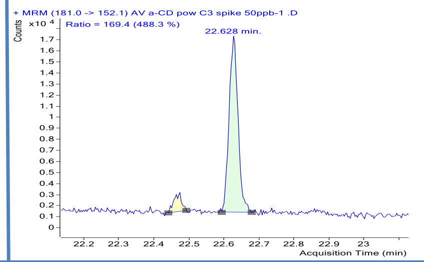
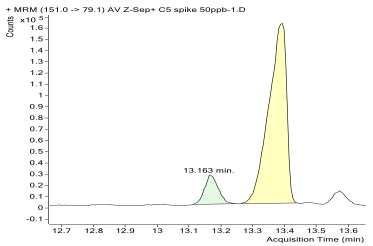
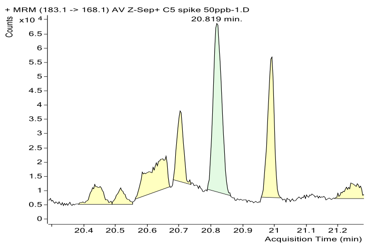
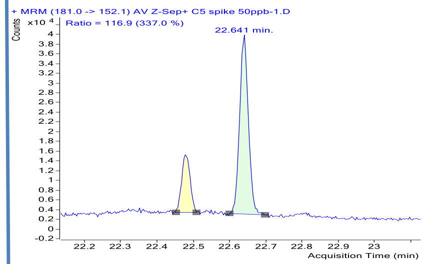
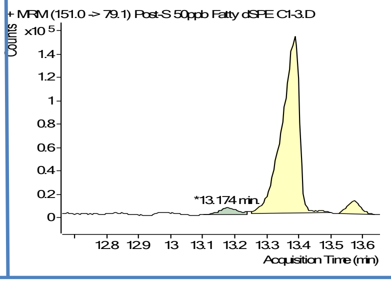
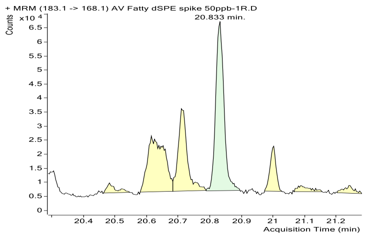
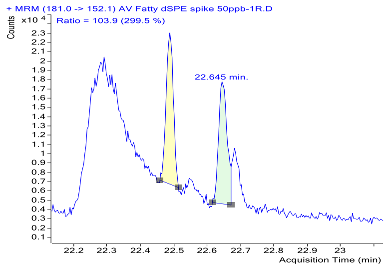
Solid Phase Extraction cartridges and plates

Synthetic Chem Elut S

Filtration cartridges and plates

Captiva EMR Lipid

Captiva EMR–Lipid Cleanup Improves Analytes S/N Ratio and Integration Accuracy on GC/MS(/MS) of Pesticides in Olive Oil

Pesticide	Captan	Permethrin	Deltamethrin
EMR-Lipid cleanup			
Zirconia sorbent cleanup			
C18/PSA cleanup			

Agilent

Stationary Phase Selection
Part 2

- Capacity
- Analysis time
- Bleed
- Versatility
- Selective detectors

Column Dimensions

- Inner diameter
- Length
- Film thickness

Column Diameter
Capillary Columns

id (mm)	Common Name
0.53	Megabore
0.45	High speed megabore
0.32	Wide
0.20–0.25	Narrow
0.18	Minibore

Column Diameter
Theoretical Efficiency

id (mm)	N/m
0.10	11905
0.18	6666
0.20	5941
0.25	4762
0.32	3717
0.53	2242

k = 5

Efficiency and Resolution

Relationship

$$\sqrt{N} \propto R_s$$

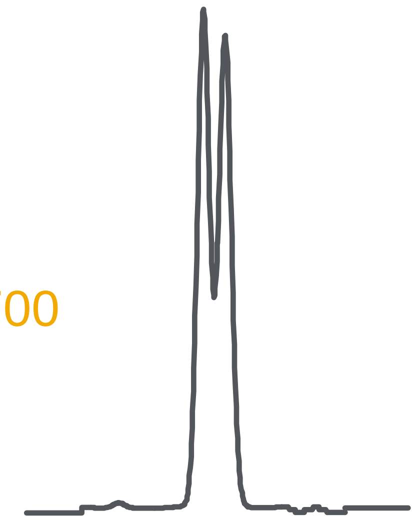
efficiency x 4 = resolution x 2

Column Diameter

Resolution (180 °C isothermal)

R= 0.87

n =58,700



0.53 mm

R= 1.01

n =107,250

0.32 mm

Square root of resolution is inversely proportional to column diameter

Column Diameter

Inlet head pressures for 30 meter column (helium)

id (mm)	Pressure (psig)
0.10	225–250
0.20	25–35
0.25	15–25
0.32	10–20
0.53	2–4

Hydrogen would produce about half the amount of pressure

Column Diameter

Capacity (0.25 µm film thickness)

id (mm)	Capacity (ng)
0.20	50–100
0.25	75–150
0.32	125–250
0.53	200–400

Like polarity phase/solute

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)

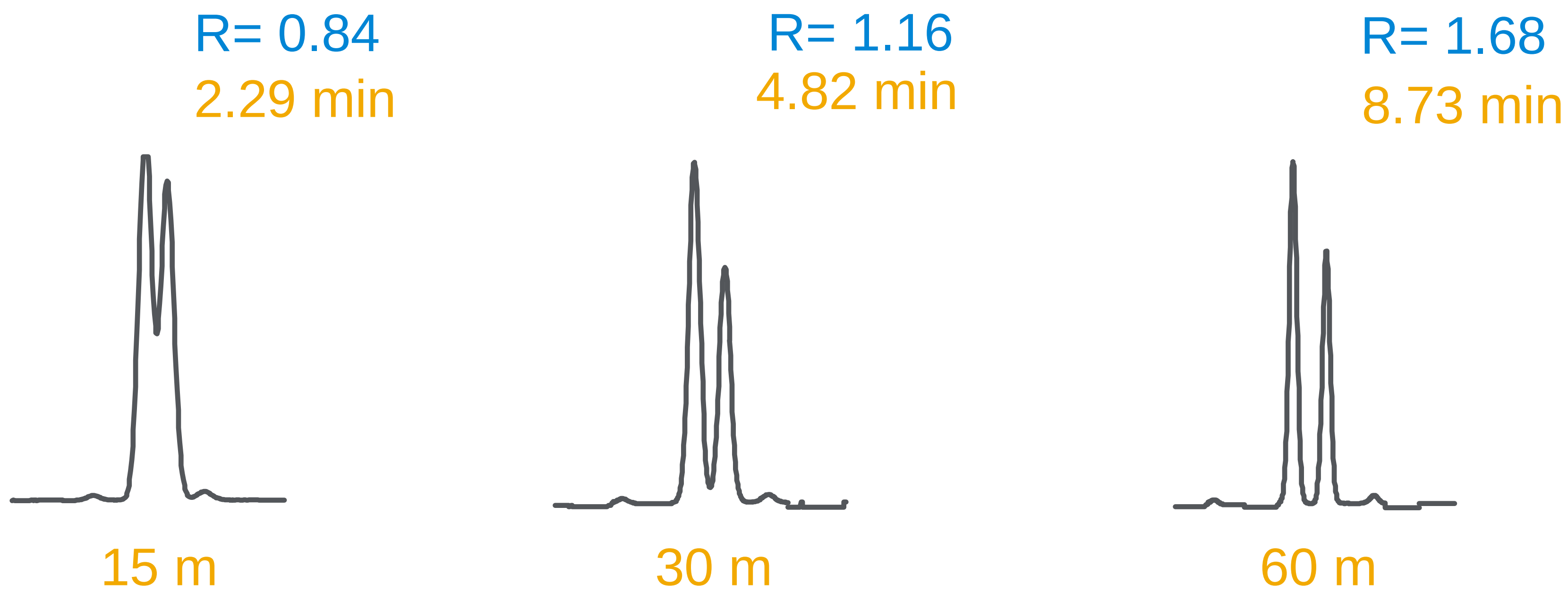
Column Length

Most common: 15–60 meters

Available: 5–200 meters

Column Length

Resolution and retention 210°C isothermal

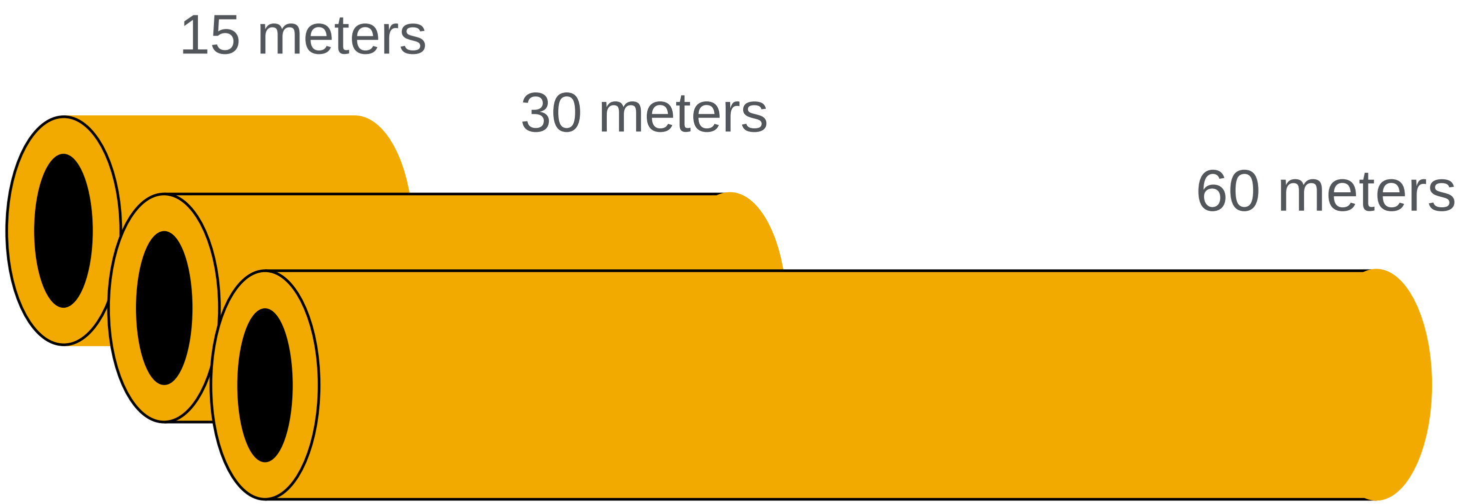


Resolution is proportional to the square root of column length

Isothermal: retention is proportional to length

Temperature program: 1/3–1/2 of isothermal values

Column Length and Cost

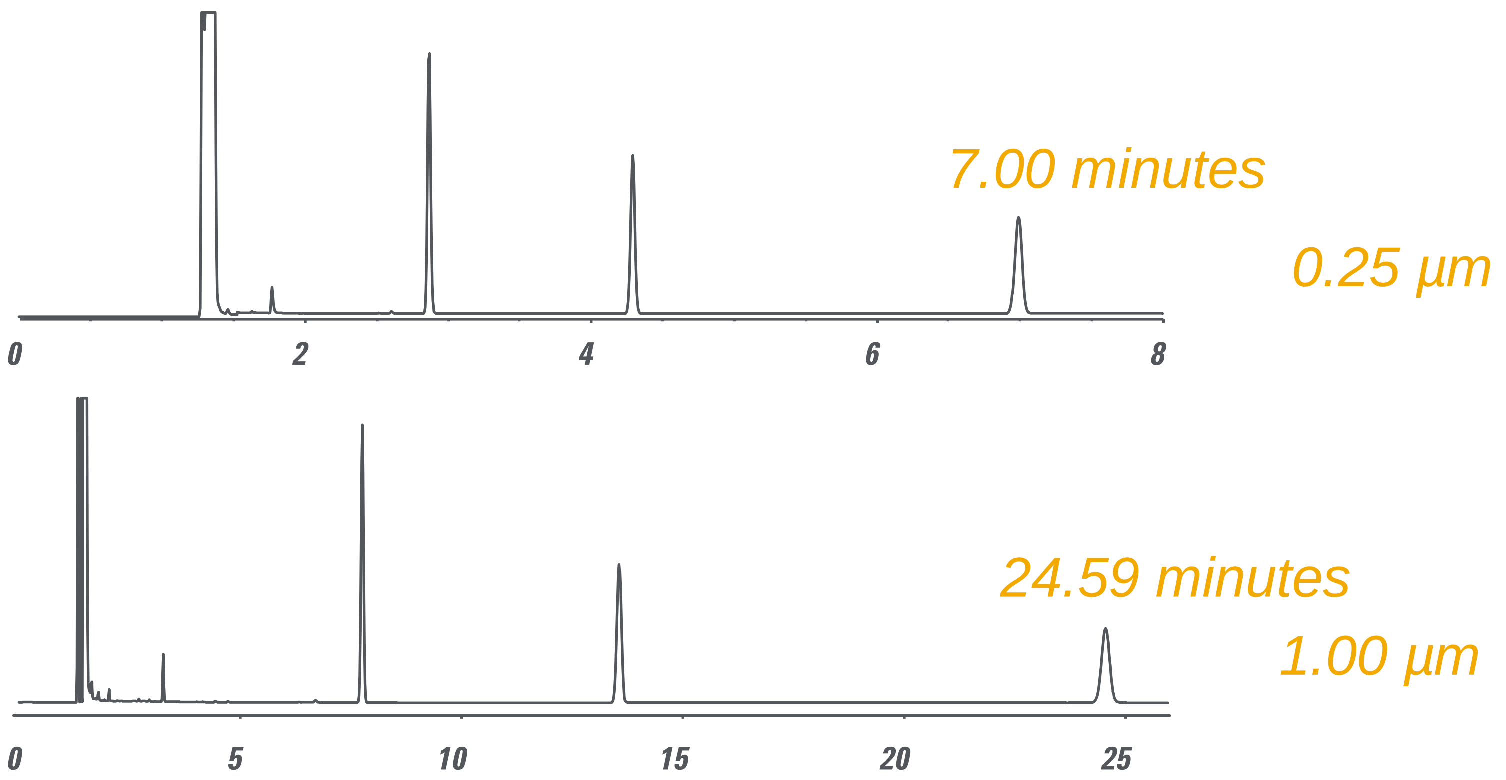


Film Thickness

Most common: 0.1–3.0 µm

Available: 0.1–10.0 µm

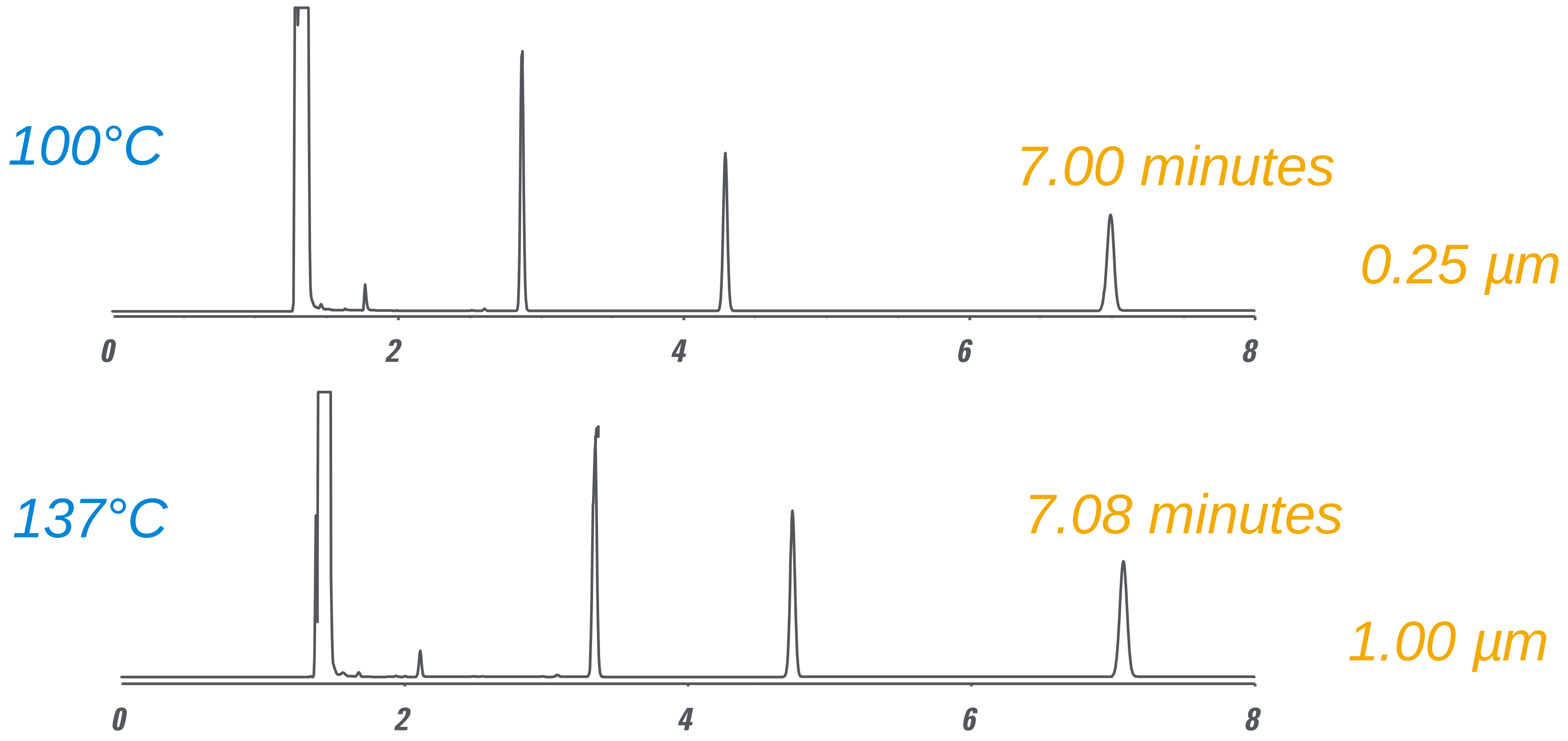
Film Thickness and Retention (100°C Isothermal)



Isothermal: Retention is proportional to film thickness
Temperature program: 1/3–1/2 of isothermal values

Film Thickness

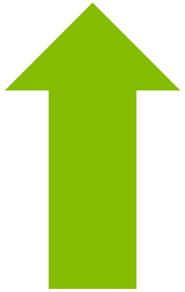
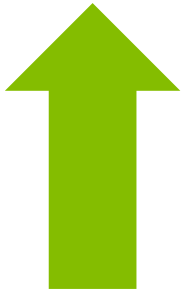
Equal Retention: Isothermal



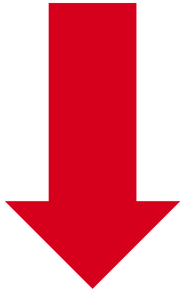
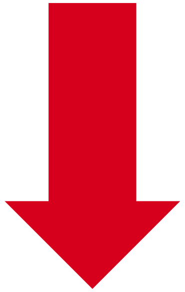
Agilent J&W DB-1, 30 m x 0.32 mm id
He at 37 cm/sec
C10, C11, C12

Film Thickness and Resolution

When solute k < 5

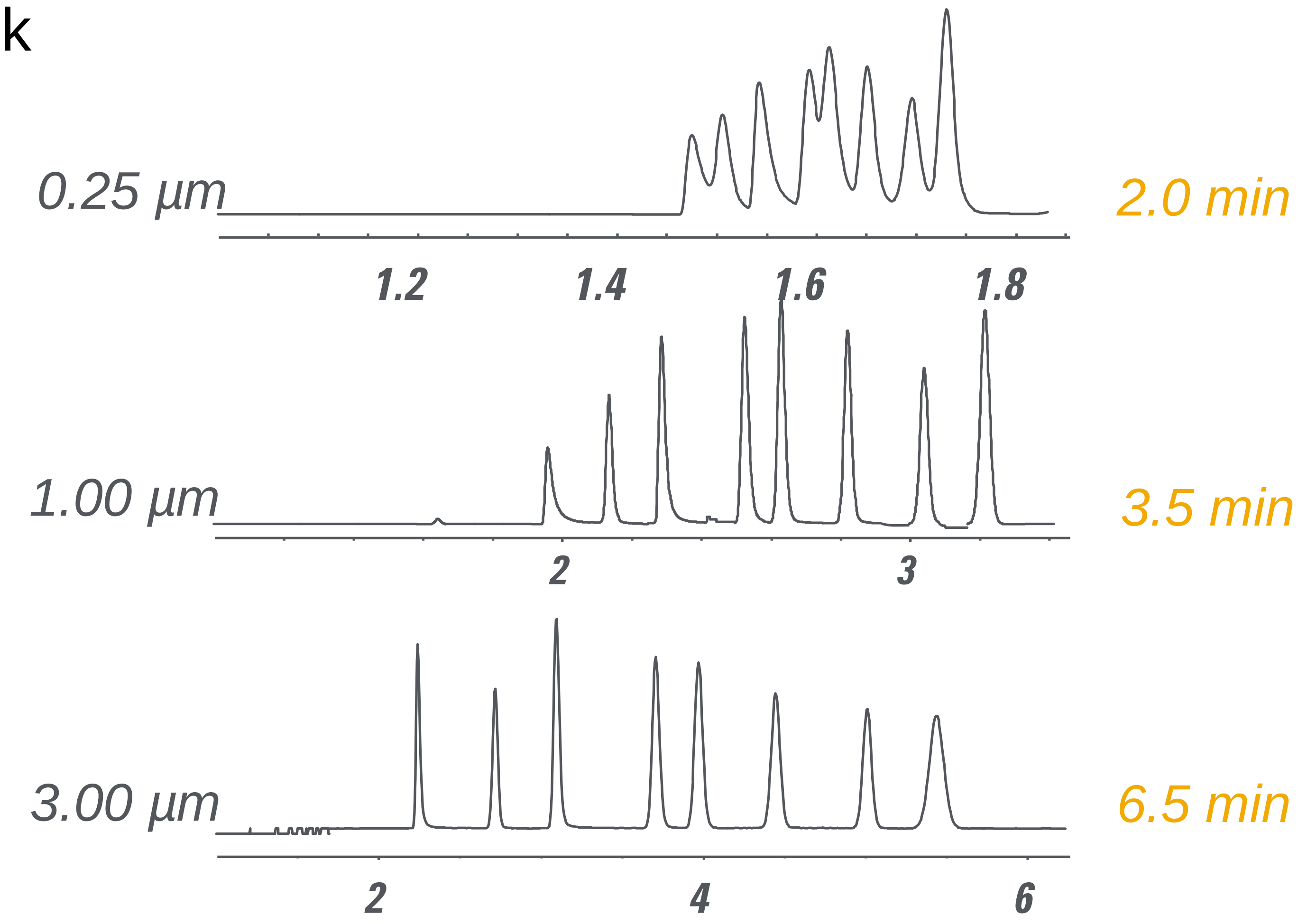
d_f  R 

When solute k > 5

d_f  R 

Film Thickness

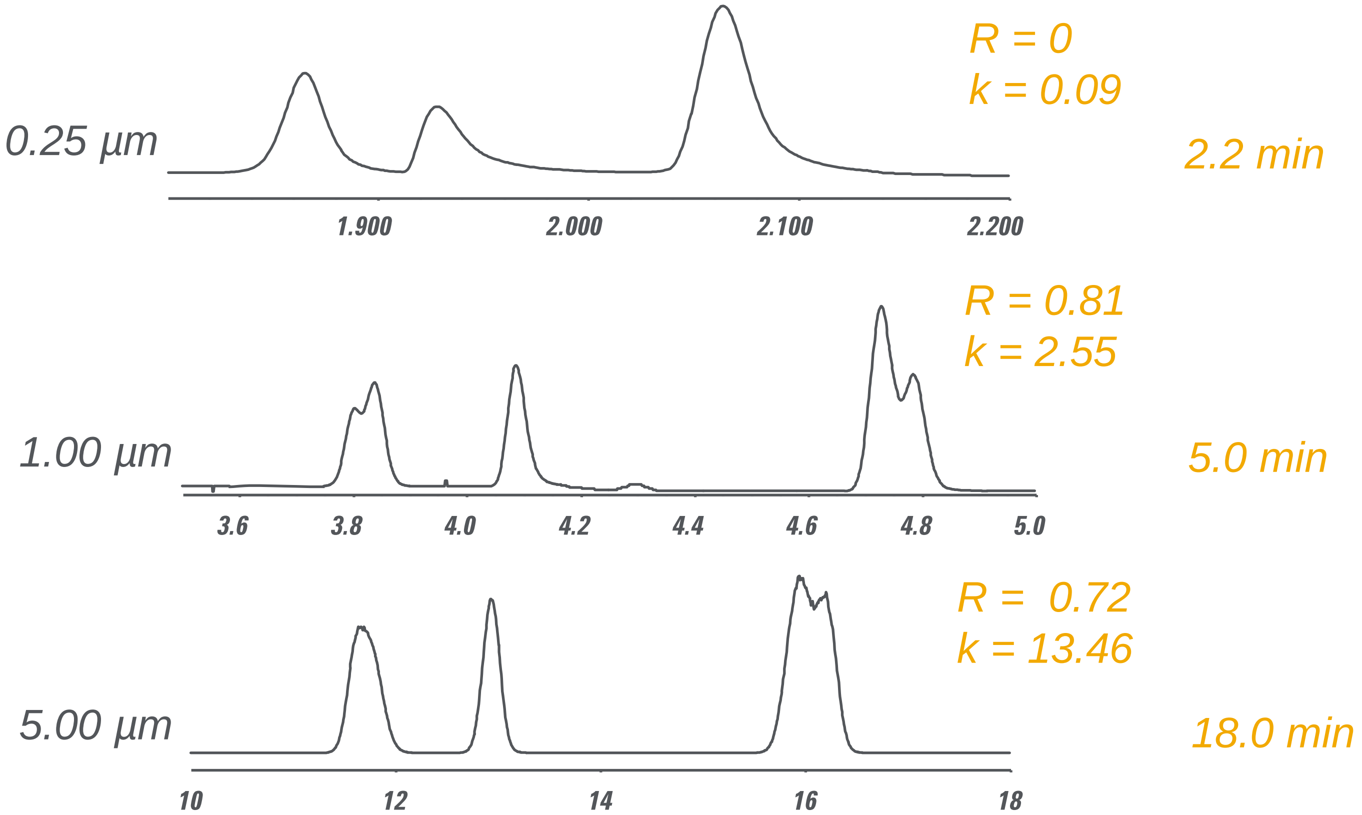
Resolution at low k



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

Film Thickness (Capacity)

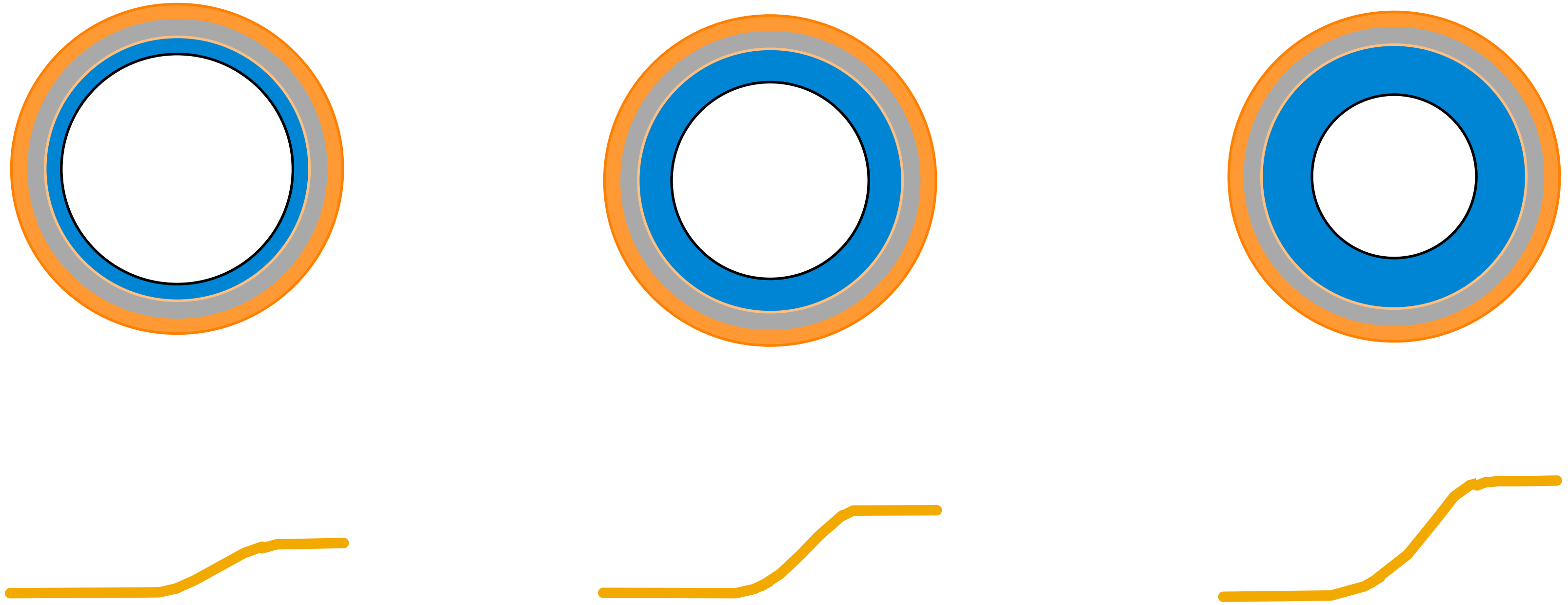
Thickness (µm)	Capacity (ng)
0.10	50-100
0.25	125-250
1.0	500-1000
3.0	1500-3000
5.0	2500-5000

0.32 mm column id

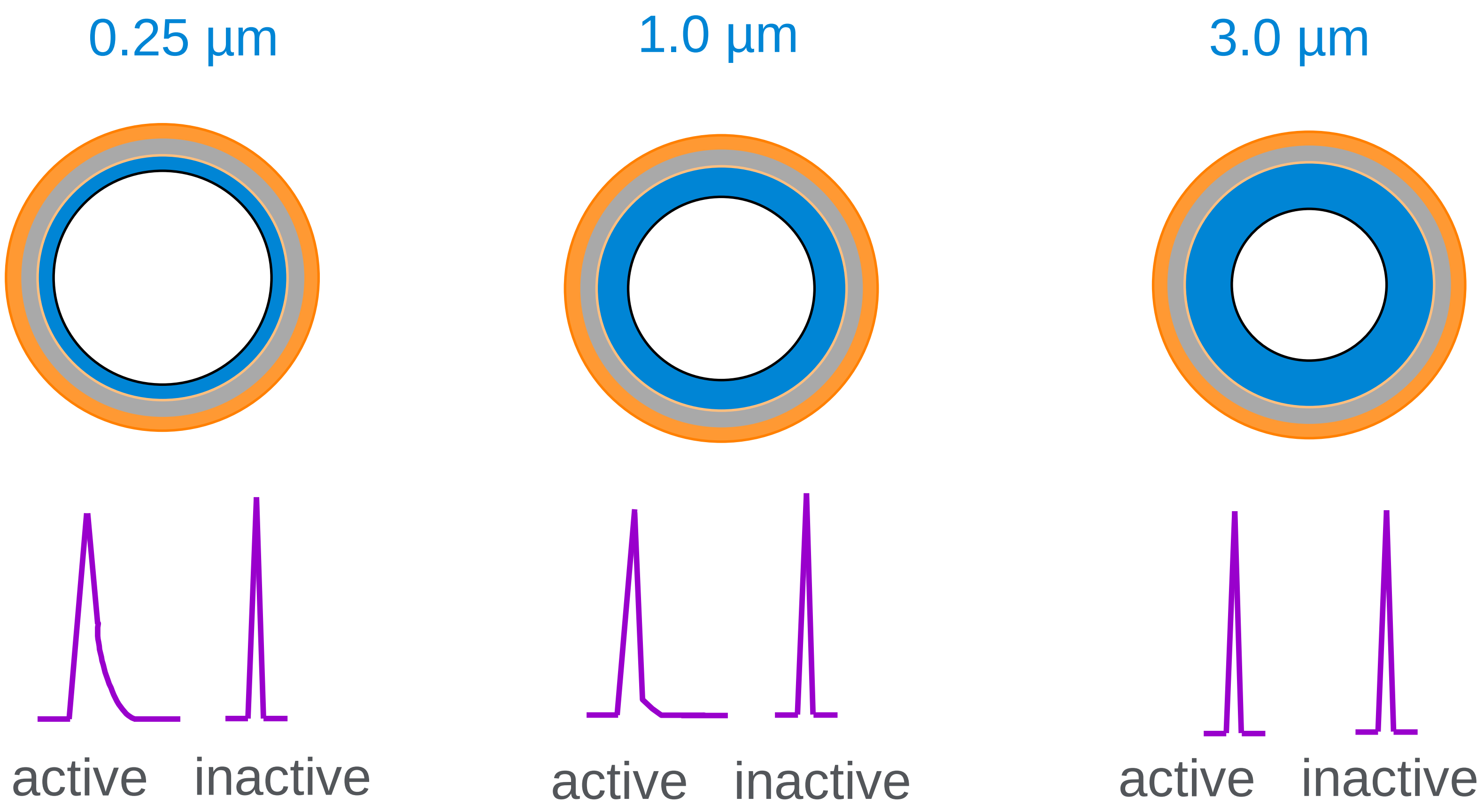
Like polarity phase/solute

Film Thickness (Bleed)

More stationary phase = More degradation products



Film Thickness (Inertness)



Column Dimensions

Diameter summary

To Increase	Make Diameter
Resolution	Smaller
Retention	Smaller
Pressure	Smaller
Flow rate	Larger
Capacity	Larger

Column Dimensions

Length summary

To Increase	Make Length
Resolution	Longer
Retention	Longer
Pressure	Longer
Cost	Longer

Column Dimensions

Film thickness summary

To Increase	Make Film
Retention	Thicker
Resolution (k<5)	Thicker
Resolution (k>5)	Thinner
Capacity	Thicker
Inertness	Thicker
Bleed	Thicker

Example of Changing Dimensions to Achieve Faster Chromatography

Before

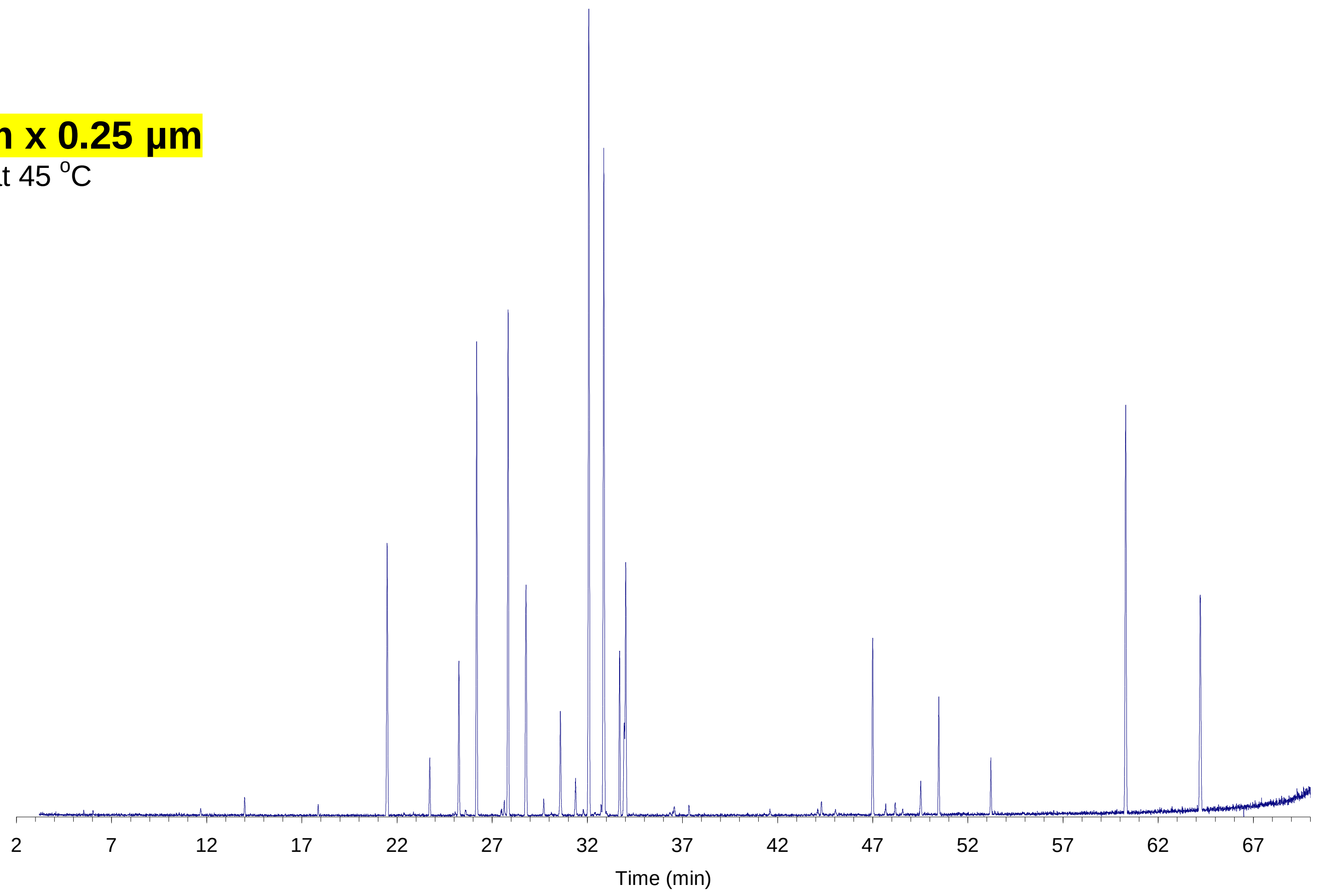
Column: DB-WAX 30 m x 0.25 mm x 0.25 µm

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
1 µL of 1:35 oil in Acetone

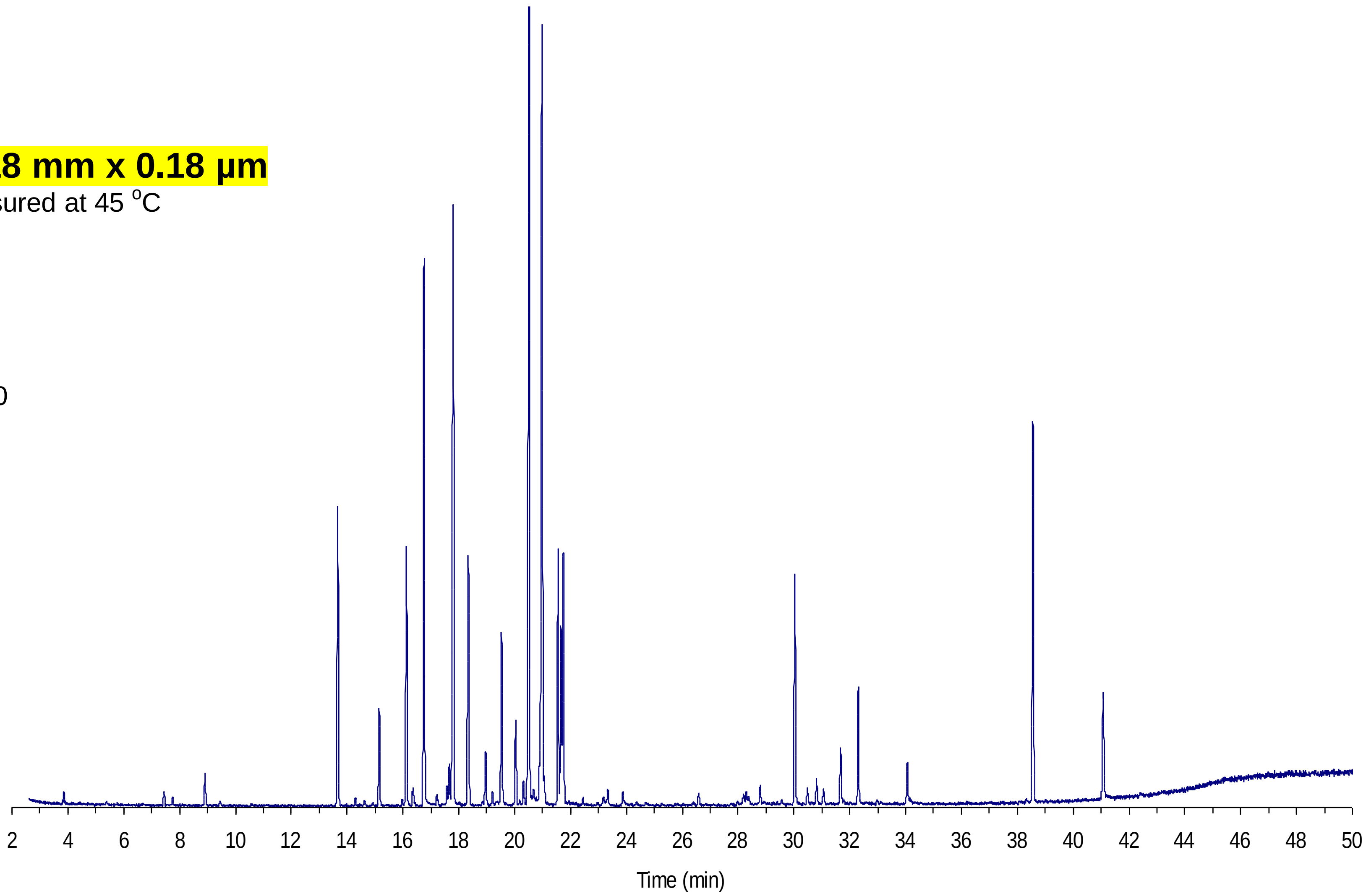
Detector: MSD full scan at m/z 40–500
250 °C transfer line



Example of Changing Dimensions to Achieve Faster Chromatography
After

Column: DB-WAX 20 m x 0.18 mm x 0.18 µm

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
	1 µL 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!

Contact Agilent Chemistries and Supplies Technical Support

1-800-227-9770 Option 3, Option 3:

Option 1 for GC and GC/MS columns and supplies

Option 2 for LC and LC/MS columns and supplies

Option 3 for sample preparation, filtration, and QuEChERS

Option 4 for spectroscopy supplies

Option 5 for chemical standards

Available in the USA and Canada 8–5, all time zones

gc-column-support@agilent.com

lc-column-support@agilent.com

spp-support@agilent.com

spectro-supplies-support@agilent.com

chem-standards-support@agilent.com