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PCB, PCDD and PCDF congener profiles in two types of Aroclor 1254

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Abstract

Monsanto produced two distinct variants of Aroclor 1254. The late-production variant resulted from a change in Monsanto's manufacturing process in the early 1970s. Previous literature had reported that the late-production variant was produced from 1974 to 1976, but subsequent work has identified a sample known to be obtained in 1972. In this paper, we present congener-specific PCB and PCDD/F data for this 1972 late-production sample, and a brief historical record of late-production Aroclor 1254.

Keywords: Aroclor 1254; Polychlorinated biphenyls; Polychlorinated dibenzofurans (PCDF); Congener patterns

1. Introduction

Congener pattern analysis is a powerful tool for inference of sources, fate and transport of PCBs in the environment. A standard aspect of such an analysis is comparison of congener patterns observed in field sampling studies to the congener patterns of reference standards of PCB products (e.g. Aroclors). With one notable exception, the congener patterns for Aroclor standards run by various labs are consistent (Frame et al., 1996; Schulz et al., 1989; Rushneck et al., 2004). The differences between them are typically related more to different analytical methods and coeutions than to a true differences in the congener patterns (Johnson et al., 2006). However, there is one notable exception: Aroclor 1254 (A1254). Frame et al. (1996) reported data for two distinct PCB mixtures, both marketed as Aroclor 1254. Frame (1999) subsequently reported that (1) the late-production variant could be traced to several Aroclor 1254 lots dating back to 1974–1976, and (2) the congener pattern differences of the late-production variant were due to an early 1970s change in Monsanto's Aroclor 1254 manufacturing process. The "late-production Aroclor 1254" was related to the onset of production of Aroclor 1016 which began in 1971. The new Aroclor 1016 product (produced as replacement for Aroclor 1242) followed typical production techniques for Aroclors with one notable exception. As with Aroclor 1242, biphenyl was chlorinated to 42% of total mass and was then distilled to separate lower temperature boiling homologues into Aroclor 1016 and tetra- and higher chlorinated homologs into a residual product called Montar. In the production of most Aroclors, Montar was a waste product of very high-molecular mass PCB that was discarded (Hermanson and Johnson, 2007). In the case of Aroclor 1016 production, the residual Montar was at least partially recycled by increasing the chlorination and redistilling to produce the later variant Aroclor 1254 and another type of Montar. Frame (1999) also pointed out that the late-production variant was noteworthy because it contains higher relative proportions of non-ortho substituted PCBs, and thus has higher toxicity from dioxin-like PCBs.

Prior to Frame's papers, several workers in the field had observed that an Aroclor 1254 used for nearly 30 years in the lab of one of the authors here (LGH) had higher relative proportions of dioxin-like PCBs (non- and mono-ortho substituted PCBs) than other A1254 samples, as well as higher 2,3,7,8-substutitued polychlorinated dibenzofurans (PCDFs). This was noted in informal communications among various researchers (Hansen, O'Keefe, Schantz, Seegal) but not published (Hansen, personal communication; Schantz, personal communication). At that point, the production history and congener-specific

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Table 1
PCB Congener concentrations in two different lots of Aroclor 1254 (pg/μg) SPB-Octyl[a] GC column

IUPAC congener	Typical A1254		Late-production A1254	
	Replicate 1 (124–191)	Replicate 2 (124–191)	Replicate 1 (KB05-612)	Replicate 2 (KB05-612)
PCB 1	106	105	45	45
PCB 2	< 6.6	6.5	< 2.5	2.5
PCB 3	41	40	14	15
PCB 4	439	442	24	20
PCB 5	< 15	15	< 3.5	< 3.7
PCB 6	175	175	6.8	< 9.2
PCB 7	32	30	2.1	2.7
PCB 8	851	844	29	29
PCB 9	58	56	2.8	< 4.4
PCB 10	19	18	< 3.2	< 3.4
PCB 11	< 4.4	< 3.9	< 3.2	< 3.4
PCB 12 + 13	< 28	26	< 3.2	< 3.4
PCB 14	< 4.3	< 3.9	< 3.2	< 3.4
PCB 15	294	302	< 13	13
PCB 16	491	465	39	38
PCB 17	461	438	35	35
PCB 19	132	128	6.5	5.7
PCB 21 + 33	719	719	127	126
PCB 22	431	409	90	88
PCB 23	< 2.8	< 3.1	< 0.92	< 1.9
PCB 24	16	15	< 0.74	< 1.0
PCB 25	99	89	21	< 1.6
PCB 26 + 29	185	186	16	< 15
PCB 27	71	68	3.1	< 3.4
PCB 28 + 20	1103	1045	339	341
PCB 30 + 18	1087	1026	353	343
PCB 31	1525	1476	965	983
PCB 32	273	270	45	47
PCB 34	2.7	< 3.3	< 0.88	< 1.8
PCB 35	< 7.4	< 6.9	< 1.3	< 2.0
PCB 36	< 2.3	< 2.6	< 0.77	< 1.6
PCB 37	344	356	230	234
PCB 38	< 2.5	< 2.7	< 1.2	< 1.7
PCB 39	< 2.5	< 2.8	< 0.82	< 1.7
PCB 41 + 40 + 71	2560	2648	2413	2423
PCB 42	1130	1158	932	975
PCB 43	362	317	208	225
PCB 44 + 47 + 65	16,968	17,525	6773	6914
PCB 45 + 51	352	354	428	446
PCB 46	143	136	156	167
PCB 48	687	716	714	720
PCB 50 + 53	888	886	677	660
PCB 52	47,574	48,161	11,387	11,435
PCB 54	< 2.4	< 2.4	< 2.1	< 2.3
PCB 55	< 27	< 26	< 43	< 48
PCB 56	3434	3348	16,934	17,171
PCB 57	< 28	< 26	< 43	< 48
PCB 58	< 28	< 27	< 45	< 50
PCB 59 + 62 + 75	< 226	228	196	211
PCB 60	1296	1339	8454	8482
PCB 61 + 70 + 74 + 76	35,670	38,639	83,067	85,170
PCB 63	285	297	755	781
PCB 64	5021	5189	3014	3052
PCB 66	7309	7731	31,065	31,976
PCB 67	< 24	< 23	64	61
PCB 68	< 28	< 26	< 44	< 49
PCB 69 + 49	8267	8455	3364	3421
PCB 72	< 27	< 26	< 43	< 48
PCB 73	< 0.77	< 0.82	< 0.83	< 0.92
PCB 77*	152	136	1766	1796
PCB 78	< 26	< 24	< 40	< 45
PCB 79	479	360	563	505