

PCDD- and PCDF-Contamination in Pentachlorophenol and Lindane Impregnated Wood

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Since the early 1950s, pentachlorophenol (PCP) and lindane have been used as wood preservatives; pentachlorophenol and its salts (PCP-Na) because of their fungicide effects and lindane because of its insecticide properties. PCP was licensed as a wood preservative until the end of the 1980s. The commercially available wood preservatives in Germany had a maximum content of 8.8 % PCP, lindane (γ -HCH) or a mixture of the two ¹.

Technically produced PCP contained impurities which, apart from other chlorophenols, also include polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) ². Technical HCH is also contaminated with PCDD and PCDF ³. However, only lindane with at least 99 % γ -HCH as active substance is currently permitted as wood preservative in Germany.

The contamination with PCDF and PCDD in the different technical PCPs cover a range of concentrations. Values between 15 and 2500 ppm have been stated for OCDD (the main contaminant) ⁴. Similarly the ratio of the dioxin to furan concentrations in the different PCP batches varies greatly. The PCDD/F contamination in technical PCPs is much higher than in PCP-Na.

Even decades after application, the pollution of the air with PCP and lindane and, in some cases, with PCDD/F can still be detected in the interior of buildings ^{5,6}.

In this study, samples of wood panelling from the interior of rooms were tested for PCP, lindane and PCDD/F. As far as possible the samples were taken from several places by planing shavings off the surface to depth of 0 - 1 mm. Thereby about 90 % of the contaminants were detected ⁵.

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PCP was determined by means of HRGC/MS, lindane by means of HRGC/ECD and PCDD/F by HRGC/HRMS.

The PCP content of the samples tested was between < 0.3 mg/kg and 3880 mg/kg. The samples with positive PCP findings contained high PCDD/F concentrations of up to 19653 ng TEq/kg. The four main contaminants of the sample with the highest PCP content (1,2,3,6,7,8-HxCDD; 1,2,3,4,6,7,8-HpCDD, OCDD and 1,2,3,4,6,7,8-HpCDF) contribute to 96,6 % of the total TEq.

The draft of the Dioxin Regulation which is passed by the government of the Federal Republic of Germany gives a threshold value of $1 \mu\text{g}/\text{kg}$ for the sum of 2,3,7,8-TCDD/F, 2,3,4,7,8-PeCDF and 1,2,3,7,8-PeCDD, $5 \mu\text{g}/\text{kg}$ for the sum of the twelve 2,3,7,8-tetra- to hexa-CDD/F congeners, and a value of $100 \mu\text{g}/\text{kg}$ for the 17 tetra to octachlorinated congeners⁷. In most of the samples investigated, these values were exceeded, in some cases by a considerable amount. The lowest PCP content when the dioxin threshold value of $100 \mu\text{g}/\text{kg}$ was exceeded was 25.2 mg/kg.

Some results of the measured concentrations of PCP and PCDD/F in wood evaluated to the German Dioxin Regulation are shown in table 1.

No correlation could be established between the PCP and/or lindane content and the PCDD/F concentration because PCDD/F-contamination in the different PCP-batches vary greatly as mentioned above.

Figure 1 shows the content of different PCDD/F-congeners in three samples. The content of this PCDD/F-congeners varies over a wide range. The ratio of the furans to dioxins as regulated in the Dioxin Regulation are 0.8 in sample 3, 2.7 in sample 4 and 17.2 in sample 7.

In addition to the wood preservatives used, PCDD/F also represent a long-term problem of contaminated waste which should not be underestimated, and is, therefore, also a danger for man and the environment.

Table 1: PCDD/F-concentrations of some wood samples impregnated with Pentachlorophenol

	I-TEq $\mu\text{g}/\text{kg}$	Gefahrstoff- verordnung 1986 ^{a)} Sum of PCDD/F ^{b)} $\mu\text{g}/\text{kg}$	German Dioxin Regulation, 1993			Ratio Dioxins/ Furans	PCP mg/kg wood
			Group 1 ^{c)} $\mu\text{g}/\text{kg}$	Group 2 ^{d)} $\mu\text{g}/\text{kg}$	Group 3 ^{e)} $\mu\text{g}/\text{kg}$		
Sample 1	0.005	< 0.01	< 0.01	< 0.01	0.98	4.9	< 0.3
Sample 2	1.8	2.8	0.01	3.0	743	7.3	25.2
Sample 3	1.48	4.9	0.16	7.3	151	0.8	75.7
Sample 4	1.5	3.7	0.16	5.6	321	2.7	147
Sample 5	16.7	18.2	0.03	19.9	9612	13.0	286
Sample 6	17.6	21.6	0.03	24.8	9352	12.6	832
Sample 7	16.7	32.8	0.32	39.2	6881	17.2	1660
Sample 8	19.0	27.8	0.16	31.8	8390	10.1	3880
Limit value		5	1	5	100	-	-

a) Regulation of Dangerous Substances

b) 2,3,7,8-TCDD/F; 1,2,3,7,8-PeCDD; 2,3,4,7,8-PeCDF; 1,2,3,6,7,8-HxCDD/F; 1,2,3,7,8,9-HxCDD; 1,2,3,4,7,8-HxCDD

c) Group 1 contains the 2,3,7,8-TetraCDD/F; 1,2,3,7,8-PeCDD and 2,3,4,7,8-PeCDF

d) Group 2 contains the 12 2,3,7,8-substituted tetra- to hexa-CDD/F-congeners

e) Group 3 contains the 17 2,3,7,8-substituted tetra- to octa-CDD/F-congeners

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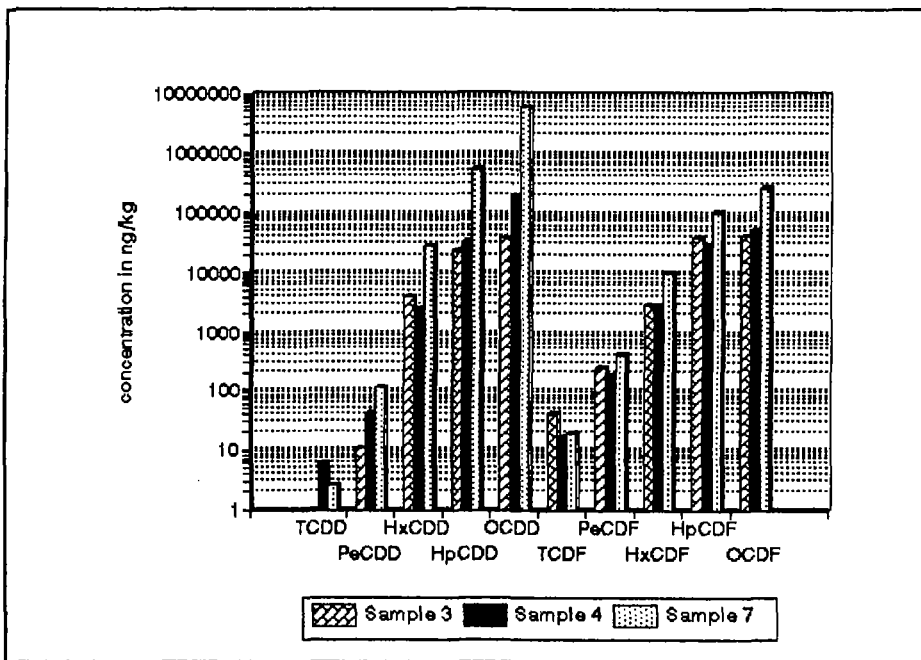


Fig. 1: 2,3,7,8-substituted PCDD/F-congeners in three wood samples treated with pentachlorophenol

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