Application Note

From Sample to Reports: Rapid Dioxin/PCB Analysis Using Fully Automated Sample Preparation

Introduction

Persistent organic pollutants (POPs) such as polychlorinated dibenzo-p-dioxins (PCDDs), furans (PCDFs) and biphenyls (PCBs) continue to attract interest around the world due to strict regulations in force in many countries. Rapid sample clean up, and analysis are therefore needed for many laboratories processing samples for POPs. In addition to processing times, solvent use is an important consideration as the cost of sample clean up involving large amounts of solvents can be very high.

In this app note we show a cleanup system, which allows for rapid cleanup (40 min) of complex matrices. Solvent consumption is limited to 100-260 mL and no dichloromethane is used during the cleanup step. Our fully automated system allows for sample turnaround times of only a few hours and same day analysis and results.

Instrumentation

- FMS, Inc. EP-110 Dioxin & PCBs sample preparation system
- FMS, Inc. SuperVap® 12 position 50 mL Concentrator
- FMS, Inc. SuperVap® Vial Concentrator
- Agilent 7010B TripleQuad GC/MS/MS System with J&W DB-5 GC Column, 60 m, 0.25 mm, 0.25 µm

Consumables

- FMS, Inc. High-Capacity Acidic Silica column
- FMS, Inc. Carbon column
- FMS, Inc. 6 g Basic Alumina column
- Fisher Hexane Pesticide Grade
- Fisher Toluene Pesticide Grade
- Relevant ^{13}C PCDD/Fs and PCBs isotope dilution and recovery standards

PLE

- 5-10 g sample mixed with Hydromatrix® and spiked with surrogates
- Sample placed in extraction cell
- Capped with disposable Teflon end caps
- Heated with 50% Dichloromethane/50% Hexane for 20 min at 120 ^{o}C and 1500 psi
- Nitrogen flush to transfer analytes and extract to 250 mL collection tubes

SuperVap Concentration

- Pre-heat temperature: 50 ^{o}C
- Pre-heat time: 5 min
- Heat in Sensor mode: 50 ^{o}C
- Nitrogen Pressure: 8 psi
- Solvent exchange to hexane
- Reduce sample volume to 1 mLs

Sample Clean Up

- Install high-capacity acid silica, carbon, and alumina columns
- Order of columns is acidic silica -carbon - alumina
- Uses hexane and toluene for 6-step program
- Spike samples with relevant standards if necessary
- Condition with 40 mL hexane
- Load sample in hexane onto silica column
- Elute all columns with 160 mL hexane and transfer analytes onto carbon and alumina
- Elute carbon in reverse (upward) direction with 40 mL toluene (collect PCDD/F and co-planary PCBs)
- Elute alumina in reverse direction with 40 mL toluene (collect mono-ortho and di-ortho PCBs)

FMS
Fluid Management Systems

SuperVap Concentration

- Pre-heat temperature: 50 °C
- Pre-heat time: 5 min
- Heat in Sensor mode: 50 °C
- Nitrogen Pressure: 8 psi
- Reduce sample volume to 1 mL

Vial Evaporator

- Reduce sample to 10 uL final volume under 1.5 psi nitrogen at 25 °C

Analysis 7010B Agilent TripleQuad GC/MS/MS

PCDD/Fs

Carrier gas helium 1.2 mL/min
T_{inj}= 300 °C split/splitless
Inject 1 mL sample
T-program: 130 °C 1 min hold
40 °C/min to 200 °C no hold
3 °C/min to 235 °C no hold
5 °C/min to 300 °C 13 min hold
Transfer line: 280 °C
Ion source: 300 °C with Quad 1 and 2 at 150 °C

PCBs

Carrier gas helium 1.2 mL/min
T_{inj}= 280 °C split/splitless
Inject 1 mL sample
T-program: 130 °C 1 min hold
40 °C/min to 200 °C no hold
3 °C/min to 235 °C no hold
5 °C/min to 300 °C 9 min hold
Transfer line: 280 °C
Ion source: 300 °C with Quad 1 and 2 at 150 °C

	spike	IDC-1	IDC-2	IDC-3	IDC-4	Average	STDEV	RSD (%)	Acceptable Window
2,3,7,8 TCDF	400	111.6	106.0	111.3	104.7	108.4	3.6	3.3	70%-130%
2,3,7,8 TCDD	400	107.5	111.2	107.8	111.4	109.5	2.1	1.9	70%-130%
1,2,3,7,8 PCDF	2000	106.8	98.8	109.8	97.5	103.2	6.0	5.8	70%-130%
2,3,4,7,8 PCDF	2000	111.7	98.5	108.5	100.0	104.7	6.4	6.1	70%-130%
1,2,3,7,8 PCDD	2000	111.0	103.2	113.2	104.1	107.9	5.0	4.6	70%-130%
1,2,3,4,7,8 HxCDF	2000	98.8	95.3	94.9	95.4	96.1	1.8	1.9	70%-130%
1,2,3,6,7,8 HxCDF	2000	102.5	99.9	100.0	98.1	100.1	1.8	1.8	70%-130%
2,3,4,6,7,8 HxCDF	2000	95.4	91.9	93.6	92.7	93.4	1.5	1.6	70%-130%
1,2,3,4,7,8 HxCDD	2000	99.4	113.8	99.2	95.7	102.0	8.0	7.9	70%-130%
1,2,3,6,7,8 HxCDD	2000	103.3	102.8	107.0	106.9	105.0	2.3	2.1	70%-130%
1,2,3,7,8,9 HxCDD	2000	115.7	93.6	103.9	110.6	105.9	9.6	9.0	70%-130%
1,2,3,7,8,9 HxCDF	2000	91.5	98.4	95.9	90.9	94.2	3.6	3.8	70%-130%
1,2,3,4,6,7,8 HpCDF	2000	106.3	104.1	108.4	96.9	103.9	5.0	4.8	70%-130%
1,2,3,4,6,7,8 HpCDD	2000	100.9	97.8	107.3	95.8	100.5	5.0	5.0	70%-130%
1,2,3,4,7,8,9 HpCDF	2000	103.3	98.4	105.6	94.9	100.5	4.8	4.8	70%-130%
OCDD	4000	96.2	95.9	98.3	90.5	95.2	3.3	3.5	70%-130%
OCDF	4000	112.8	95.3	99.6	91.5	99.8	9.3	9.3	70%-130%

Table 1 - Native PCDD/Fs for Initial Demonstration of Capability - Native spike 400-4000 pg - native amounts reported as percent recovery of spike (extraction, cleanup, and concentration - note that these are not ^{13}C recoveries)

	spike	IDC-1	IDC-2	IDC-3	IDC-4	Average	STDEV	RSD (%)	Acceptable Window
PCB-81	4000	102.2	110.2	118.7	111.4	110.6	6.8	6.1	70%-130%
PCB-77	4000	95.3	107.9	118.1	107.1	107.1	9.3	8.7	70%-130%
PCB-123	4000	85.6	94.0	92.2	90.7	90.6	3.6	4.0	70%-130%
PCB-118	4000	93.3	102.4	100.5	98.9	98.8	3.9	4.0	70%-130%
PCB-114	4000	88.0	97.5	96.2	95.4	94.3	4.3	4.5	70%-130%
PCB-105	4000	91.2	96.5	95.3	92.7	94.0	2.4	2.6	70%-130%
PCB-126	4000	99.4	112.0	114.4	112.2	109.5	6.8	6.2	70%-130%
PCB-167	4000	83.5	93.6	90.5	88.0	88.9	4.3	4.8	70%-130%
PCB-156	4000	91.3	92.4	92.4	86.0	90.5	3.0	3.4	70%-130%
PCB-157	4000	93.6	93.5	92.4	86.0	91.4	3.6	4.0	70%-130%
PCB-169	4000	113.0	100.6	97.8	104.8	104.0	6.6	6.4	70%-130%
PCB-189	4000	90.3	89.0	88.0	87.2	88.6	1.3	1.5	70%-130%

Table 2 - Native PCBs for Initial Demonstration of Capability - Native spike 400-4000 pg - native amounts reported as percent recovery of spike (extraction, cleanup, and concentration - note that these are not ^{13}C recoveries)

MDL study	native										
	spike	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt
	ppt	MDL-1	MDL-2	MDL-3	MDL-4	MDL-5	MDL-6	MDL-7	MB	STDEV	MDL
2,3,7,8 TCDF	0.20	0.19	0.20	0.20	0.19	0.21	0.28	0.24	0.08	0.03	0.10
2,3,7,8 TCDD	0.20	0.19	0.23	0.22	0.20	0.20	0.21	0.20	0.03	0.01	0.04
1,2,3,7,8 PCDF	1.00	1.03	1.08	1.08	1.00	1.04	0.91	1.10	0.16	0.06	0.20
2,3,4,7,8 PCDF	1.00	1.09	1.00	0.97	1.09	0.99	1.13	1.22	0.06	0.09	0.28
1,2,3,7,8 PCDD	1.00	0.91	1.11	1.09	1.05	1.04	1.36	1.39	0.04	0.18	0.55
1,2,3,4,7,8 HxCDF	1.00	0.91	0.99	0.80	0.88	0.96	1.24	1.18	0.02	0.16	0.51
1,2,3,6,7,8 HxCDF	1.00	0.88	0.96	0.77	1.13	0.93	0.90	1.15	0.03	0.13	0.42
2,3,4,6,7,8 HxCDF	1.00	0.96	1.08	0.88	1.04	1.31	1.13	1.01	0.03	0.14	0.43
1,2,3,4,7,8 HxCDD	1.00	0.89	0.91	1.11	1.22	1.06	1.35	1.39	0.00	0.20	0.62
1,2,3,6,7,8 HxCDD	1.00	1.01	0.84	1.03	1.19	1.09	1.65	0.93	0.00	0.26	0.83
1,2,3,7,8,9 HxCDD	1.00	0.74	0.74	0.91	0.87	1.07	1.14	1.33	0.00	0.22	0.69
1,2,3,7,8,9 HxCDF	1.00	0.97	1.20	1.03	0.96	1.19	1.52	1.08	0.03	0.19	0.61
1,2,3,4,6,7,8 HpCDF	1.00	0.93	0.99	1.02	1.16	0.93	1.31	1.29	0.04	0.16	0.51
1,2,3,4,6,7,8 HpCDD	1.00	1.53	1.33	1.26	0.99	1.04	1.61	1.48	0.04	0.24	0.75
1,2,3,4,7,8,9 HpCDF	1.00	1.00	1.17	1.23	0.84	0.92	1.43	1.08	0.18	0.20	0.63
OCDD	2.00	2.14	1.81	1.58	2.15	2.57	2.16	2.29	0.08	0.32	1.01
OCDF	2.00	1.79	1.88	2.12	1.84	2.19	2.34	2.11	0.07	0.21	0.65

Table 3 - Native PCDD/Fs Method Detection Limit in pg/g - extraction, cleanup, and concentration -

MDL study	native										
	spike	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt	ppt
	ppt	MDL-1	MDL-2	MDL-3	MDL-4	MDL-5	MDL-6	MDL-7	MB	STDEV	MDL
PCB-81	10	11.05	11.16	11.59	10.70	11.48	10.53	11.46	0.42	0.41	1.28
PCB-77	10	10.92	11.51	10.77	12.00	11.75	12.75	12.44	0.00	0.74	2.31
PCB-123	10	11.48	13.36	12.18	11.14	12.13	11.89	11.64	0.58	0.71	2.24
PCB-118	10	10.27	10.33	10.45	10.70	13.26	13.11	12.06	0.30	1.33	4.18
PCB-114	10	9.82	8.71	11.75	9.84	11.86	11.93	11.82	0.00	1.33	4.17
PCB-105	10	11.64	12.11	12.03	11.05	12.43	12.61	12.98	0.14	0.64	2.01
PCB-126	10	9.80	9.93	9.69	10.17	12.82	13.34	13.09	0.56	1.72	5.39
PCB-167	10	10.70	10.97	10.69	10.53	12.00	11.60	11.61	0.00	0.57	1.80
PCB-156	10	11.42	11.46	10.60	9.42	11.15	11.46	11.51	0.00	0.77	2.41
PCB-157	10	10.85	11.98	10.85	11.29	11.76	12.40	12.02	0.42	0.61	1.91
PCB-169	10	11.01	9.50	10.05	9.72	11.97	13.29	12.32	0.68	1.45	4.56
PCB-189	10	10.84	11.44	11.11	11.15	11.27	11.85	11.35	0.00	0.32	0.99

Table 4 - Native PCBs Method Detection Limit in pg/g - extraction, cleanup, and concentration -

	Channel-1	Channel-2	Channel-3	Channel-4	Channel-5	Channel-6	Average	STDEV	RSD (%)
2,3,7,8 TCDF	91	93	85	91	74	83	86	7.1	8.2
2,3,7,8 TCDD	86	85	87	86	80	75	83	4.8	5.7
1,2,3,7,8 PCDF	94	90	83	92	95	75	88	7.9	8.9
2,3,4,7,8 PCDF	94	80	85	94	87	80	87	6.1	7.0
1,2,3,7,8 PCDD	93	91	84	92	77	77	86	7.3	8.5
1,2,3,4,7,8 HxCDF	74	72	83	74	77	76	76	3.9	5.1
1,2,3,6,7,8 HxCDF	79	72	82	78	77	89	79	5.5	7.0
2,3,4,6,7,8 HxCDF	84	70	83	84	84	70	79	7.0	8.8
1,2,3,4,7,8 HxCDD	81	75	95	80	79	89	83	7.4	8.9
1,2,3,6,7,8 HxCDD	87	80	82	87	79	86	84	3.6	4.3
1,2,3,7,8,9 HxCDF	91	81	88	90	70	80	83	8.0	9.6
1,2,3,4,6,7,8 HpCDF	79	71	83	79	73	79	77	4.5	5.9
1,2,3,4,6,7,8 HpCDD	83	81	92	83	87	100	88	7.1	8.1
1,2,3,4,7,8,9 HpCDF	91	77	92	91	80	89	87	6.3	7.3
OCDD	70	70	82	70	81	70	74	6.1	8.2

Table 5 - ^{13}C PCDD/F percent recoveries across extraction, cleanup, and concentration - channels # 1-3 no matrix, channels # 4-6: 2.5 g corn oil.

	Channel-1	Channel-2	Channel-3	Channel-4	Channel-5	Channel-6	Average	STDEV	RSD (%)
PCB-81	95	109	93	104	109	100	102	6.9	6.7
PCB-77	105	96	82	93	92	103	95	8.3	8.8
PCB-123	88	95	75	76	84	87	84	7.6	9.1
PCB-118	87	90	76	74	75	87	82	7.2	8.9
PCB-114	88	93	79	82	88	97	88	6.7	7.6
PCB-105	94	90	80	98	86	102	92	8.0	8.8
PCB-126	80	90	78	96	80	92	86	7.6	8.8
PCB-167	84	84	71	72	86	77	79	6.6	8.3
PCB-156	80	83	72	74	86	74	78	5.7	7.3
PCB-157	80	83	76	84	92	73	81	6.7	8.2
PCB-169	88	85	84	95	100	104	93	8.3	8.9
PCB-189	80	83	72	85	90	82	82	6.0	7.3

Table 6 - ^{13}C PCB percent recoveries across extraction, cleanup, and concentration - channels # 1-3 no matrix, channels # 4-6: 2.5 g corn oil.

	Cod oil		Pumpkin oil		Corn oil	
Natives in pg	Channel-1	Channel-2	Channel-3	Channel-4	Channel-5	Channel-6
T 2,3,7,8 TCDF	0.0	0.0	0.1	0.2	0.2	0.1
T 2,3,7,8 TCDD	0.2	0.0	0.0	0.0	0.0	0.0
T 1,2,3,7,8 PCDF	0.1	0.1	0.4	0.2	0.2	0.0
T 2,3,4,7,8 PCDF	0.4	0.4	0.1	0.4	0.4	0.2
T 1,2,3,7,8 PCDD	0.0	0.0	0.1	0.0	0.0	0.5
T 1,2,3,6,7,8 HxCDF	0.0	0.7	0.0	0.8	0.8	0.7
T 1,2,3,4,7,8 HxCDF	0.0	0.2	0.0	0.0	0.0	0.0
T 2,3,4,6,7,8 HxCDF	0.7	0.4	0.1	0.3	0.3	0.2
T 1,2,3,4,7,8 HxCDD	0.2	0.0	0.7	0.4	0.4	0.3
T 1,2,3,6,7,8 HxCDD	0.3	0.1	0.2	0.0	0.0	0.0
T 1,2,3,7,8,9 HxCDD	0.0	0.2	0.3	0.0	0.0	0.3
T 1,2,3,7,8,9 HxCDF	0.2	0.0	0.2	0.2	0.2	0.3
T 1,2,3,4,7,8,9 HpCDF	0.3	0.0	0.0	0.3	0.3	0.2
T 1,2,3,4,6,7,8 HpCDF	0.4	0.2	0.2	0.3	0.3	0.2
T 1,2,3,4,6,7,8 HpCDD	0.0	0.2	0.4	0.0	0.0	0.0
T OCDF	0.0	0.0	0.2	0.0	0.0	0.0
T OCDD	0.2	0.0	0.3	0.1	0.1	0.0

Table 7 - Native PCDD/Fs in oils - cleanup and concentration - 2.5 g oil - data in pg

	Cod oil		Pumpkin oil		Corn oil	
13C recoveries (%)	Channel-1	Channel-2	Channel-3	Channel-4	Channel-5	Channel-6
2,3,7,8 TCDF	87	93	79	72	95	88
2,3,7,8 TCDD	102	92	78	73	77	88
1,2,3,7,8 PCDF	90	87	80	71	73	80
2,3,4,7,8 PCDF	92	103	83	71	80	87
1,2,3,7,8 PCDD	80	119	75	73	85	82
1,2,3,4,7,8 HxCDF	73	84	76	72	72	75
1.2.3.6.7.8 HxCDF	74	95	89	81	84	76
2,3,4,6,7,8 HxCDF	92	88	87	82	82	77
1,2,3,4,7,8 HxCDD	97	89	87	75	83	81
1,2,3,6,7,8 HxCDD	76	83	80	74	75	70
1,2,3,7,8,9 HxCDF	83	93	74	76	81	77
1,2,3,4,6,7,8 HpCDF	73	72	74	73	70	70
1,2,3,4,6,7,8 HpCDD	71	85	76	74	83	71
1,2,3,4,7,8,9 HpCDF	79	94	73	75	83	82
OCDD	73	85	71	72	88	76

Table 8 - ^{13}C PCDD/Fs in oils - cleanup and concentration - 2.5 g oil - recoveries in %

	Cod oil		Pumpkin oil		Corn oil	
Natives in pg	Channel-5	Channel-6	Channel-1	Channel-2	Channel-3	Channel-4
PCB-81	1.40	1.50	1.60	5.90	1.90	0.40
PCB-77	2.60	3.20	9.70	7.80	12.40	2.00
PCB-123	1062.00	975.10	0.00	0.00	0.00	0.00
PCB-118	6530.00	6688.50	199.51	212.17	15.30	22.80
PCB-114	142.60	143.30	0.00	0.00	0.00	22.84
PCB-105	2242.80	2268.50	0.00	0.00	3.60	6.30
PCB-126	17.90	19.50	20.80	14.20	12.40	13.60
PCB-167	4694.08	4284.71	38.63	43.30	7.50	0.00
PCB-156	1495.50	1492.20	24.48	26.30	1.75	0.00
PCB-157	411.30	384.70	26.35	19.65	0.00	0.00
PCB-169	11.70	7.40	0.00	2.40	2.50	2.00
PCB-189	0.00	0.00	10.80	10.60	0.00	0.00

Table 9 - Native PCBs in oils - cleanup and concentration - 2.5 g oil - data in pg

	Cod oil		Pumpkin oil		Corn oil	
13C recoveries (%)	Channel-5	Channel-6	Channel-1	Channel-2	Channel-3	Channel-4
PCB-81	99	94	86	85	80	84
PCB-77	111	101	91	96	89	90
PCB-123	79	79	95	91	92	92
PCB-118	84	84	96	93	97	94
PCB-114	79	80	94	98	105	89
PCB-105	81	81	95	100	88	93
PCB-126	81	74	78	96	77	85
PCB-167	77	78	82	78	78	85
PCB-156	79	80	81	80	80	90
PCB-157	85	74	83	75	80	90
PCB-169	76	91	74	93	74	78
PCB-189	80	78	82	73	73	78

Table 10 - ^{13}C PCBs in oils - cleanup and concentration - 2.5 g oil - recoveries in %

Natives (pg)	Feed-1	Feed-2	Soil-1	Soil-2	MB
2,3,7,8 TCDF	0.0	0.0	2.1	3.9	0.0
2,3,7,8 TCDD	0.0	0.0	1.4	4.0	0.2
1,2,3,7,8 PCDF	0.0	0.0	7.4	3.0	0.0
2,3,4,7,8 PCDF	0.0	0.0	8.2	4.9	0.0
1,2,3,7,8 PCDD	0.0	0.0	2.0	5.6	0.0
1,2,3,4,7,8 HxCDF	0.0	0.0	11.2	0.0	0.0
1,2,3,6,7,8 HxCDF	0.0	0.0	14.9	33.6	0.0
2,3,4,6,7,8 HxCDF	0.0	0.0	13.6	21.7	0.0
1,2,3,4,7,8 HxCDD	0.0	0.0	0.0	15.6	0.0
1,2,3,6,7,8 HxCDD	0.0	0.0	0.0	6.4	0.0
1,2,3,7,8,9 HxCDD	0.1	0.0	19.8	0.0	0.0
1,2,3,7,8,9 HxCDF	0.0	0.0	7.5	10.5	0.0
1,2,3,4,6,7,8 HpCDF	0.2	0.0	64.6	90.0	0.1
1,2,3,4,6,7,8 HpCDD	0.0	0.1	267.7	393.5	0.0
1,2,3,4,7,8,9 HpCDF	0.1	0.1	143.8	161.3	0.1
OCDD	1.4	1.6	5969.0	6291.7	0.0
OCDF	0.0	0.1	278.6	222.7	0.0

Table 11 - native PCDD/Fs - extraction, cleanup, and concentration- 5g feed and 10g soil - MB = method blank

13C recoveries (%)	Feed-1	Feed-2	Soil-1	Soil-2	MB
2,3,7,8 TCDF	94	98	113	81	121
2,3,7,8 TCDD	103	110	108	82	99
1,2,3,7,8 PCDF	95	95	118	81	74
2,3,4,7,8 PCDF	102	86	116	76	96
1,2,3,7,8 PCDD	96	81	113	77	75
1,2,3,4,7,8 HxCDF	71	70	78	98	88
1,2,3,6,7,8 HxCDF	74	85	71	81	87
2,3,4,6,7,8 HxCDF	80	90	96	85	100
1,2,3,4,7,8 HxCDD	114	95	86	81	116
1,2,3,6,7,8 HxCDD	110	88	102	92	106
1,2,3,7,8,9 HxCDF	97	87	107	99	120
1,2,3,4,6,7,8 HpCDF	80	98	93	89	79
1,2,3,4,6,7,8 HpCDD	109	116	129	102	85
1,2,3,4,7,8,9 HpCDF	107	119	120	129	78
OCDD	106	88	94	87	74

Table 12 - ^{13}C PCDD/Fs - extraction, cleanup, and concentration - 5g feed and 10g soil - MB = method blank

Natives (pg)	Feed-1	Feed-2	Soil-1	Soil-2	MB
PCB-81	0.0	0.0	0.0	0.0	0.42
PCB-77	16.0	17.5	28.5	17.2	0.38
PCB-123	0.0	0.0	77.1	53.6	1.10
PCB-118	81.0	74.6	480.8	372.6	0.84
PCB-114	0.0	0.0	0.0	0.0	0.47
PCB-105	31.0	32.0	243.9	172.3	0.50
PCB-126	0.0	0.0	17.7	11.4	0.50
PCB-167	0.0	9.5	238.5	178.7	0.26
PCB-156	5.4	0.0	0.0	0.0	0.26
PCB-157	0.0	0.0	0.0	0.0	0.42
PCB-169	0.4	1.0	3.8	2.3	0.42
PCB-189	0.0	0.0	0.0	0.0	0.70

Table 13 - native PCBs - extraction, cleanup, and concentration - 5g feed and 10g soil - MB = method blank

13C recoveries (%)	Feed-1	Feed-2	Soil-1	Soil-2	MB
PCB-81	71	70	86	76	82
PCB-77	70	75	104	80	90
PCB-123	78	71	110	86	96
PCB-118	90	82	85	71	98
PCB-114	82	74	109	76	84
PCB-105	82	78	125	76	98
PCB-126	74	84	117	92	75
PCB-167	72	72	104	84	80
PCB-156	73	75	72	72	80
PCB-157	72	74	74	76	86
PCB-169	72	77	88	70	88
PCB-189	71	74	98	80	74

Table 14 - ^{13}C PCBs - extraction, cleanup, and concentration - 5g feed and 10g soil - MB = method blank

EP-110 Fully Automated Dioxin & PCBs Sample Preparation System

Agilent 7010B TripleQuad

Conclusions

The system gives excellent recoveries for several matrices. It is a green option with low electrical power use. The system uses only a total volume of 100-260 mL of hexane and toluene and no dichloromethane.

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