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

Ramkumar Dhandapani[1], Richard Jack[1], Rola Elabaji[1], Agustin Pieri[2], Eduardo Morales[2] and Eric Cull[2]
[1]Phenomenex, Inc., 411 Madrid Ave., Torrance, CA 90501 USA
[2] Weck Laboratories, Inc., 14859 Clark Avenue, Industry, CA 91745 USA

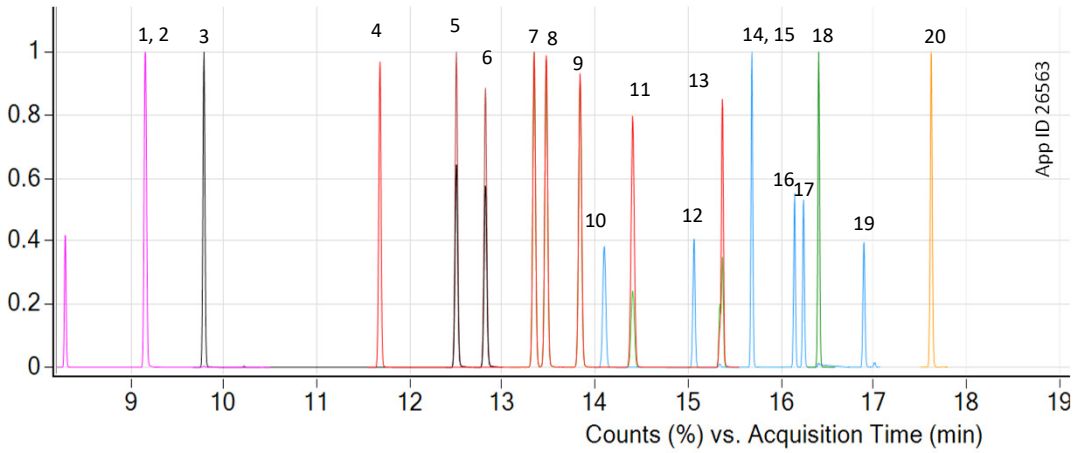
Overview

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: Zebron ZB-Dioxin
Dimension: 40 meter x 0.18 mm x 0.14 µm
Part No.: 7PD-G045-47
Injection: Splitless for 1.5 min@ 290 °C, 1 µL
Recommended Liner: Zebron PLUS Z-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/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 Zebron ZB-Dioxin GC Column

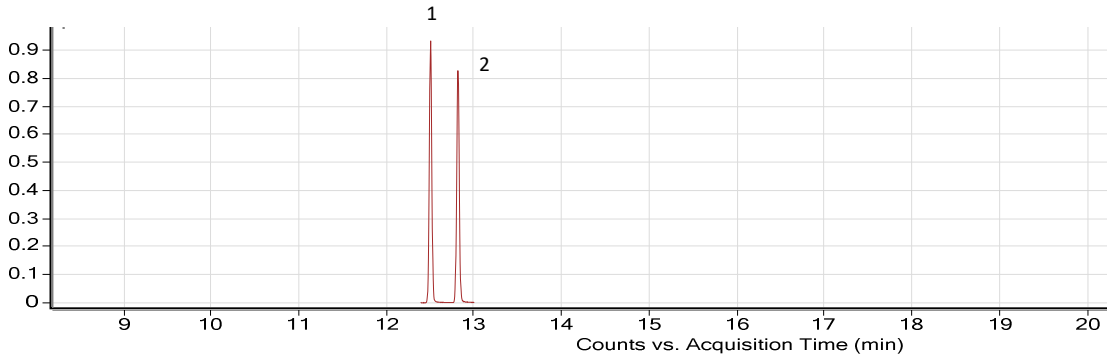


Analyte:

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

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

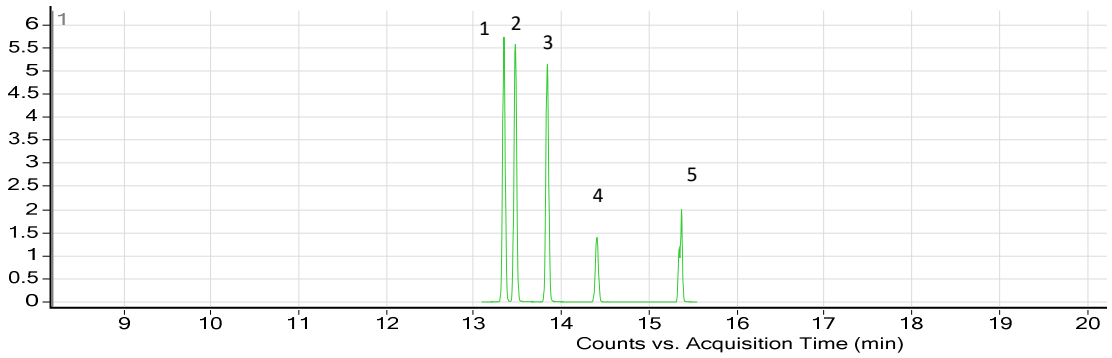
Figure 2a. **GC-MS/MS Analysis of PCBs (MRM 290->220 m/z) on a 40 Meter Zebron ZB-Dioxin GC Column**



Analyte:

1. PCB 81
2. PCB 77

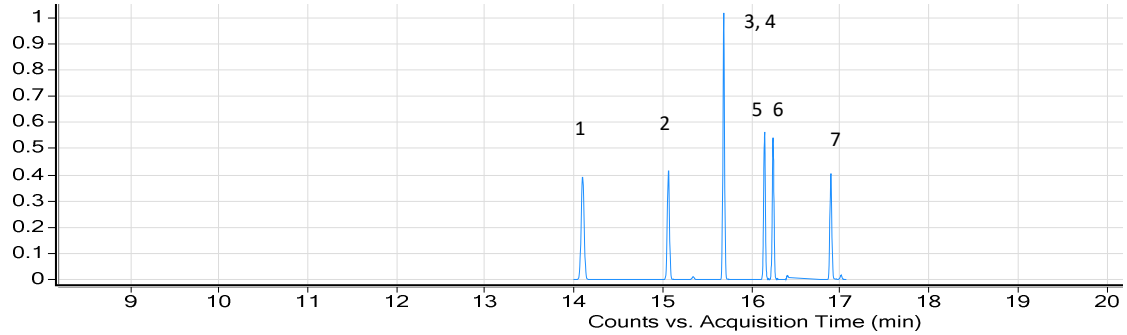
Figure 2b. **GC-MS/MS Analysis of PCBs (MRM 324->254 m/z) on a 40 Meter Zebron ZB-Dioxin GC Column**



Analyte:

1. PCB 123
2. PCB 118
3. PCB 114
4. PCB 105
5. PCB 126

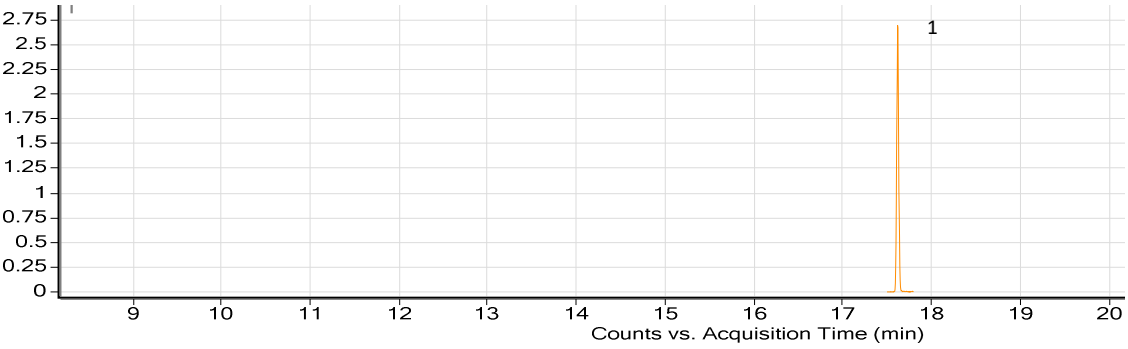
Figure 2c. **GC-MS/MS Analysis of PCBs (MRM 360->290 m/z) on a 40 Meter Zebron ZB-Dioxin GC Column**



Analyte:

1. PCB 153
2. PCB 138
3. PCB 167
4. PCB 128
5. PCB 156
6. PCB 157
7. PCB 169

Figure 2d. **GC-MS/MS Analysis of PCBs (MRM 394->324 m/z) on a 40 Meter Zebron ZB-Dioxin GC Column

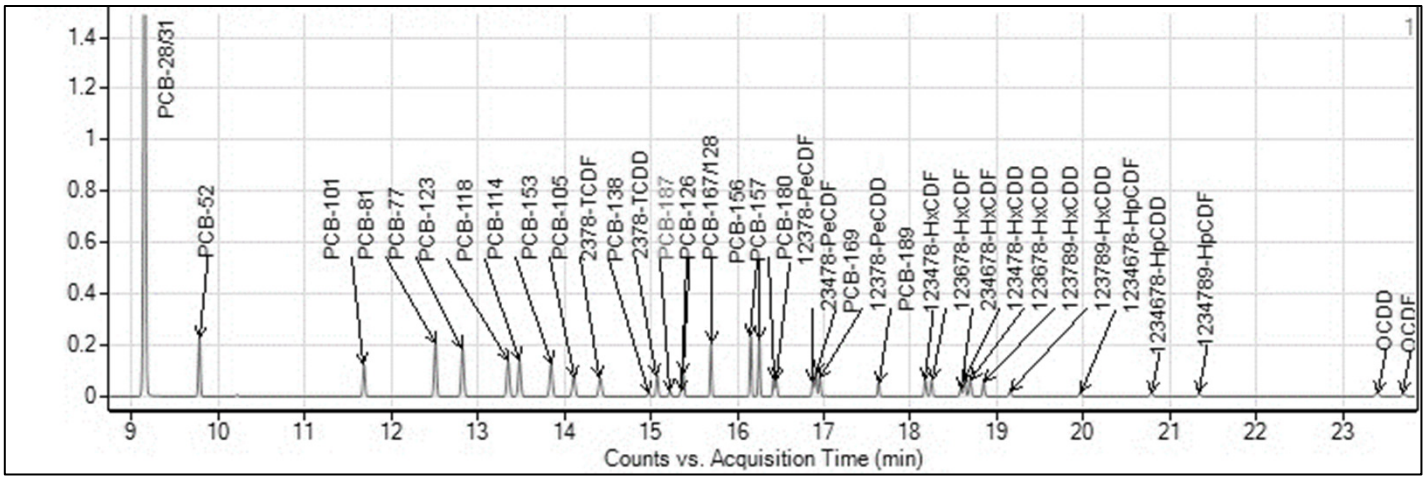


Analyte:

1. PCB 189

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

Figure 3. **GC-MS/MS Analysis of PCBs and Dioxins on a 40 Meter ZB-Dioxin GC column**



App ID 26562

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

GC-MS/MS Conditions

Column: Zebron ZB-Dioxin
Dimension: 40 meter x 0.18 mm x 0.14 µm
Part No.: 7PD-G045-47
Injection: Splitless for 1.5 min@ 290 °C, 1 µL
Recommended Liner: Zebron PLUS Z-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/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:

PCB-28
PCB-31
PCB-52
PCB-101
PCB-81
PCB-77
PCB-123
PCB-118
PCB-114
PCB-153
PCB-105
2,3,7,8-TCDF
PCB-138
2,3,7,8-TCDD
PCB-187
PCB-126
PCB-167
PCB-128
PCB-156
PCB-157
PCB-180
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
PCB-169
1,2,3,7,8-PeCDD
PCB-189
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
2,3,4,7,8-HxCDF
1,2,3,4,7,8-HxCDD
1,2,3,6,7,8-HxCDD
2,3,4,7,8-HxCDD
1,2,3,4,6,7,8-HpCDD
1,2,3,4,6,7,8-HpCDF
OCDD
OCDF

Our Customer Says Yes!

"The ZB-Dioxin achieves superior resolution for both 2,3,7,8-TCDD and 2,3,7,8-TCDF while not only maintaining chromatography for the hexes but improving it. This is all performed while reducing the overall runtime over traditional 5ms dioxin columns by as much as 25%. The ZB-Dioxin increases throughput by not only eliminating the need for a second column confirmation, but also by allowing additional samples to be analyzed in each 12-hour analytical sequence" **Andrew Patterson, Technical Director, Eurofins Specialty Services, USA**

The opinions stated herein are solely those of the speaker and not necessarily those of any company or organization.

Table 1. **MS/MS Method Parameters for Dioxin and PCB Separation**

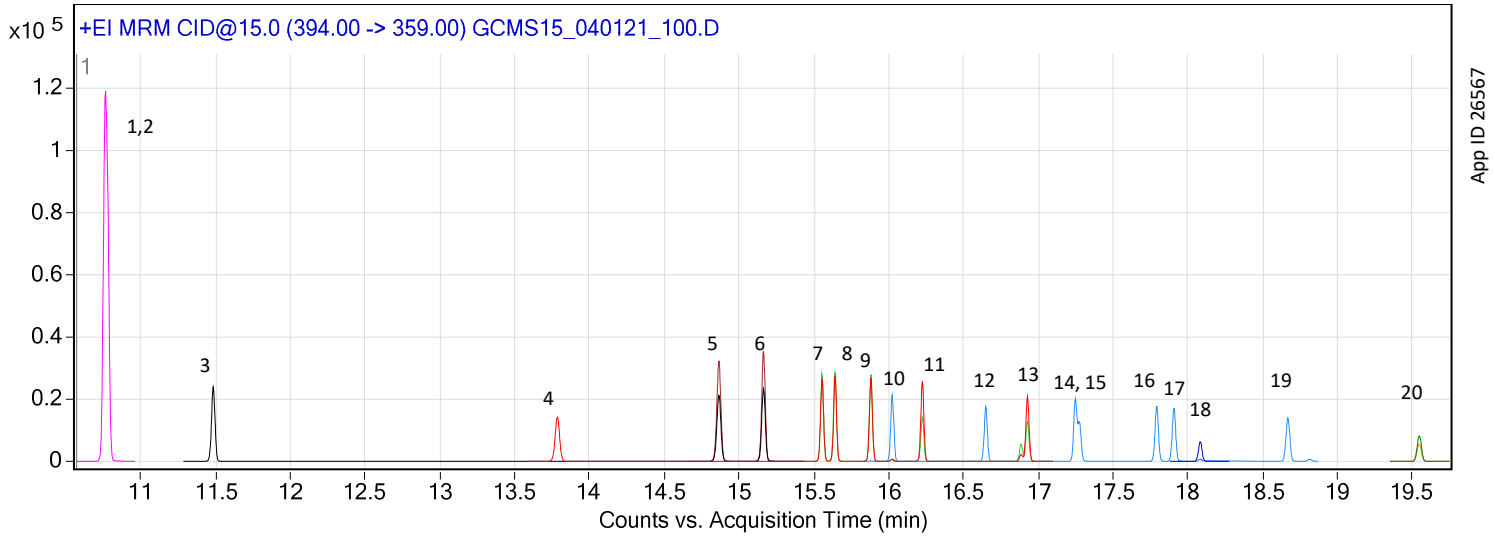
Analyte Name	Precursor ion	Product ion	RT		Dwell (ms)	CE (V)
			40 meter	60 meter		
PCB 28	258	186	9.19	10.77	72.1	25
	256	186	9.19	10.77	72.1	25
PCB 31	258	186	9.5	10.77	72.1	25
	256	186	9.5	10.77	72.1	25
PCB 52	292	220	9.82	11.48	40.8	27
	220	150	9.82	11.48	40.8	35
PCB 101	326	256	11.71	13.79	124	35
	254	184	11.71	13.79	124	35
PCB 81	292	220	12.54	14.87	124.1	27
	290	220	12.54	14.87	124.1	24
PCB 77	292	220	12.86	15.16	124.1	27
	290	220	12.86	15.16	124.1	24
PCB 123/118	326	256	13.36	15.56	186.7	25
	324	254	13.38	15.64	186.7	25
PC 114	326	256	13.47	15.88	92.9	25
	324	254	13.47	15.88	92.9	25
PCB 153	362	290	14.14	16.03	92.9	30
	360	290	14.14	16.03	92.9	30
PCB 105	326	256	14.45	16.23	124.1	25
	324	254	14.45	16.23	124.1	45
2378-TCDF	306	243	15	16.61	75.5	40
	304	241	15	16.61	75.5	40
138	362	290	15.1	16.65	51.2	30
	360	290	15.1	16.65	51.2	30
2378-TCDD	322	259	15.25	16.8	47.7	26
	320	257	15.25	16.8	47.7	26
PCB 126	326	256	15.4	16.9	82.5	35
	324	254	15.4	16.9	82.5	45
128/167	358	288	15.71	17.25	124.1	24
	360	290	15.71	17.25	124.1	30
156	360	290	16.18	17.79	64.3	30
	358	288	16.18	17.79	64.3	24
157	360	290	16.27	17.9	44.3	30
	358	288	16.27	17.9	44.3	24
180	396	324	16.43	18.08	44.3	25
	394	359	16.43	18.08	44.3	15

Total MRMs	70
Minimum Concurrent MRMs	1
Maximum Concurrent MRMs	8
Min Dwell (group average)	40.8
Max Dwell (group average)	186.7
Estimated Cycle Time	250
IonSource	EI
Source Temp. (°C)	300
Solvent Delay (min)	8

Table 1. **MS/MS Method Parameters for Dioxin and PCB Separation (Continued)**

Analyte Name	Precursor ion	Product ion	RT		Dwell (ms)	CE (V)
			40 meter	60 meter		
12378-PeCDF	340	277	16.46	18.18	72	40
	338	275	16.46	18.18	72	40
23478-PeCDF	340	277	16.89	18.67	75.5	40
	338	275	16.89	18.67	75.5	40
169	360	290	16.92	18.68	54.7	30
	358	288	16.92	18.68	54.7	24
12378-PeCDD	356	293	16.97	18.76	75.5	26
	354	291	16.97	18.76	75.5	26
189	394	324	17.65	19.55	124.1	34
	392	322	17.65	19.55	124.1	28
123478-HxCDF	376	313	18.19	20.28	92.9	40
	374	311	18.19	20.28	92.9	40
123678-HxCDF	376	313	18.26	20.37	92.9	40
	374	311	18.26	20.37	92.9	40
234678-HxCDF	376	313	18.6	20.79	64.3	40
	374	311	18.6	20.79	64.3	40
123478-HxCDD	392	329	18.64	20.84	43.5	25
	390	327	18.64	20.84	43.5	25
123678-HxCDD	392	329	18.71	20.92	43.5	25
	390	327	18.71	20.92	43.5	25
123789-HxCDD	392	329	18.86	21.13	64.3	25
	390	327	18.86	21.13	64.3	25
123789-HxCDF	376	313	19.17	21.56	124.1	40
	374	311	19.17	21.56	124.1	40
1234678-HpCDF	410	347	19.98	22.59	124.1	40
	408	345	19.98	22.59	124.1	40
1234678-HpCDD	426	363	20.81	23.67	124.1	24
	424	361	20.81	23.67	124.1	24
1234789-HpCDF	410	347	21.37	24.45	124.1	40
	408	345	21.37	24.45	124.1	40
OCDD	460	397	23.43	27.21	92.9	24
	458	395	23.43	27.21	92.9	24
OCDF	444	381	23.73	27.67	61.6	40
	442	379	23.73	27.67	61.6	40

Figure 4. GC-MS/MS Analysis of PCBs on a 60 Meter ZB-Dioxin GC column



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

GC-MS/MS Conditions

Column: Zebron ZB-Dioxin
Dimension: 60 meter x 0.25 mm x 0.20 µm
Part No.: 7KG-G045-10
Injection: Splitless for 1.5 min@ 290 °C, 1 µL
Recommended Liner: Zebron PLUS Z-Liner™ (Compatible with Agilent® & Thermo® GC instrument)
Part No.: AG2-0A13-05
Carrier Gas: Helium @ 1.5 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 15 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

Analyte:

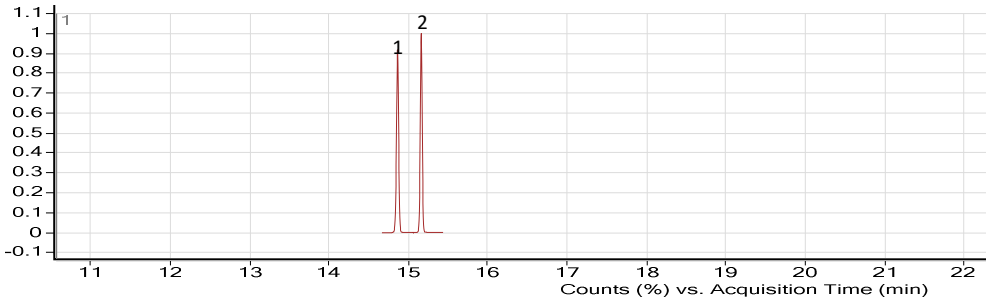
1. PCB-28
2. PCB-31
3. PCB-52
4. PCB-101
5. PCB-81
6. PCB-77
7. PCB-123
8. PCB-118
9. PCB-114
10. PCB-153
11. PCB-105
12. PCB-138
13. PCB-126
14. PCB-167
15. PCB-128
16. PCB-156
17. PCB-157
18. PCB-180
19. PCB-169
20. PCB-189

Our Customer Says Yes!

"The ZB-Dioxin column better resolution in all congeners and in the critical separations of the standard mixture compared to the one normally used (5% Phenyl Arylene)." **Dr. Fabio Busico, Istituto Zooprofilattico Sperimentale del Lazio e Toscana M.Aleandri**

The opinions stated herein are solely those of the speaker and not necessarily those of any company or organization.

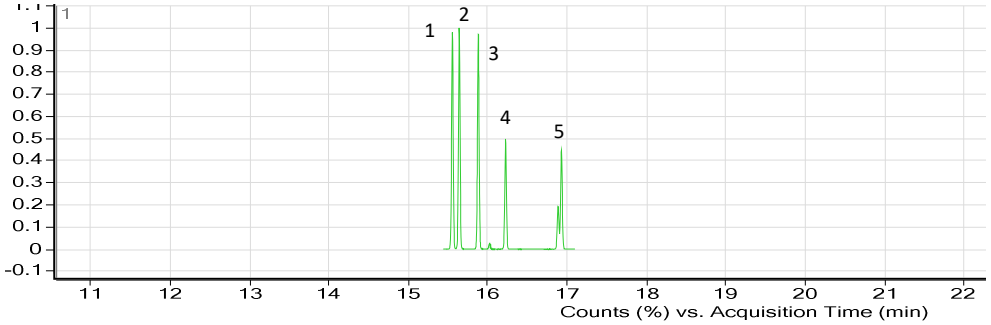
Figure 5a. GC-MS/MS Analysis of PCBs (290->222 m/z) on a 60 Meter ZB-Dioxin GC column



Analyte:

1. PCB 81
2. PCB 77

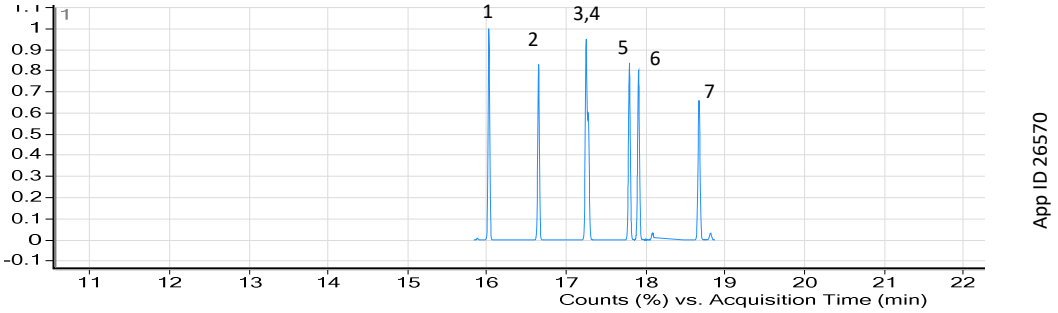
Figure 5b. GC-MS/MS Analysis of PCBs (324->254 m/z) on a 60 Meter ZB-Dioxin GC column



Analyte:

1. PCB 123
2. PCB 118
3. PCB 114
4. PCB 105
5. PCB 126

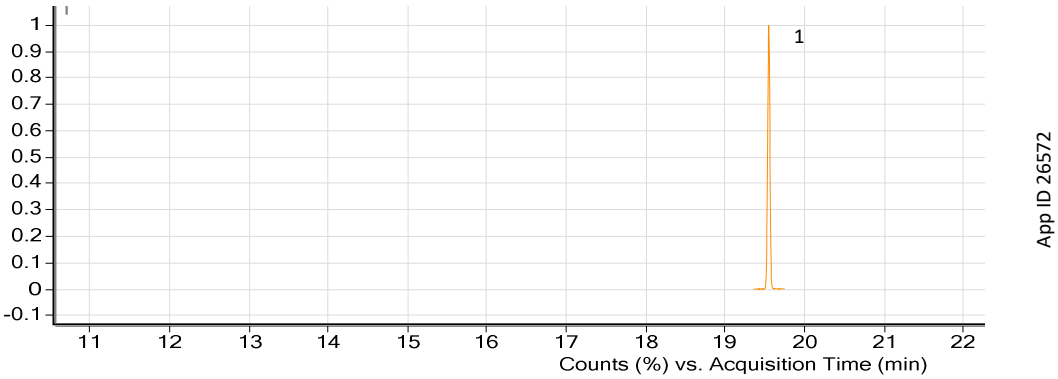
Figure 5c. GC-MS/MS Analysis of PCBs (360->290 m/z) on a 60 Meter ZB-Dioxin GC column



Analyte:

1. PCB 153
2. PCB 138
3. PCB 167
4. PCB 128
5. PCB 156
6. PCB 157
7. PCB 169

Figure 5d. GC-MS/MS Analysis of PCBs (392->322 m/z) on a 60 Meter ZB-Dioxin GC column

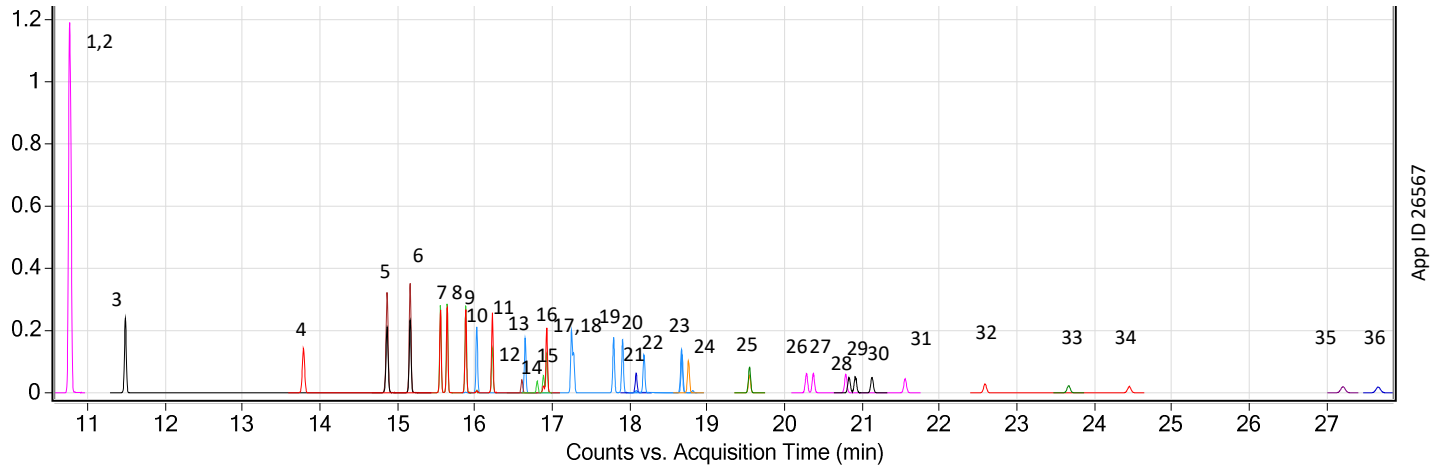


Analyte:

1. PCB 189

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

Figure 6. **GC-MS/MS Analysis of PCBs and Dioxins on a 60 Meter ZB-Dioxin GC column**



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

GC-MS/MS Conditions

Column: Zebron ZB-Dioxin
Dimension: 60 meter x 0.25 mm x 0.20 µm
Part No.: 7KG-G045-10
Injection: Splitless for 1.5 min@ 290 °C, 1 µL
Recommended Liner: Zebron PLUS Z-Liner™ (Compatible with Agilent® & Thermo® GC instrument)
Part No.: AG2-0A13-05
Carrier Gas: Helium @ 1.5 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 15 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

Analyte:

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

By structure, Dioxins and Furans have a hetero atom while PCBs have a biphenyl ring with substituted chlorine group at different position. So, the EI source fragmentation as well as MS/MS transition can spectrally resolve Dioxins from PCBs. For this experiment, mixture of 36 components including PCBs and Dioxins and Furans were analyzed on a 40m and 60m ZB-Dioxin GC Column. **Figure 1** represents the separation of 20 PCBs on a ZB-Dioxin GC column with 20 PCBs run within 19 min. **Figure 2a to 2d** represents individual PCBs that are quantified by their precursor to product transitions. This includes commonly analyzed critical pairs in PCB including PCB 123 and PCB 118, PCB 105 and 153 and PCB 156/157 that are completely resolved from each other. **Figure 3** represents the separation of 36 Dioxins , furans and PCBs on 40m ZB-Dioxin using the same method parameters within 24 min run time. Thus, the developed GC-MS/MS method provided fast analysis of Dioxins and PCBs within 24 min on a 40 meter ZB-Dioxin GC column. Traditionally, Dioxin and PCB analysis can take up to 60 minutes run time. With the optimal selectivity and column dimensions, such short run time is realized.

Generally, laboratories analyzing Dioxins perform their analysis on a 60 meter 5ms selectivity GC column and swap a different selectivity for their PCB analysis. Presented in **Figure 4** is the separation of 20 PCBs on a 60 meter ZB-Dioxin GC column. Figure **5a to d** represents individual critical PCBs by MS/MS transitions and **Figure 6** represents 36 Dioxins and PCBs on a single method. In addition to providing fast overall run time, 60 meter ZB-Dioxin GC column provides optimal separation of critical pairs of Dioxins and PCBs. The complete list of PCBs, Dioxins and furans along with MS transitions and their retention times on 40m and 60m ZB-Dioxin GC columns are presented in **Table 1**.

Notably, both 60 meter and 40 meter ZB-Dioxin provides similar profile due to the equivalent phase volume ratio in these two columns. While 60 meter ZB-Dioxin column dimension provides loadability, the 40 meter x 0.18 mm x 0.14 µm provides similar profile and resolution with much shorter analysis time. The versatile selectivity of ZB-Dioxin GC column allows it to analyze PCBs and dioxins in a single method without the necessity to change columns, in addition, this column also provides fast analysis, thus reducing down time and improving lab productivity.

Conclusion

Zebron™ ZB-Dioxin GC column provides optimal selectivity to analyze Dioxins and PCBs on a single column. With optimal dimension, a runtime as short as 24 min was achieved to separate 36 PCBs and Dioxins mixture.

Need a different column size or sample preparation format?

No problem! We have a majority of our available dimensions up on www.phenomenex.com, but if you can't find what you need right away, our super helpful Technical Specialists can guide you to the solution via our online chat portal www.phenomenex.com/LiveChat.

Australia
t: +61 (0)2-9428-6444
auinfo@phenomenex.com

Austria
t: +43 (0)1-319-1301
anfrage@phenomenex.com

Belgium
t: +32 (0)2 503 4015 (French)
t: +32 (0)2 511 8666 (Dutch)
beinfo@phenomenex.com

Canada
t: +1 (800) 543-3681
info@phenomenex.com

China
t: +86 400-606-8099
cninfo@phenomenex.com

Czech Republic
t: +420 272 017 077
cz-info@phenomenex.com

Denmark
t: +45 4824 8048
nordicinfo@phenomenex.com

Finland
t: +358 (0)9 4789 0063
nordicinfo@phenomenex.com

France
t: +33 (0)1 30 09 21 10
franceinfo@phenomenex.com

Germany
t: +49 (0)6021-58830-0
anfrage@phenomenex.com

Hong Kong
t: +852 6012 8162
hkinfo@phenomenex.com

India
t: +91 (0)40-3012 2400
indiainfo@phenomenex.com

Ireland
t: +353 (0)1 247 5405
eireinfo@phenomenex.com

Italy
t: +39 051 6327511
italiainfo@phenomenex.com

Luxembourg
t: +31 (0)30-2418700
nlinfo@phenomenex.com

Mexico
t: 01-800-844-5226
tecnicomx@phenomenex.com

The Netherlands
t: +31 (0)30-2418700
nlinfo@phenomenex.com

New Zealand
t: +64 (0)9-4780951
nzinfo@phenomenex.com

Norway
t: +47 810 02 005
nordicinfo@phenomenex.com

Poland
t: +48 22 104 21 72
pl-info@phenomenex.com

Portugal
t: +351 221 450 488
ptinfo@phenomenex.com

Singapore
t: +65 800-852-3944
sginfo@phenomenex.com

Slovakia
t: +420 272 017 077
sk-info@phenomenex.com

Spain
t: +34 91-413-8613
espinfo@phenomenex.com

Sweden
t: +46 (0)8 611 6950
nordicinfo@phenomenex.com

Switzerland
t: +41 (0)61 692 20 20
swissinfo@phenomenex.com

Taiwan
t: +886 (0) 0801-49-1246
twinfo@phenomenex.com

Thailand
t: +66 (0) 2 566 0287
thaiinfo@phenomenex.com

United Kingdom
t: +44 (0)1625-501367
ukinfo@phenomenex.com

USA
t: +1 (310) 212-0555
info@phenomenex.com

All other countries/regions
Corporate Office USA
t: +1 (310) 212-0555
info@phenomenex.com

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