

Polychlorinated Dibenzo-p-dioxins (PCDDs) Leaching from Pentachlorophenol-Treated Utility Poles

Narine Gurprasad, Miles Constable, Nizar Haidar and Edna Cabalo

Toxic Substances Division, Environmental Protection Branch, Environment Canada, Edmonton, Alberta, Canada T6H 3S5

1. Introduction

Since the mid-1980s, the use of pentachlorophenol (PCP) as a wood preservative has been restricted to the preservation of utility poles in the power and telephone industries¹⁾. The contamination of PCP with polychlorinated dibenzo-*para*-dioxins (PCDDs) is well documented^{1,3)}. The use of PCP may be considered to be a significant source of PCDD contamination of the environment. In 1993, as part of its Priority Substances toxicity assessment process, Environment Canada declared PCDDs to be toxic to the environment and a danger to human health²⁾. Although there is considerable information on the amounts of PCP leaching from utility poles^{4, 5)}, very little information has been published on PCDD contamination of soil from this source. This project was developed as a preliminary study of the amounts of PCDDs (Table 1) leaching to the soil from PCP preserved utility poles.

2. Sampling

Three PCP-treated utility poles were selected at random in Edmonton. One was in a light industrial area across from the Environment Canada offices (pole 1), one was along a busy road in a sparsely settled, industrial area (pole 2) and the third was in an undeveloped area of the city (pole 3). Two poles (1 and 2) appeared to be treated along their entire length as they had a light brown, oily appearance overall, while the third pole appeared to have received only a butt-treatment with PCP as the brown colour extended only a metre above the ground. Care was taken to avoid cross contamination of samples.

Wood strips were removed from the surface of each pole with a knife. The samples were broken to reduce their length and placed into a clean jar. Soil samples were taken with a trowel at three distances from the poles: immediately adjacent to the pole, at a radius 20 cm from the pole, and at a point half way between the pole and the next pole in sequence (approx. 26 metres). Samples were placed into clean glass jars. All soil samples were taken from the surface, since it was considered that surface samples would be most likely to provide the highest levels of contaminants⁵⁾.

3. Method

The analytical method used was adapted with modifications from Environment Canada Reference

Method 1/RM/19⁶). The soil sample was mixed and a 20 g subsample was weighed out for analysis. A 5 g subsample of the wood strips was weighed out, using most of the sample provided for analysis. Each sample was Soxhlet extracted with toluene for 20 hours. This toluene extract was concentrated to 5 ml. A 1 ml aliquot was solvent exchanged to hexane and cleaned up using a acid/base/silver nitrate/silica column which was eluted with 50 ml of 2% dichloromethane/hexane. The extract was concentrated just to dryness. The extract was then transferred to a 1 ml volumetric flask with toluene for instrumental analysis.

Analysis was carried out using a HP5971 GC/MSD in the electron impact (70 eV), selective ion monitoring mode (ions monitored and retention times for each congener are listed in Table 1). For the GC, a Rtx-5 capillary column, 30 m long, 0.25 µm film thickness, 0.25 mm I.D. (Restek Corporation) was used with helium carrier gas at 10 psi head pressure. The splitless injector was set at 280 °C with the GC temperature programmed at 100 °C for 1 min, 100 °C to 200 °C at 20 °C/min, hold at 220 °C for 5 min, 220 °C to 300 °C at 5 °C/min and hold at 300 °C for 5 min. The transfer line was set at 300 °C.

Table 1: Polychlorinated Dibenzo-*para*-dioxins (PCDDs) Analysed

Congener	Abbreviation	SIM Ions (m/z)		Ion Type	Retention Time Windows (min)
		Pri	Sec		
Pentachlorinated Dibenzo- <i>para</i> -dioxin	P5CDD	356	358	M+2/M+4	16.0 to 19.7
Hexachlorinated Dibenzo- <i>para</i> -dioxin	H6CDD	390	392	M+2/M+4	19.8 to 22.9
Heptachlorinated Dibenzo- <i>para</i> -dioxin	H7CDD	424	426	M+2/M+4	23.0 to 25.9
Octachlorinated Dibenzo- <i>para</i> -dioxin	OCDD	458	460	M+2/M+4	26.0 to 33.0

For quality control (QC) purposes, blanks, soil spikes and wood spikes were prepared and analysed in the same manner. Both untreated wood and clean soil blanks were found to be non-detected for PCDDs. The spike results of both soil and wood showed good recovery with little deviation for the PCDDs (Table 2).

Table 2: Wood and Soil Spikes Recovery and Deviation

PCDDs	WOOD SPIKES		SOIL SPIKES	
	Ave. % Rec.	% RSD	Ave. % Rec.	% RSD
P5CDD	105	11	107	4.9
H6CDD	98.0	7.1	105	7.7
H7CDD	94.0	10	116	5.8
OCDD	87.0	20	120	5.1

4. Results and Discussion

Data from analysis of the samples are listed in Table 3. All three poles showed significant levels of H6CDD, H7CDD and OCDD for the wood and the soil samples adjacent to each pole. The soil at 20 cm away from each pole showed detectable amounts of H7CDD and OCDD, except for pole 1 which had trace levels of the H6CDD congener present. The soils at 26 m away from the poles were generally clean, showing non-detected or close to detection limit levels of 0.01-0.02 µg/g for the PCDDs.

Table 3: PCDDs Detected in Wood and Soil Samples

PCDD	Pole 1 (µg/g)				Pole 2 (µg/g)				Pole 3 (µg/g)			
	Wd*	2 cm	20 cm	26 m	Wd	2 cm	20 cm	26 m	Wd	2 cm	20 cm	26 m
P5CDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
H6CDD	0.43	0.41	0.05	ND	0.29	0.13	ND	ND	0.47	0.07	ND	ND
H7CDD	6.63	4.85	0.16	0.01	4.69	1.13	0.10	ND	5.11	0.10	0.12	ND
OCDD	42.1	28.3	0.78	0.02	35.6	4.62	0.16	ND	27.9	0.99	0.42	ND

* Wd - Wood samples

The results show that the concentrations of PCDDs in the soil decrease rapidly with distance from the pole. There was roughly an order of magnitude drop in PCDD concentrations from soil immediately adjacent to the pole to 20 cm from the pole. There was no consistent pattern in the wood concentrations of PCDDs between the three poles and PCDD soil concentrations adjacent to the poles. Octa-CDD was consistently higher than hepta-CDD, which was consistently higher than hexa-CDD in all samples. This is similar to ratios of PCDDs found in PCP⁷⁾ and is in keeping with other results on the leaching of PCP from treated poles to adjacent soils⁵⁾. EPRI (1995) found similar patterns of PCP distribution in surrounding soils⁵⁾. They also did not find any trends between PCP concentration in the wood and either age of the pole or PCP concentration in the surface soil.

5. Conclusions

These results and those of EPRI (1995) likely indicate that the PCDDs are leaching from PCP preserved poles with the PCP/oil carrier, and are travelling in the soil in a similar manner.

This study found significant concentrations of PCDDs (ppm levels) in the soil surrounding the base of PCP treated utility poles. Since this study was preliminary, further studies should be conducted to confirm these findings and to explore their environmental significance.

6. References

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- 5) Electric Power Research Institute, "Pentachlorophenol (PCP) in Soils Adjacent to In-Service Utility Poles in New York State", EPRI TR-104893 (1995).
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