Market Focus:

Petrochemical

Gary Stidsen

Jaap de Zeeuw

Who are our Customers?

Petroleum

Chemicals

Products analyzed in Segment

Petroleum

Oil, Natural gas, gasoline, kerosene, diesel, Naphtha

Hydrocarbons, Sulfur, Biomarkers, Aromatics, Alcohols

Bio-Fuels, Biodiesel, Bioethanol

glycerides, FAME, alcohols

Chemicals

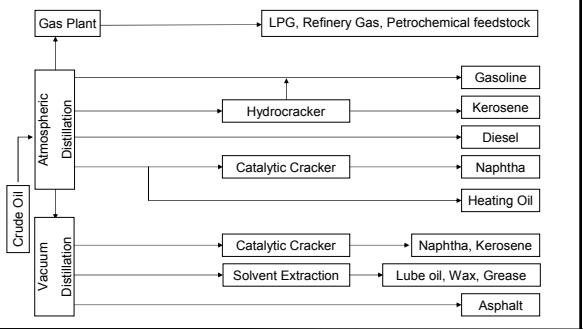
Intermediates and final product

C2-C5 Alkenes, Aromatics, Amines, Glycols, Acids, Solvents, Halogenated compounds, Alcohols, Aldehydes

Outline

- MXT-1HT Sim Dist
- MXT-2887
- Rtx-DHA
- D3606 packed column set
- Rt-XL Sulfur packed column
  - And Siltek deactivation for sulfurs
- PLOT columns
- Appendix
  - Products for biodiesel and chemical analysis

Refinery Process Map

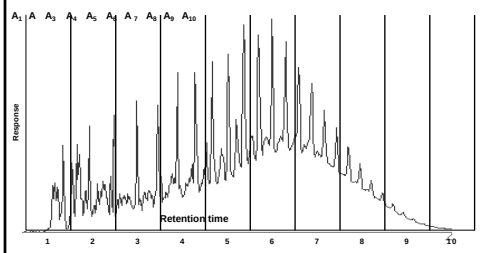


What does every refinery do?

- Simulated Distillation
- Detailed Hydrocarbon Analysis
- Benzene /Toluene
- Refinery gases
- Sulfur analysis
- Oxygenates

What Solutions does Restek offer?

Simulated Distillation



- The chromatogram of the sample is divided into time slices
- The software determines the area count for each slice

Challenges

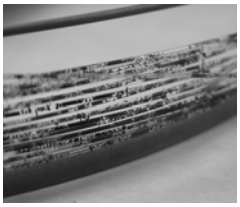
- Columns Break (fused silica)
- Columns loose stationary phase by bleed
  - Need to recalibrate often (time)
  - Replace columns (price per analysis, time)
  - Reduced accuracy (reliability challenge)
- Columns are not efficient
  - Do not meet resolution requirements

Needs for Accurate Simulated Distillation Analysis

- High temperature stable columns
- Low Bleed phases

Sim Dist with fused silica: Big Problem area..

- FS Standard fused silica column polyimide coated, type Inferno..



Polyimide outside coating seriously damaged

This will happen with ALL fused silica columns

Optimize strength/robustness of capillary

Application of MXT Metal capillary tubing

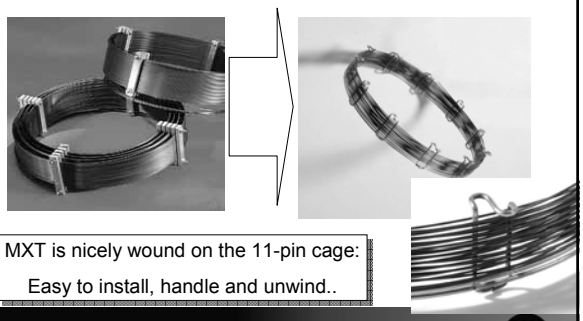
MXT Tubing is Extremely Strong

- Virtually unbreakable
  - Stainless steel with Siltek coated surface
- Can be bent / coiled to small radius
- Siltek surface stabilizes the stationary phase
- Sim Dist columns wound on standard 11-pin cage
- MXT columns can be cut with standard scoring wafer
  - Special tools also available

MXT columns provide reliability:

No column breakage possible!

New, easy accessible column cage



MXT is nicely wound on the 11-pin cage:

Easy to install, handle and unwind..

Simulated Distillation of Crude oil

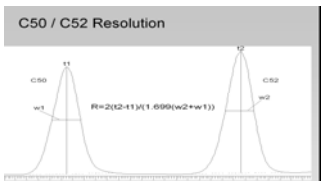
Analysis: Simulated Distillation

C5-C110	D6352 High Temp

C5-C44 D2887

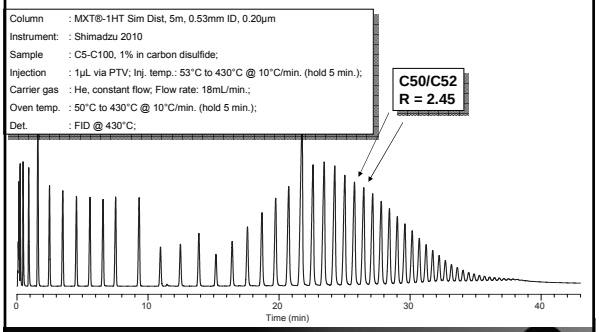
ASTM Spec for High Temperature Sim Dist

- In order to be approved for ASTM D86 and 6352, 7169 and 7500:
  - Resolution between C50 and C52 > 2.0, running under ASTM conditions

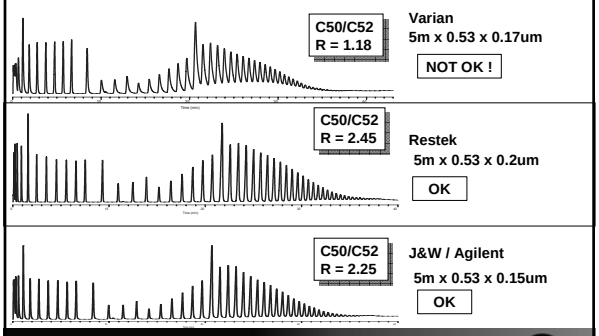


Resolution new MXT-1HT Sim Dist

5m x 0.53 x 0.2um



Comparison of Resolution values



Resolution values

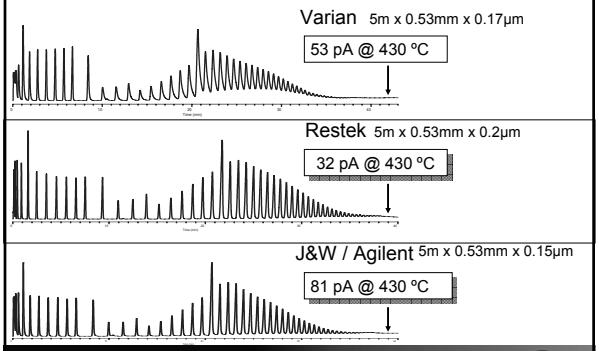
The higher resolution value indicates the Restek MXT-1HT Sim Dist:

- Has a smoother coated surface of the PDMS phase over the length of the column
- The higher resolution value allows for a longer column lifetime

Column Stability / Lifetime

- Column lifetime in Sim Dist applications are also in direct proportional with the level of the column bleed
- The LOWER the bleed, The LONGER the life time

Comparison of Bleed values

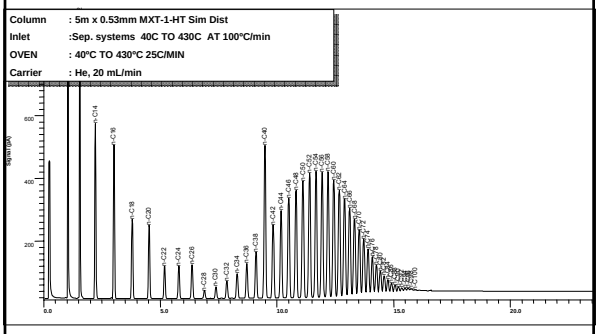


Performance-ASTM D7169

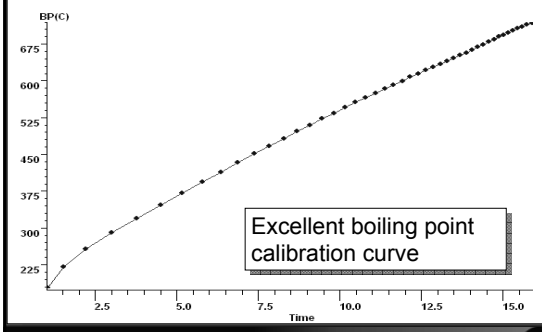
- Customer feedback on Beta testing, done by Joaquin Lubkowitz, Separation systems.
- Authority in petro – analysis field and ASTM

Separation Systems, Inc.
Experts In Gas Chromatography

C10-C100 calibration standard



Calibration curve C10-C100

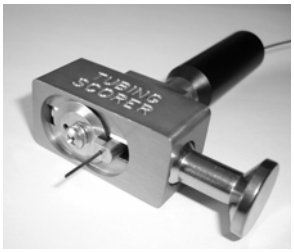


Column Cutting

For installation in a PTV or on-column injector, the column inlet must be well-cut..

MXT Column Cutting

- A special tube “scorer” has been developed..



Makes a perfect “cut” required for “on-Column injection”..

For 0.25 - 0.53mm MXT

tubing scorer : 20523
replacement wheel: 20522

Carrier gas considerations

Avoid introduction of oxidizers

Impact of Oxygen/Moisture

- Increase of bleed
- Retention times drop fast
- Peaks will broaden
- Peaks will tail

Carrier Gas purification

- Degradation reaction of stationary phase + water/oxygen develops exponentially with higher temperature..

Need: Pure gases

Also use graphite ferrules for temperatures above 360ºC

Need: Elimination of leaks

Simulated Distillation of Gasoline Range Hydrocarbons

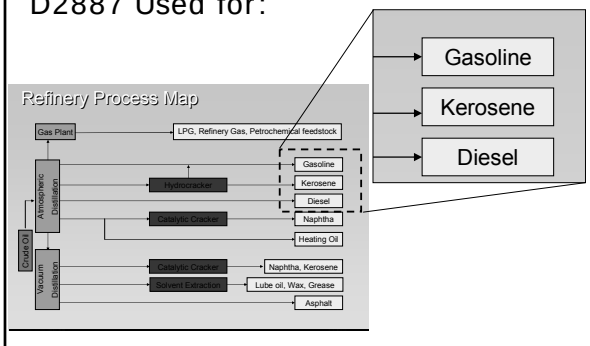
Analysis: Simulated Distillation

C5-C110 D6352 High Temp

C5-C44 D2887

Also Called “gasoline-range” Sim Dist

D2887 Used for:



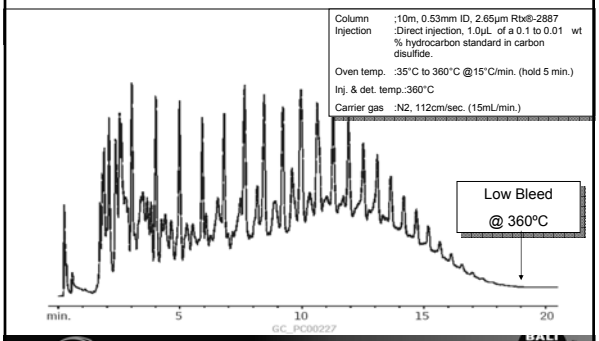
Gasoline Range Sim Dist

- C5-C44 D2887
- Column: 10m x 0.53mm x 2.65um Rtx-2887 (Fused silica or MXT)

Uses a THICK film because the sample is injected on the column with no dilution;

Need LOADABILITY !!

D-2887 Sim Dist



Restek New Generation MXT Sim Dist Columns

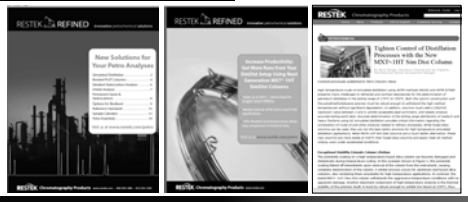
- Features: Low bleeding, Temperature Stable, Better Efficiency
- Benefit: Longer Column Lifetime, Less Replacement, less calibrations, Saving $$$$$

Product information for MXT Sim Dist

- Sim Dist sales companion + presentation
- Restek Refined brochure PCFL1195A; http://www.restek.com/restek/images/external/PCFL1195A.pdf
- Simdist brochure PCFL1201A: http://www.restek.com/restek/images/external/PCFL1201A.pdf

- Applications see: http://www.restek.com/restek/class/5004088.asp; and http://www.restek.com/info_chromatograms.asp
- Technical Literature: http://www.restek.com/aoi_lit_main.asp

- Article: **Tighten Control of Distillation Processes with the New MXT®-1HT Sim Dist Column : http://www.restek.com/aoi_petro_A022.asp**



RESTEK 2011 ✳ International Distributor Conference BALI

What does every refinery do?

- Simulated Distillation
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- Benzene /Toluene
- Refinery gases
- Sulfur analysis
- Oxygenates

What Solutions does Restek offer?

RESTEK 2011 ✳ International Distributor Conference BALI

What products come from most refineries?

- Gasoline
- Diesel
- Jet Fuel
- Refinery Gas

RESTEK 2011 ✳ International Distributor Conference BALI

Analysis: Gasoline

Detailed Hydrocarbon Analysis (DHA) D6730

- Column: 100m x 0.25mm x 0.50um Rtx-DHA 100
- Tuning column: 5m x 0.25mm x 1.0um Rtx-5
- Tuning column is for adjusting selectivity for aromatics

Biggest Challenges for Customers Running ASTM D6730

- Have good peak shape for alcohols
- Have sufficient theoretical plates to separate the complex samples
- Coupling of “tuning” capillary
- Analysis time too long, wish for faster methods
- Reproducibility of column-column quality parameters

Why do the Refiners Run DHA Analysis?

- At the end a certain gasoline must have a certain octane number..
- It is very important for the refiner to monitor the blending process carefully to avoid too much yield.

Different octane numbers are available

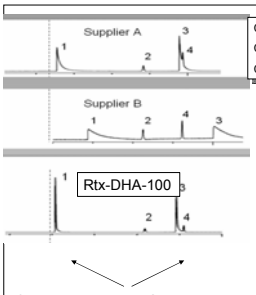
- Accurate DHA analysis can save a lot of money ..

Important Quality Parameter for DHA Analysis

- The column must not only elute hydrocarbons
- Also need to elute alcohols

This is a big challenge and that's why Rtx-DHA 100 columns are preferred

Elution of Alcohols on the DHA-type Columns ASTM Method D6730



Column : 100m x 0.25mm PONA/DHA-type
Conditions : acc to ASTM 6730
Concentration: The SAME amount injected on every column

1. ethanol
2. pentane
3. t-butanol
4. 2-methylbutene-2

Position of alcohols depend on the activity of the surface..

Correct positions, Good deactivation

Impact of a Tailing Alcohol Peak

Supplier 1 type DHA column

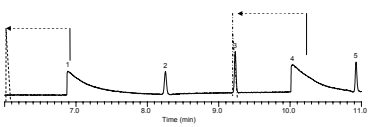
Oven: 5 ºC → 8.23 min., 22ºC/min → 48 ºC

 # 24160U

1. ethanol
2. C5
3. 2 methyl butene 2
4. t butanol

Alcohol peaks are retained by column activity / adsorption;

They elute at wrong position..



Risk: Misidentification and possible wrong data

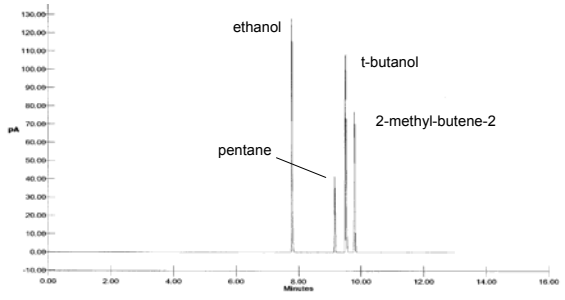
ASTM D 6730 Specifications

Specifications DHA column: for AstmD6730

Material	fusedsilica
Length	100m
Internaldiameter	0.25mm
Liquidphase	methylsilicone
Filmthickness	0.50 µm

Theoreticalplates,n,pentane at 35°C;	400000 to 500000
Retentionfactor,k,pentane at 35°C	0.45 to 0.50
Resolution, R,t-butanoland2-methylbutene-2at 35°C	3.25 to 5.25
Peak symmetry, t-butanolat 35°C	>1.0 to <5.0

Standard ASTM-Specs Test for all Restek Rtx-DHA 100 Columns



Specs Data is Listed on each Rtx-DHA-100 Test Report

TEMP PROGRAM: 35°C Isothermal

INJ TYPE:	Split	**INJ TEMP:**	250°C
DET TYPE:	FID	**DET TEMP:**	300°C
LINEAR VELOCITY:	27 cm/sec(Helium)	**SPLIT FLOW:**	230 ml/min

Retention Time	Name	Area	Height	Width @ 50%
7.79	ethanol	213288	127.793	0.024
9.16	C5	79783	41.430	0.028
9.51	t butanol	226500	108.583	0.030
9.80	2 methylbutene 2	162390	77.061	0.031

Partition Ratio (K) C5:	0.48	**Resolution (t butanol / 2 methylbutene 2):**	5.63
Theoretical Plates (C5):	589,096	**Asymmetry (t butanol):**	1.38
Plates per meter (C5):	5,918		
		Column Bleed (pA):	9.9

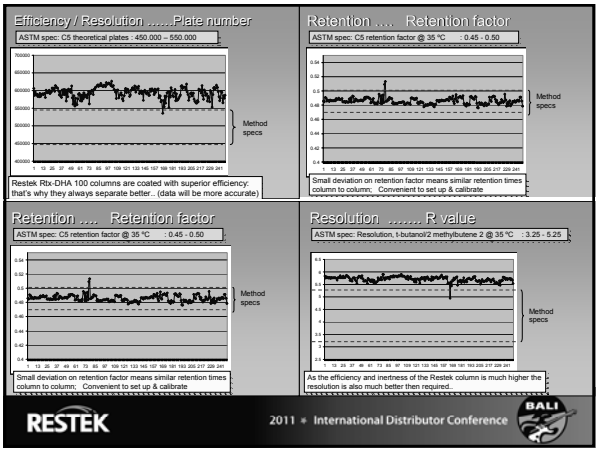
Reproducibility of Rtx-DHA-100 Columns

Following graphs show the typical performance of the chronological production of 250 Rtx-DHA 100 columns

- Efficiency /Resolution
- Retention
- Inertness

} Set by ASTM

- Bleed



ASTM D 6730 Requires a "tuned" Column…

ASTM wants general purpose methods

Columns from different suppliers will show small differences in selectivity..

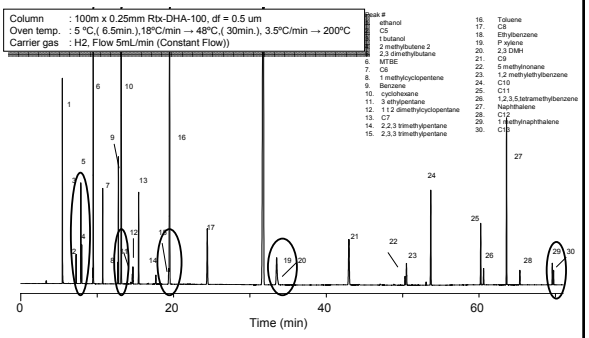
By coupling a short piece of Rtx-5, every column can be "tuned" to fulfill ASTM specs on selectivity..

Tuning pre-column: Rtx-5, 2-5 meters
Length to be determined empirically

ASTM 6730 DHA Evaluation Mix

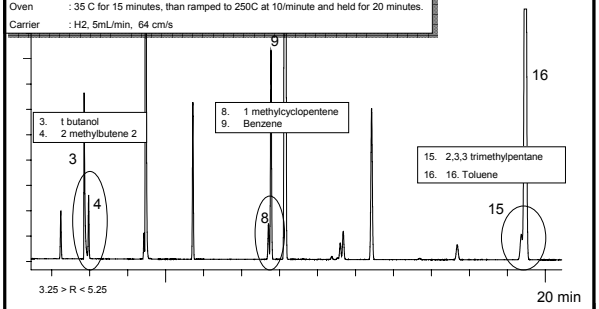
Column : 100m x 0.25mm Rtx-DHA-100, df = 0.5 um
Oven temp. : 5 °C,(6.5min.),18°C/min → 48°C,(30min.), 3.5°C/min → 200°C
Carrier gas : H2, Flow 5mL/min (Constant Flow))

Peak #
1. ethanol
2. C5
3. t butanol
4. 2 methylbutene 2
5. 2,3 dimethylbutane
6. MTBE
7. C6
8. 1 methylcyclopentene
9. Benzene
10. cyclohexane
11. 3 ethylpentane
12. 1 1,2 dimethylcyclopentane
13. C7
14. 2,2,3 trimethylpentane
15. 2,3,3 trimethylpentane
16. Toluene
17. C8
18. Ethylbenzene
19. P xylene
20. 2,3 DMH
21. C9
22. 5 methylnonane
23. 1,2 methylethylbenzene
24. C10
25. C11
26. 1,2,3,5 tetramethylbenzene
27. Naphthalene
28. C12
29. 1 methylnaphthalene
30. C13



Focusing on Critical Areas of Resolution

Column : 100m x 0.25mm Rtx-DHA-100, df = 0.5 um + 2.6 m tuning column
Oven : 35 C for 15 minutes, than ramped to 250C at 10/minute and held for 20 minutes.
Carrier : H2, 5mL/min, 64 cm/s



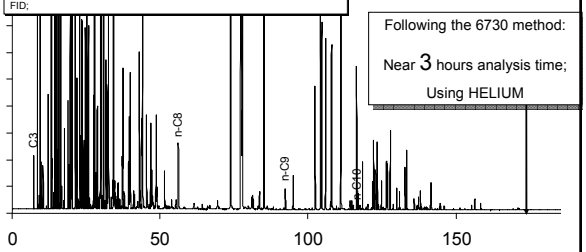
Gasoline Analysis Following ASTM D6730, Helium as carrier gas

Column : 100 x 0.25 mm Rtx-DHA-100 , tuned 5%phenyl PDMS
Oven : 5°C, 10 min -> 50°C, 5°C/min, 54 min, --> 200°C, 1.3 °C/min
Carrier gas : He, 24 cm/s, 39.3 Psi; Injection Split, 1 : 150; Detection : FID;

Following the 6730 method:

Near 3 hours analysis time;

Using HELIUM



There will be always a wish from customers to SPEED UP the analysis

Using Helium and different temperature program

Using Hydrogen

Using shorter, smaller ID columns

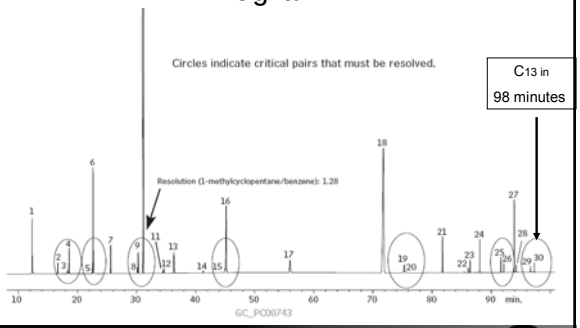
Using Helium and a different program

Using the same column, same GC

Column : 100m x 0.25mm Rtx-DHA-100, df = 0.5 µm coupled with 2.6m x 0.25mm Rtx-5DHA tuning column, df = 1.0 um

- Carrier gas : He, Flow 2.3 mL/min (Constant Flow), 28 cm/s
- Oven temp. : 5 ºC → 15min., 5ºC/min → 50ºC, 50min. 8ºC/min → 200ºC, 10 min

Using Helium and a Different Program

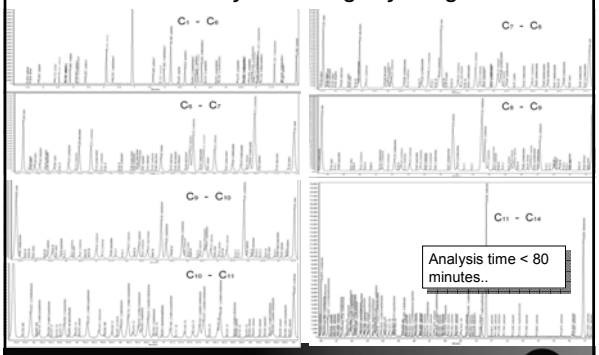


Speeding up the Application using HYDROGEN Carrier Gas

- Using hydrogen we can operate at near 2 times the linear velocity as used for helium
- This results in significant shorter run time

- To get the same chromatogram/separation, we need to adjust the oven temperature program

Fast DHA Analysis using Hydrogen…



Analysis time < 80 minutes..

Fast DHA using Hydrogen

Neil Johansen

- Same GC
- Same method
- Same Injection/detection techniques
- Same column
- No issues with overloading, peak shifts, tailing, high inlet pressures, discrimination and reduced life time..

All retention data and identification is generated by Neil Johansen, developer of the D6730 DHA method.

Available on the Restek website
: http://www.restek.com/promo_gc_pona.asp#004

Hydrogen : Safety Issues

Need to make sure there is no accumulation of H2 possible in the oven..

Hydrogen is combustible over a concentration range of 4% to 74% by volume;

Diffusion VERY fast;

- Use of Hydrogen generators: limited amount of hydrogen
- Hydrogen Flow restriction to set with GC inlet (electronic flow setting)
- Hydrogen detection systems (sniffer)

Rtx-DHA Columns for Other ASTM Methods

For ASTM D6733	: Rtx-DHA-50	50m x 0.25mm, df = 0.5 µm
For ASTM D6729	: Rtx-DHA-100	100m x 0.25mm, df = 0.5 µm
For ASTM D5501	: Rtx-DHA-150	150m x 0.25mm, df = 1.0 µm

NOTE:

This column was called earlier Rtx-1 PONA, which is a WRONG name as the application is DHA, not PONA.

Competing products are still called: HP-PONA, DB-PONA, CP-Sil PONA CB, BP-1PONA and Petrocol

Biggest Challenges for customers running ASTM D6730

Have good peak shape for alcohols……	✓
Have sufficient theoretical plates ……...	✓
Coupling of “tuning” capillary …….....	✓
Analysis time too long, wish for faster methods ..	✓
Reproducibility of column quality parameters …..	✓

Customer referral

I just wanted to relay to you how pleased I am with the performance of the Restek DHA PONA bonded to the 5 meter RTX-5 pre-column. We've found that the optimal tuning length is 2.05 meters ± 0.5 meters, which means less time finding the optimal length as compared to the prior Supelco columns.

The peaks look great – far superior to the prior supplier. I am especially pleased with the critical separation of t-butanol and 2-methylbutene-2. The t-butanol peak only tails minimally with the temperature programming, and it keeps us from having to scrap failed columns. This improvement process of switching columns has improved our production rate by nearly half and cut our waste costs as well.

Terry Osenbach
PerkinElmer Health Science
GC Application and Engineered Solutions Chemist
710 Bridgeport Ave, Shelton, CT 06614

Product information Rtx DHA columns

- Rtx-DHA sales companion + presentation
- Restek Refined brochure PCFL1195A: http://www.restek.com/restek/images/external/PCFL1195A.pdf
- Brochure Rtx-DHA 100 PCFL1007A: http://www.restek.com/restek/images/external/PCFL1007A.pdf
- Recorded WEBINAR
- Applications see: http://www.restek.com/restek/class/5004088.asp; and http://www.restek.com/info_chromatograms.asp
- Technical Literature: http://www.restek.com/aoi_lit_main.asp
- Article: **Faster DHA Analyses Using Helium or Hydrogen:** http://www.restek.com/aoi_petro_A025.asp
- Article: **How Good is Your PONA Column?:** http://www.restek.com/aoi_petro_A006.asp



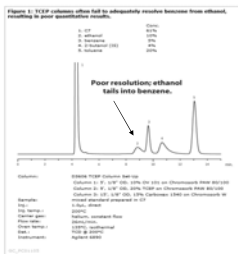
What does every refinery do?

- Simulated Distillation
- Detailed Hydrocarbon Analysis
- Benzene / Toluene/ ethanol in gasoline
- Refinery gases
- Sulfur analysis
- Oxygenates

What Solutions does Restek offer?

Benzene / Toluene/ Ethanol in Gasoline

ASTM Method D3606



Present solution is problematic:

Big issues with separations and peak shapes

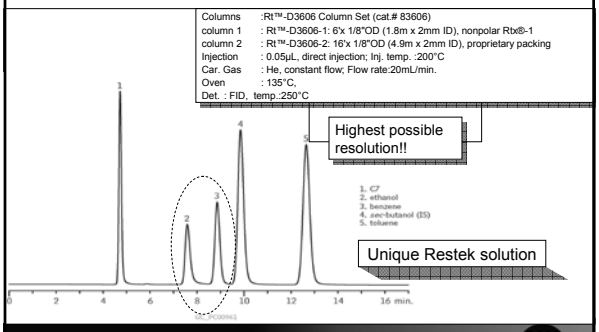
Modified ASTM D3606 Method using the D3606 Column Set

Uses a SET of packed columns:	
Material	Siltek deactivated SS
ID / OD	2mm / 1/8"
Lengths	6' and 16' long
Phases	Rtx-1 and proprietary

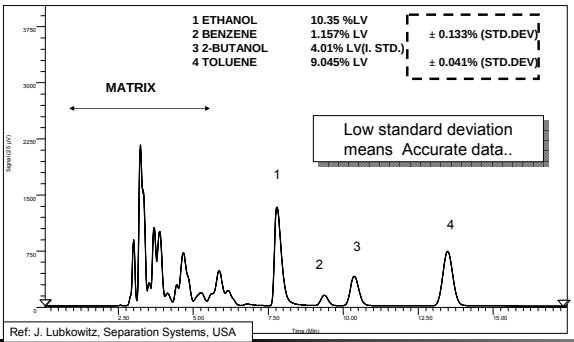
- First part of eluting peaks is sent to the second, highly selective column, where the alcohols and aromatics are separated
- Higher boiling compounds are back-flushed
- Unique column set, only from Restek

New D3606 Method

Columns	:Rt™-D3606 Column Set (cat.# 83606)
column 1	: Rt™-D3606-1: 6'x 1/8"OD (1.8m x 2mm ID), nonpolar Rtx®-1
column 2	: Rt™-D3606-2: 16'x 1/8"OD (4.9m x 2mm ID), proprietary packing
Injection	: 0.05µL, direct injection; Inj. temp. :200°C
Car. Gas	: He, constant flow; Flow rate:20mL/min.
Oven	: 135°C,
Det.	: FID, temp.:250°C



Repeatability of 4 Injections of Wallmart Gasoline



Low standard deviation means Accurate data..

Ref: J. Lubkowitz, Separation Systems, USA

Product Information for D3606

- Restek Refined brochure PCFL1195A; http://www.restek.com/restek/images/external/PCFL1195A.pdf
- Applications see : http://www.restek.com/restek/class/5004088.asp;
- Technical Literature: http://www.restek.com/aoi_lit_main.asp
- Article: **New D3606 Column Set Outperforms TCEP Columns for Benzene Analysis:** http://www.restek.com/aoi_petro_A020.asp

What does every refinery do?

- Simulated Distillation
- Detailed Hydrocarbon Analysis
- Benzene / Toluene/ ethanol in gasoline
- Refinery gases
- Sulfur analysis
- Oxygenates

What Solutions does Restek offer?

Refinery Gases

- Refinery Gas, what is it?
- Gas produced in petroleum refineries by cracking, reforming, and other processes;
- Mainly Light hydrocarbons and permanent gases

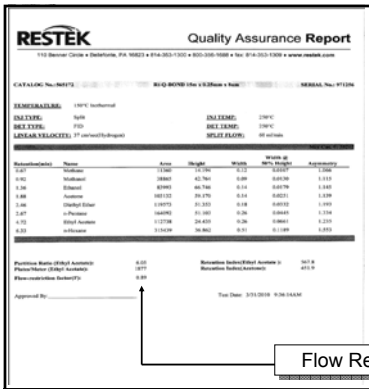
Separation done with PLOT columns

Restek PLOT Columns Versus Competitor Columns

The PLOT columns supplied by competition have issues with:

- Particle stabilization
- Reproducibility of retention
- Reproducibility of Flow

- All Restek PLOT columns have unique bonding chemistry to eliminate particle generation and are ALL tested for Flow-Restriction.
- The Flow Restriction Factor (F) is printed on each test report

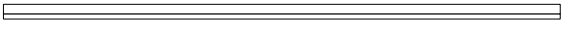

RESTEK Quality Assurance Report

Flow Restriction Factor (F)

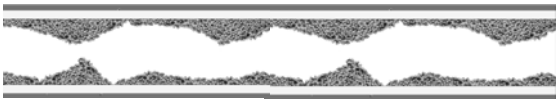
PLOT Layer is often deposited as non homogeneous film

FLOW Restriction

Ideal “open Path: Flow-restriction factor = 1.0



PLOT column with Flow-Restrictions: Flow restriction factor “F” = 0.2-0.8



This was one of the reasons why we could replace Varian and Agilent PLOT columns for:

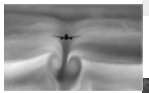
- Siemens
- Agilent micro GC
- C2V (Thermo)
- Schlumberger
- Many companies that supply Analyzer solutions (PAC, Interscience,..)

Transportation

Transportation of PLOT columns

During transport columns are subjected to uncontrolled:

- Vibrations
- Pressure changes
- Temperature changes
- Shocks



Which all can destabilize the adsorption layer..

Dow Chemical, J . Luong

One of the concerns involves the use of PLOT column technology is adsorbent particle shedding. The shedding of adsorbent particles has the potential of plugging the flow channel of the capillary flow Deans switch device. This in turn can cause retention time shift.

Prior to connecting the columns to the capillary flow Deans switch device, we highly recommend the columns be purged with carrier gas at a flow of 50 mL/min for 15 min to remove any particles that might have been dislodged during shipment of the columns from the manufacturers.

Refinery Gas Analysis

- C_1-C_5
  - Rt AluminaBOND KCl or Na2SO4
- Permanent gases, C_1-C_2 and CO2:
  - Rt Msieve 5A / Rt-Q BOND
  - ShinCarbon

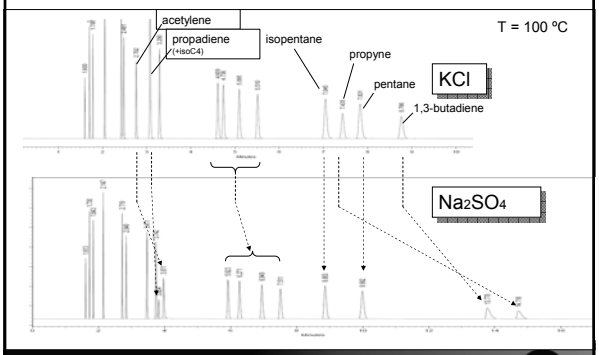
C1-C5 Hydrocarbons Rt-Alumina BOND

KCl : Non polar Al2O3 surface

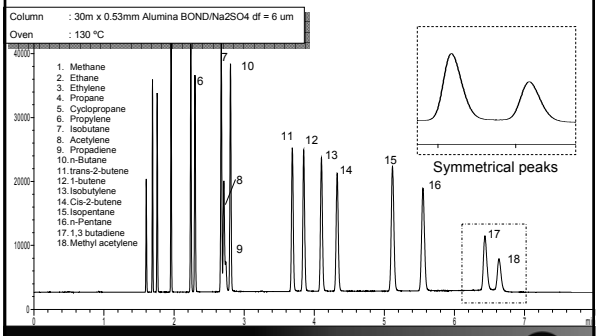
Na2SO4 : Polar Al2O3 surface

Deactivation is necessary to reduce the activity of the alumina..

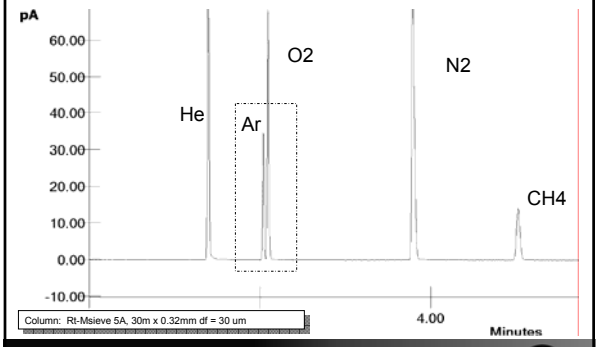
Difference Between Na_2SO_4 and KCl



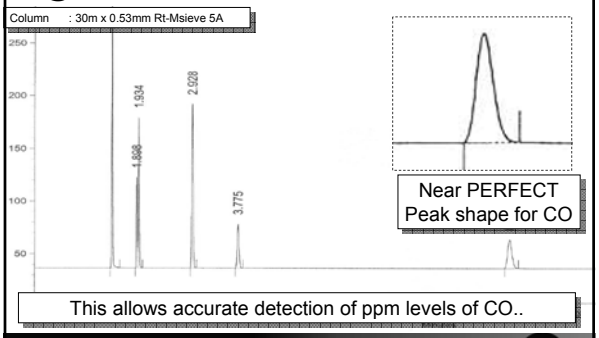
ASTM D2163 C1- C5 Hydrocarbons



Permanent Gases on Rt-MSieve 5A

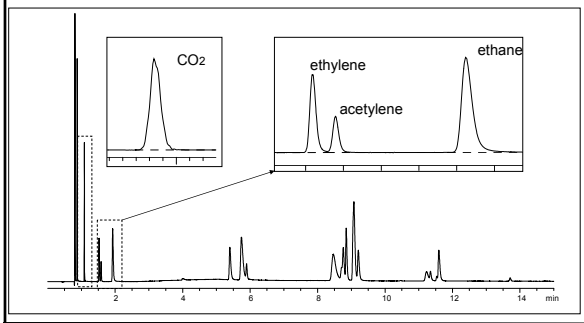


Permanent gases on Rt-MSieve 5A @50ºC

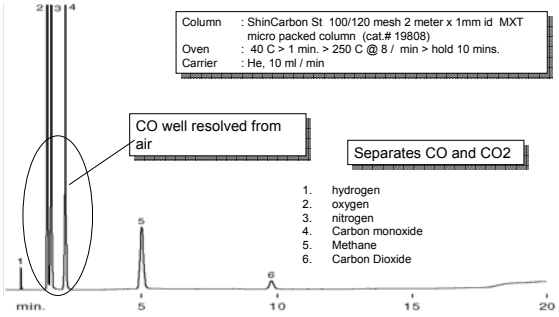


This allows accurate detection of ppm levels of CO..

Rt-Q-BOND Peak Shape for CO_2 and C_2 Isomers



Permanent Gases, CO and CO2 on ShinCarbon Micropacked Column..

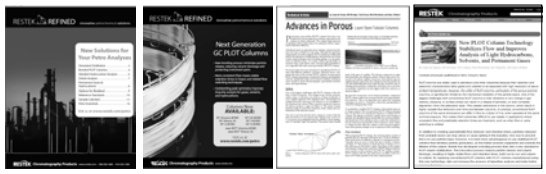


Product Information for PLOT

- Restek Refined brochure PCFL1195A: http://www.restek.com/restek/images/external/PCFL1195A.pdf
- Next generation PLOT columns PCFL1163A: http://www.restek.com/restek/images/external/PCFL1163A.pdf

- Applications see: http://www.restek.com/restek/class/5004088.asp;
- Technical Literature: http://www.restek.com/aoi_lit_main.asp

- Article: New PLOT Column Technology Stabilizes Flow and Improves Analysis of Light Hydrocarbons, Solvents, and Permanent Gases : http://www.restek.com/aoi_petro_A023.asp
- Article: Advances in Porous Layer Open Tubular Columns : http://www.iscpubs.com/Media/PublishingTitles/deZeeuw%20layout_0.pdf



Additional UNIQUE Restek Development

Making PLOT and LIQUID PHASE columns available in MXT..

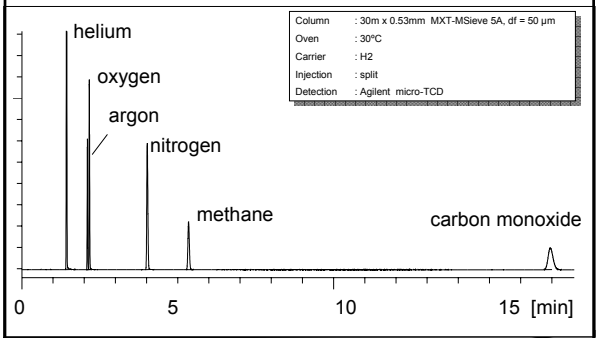
In PROCESS type applications, customers look for:

RELIABILITY..

MXT columns will offer extra security and value..

MXT-MSieve 5A

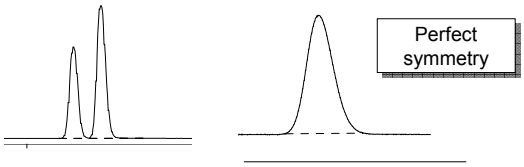
Molecular Sieve 5A in MXT



Zooming into some details

Argon-Oxygen separation

Peak shape of CO

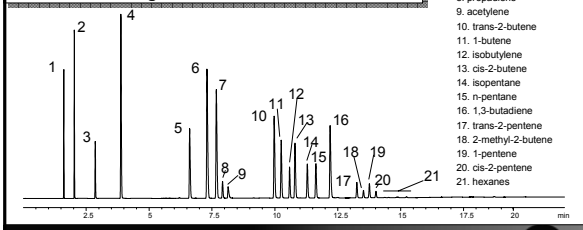


Perfect symmetry

MXT-Alumina BOND (Na_2SO_4 deactivation)

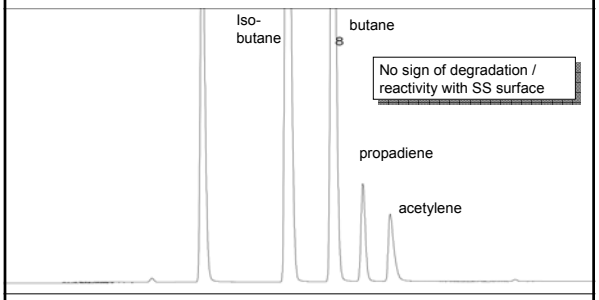
Refinery gas sample

Column:	**MXT-Alumina BOND /Na2SO4** 30m, 0.53mm ID, 10.0µm df
Sample:	Refinery Gas Standard
Inj.:	10.0µL split, split vent flow rate – 80ml/min, 2mm split inlet liner
Inj. temp.:	200°C
Carrier gas:	He, constant pressure (10 psi, 68.9 kPa)
Linear velocity:	31 cm/sec. @ 45°C
Oven temp.:	45°C (1) to 200°C @ 10°C/min. (8.50 min.)
Det.:	FID @ 200°C



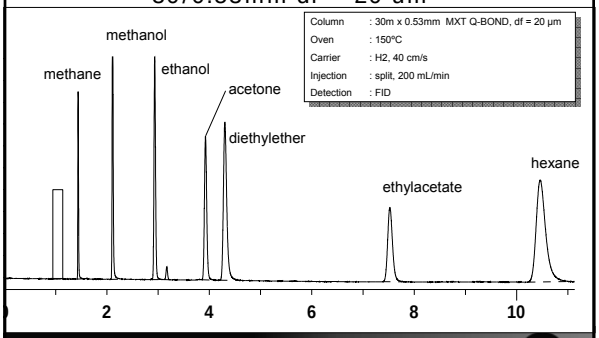
1. methane
2. ethane
3. ethylene
4. propane
5. propylene
6. isobutane
7. n-butane
8. propadiene
9. acetylene
10. trans-2-butene
11. 1-butene
12. isobutylene
13. cis-2-butene
14. isopentane
15. n-pentane
16. 1,3-butadiene
17. trans-2-pentene
18. 2-methyl-2-butene
19. 1-pentene
20. cis-2-pentene
21. hexanes

Acetylene and Propadiene

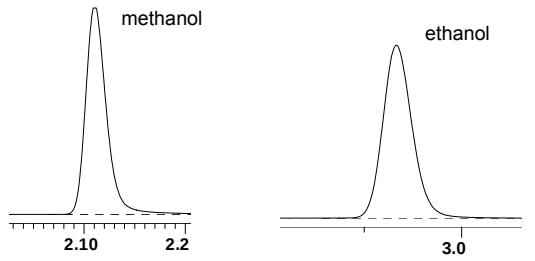


MXT Q-BOND

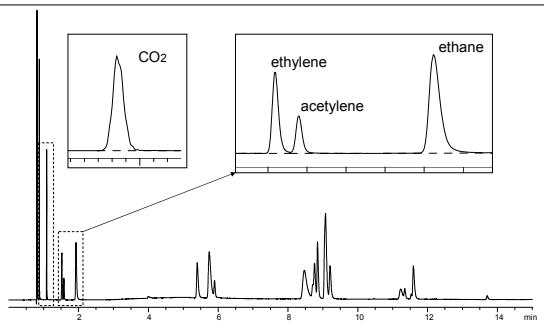
Solvent Test on MXT-Q-BOND 30/0.53mm df = 20 um



Peak Shape of Alcohols



Peak Shape for CO_2 and C_2 Isomers



Product information MXT PLOT

- Brochure Restek Refined PCFL1195A; http://www.restek.com/restek/images/external/PCFL1195A.pdf
- Brochure Next generation PLOT columns PCFL1163A; http://www.restek.com/restek/images/external/PCFL1163A.pdf
- Applications see: http://www.restek.com/restek/class/5004088.asp and http://www.restek.com/info_chromatograms.asp
- Technical Literature: http://www.restek.com/aoi_lit_main.asp

What does every refinery do?

- Simulated Distillation
- Detailed Hydrocarbon Analysis
- Benzene / Toluene/ ethanol in gasoline
- Refinery gases
- Sulfur analysis
- Oxygenates

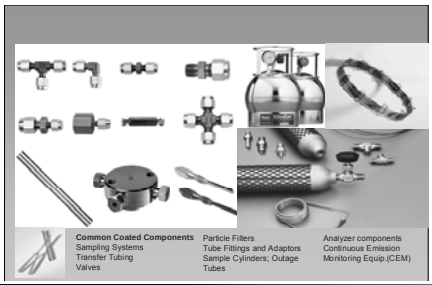
What Solutions does Restek offer?

Reference

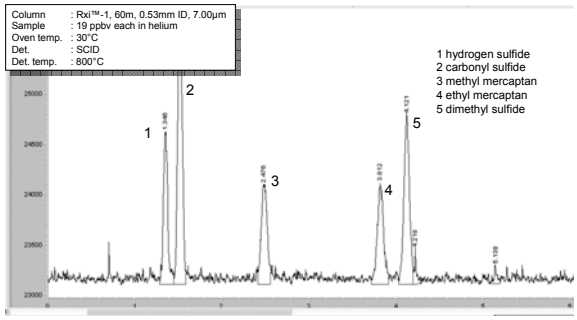
Restek is internationally known for the Siltek / and SilcoSteel deactivations;

Siltek treated parts are widely used and acknowledged in the petrochemical Industry for sulfur compound stability...

All parts in the GC system that come in contact with sulfur compounds can be deactivated by the Siltek technology...



Sulfur Gases at 19 ppb



Most Important Issue for Trace Sulfur Analysis

System Inertness

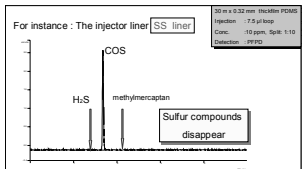
Use a complete Inert system

- Deactivated transfer tubing, Inert Valves / coupling devices, Inert columns, Inert detection liners, Pressure regulators

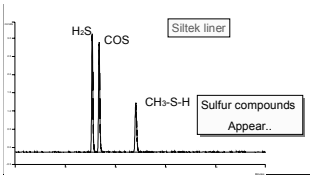
Sulfur compounds will disappear especially at low levels..

Restek Developed Siltek deactivated tubing..

For instance : The injector liner SS liner



Siltek liner

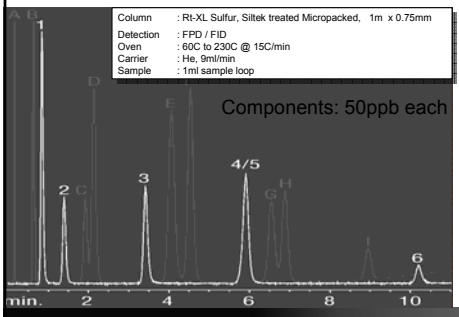


RESTEK

2011 ✳ International Distributor Conference

BALI

Rt-XL Sulfur : Sulfurs and Hydrocarbon Analysis of Natural Gas / Refinery Gas at 50 ppb level



1. hydrogen sulfide
2. carbonyl sulfide
3. methyl mercaptan
4. ethyl mercaptan
5. dimethyl sulfide
6. dimethyl disulfide

A. methane
B. ethane
C. propylene
D. propane
E. isobutane
F. butane
G. isopentane
H. pentane
I. hexane

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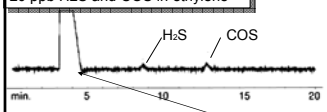
Trace H2S and COS in Ethylene/Propylene using Selective Detection

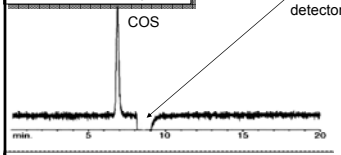
20 ppb H2S and COS in ethylene

Column : Rt-XL Sulfur, Micropacked,
Detection : sulfur selective detector



20 ppb COS in propylene

Impact of large matrix peak on detector signal..



RESTEK

2011 ✳ International Distributor Conference

BALI

Product information Sulfur

- Restek Refined brochure : PCFL1195A; http://www.restek.com/restek/images/external/PCFL1195A.pdf
- Applications :gc_pc00202.pdf; gc_pc00202.pdf; gc_pc00202.pdf; gc_pc00199.pdf; gc_pc00199.pdf
- Powerpoint handout : http://www.restek.com/restek/images/external/PASS6_SF_TraceLevelSulfurs_Restek.pdf
- Applications see : http://www.restek.com/restek/class/5004088.asp
- Technical Literature : http://www.restek.com/aoi_lit_main.asp
- Article: Stable Sulfur & Mercury Sampling in Refineries Using Siltek® and Sulfinert® Surface Treated Components: http://www.restek.com/aoi_petro_A016.asp

What does every refinery do?

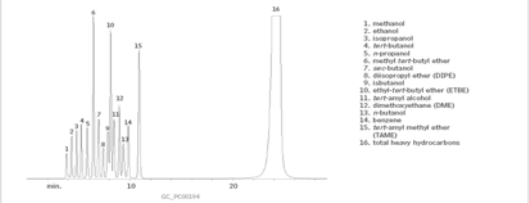
- Simulated Distillation
- Detailed Hydrocarbon Analysis
- Benzene / Toluene/ ethanol in gasoline
- Refinery gases
- Sulfur analysis
- Oxygenates

What Solutions does Restek offer?

Oxygenates in Gasoline Analyses: ASTM D4815

- Oxygenates in Finished Gasoline (Octane boosters) D4815
- Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 to C4 Alcohols in Gasoline by Gas Chromatography
- TCEP column plus Rtx-1 column or Rtx-DHA column

Alcohols in Gasoline by ASTM D4815



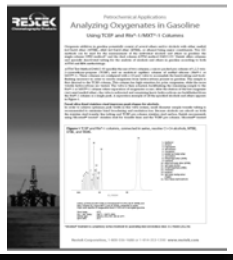
0.56m, 0.75mm ID 20% TCEP on Chromosorb® P A/W (cat.# 19040) and 30m, 0.53mm ID, 3.0µm Rtx®-1 (cat.# 10105) connected in series
0.5µL split injection of oxygenates blend 1–10% wt in surrogate gasoline

Oven temp.:	60°C
Inj. / det. temp.:	200°C / 250°C (FID)
Carrier gas:	helium, 5mL/min, set @ 60°C
Split ratio:	15:1

*Silcosteel® treatment is a proprietary surface treatment for passivating steel and stainless steel. U.S. Patent 6,511,760.

Product Information for Oxygenates

- Applications : gc_pc00194.pdf
- Application article : Oxygenates in gasoline: 59587A



Questions?