POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS (PCDDs/PCDFs) LEVELS IN ENVIRONMENTAL AND HUMAN HAIR SAMPLES AROUND AN ELECTRONIC WASTE PROCESSING SITE IN GUIYU, GUANGDONG PROVINCE, CHINA

William J. Luksemburg[1], Robert S. Mitzel[1], Robert G. Peterson[1], James M Hedin[1], Martha M. Maier[1], Melanee Schuld[1], HuaiDong Zhou[2], Anthony S. Wong[1]

[1]Alta Analytical Laboratory, 5070 Robert J. Mathews Parkway, El Dorado Hills, CA 95762, USA.
[2]Department of Water Environment, China Institute of Water Resources and Hydropower Research, Science & Technology Garden, Haidian District, Beijing 100038, China

Introduction

The disposal, recycling and part salvaging of millions of discarded electronic devices such as computers, printers, televisions and toys every year are now creating a new set of waste (e-waste) problems. It has been estimated that between 50 to 80 % of the e-waste from industrial countries such as the U.S. ends up in recycle plants in Asian countries such as China, Pakistan and India. Without the benefit of modern and safe technology for recycling and disposal of e-waste, many Asian countries employ primitive and unsafe techniques. Removing electronic components from a circuit board by heating it over a grill, stripping of metals in open-pit acid baths, chipping and melting plastics without proper ventilation, and recovering metals by burning cables and parts are common practices. Unsalvageable materials are disposed of either by dumping in the fields and rivers or by burning in open air. These processes expose workers to toxic chemicals and can lead to environmental damage.

In this paper we report the level of PCDD/PCDFs in samples from the town of Guiyu in Guangdong Province near Hong Kong. Most of the e-waste activities in Guiyu take place at the banks of Lianjing River. While it is difficult to estimate the total tonnage of e-waste handled in Guiyu, the Chinese press estimates that it is large enough to employ tens of thousands of laborers.

Sample Description

Sediment Samples

All sediment samples were collected near the Lianjiang River in the Chaoyang region of Guangdong Province. Sediment Nos. 1, 2, and 3 were collected in Guiyu near the site where the recycling e-waste takes place. Sediment Nos. 4, 5, 6 and 7 were collected at river towns located about 20 to 50 kilometers downstream from Guiyu.

Ash Samples

Three ash samples were collected near the site. Ash Sample No. 1 mainly contained larger pieces of charred plastic parts. Ash Sample Nos. 2 and 3 were wet mixtures of black ash, mud and sand taken from an area where the ash is covered and mixed with soil.

Electronic Component Waste (ECW) Sample

The sample was collected from a waste container. It is a blackened waste consisting of ash, dirt and a very large percentage of tiny metallic parts from electronic devices.

Hair samples

The hair samples were collected from two barber shops in Guiyu near the shops and huts where the salvaging took place.

Analytical Methods

The samples were analyzed according to U.S. EPA Method 1613 (Revision B, dated Sept., 1997) and EPA Method 1668 (EPA 821/R-97-001, 1997). The hair samples were repeatedly washed with water to remove the dust and then digested with NaOH prior to extraction.

Results and Discussion

The results are presented in Table. 1. The sampling locations were selected mainly because of accessibility rather than based on being representative of the sites. The sediment samples from Guiyu are much higher than those from locations downstream from the site. Because of the low flow rate of the river in this area translocation of the contaminants is not extensive. The concentrations among the three Guiyu sediments differ greatly from each other. Sediment No. 1 was sampled at a part of the riverbank where ash had been dumped. Sediments No. 2 and No. 3 were from residential areas adjacent to the site. Water from the river is frequently used to wash clothes and cooking utensils.

The three ash samples were from sites where plastic was melted and burned. Ash No. 1, which contained mainly larger pieces of charred plastic, has much lower concentrations than the other two samples, which contained soil and finer ash particles.

The Electronic Component Waste (ECW) is from a large container of blackened material, and has many recognizable small metallic parts in it. This material is for disposal.

Few human hair studies are available for data comparison. However, the two hair samples have concentrations that are much higher than the less than 1pg/g (TEQ) reported by Tirler and co-workers.(1) The 25.6 and 16.4 pg/g (TEQ) values are near the lower values of the two hair samples (12 and 120 pg/g, TEQ) collected near a very contaminated pentachlorophenol site as reported by us in an earlier paper (2).

Although the samples collected for this study are not comprehensive, higher values are indicative of contamination in the town Guiyu. Similar contamination may occur in other locations where the recycling of electronic devices is being conducted. Besides concerns of dioxins/furans in sediment and scattered ash, the quality of the air at or near these e-waste processing sites should be tested. Future studies will focus on accurately defining the extent of the contamination in the area and assesing ambient air levels.

References

1. Werner Tirler, Giulo Voto, Massino Donega, PCDD/F, PCB and Hexachlorobenzene level in Hair. (Halogenated Environmental Organic Pollutants and POPs, Vol. 52, p. 290, 2001)
2. William J. Luksemburg, R.S. Mitzel, J.M. Hedin, A.S. Wong and H.D. Zhou, Poluchlorinated and Dibenzofurans (PCDDs/PCDFs) Levels in Environmental and Human Hair Samples Around a Pentachlorophenol Plant in China. (Halogenated Environmental Organic Pollutants and POPs, Vo. 32, p. 38, 1997)

Table 1. Analytical Results (in pg/gm, dry wt.)

	Sed-1	Sed-2	Sed-3	Sed-4	Sed-5	Sed-6	Sed-7	ECW-1	Ash-1	Ash-2	Ash-3	Hair-1	Hair-2
2,3,7,8-TCDD	364	0.997	42.5	ND	ND	ND	ND	13.4	8.08	178	10.7	2.93	1.98
1,2,3,7,8-PeCDD	1130	2.62	134	ND	0.628	1.15	0.594	50.6	24.3	594	542	4.95	4.22
1,2,3,4,7,8-HxCDD	846	ND	108	ND	0.695	1.12	ND	39.8	24.6	629	1060	2.04	1.77
1,2,3,6,7,8-HxCDD	1600	ND	184	1.38	1.79	1.98	ND	65.1	50.9	1090	1220	5.24	4.71
1,2,3,7,8,9-HxCDD	1090	ND	117	3.36	2.62	3.59	ND	53.9	36.6	822	1070	3.30	3.12
1,2,3,4,6,7,8-HpCDD	8150	51.2	893	21.1	31.2	29.5	1.94	286	270	6400	364	16.8	15.7
OCDD	11700	1270	1360	250	451	430	31.3	307	504	9210	545	87.7	24.0
2,3,7,8-TCDF	19200	15.2	1610	1.26	1.37	1.71	4.76	220	96.8	6370	1550	24.9	12.6
1,2,3,7,8-PeCDF	37400	22.2	2670	1.24	2.02	1.63	2.92	396	69.9	15300	2780	23.7	13.0
2,3,4,7,8-PeCDF	37700	17.8	2790	0.938	1.92	1.35	3.30	462	93.0	14700	2460	18.8	10.0
1,2,3,4,7,8-HxCDF	26900	13.8	1890	0.975	1.79	1.44	1.75	365	124	11600	1450	10.2	7.05
1,2,3,6,7,8-HxCDF	32200	13.9	2160	0.784	1.59	0.791	1.60	384	92.7	13400	1860	10.7	6.62
2,3,4,6,7,8-HxCDF	26200	16.5	2230	0.660	1.91	0.930	4.4	407	146	11700	1400	8.43	5.54
1,2,3,7,8,9-HxCDF	14100	7.09	910	0.766	0.965	0.663	1.27	132	42.6	6510	940	2.44	1.47
1,2,3,4,6,7,8-HpCDF	484000	18.3	4010	ND	4.43	1.53	0.449	855	758	21500	2130	17.7	12.1
1,2,3,4,7,8,9-HpCDF	18800	6.41	867	ND	0.944	0.416	0.347	122	73.5	7610	847	21.3	ND
OCDF	21800	10.4	1400	ND	4.32	1.38	1.43	250	530	10300	942	7.63	9.10
TEQ (WHO ’98)	35200	21.2	2690	1.69	3.37	3.49	3.42	494	155	14400	3020	25.6	16.4