Polychlorinated and Dibenzofurans (PCDDs/PCDFs) Levels in Environmental and Human Hair Samples Around a Pentachlorophenol Plant in China

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Abstract

High levels of PCDDs/PCDFs were previously reported in soil taken inside a sodium pentachlorophenate plant in Tianjin, China. This paper represents additional data obtained from areas just outside the same plant. The plant is built on the slightly elevated part of a low and wet area close to the bay. A small river, the Hai River, and a wastewater ditch drain indicate potential threats to the areas around the plant as well as the bay. Human hair samples from a nearby housing development also have significant levels of PCDDs/PCDFs. The isomer patterns of all the samples are consistent with pentachlorophenol sources. The results from this still preliminary study clearly calls for more extensive analysis of environmental (soil, sediment, water, air) and biological (human and wildlife) samples to gather data for future risk assessment and remediation actions.

Introduction

In a preliminary survey of several locations in China for levels of polychlorinated dioxins (PCDD) and dibenzofurans (PCDF)[1], a highly contaminated soil sample was discovered within a pentachlorophenol (PCP) production plant, the Dagu Chemical Factory in Tianjin. Since the plant is situated in a wetland with rivers that empty into the nearby Pacific Ocean, and also dangerously close to several large housing developments; it is feared that PCDD and PCDF, by-products in the synthesis of PCP, might have contaminated the surrounding areas. This paper reports the findings of a follow-up study designed to evaluate the seriousness of PCDD and PCDF contamination around the plant.

Experimental Methods

Soil samples from the plant as well as from dry areas near the plant were obtained. Sediment samples from nearby streams, rivers and the Pacific Ocean were also collected. The streams and rivers actually look like open sewage more than natural waterways. Since the sampling team did not originally intend to collect biological samples such as urine, milk and blood from the people living in the housing development areas near the plant, it decided on the spot to collect some human hair samples from the barber shops out of curiosity. The originally planned air sampling has to be deferred until the next phase of the study due to difficulties in shipping the equipment to China. The locations and description of the samples are presented in Table 1.

The samples were analyzed according to US EPA Method 1613A (Revision A, dated October 1992). 10 gm of soil or sediment was extracted for each sample. The hair sample was first lightly

rinsed with a dilute detergent to remove the dust and then digested with NaOH prior to extraction.

Results and Discussion

Table 1: Sample Locations and Description

Location	Location Description
1	Soil near Hai River, upstream from PCP plant
2	Soil outside west gate of PCP plant
3	Soil from the PCP plant
4	Soil from southwest (downwind) of PCP plant
5	Sediment from wetland outside the west gate of PCP plant
6	Sediment from drainage canal southwest of PCP plant
7	Sediment from wetland outside east gate of PCP plant
8	Sediment from Yungyanqiao (Wastewater) River, 10 Km from PCP plant
9	Sediment from Pacific Ocean 50 Km from PCP plant
10	Human hair from barber shop in housing development west of plant
11	Human hair from barber shop in housing development east of plant

The analytical results together with the calculated Toxic Equivalent concentrations (TEQ) are presented below in Table 2.

Table 2: Concentration of PCDDs and PCDFs (pg/g)

LOCATION SAMPLE TYPE	1 Soil	2 Soil	3 Soil	4 Soil	5 Sediment	6 Sediment	7 Sediment	8 Sediment	9 Sediment	10 HH*	11 HH*
2,3,7,8-TCDD	0.54	8.4	9000	21	23	1000	4	60	2.9	0.87	ND
Total TCDD	1.8	260	70000	280	520	22000	28	2400	66	17	5.2
1,2,3,7,8-PeCDD	1.3	110	130000	120	140	5400	21	320	4.1	7.4	ND
Total PeCDD	10	990	420000	1100	1600	27000	250	2300	150	49	11
1,2,3,4,7,8-HxCDD	10	480	440000	100	990	55000	84	5500	94	31	3
1,2,3,6,7,8-HxCDD	10	1700	780000	2200	3700	82000	550	15000	29	130	15
1,2,3,7,8,9-HxCDD	6.1	900	610000	900	2000	29000	270	6900	17	73	7.5
Total HxCDD	76	9300	3600000	11000	20000	370000	2400	68000	940	650	72
1,2,3,4,6,7,8-HpCDD	270	47000	12000000	67000	180000	3700000	17000	770000	2400	6900	320
Total HpCDD	410	66000	15000000	96000	230000	4600000	22000	940000	3700	4000	450
OCDD	3300	200000	110000000	280000	2000000	6000000	260000	5800000	71000	27000	2800
2,3,7,8-TCDF	2.1	44	4400	7	220	490	12	1400	1.5	4.6	0.99
Total TCDF	21	540	140000	243	1900	4200	120	12000	100	80	29
1,2,3,7,8-PeCDF	1.8	62	22000	29	170	2300	15	440	1.7	11	11
2,3,4,7,8-PeCDF	2	120	59000	92	320	6300	37	1200	7.1	10	1.9
Total PeCDF	17	1300	820000	900	4500	110000	400	19000	140	120	27
1,2,3,4,7,8-HxCDF	21	3000	1100000	5100	12000	280000	1400	48000	160	150	14
1,2,3,6,7,8-HxCDF	3.8	410	1400000	520	1300	54000	180	6100	21	29	3.1
2,3,4,6,7,8-HxCDF	2.6	140	82000	130	400	11000	48	1500	6.4	10	1.8
1,2,3,7,8,9-HxCDF	3.2	460	170000	670	1600	41000	130	8600	25	21	1.9

Total HxCDF	53	6700	3200000	8900	26000	610000	2600	110000	500	400	42
1,2,3,4,6,7,8-HpCDF	58	6300	3100000	8500	26000	340000	3300	60000	320	400	31
1,2,3,4,7,8,9-HpCDF	10	21000	690000	3300	8200	320000	1200	35000	110	68	6.9
Total HpCDF	96	12000	5500000	17000	50000	1020000	6400	160000	690	640	55
OCDF	210	21000	38000000	24000	70000	330000	5000	380000	2000	960	80
TEQ	15	1800	740000	2200	6700	110000	800	25000	150	120	12

***Human Hair**

The soil sample from within the plant compound (Location 3) has extremely high concentrations of PCDD and PCDF, indicating problems in safety and environmental controls during the production and handling of PCP and its by-products. The isomer profiles and concentrations of the compounds detected in soil (Locations 1,2 and 4) and sediment samples show that the contamination has extended outside the plant to the wetland (Locations 5 and 7), waterways (Locations 6 and 8) that flow to the bay connecting to the Pacific Ocean (Location 9). Although only a few environmental samples were tested in this study, the alarming high concentrations and widespread of PCDD and PCDF warrant a more complete and thorough study of the entire area to assess the seriousness of the situation. The close proximity of the plant to the housing development really makes the case worse. The detection of the compounds in human hair samples from nearby housing developments (Locations 10 and 11) calls for quick actions to protect the health of the people that live there. It is not clear how long the people have been living in the housing developments, but a survey and review of the health records and birth defects may be needed.

Reference

[1] William J. Luksemburg, Robert S. Mitzel, Huaidong Zhou, James M. Hedin, Bradley B. Silverbush, and Anthony S. Wong (1996): Polychlorinated Dioxins And Dibenzofurans In Environmental Samples From China. 16th Symposium On Chlorinated Dioxins And Related Compounds, Amsterdam, 1996. Vol. 28, p.262.