Bioaccumulation of PCDEs and PCDFs from contaminated river sediment to fish (Burbot) feeding bottom fauna

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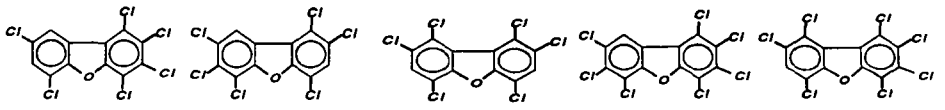
Introduction

The large Kymijoki river in Southeast Finland has been heavily polluted by organochlorine compounds (OCC) from paper and chemical industry. After the emissions decreased to near zero in mid 1980s, the river bottom solids still have been contaminated by OCC traces. Marked levels of pulp bleaching originated sediment-bound chlorocatechols, guaiacols and alkylaromatic chlorohydrocarbons are still found /1,2/. OCCs leaked from production of chlorophenol formulation Ky-5 during years1945-1984 also occur in high concentrations in the Kymijoki river bottom sediments. Toxic equivalent (TEQ) values of the Ky-5 originated PCDDs and PCDFs in some surface sediments were measured to be even 60 μg/g dw /3/. Besides, in bottom fauna of some contaminated sites, developmental abnormalities and population changes were observed /4/. A cooperative national project KYPRO, led by Finnish Environment Center and involving several Universities and Research Institutes, during three years 1996-98, aims to evaluate this OCC pollution and its hazard to man and wildlife. First screening results of KYPRO on PCDDs and PCDFs in fish was presented in DIOXIN'97 /5/. The present work aims to study natural condition bioaccumulation rates of most abundant PCDF and PCDE congeners from Kymijoki sediment via bottom fauna to its consumer fish (burbot).

Compounds studied

Ky-5 was manufactured by chlorination of phenol. Typical product used as wood preservative consisted of 2,3,4,6-tetrachlorophenol as main component (80%). Main impurities were 2,4,6-tetrachlorophenol (10%), pentachlorophenol (8%) and eight congeners of polychlorinated phenoxyphenols (PCPP; < 2%). Minor important impurities were polychlorodibenzofurans (PCDF; five major congeners = 100 μg/g), polychlorodibenzo-p-dioxins (PCDD; ten major congeners = 10 μg/g) and polychlorodiphenyl ethers (PCDE; 14 major congeners 15 μg/g) /6/. Five dominating PCDF and twelve PCDE congeners /6,7/ were taken to the present study.



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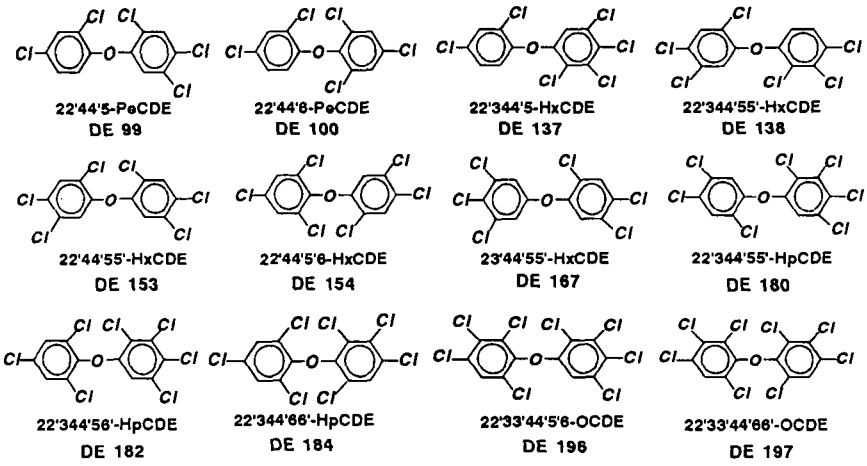

Samples and analyses

River sediment samples were collected from 16 locations during spring 1996 with an pistonless corer. From each location 3-4 samples were collected, sliced in the field and transported to the laboratory. From each location at least two cores were determined for chemical contaminants including also PCDDs, PCDFs and PCDEs. Fish samples were collected during 1996 from localities near to the sediment sample places. Burbot (*Lota lota*), bottom fauna feeder, was sampled from two localities of the river below the closed Ky-5 factory and from estuary area. Analysis methods were the same as reported earlier for PCDFs and PCDEs in sediment and fish /3/. Determination of the four congeners (HxCDF1,2, and3, HpCDF2) which are not included in 17 laterally 2,3,7,8-substituted PCDD/Fs was obtained the GC/MS/SIM windows for Hx- and HpCDFs in the standard determination of the latter "toxic" congeners with aid of the reference from Humppi /6/.

Results and discussion

The present results are from sampling station six km downstream of a major pulp mill and the closed Ky-5 factory. Comparison of the concentration profiles in sediment, burbot and Ky-5 formulation are illustrated in Fig. 1 for PCDEs and in Fig. 2 for PCDF congeners.

Bioaccumulating factors (BAF) calculated by dividing concentration in wet fish muscle with concentration in dry sediment were 0.089 - 3.6 for PCDEs and $6x10^{-7}$ - $2x10^{-4}$ for PCDFs. Simple modeling /8/ using log Kow as substance property parameter estimated from similar PCB congeners for PCDEs /9/ and from similar PCDF congeners for PCDFs and sediment as the only present source of contamination was unable to explain the wast difference of the observed BAFs between PCDEs and PCDFs.

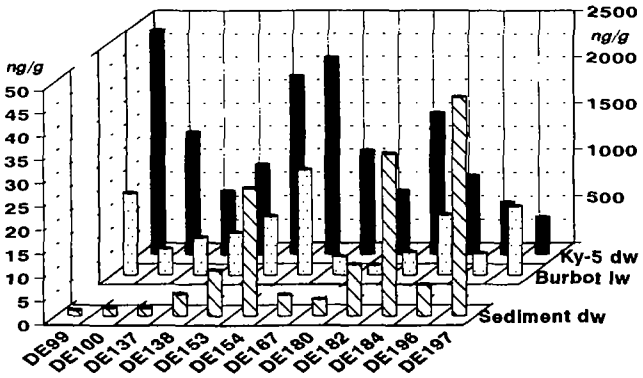

Fig. 1. Mean concentrations of PCDEs in sediment (N = 4) and burbot muscle (N = 3) compared to levels in typical Ky-5 formulation sample /3/.

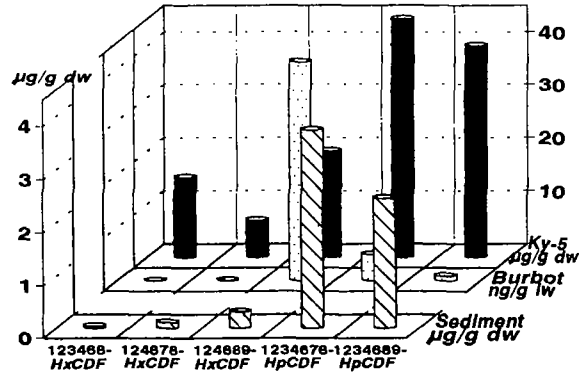

Fig. 2. Mean concentrations of PCDFs in sediment (N = 2) and burbot muscle (N = 2) compared to levels in typical Ky-5 formulation sample /6/.

Acknowledgements

The authors are grateful to Ministry of the Environment, Finland and UPM-Kymmene Co for financial support.

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