PLOT TWIST:
Using PLOT Columns for the Analysis of Gasses and Very Volatile Compounds

Porous **L**ayer **O**pen **T**ubular columns

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Application Engineer
November 2024

Table of Boiling Point Fractions

Carbon #	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
Bpt of n-Paraffin at 760 mm Hg																
Centigrade	-161	-89	-42	-0.5	+36	69	98	126	151	174	196	216	235	253	270	287
Fahrenheit	-259	-127	-44	+31	97	156	209	258	303	345	384	421	421	488	519	548

Refinery off gas

Naphtha solvents

Cracking naphtha

Reformate

Gasoline

Kerosine, diesel — to C_{18}

Jet fuel — to C_{17}

Gas oil — to $>C_{20}$

Lube oil — C_{20}

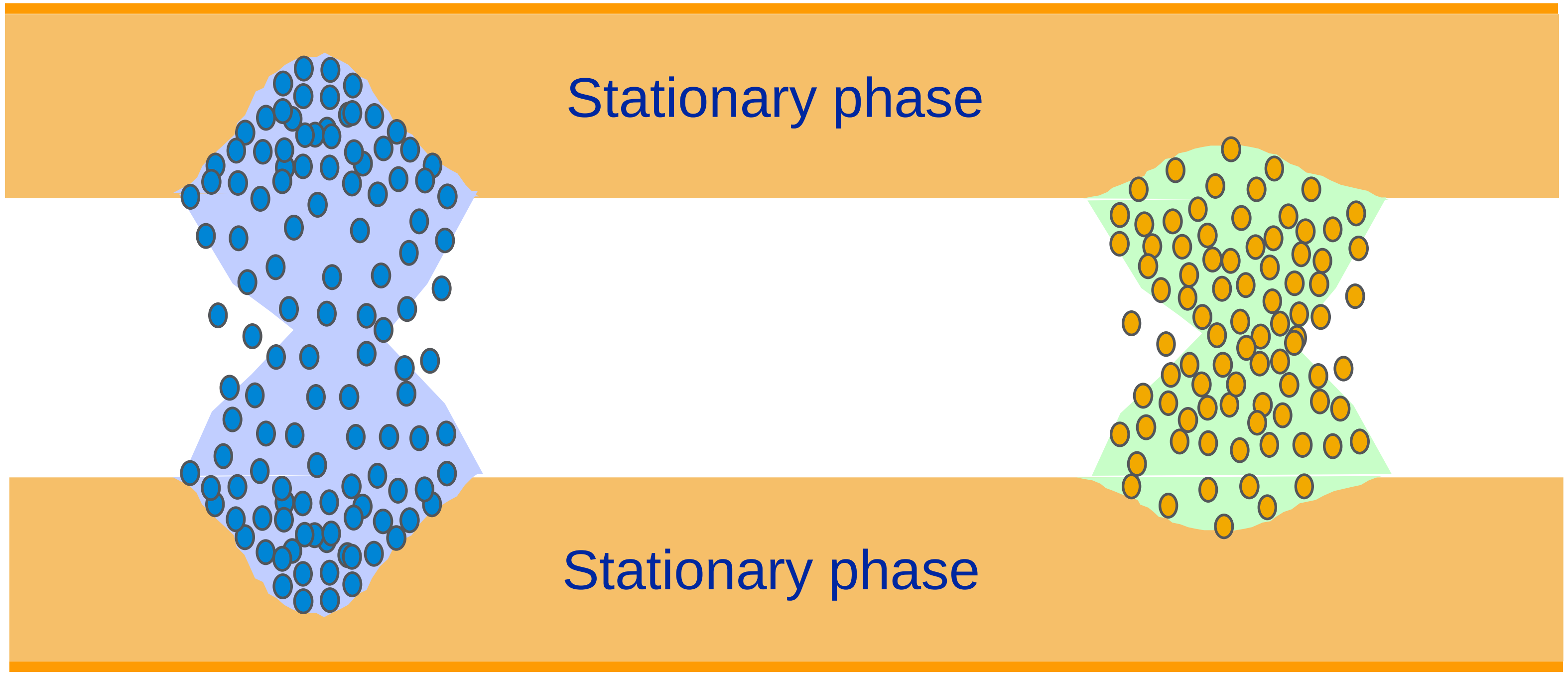
Pitch asphalt — C_{20}

Wax — C_{17}

Residues — C_{44}+

Wall Coated Open Tubular (WCOT) Columns

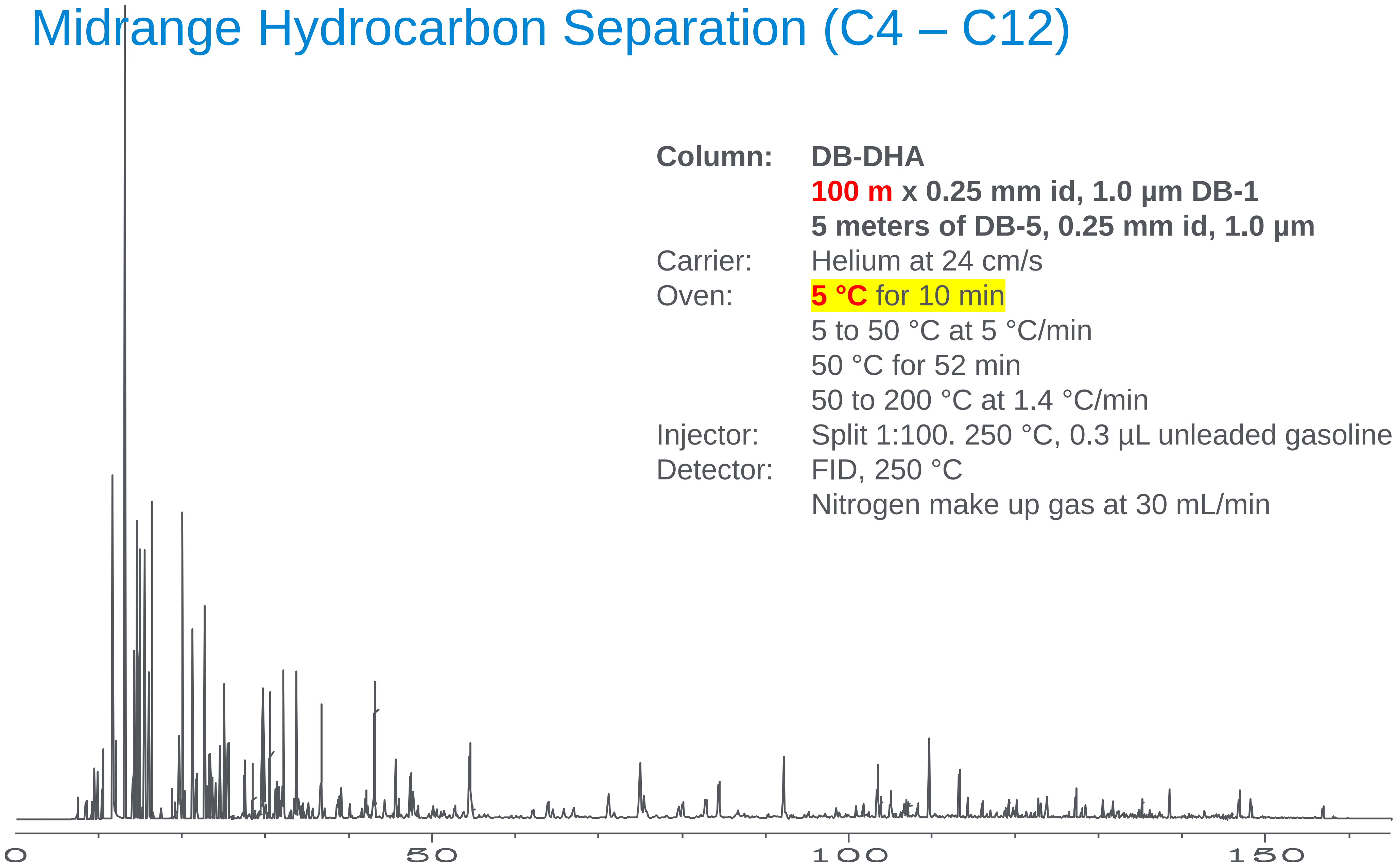
WCOT = **W**all **C**oated **O**pen **T**ubular



K_c => large

K_c => small

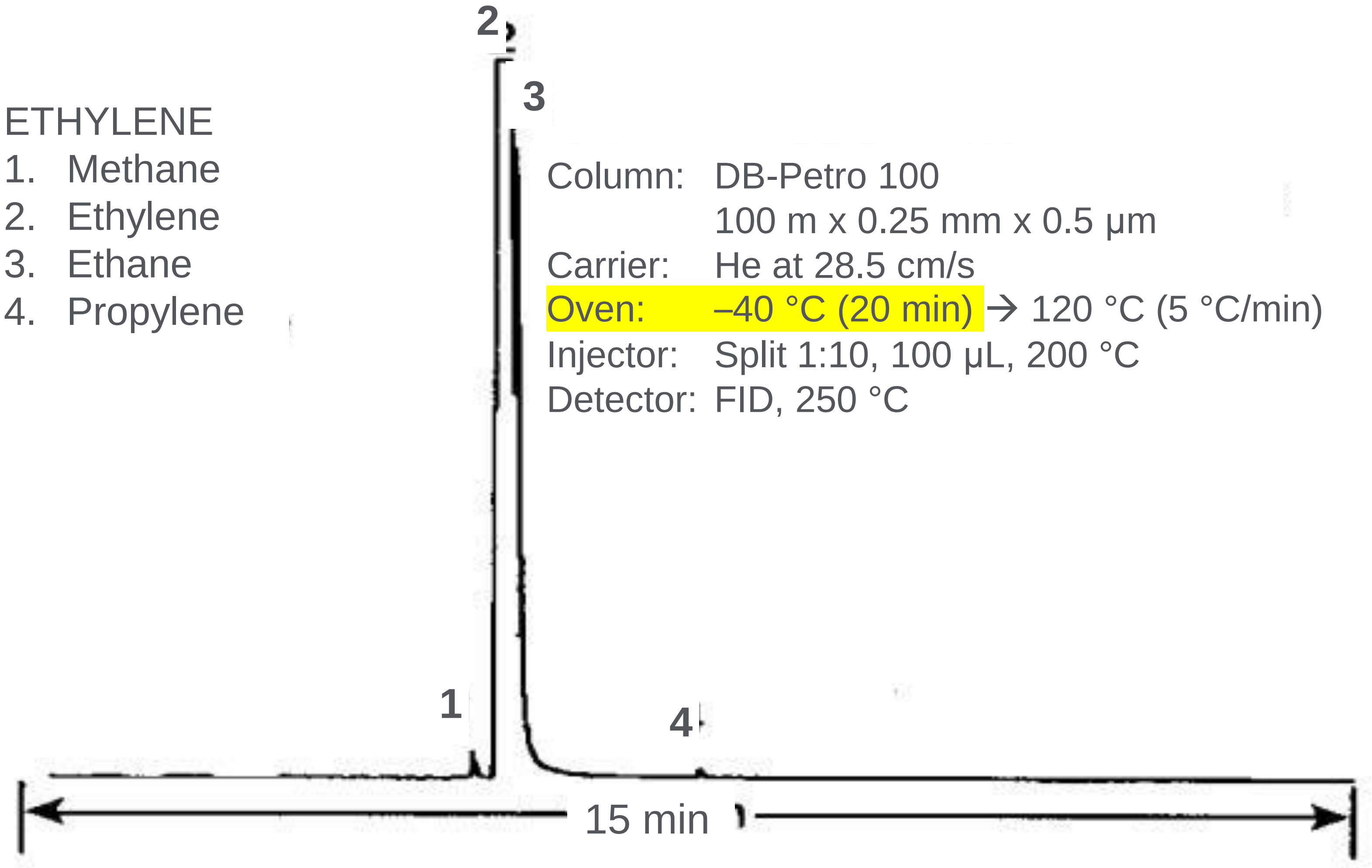
Midrange Hydrocarbon Separation (C4 – C12)



Column:	**DB-DHA**
	100 m x 0.25 mm id, 1.0 µm DB-1
	5 meters of DB-5, 0.25 mm id, 1.0 µm
Carrier:	Helium at 24 cm/s
Oven:	**5 °C** for 10 min
	5 to 50 °C at 5 °C/min
	50 °C for 52 min
	50 to 200 °C at 1.4 °C/min
Injector:	Split 1:100. 250 °C, 0.3 µL unleaded gasoline
Detector:	FID, 250 °C
	Nitrogen make up gas at 30 mL/min

Ethylene Analysis on Nonpolar WCOT

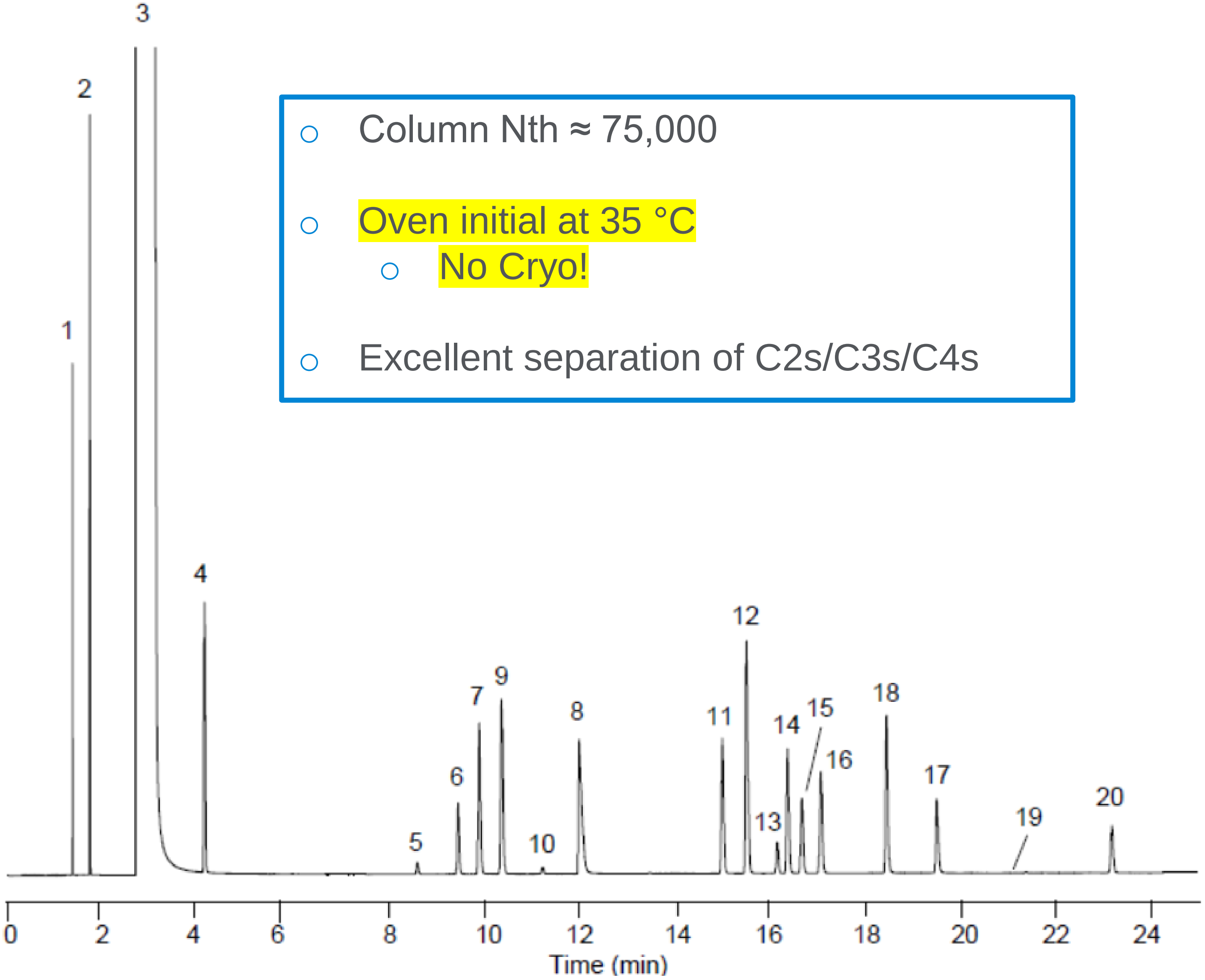
ETHYLENE
1. Methane
2. Ethylene
3. Ethane
4. Propylene



Column:	DB-Petro 100 100 m x 0.25 mm x 0.5 µm
Carrier:	He at 28.5 cm/s
Oven:	–40 °C (20 min) → 120 °C (5 °C/min)
Injector:	Split 1:10, 100 µL, 200 °C
Detector:	FID, 250 °C

- Column Nth = 350,000
- Oven start at –40 °C
- Poor separation of C2s
- Poor separation of C3s

Ethylene Analysis on Alumina PLOT



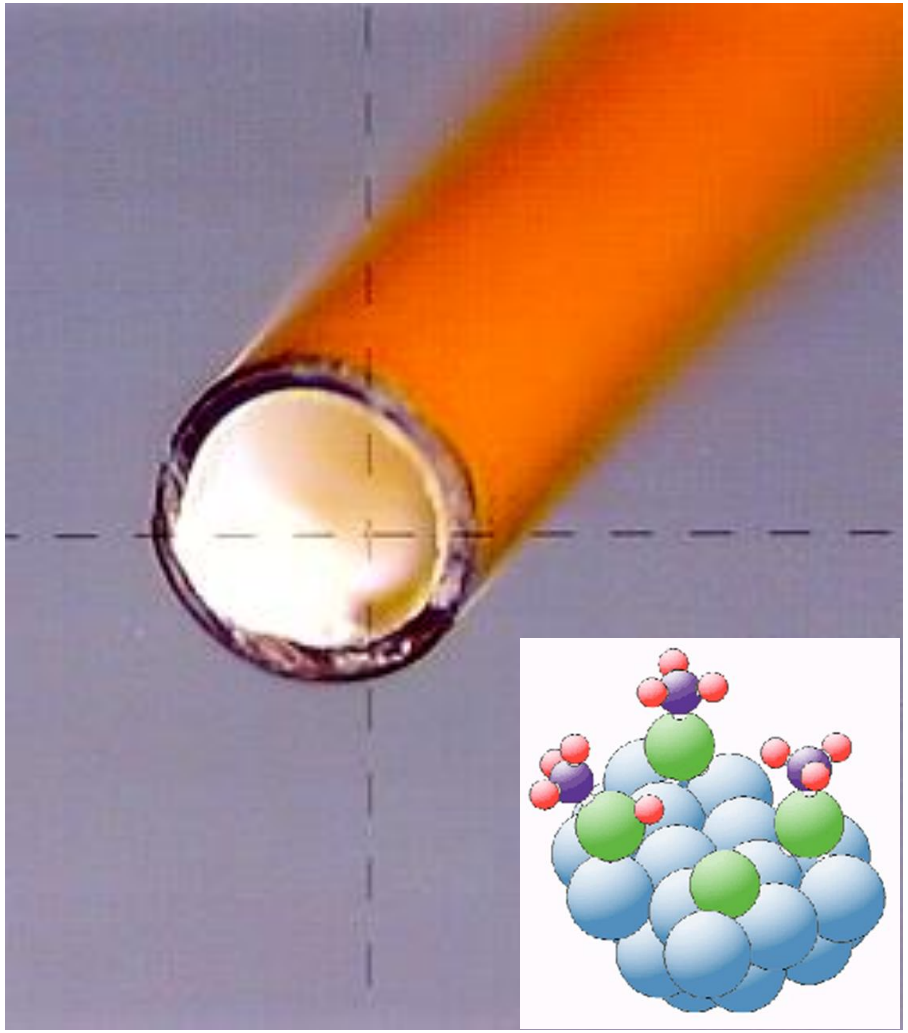
- Column Nth ≈ 75,000
- Oven initial at 35 °C
  - No Cryo!
- Excellent separation of C2s/C3s/C4s

Column:	**GS-Alumina**
	50 m x 0.53 mm I.D.
J&W P/N:	**115-3552**
Carrier:	Helium at 11 mL/min, measured at 35°C
Oven:	35°C for 2 min
	35-190°C at 6°/min
	190°C for 3 min
Injector:	Split 1:30, 200°C
	0.2 mL of trace hydrocarbons in ethylene
Detector:	FID, 200°C
	Nitrogen makeup gas at 20 mL/min

1. Methane
2. Ethane
3. Ethylene
4. Propane
5. Cyclopropane
6. Propylene
7. Isobutane
8. Acetylene
9. *n*-Butane
10. Propadiene
11. *trans*-2-Butene
12. 1-Butene
13. Isobutylene
14. *cis*-2-Butene
15. Isopentane
16. *n*-Pentane
17. Propyne
18. 1,3-Butadiene
19. 1-Pentene
20. *n*-Hexane

What Is a PLOT column?

- PLOT = **P**orous **L**ayer **O**pen **T**ubular
- Porous layer (surface) on the inner wall capillary
- Deposition of porous particles on the wall from suspension
- Porous layer serves as a stationary phase
- Gas-solid **ad**sorption chromatography
  - Differences in analyte distribution between carrier gas and surface of the adsorbent (stationary phase)
- Gas-liquid chromatography – WCOT
  - Differences in solubility in liquid phase (stationary phase)



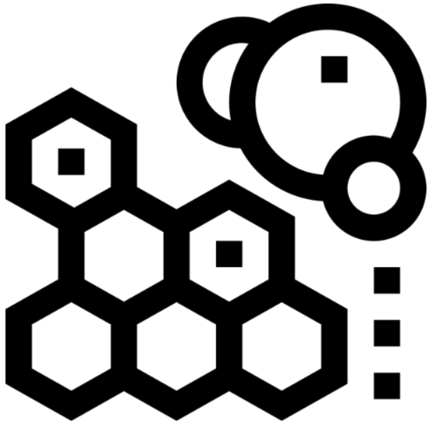
Advantages of GSC:
– Improved selectivity (α)
– Retention (k) of highly volatile solutes

Selectivity Interactions in PLOT Phases

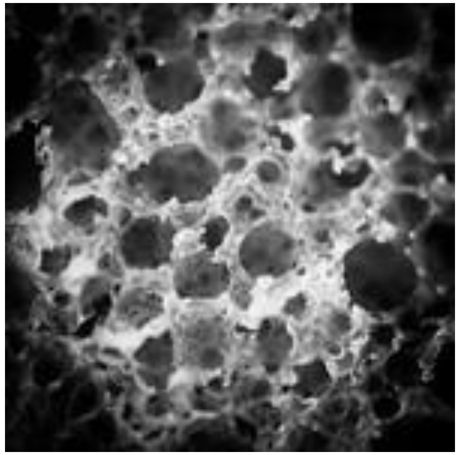
Shape/size ⟷ **Surfaces**

Zeolites

Bonded carbon
Molecular sieves



Porous polymers



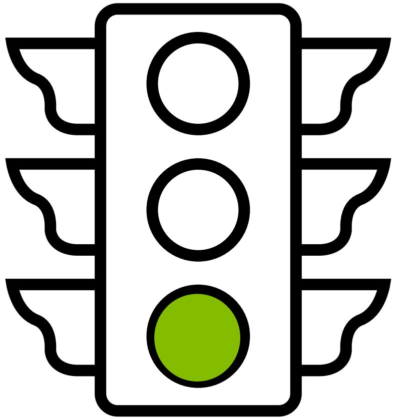
Al_2O_3

Bonded silica

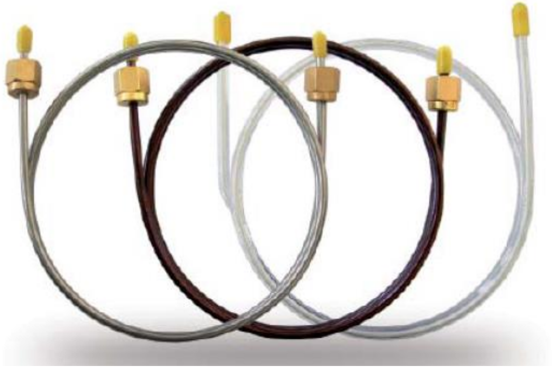
*Molecular sieve by Bearfruitidea from the Noun Project

Creative Commons: Daniel Kulinski

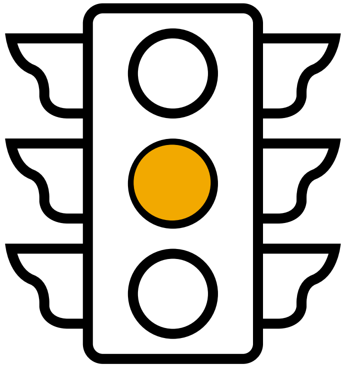
Porous Layer Open Tubular (PLOT) Columns
Advantages



- Retention for high vapor pressure solutes
  - No cryogenics needed
  - Useful for multicolumn and valve switching, as well as heart cutting techniques
- Variety adsorbents
  - Porous polymers, alumina, molecular sieve, silica
  - Selectivity for isomeric compounds (HC isomers)
  - Gas and solvent separations
- Efficiency of a capillary
  - Preferred over packed columns
  - Packed columns have advantages in specific applications



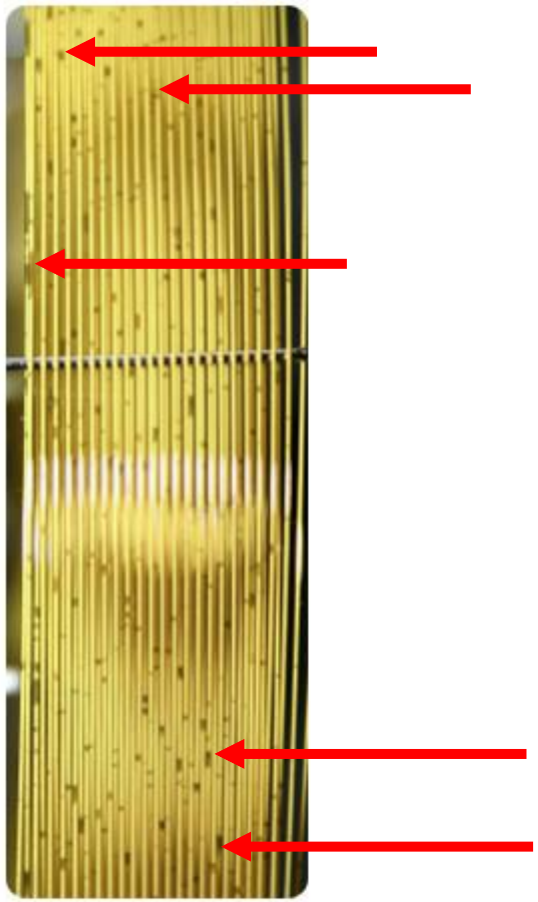
PLOT – Some Limitations and Considerations



- Lower sample capacity than thick film (1 to 5 µm) liquid phase columns
  - The 0.53 mm PLOT columns offer highest loadability
- More limited maximum temperatures than siloxanes – limiting analyte scope
- Highly active – some compounds do not elute or require extensive column conditioning (CO_2/H_2O)
- Molecular rearrangements above Maximum Allowable Operating Temperature (MAOT) – selectivity might change
  - Do not exceed MAOT
- Particles may dislodge under mechanical/flow stress – but solutions do exist

PLOT – Voids/gaps

- Different manufacturing process than for WCOT columns
- Normal to find some Voids/gaps are normal
  - Areas of uneven coating
- Visual examination is performed to ensure no excessive number of voids/gasp
  - Picture to the right is showing unacceptable gaps/voids
- Each column is individually tested to ensure proper chromatographic performance



This is considered excessive!

Agilent J&W PLOT Column Portfolio

Porous polymers
- HP-PLOT Q and U
- PoraBOND Q and U
- PoraPLOT Q, U, and S
- GS-Q
- PoraPLOT Q-HT

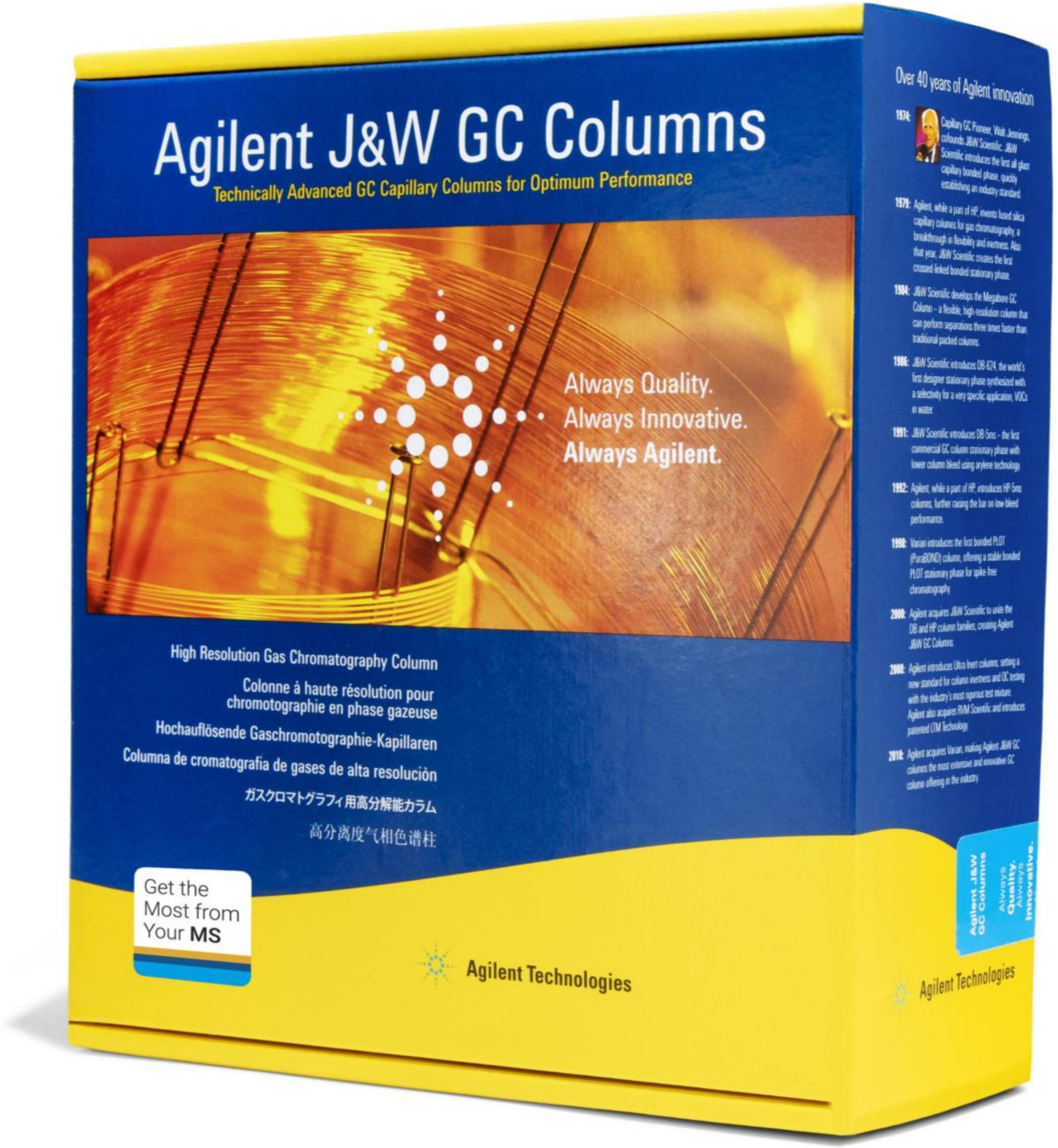
Alumina
- Al_2O_3/KCl, HP-PLOT Al_2O_3/KCl
- Al_2O_3/Na_2SO_4 , HP-PLOT Al_2O_3 S
- GS-Alumina
- Select MAPD

Zeolites
- HP-Molesieve
- CP-Molsieve 5A

Porous silica
- GS-GasPro - No Particles
- SilicaPLOT - No Particles

Oxygenates
- CP-Lowox
- GS-OxyPLOT

Graphitised carbon
- CarboPLOT P7
- CarboBOND
- GS-CarbonPLOT - No Particles



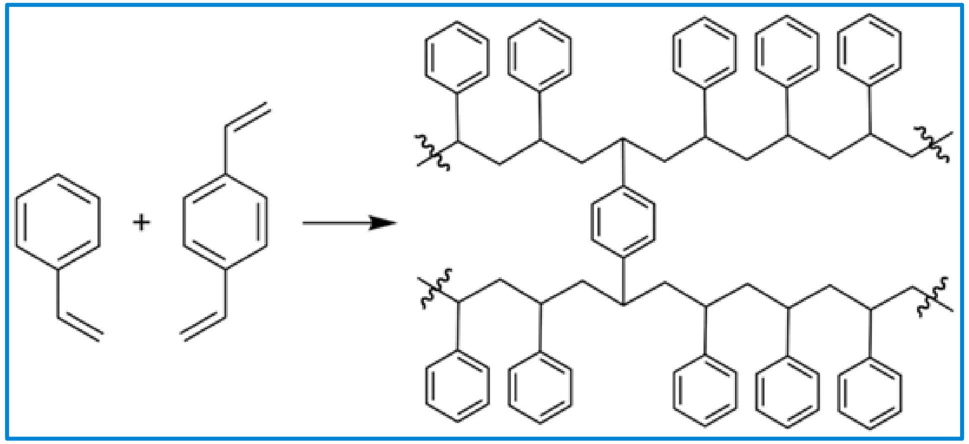
Compounds and PLOT Column Selection

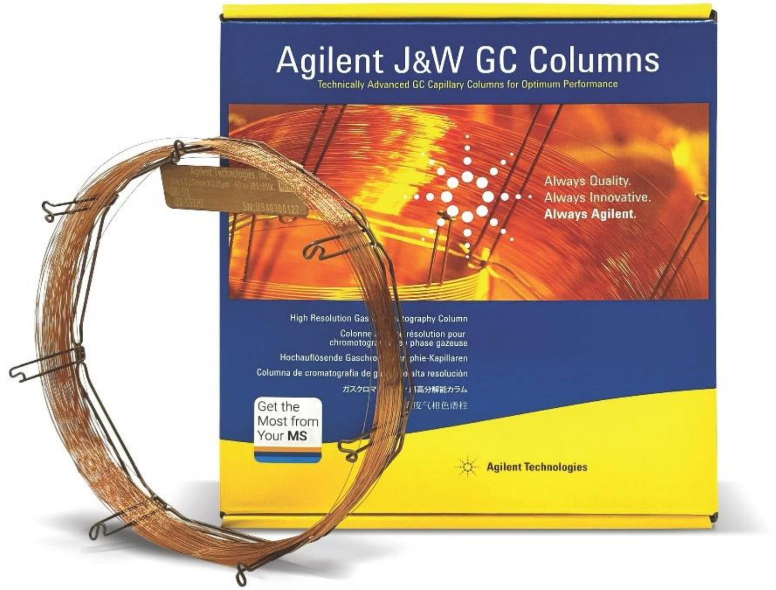
Compounds	Columns	
Permanent gases – Noble gases, O_2, N_2, H_2, CO, CO_2, CH_4 	Molsieve	Select Permanent Gases
Light hydrocarbons – C1 – C8, saturated, unsaturated, – Aromatics, natural gas, C2, C3, C4 streams	Alumina Silica	Porous carbon Porous polymers
Volatile sulfur compounds – H_2S, COS, mercaptans, sulfides, disulfides	Select Low Sulfur Silica	Porous polymers
Oxygenates – Alcohols, ketones, ethers	Lowox	OxyPLOT
Solvents – Oxygenates, aromatics, alkanes, – Chlorinated hydrocarbons	Porous polymers	
Chlorinated and fluorinated hydrocarbons	Silica	Porous polymers

Porous Polymer PLOT Columns

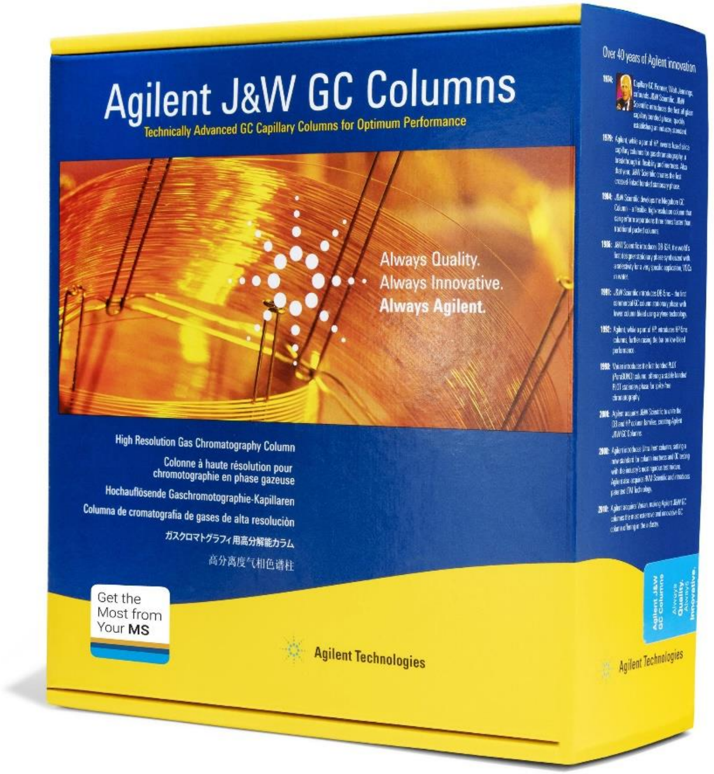
- Analyses of polar and nonpolar volatile compounds
  Oxygenates, gases, halogenated compounds, hydrocarbons C1 to C6, ketones, solvents
- Most versatile of adsorbent materials
- Suitable for aqueous injections and polars
  (in split and direct mode through the inlet)
- Elution of water as a sharp peak, plus quantification of water
  (on the polar U type)
- Recommended for column switching systems
- Styrene/divinyl benzene polymer = Nonpolar “Q type”
- Styrene-glycol methacrylate copolymer = Polar “U type”
- Divinylbenzene/vinylpyridine polymer = Midpolar “S type”

Styrene/divinylbenzene polymer





Porous Polymer PLOT columns

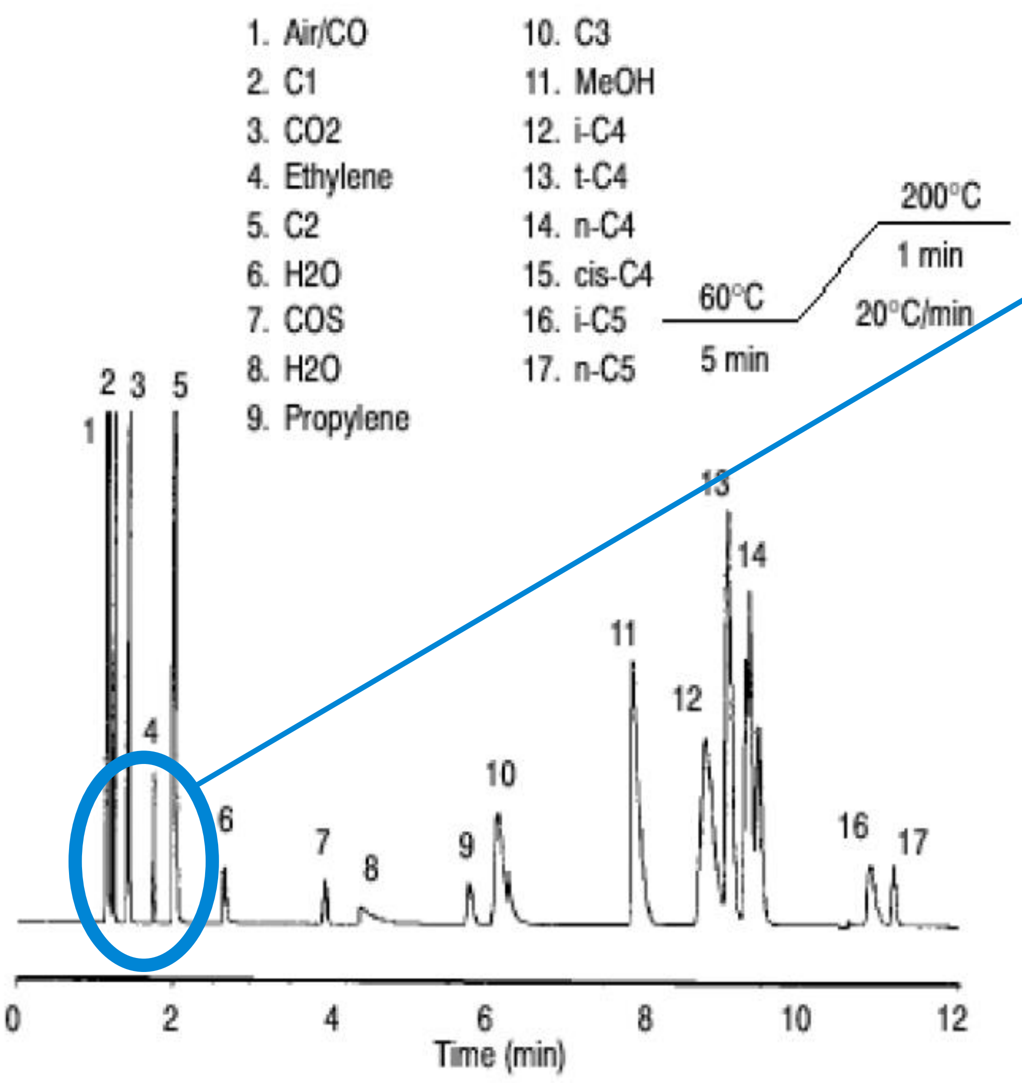


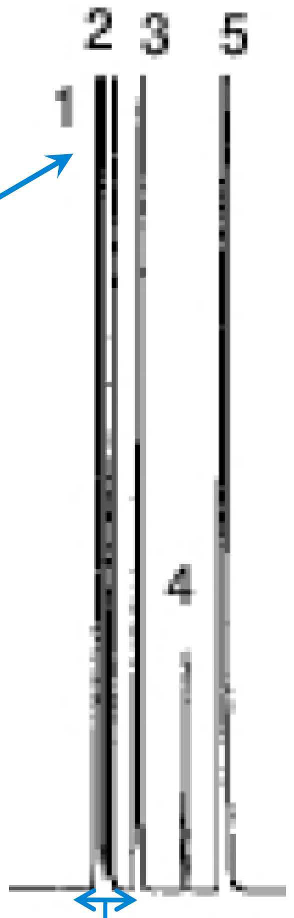
HP-PLOT Q, GS-Q, and PoraPLOT Q

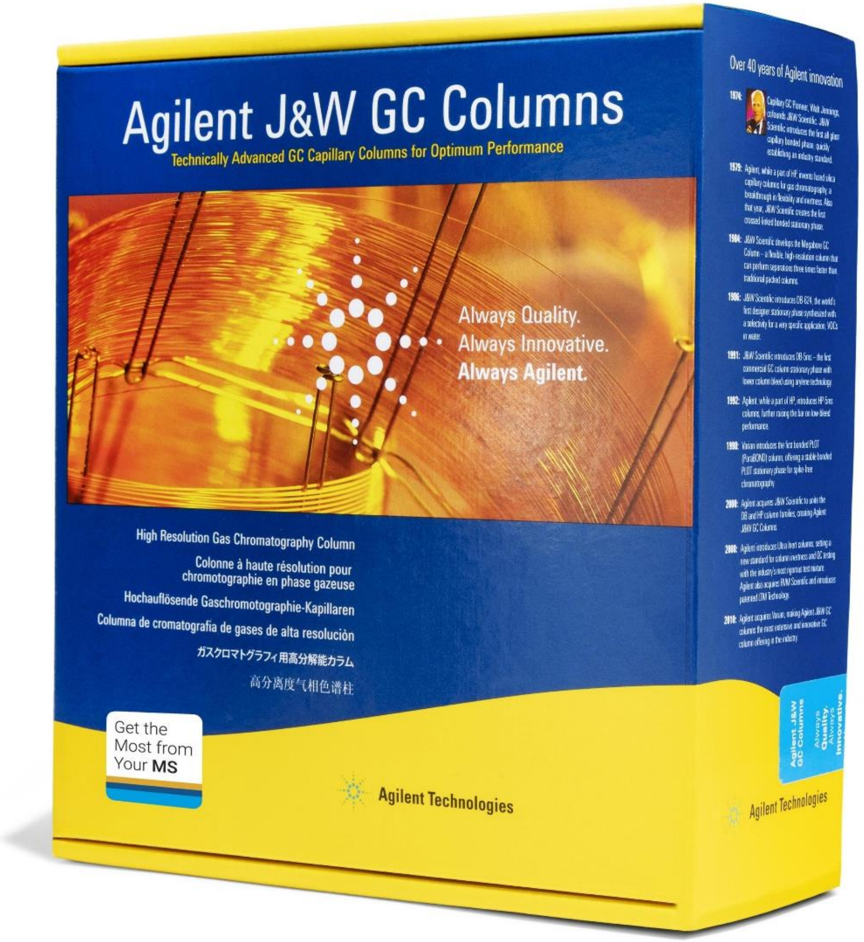
- Bonded polystyrene-divinylbenzene
- Separation ethane/ethylene, propane/propylene
  - Percentage levels, not ppm impurities in C2, C3 matrix
- H_2S and COS
  - Refinery gas analysis (RGA)
  - 100 ppm - percentage, **but not low ppm due to strong surface interactions for H_2S**
- Precolumn for O_2, N_2, CH_4, CO separations on Molsieve column
- Poor C4 isomer separation
  - Alumina preferred
- Not sensitive to moisture, stable retention, no selectivity changes
- Good choice for solvents and CFCs

Refinery Fuel Gas, Porous Polymer Separation

HP- PLOT Q



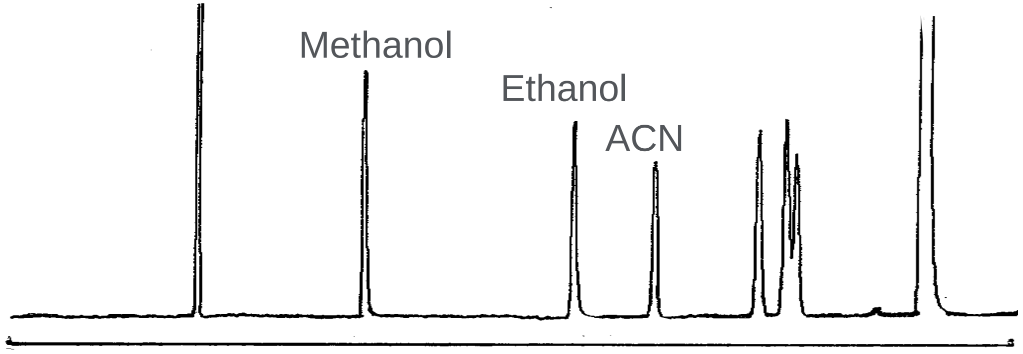




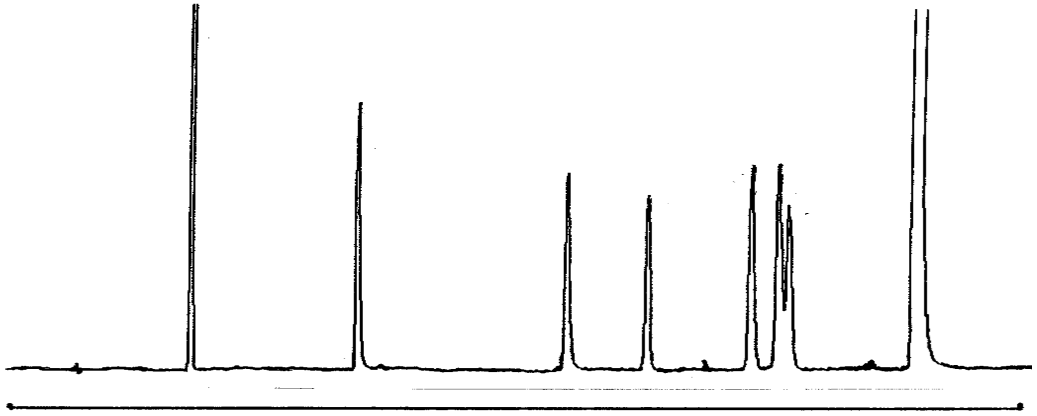
To Molsieve column for further separation

Aqueous Injections on Porous Polymer Q-PLOT

Before



After 5 x 5 µL water, **splitless** at 80 °C



Retention times

unchanged

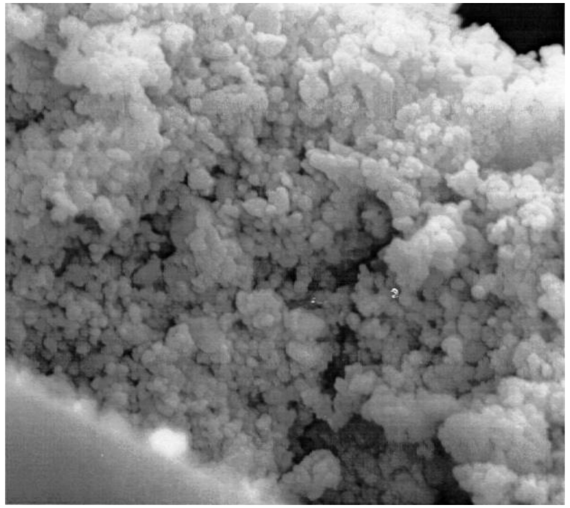
for all compounds

Samples containing water can be analyzed

Isothermal and short cycle time

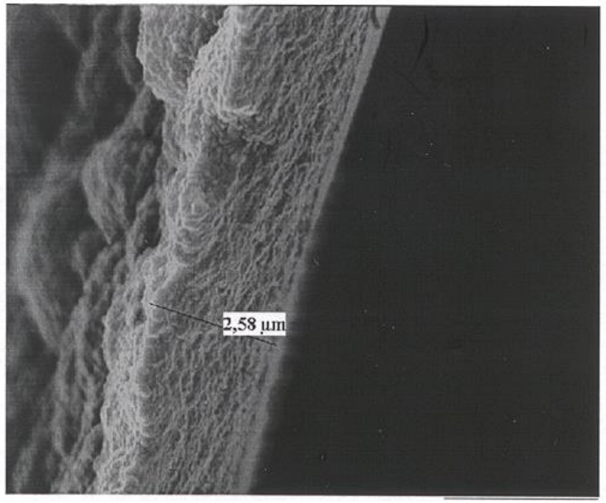
Agilent “BOND” Technology and Traditional Particle Traps

Particle PLOT Q

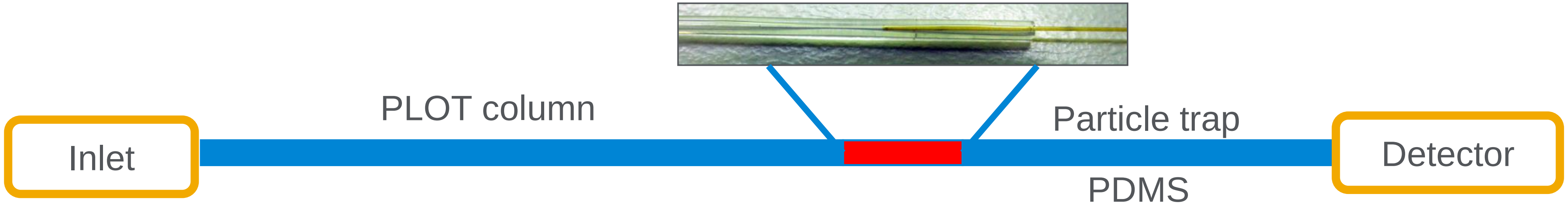


Particle size: 0.1 to 2 µm
Number: > 10^{12}

PoraBOND Q



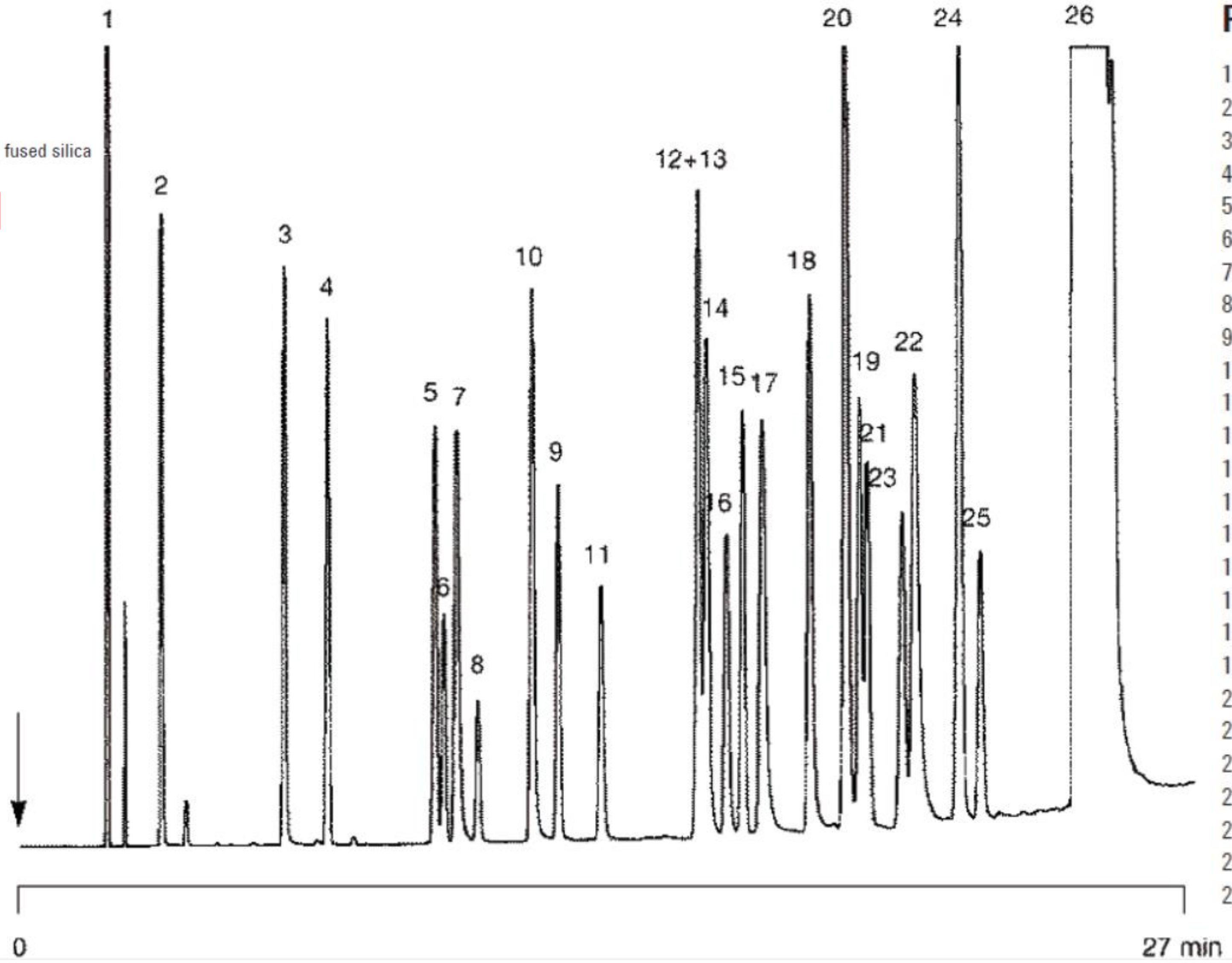
Bonded polymer layer
Reduced need particle trap



Solvent Analysis on PoraBOND Q

Conditions

Technique	:	GC-wide-bore
Column	:	Agilent PoraBOND Q, 0.53 mm x 25 m fused silica PLOT (df = 10 µm) (Part no. CP7354)
Temperature	:	100 °C (2 min) ⟶ 300 °C. 5 °C/min
Carrier Gas	:	He, 25 kPa (0.25 bar, 3.5 psi)
Injector	:	Split, T = 250 °C
Detector	:	FID, T = 250 °C
Sample Size	:	0.5 µL
Concentration Range	:	0.1% per compound
Solvent Sample	:	DMSO



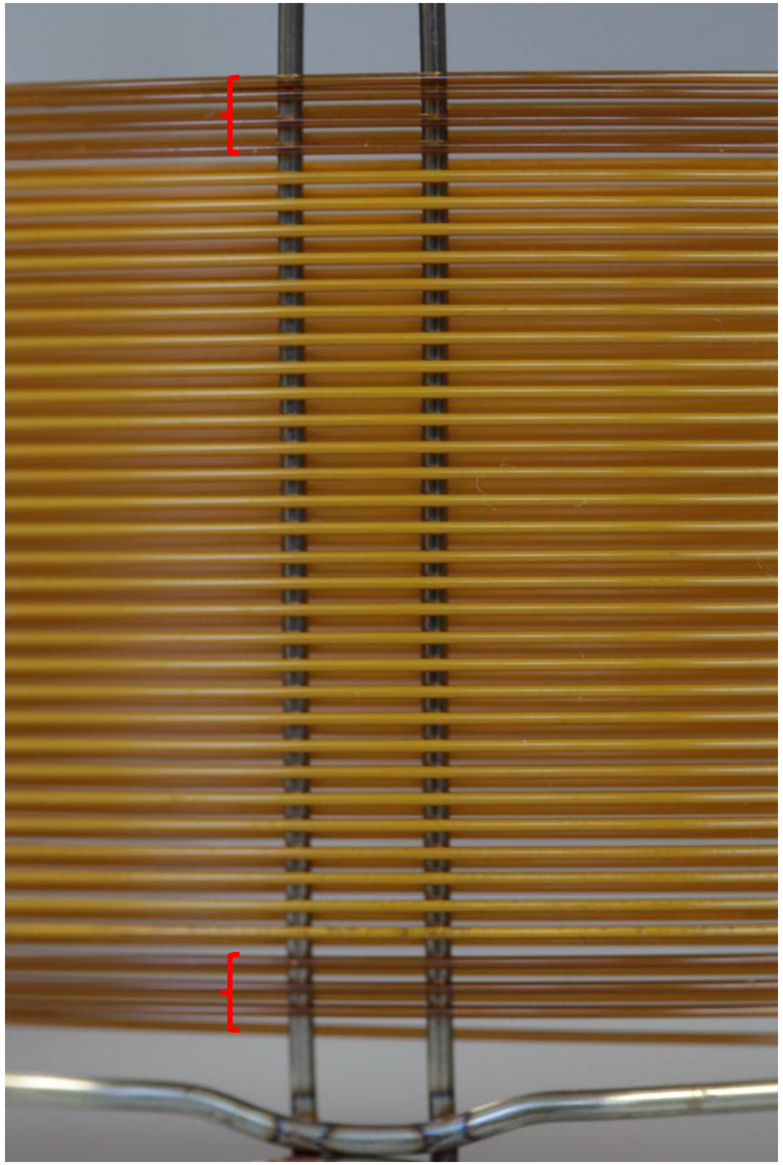
Peak identification

1. methane
2. methanol
3. ethanol
4. acetonitrile
5. acetone
6. dichloromethane
7. 2-propanol (isopropanol)
8. dimethyl sulfide
9. diethyl ether
10. 1-propanol
11. pentane
12. 2-butanone
13. trichloromethane
14. tetrahydrofuran
15. ethyl acetate
16. 2-methoxyethanol
17. isobutanol
18. butanol
19. hexane
20. benzene
21. trichloroethylene
22. cyclohexane
23. 1.4-dioxane
24. pyridine
25. N,N-dimethylformamide
26. dimethyl sulfoxide

Integrated Particle Trap (PT)

Integrated particle trap at the front and back of the column

PLOT column

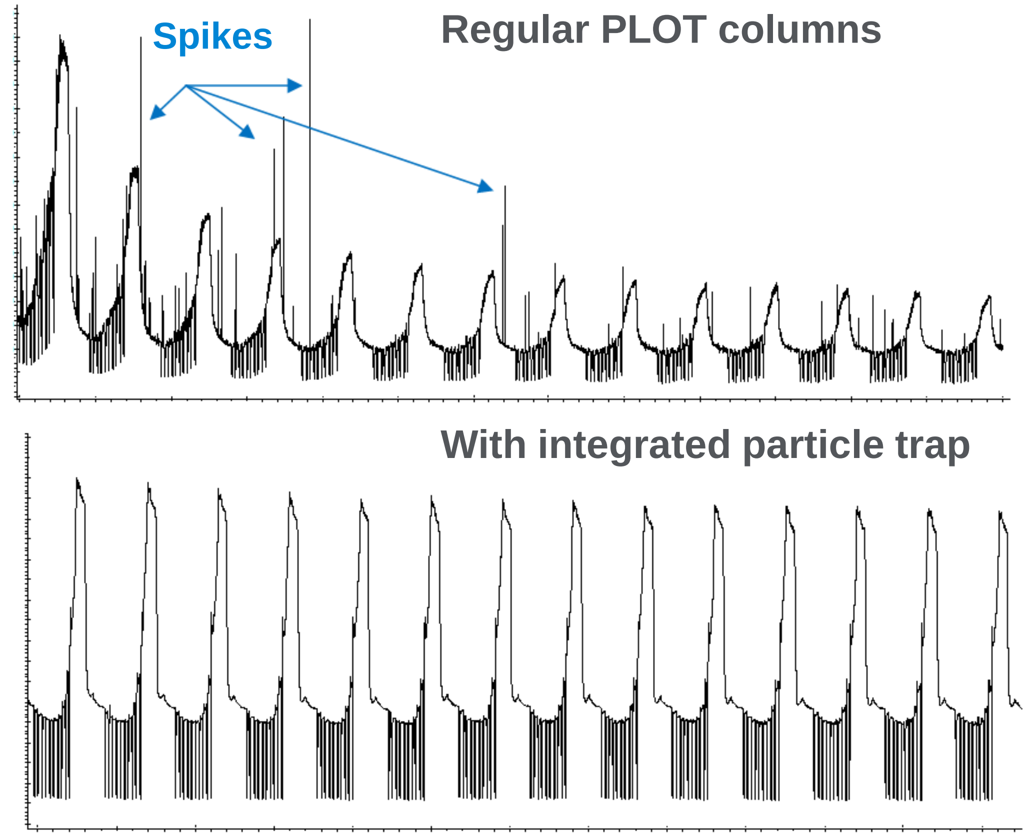


Assurance and safety for valves and detectors in valve switching and backflush modes

Agilent

Proof of Agilent J&W PLOT PT Column Performance

- 150 °C → 250 °C at 20 °C/min
- Pressure 3x higher than optimal
- 15 cycles
- 10x carrier gas off/on



Agilent PLOT PT

- Zero particle shedding
- No unions and fittings – no blockage
- Multicolumn valve switching
- Particle traps are integrated on both ends – supports backflush and CFT technology
- Similar selectivity, efficiency, and peak shape performance to existing Agilent porous polymer PLOT columns
- Minimum method redevelopment required
- Available for the most popular porous polymer PLOT columns

PLOT-PT Chromatographic Performance

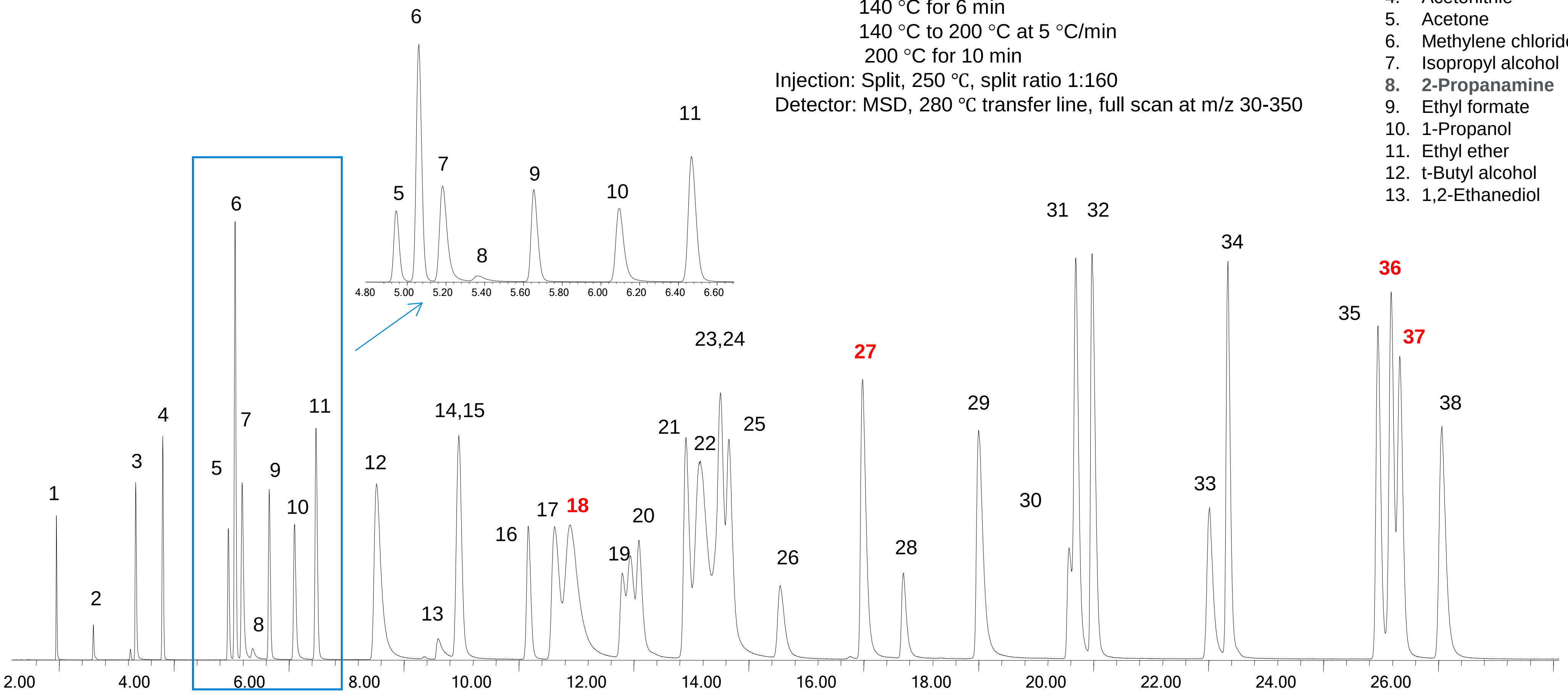
Column: PoraBOND Q PT, 30 m × 0.25 mm, 3 µm

Carrier : Helium, 43 cm/s at 90 °C

Oven: : 90 °C to 140 °C at 10 °C/min
140 °C for 6 min
140 °C to 200 °C at 5 °C/min
200 °C for 10 min

Injection: Split, 250 ℃, split ratio 1:160

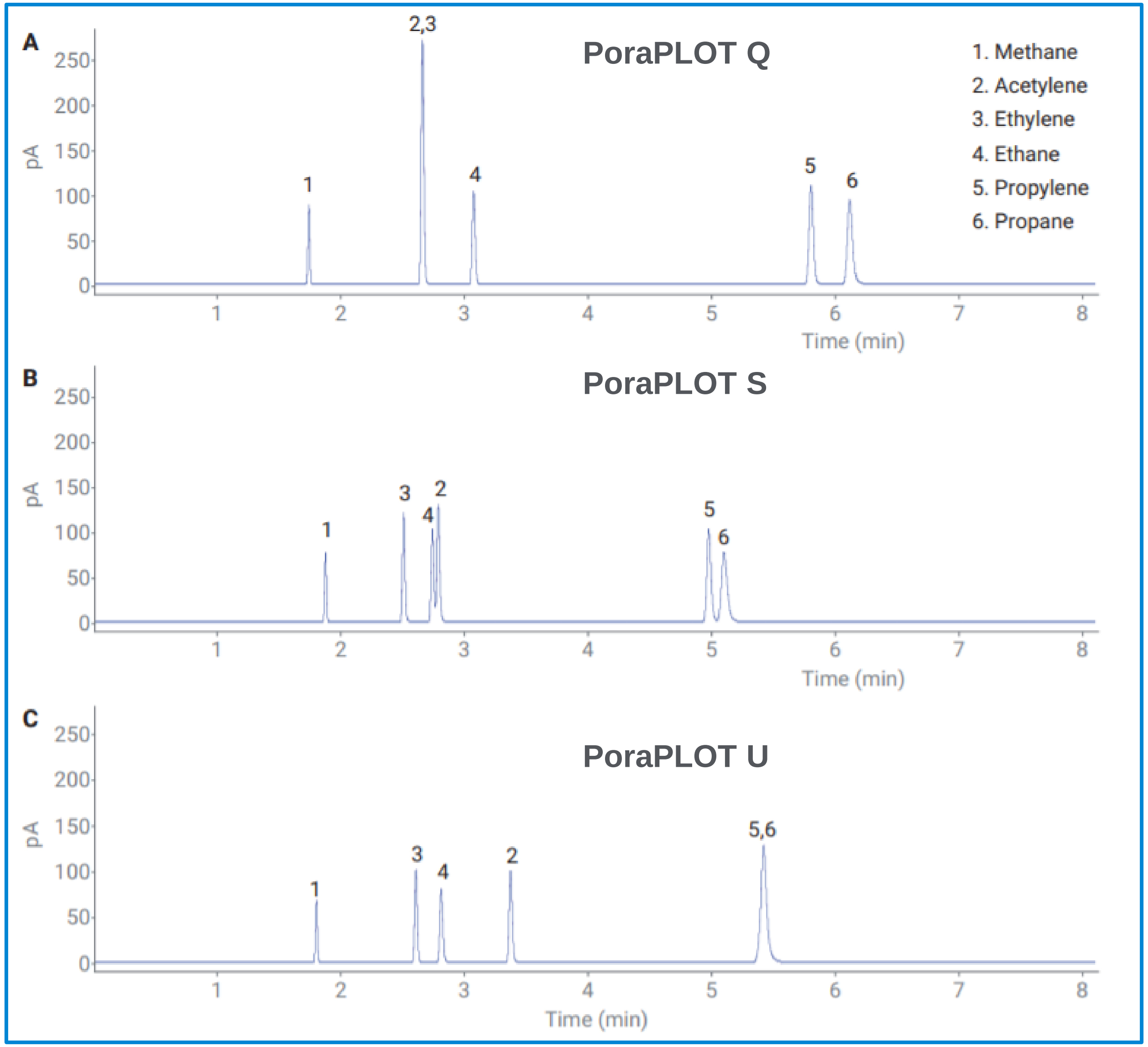
Detector: MSD, 280 ℃ transfer line, full scan at m/z 30-350



1. Methyl alcohol
2. **Acetaldehyde**
3. Ethanol
4. Acetonitrile
5. Acetone
6. Methylene chloride
7. Isopropyl alcohol
8. **2-Propanamine**
9. Ethyl formate
10. 1-Propanol
11. Ethyl ether
12. t-Butyl alcohol
13. 1,2-Ethanediol
14. Trichloromethane
15. 2-Butanone (MEK)
16. Ethyl acetate
17. sec-Butyl alcohol
18. **MTBE**
19. 2-chlorobutane
20. 1-Butanol
21. Benzene
22. 1,1,1-Trichloroethane
23. 1-Chlorobutane
24. Carbon tetrachloride
25. Hexane
26. 1,4-Dioxane
27. Pyridine
28. Dimethylformamide (DMF)
29. Isoamyl alcohol
30. Dimethyl sulfoxide (DMSO)
31. Toluene
32. Heptane
33. Paraldehyde
34. **Chlorobenzene**
35. Ethylbenzene
36. m-Xylene
37. p-Xylene
38. o-Xylene

Agilent

Selectivity Comparison of Porous Polymer PLOT



GC Conditions	
Columns	Agilent J&W PoraPLOT Q, 25 m × 0.53 mm × 20 µm (p/n CP7554) Agilent J&W PoraPLOT S, 25 m × 0.53 mm × 20 µm (p/n CP7574) Agilent J&W PoraPLOT U, 25 m × 0.53 mm × 20 µm (p/n CP7584) Agilent J&W PoraPLOT Q, 10 m × 0.53 mm × 20 µm (p/n CP7553) Agilent J&W PoraBOND Q, 25m × 0.53 mm × 10 µm (p/n CP7354)
Carrier	Helium, constant flow, 5 mL/min
Oven	50 °C (1.0 min), Ramp 10 °C/min to 200 °C (2 min) *Ramp to 180 °C for the J&W PoraPLOT U
Inlet	SSL Inlet, split mode, 200 °C, split ratio 20:1
Inlet Liner	Ultra Inert, split, low pressure drop, glass wool (p/n 5190-2295)
GC/FID	Agilent 7890B GC equipped with FID
Sampler	Agilent 7693 automatic liquid sampler
FID Conditions	
Temperature	200 °C
Hydrogen	30 mL/min
Air	350 mL/min
Col + Make Up	25 mL/min

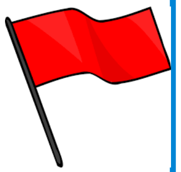
5994-3485EN

Alumina Adsorbent and PLOT Columns

Best selectivity for light hydrocarbon separations

Applications

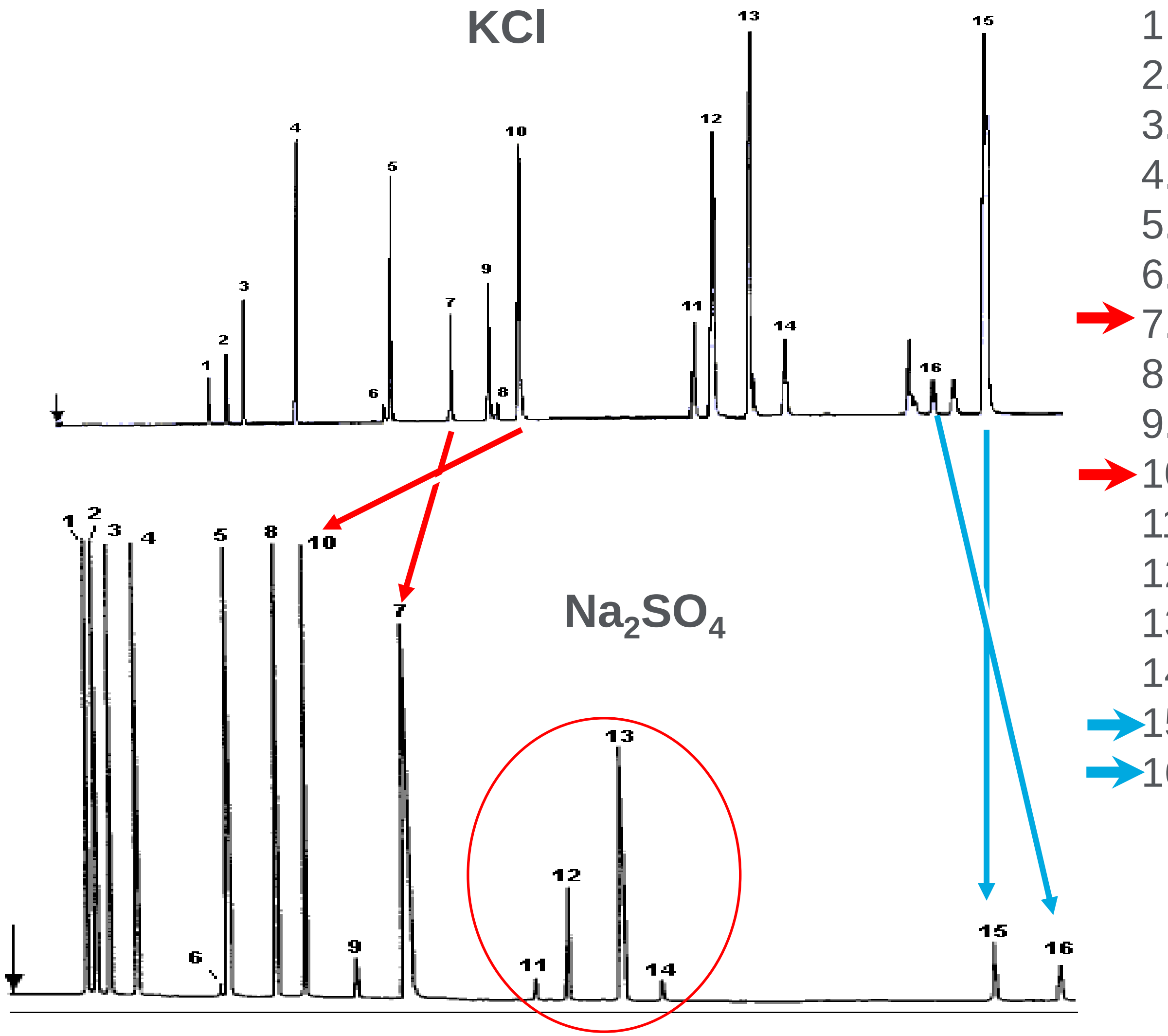
- General C1 to C6 (C9) hydrocarbons
- Natural gas
- Ethylene streams, impurities
- Impurities in propylene
- Butylene streams, impurities
  complex C4 composition
- Environmental hydrocarbon distributions
- Not suitable for polars
- Sample needs to be dry



Separation and conditions

- Degree of saturation
  Elution: alkane, alkene, alkyne, (dialkenes)
- Selectivity: types of deactivation
  KCl, Na_2SO_4 and proprietary
- Selectivity: column flow and temperature
- Moisture carrier gas (and sample)
  Retention and selectivity impacted
  Gas Clean moisture filters are recommended
- Not suitable for polar solutes

Selectivity Difference between KCl and Na_2SO_4



1. Methane
2. Ethane
3. Ethene
4. Propane
5. Propene
6. Cyclopropane
7. Ethyne
8. Isobutane
9. Propadiene
10. N-butane
11. T-2-butene
12. 1-butene
13. Isobutene
14. C-2-butene
15. 1,3-butadiene
16. Propyne

KCl for:
- Impurities in ethylene
- Impurities propylene
- Impurities in 1,3 butadiene

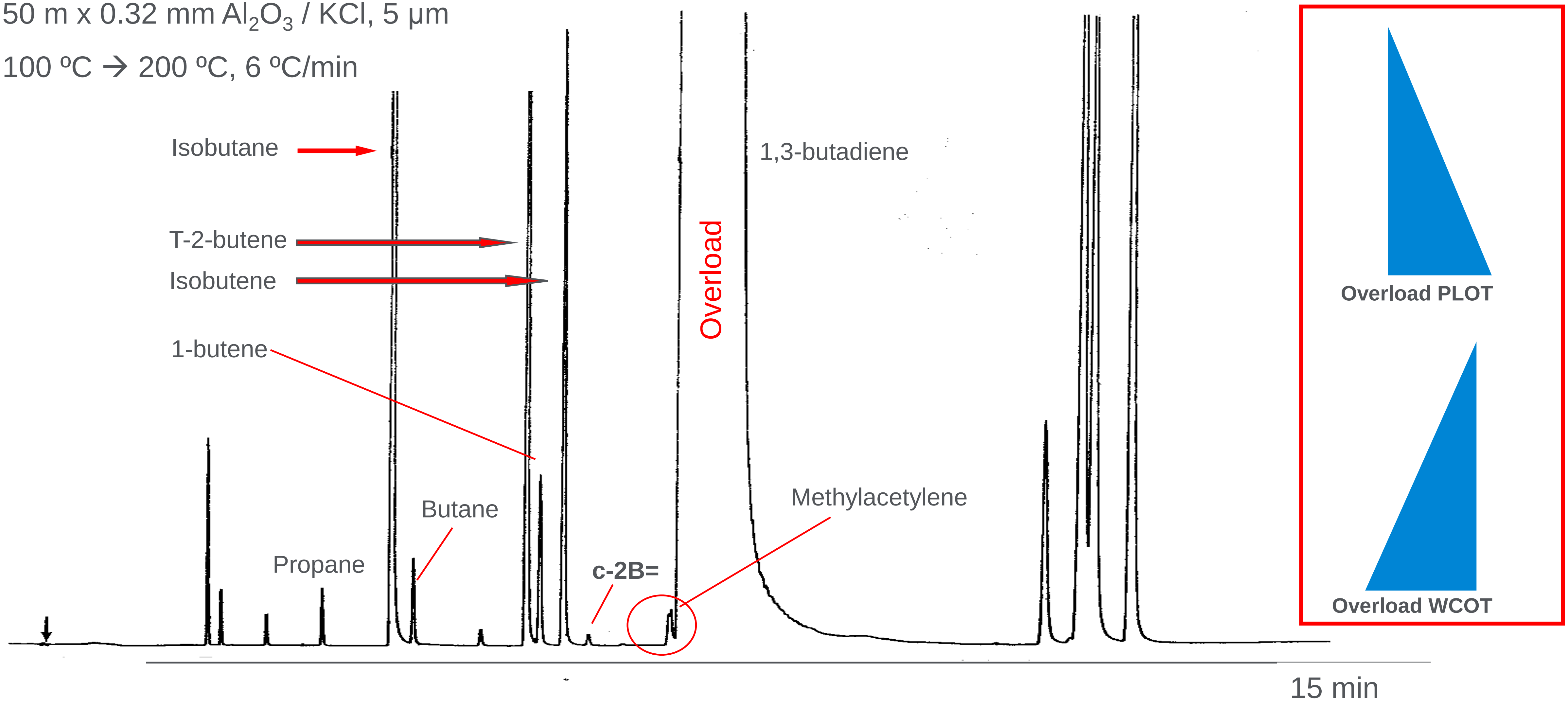
Na_2SO_4 for C4 feeds

Alumina columns tend to exhibit overload for highly unsaturated analytes more quickly

Impurities in 1,3-Butadiene

50 m x 0.32 mm Al_2O_3 / KCl, 5 µm

100 ºC → 200 ºC, 6 ºC/min

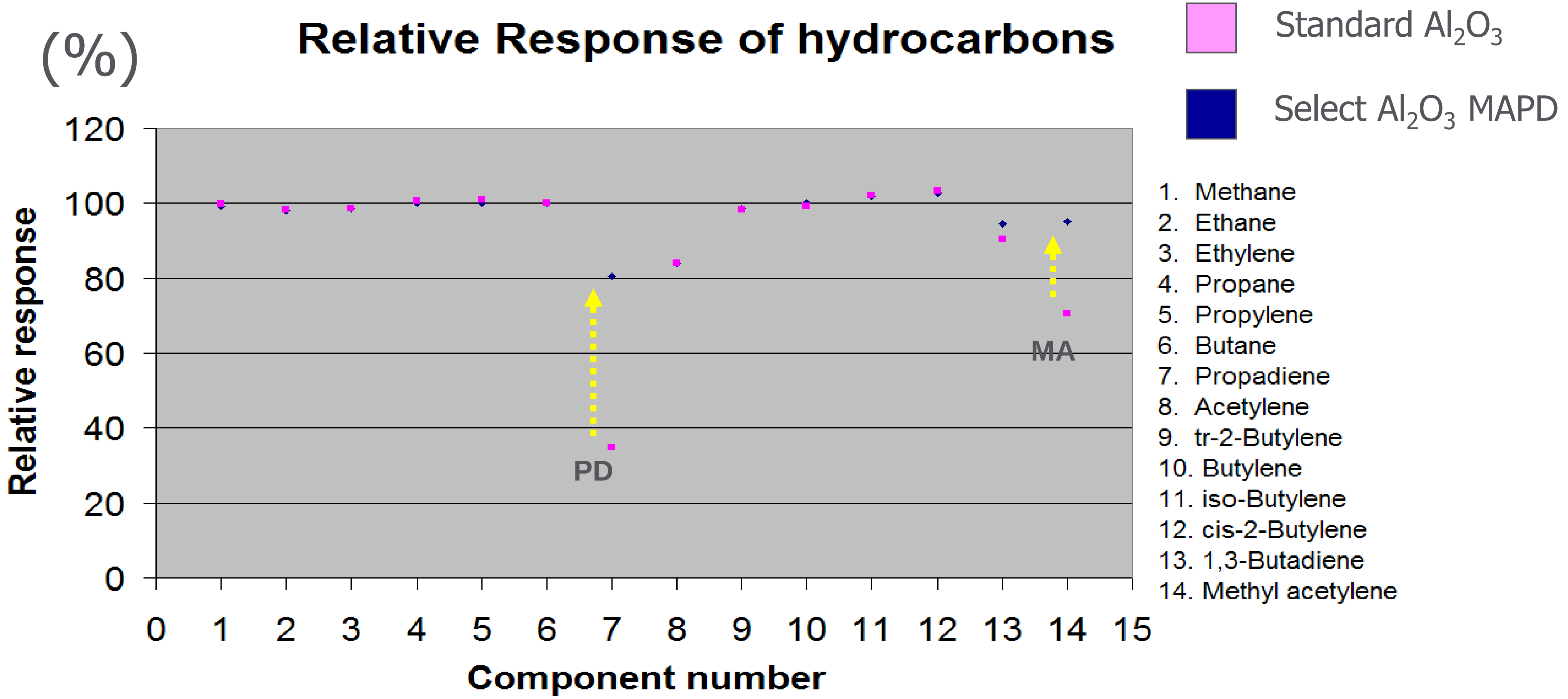


Absorption and Response of Hydrocarbons

The case for Al_2O_3 MAPD – **M**ethyl **A**cetylene - **P**ropa**D**iene

Be aware

Alumina columns exhibit partial irreversible absorption of highly unsaturated HC
–
No 100% level calibration

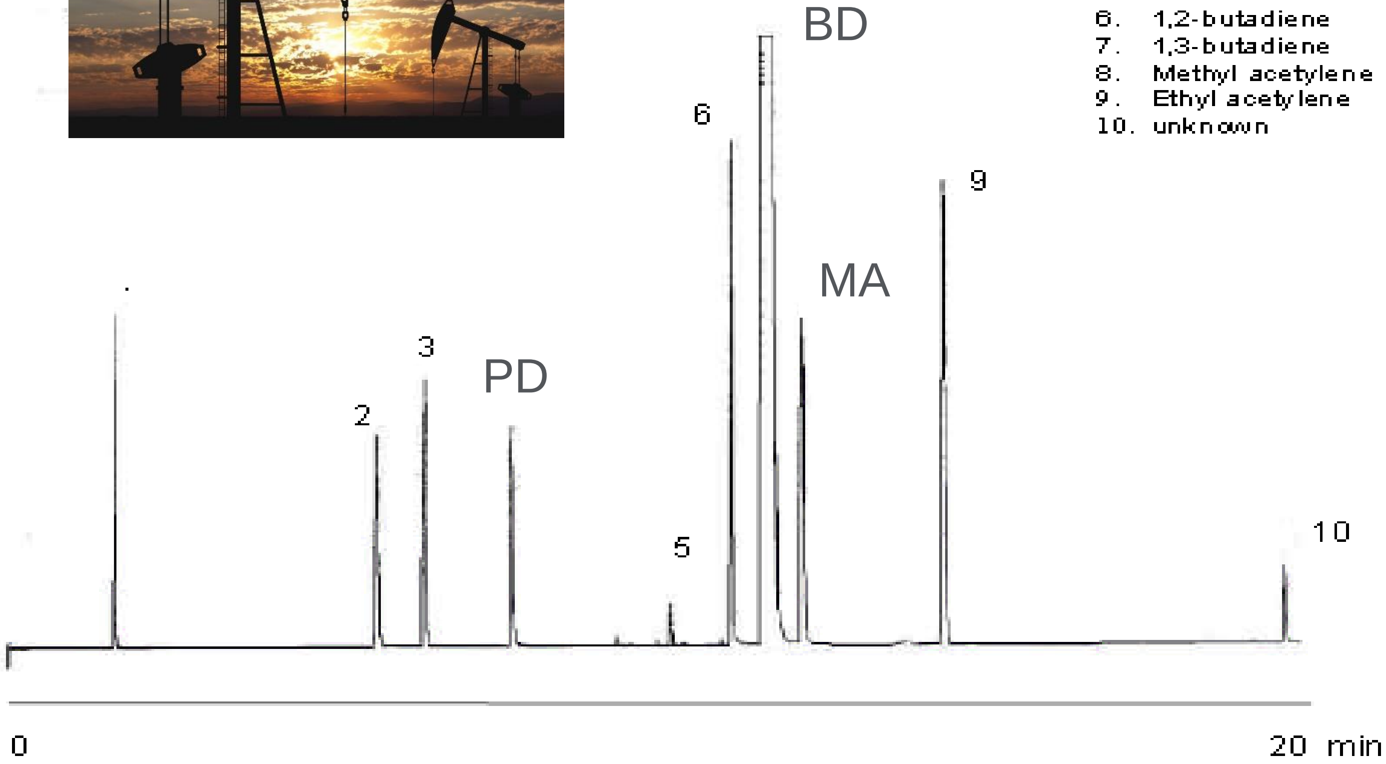


1. Methane
2. Ethane
3. Ethylene
4. Propane
5. Propylene
6. Butane
7. Propadiene
8. Acetylene
9. tr-2-Butylene
10. Butylene
11. iso-Butylene
12. cis-2-Butylene
13. 1,3-Butadiene
14. Methyl acetylene

Improved Response on Select for MAPD

Select for MAPD
30 m x 0.53 mm

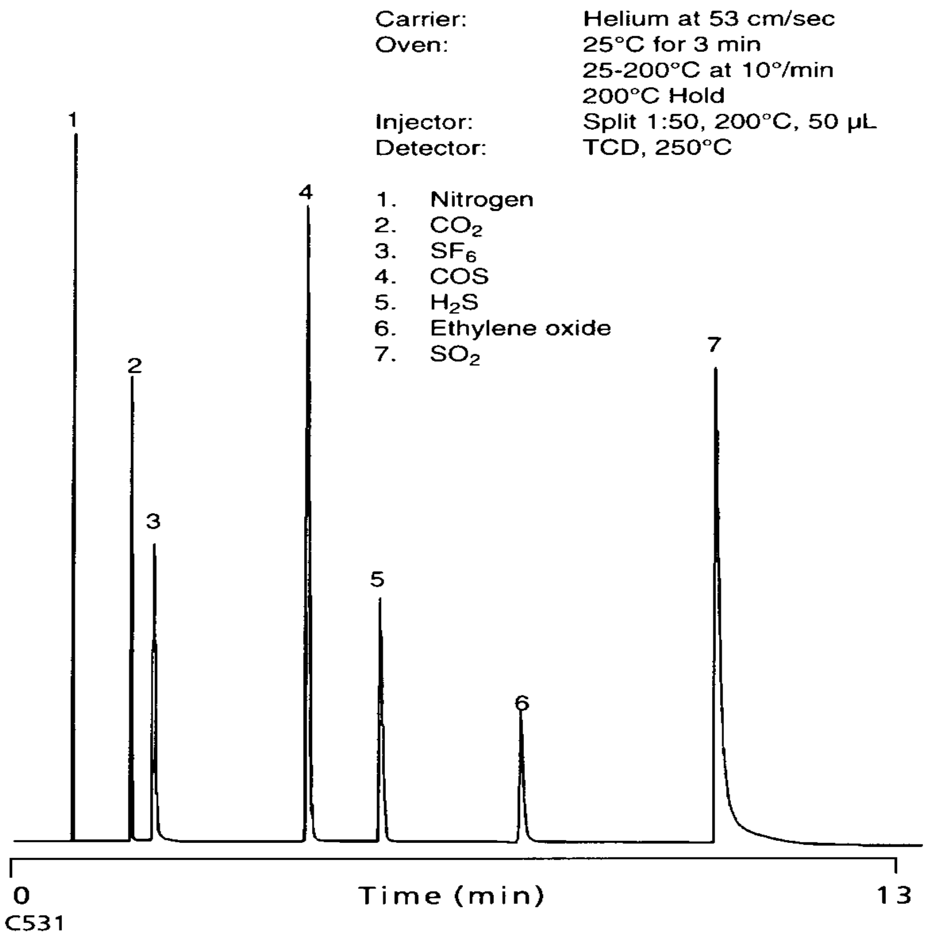
Peak Identification
1. Ethylene
2. Iso-butane
3. n-butane
4. Propadiene
5. Cis-2-butene
6. 1,2-butadiene
7. 1,3-butadiene
8. Methyl acetylene
9. Ethyl acetylene
10. unknown



Courtesy: J. Luong, Dow Chemical Canada

Silica-based PLOT

Inorganic gases on J&W GC-GasPro
30 m x 0.32 mm

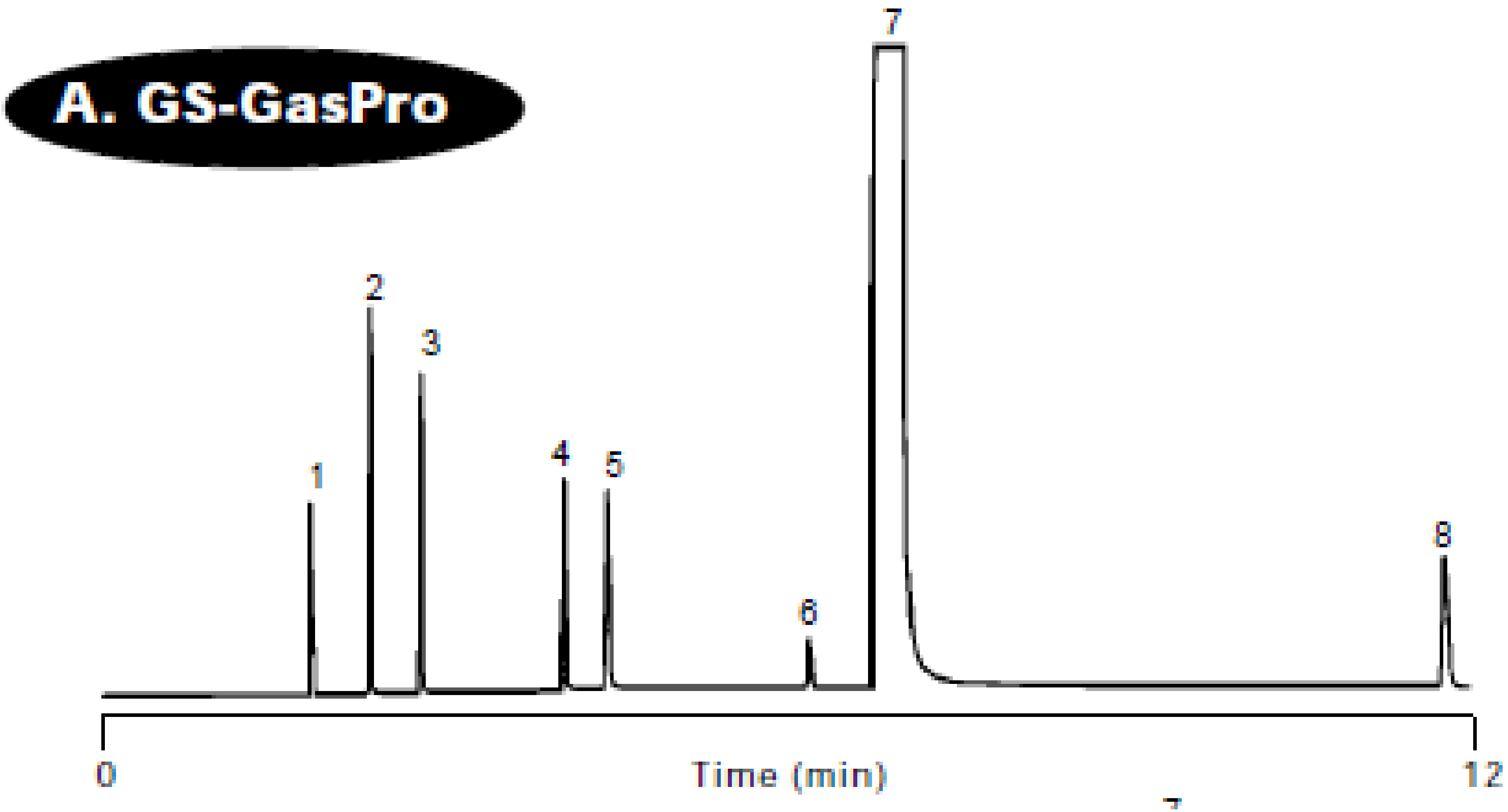


- GS-GasPro and CP-SilicaPLOT
- Light hydrocarbon separation: C1 to C4
- Extended hydrocarbon range compared to other PLOTs
  - Up to ~C12
- Inert enough for low ppm light sulfurs, H_2S, COS, mercaptans
- CFCs
- Not sensitive to moisture in carrier gas
- MSD compatible
- MAOT of 260/300 °C (GasPro)
- MAOT of 225/225 °C (SilicaPLOT)

GS-GasPro - Hydrocarbons

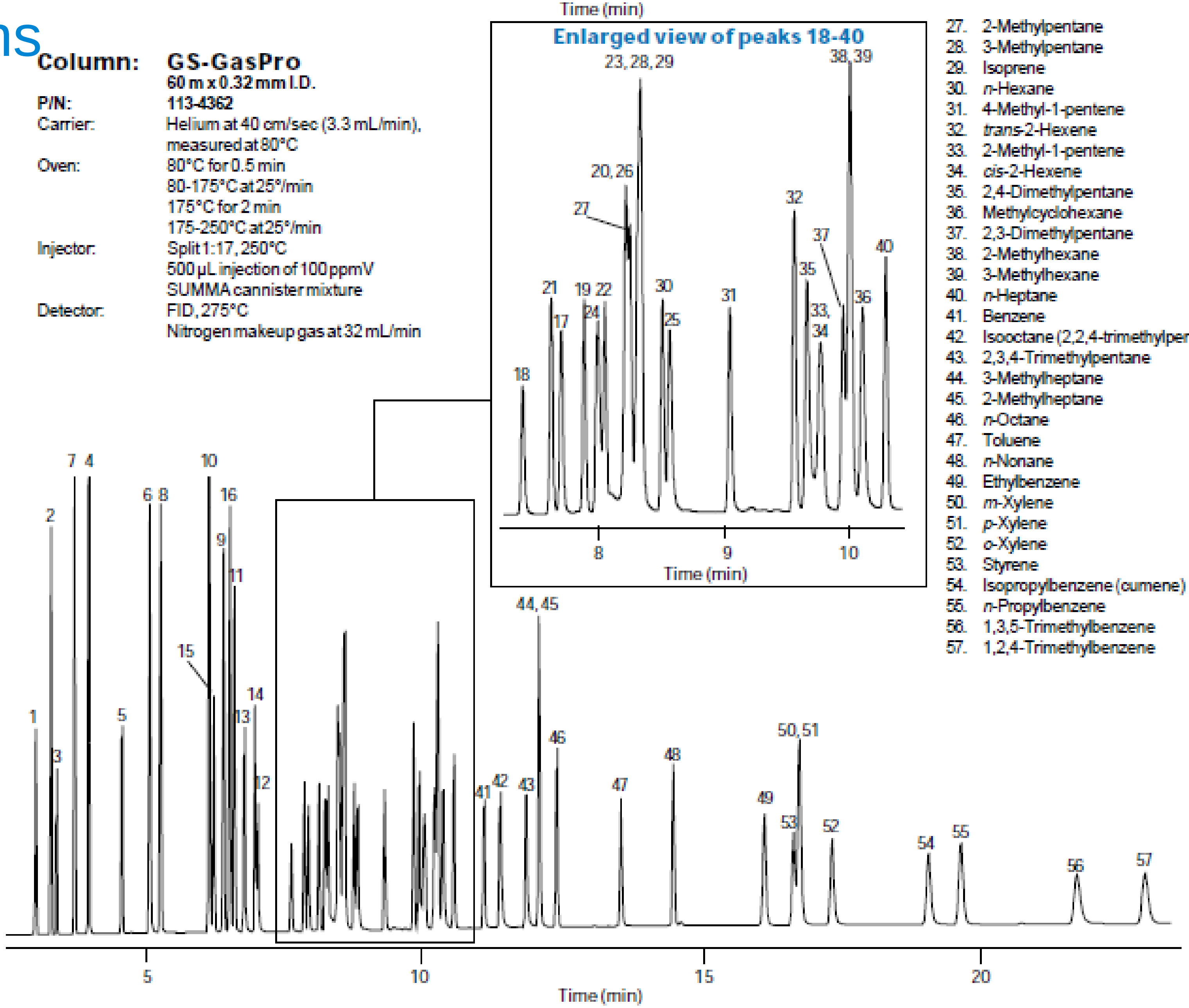
Column:	**GS-GasPro**
	30 m x 0.32 mm I.D.
J&W P/N:	**113-4332**
Carrier:	Nitrogen at 29 cm/sec
Oven:	40°C for 2 min
	40 - 200°C at 10°/min
Injector:	200 µL
Detector:	FID

1. Methane
2. Ethane
3. Ethylene
4. Acetylene
5. Propane
6. Cyclopropane
7. Propylene
8. *cis*-2-Butene



GS-GasPro - Hydrocarbons

Column: **GS-GasPro**
60 m x 0.32 mm I.D.
P/N: **113-4362**
Carrier: Helium at 40 cm/sec (3.3 mL/min), measured at 80°C
Oven: 80°C for 0.5 min
80-175°C at 25°/min
175°C for 2 min
175-250°C at 25°/min
Injector: Split 1:17, 250°C
500 µL injection of 100 ppmV SUMMA cannister mixture
Detector: FID, 275°C
Nitrogen makeup gas at 32 mL/min

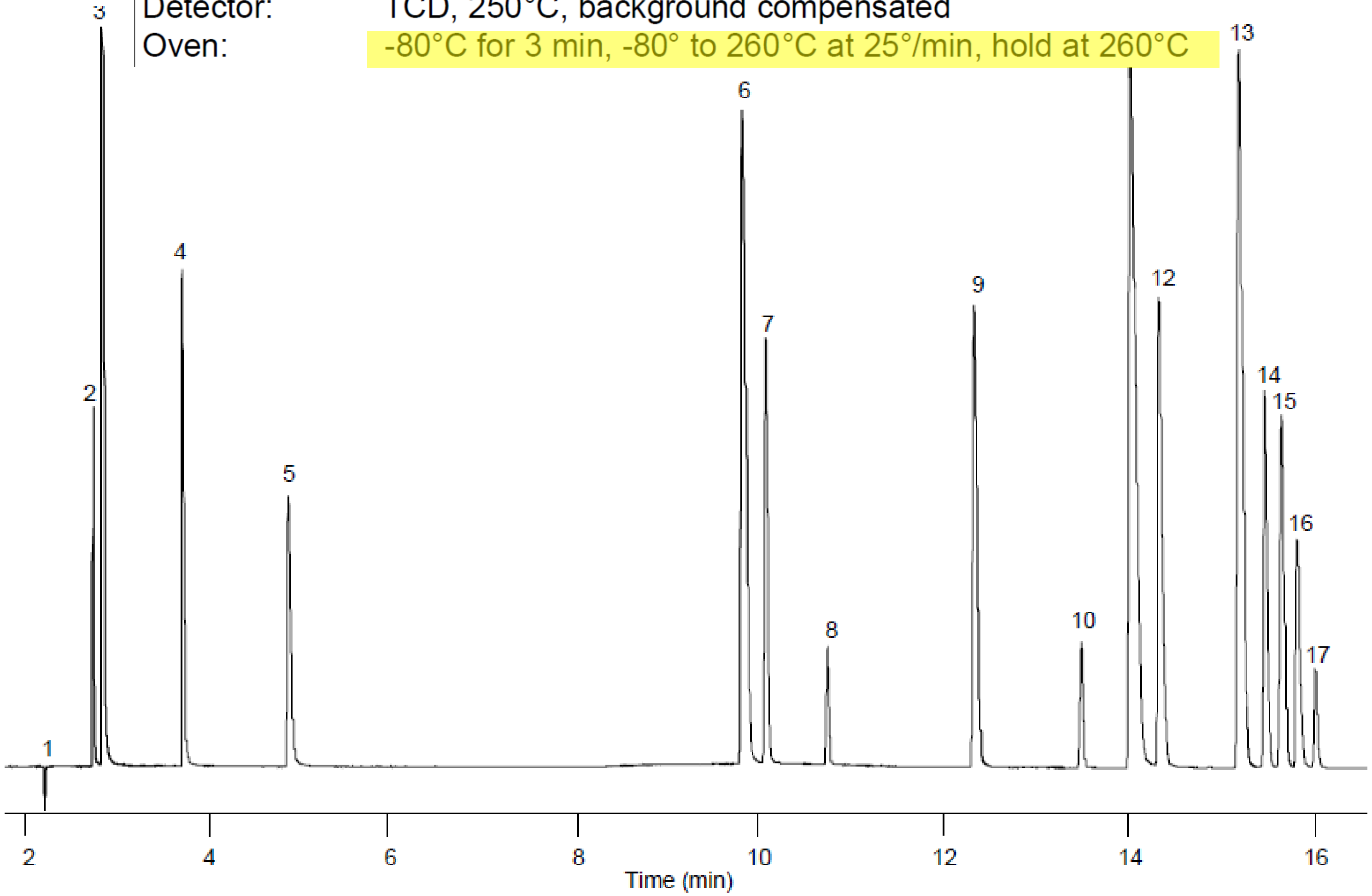


27. 2-Methylpentane
28. 3-Methylpentane
29. Isoprene
30. *n*-Hexane
31. 4-Methyl-1-pentene
32. *trans*-2-Hexene
33. 2-Methyl-1-pentene
34. *cis*-2-Hexene
35. 2,4-Dimethylpentane
36. Methylcyclohexane
37. 2,3-Dimethylpentane
38. 2-Methylhexane
39. 3-Methylhexane
40. *n*-Heptane
41. Benzene
42. Isooctane (2,2,4-trimethylpentane)
43. 2,3,4-Trimethylpentane
44. 3-Methylheptane
45. 2-Methylheptane
46. *n*-Octane
47. Toluene
48. *n*-Nonane
49. Ethylbenzene
50. *m*-Xylene
51. *p*-Xylene
52. *o*-Xylene
53. Styrene
54. Isopropylbenzene (cumene)
55. *n*-Propylbenzene
56. 1,3,5-Trimethylbenzene
57. 1,2,4-Trimethylbenzene

GS-GasPro – Permanent Gases Cryogenic (-80 °c)

1. Hydrogen
2. Oxygen
3. Nitrogen
4. Carbon monoxide
5. Methane
6. Ethane
7. Carbon dioxide
8. Ethylene
9. Propane
10. Propylene
11. Isobutane
12. *n*-Butane
13. 1-Butene
14. *trans*-2-Butene
15. *cis*-2-Butene
16. Isopentane
17. *n*-Pentane

Column:	**GS-GasPro, 60 m x 0.32 mm I.D.**
J&W P/N:	**113-4362**
Carrier:	Helium, 20 psig (constant pressure)
Inlet:	200°C, 1:15 split
Sample:	100 µL, manual inject
Detector:	TCD, 250°C, background compensated
Oven:	-80°C for 3 min, -80° to 260°C at 25°/min, hold at 260°C

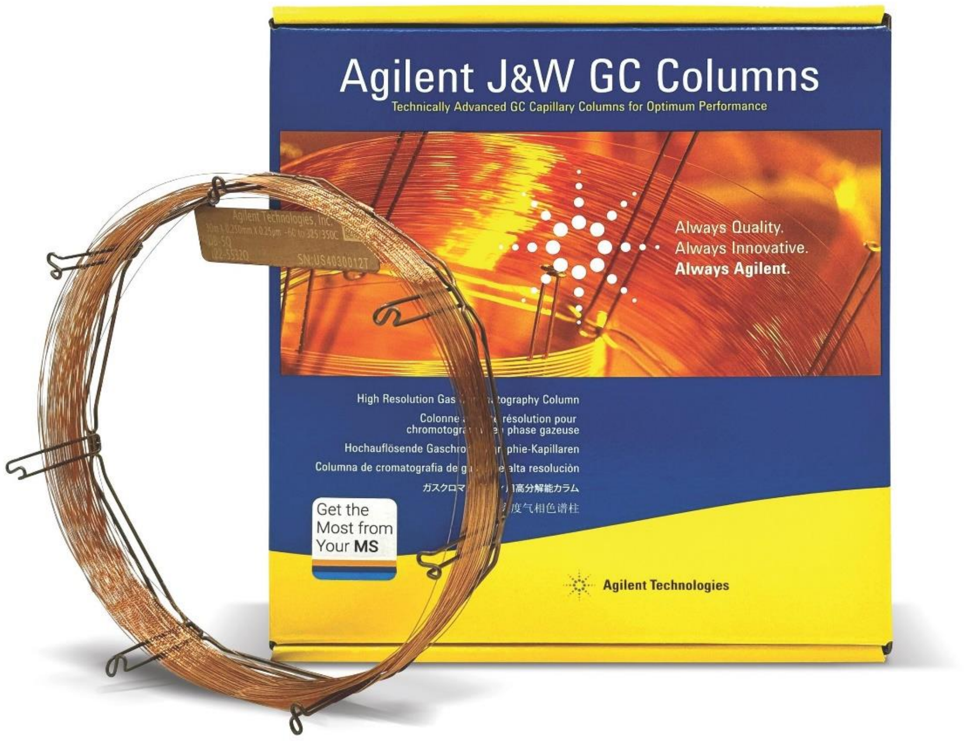


Molecular Sieves

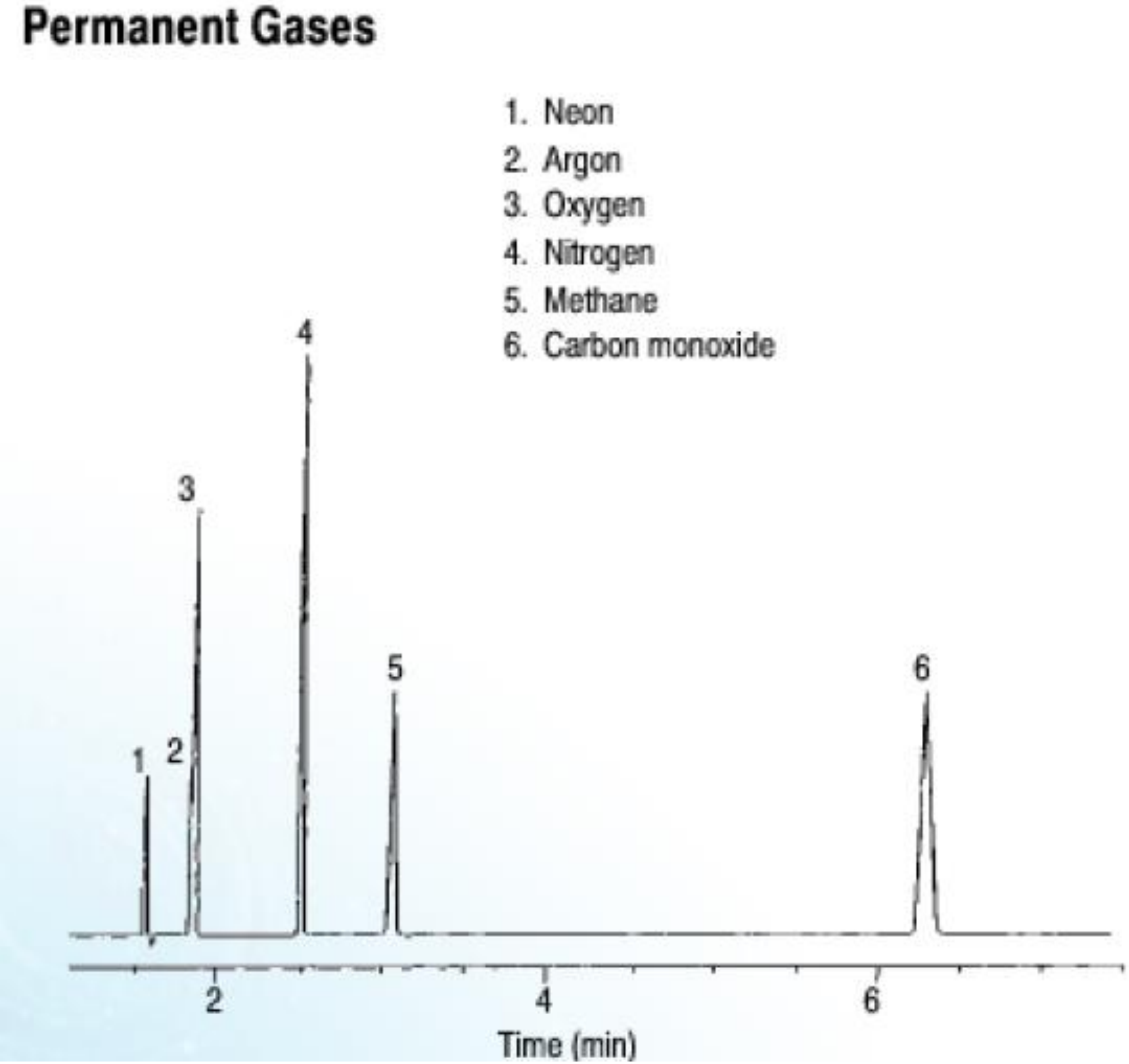
- Noble gases, Kr, He, Ar, Xe
- N2, O2, H_2, CH_4, CO (not CO_2)

- HP-Molesieve
- CP-Molsieve 5 A

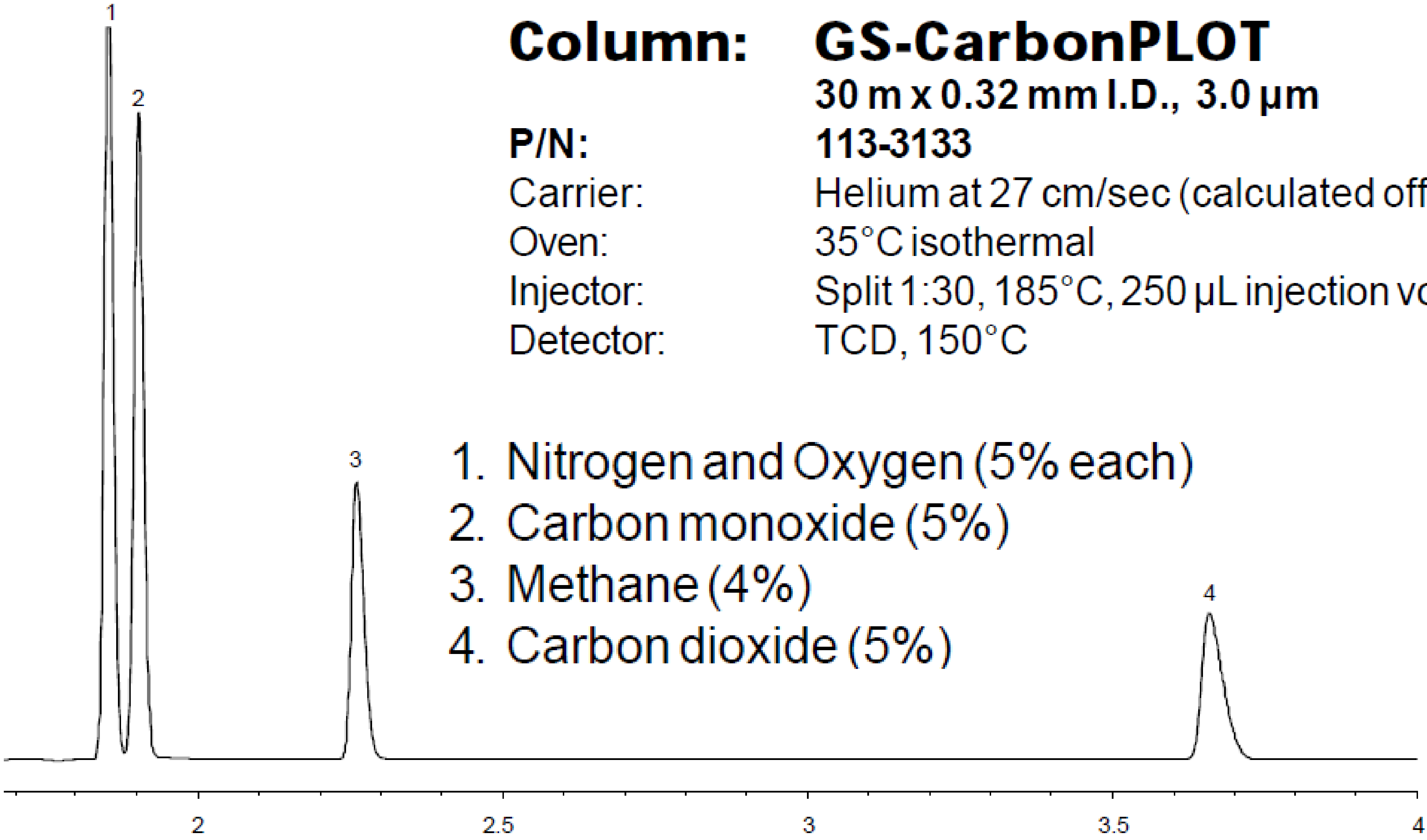
- Very sensitive to moisture/CO_2 in carrier gas/sample
  – Conditioning needed
  – Gas Clean moisture filters in carrier gas essential



Molecular Sieves



GS-CarbonPLOT – Permanent Gases



Column:	**GS-CarbonPLOT**
	30 m x 0.32 mm I.D., 3.0 µm
P/N:	**113-3133**
Carrier:	Helium at 27 cm/sec (calculated off N_2 at 35°C)
Oven:	35°C isothermal
Injector:	Split 1:30, 185°C, 250 µL injection volume
Detector:	TCD, 150°C

1. Nitrogen and Oxygen (5% each)
2. Carbon monoxide (5%)
3. Methane (4%)
4. Carbon dioxide (5%)

Oxygenates in Hydrocarbons

Oxygenates blended in gasoline

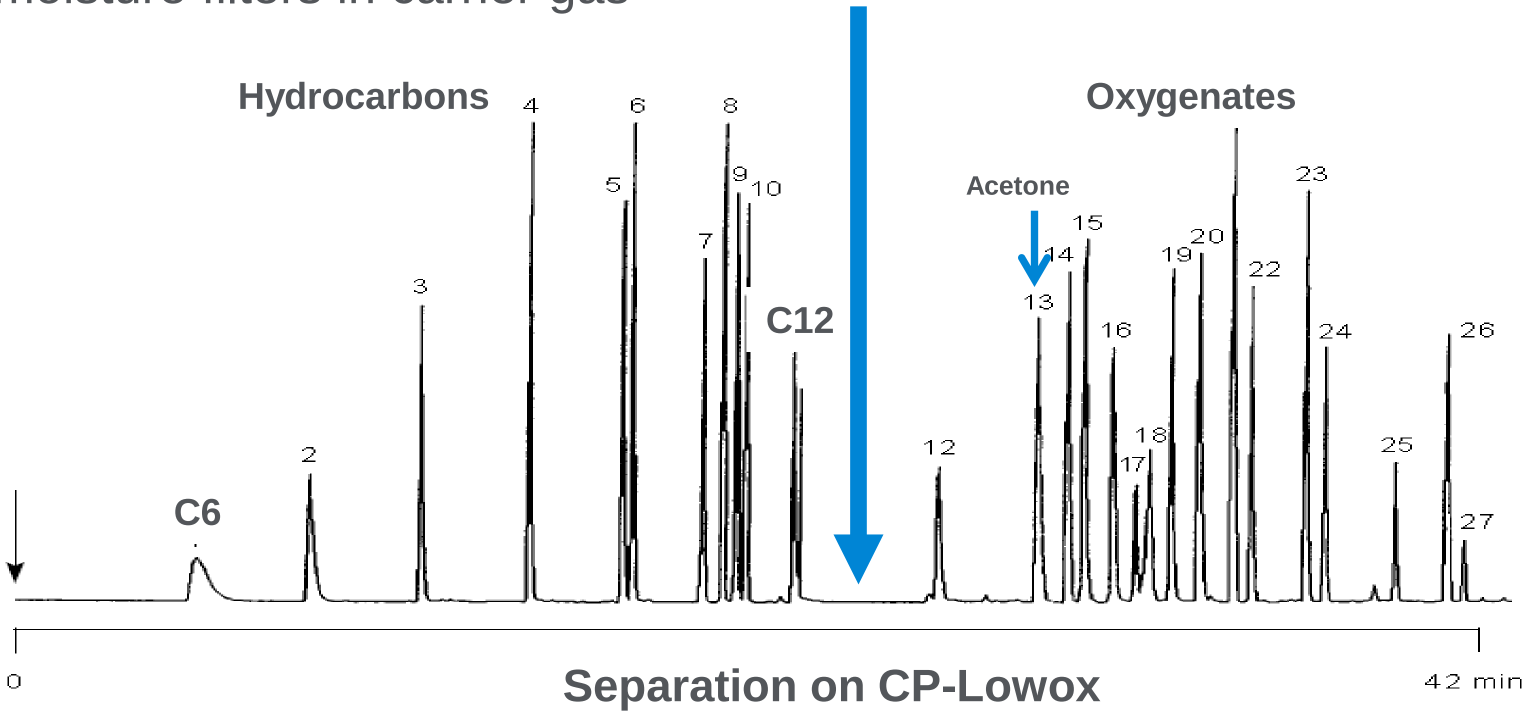
- Additives to boost octane content, prevent engine “knocking”
- MTBE, ETBE, ethanol
- **Percentage level oxygenates**
- **GC analyses on WAX or TCEP polar liquid phase columns**

Oxygenate in intermediates (monomers, naphthas)

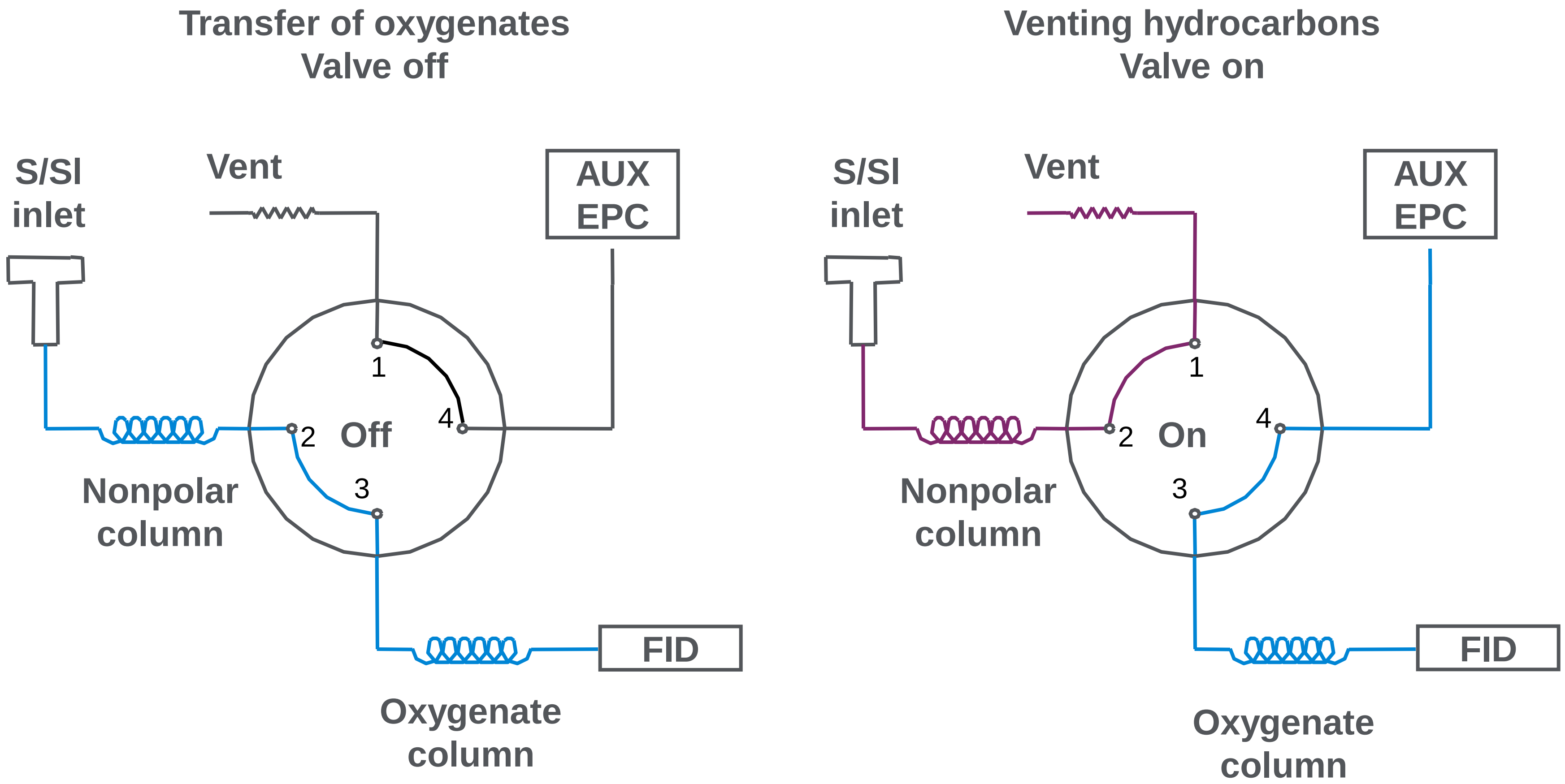
- Lower effectiveness catalysts – lower yield
- Higher costs of catalysts
- More refinery downtime
- **Oxygenates at ppm level**
- **GC analyses on Lowox, OxyPLOT columns, Agilent exclusives**

Analyzing Oxygenates in Hydrocarbon Matrix

- Low ppm concentration level of oxygenates – low analyte capacity of stationary phase
- FID detection (MSD uncommon)
- Agilent columns with high selectivity hydrocarbons/oxygenates: CP-Lowox/OxyPLOT
- Very moisture sensitive
- Use Gas Clean moisture filters in carrier gas



ASTM Trace Oxygenate Analysis Methods
Valve Configuration



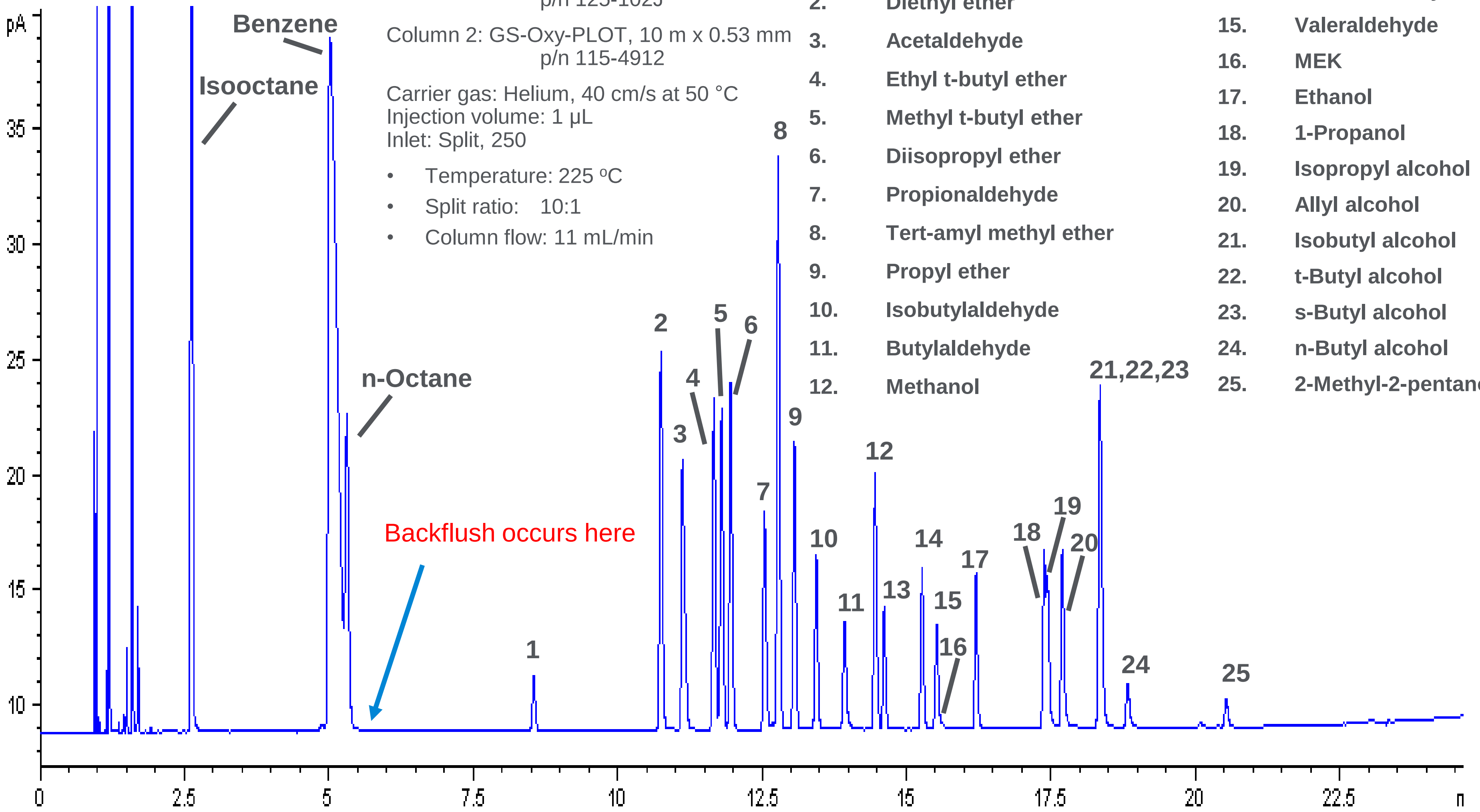
Oxygenate Analysis

Column 1: DB1, 25 m x 0.53 mm x 1 µm
p/n 125-102J

Column 2: GS-Oxy-PLOT, 10 m x 0.53 mm
p/n 115-4912

Carrier gas: Helium, 40 cm/s at 50 °C
Injection volume: 1 µL
Inlet: Split, 250

- Temperature: 225 °C
- Split ratio: 10:1
- Column flow: 11 mL/min



1. **Dimethyl ether**
2. **Diethyl ether**
3. **Acetaldehyde**
4. **Ethyl t-butyl ether**
5. **Methyl t-butyl ether**
6. **Diisopropyl ether**
7. **Propionaldehyde**
8. **Tert-amyl methyl ether**
9. **Propyl ether**
10. **Isobutylaldehyde**
11. **Butylaldehyde**
12. **Methanol**
13. **Acetone**
14. **Isovaleraldehyde**
15. **Valeraldehyde**
16. **MEK**
17. **Ethanol**
18. **1-Propanol**
19. **Isopropyl alcohol**
20. **Allyl alcohol**
21. **Isobutyl alcohol**
22. **t-Butyl alcohol**
23. **s-Butyl alcohol**
24. **n-Butyl alcohol**
25. **2-Methyl-2-pentanol**

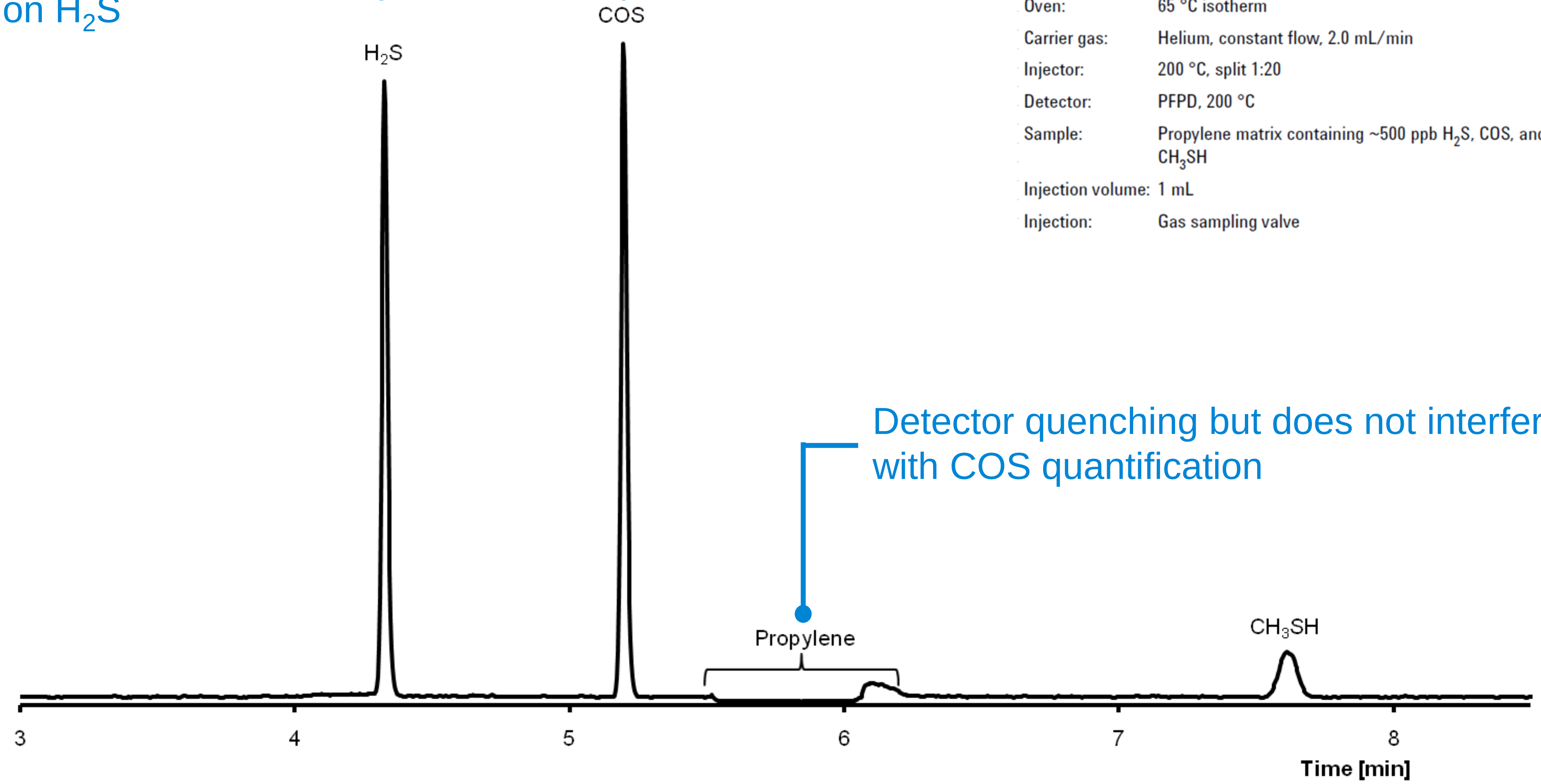
Select Low Sulfur – PLOT

- Super permeable and porous stationary phase
  - Proprietary material
- Unique selectivity characteristics for volatile sulfurs/hydrocarbons
  - No detector quenching for propane/propylene matrix
- Highly inert for volatile sulfurs, H_2S, methyl mercaptan
- One part number: 60 m x 0.32 mm, p/n CP8575
- Near 100% recovery for H_2S at 20 to 100 ppb levels
- Zero particle loss
- FPD, PFPD, SCD, and AED compatible

Sulfur Components in Propylene by PFPD

- H_2S and COS at 500 ppbv
- Same response
- No absorption H_2S

Technique:	GC-PFPD
Column:	Agilent J&W Select Low Sulfur, 60 m × 0.32 mm (p/n CP8575)
Oven:	65 °C isotherm
Carrier gas:	Helium, constant flow, 2.0 mL/min
Injector:	200 °C, split 1:20
Detector:	PFPD, 200 °C
Sample:	Propylene matrix containing ~500 ppb H_2S, COS, and CH_3SH
Injection volume:	1 mL
Injection:	Gas sampling valve



Detector quenching but does not interfere with COS quantification

Considerations for PLOT Column Analysis

Columns

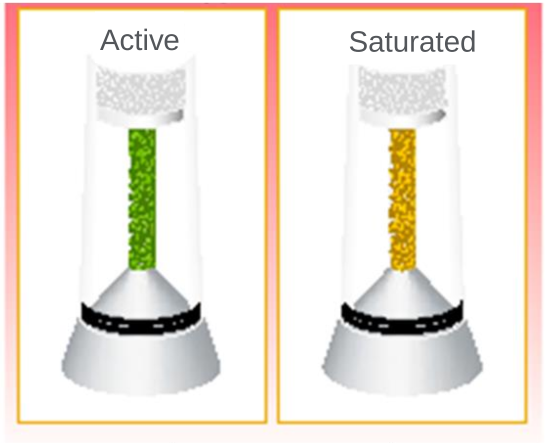
- Selectivity – consider elution pattern
- Capacity – overloading – 0.53 mm
- Inertness (low concentration sulfurs)
- Temperature limits

Contamination

- Efficiency loss, “ghost peaks”, increase in bleed
- Water, CO_2, high molecular weight hydrocarbons
- Carrier gas purifiers are highly recommended

Hydrocarbon filter

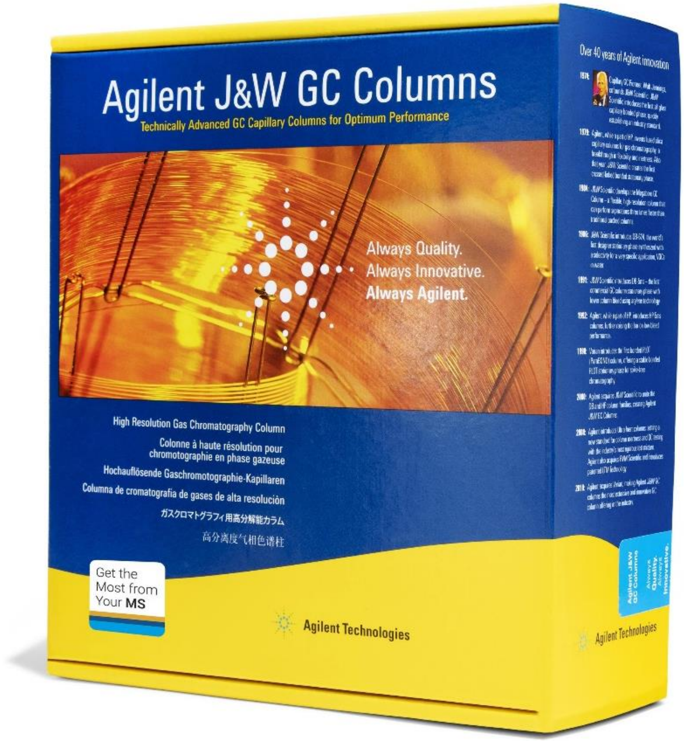
Moisture indicator
Green > Pale Brown



At 200 ppb

Summary

- PLOT columns are an excellent option for achieving separation of solutes that are gasses at non-cryo/room temperature conditions.
- PLOT columns have a lower capacity than equivalent diameter WCOT columns.
- Due to their high degree of retention, be careful to not inject solutes that are too high boiling or incompatible with the phase.
- Be mindful of larger volumetric flow when interfacing to MSD (require TURBO pump or restrictor)
- Alumina columns are excellent for hydrocarbon separations, but not compatible with water or polar compounds.
- For water and polar compounds, porous polymer columns are ideal (PLOT-Q, PLOT-U).
- GS-GasPro/CP-SilicaPLOT are not compatible with alcohols (absorbed).
- Use a particle trap when interfacing with MSD or VALVES (“PT” columns are best).
- All columns are fully QC-tested to assure column-to-column reproducibility.



Contact Agilent Chemistries and Supplies Technical Support

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

- Option 1 for GC or GC/MS columns and supplies
- Option 2 for LC or LC/MS columns and supplies
- Option 3 for sample preparation, filtration and QuEChERS
- Option 4 for spectroscopy supplies
- Option 5 for chemical standards (formerly ULTRA)

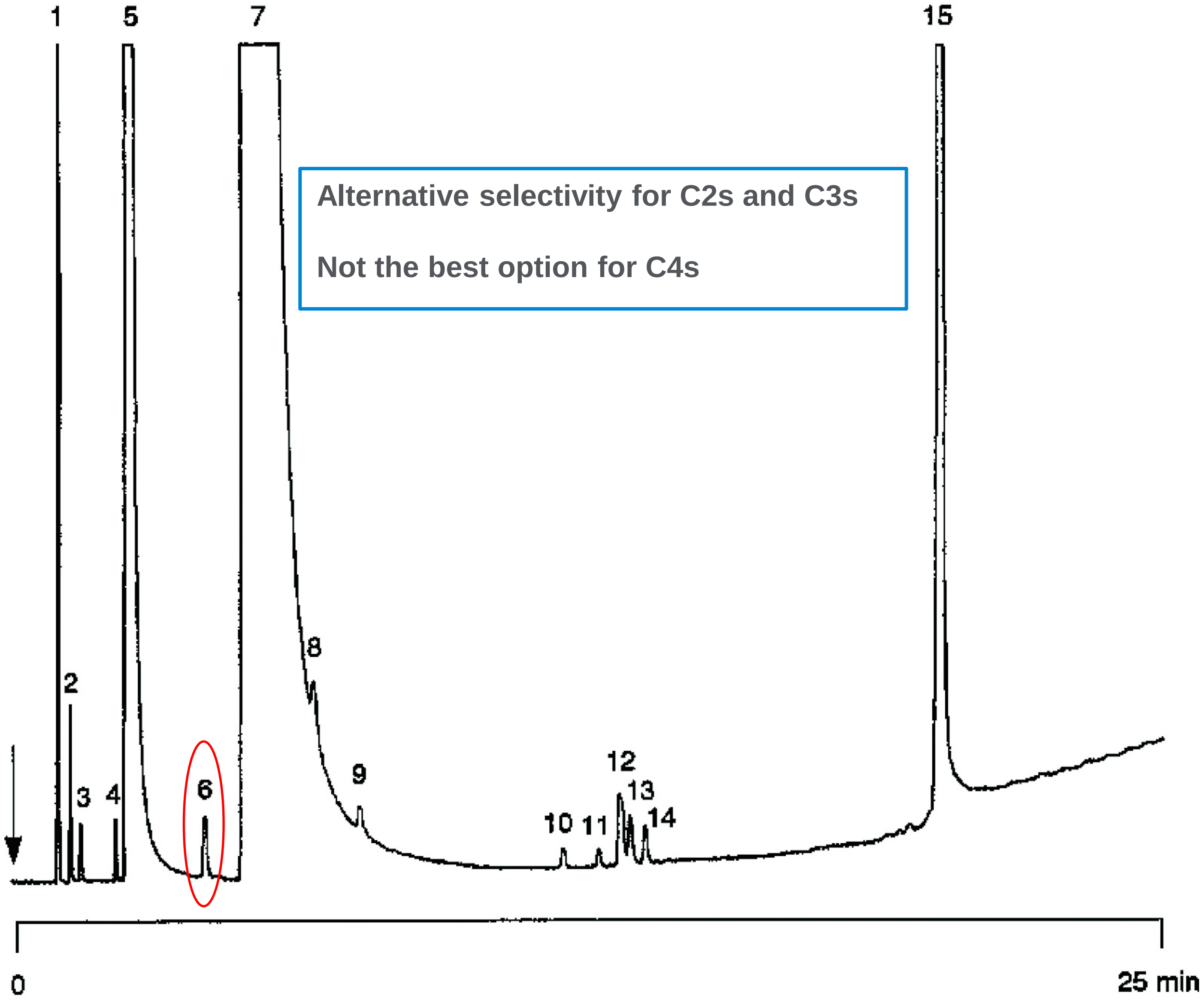
- gc-column-support@Agilent.com
- lc-column-support@agilent.com
- spp-support@agilent.com
- spectro-supplies-support@agilent.com
- chem-standards-support@agilent.com

CP-SilicaPLOT – Hydrocarbons

Column	:	Agilent CP-SilicaPLOT, 0.53 mm x 30 m, fused silica PLOT CP-SilicaPLOT (df = 6 µm) (Part no. CP8570)
Temperature	:	50 °C (5 min) → 225 °C, 5 °C/min
Carrier Gas	:	He, 20 kPa (0.2 bar, 2.9 psi)
Injector	:	Direct T = 225 °C
Detector	:	FID T = 250 °C
Sample Size	:	2 µL
Concentration Range	:	ppm %

Peak identification

1. methane
2. ethane
3. ethylene
4. acetylene
5. propane
6. cyclopropane
7. propylene
8. isobutane
9. butane
10. 1-butene
11. propyne (methylacetylene)
12. 1,3-butadiene
13. isobutene
14. cis-2-butene
15. hexane



Alternative selectivity for C2s and C3s

Not the best option for C4s