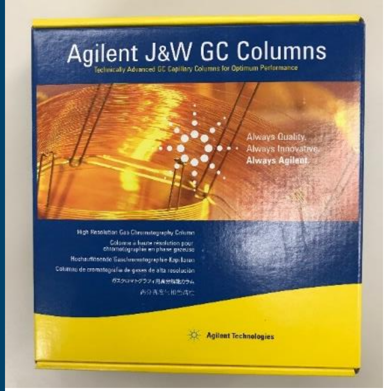
Decisions, Decisions: How to Select the Correct GC Column for Your Application



Agilent
Trusted Answers

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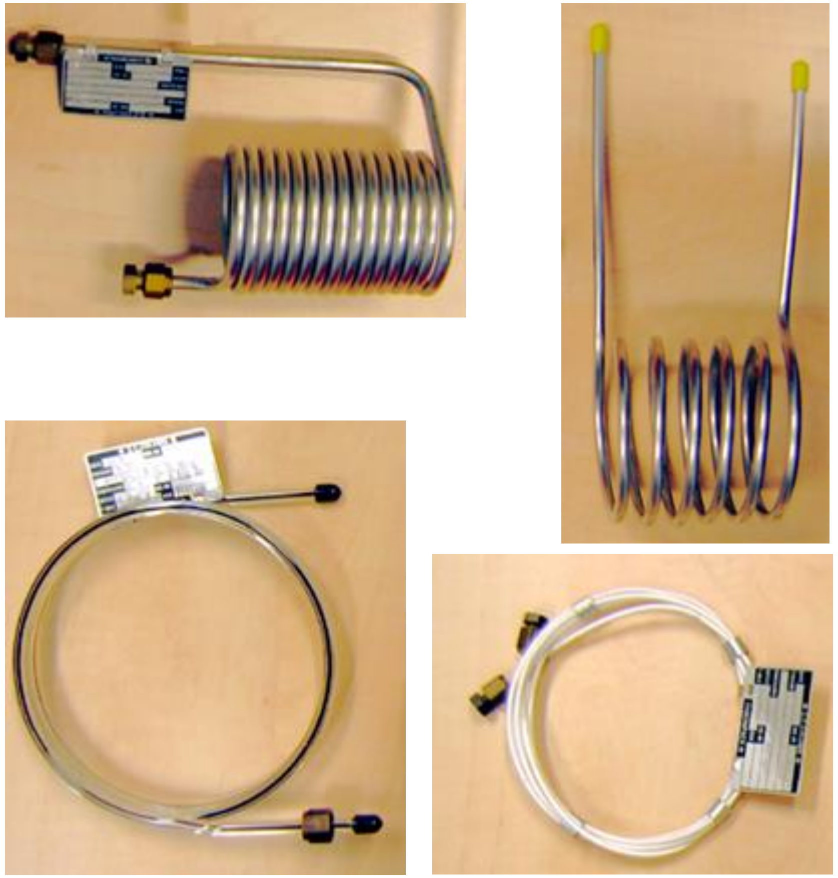
Online Application Engineer
July 21, 2021

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 cleanup?
- Is it an established method?
- What do we know about the analytes?
- What else *may* be present in the sample?

Column History

1969:



1977: First glass capillary columns

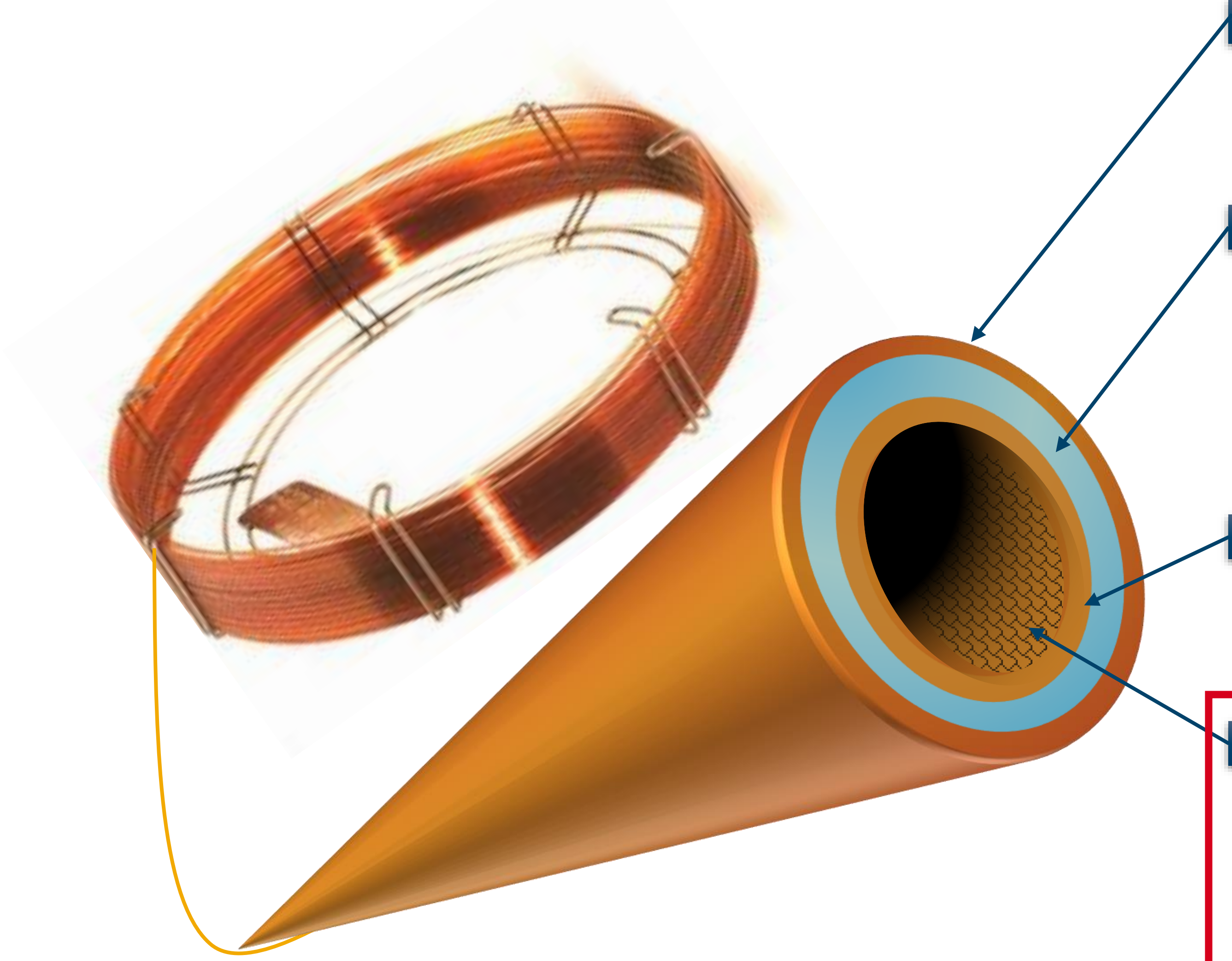
1979: First WCOT fused silica capillary columns

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.

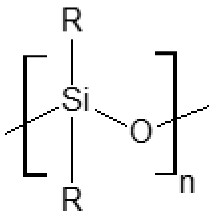
Deactivation

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

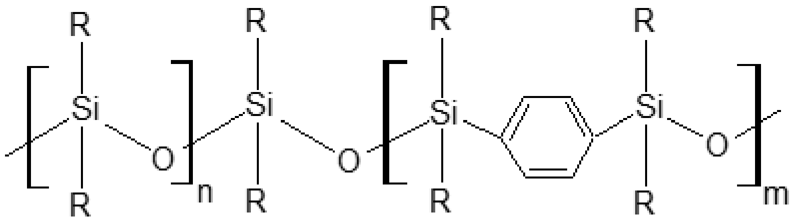
Stationary Phase Polymers



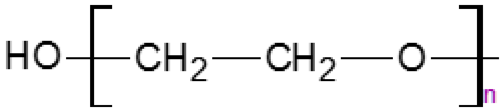
Siloxane

R= methyl, phenyl, cyanopropyl, trifluoropropyl

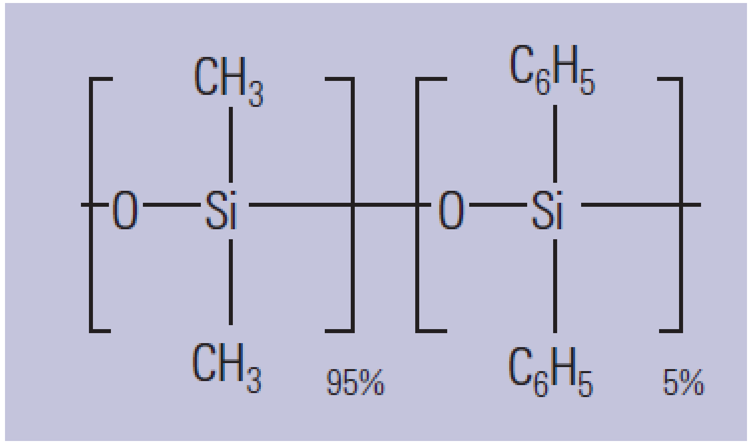
% = number of sites on silicon atoms occupied



Siarylene backbone



Polyethylene glycol

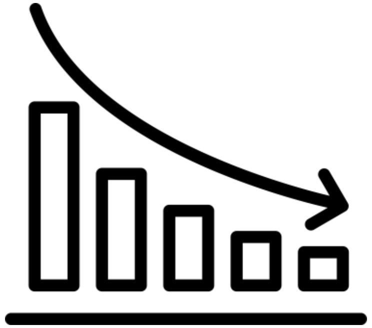


Structure of Agilent J&W HP-5ms

5% phenyl / 95% methyl

Polyethylene Glycol Phases

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



Less Stable than Polysiloxanes

Unique Separation Characteristics

Agilent J&W DB-WAX UI
Agilent J&W DB-HeavyWAX
Agilent J&W DB-FATWAX UI

Another New Column: J&W DB-HeavyWAX

The WAX column you've been waiting for!

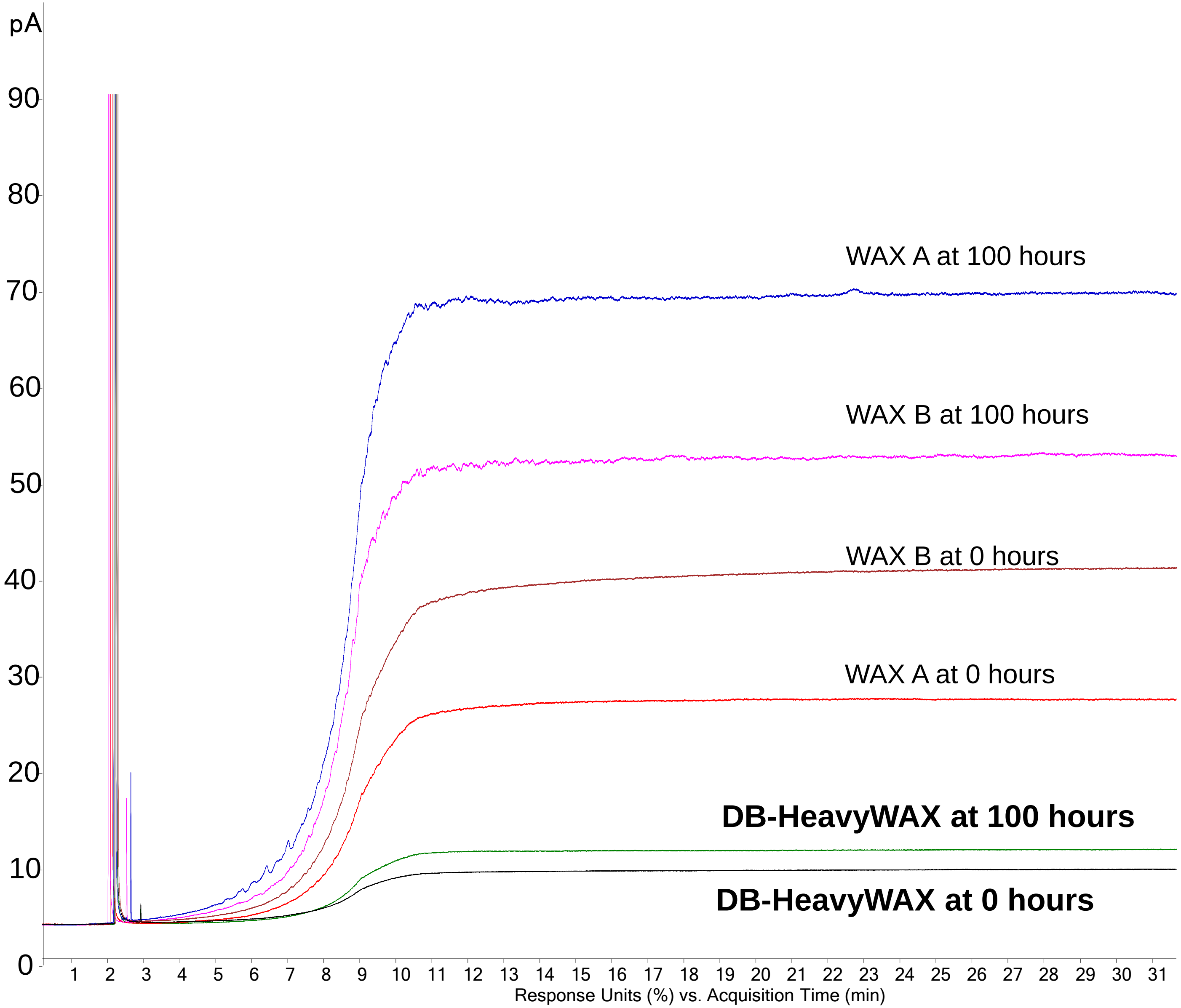
www.agilent.com/chem/db-heavywax

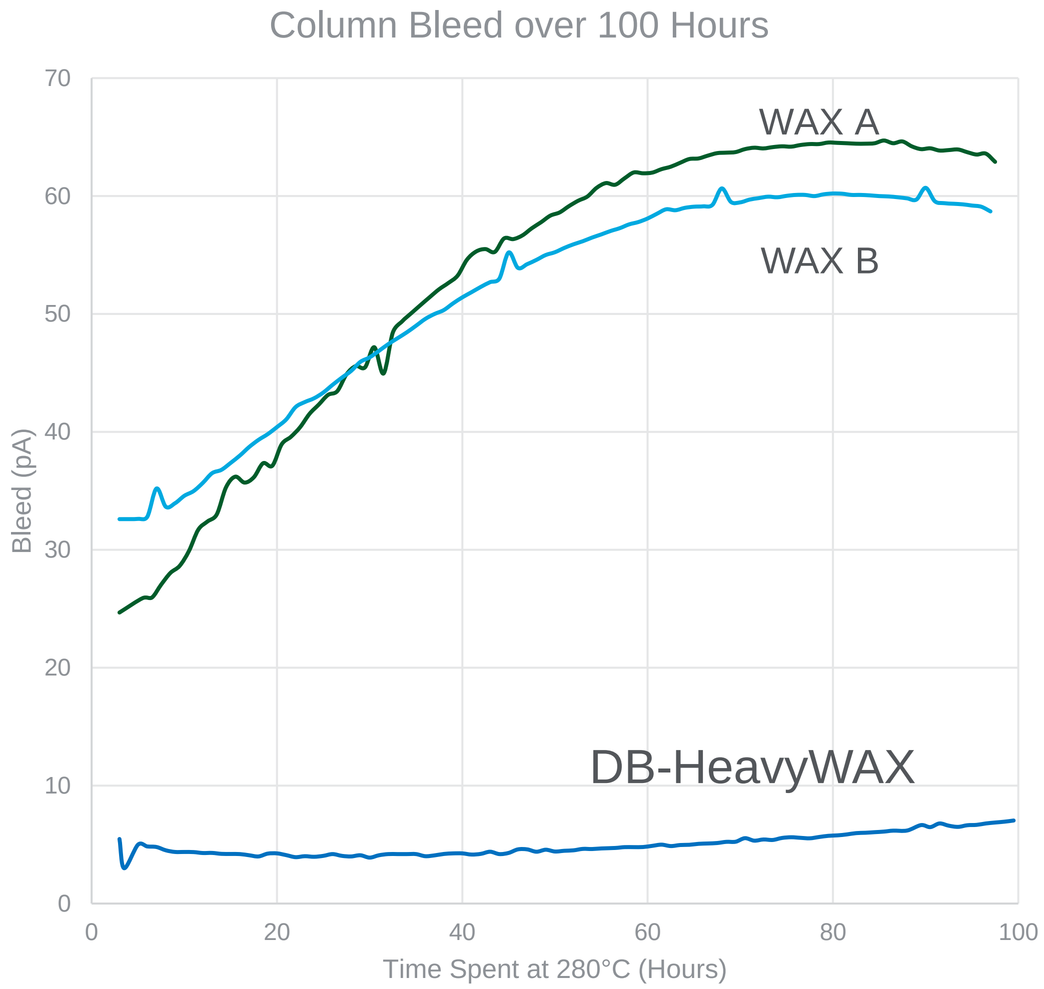
Increased temperature limit (280 °C / 290 °C)

Increased thermal stability

Lower bleed

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-1ms UI HP-1ms UI	DB & HP-5ms UI	DB-XLB	DB-225ms	DB-ALC1	HP-88	DB-WAX	DB-WAX UI
DB-MTBE	DB-1ms HP-1ms	DB & HP-5ms	VF-Xms	DB-225	DB-Dioxin	CP-Sil 88	DB-WAXetr	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-1701ms	VF-200ms	VF-23ms	VF-WAXms	
	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-FFAP 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					

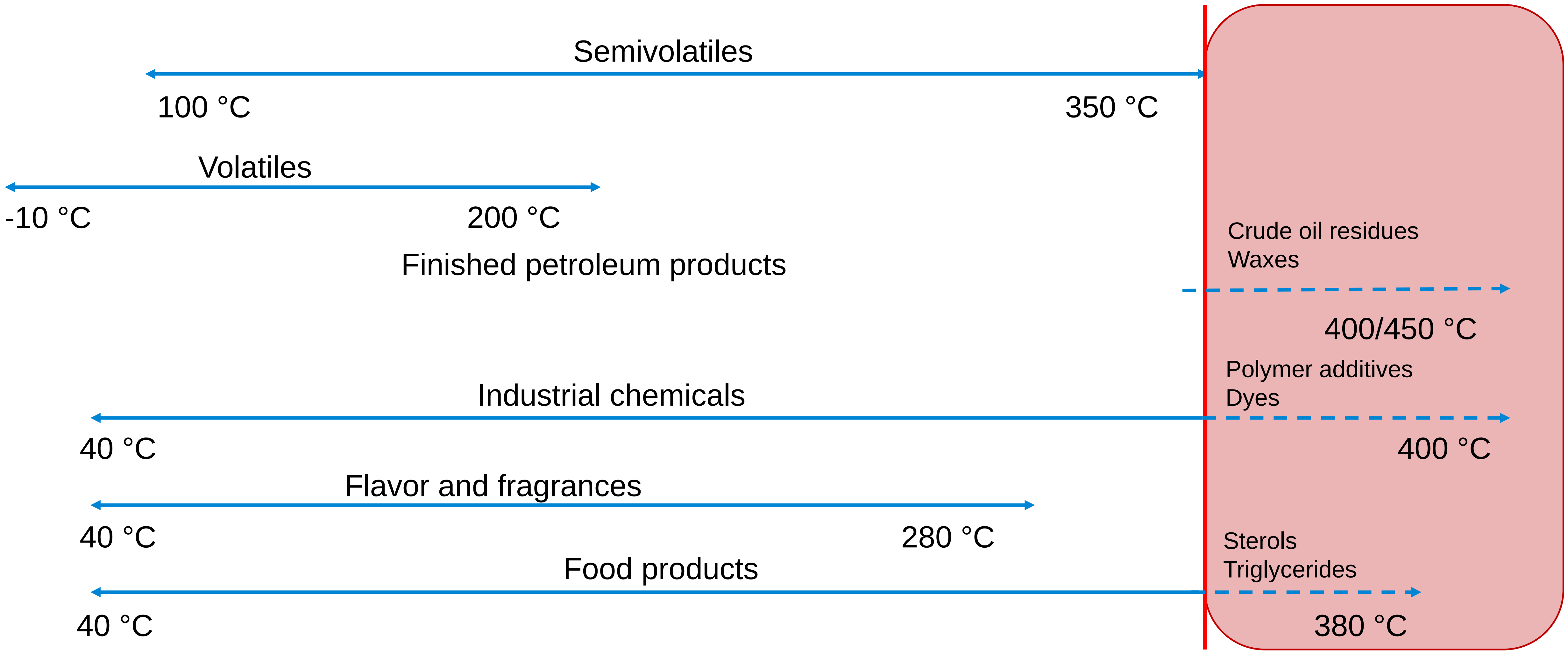
Agilent J&W has over 50 different stationary phase offerings

Specialty Phases

Columns developed for specific 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!

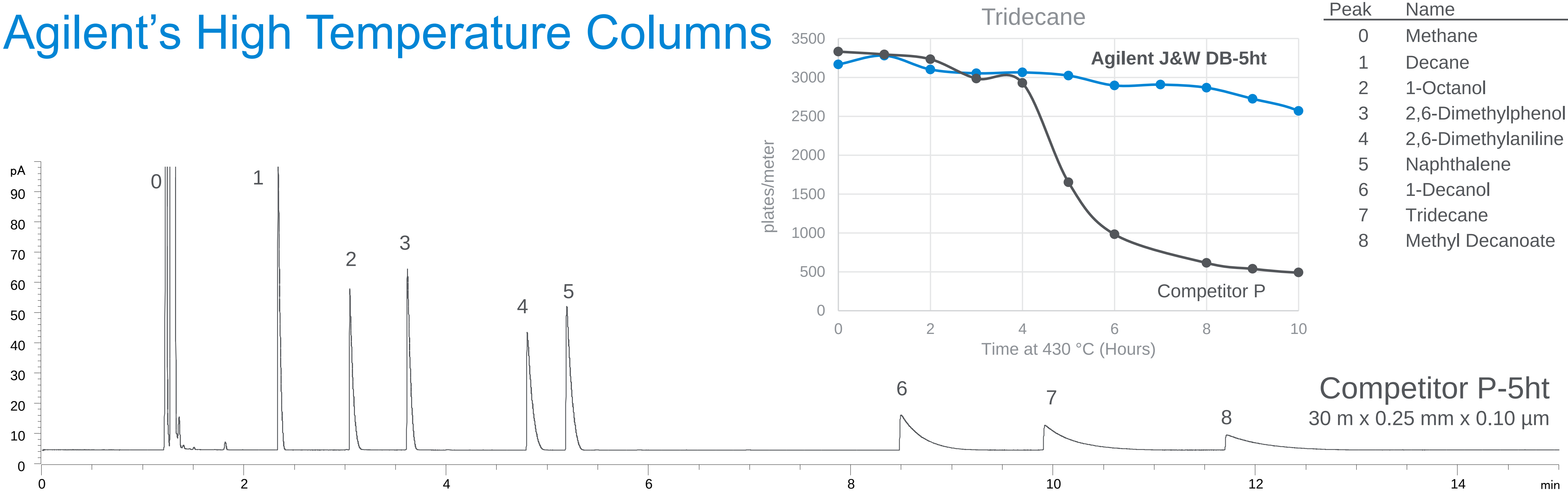
High Temperature Applications

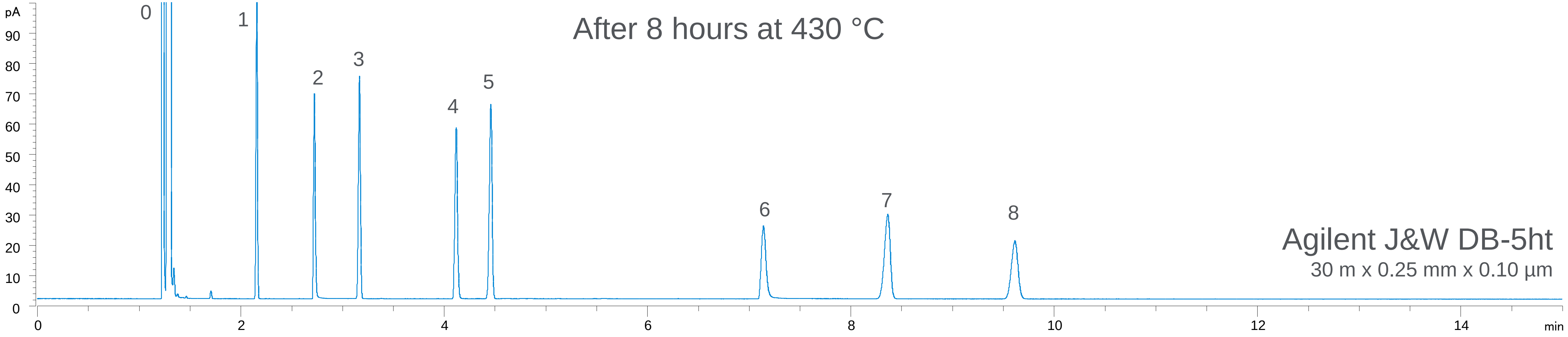


You only need a high-temperature column for temperatures above 350 °C

Agilent's High Temperature Columns

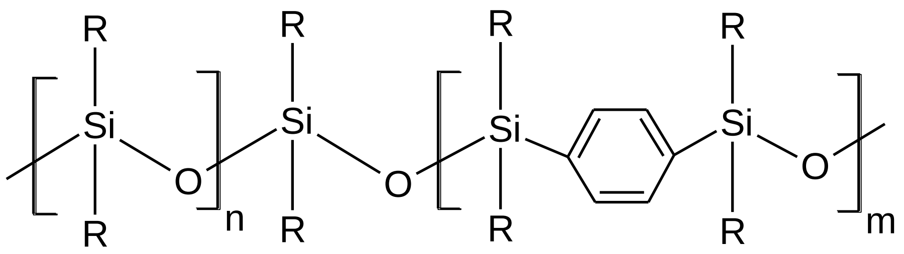
Peak	Name
0	Methane
1	Decane
2	1-Octanol
3	2,6-Dimethylphenol
4	2,6-Dimethylaniline
5	Naphthalene
6	1-Decanol
7	Tridecane
8	Methyl Decanoate





Low Bleed Phases

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



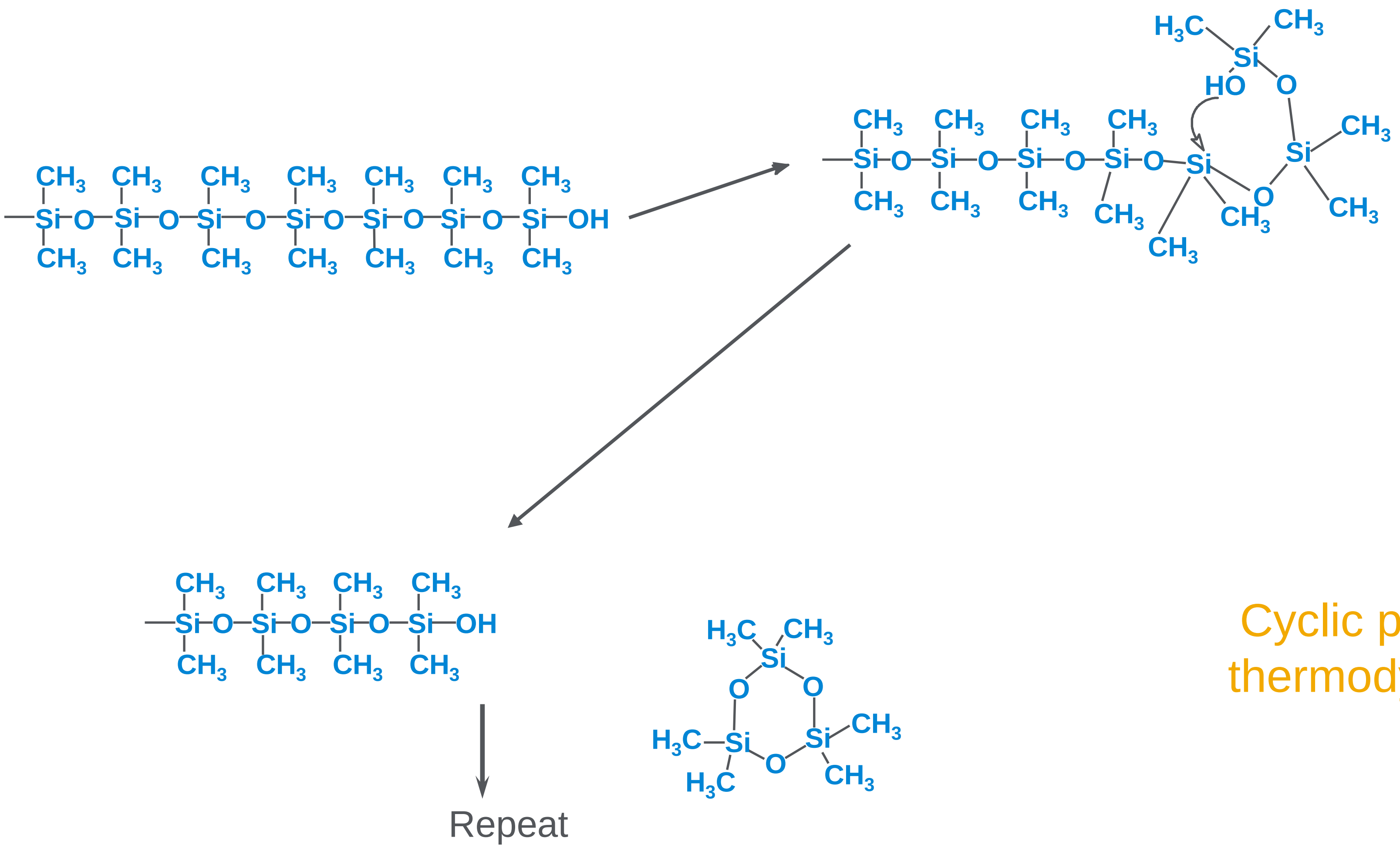
Siarylene backbone

- 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?

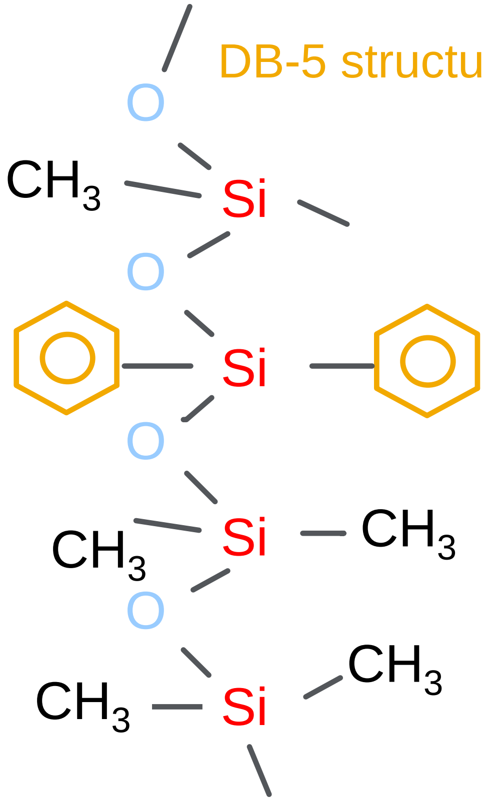
"Back biting" mechanism of product formation



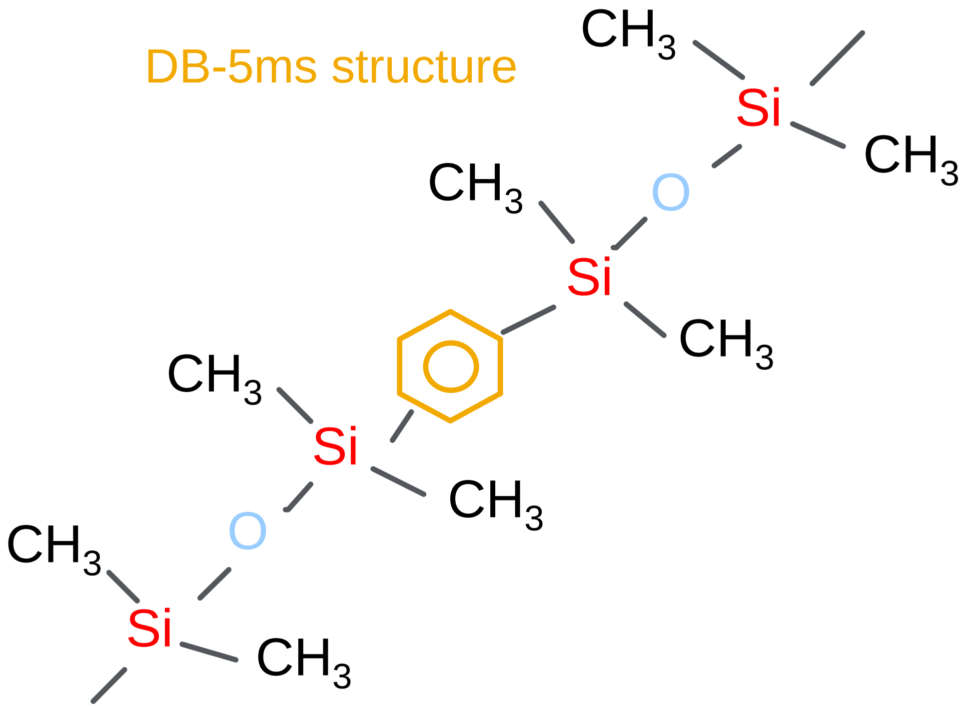
Cyclic products are more thermodynamically stable!

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

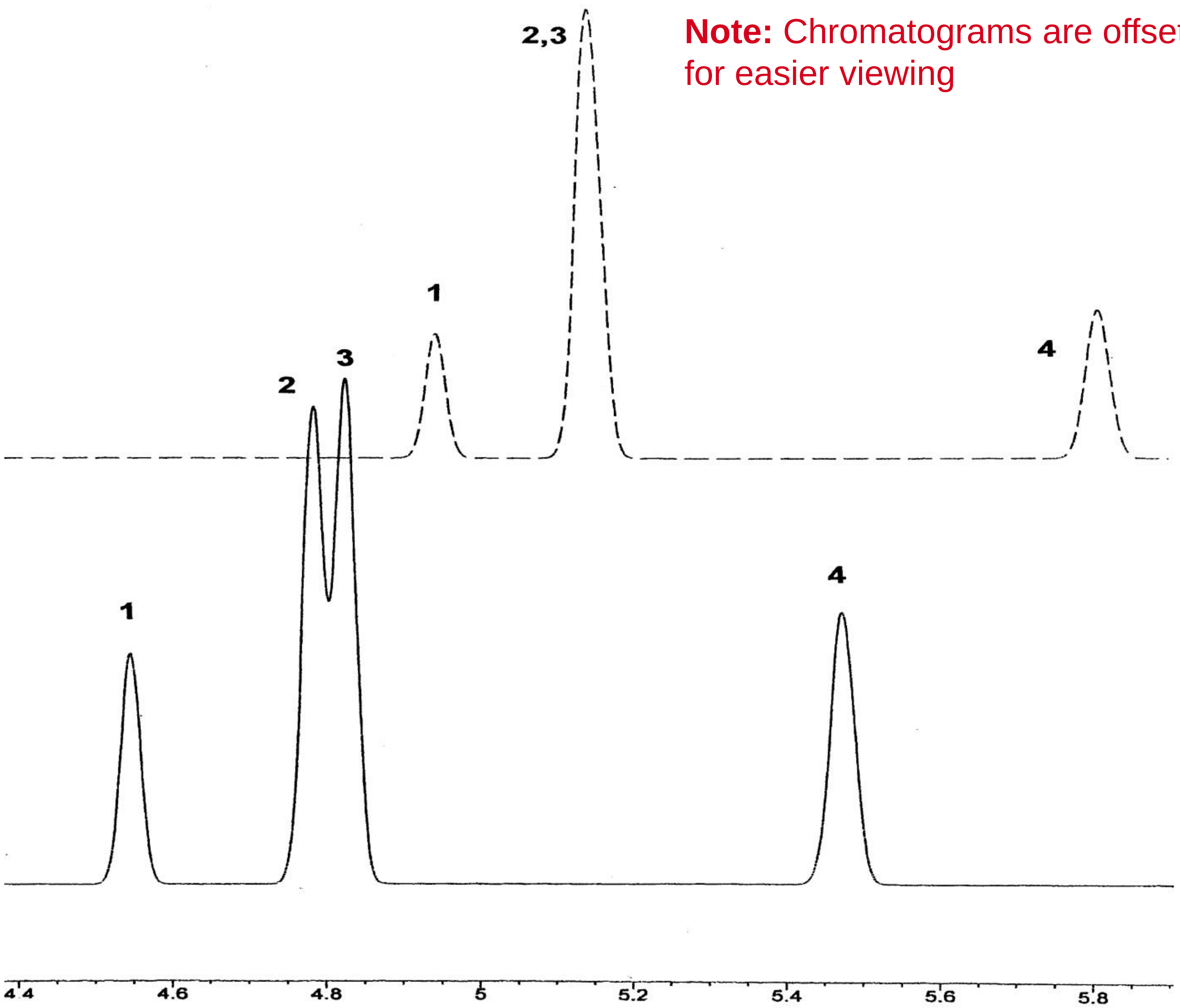
DB-5ms versus DB-5 Selectivity

Note: Chromatograms are offset on X-axis for easier viewing

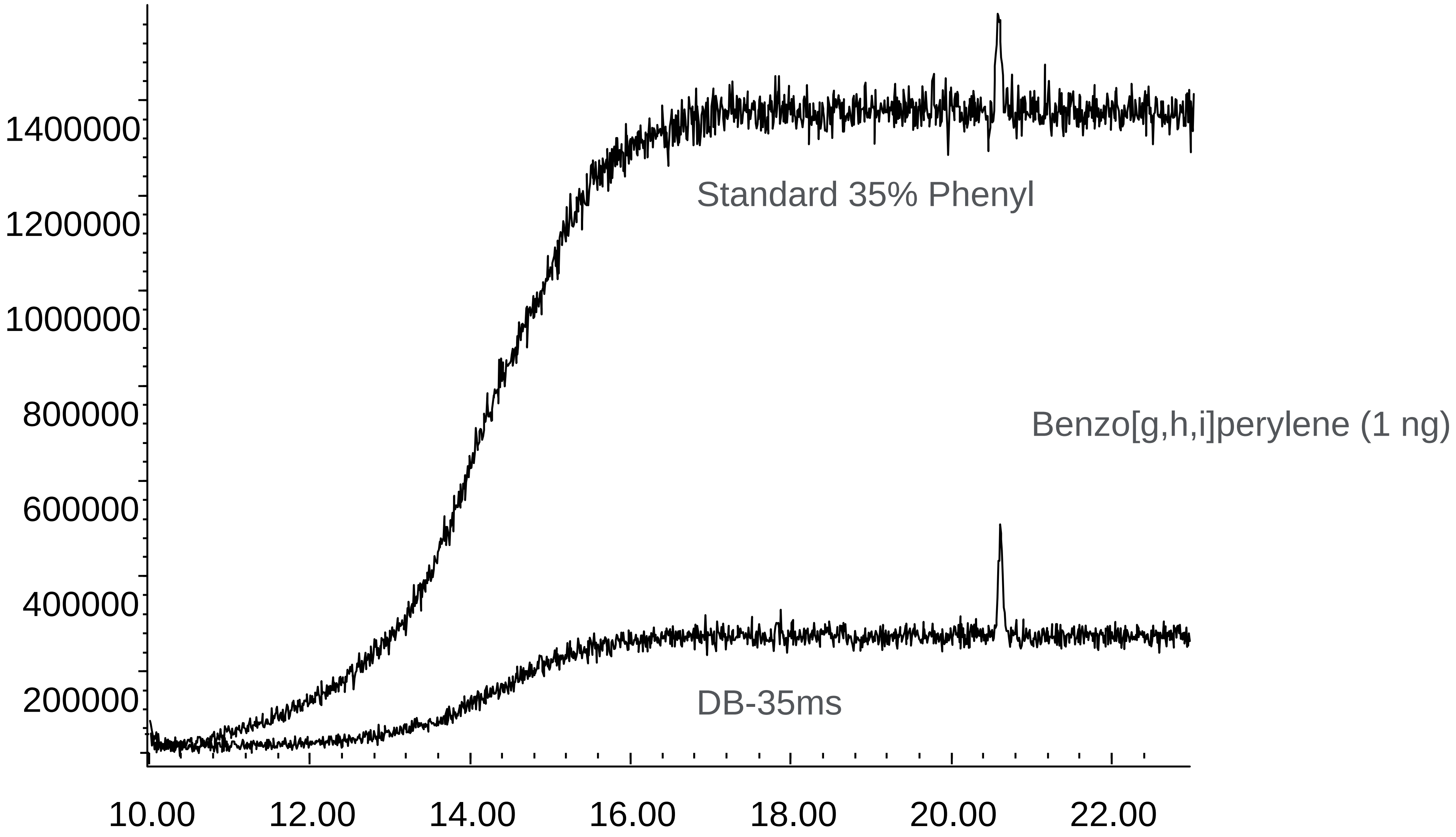
Solid line: Agilent J&W **DB-5ms**
30 m x 0.25 mm id x 0.25 µm
Dashed line: Agilent J&W **DB-5**
30 m x 0.25 mm id x 0.25 µm
Oven: 60 ˚C isothermal
Carrier gas: H_2 at 40 cm/sec

1: Ethylbenzene
2: m-Xylene

3: p-Xylene
4: o-Xylene



Comparison of Agilent J&W DB-35ms Versus Standard DB-35



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

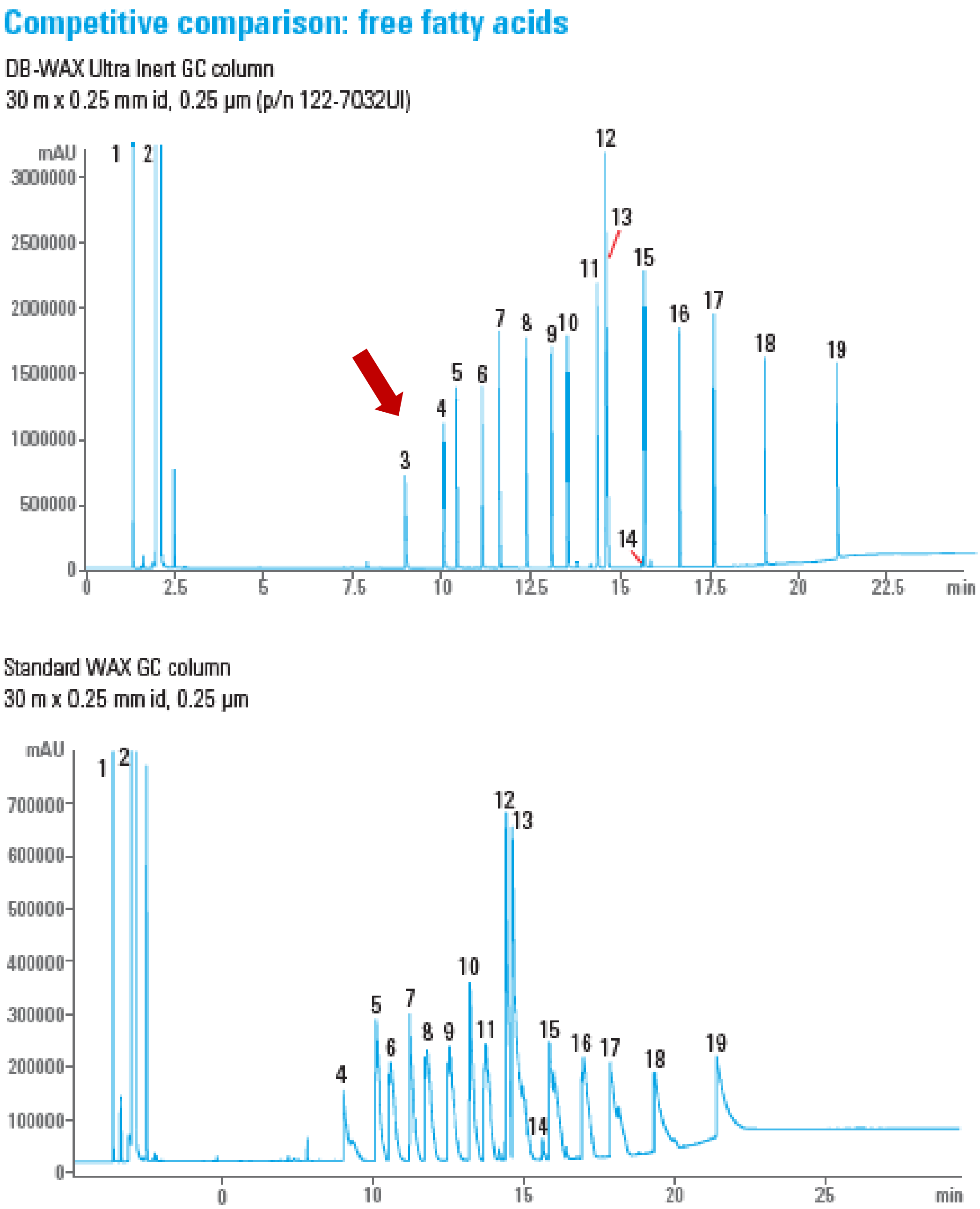
- Easier to describe "lack of inertness"
  - Peak tailing (reversible interaction)
  - Complete loss of compound (irreversible interaction)

- 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
  - Compounds such as 2,4-DNP, Endrin, etc.

DB-WAX Ultra Inert and Free Fatty Acid

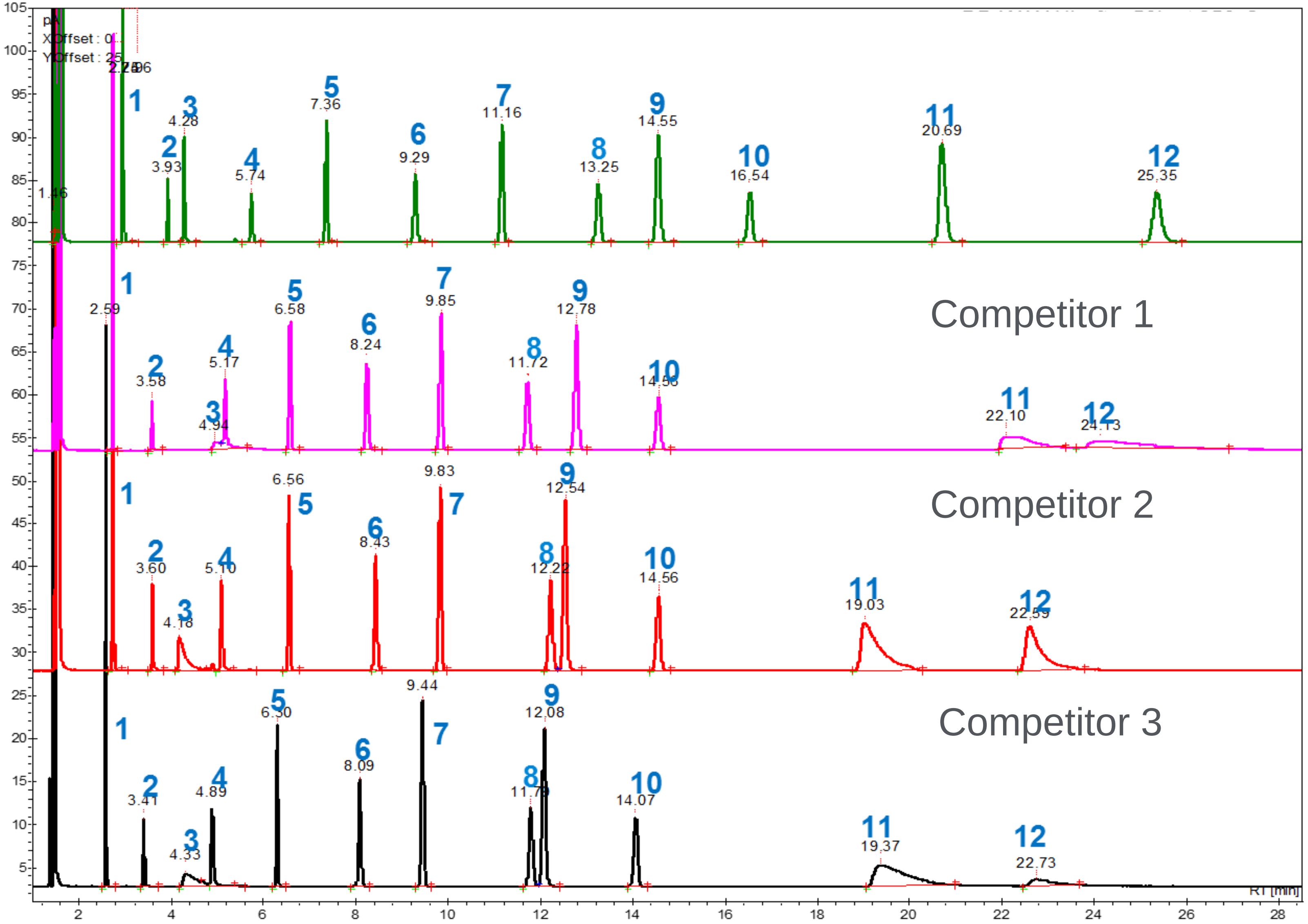
Peak identification:
1. Methane
2. Acetone (solvent)
3. Acetic acid
4. Propionic acid
5. Isobutyric acid
6. Butyric acid
7. Isovaleric acid
8. Valeric acid
9. 4-Methylvaleric acid
10. Hexanoic acid
11. 4-Methylhexanoic acid
12. 2-Ethylhexanoic acid
13. Heptanoic acid
14. Pyruvic acid
15. Octanoic acid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



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



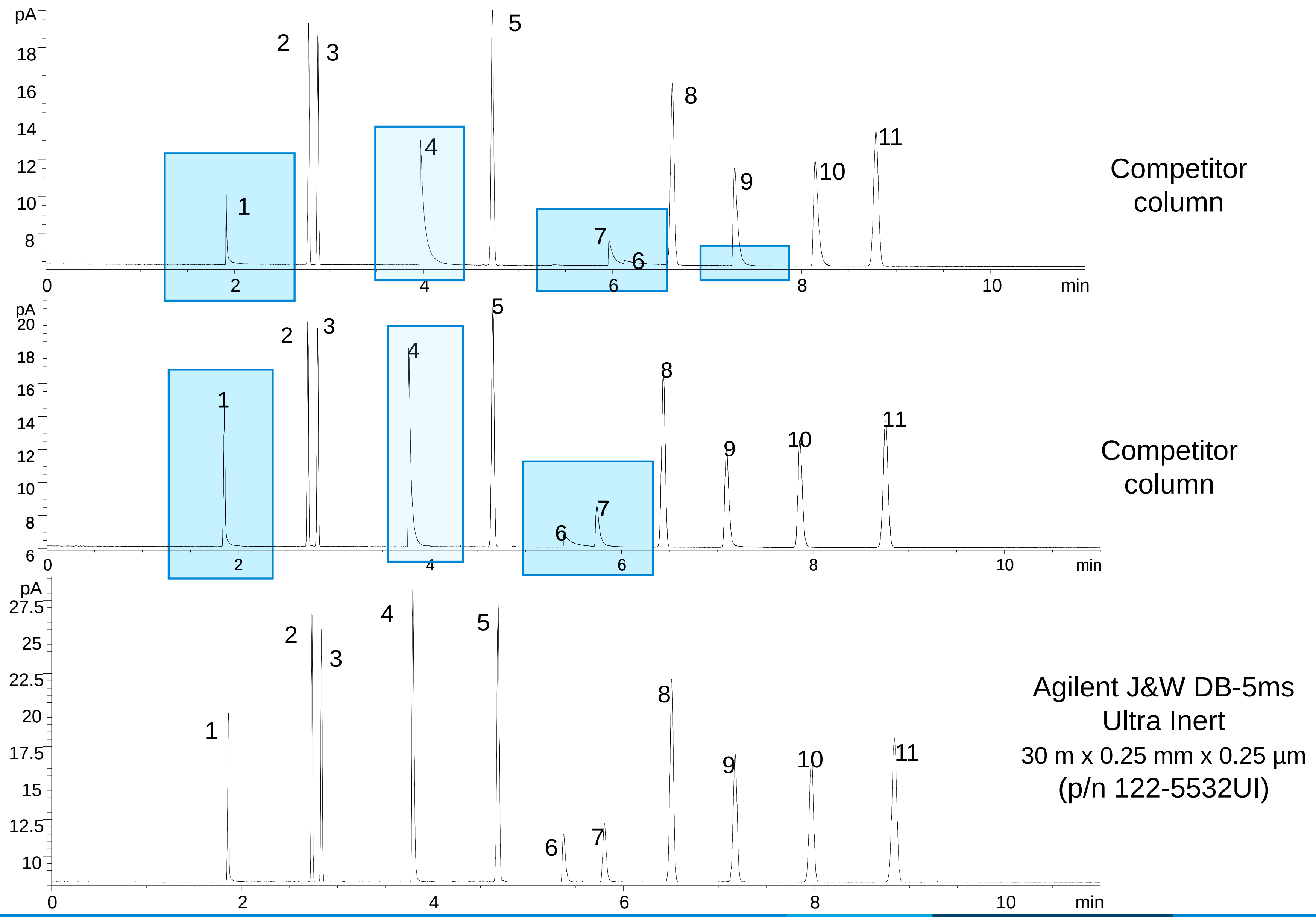
Compound I.D.

*. 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 versus 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*

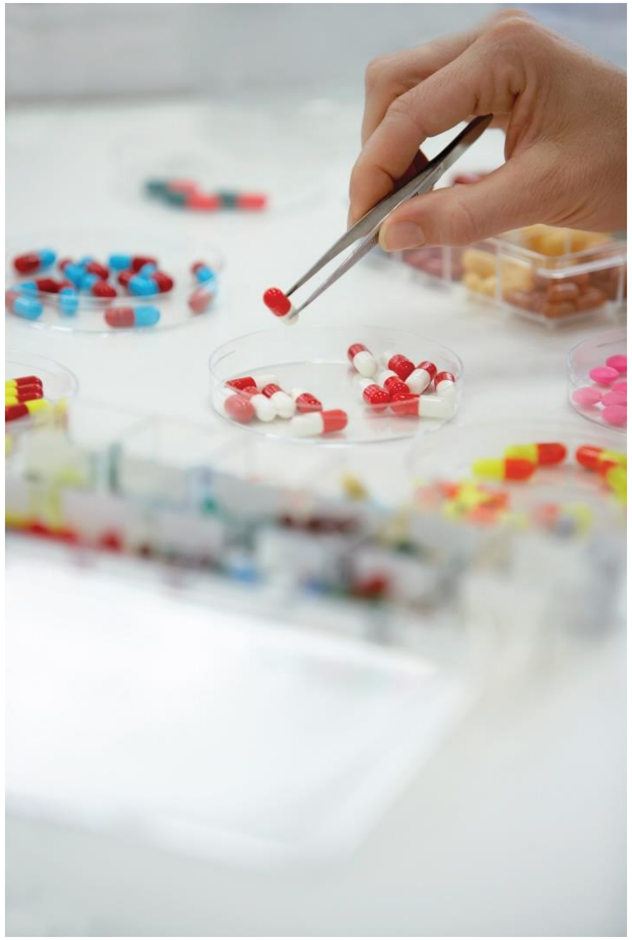
$$\alpha = \frac{k_2}{k_1}$$

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

Selectivity

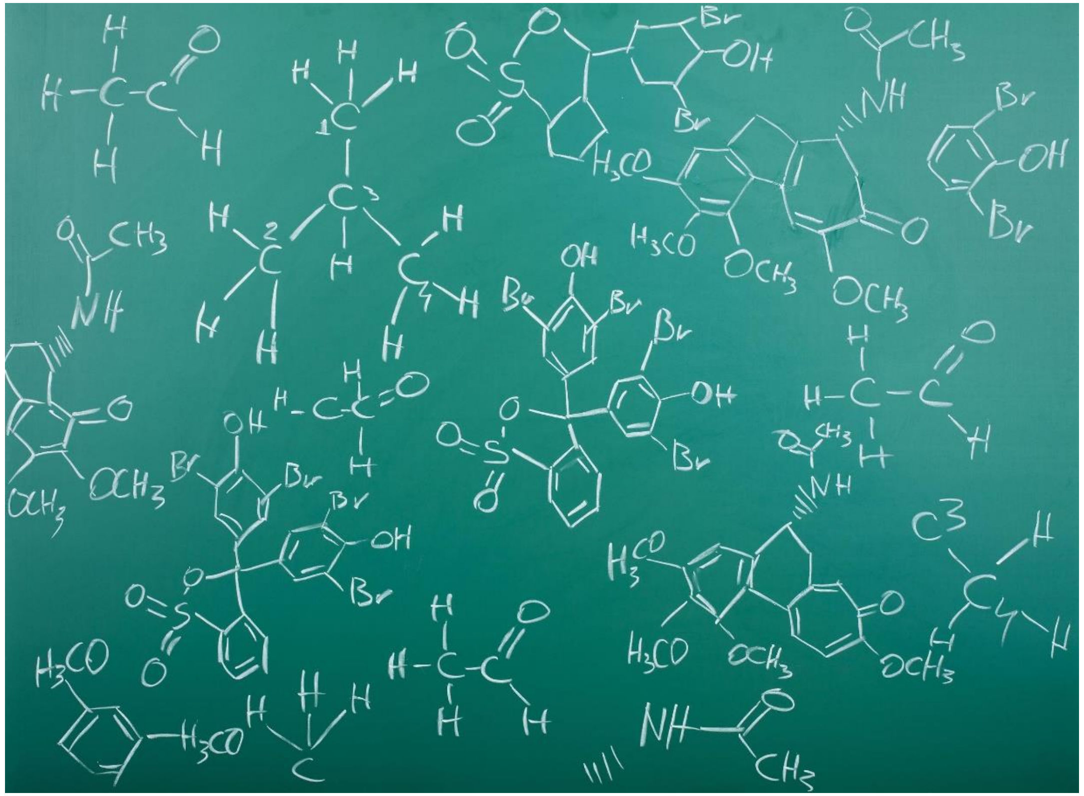
- Relative spacing of the chromatographic peaks

- The result of all nonpolar, polarizable, and polar interactions that cause a stationary phase to be more or less retentive to one analyte than another

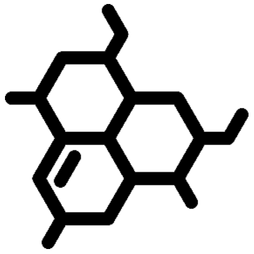


Optimizing Selectivity (α)

- Match analyte polarity to stationary phase polarity
  - "Like dissolves like"
- Take advantage of unique interactions between analyte and stationary phase functional groups

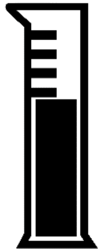


Analyte Polarity

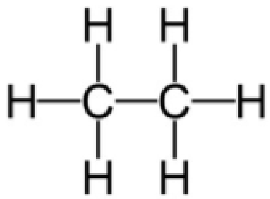


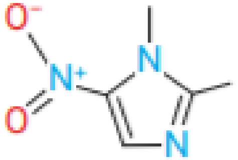
Nonpolar

Polar

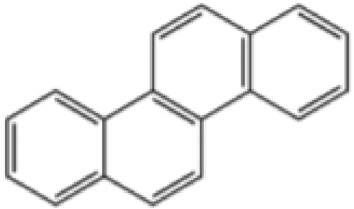


Polarizable





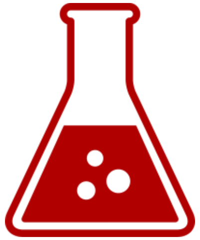
Dimetridazole (DMZ)
(1,2-dimethyl-5-nitroimidazole)



Chrysene

Selectivity Interactions

Dispersion



Dipole

Hydrogen bonding

Dispersion Interaction (ΔH_{vap})

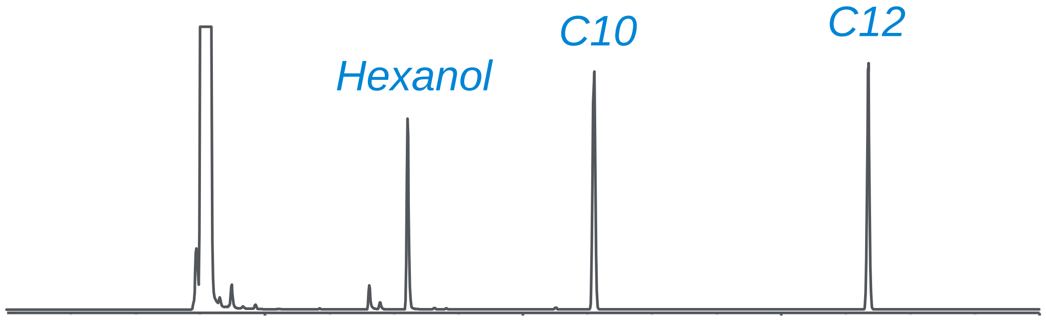
- Separation by differences in analyte heat of vaporizations (ΔH_{vap})

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

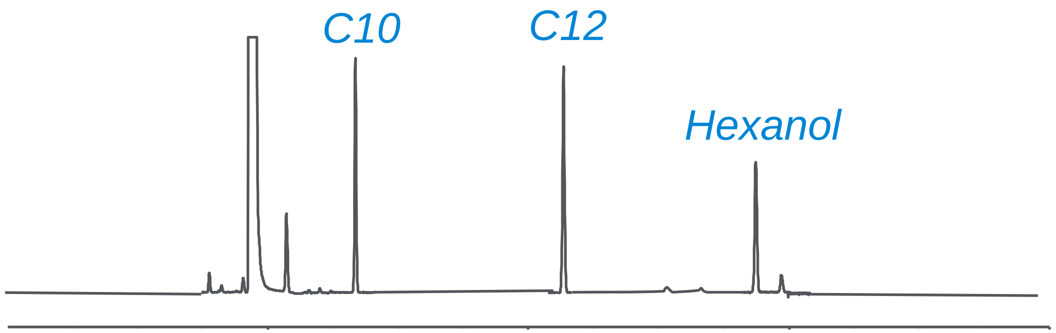
Dispersion Interaction

Solubility and retention

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



100% Methyl (nonpolar)



100% PEG (polar)

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})

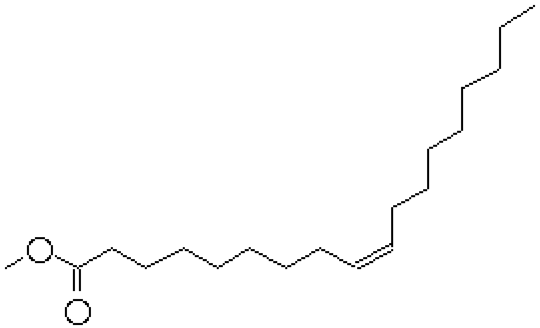
Vapor pressure: good approximation

Boiling point: poor approximation

Dipole Interaction

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

B.Pt. 186 °C



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

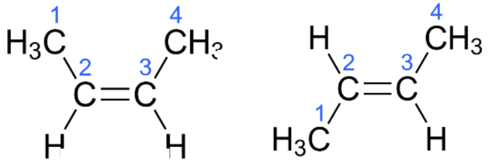
B.Pt. 186 °C

Smaller differences require a stronger dipole phase

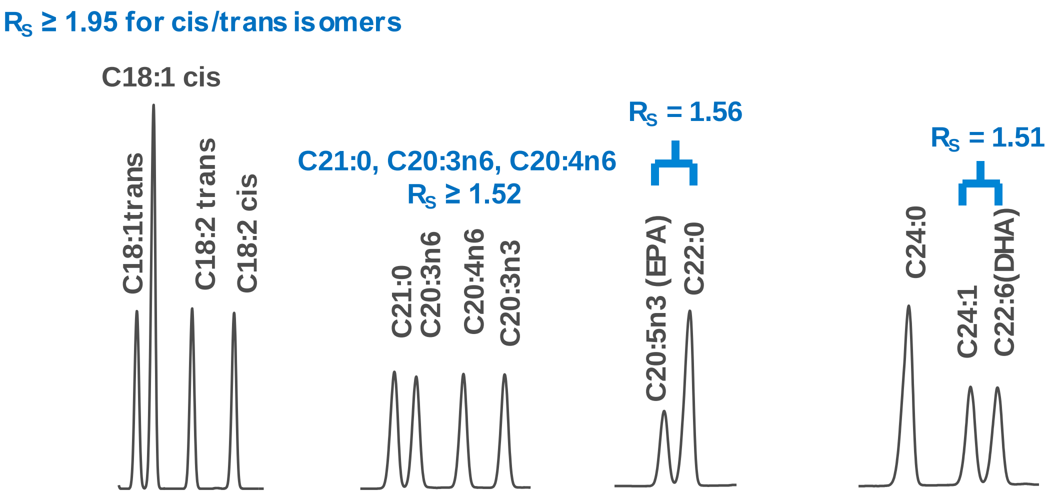
DB-FastFAME

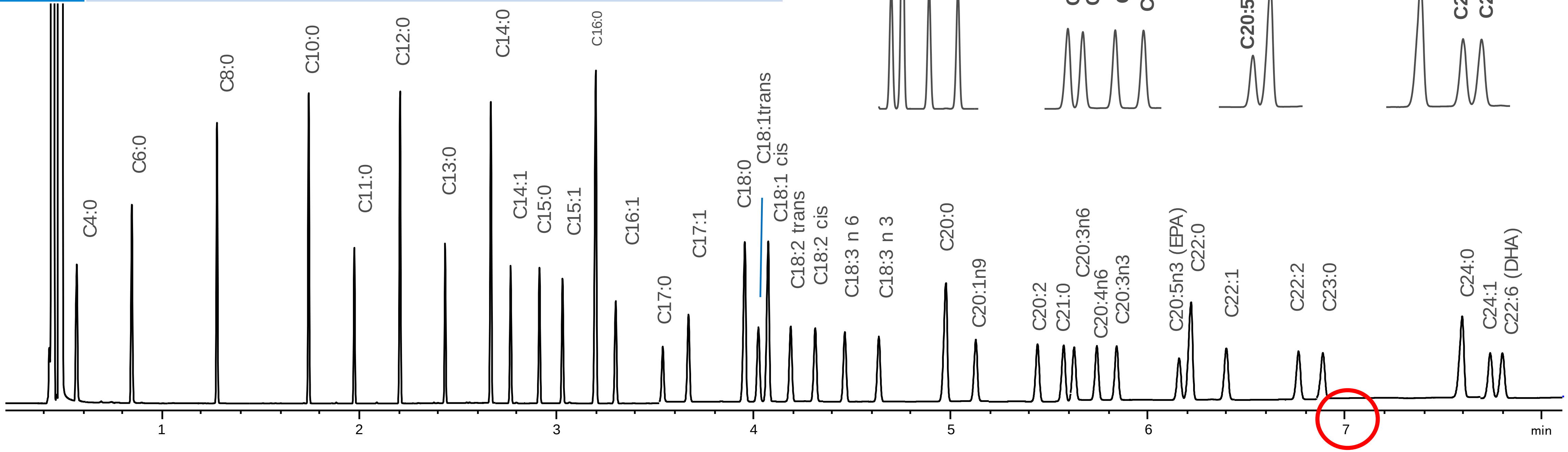
20 m x 0.18 mm x 0.20 µm

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



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

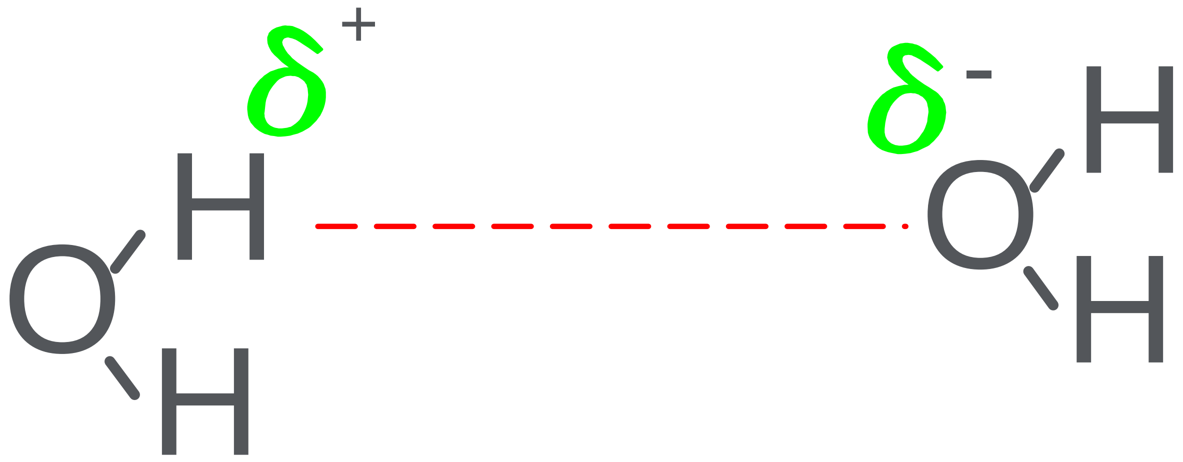




Application note: 5991-8706EN

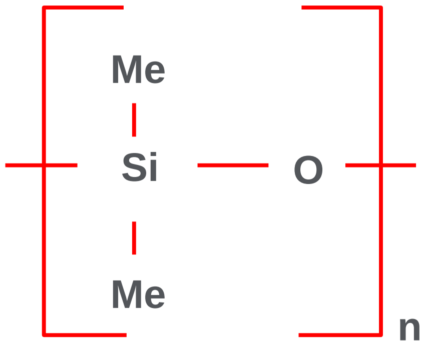
Hydrogen Bonding Interaction

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

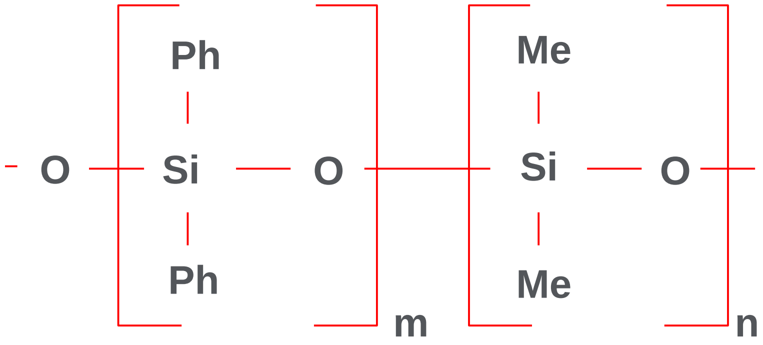


Separation mechanisms:

- 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)



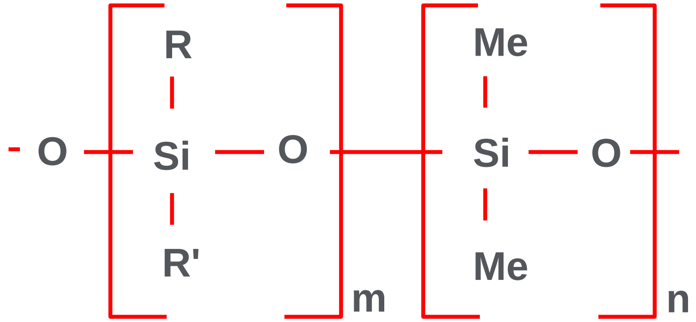
5%--weakly polar,
50%-- midpolar

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)



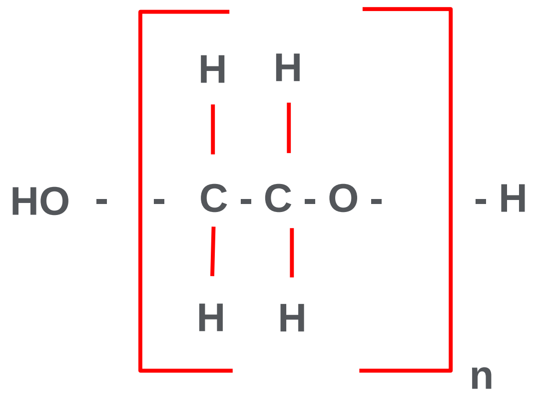
R = cyanopropyl or trifluoropropyl
R′ = phenyl or methyl

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-Wax 52 CB…)



Separation mechanisms:

- Dispersion
- Strong permanent dipole
- Hydrogen bonding

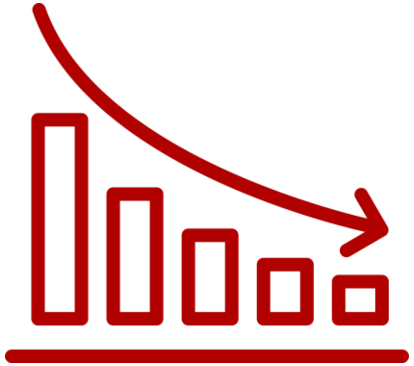
Selectivity

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

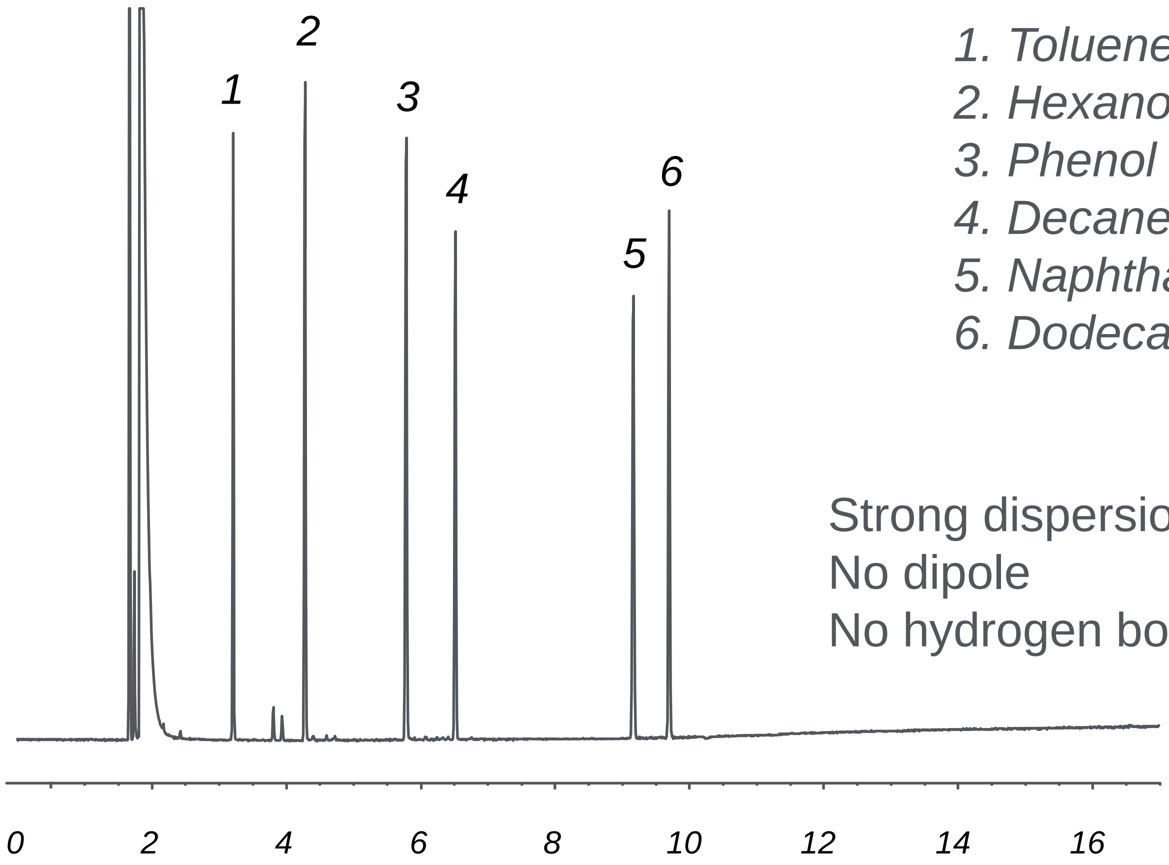


Stability
Temperature Range

Compounds and 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

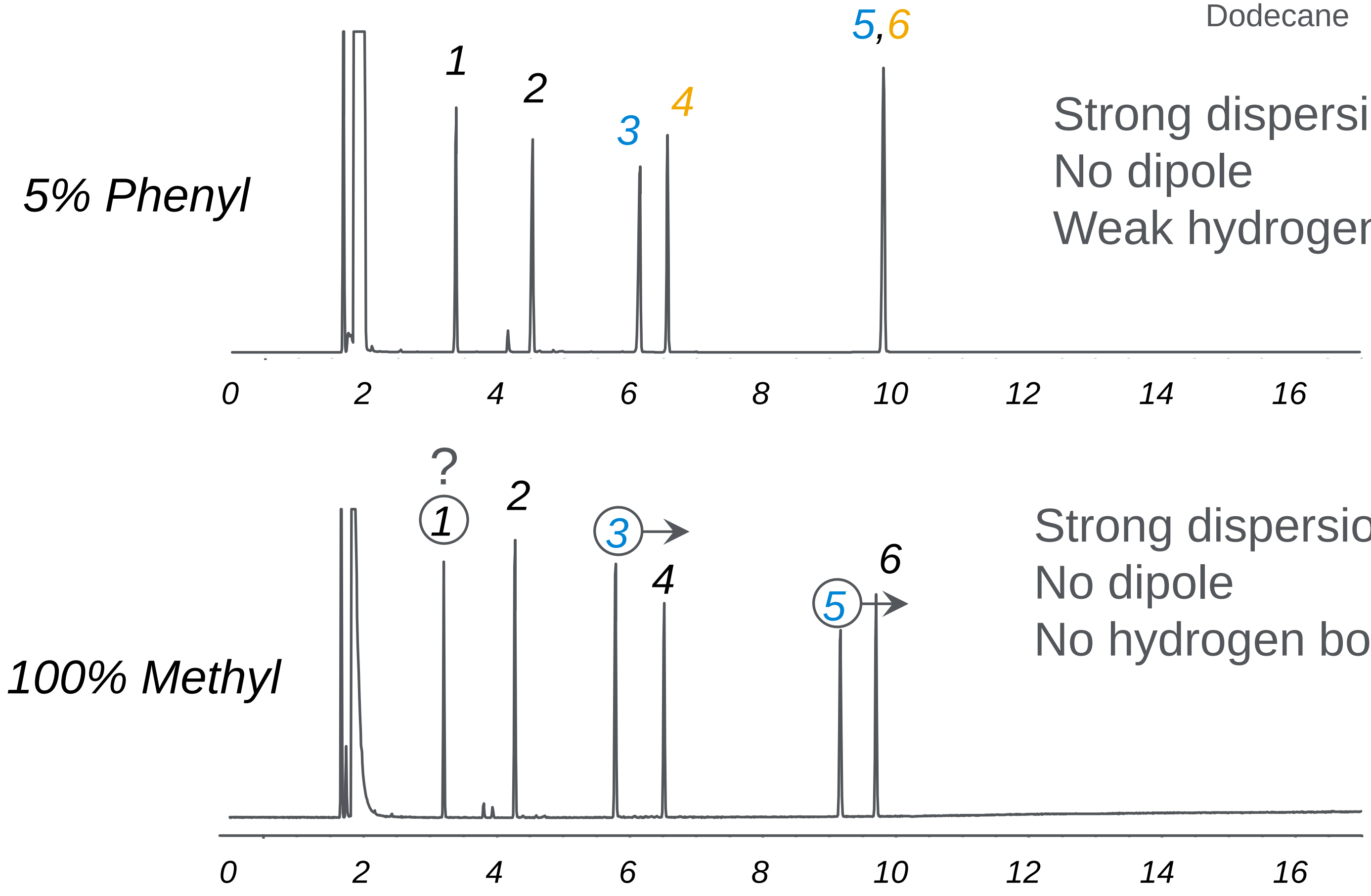


1. *Toluene* *110* °C
2. *Hexanol* *156* °C
3. *Phenol* *182 °C*
4. *Decane (C10)* *174* °C
5. *Naphthalene* *218 °C*
6. *Dodecane (C12)* *216* °C

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



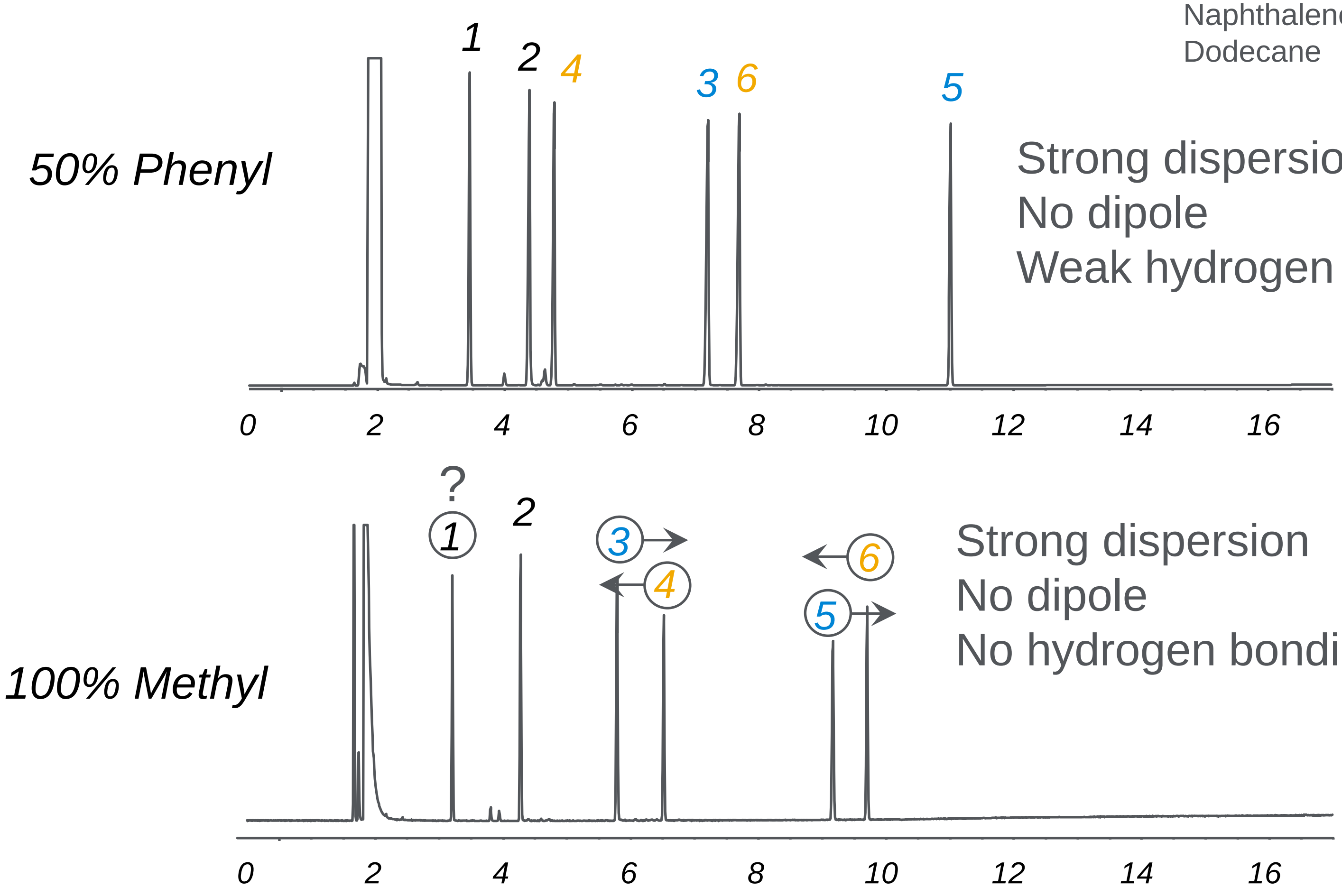
Strong dispersion
No dipole
Weak hydrogen bonding

Strong dispersion
No dipole
No hydrogen bonding

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

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

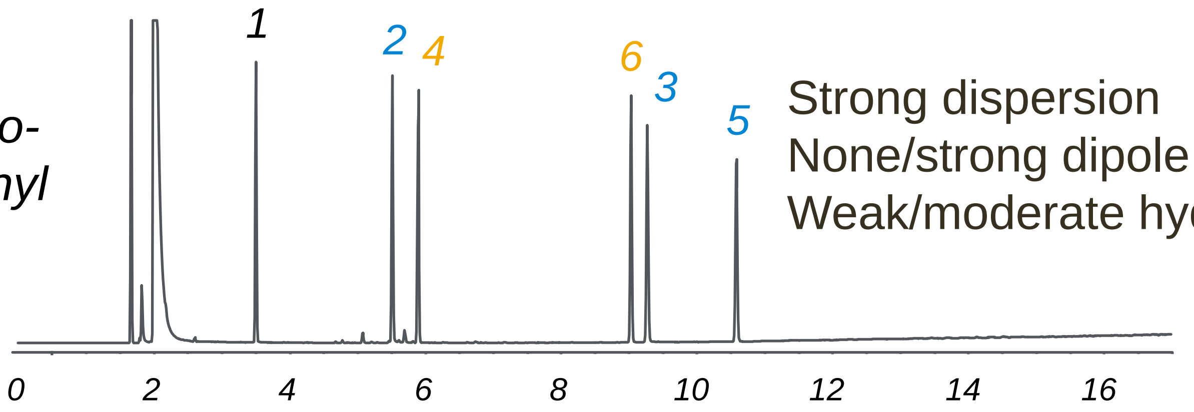
Strong dispersion
No dipole
No hydrogen bonding

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

14% Cyanopropylphenyl

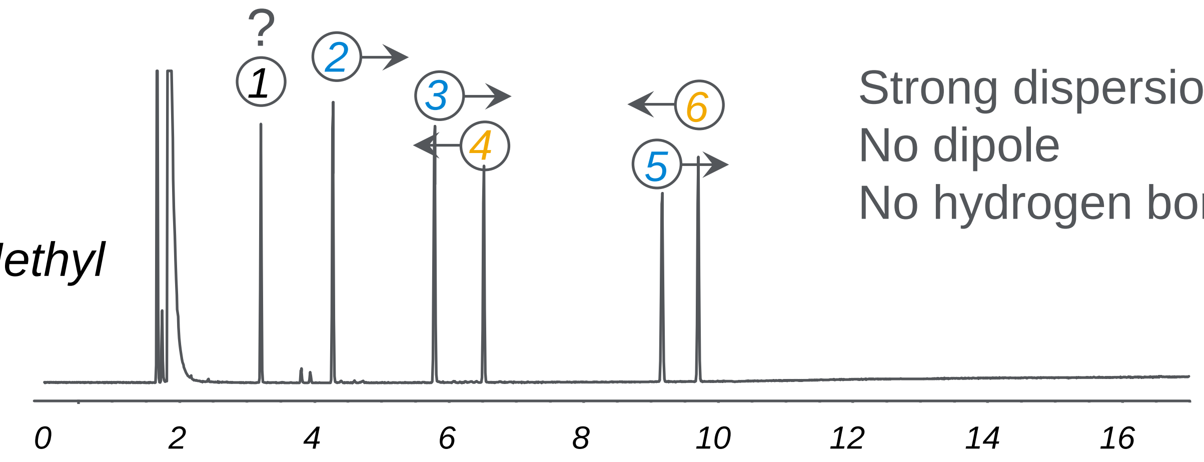
Compounds	Polar	Aromatic	Hydrogen Bonding	Dipole
Toluene	no	yes	no	induced
Hexanol	**yes**	no	**yes**	**yes**
Phenol	**yes**	yes	**yes**	**yes**
Decane	**no**	no	**no**	**no**
Naphthalene	no	**yes**	no	**induced**
Dodecane	**no**	no	**no**	**no**

14% Cyano-propylphenyl



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

100% Methyl

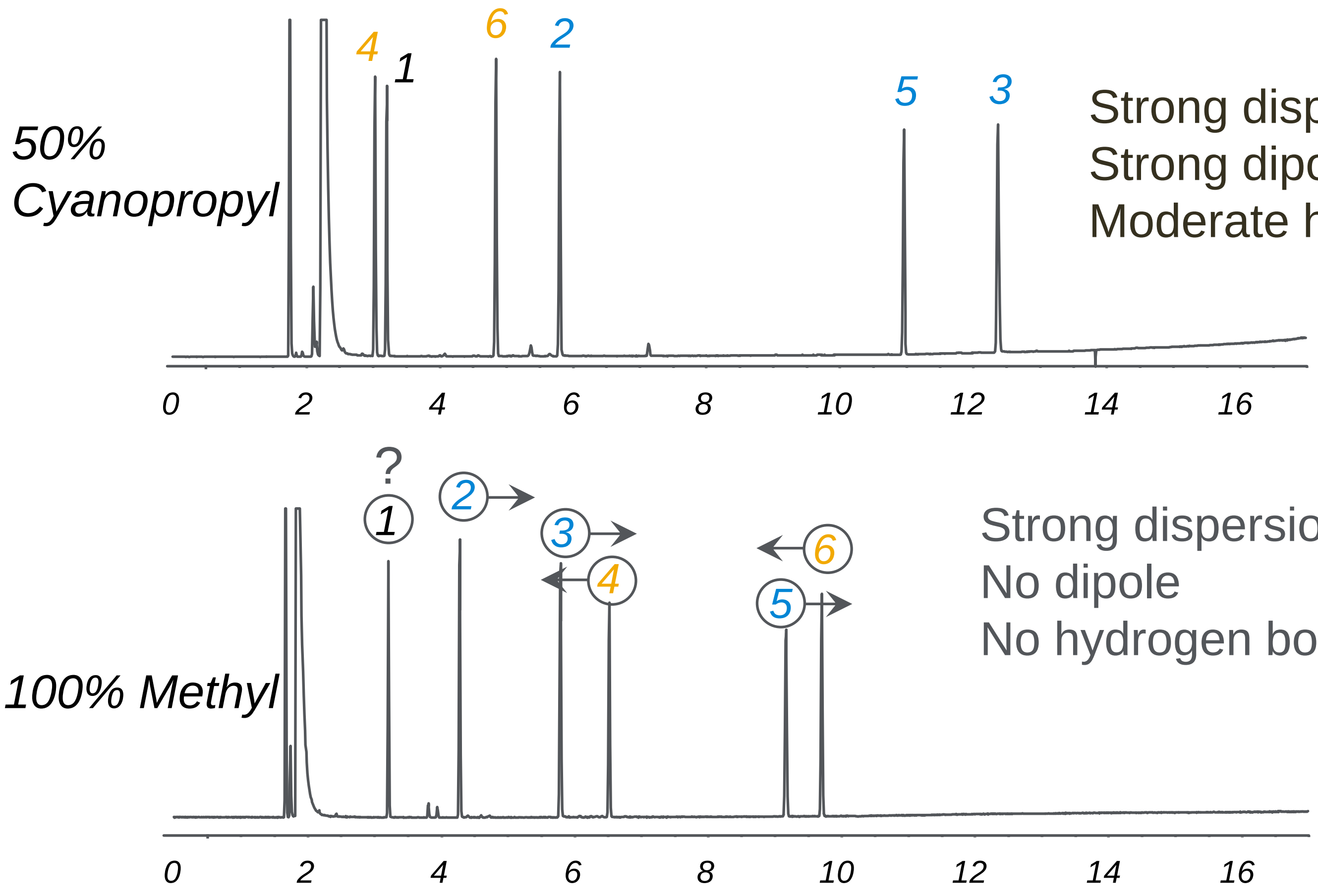


Strong dispersion
No dipole
No hydrogen bonding

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

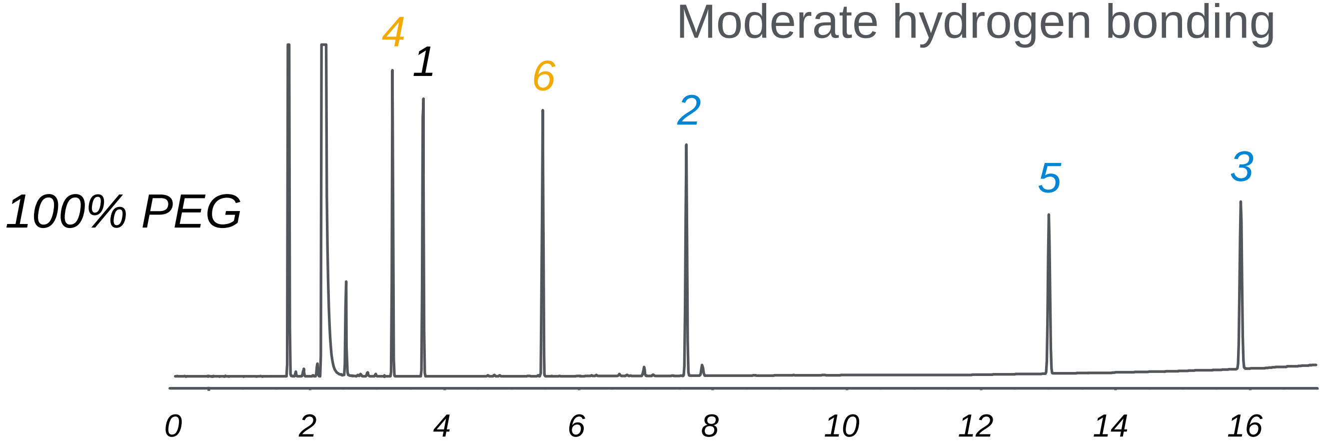
Strong dispersion
No dipole
No hydrogen bonding

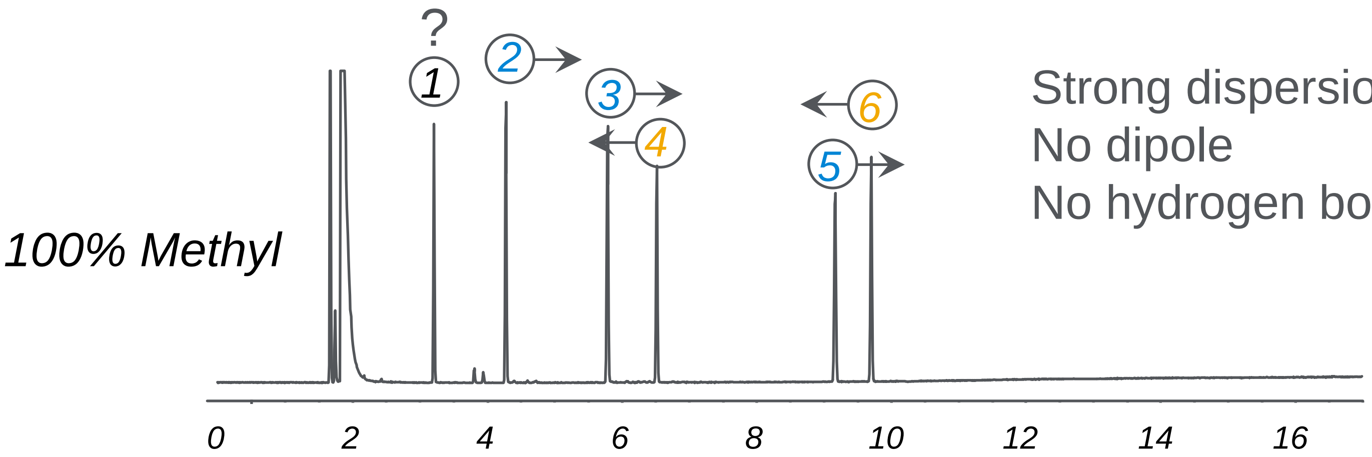
1. *Toluene*
2. *Hexanol*
3. *Phenol*
4. *Decane (C10)*
5. *Naphthalene*
6. *Dodecane (C12)*

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)

Stationary Phase Selection
Part 1

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

Agilent Bond Elut Sample Cleanup Products

Filtration cartridges and plates

Solid Phase Extraction cartridges and plates

Synthetic Chem Elut S

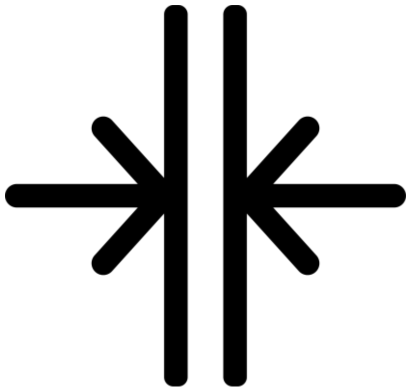
Captiva EMR Lipid

Stationary Phase Selection

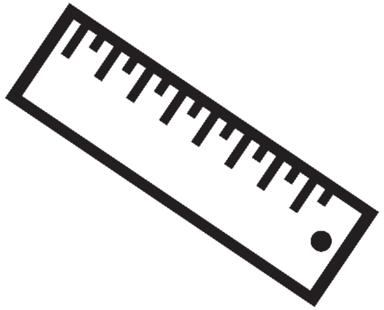
Part 2

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

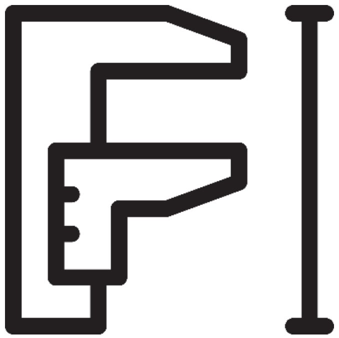
Column Dimensions



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

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

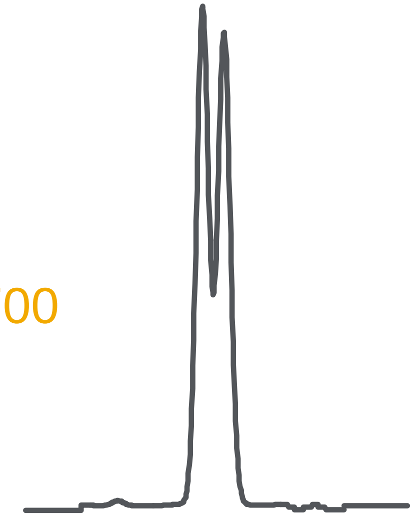
efficiency x 4 = resolution x 2

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

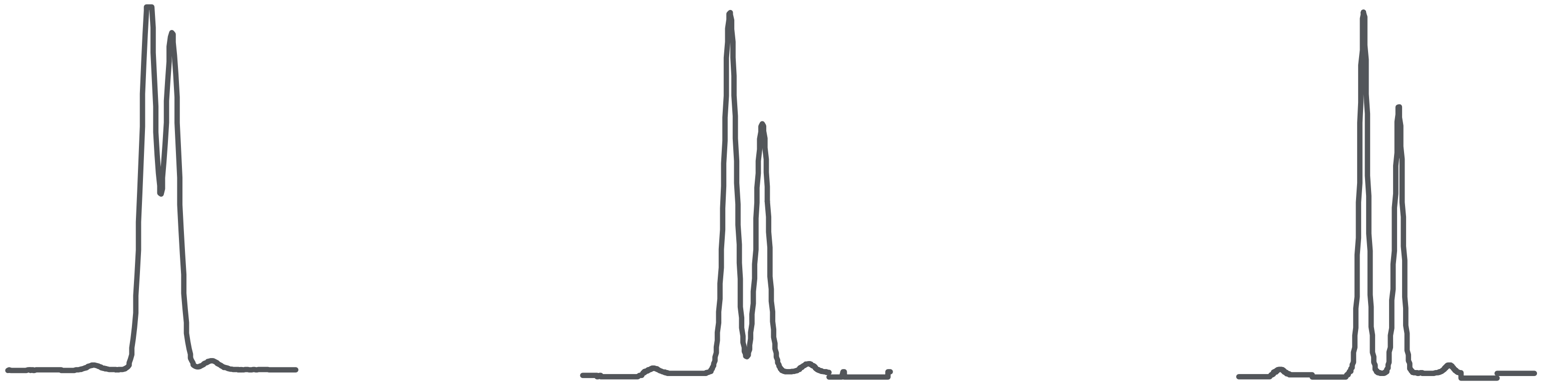
Column Length

Resolution and retention 210 °C isothermal

R= 0.84
2.29 min

R= 1.16
4.82 min

R= 1.68
8.73 min



15 m

30 m

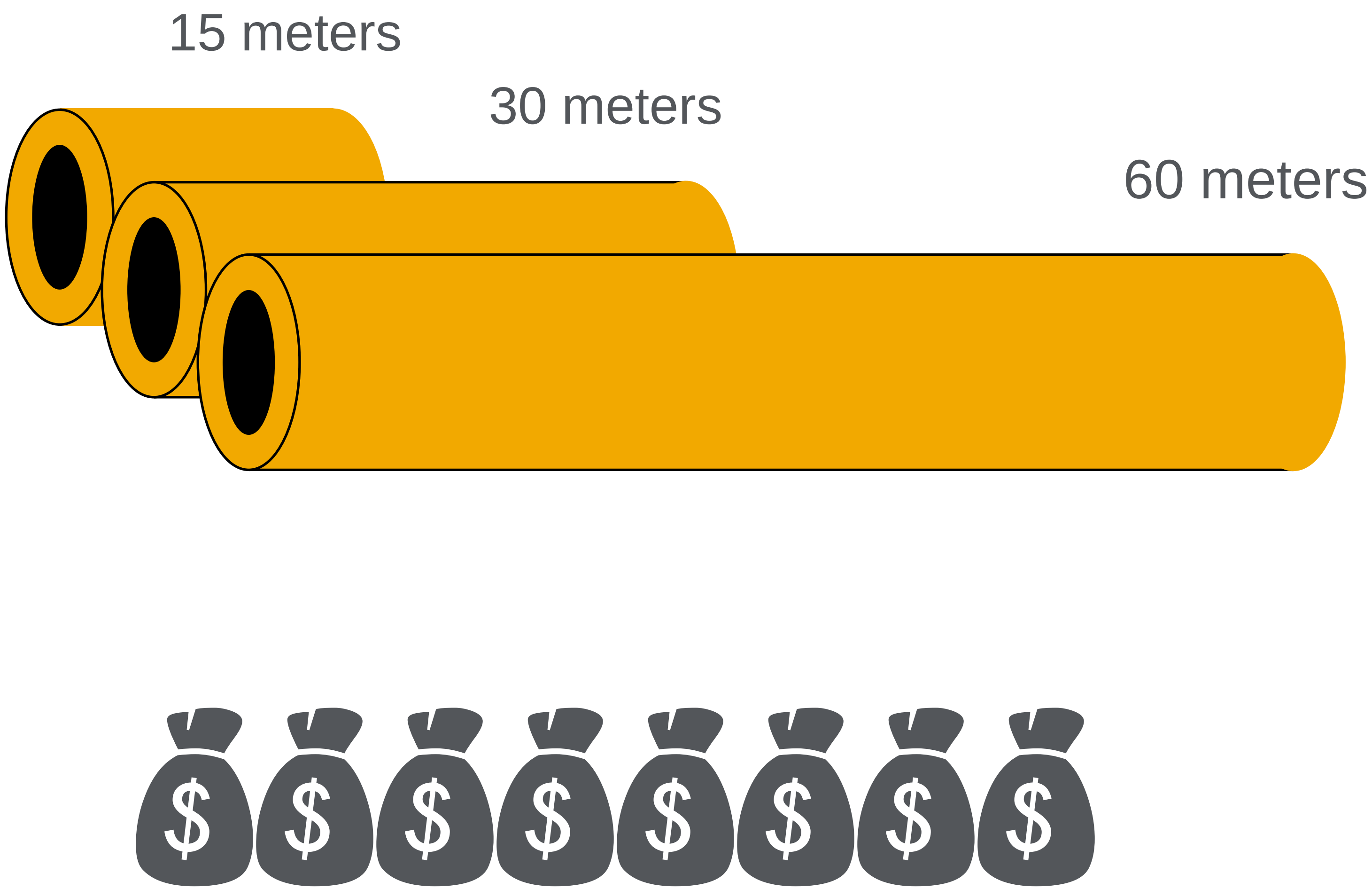
60 m

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

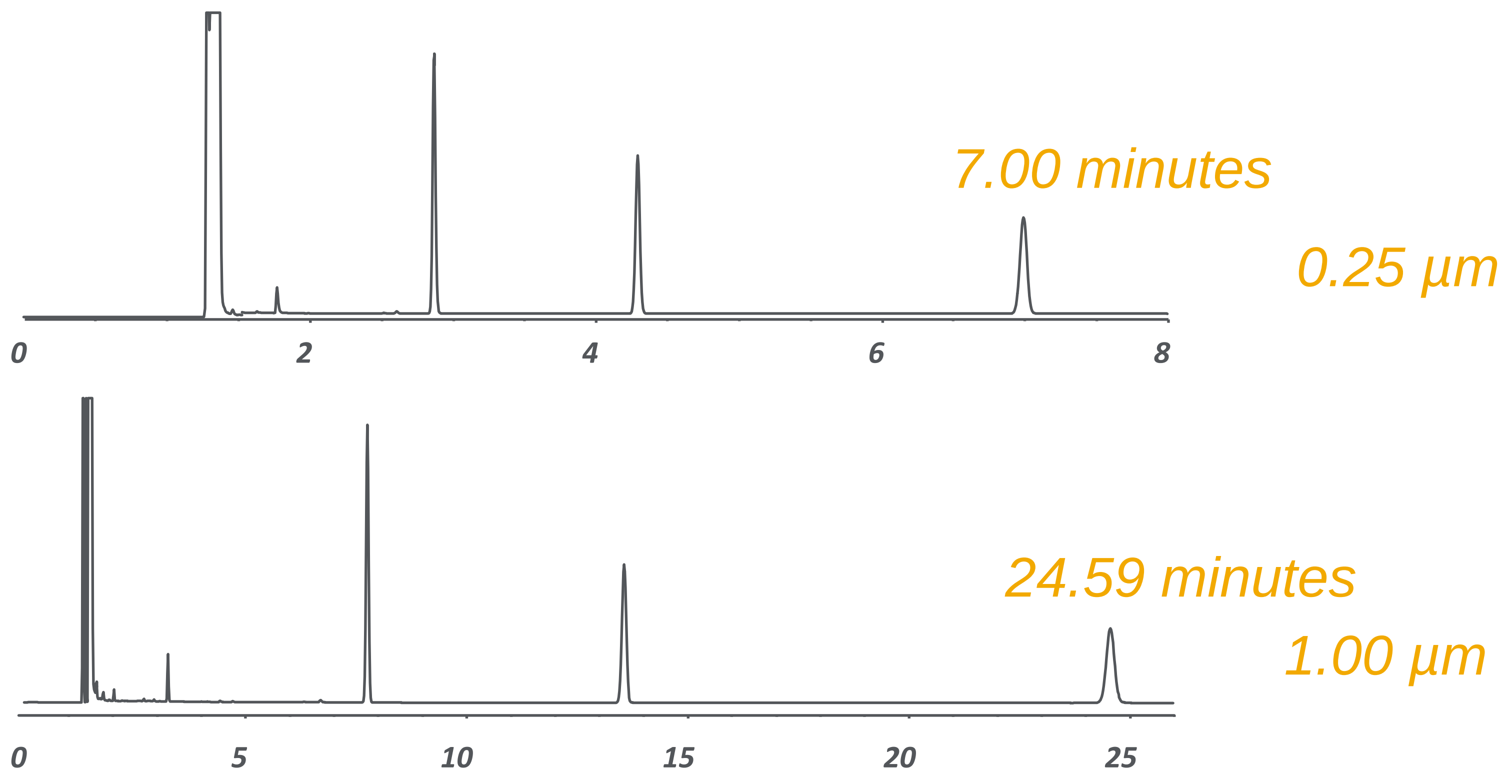


Film Thickness

Most common: 0.1–3.0 µm

Available: 0.1–10.0 µm

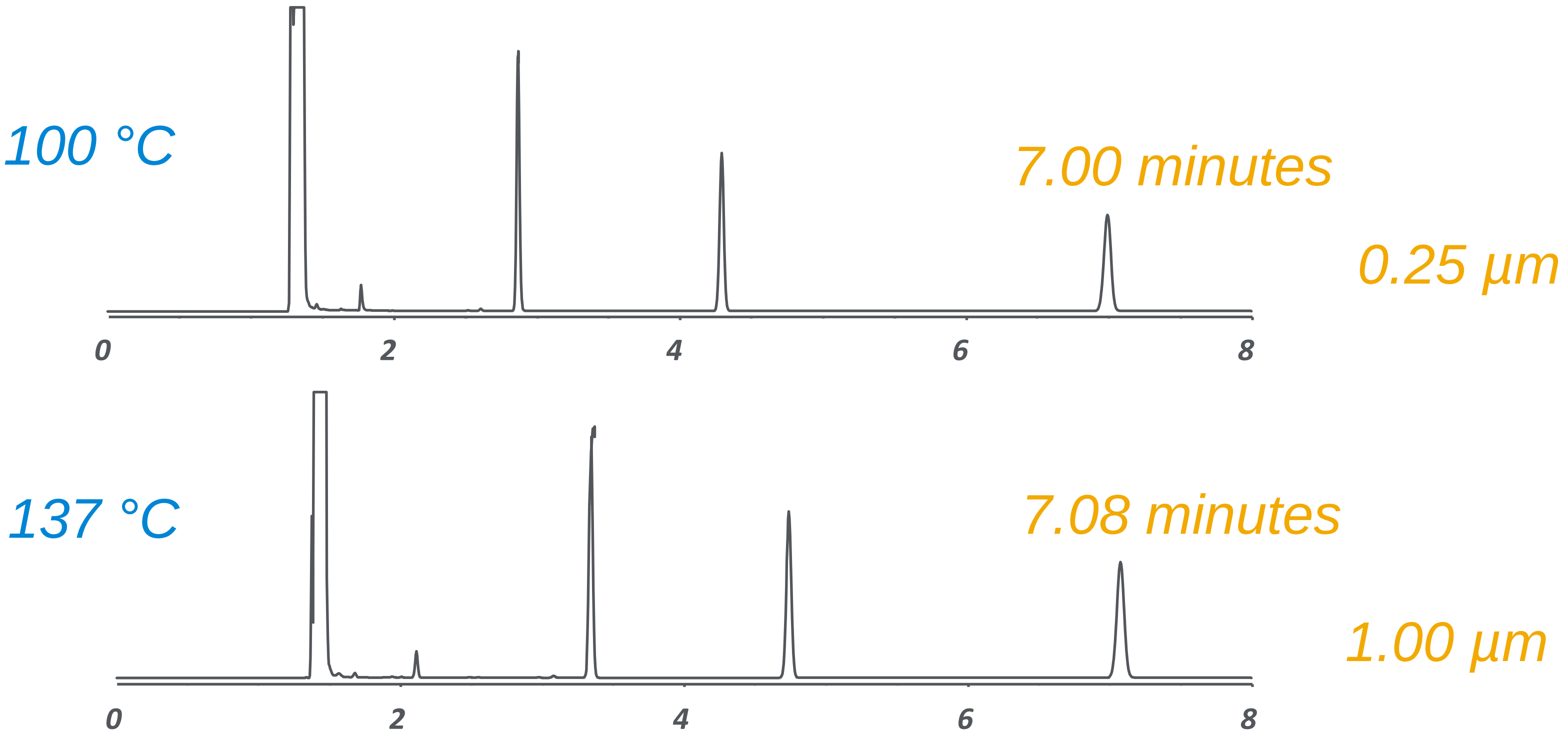
Film Thickness and Retention (100 °C Isothermal)



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

Film Thickness

Equal retention: Isothermal

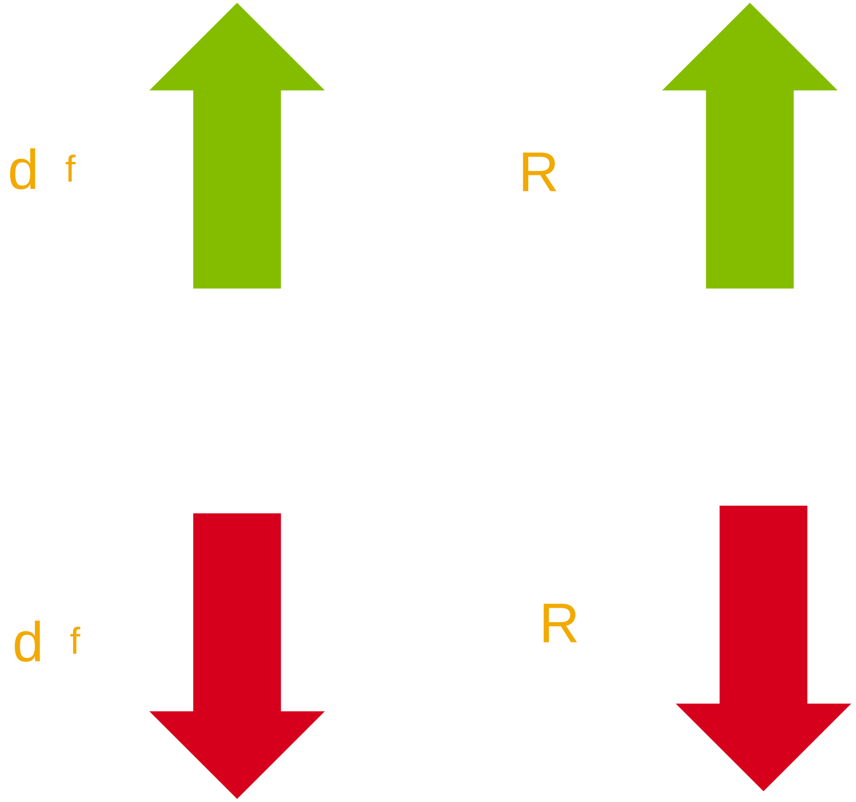


Agilent J&W DB-1, 30 m x 0.32 mm id
He at 37 cm/sec
C10, C11, C12

Film Thickness and Resolution

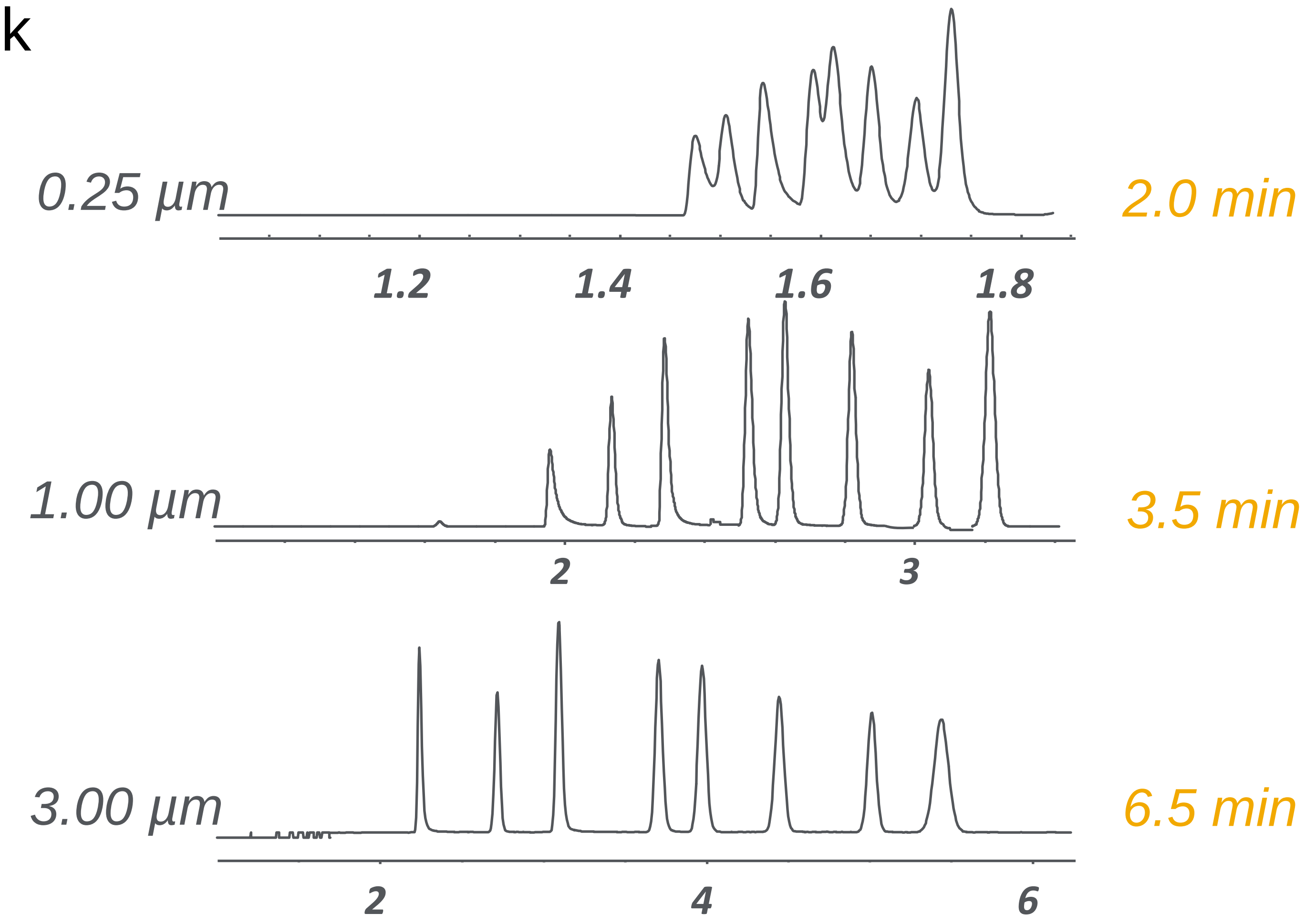
When solute k < 5

When solute k > 5



Film Thickness

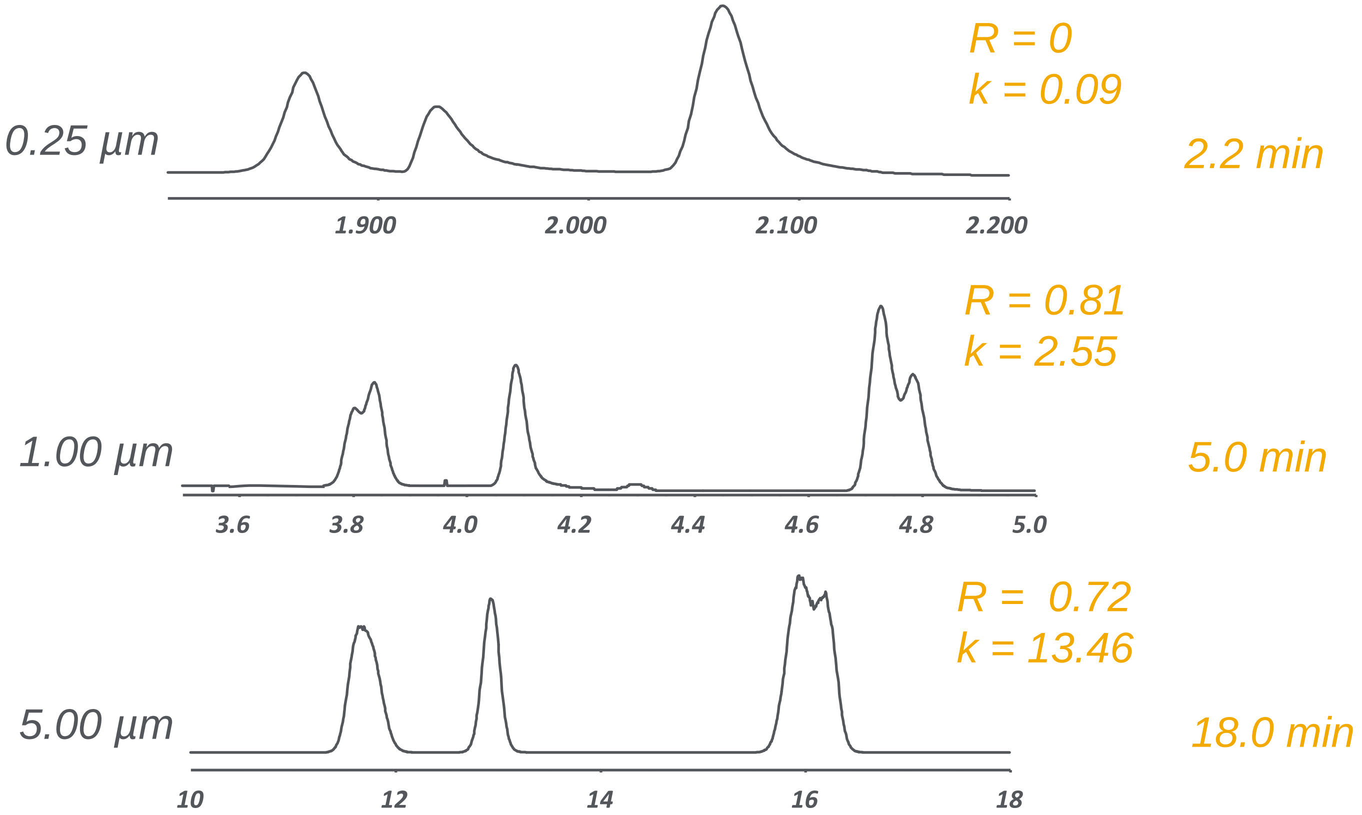
Resolution at low k



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)

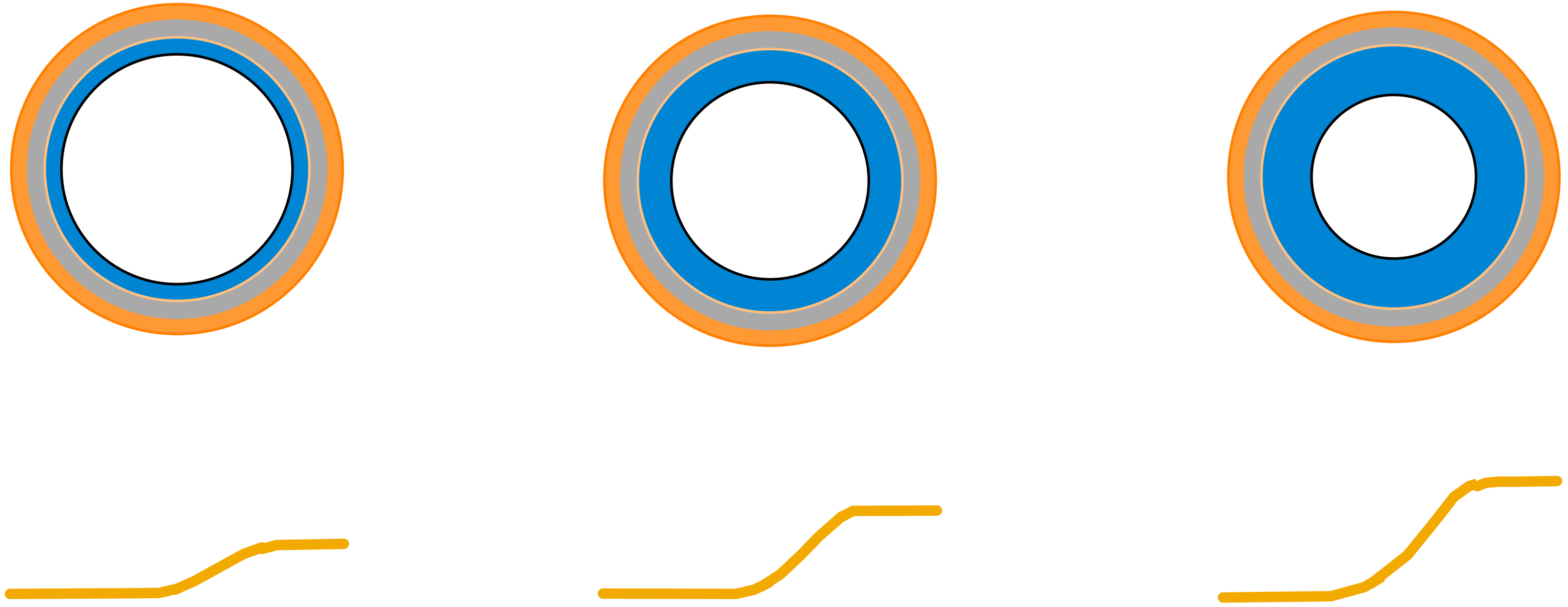
Thickness (µm)	Capacity (ng)
0.10	50-100
0.25	125-250
1.0	500-1000
3.0	1500-3000
5.0	2500-5000

0.32 mm column id

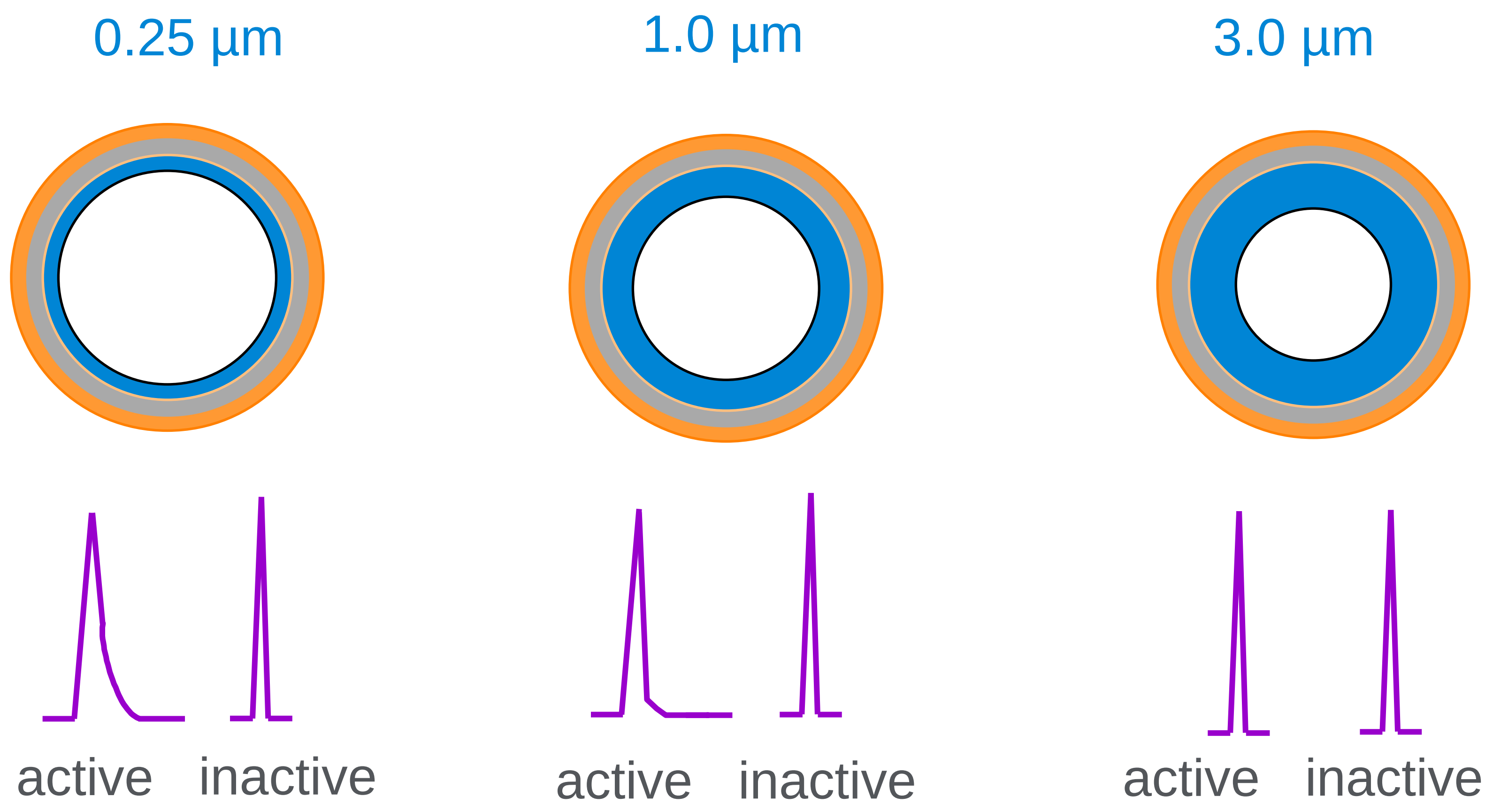
Like polarity phase/solute

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

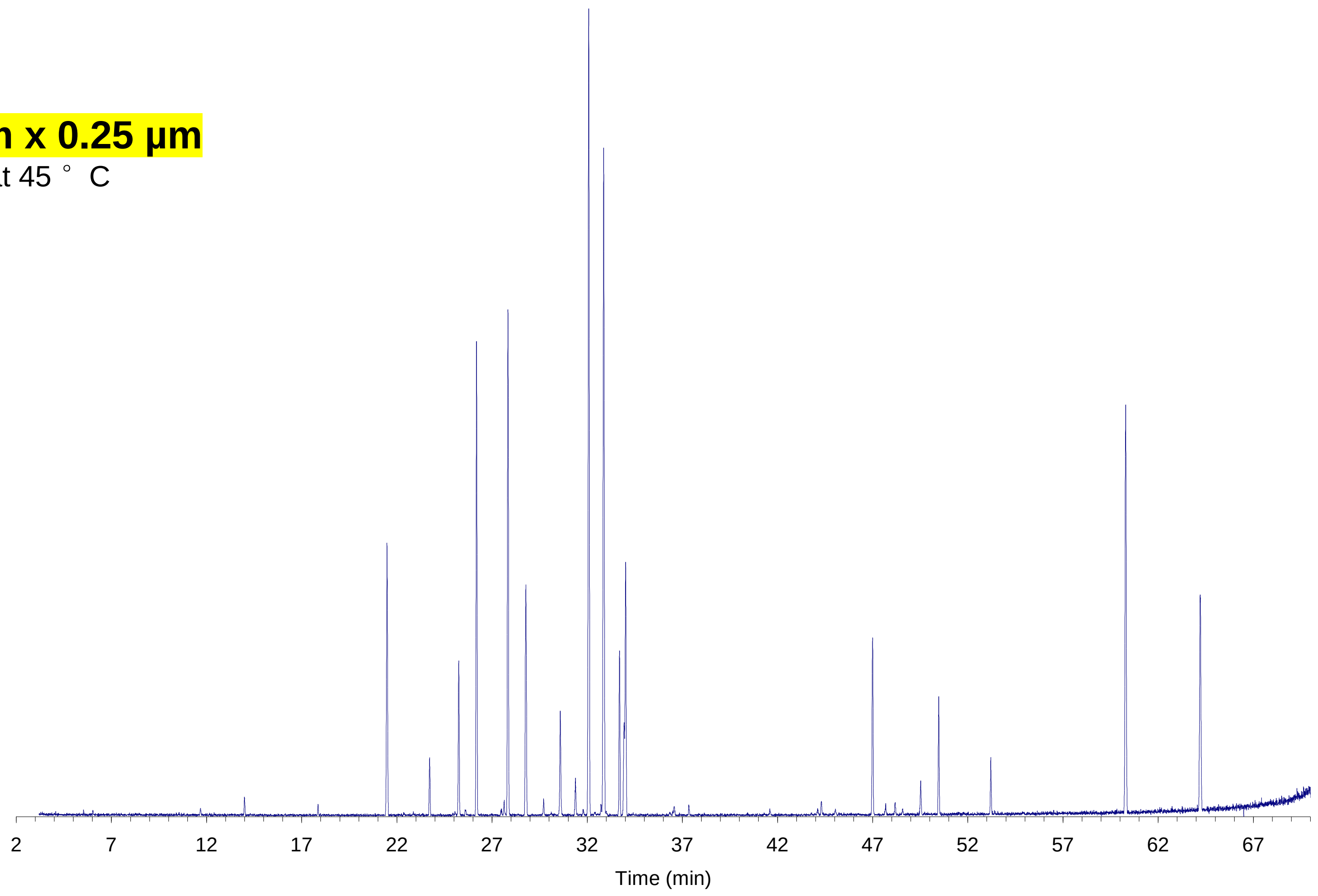
Column: DB-WAX 30 m x 0.25 mm x 0.25 µm

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

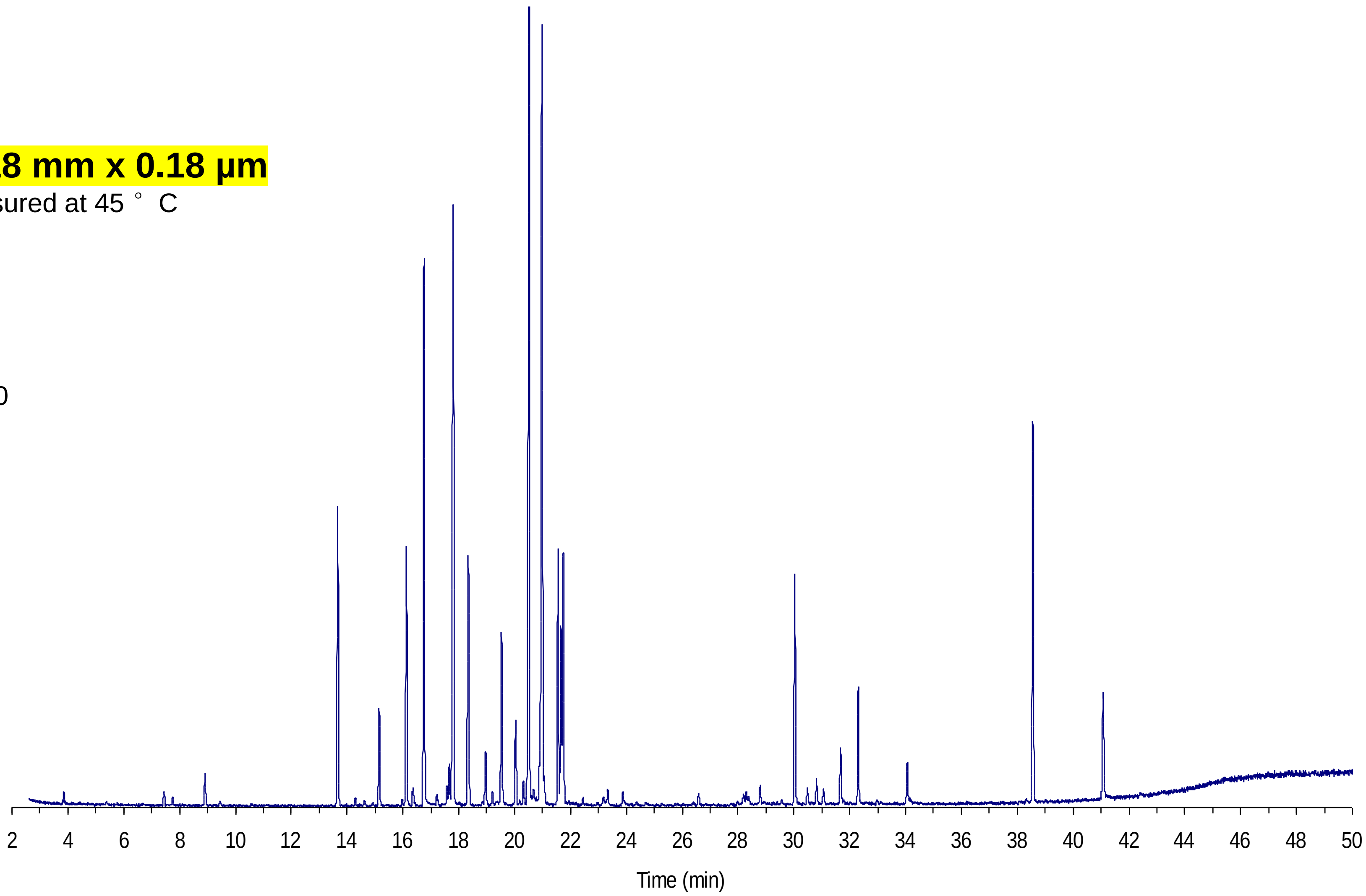
Detector: MSD full scan at m/z 40–500
250 °C transfer line



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



Agilent University

Why training? What can we help with?

Agilent University:

- Trained over 38K students FY19
- 98% customer recommended
- 4.6 out of 5 customer satisfaction
- 94% excellent & very good

Labs who want faster and more efficient learning options to help overcome training challenges	
	Overtasked staff
	Staff turnover
	Pressure to improve quality and productivity
	Daily consistency with output and results
	Reduce costs associated with lab operations

Flexible and convenient training options when and where you need it:

Virtual Training

Virtual Instructor Led

eLearning self-paced

In-person Training

Classroom

On-site or Virtual On-site

Trust Agilent for answers leveraging up-to-date knowledge and generally accepted practices for all your training needs

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

Test Your Knowledge

Q Which one of these Agilent HP-5ms columns have the highest theoretically efficiency?

A. 0.53 i.d. X 30 meters X 3.00 um

B. 0.18 i.d. X 20 meters X 0.18 um

C. 0.18 i.d. x 40 meters X 0.18 um

D. 0.25 i.d. X 15 meters X 0.25 um

Test Your Knowledge

Q Which column below is the most inert?

A. Agilent DB-5ms UI 0.25 i.d. X 30 meters X 0.25 um

B. Agilent HP-5ms 0.25 X 60 meters X 0.25 um

C. Agilent DB-WAX 0.32 i.d. X 30 meters X 0.50 um

D. Agilent DB-5ms UI 0.25 X 30 meters X 0.50 um

Test Your Knowledge

Q If I double my column length, my resolution will also double.

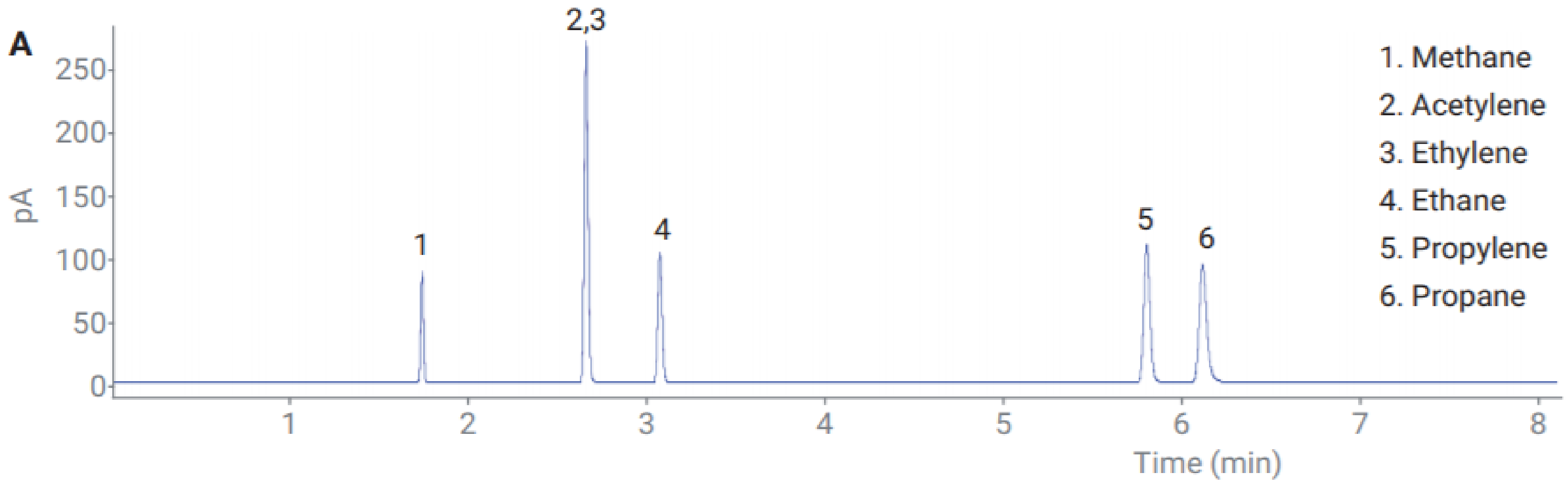
True

Or

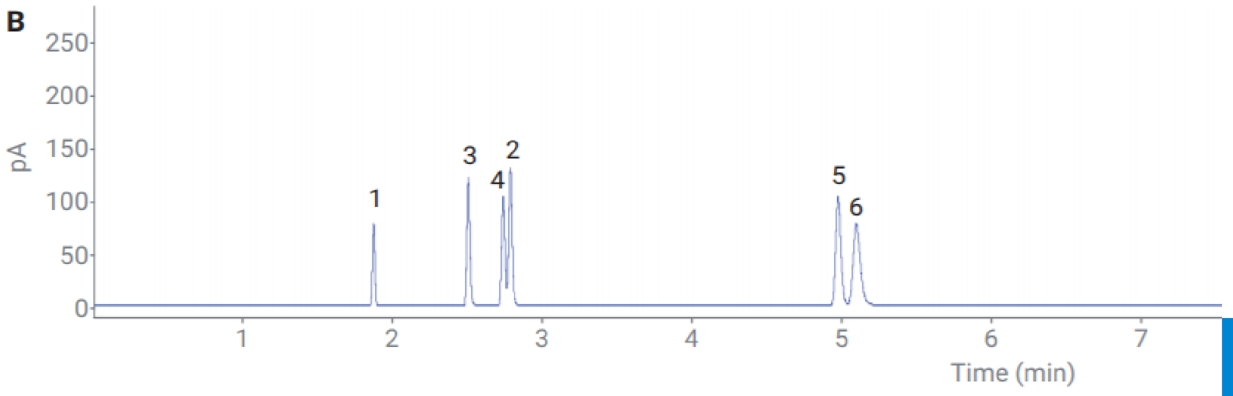
False

Separation of Volatile Organic Hydrocarbons with Agilent J&W PLOT GC Columns and Selectivity Tuning (5994-3485EN)

PoraPLOT Q



PoraPLOT S



PoraPLOT U