The US EPA National Sewage Sludge Survey (NSSS) – a Recalculation

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Abstract

In 1988/89 US EPA conducted a survey (National Sewage Sludge Survey – NSSS) of 240 samples collected at 181 of the 15000 publicly owned sewage treatment works (POTW). We have used this database and calculated the concentrations of PCDDs and PCDFs expressed on dry weight basis to facilitate comparison between the NSSS and other studies. We have also calculated TEQ values for the PCDDs and PCDFs. The median value is 14 pg TEQ/g dry matter.

Introduction

In 1984 Lamparski *et al.* reported on the analyses of PCDDs and PCDFs in a dried sample of sewage sludge (biosolids) from Milwaukee, WI, USA, sold as fertilizer [1]. Two samples were collected in 1983 and 1982, and the third sample was collected and sealed in 1933. In all three samples, the concentration of octaCDD was 50 000 – 60 000 pg/g dry matter (d.m.), and the concentration of heptaCDDs ranged between 7400 and 9700 pg/g d.m.

Weerasinghe *et al.* 1985 reported on the concentrations of PCDDs and PCDFs in two samples of sewage sludge from New York State, USA [2]. One sample from Syracuse which represents an urban area with wood processing industries as well as many other industries, while the other sample should represent a rural area. The Syracuse sample contained 60 000 pg/g d.m. of octaCDD, while the concentration of this compound in the rural sample was 7600 pg/g d.m.

The NSSS study

Between July 1988 and March 1989 the United States Environmental Protection Agency (US EPA) conducted a survey of 240 samples collected at 181 of the totally 15 000 publicly-owned sewage treatment works (POTW) in USA. The samples were analyzed for several different organic and inorganic substances and are reported in 8 volumes covering approximately 6000 pages, the NSSS study. In 1993 the material became available on 14 diskettes. No summary or conclusion is given in this exclusive material [3].

At DIOXIN '90 Telliard *et al.* published a paper where they discussed 211 of the 240 samples [4]. However, for reasons given in the paper the data are presented on a "wet weight" basis that makes it very difficult to compare the NSSS-study with any other study where the data are presented on a dry weight basis. Moreover, the sum of the TEQ-values is not presented either in the original NSSS report or in the Telliard abstract [3,4]. Here we report the concentration of 239 samples based on d.m., as well as the TEQ-concentrations found in the NSSS [5].

Table 1. NSSS data (concentration) for 2,3,7,8-substituted PCDD and PCDF congeners.

Note: concentration in pg/g dry matter. Not TEQ.
239 unique samples. Duplicates included. Non-detects excluded.
All data from DB-5 column. TCDF data from SP-2330 and DB-225 columns excluded.

		Concentration (pg/g d.m.)							Mean	Median
Congener		Max.	Min.	Mean	Median	SD pop	No. obs.	Occur.	contrib.	contrib.
TCDF	2378	310	0.19	20	9.6	36	151	63%	0.1%	0.2%
PeCDF	12378	450	0.67	26	9	60	63	26%	0.1%	0.2%
	23478	330	0.25	26	6.6	51	69	29%	0.1%	0.2%
HxCDF	123478	2000	0.60	98	16	300	101	42%	0.5%	0.4%
	123678	490	0.18	25	5	66	71	30%	0.1%	0.1%
	234678	910	0.39	30	9	110	71	30%	0.2%	0.2%
	123789	1300	0.25	78	11	200	41	17%	0.4%	0.3%
HpCDF	1234678	9500	3.1	280	81	980	194	81%	1.4%	1.8%
	1234789	840	0.46	61	11	150	65	27%	0.3%	0.3%
OCDF		95000	2.1	1300	210	7400	200	84%	6.5%	4.8%
Σ PCDFs		110000	7.0	1700	340	8200	208	87%	8.5%	7.9%
TCDD	2378	120	0.33	11	2.7	23	44	18%	0.1%	0.1%
PeCDD	12378	650	0.67	29	8.9	86	59	25%	0.1%	0.2%
HxCDD	123478	870	0.72	40	9.7	120	61	26%	0.2%	0.2%
	123678	1000	0.89	57	20	130	119	50%	0.3%	0.5%
	123789	1300	0.26	58	21	150	96	40%	0.3%	0.5%
HpCDD	1234678	70000	5.5	1300	420	5300	236	99%	6.5%	9.4%
OCDD		1200000	44	17000	3600	88000	238	100%	83%	81%
Σ PCDDs		1300000	15	18000	4000	93000	239	100%	92%	92%
Total		1400000	33	19000	4200	100000	239	100%	100%	100%
D/F ratio		150	0.8	20	15	19	208	87%	11	12

Results and Discussion

Table 1 contains the data for the 239 samples where the same analytical method was used and includes 2,3,7,8-substituted PCDDs and PCDFs: the maximum and the minimum concentrations as well as the mean and the median values. We also give the number and the frequency of a positive identification for the specific congeners.

OctaCDD was detected in 238 of the 239 samples (100%). On the other hand 1,2,3,7,8,9-hexaCDF was only detected in 41 of the 239 samples (17%). The three congeners with the highest TEF 2,3,7,8-tetraCDD, 1,2,3,7,8-pentaCDD and 2,3,4,7,8-pentaCDF were detected in 44 samples (18%), 59 samples (25%), and 69 samples (29%), respectively.

The highest concentration was found for the octaCDD in two samples from Billerica, MA. The reported values are 1 200 000 pg/g d.m. and 1 000 000 pg/g d.m. These samples also showed the highest concentrations of pentachlorophenol (PCP, 53 μg/g) supporting a conclusion of a local source of both PCP and octaCDD, which is a known contaminant in technical PCP.

The highest concentration of 2,3,7,8-tetraCDD was found in the sample from Corinth, MS, 116 pg/g d.m. A sample collected in 1995 showed only 0.3 pg 2,3,7,8-tetraCDD/g d.m. with a major peak eluting very close to the 2,3,7,8-isomer indicating a false positive in the NSSS analyses [6]

Table 2. NSSS data (concentration) for PCDD and PCDF homologues, all congeners included.

Note: concentration in pg/g dry matter. Not TEQ. See other comments in Table 1.

	Concentration (pg/g d.m.)							Mean	Median
Homologue	Max.	Min.	Mean	Median	SD pop	No. obs.	Occur.	contrib.	contrib.
TCDFs	1000	0.5	62	16	150	159	67%	0.3%	0.3%
PeCDFs	21000	1.6	260	35	1600	171	72%	1.2%	0.7%
HxCDFs	6800	2.9	390	100	930	154	64%	1.7%	2.0%
HpCDFs	44000	3.1	770	190	3600	199	83%	3.5%	3.8%
OCDF	95000	2.1	1300	210	7400	200	84%	5.9%	4.2%
Σ PCDFs	140000	8.2	2500	570	12000	210	88%	12%	12%
TCDDs	1400	0.3	84	17	190	92	38%	0.4%	0.3%
PeCDDs	2300	1.1	100	24	260	114	48%	0.5%	0.5%
HxCDDs	5000	1.9	340	120	710	183	77%	1.5%	2.4%
HpCDDs	110000	11	2300	780	8400	236	99%	10%	15%
OCDD	1200000	44	17000	3600	88000	238	100%	75%	70%
Σ PCDDs	1300000	30	19000	4400	97000	239	100%	88%	88%
Total	1500000	52	21000	5000	110000	239	100%	100%	100%
D/F ratio	380	0.7	15	10	29	210	88%	8	8

Table 2 contains the same data based on congener groups *i.e.*, all 38 tetraCDDs, all 14 pentaCDDs and all 4 heptaCDFs.

Table 3 shows the contribution to the toxic equivalents (TEQ) from each of the 2,3,7,8-substituted congeners using the toxic equivalent factors (TEFs) accepted by WHO [5]. Based on means as well as medians the contribution of the PCDDs is 69% and by PCDFs 31%. The largest contribution comes from 1,2,3,7,8-pentCDD and octaCDD (13–14%) followed by 2,3,4,7,8-pentaCDF and 1,2,3,4,6,7,8–heptaCDD (11%) and 2,3,7,8-tetraCDD (10%).

Table 3 also contains the mean and the median TEQ-values for the 239 samples analyzed. In a situation where two high outliers will have significant influence to the mean values (the two Billerica samples) the situation is much better expressed by the median value. The median value for the 1988/89 sampling of the 181 POTWs in the US is 14 pg TEQ/g d.m.

Several studies indicate a significant and dramatic decrease in the contamination of PCDDs in most environmental samples including human tissue. Sewage sludge samples from Switzerland and Sweden also shows a dramatic decrease during the period 1989 up to present time [7]. The median value presented here from the 1988/89 sampling campaign in the US is probably at the higher end.

Table 3. NSSS data (TEQ-values) for 2,3,7,8-substituted PCDD and PCDF congeners.

Note: concentration in pg TEQ/g dry matter. See other comments in Table 1.

Congener		Concentration (pg TEQ/g d.m.) Max.	Min.	Mean	Median	SD pop	No. obs.	Occur.	Mean TEQ %	Median TEQ %
TCDF	2378	31	0.019	2.0	1.0	3.6	151	63%	1.7%	3.2%
PeCDF	12378	23	0.034	1.3	0.44	3.0	65	27%	1.1%	1.5%
	23478	170	0.13	13	3.3	26	71	30%	11%	11%
HxCDF	123478	200	0.060	10	1.6	29	103	43%	8.4%	5.3%
	123678	49	0.018	2.6	0.54	6.7	72	30%	2.3%	1.8%
	234678	91	0.039	3.1	0.90	11	72	30%	2.7%	3.0%
	123789	130	0.025	7.9	1.4	20	42	18%	6.8%	4.7%
HpCDF	1234678	95	0.031	2.8	0.81	10	194	81%	2.4%	2.7%
	1234789	8.4	0.0046	0.6	0.11	1.5	67	28%	0.5%	0.4%
OCDF		95	0.0021	1.3	0.21	7.4	200	84%	1.1%	0.7%
Σ PCDFs		630	0.051	18	3.1	59	208	87%	31%	23%
TCDD	2378	120	0.33	11	2.7	23	44	18%	10%	9%
PeCDD	12378	330	0.34	15	4.5	43	61	26%	13%	15%
HxCDD	123478	87	0 072	4.2	1.0	12	62	26%	3.6%	3.4%
	123678	100	0.089	5.8	2.0	12	120	50%	5.0%	6.6%
	123789	130	0.026	5.8	2.1	15	96	40%	5.0%	6.8%
HpCDD	1234678	700	0.055	13	4.2	53	236	99%	11%	14%
OCDD		1200	0.044	17	3.6	88	238	100%	14%	12%
Σ PCDDs		2000	0.099	41	10	160	239	100%	69%	77%
Total		2300	0.23	57	14	200	239	100%	100%	100%
D/F ratio		260	0.073	7.7	3.8	19	210	87%	2.2	3.3

Literature Cited

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