Hair Analysis of PCDD/F and PCB: Applications to Human- and Ecotoxicology

K.-W. Schramm[1], A. Kettrup[2]

[1]Institut für Ökologische Chemie

GSF-Forschungszentrum für Umwelt und Gesundheit, Neuherberg, Ingolstädter Landstr. 1, D-85764 Oberschleißheim, Germany

[2]Chair of Ecological Chemistry and Environmental Analysis, Technical University Munic, Weihenstephan, D-85354 Freising, Germany

Abstract

The occurrence of organic xenobiotica in environmental compartments and biota has been already reported. Hair has been monitored for drugs and metals[1]. Recently the attention was drawn to organic compounds in hair for two reasons[2].

1. Use of hair as bioindicator with respect to the lipid content and the hydrophobic surface properties[3]

2. Use of hair as passive sampling system with respect to its large surface

Establishing knowledge in these two research fields has several advantages which are:

1. Monitoring of environmental levels, protected animals included. The goal is to establish safe concentrations by relating hair concentrations to physiological fluid concentrations. Klein et al.[4] found relationships between hair, blood, and milk for hair from exposed cows, which ingested PCB.

2. Reporting short-term exposure in the environment and at working places by wet, dry, and particle deposition.

The analysis of hair is believed to be applicable in minimum to the chemical groups toxaphene, PAH, chlorinated benzenes, semi- and non volatile pesticides (DDT, DDE,

Pentachlorophenol) and detectiion by bioassays (P450-EROD, Ames Test) of public concern.

To apply hair analysis to the above mentioned goals a couple of presumptions have to be fulfilled:

1. The kinetics of accumulation must be rapid.
2. The kinetics of elimination must be slow.
3. The partition-coefficients of the compounds between air and hair, as well as body fluids and hair should meat values which allow the detection in hair.
4. Hair washing procedures should be predictable in their influence on hair contamination and decontamination.
5. Effects of hair-type differences must be within one order of magnitude

Levels of PCDD/F and PCB in hair and first results about the effect of hair washing and habits (i.e. smoking) have been reported [5,6,7]. Consequently new results on the adsorption and desorption are presented.

In the experiment hair was exposed to gaseous PCB (Clophen A 40) in a closed system. Adsorption traps in the outflow allowed the semicontinous measurement of the gas concentrations. The gas bulk flow applied was measured by two flowmeters in the in- and outflow. At certain times samples of hair in the exposure chamber were taken to resolve the kinetics of accumulation and elimination. The concentrations of PCB in hair and air were measured applying a simple cleanup followed by isotope dilution HRGC/HRMS.

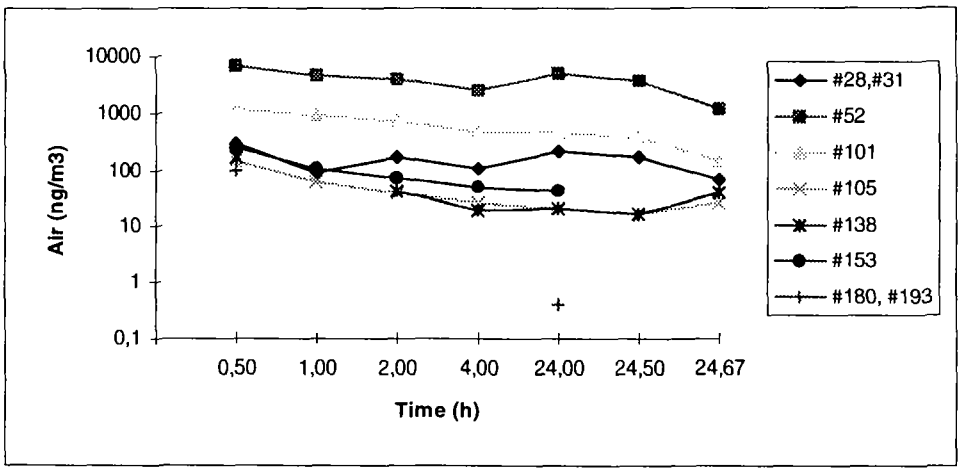

Fig. 1: Air concentrations of Ballschmiter PCB in the outflow of the exposure chamber. Accumulation period is between 0 and 24 h. Elimination period is from 24 to 24.67 h.

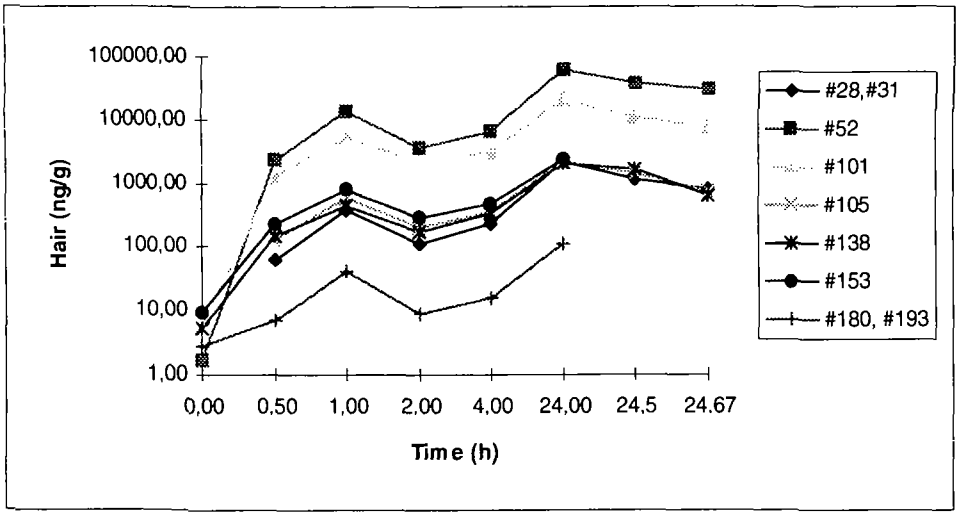

Fig. 2: Hair concentrations of Ballschmiter PCB in the the exposure chamber
Accumulation period is between 0 and 24 h. Elimination period is from 24 to 24.67 h.

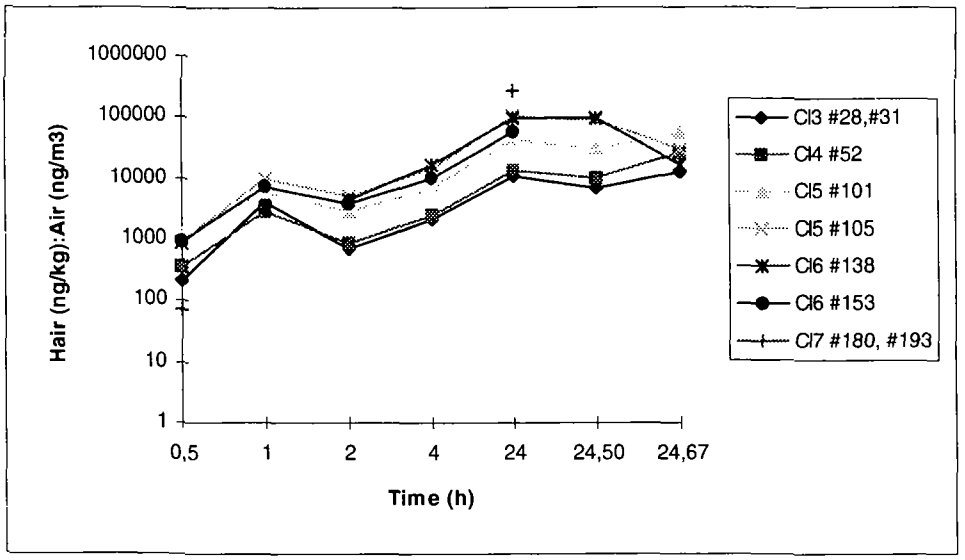

Fig. 3: Partition coefficients between hair and air during the exposure experiment.

The results show that the adsorption kintetics from the gas phase proceeds very fast. Desorption is less rapid depending on the chemical properties (vapor pressure, octanol/water-partition) of the compound. The resulting partition-coefficients are in the range

of 100 (dichlorobiphenyls) and 100000 (heptachlorobiphenyls) in (ng/kg hair)/(ng/m3 air). These results enable us to predict gaseous exposure from hair concentration. Current air concentrations in the pg/m3 range will lead hexachlorobiphenyl-concentrations of hair in the ng/kg range.

It is recognized that hair of seals is exposed to water and reflects the partition between the seal as bioindicator, ist food and water.

In conclusion hair is establishing to an overall bioindicator with properties which allow (eco)toxicological risk assessment. Hair sampling of vital and deceased protected species and i.e. children did not lead to any ethical doubts.

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