

Fast and Efficient Dioxins Analysis With Optimal GC Column Selectivity



Presented By

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Global Product Manager –GC
Phenomenex

Overview

Introduction

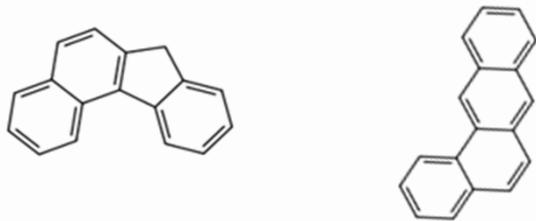
- POPs
- Resolution Improvement
- Current Challenges with Dioxin analysis

ZB-Dioxin Applications

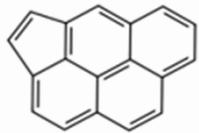
- Exceeding EPA 1613 requirement
- Balance of Resolution and Speed
- Extend lifetime with Guardian
- Dioxins & PCBs
- Robustness with Real Sample Matrix

What Are POP?

PAH

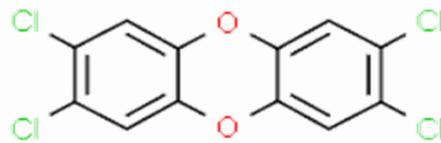


Benzo[c]fluorene Benz[a]anthracene



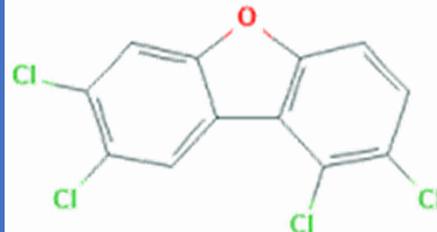
Cyclopenta[cd]pyrene

Dioxins



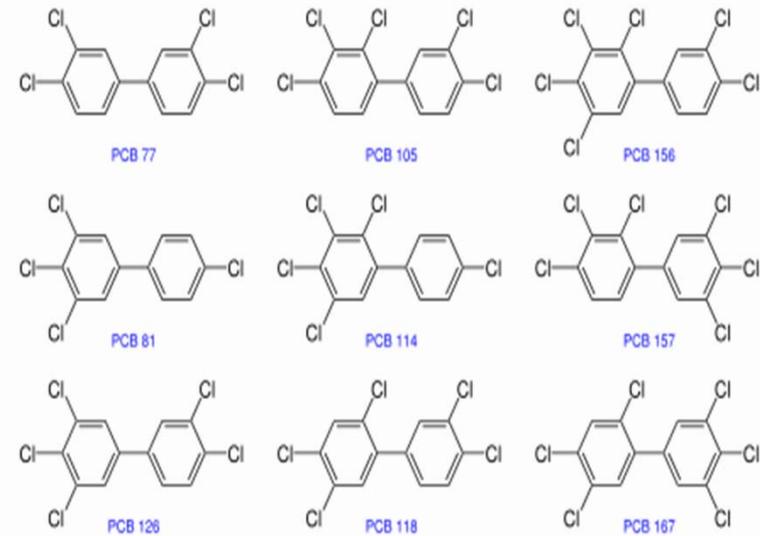
2,3,7,8-TCDD

Furans



2,3,7,8-TCDF

PCB



Factors Influencing Resolution

Master Resolution Equation

$$R_s = \frac{\sqrt{N}}{4} \cdot \frac{\alpha - 1}{\alpha} \cdot \frac{k}{1 + k}$$

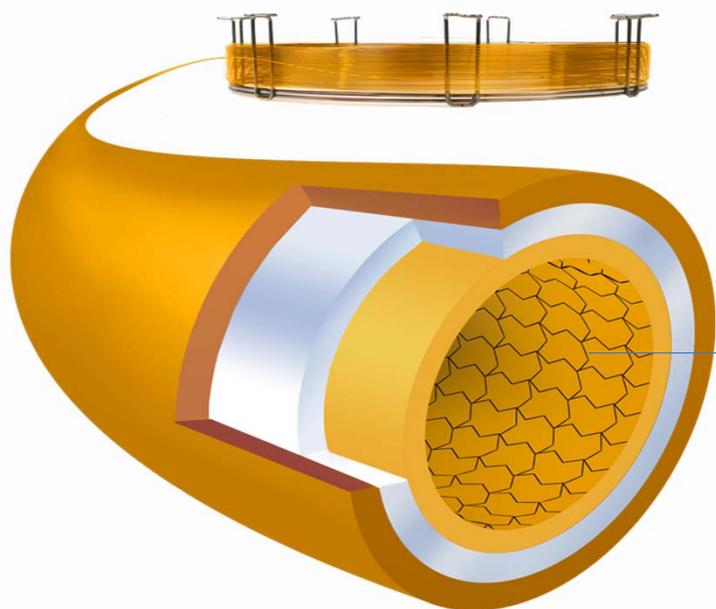
Efficiency Selectivity Retention

N = theoretical plates

α = k_2/k_1

k = $(t_R - t_o)/t_o$

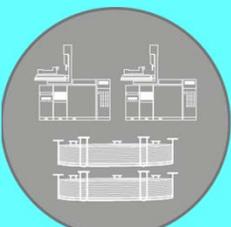
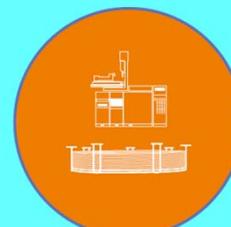
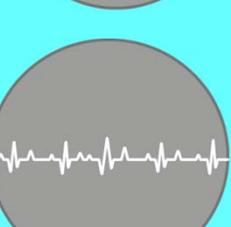
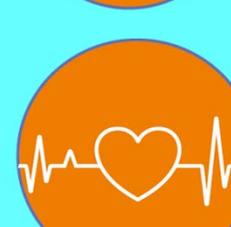
New Zebron ZB-Dioxin GC Column



- Unique selectivity for improved 2,3,7,8-TCDD and 2,3,7,8-TCDF resolution
- Ideal selectivity for Dioxins and PCBs
- Optimal phase volume ratio for shorter run time
- Extensive cross-linking through ESC™ (Engineered Self Cross-Linking™) for low bleed and high temperature stability to minimize GC-MS maintenance and system downtime

ZB-Dioxin is a Single column solution for Dioxins & PCBs

Current Challenges with Dioxin Analysis

Traditional	ZB-Dioxin Upgrade
	
Vs.	
	
Vs.	
	
Vs.	

Single Column
Single GC-HRMS

Fast Analysis

Extended lifetime
with Guardian

Traditional	ZB-Dioxin Upgrade
	
Vs.	
	
Vs.	
	
Vs.	

High Throughput

Single Column for
PCB & Dioxin

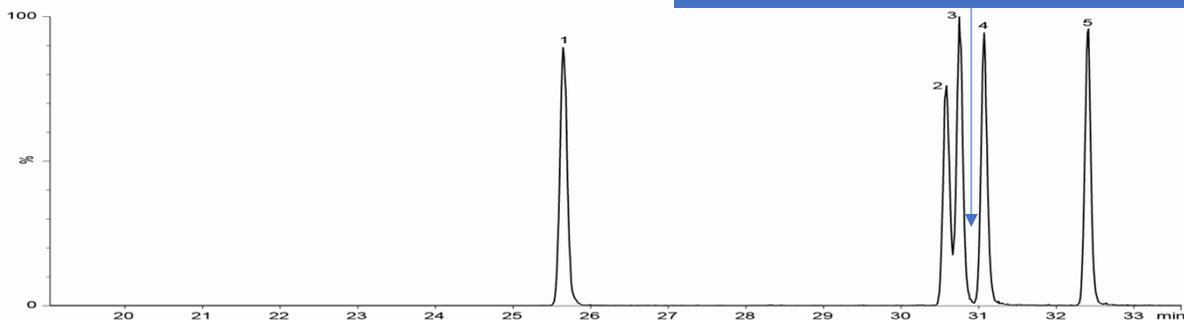
High Temperature
Resistance



TCDD Analysis- Exceeding EPA-1613 Requirement

2,3,7,8-TCDD on Zebron ZB-Dioxin GC column
60 meter x 0.25 mm x 0.20 μm

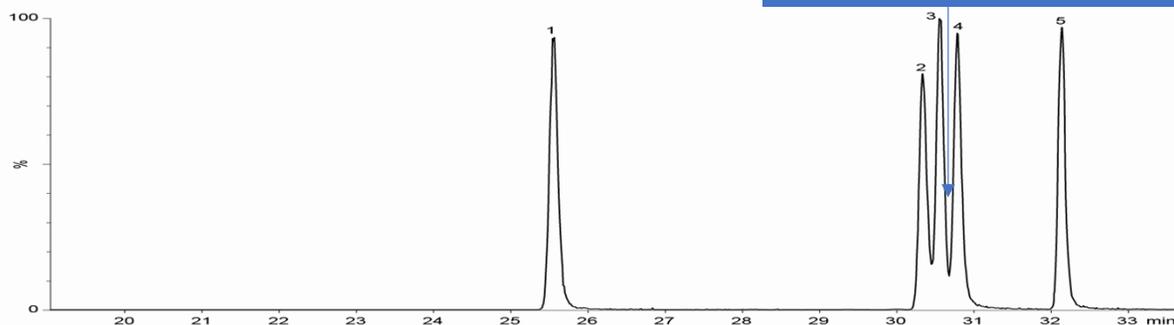
High Resolution of 2,3,7,8-TCDD, exceeds 25% valley EPA-1613 method requirement. This extends column lifetime



App: 26010

2,3,7,8-TCDD on Brand A Premium 5MS
60 meter x 0.25 mm x 0.25 μm

2,3,7,8-TCDD is not completely resolved and reduces lifetime



App: 26011

GC-HRMS Method Conditions

Column1: Zebron™ ZB-Dioxin

Dimensions: 60 meter x 0.25 mm x 0.20 μm

Part No.: 7KG-G045-10

Column2: Brand A Premium 5ms

Dimensions: 60 meter x 0.25 mm x 0.25 μm

Injection: Pulse Splitless (2.0 min, 60 psi) @ 280 °C, 1 μL

Recommended Liner: Zebron PLUS 4 mm ID Single Taper

Liner Part No.: AG2-0A10-05

Carrier Gas: Helium @ 1.25 mL/min (constant flow)

Oven Program: 160 °C for 2.4 min to 200 °C @ 25 °C/min

to 220 °C @ 5 °C/min for 19 min to 288 °C @ 4 °C/min to

300 °C @ 5 °C/min for 7.6 min

Detector: HRMS

Transfer line Temperature: 300 °C

Analyte:

1. 1,3,6,8-TCDD
2. 1,2,3,7-TCDD
3. 1,2,3,8-TCDD
4. 2,3,7,8-TCDD
5. 1,2,8,9-TCDD



Single Column Solution for EPA-1613

Zebron ZB-Dioxin GC column
60 meter x 0.25 mm x 0.20 μm

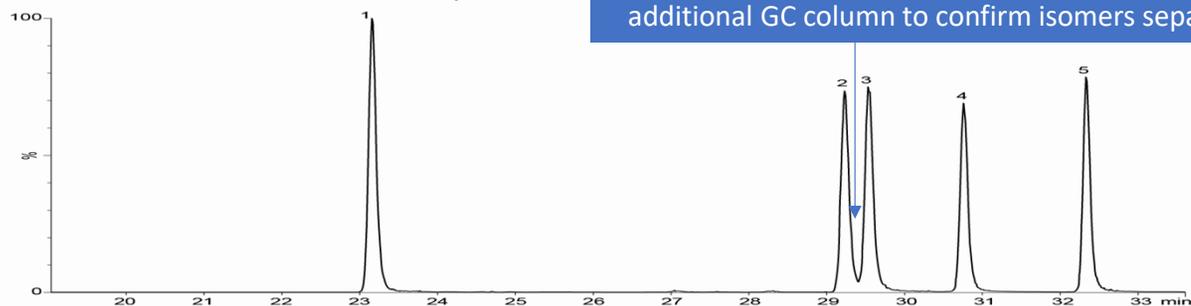
Complete resolution of 2,3,7,8-TCDF on a single column ZB-Dioxin



App: 26012

Brand A Premium 5MS
60 meter x 0.25 mm x 0.25 μm

2,3,7,8-TCDF are not completely resolved and need an additional GC column to confirm isomers separation



App: 26013

GC-HRMS Method Conditions

Column1: Zebron™ ZB-Dioxin
Dimensions: 60 meter x 0.25 mm x 0.20 μm
Part No.: 7KG-G045-10
Column2: Brand A Premium 5ms
Dimensions: 60 meter x 0.25 mm x 0.25 μm
Injection: Pulse Splitless (2.0 min, 60 psi) @ 280 °C, 1 μL

Recommended Liner: Zebron PLUS 4 mm ID Single Taper
Liner Part No.: AG2-0A10-05

Carrier Gas: Helium @ 1.25 mL/min (constant flow)

Oven Program: 160 °C for 2.4 min to 200 °C @ 25 °C/min
to 220 °C @ 5 °C/min for 19 min to 288 °C @ 4 °C/min to
300 °C @ 5 °C/min for 7.6 min

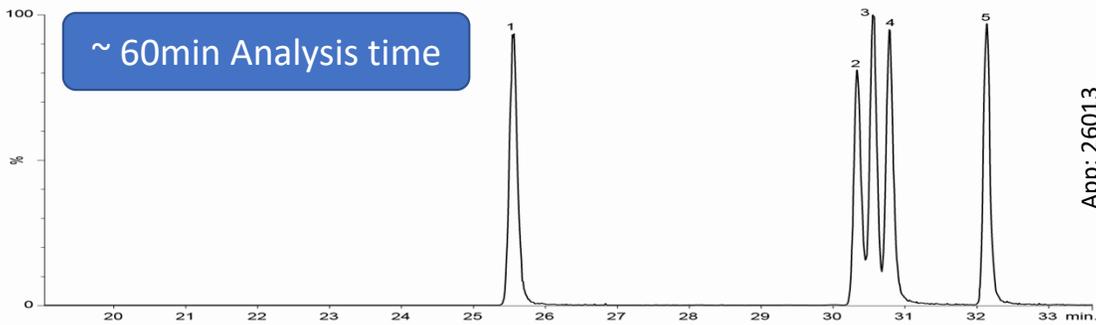
Detector: HRMS
Transfer line Temperature: 300 °C

Analyte:

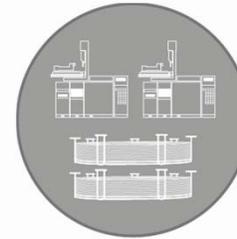
1. 1,3,6,8-TCDF
2. 1,3,4,7-TCDF
3. 2,3,7,8-TCDF
4. 1,2,3,9-TCDF
5. 1,2,8,9-TCDF

Traditional Solution for EPA-1613

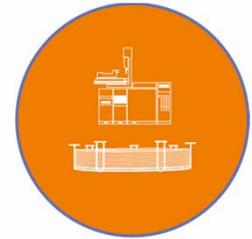
Incomplete TCDF separation on a traditional **5MS Phase**



Traditional



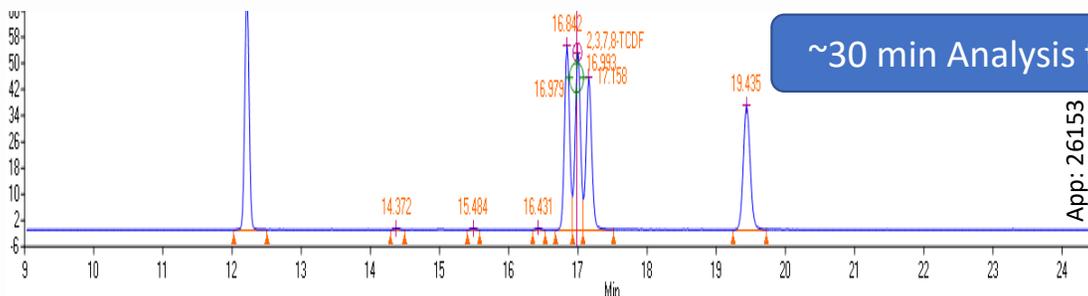
ZB-Dioxin Upgrade



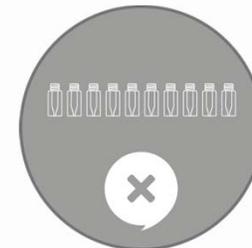
Vs.

- 5MS phase does not completely resolve TCDF
- Isomer specific separation to be confirmed on a 225 phase

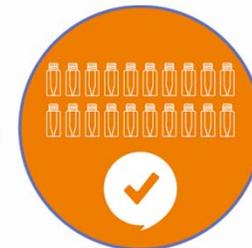
TCDF Isomer separation on **225 Phase**



Traditional



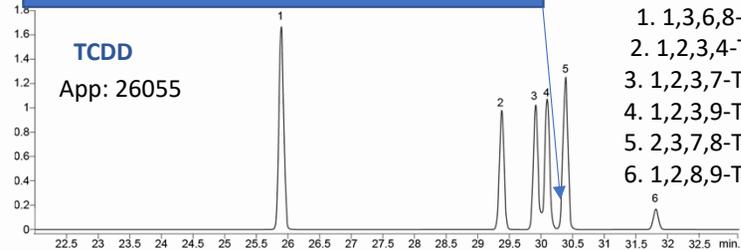
ZB-Dioxin Upgrade



Vs.

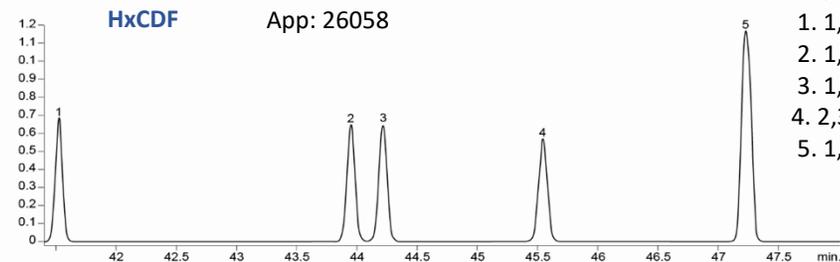
GC-MS/MS analysis of Dioxins on Zebron ZB-Dioxin GC Columns

Complete Baseline separation of 2,3,7,8-TCDD using SINGLE column ZB-Dioxin



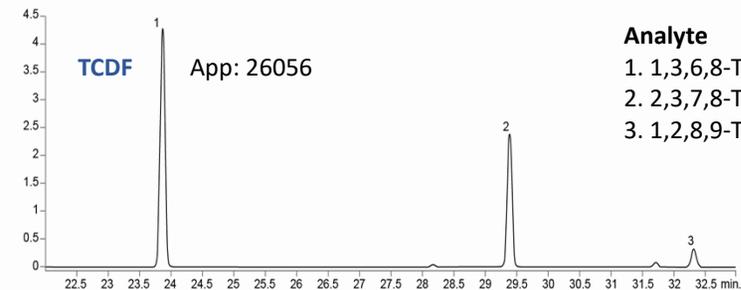
Analyte

1. 1,3,6,8-TCDD
2. 1,2,3,4-TCDD
3. 1,2,3,7-TCDD/ 1,2,3,8-TCDD
4. 1,2,3,9-TCDD
5. 2,3,7,8-TCDD
6. 1,2,8,9-TCDD



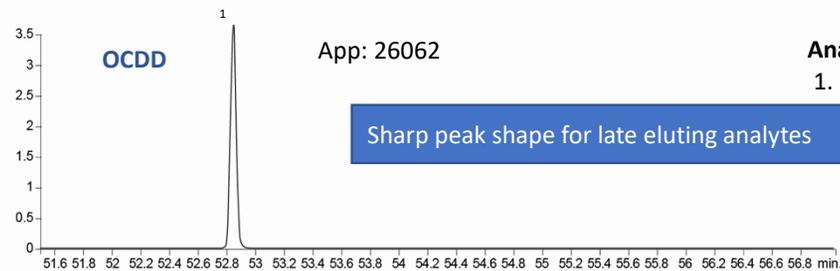
Analyte

1. 1,2,3,4,7,8-HxCDF
2. 1,2,3,4,6,8-HxCDF
3. 1,2,3,6,7,8-HxCDF
4. 2,3,4,6,7,8-HxCDF
5. 1,2,3,7,8,9-HxCDF



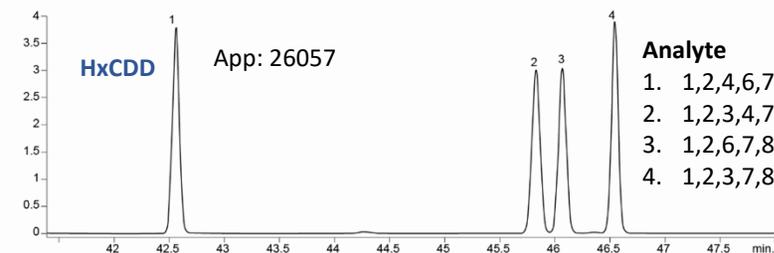
Analyte

1. 1,3,6,8-TCDF
2. 2,3,7,8-TCDF
3. 1,2,8,9-TCDF



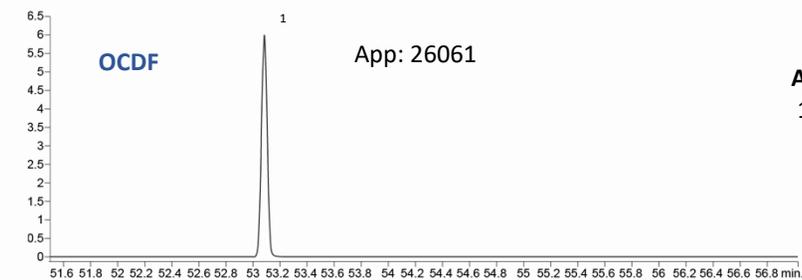
Analyte

1. OCDD



Analyte

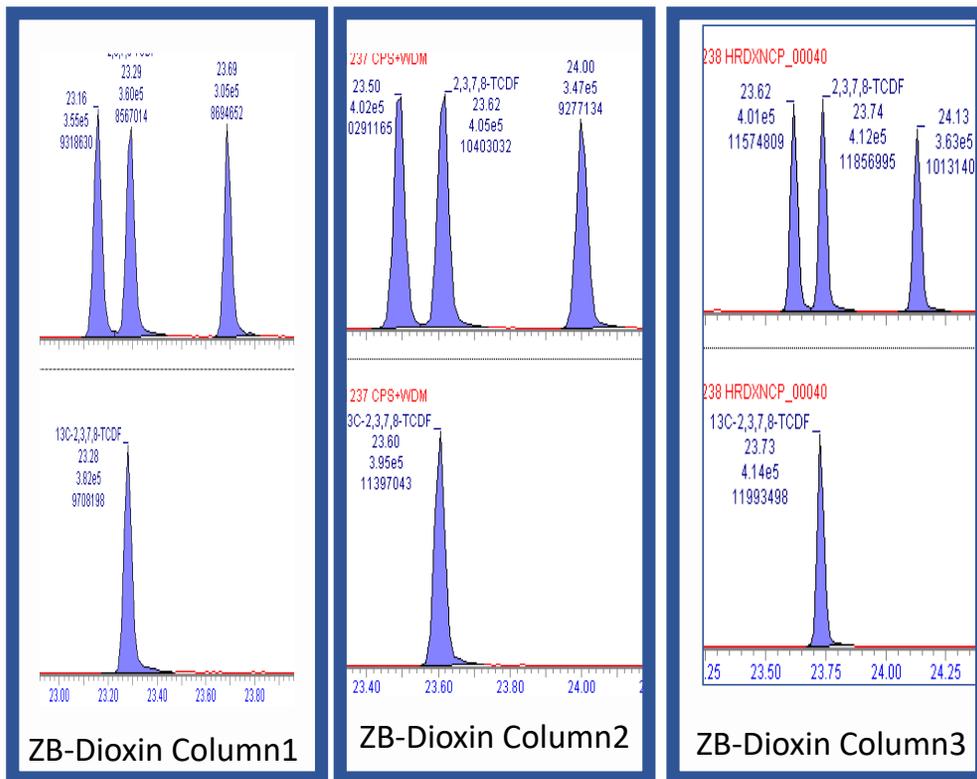
1. 1,2,4,6,7,9-HxCDD
2. 1,2,3,4,7,8-HxCDD
3. 1,2,6,7,8-HxCDD
4. 1,2,3,7,8,9-HxCDD



Analyte

1. OCDF

ZB-Dioxin Column to Column Reproducibility



TCDF Separation

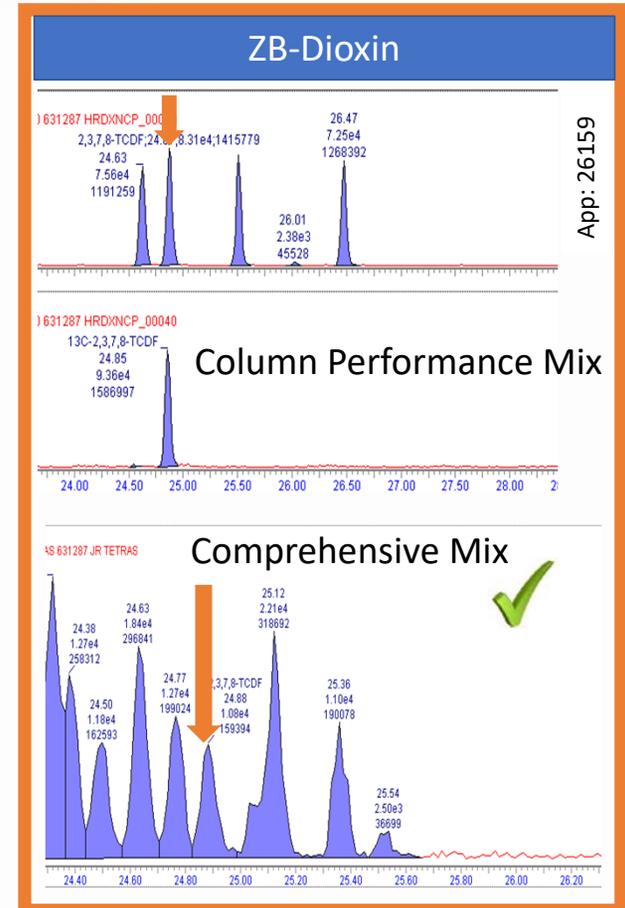
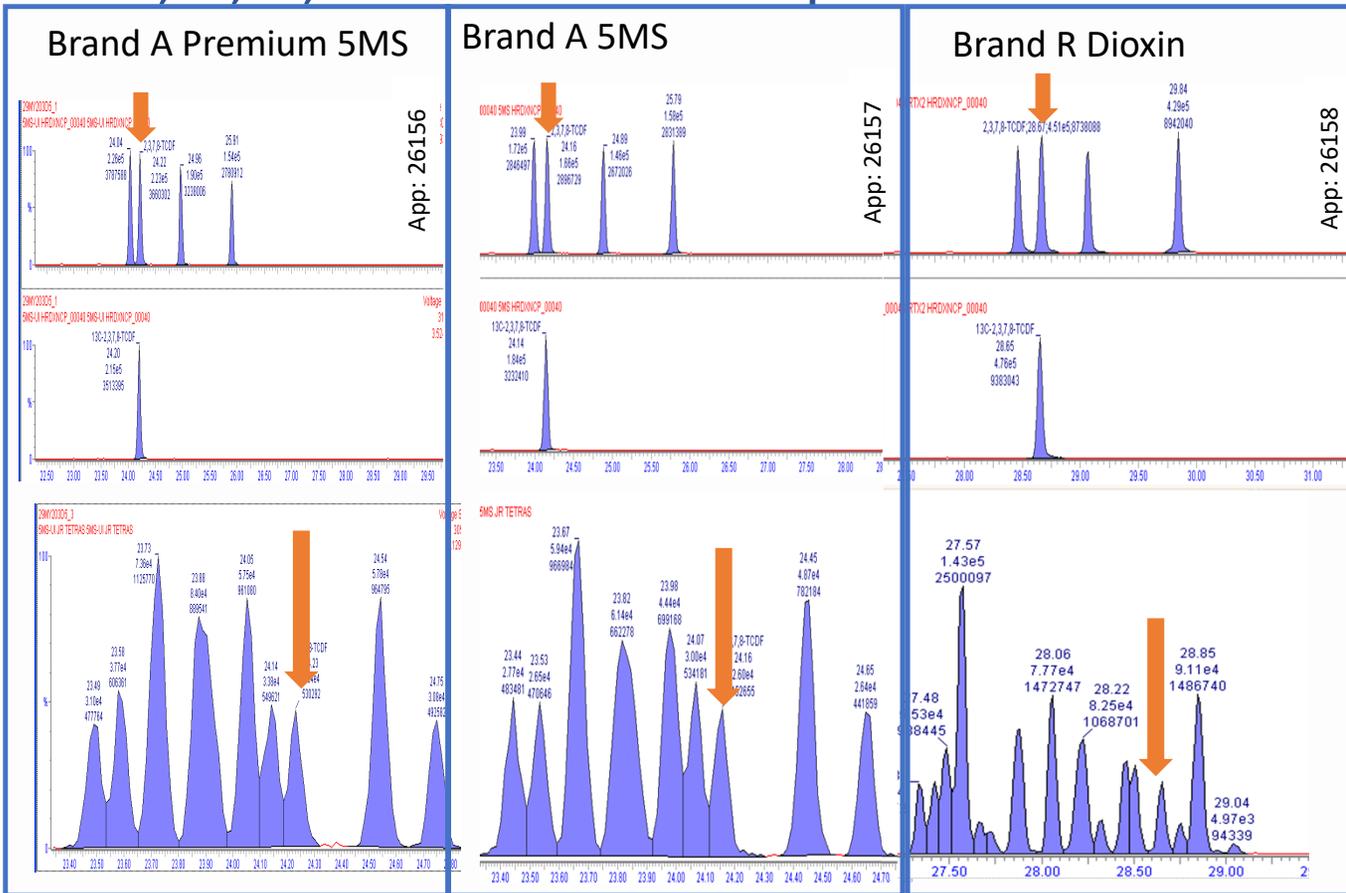
Compound	Relative Retention Time (RRT)			% RSD
	Column1	Column2	Column3	
2,3,7,8-TCDF	1.000	1.000	1.000	-
1,2,3,7,8-PeCDF	1.098	1.097	1.097	0.05%
2,3,4,7,8-PeCDF	1.127	1.127	1.128	0.05%
1,2,3,4,7,8-HxCDF	1.220	1.223	1.223	0.14%
1,2,3,6,7,8-HxCDF	1.225	1.227	1.228	0.12%
2,3,4,6,7,8-HxCDF	1.248	1.249	1.248	0.05%
1,2,3,7,8,9-HxCDF	1.280	1.277	1.277	0.14%
1,2,3,4,6,7,8-HpCDF	1.321	1.319	1.319	0.09%
1,2,3,4,7,8,9-HpCDF	1.382	1.381	1.381	0.04%
OCDF	1.482	1.485	1.485	0.12%

Low % RSD =
Reproducible results

Why compromise your Dioxin analysis quality with an average separation on a 5% Phenyl GC phase when you can upgrade to the Zebron ZB-Dioxin that is specially tailored for reproducible Dioxin analysis.

App: 26076

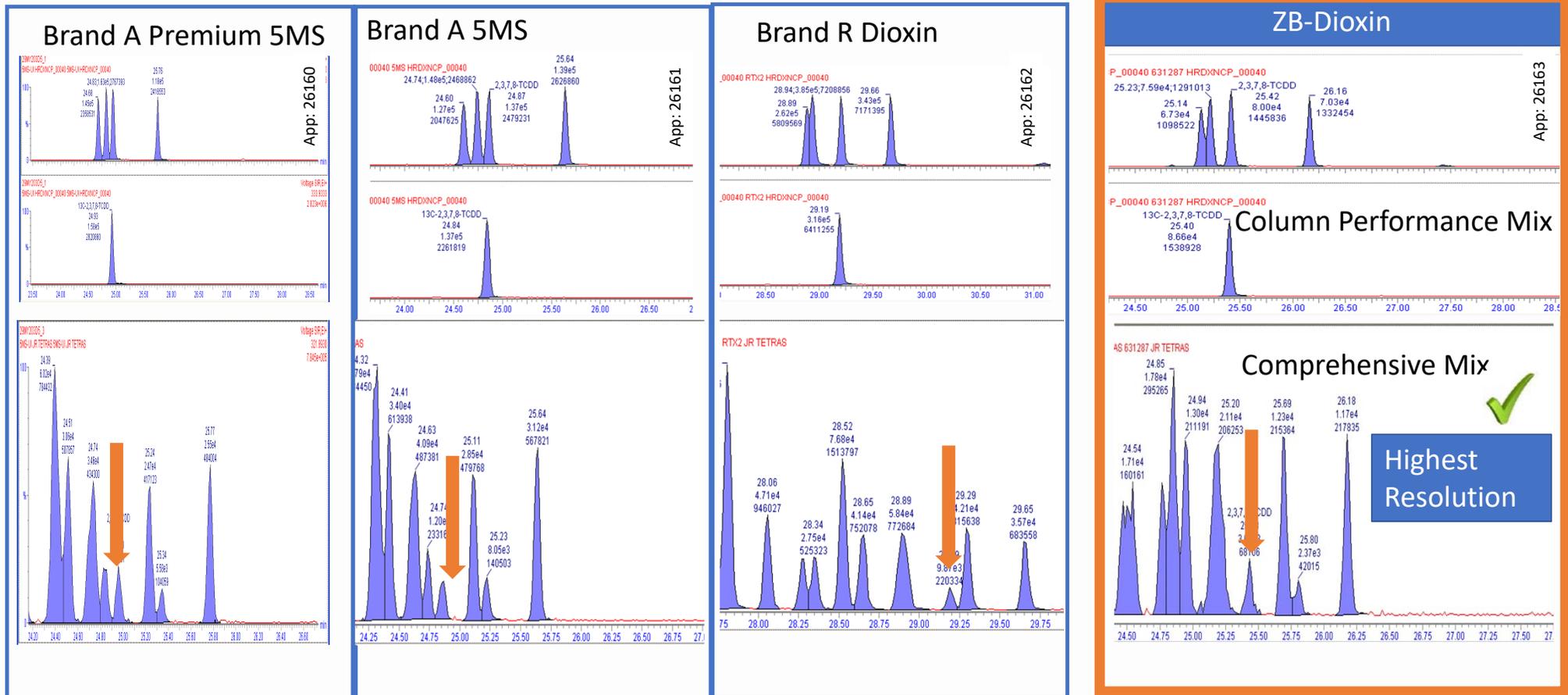
2,3,7,8-TCDF Comparison



➔ 2,3,7,8-TCDF

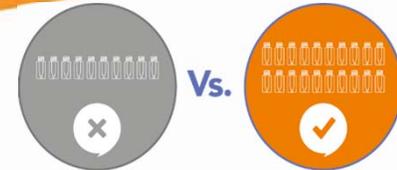
Comparative separations may not be representative of all applications.

2,3,7,8-TCDD Comparison

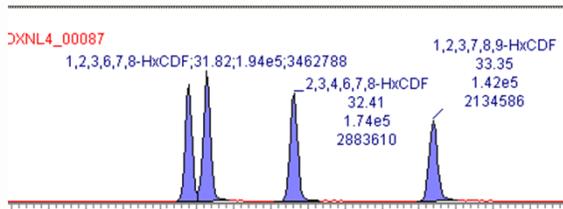


Comparative separations may not be representative of all applications.

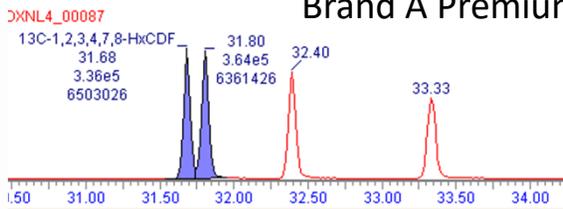
Hexa Furan Separation



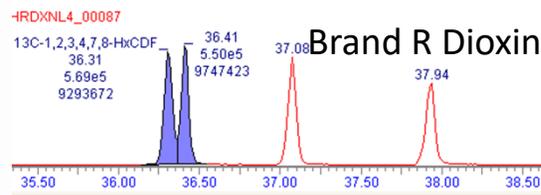
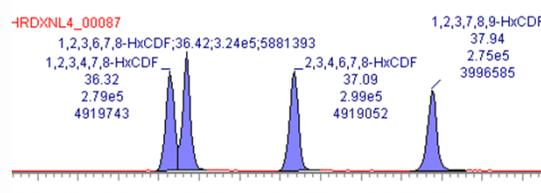
Long Run time



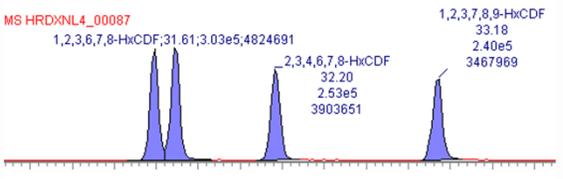
Brand A Premium 5MS



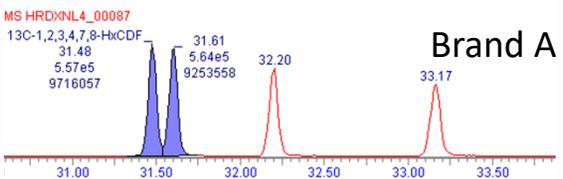
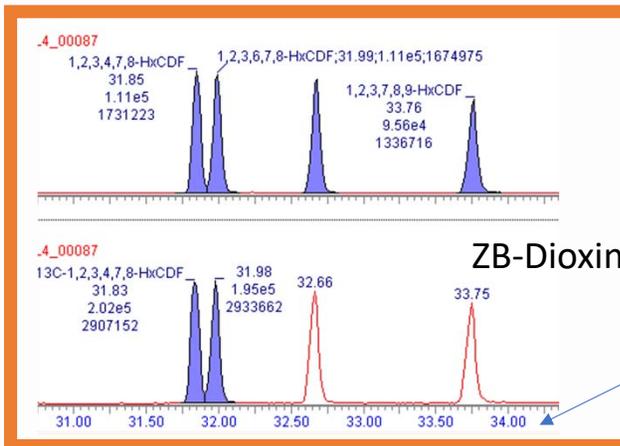
Brand R Dioxin



Short Run time and better separation



Brand A 5MS

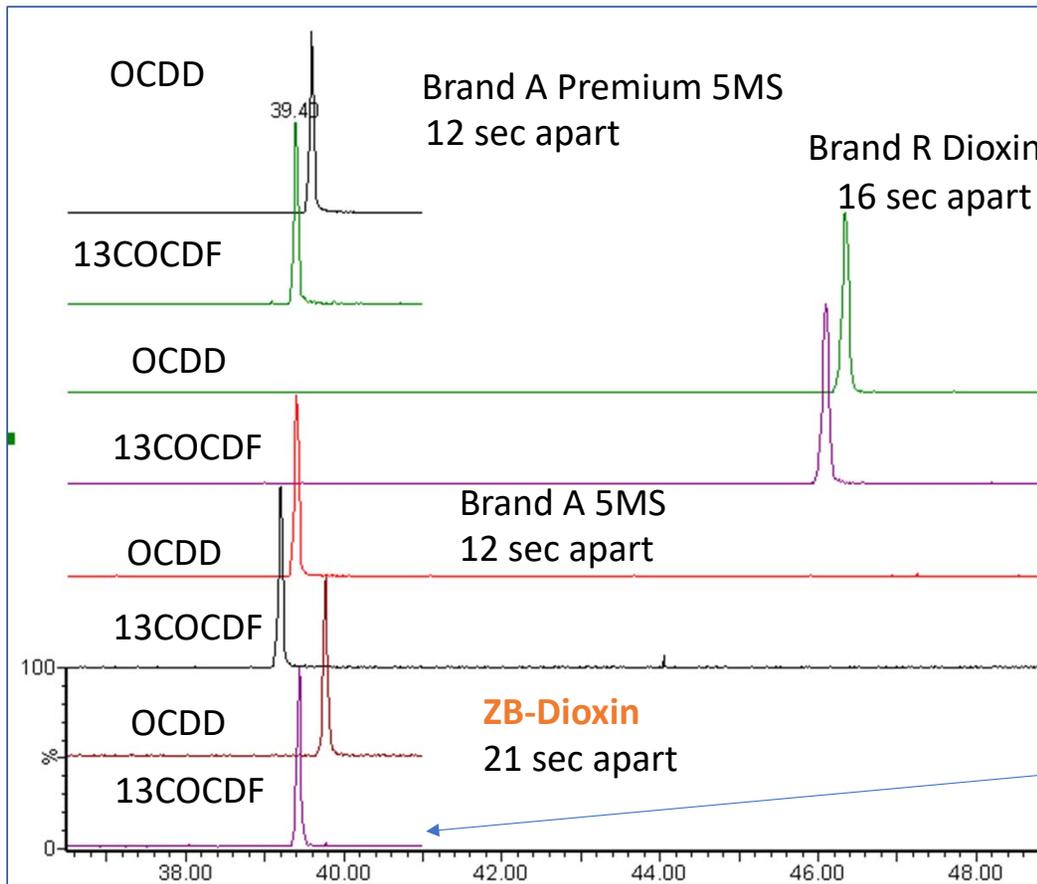


App: 26165

Comparative separations may not be representative of all applications.

Better Separation of Octa Dioxin/Furan on ZB-Dioxin

~90 mins vs. ~40 mins



Long Analysis Time

Highest Resolution= Accurate quantification

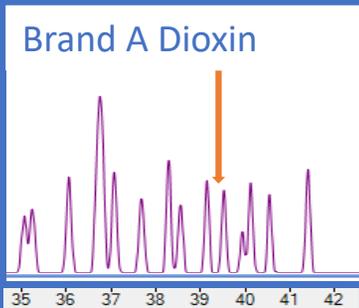
Short Analysis Time

App: 26166

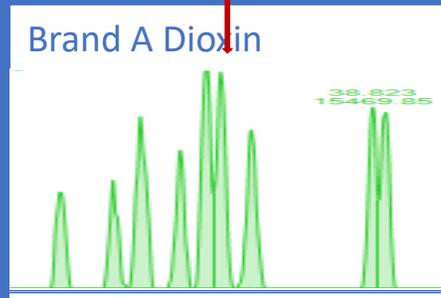
Comparative separations may not be representative of all applications.

ZB-Dioxin Comparison

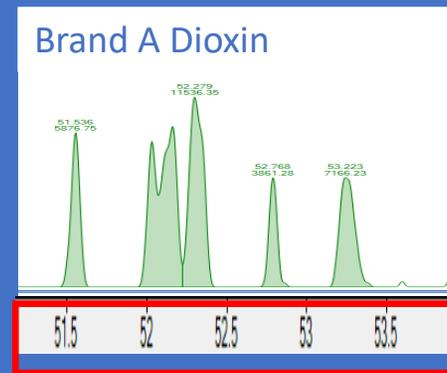
TCDF



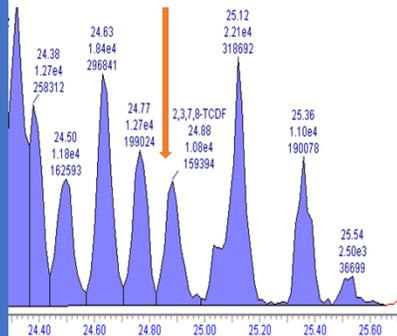
TCDD



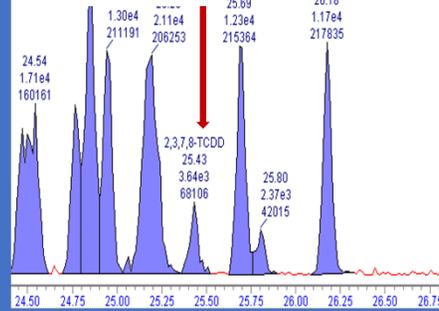
HxCDF



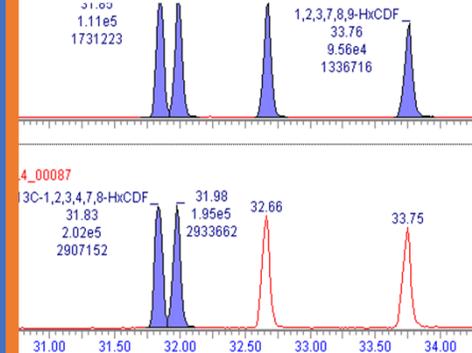
ZB-Dioxin



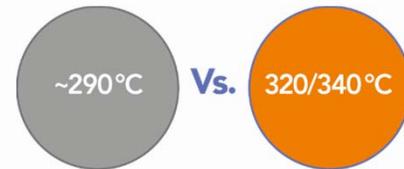
ZB-Dioxin



ZB-Dioxin



Brand A Dioxin **ZB-Dioxin Upgrade**



Brand A Dioxin

- Poor resolution
- Long Run time
- 290°C
- OCDF did not elute till 60min

ZB-Dioxin Upgrade

- Better Resolution
- Shorter Run time
- 320/340°C
- Up to 35% faster analysis

→ 2,3,7,8-TCDF

→ 2,3,7,8-TCDD

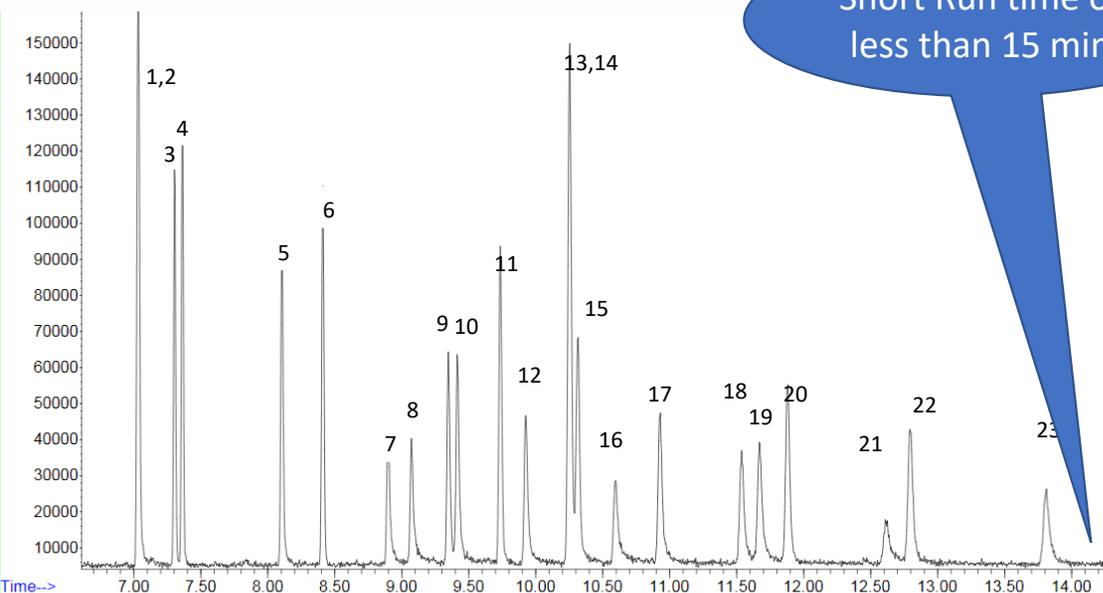
Comparative separations may not be representative of all applications.

ZB-Dioxin : Combination of Better Resolution and Speed

Separation Criteria	Brand A Premium 5MS	Brand A 5MS	Brand A Dioxin	Brand R Dioxin	ZB-Dioxin
2,3,7,8-TCDF Column Performance Test Mix	Requires additional column	Requires additional column	Requires additional column	Passes	Exceeds Requirement/ Single column solution ✓
2,3,7,8-TCDF Comprehensive Test Mix	Fail	Fail	Fail	Passes	Exceeds Requirement/ Single column solution ✓
2,3,7,8-TCDD Column Performance Test Mix	Pass	Pass	Pass	Pass	Exceeds 25% valley resolution ✓
2,3,7,8- TCDD Comprehensive Test Mix	Close to 25%	Close to 25%	Close to 25%	Pass	Exceeds Requirement ✓
OCDD/13C-OCDF Separation	12 sec	16 sec	Not eluted within time window	12 sec	21 sec ✓
Run time	40 min	40 min	60+ min	48 min	40 min ✓
Temperature Limit	325/350 °C	325/350 °C	~290 °C	320/340 °C	320/340 °C ✓

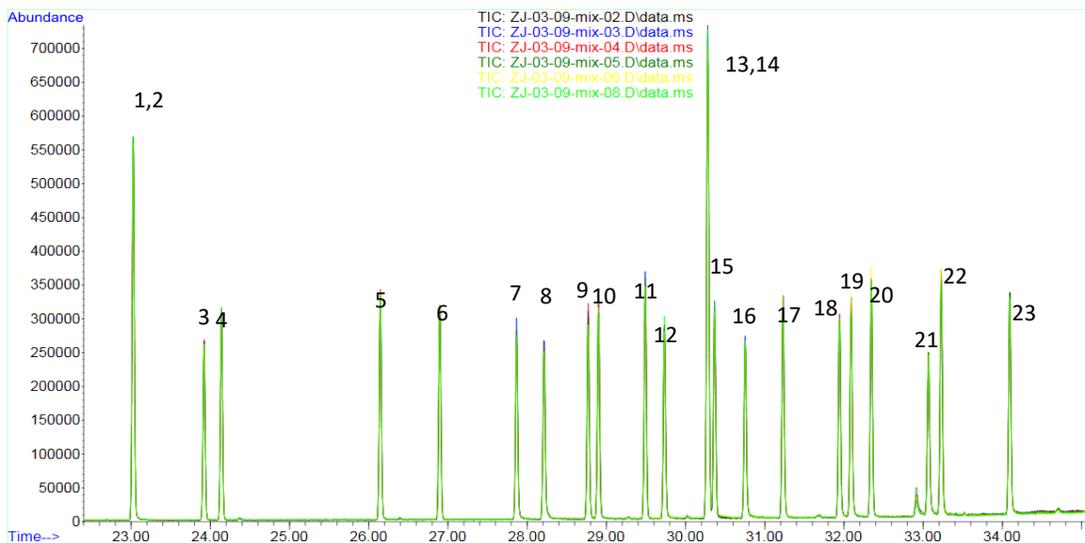
Fast PCB Analysis on a 40m ZB-Dioxin GC Column

Short Run time of less than 15 min



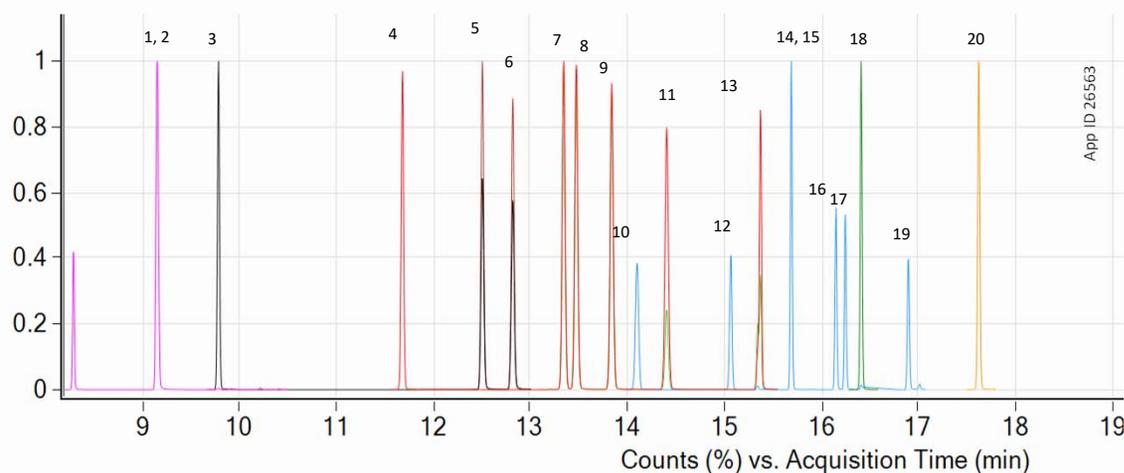
Number	PCB	Description
1	PCB 31	2,4',5-Trichlorobiphenyl
2	PCB 28	2,4,4'-Trichlorobiphenyl
3	PCB 69	2,3',4,6-Tetrachlorobiphenyl
4	PCB 52	2,2',5,5'-Tetrachlorobiphenyl
5	PCB 70	2,3',4',5-Tetrachlorobiphenyl
6	PCB101	2,2',4,5,5'-Pentachlorobiphenyl
7	PCB 81	3,4,4',5-Tetrachlorobiphenyl
8	PCB 77	3,3',4,4'-Tetrachlorobiphenyl
9	PCB 123	2',3,4,4',5-Pentachlorobiphenyl
10	PCB 118	2,3',4,4',5-Pentachlorobiphenyl
11	PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl
12	PCB 105	2,3,3',4,4'-Pentachlorobiphenyl
13	PCB 164	2,3,3',4',5',6-Hexachlorobiphenyl
14	PCB 163	2,3,3',4',5,6-Hexachlorobiphenyl
15	PCB 138	2,2',3,4,4',5'-Hexachlorobiphenyl
16	PCB 126	3,3',4,4',5-Pentachlorobiphenyl
17	PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl
18	PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl
19	PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl
20	PCB 180	2,2',3,4,4',5,5'-Heptachlorobiphenyl
21	PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl
22	PCB 170	2,2',3,3',4,4',5-Heptachlorobiphenyl
23	PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl

Reproducible PCB Analysis on a 60m ZB-Dioxin GC Column



Number	Compound	Description	RT (min)	Area-RSD%
1	PCB 31	2,4',5'-Trichlorobiphenyl	23.026	0.666
2	PCB 28	2,4,4'-Trichlorobiphenyl	23.922	0.763
3	PCB 69	2,3',4,6-Tetrachlorobiphenyl	24.140	0.962
4	PCB 52	2,2',5,5'-Tetrachlorobiphenyl	26.145	0.472
5	PCB 70	2,3',4',5-Tetrachlorobiphenyl	26.897	0.976
6	PCB101	2,2',4,5,5'-Pentachlorobiphenyl	27.867	2.696
7	PCB 81	3,4,4',5-Tetrachlorobiphenyl	28.212	2.228
8	PCB 77	3,3',4,4'-Tetrachlorobiphenyl	28.770	2.660
9	PCB 123	2',3,4,4',5-Pentachlorobiphenyl	28.901	2.626
10	PCB 118	2,3',4,4',5-Pentachlorobiphenyl	29.492	1.652
11	PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl	29.734	2.262
12	PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	30.280	2.302
13	PCB 164	2,3,3',4',5',6-Hexachlorobiphenyl	30.365	3.382
14	PCB 163	2,2',3,4,4',5'-Hexachlorobiphenyl	30.752	3.198
15	PCB 138	3,3',4,4',5-Pentachlorobiphenyl	31.231	0.605
16	PCB 126	2,3',4,4',5,5'-Hexachlorobiphenyl	31.943	0.670
17	PCB 167	2,3,3',4,4',5'-Hexachlorobiphenyl	32.089	2.127
18	PCB 156	2,2',3,4,4',5,5'-Heptachlorobiphenyl	32.346	1.292
19	PCB 157	3,3',4,4',5,5'-Hexachlorobiphenyl	33.065	1.653
20	PCB 180	2,2',3,3',4,4',5-Heptachlorobiphenyl	33.228	2.432
21	PCB 169	2,2',3,3',4,4',5-Heptachlorobiphenyl	34.093	1.510
22	PCB 170	2,3,3',4,4',5,5'-Heptachlorobiphenyl		
23	PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl		

Fast GC-MS/MS Analysis of 20 PCBs



- 20 PCBs in less than 18 min
- Critical Pair separation
- Dioxins and PCB Spectral resolution

GC-MS Conditions

Column: Zebtron™ ZB-Dioxin
Dimension: 40 meter x 0.18 mm x 0.14 μm
Part No.: 7PD-G045-47
Injection: 1 μL, Splitless for 1.5 min@ 290 °C
Recommended Liner: Zebtron™ PLUS Liner compatible with Agilent & Thermo GC instrument
Part No.: AG2-0A13-05
Carrier Gas: Helium @ 0.8 mL/min (constant flow)
Oven Program: 45 °C for 0 min to 175 °C @ 50 °C/min, to 220 °C @ 15 °C/min, to 250 °C @ 5 °C/min for 3 min, to 300 °C @ 50 °C/min for 10 min
Detector: GC-MS
Transfer Line Temperature: 300 °C
Mode: Scan (100-450 m/z)
Source Temperature: 300 °C
Quad Temperature: 150 °C
Solvent delay: 8.0 min

Analyte:

1. PCB-28	10. PCB-153	19. PCB-169
2. PCB-31	11. PCB-105	20. PCB-189
3. PCB-52	12. PCB-138	
4. PCB-101	13. PCB-126	
5. PCB-81	14. PCB-167	
6. PCB-77	15. PCB-128	
7. PCB-123	16. PCB-156	
8. PCB-118	17. PCB-157	
9. PCB-114	18. PCB-180	

Fast GC-MS/MS Analysis of PCBs



AN-1022

Fast GC-MS/MS Analysis of PCBs and Dioxins on a Single Zebtron™ ZB-Dioxin GC Column

Handbook ZB-Dioxin™, ZB-Dioxin™, ZB-Dioxin™, ZB-Dioxin™, ZB-Dioxin™ and ZB-Dioxin™
Phenomenex, Inc., 221 Market Ave., Torrance, CA 90503 USA
*Baker Laboratories, Inc., 2889 Clark Avenue, Industry, CA 91702 USA

Overview

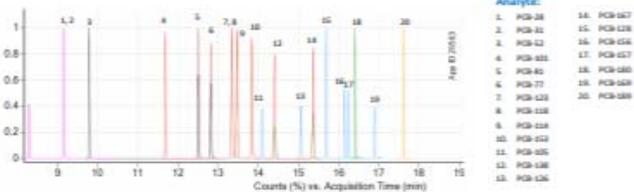
Polychlorinated Biphenyls (PCBs) are synthetic chemical compounds that are persistent in nature, as are dioxins. Persistent pollutants are constantly monitored in environmental and food samples. Both of these analyte classes have numerous congeners that are similar in structure and need high chromatographic selectivity to resolve the most toxic isomer from the other.

Commonly, two different GC column selectivities are utilized for PCBs and dioxin analysis by GC-HRMS or GC-MS/MS. The column swap between the two selectivities involves venting the MS, re-establishing vacuum, and tuning the mass spec, which causes a lot of instrument down time. In this application note, we present ZB-Dioxin as a single GC solution for both PCB and Dioxins by GC-MS/MS. This not only improves lab productivity by cutting the instrument down time but also provides a single method with short run time to process multiple Dioxin and PCB samples.

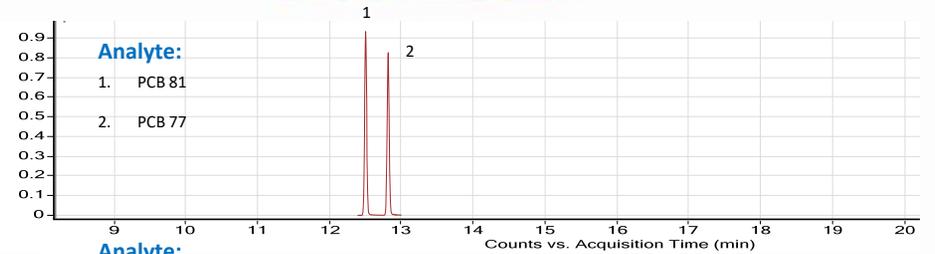
GC-MS/MS Conditions

Column: Zebtron ZB-Dioxin
Dimension: 40 meter x 0.18 mm x 0.14 μm
Part No.: ZB-DIOXIN-47
Injection: Splitless for 1.5 min @ 290 °C, 1 μL
Recommended Liner: Zebtron PLUS 2-2mm™ (Compatible with Agilent® & Thermo® GC Instrument)
Part No.: AG2-0413-00
Carrier Gas: Helium @ 0.8 mL/min (constant flow)
Oven Program: 45 °C for 0 min to 175 °C @ 50 °C/min, to 220 °C @ 15 °C/min, to 250 °C @ 5 °C/min for 2 min, to 300 °C @ 50 °C/min for 10 min
Detector: GC-MS/MS
Transfer Line Temperature: 300 °C
Mode: Scan (100-450 m/z)
Source Temperature: 300 °C
Quad Temperature: 150 °C
Solvent Delay: 8.0 min

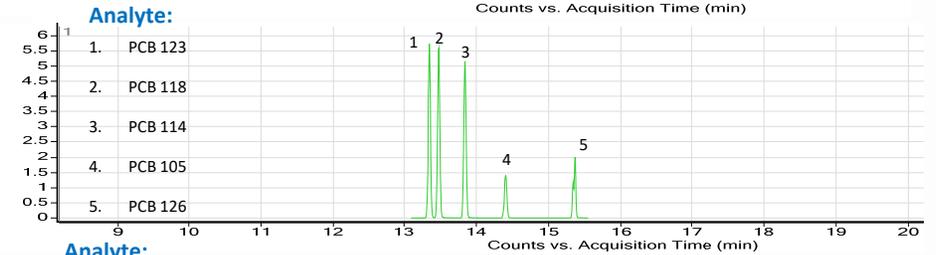
Figure 1. GC-MS/MS Analysis of PCBs on a 40 Meter Zebtron ZB-Dioxin GC Column



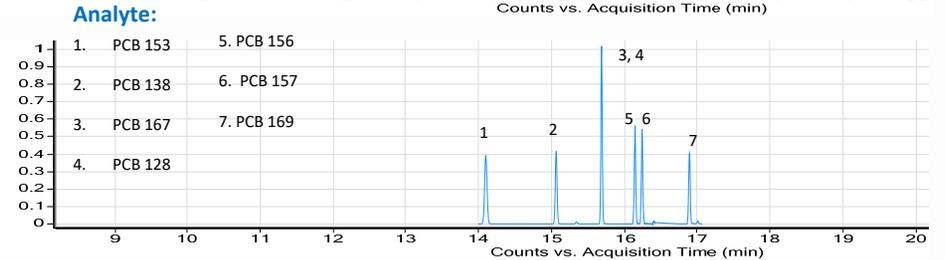
Refer to Table 1 on pages 4 & 5 for MS/MS parameters



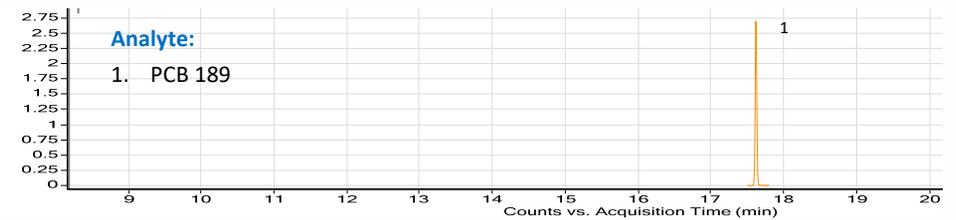
App ID 26566



App ID 26564

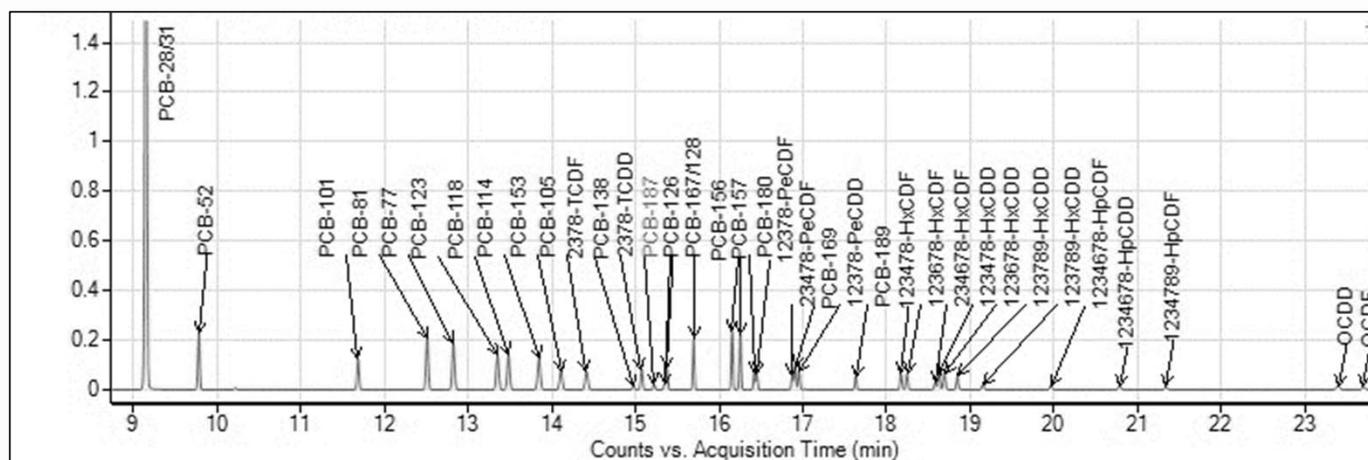


App ID 26565



App ID 26573

Fast GC-MS/MS Analysis of 36 Dioxins & PCBs

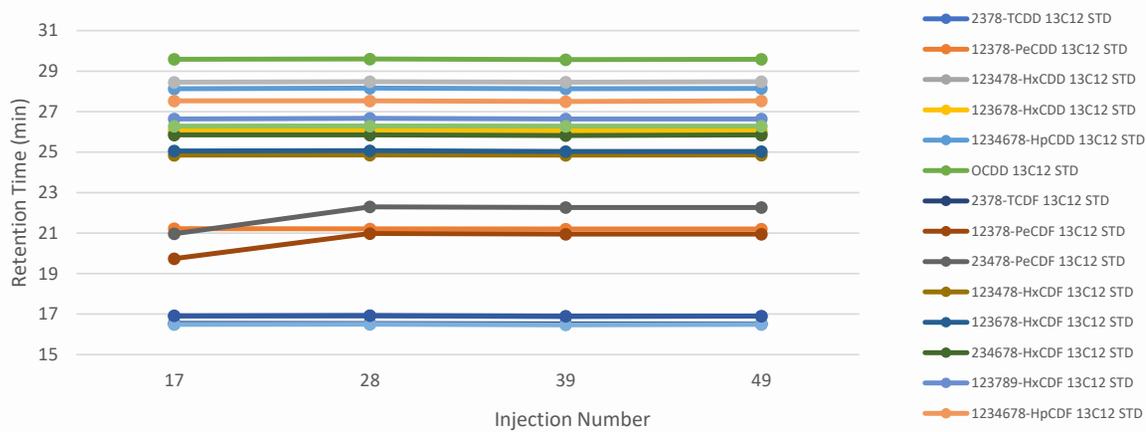


Analyte:

- | | |
|------------------|-------------------------|
| 1. PCB-28 | 20. PCB-157 |
| 2. PCB-31 | 21. PCB-180 |
| 3. PCB-52 | 22. 1,2,3,7,8-PeCDF |
| 4. PCB-101 | 23. 2,3,4,7,8-PeCDF |
| 5. PCB-81 | 24. PCB-169 |
| 6. PCB-77 | 25. 1,2,3,7,8-PeCDD |
| 7. PCB-123 | 26. PCB-189 |
| 8. PCB-118 | 27. 1,2,3,4,7,8-HxCDF |
| 9. PCB-114 | 28. 1,2,3,6,7,8-HxCDF |
| 10. PCB-153 | 29. 2,3,4,7,8-HxCDF |
| 11. PCB-105 | 30. 1,2,3,4,7,8-HxCDD |
| 12. 2,3,7,8-TCDF | 31. 1,2,3,6,7,8-HxCDD |
| 13. PCB-138 | 32. 2,3,4,7,8-HxCDD |
| 14. 2,3,7,8-TCDD | 33. 1,2,3,4,6,7,8-HpCDD |
| 15. PCB-187 | 34. 1,2,3,4,6,7,8-HpCDF |
| 16. PCB-126 | 35. OCDD |
| 17. PCB-167 | 36. OCDF |
| 18. PCB-128 | |
| 19. PCB-156 | |

- Optimal 40m column for short run time
- 36 Dioxins & PCBs in less than 24 min
- Critical PCBs resolved
- Dioxins, Furans and PCBs spectrally resolved

Robust Dioxin Analysis with Real Sample- Fly Ash

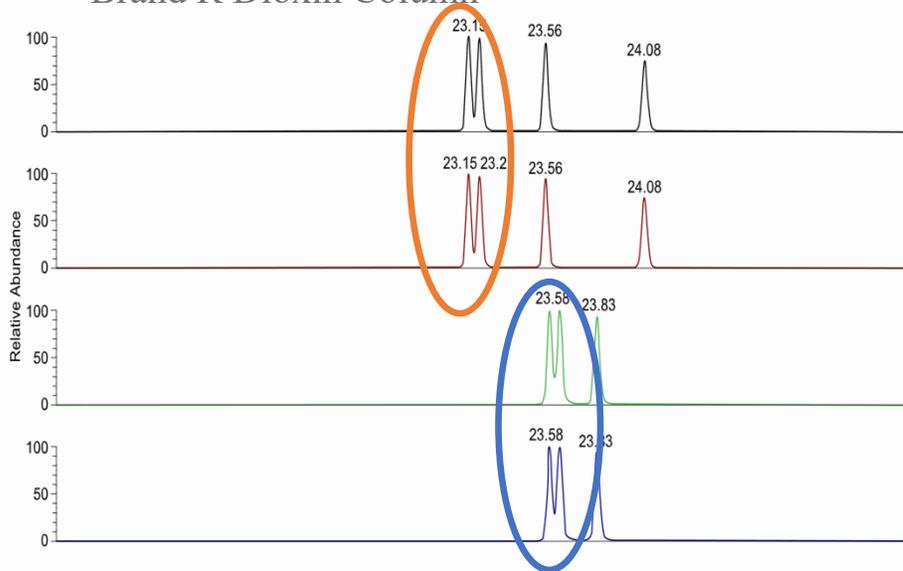


Reproducible Retention Time of Mid-Level Calibration Standards of Tetra through Octa Dioxins and Furans During the Robustness Experiment

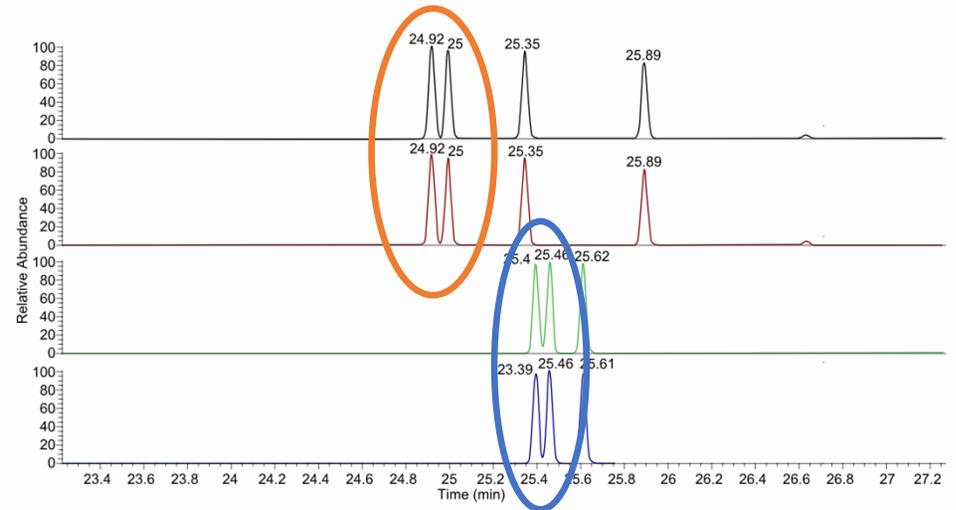
Retention Time (min)	Analyte Name	Internal Standard
15.18	1,3,6,8-TCDD	
16.95	2,3,7,8-TCDD	13C 2,3,7,8-TCDD
17.53	1,2,8,9-TCDD	
16.52	2,3,7,8-TCDF	13C 2,3,7,8-TCDF
17.83	1,2,8,9-TCDF	
18.67	1,2,4,7,9- PeCDD	
21.25	1,2,3,7,8-PeCDD	13C 1,2,3,7,8-PeCDD
21.76	1,2,3,8,9-PeCDD	
17.43	1,3,4,6,8-PeCDF	
19.78	1,2,3,7,8-PeCDF	13C 1,2,3,7,8-PeCDF
22.32	1,2,3,8,9-PeCDF	
20.79	2,3,4,7,8-PeCDF	13C 2,3,4,7,8-PeCDF
25.97	1,2,3,4,7,8-HxCDD	13C 1,2,3,4,7,8-HxCDD
23.81	1,2,4,6,7,9-HxCDD	
26.30	1,2,3,4,6,7-HxCDD	
26.08	1,2,3,6,7,8-HxCDD	13C 1,2,3,6,7,8-HxCDD
26.20	1,2,3,7,8,9-HxCDD	
24.90	1,2,3,4,7,8-HxCDF	13C 1,2,3,4,7,8-HxCDF
25.08	1,2,3,6,7,8-HxCDF	13C 1,2,3,6,7,8-HxCDF
26.69	1,2,3,7,8,9-HxCDF	13C 1,2,3,7,8,9-HxCDF
26.69	1,2,3,4,8,9-HxCDF	
25.87	2,3,4,6,7,8-HxCDF	13C 2,3,4,6,7,8-HxCDF
28.15	1,2,3,4,6,7,9-HpCDD	13C 1,2,3,4,6,7,8,9-HpCDD
27.70	1,2,3,4,6,7,8-HpCDD	
27.55	1,2,3,4,6,7,8-HpCDF	13C 1,2,3,4,6,7,8-HpCDF
28.48	1,2,3,4,7,8,9-HpCDF	13C 1,2,3,4,7,8,9-HpCDF
29.59	OCDD	
29.74	OCDF	13C OCDD

Improved Resolution of Hexachlorinated Dioxins in Real Sample- Fish Oil

Brand R Dioxin Column

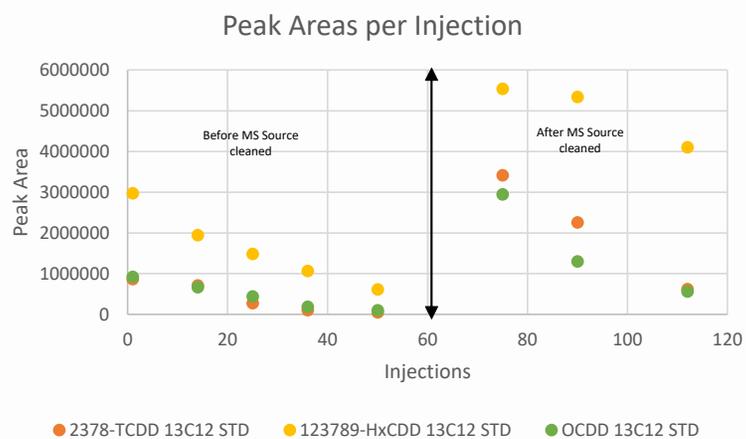


ZB-Dioxin GC Column

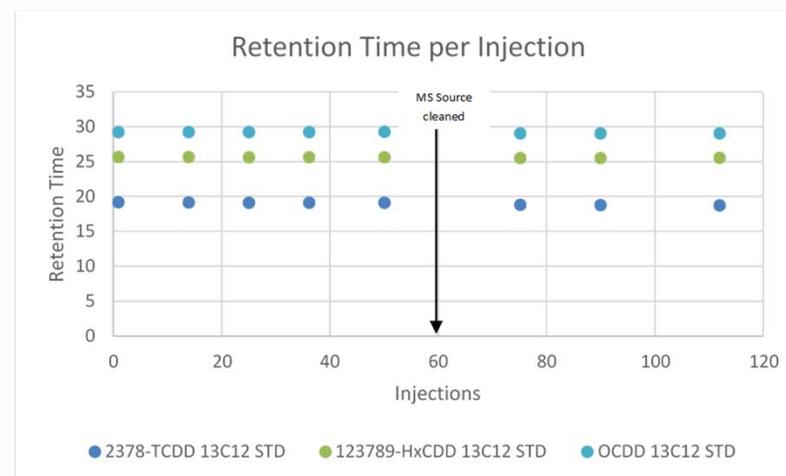


Improved Resolution of HxCDD

Robust Dioxin Analysis with Real Sample- Fish Oil

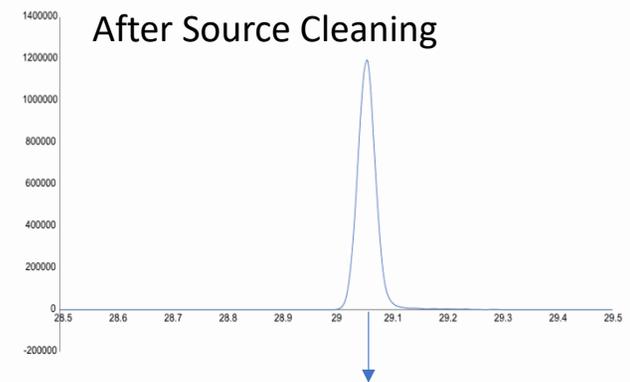
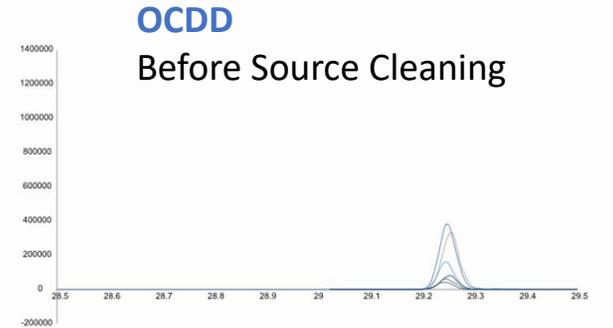
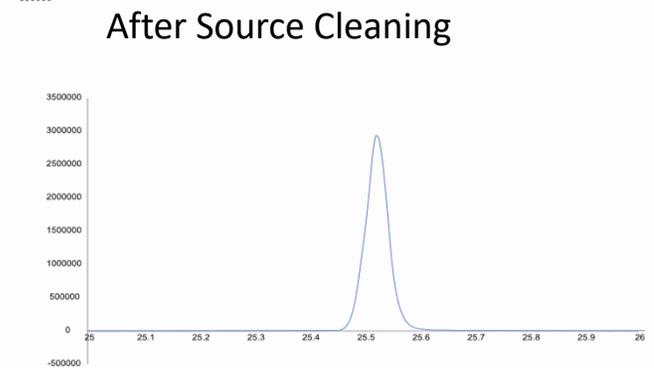
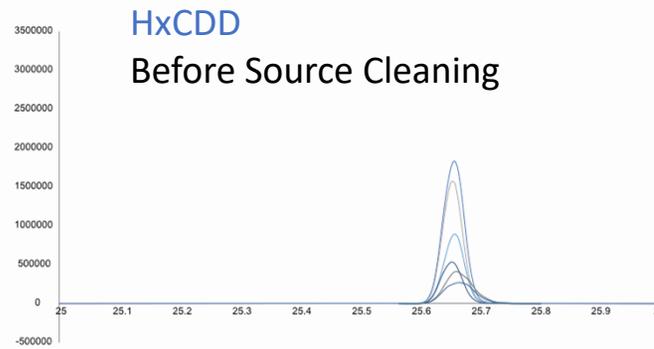
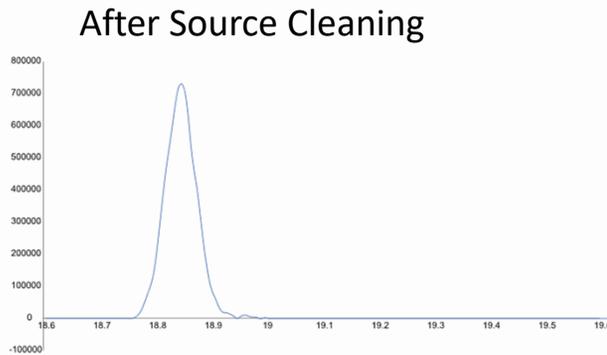
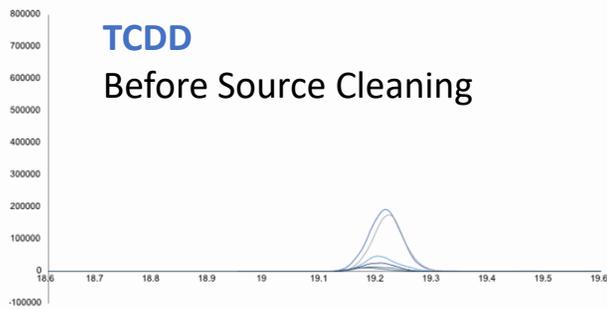


Peak areas for 2378-TCDD, 123789 HxCDD and OCDD standards after 112 injections of fish oil samples.



Retention times for 2378 TCDD, 123789 HxCDD and OCDD after 112 injections of fish oil samples.

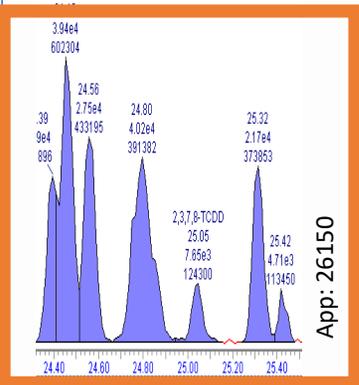
Robust Dioxin Analysis with Real Sample- Fish Oil



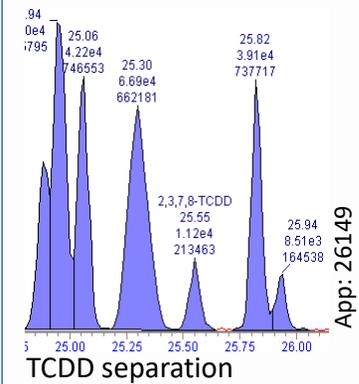
Last Eluting Dioxin within 30 min

Zebron Guardian™ Benefits

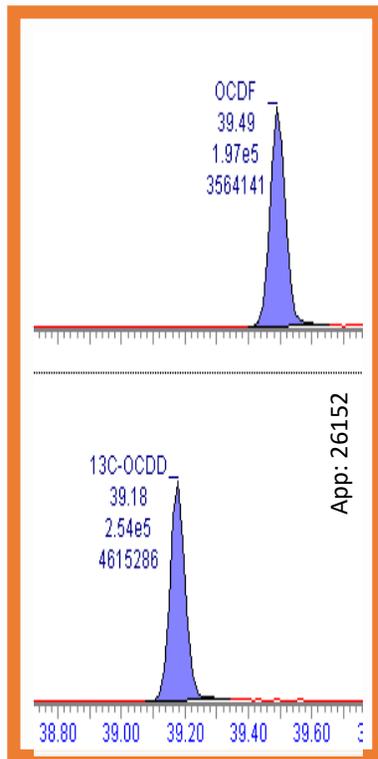
With Guardian



Without Guardian

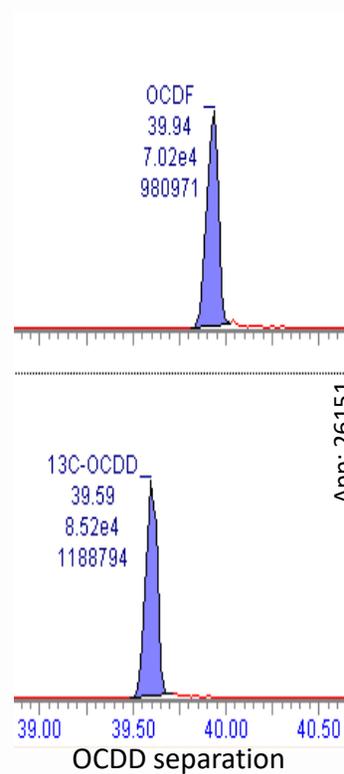


With Guardian



OCDD separation

Without Guardian

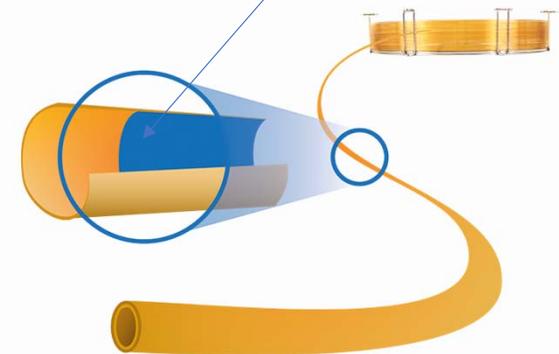


OCDD separation

ZB-Dioxin with Guardian™

- Negligible change in retention time
- Prevent Excessive trimming
- Extend life time

Seamless union of guard and analytical column for leak free connection



Summary

Introduction

- POPs
- Resolution Improvement
- Current Challenges with Dioxin analysis

ZB-Dioxin Applications

- Exceeding EPA 1613 requirement
- Balance of Resolution and Speed
- Extend lifetime with Guardian
- Dioxins & PCBs
- Robustness with Real Sample Matrix

WWW.Phenomenex.com/gcdioxin

Thank You



New ZB-Dioxin
SINGLE column solution for PCBs

www.phenomenex.com/GCDioxin

ZB-Dioxin for Fast Dioxin and PCB Analysis

www.phenomenex.com/GCDioxin

ZB-Dioxin
Increase throughput and improve resolution by using Zebtron ZB-Dioxin!

Traditional	ZB-Dioxin Upgrade
Method requires 2 different GC columns (DB-5/DB-5MS phase and 1 GC column)	ZB-Dioxin is a DB-5/DB-5MS phase and 1 GC column solution for Dioxin analysis
Higher analysis cost: 2 GC columns + 2 GC columns	Lower analysis cost: 1 GC column + 1 GC column
Long Run Time for Dioxin analysis: 90 mins	Faster Run Time using new ZB-Dioxin: 40 mins
Step column 0% phase: 140 minutes	Step column 0% phase: 30 minutes
Second column DB-5 phase: 30 minutes	Second column DB-5 phase: 30 minutes
Lower throughput from customer perspective	Higher throughput from customer perspective (due to column's used for 1 or 2 page 8)
Some GC Dioxin columns do not tolerate 250°C temperature limits	Low bleed GC column temp up to 340°C for sensitive limits

www.phenomenex.com/GCDioxin

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TN-2095 APPLICATIONS

A Single Column Solution for Improved Resolution of Tetrachlorodibenzo-p-dioxin (TCDD) and by GC-MS/MS/Tetrachlorodibenzo-p-dioxin (TCDF) using Zebtron™ ZB-Dioxin by GC-MS/MS

Introduction
Dioxins are Persistent Organic Pollutants (POPs) generated from industrial activities and their combination of electronic conjugating rings that can remain stable in the atmosphere for a long time, stabilizes their structure and makes them persistent. Accoring to World Health Organization (WHO), dioxins can cause respiratory and developmental problems, damage the immune system, interfere with hormones and also cause cancer. In addition to environmental samples, these are controlled, monitored in methods including EPA-1631 and EPA-8230 that can be used for monitoring dioxins. These methods specify that it is a 1% Pheryl GC column (8ms column) is used for the primary column for loading and GC-MS/MS analysis of 2,3,7,8-TCDD. It requires multiple columns (DB-5/DB-5MS and 1 GC column) to resolve the TCDD samples from lead, 2,3,7,8-TCDF and low GC column to complete the analysis. The Pheryl GC column provides high resolution and increases overall GC efficiency and selectivity of ZB-Dioxin provides the highest resolution (EPA-1631 method) resolution.

Figure 1a
Separation of 2,3,7,8-TCDD and its isomers on a 60 meter Zebtron ZB-Dioxin GC column.

Figure 1b
Separation of 2,3,7,8-TCDD and its isomers on a 60 meter Zebtron ZB-Dioxin GC column with 5 meter Shimadzu.

TN-2096 APPLICATIONS

GC-MS/MS Analysis of Tetra through Octa Dioxins and Furans on Zebtron™ ZB-Dioxin GC Columns

Introduction
Dioxins are Persistent Organic Pollutants (POPs) generated from industrial activities and their combination of electronic conjugating rings that can remain stable in the atmosphere for a long time, stabilizes their structure and makes them persistent. Accoring to World Health Organization (WHO), dioxins can cause respiratory and developmental problems, damage the immune system, interfere with hormones and also cause cancer. In addition to environmental samples, these are controlled, monitored in methods including EPA-1631 and EPA-8230 that can be used for monitoring dioxins. These methods specify that it is a 1% Pheryl GC column (8ms column) is used for the primary column for loading and GC-MS/MS analysis of 2,3,7,8-TCDD. It requires multiple columns (DB-5/DB-5MS and 1 GC column) to resolve the TCDD samples from lead, 2,3,7,8-TCDF and low GC column to complete the analysis. The Pheryl GC column provides high resolution and increases overall GC efficiency and selectivity of ZB-Dioxin provides the highest resolution (EPA-1631 method) resolution.

Figure 1
Separation of 2,3,7,8-TCDD and its isomers on a 60 meter Zebtron ZB-Dioxin GC column with 5 meter Shimadzu.