

INVESTIGATION OF SORPTION OF SOME CHLORINATED POLLUTANTS ON SOIL IN OIL CONTAMINATED SYSTEMS BY STATIC AND DYNAMIC METHODS

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ABSTRACT

In order to evaluate the potential risk generated by oil contaminated landfill leachates passing through soil, batch and column experiments were performed with reference systems consisting of standard soils and synthetic leachates. Sorption studies were carried out with hexachlorocyclohexane-isomers and hexachlorobenzene. The sorption behaviour was studied in aqueous systems containing the compounds at concentrations between 200 ppb and 1 ppm and various oil concentrations. The batch experiments showed isomer specific adsorption of the hexachlorocyclohexanes in the systems without oil, the adsorption levels ranging at 50% for α - and γ -BHC and at 70% for β - and δ -BHC. Concerning the column experiments, isomer specific breakthrough was observed analogously.

The experiments showed a significant influence of oil on the sorption of the components. The batch experiments showed a drastic decrease of adsorption down to 10% for all of the compounds at oil contents of 2-3%, the column experiments showed significant change of the breakthrough behaviour of the components at 0,2% of oil.

INTRODUCTION

Leachates of hazardous waste landfills represent complex matrices, partly containing high amounts of chlorinated pollutants^{1,2} and the potential risk of groundwater contamination. Additionally, oil contamination can occur, which was determined as the most important source of matrix effects in leachate analysis³ representing a sink for all of the lipophilic halogenated leachate

compounds as hexachlorocyclohexanes, chlorinated benzenes, PCDD/PCDF and PCB's^{4,5}. Concerning sorption behaviour on soils, complete change was observed for lindane by changing soil/water systems to soil/oil systems operated in the batch mode⁶. This paper deals with detailed studies on the influence of various oil concentrations on the sorption behaviour of hexachlorocyclohexane-isomers and hexachlorobenzene as determined by static methods, i.e. batch experiments and dynamic methods, i. e. column experiments.

MATERIAL AND METHODS

Materials The standard soils were obtained from the Landwirtschaftliche Untersuchungs- und Forschungsanstalt (LUFÄ, Speyer; F.R.G.). Hexachlorobenzene was from AMCHRO (Sulzbach/Taunus, F.R.G.), hexachlorocyclohexane-isomers were from RIEDEL DE HAEN (Stuttgart, F.R.G.). All solvents were purchased from PROMOCHEM (Wesel, F.R.G.). Pristane and hexadecane were purchased from ALDRICH (Steinheim, F.R.G.).

Standard solutions For the batch and the column experiments, a methanol standard was prepared containing α - and γ -BHC at 40 - 50 $\mu\text{g/ml}$, β - and δ -BHC at 80 and 110 $\mu\text{g/ml}$ and hexachlorobenzene at 20 $\mu\text{g/ml}$.

For the batch experiments, a quantity of 250 μl of the standard mixture was spiked into 25 ml of 0.01 M CaCl_2 solution. For the column experiments, 1-6 l of 0.01 M CaCl_2 solution were spiked with 10-60 ml of the standard mixture.

Sorption experiments The batch experiments were performed according to OECD guideline 106, with 5g of soil, 25 ml of spiked aqueous solution and agitation for 16 h. The column experiments were performed with columns (4,5 x 25 cm) of 200 g of soil, passing 5 - 6 l of spiked aqueous solution through the soil, the velocity ranging at 2 ml/min. The investigations of oil contaminated systems included spiking of the water system with oil and homogenisation with an ultrasonic tube before spiking of the methanol standard mixture. The supernatant of the batch experiments and the effluent concentration from the column experiments was determined by GC (ECD) after extraction with hexane.

RESULTS AND DISCUSSION

The table shows the percent adsorption of BHC-isomers (isomers of benzene hexachloride) and hexachlorobenzene on soil A, as determined without oil and at percent oil concentrations. At 0,2% of oil, the adsorption for the hexachlorocyclohexanes was slightly decreased, whereas for hexachlorobenzene a drastic decrease was observed from a 95% adsorption to 25% adsorption. With increasing oil concentrations, the adsorption of all the

Table 1: % Adsorption of BHC-Isomers and HCB on soil A, in absence of oil and at percent oil concentrations

Compound	C_0^* (ppb)	concentrations of oil				
		—	0.2%	1%	2%	3%
α -BHC	460	55	27	24	10	7
β -BHC	1130	76	61	36	18	2
γ -BHC	480	54	46	34	21	7
δ -BHC	846	77	66	5	2	1
HCB	200	95	25	20	13	11

C_0 = initial concentration

components was decreased to residual adsorption rates between 1 - 10 % at maximal oil content. Fig. 1 shows the adsorption isotherms for β -BHC and hexachlorobenzene as determined without oil and at 0,2% of oil. The isotherms for each component are nearly parallel, the difference of axis intercepts for hexachlorobenzene is more pronounced indicating the more significant oil effect on the adsorption of hexachlorobenzene.

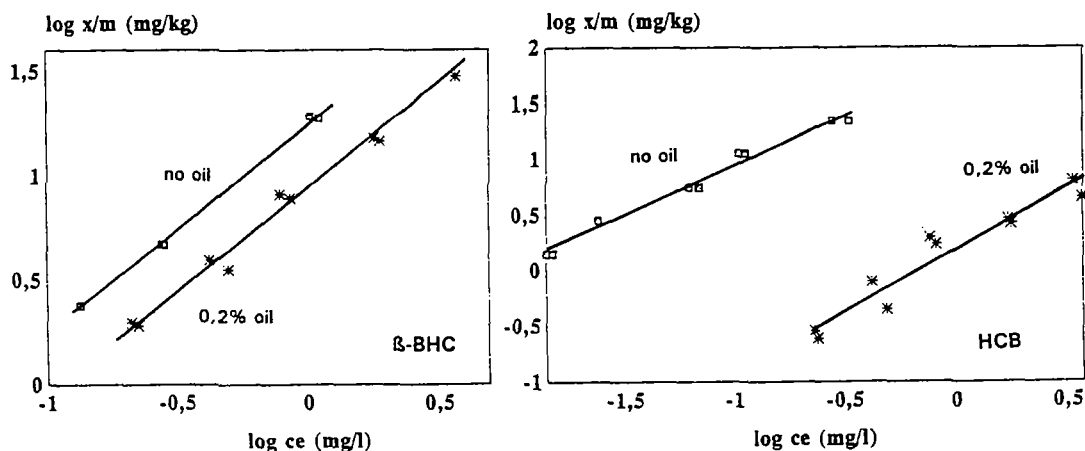


Fig. 1: Adsorption isotherms of β -BHC and hexachlorobenzene (HCB), as determined for soil A without oil and at 0,2% of oil.

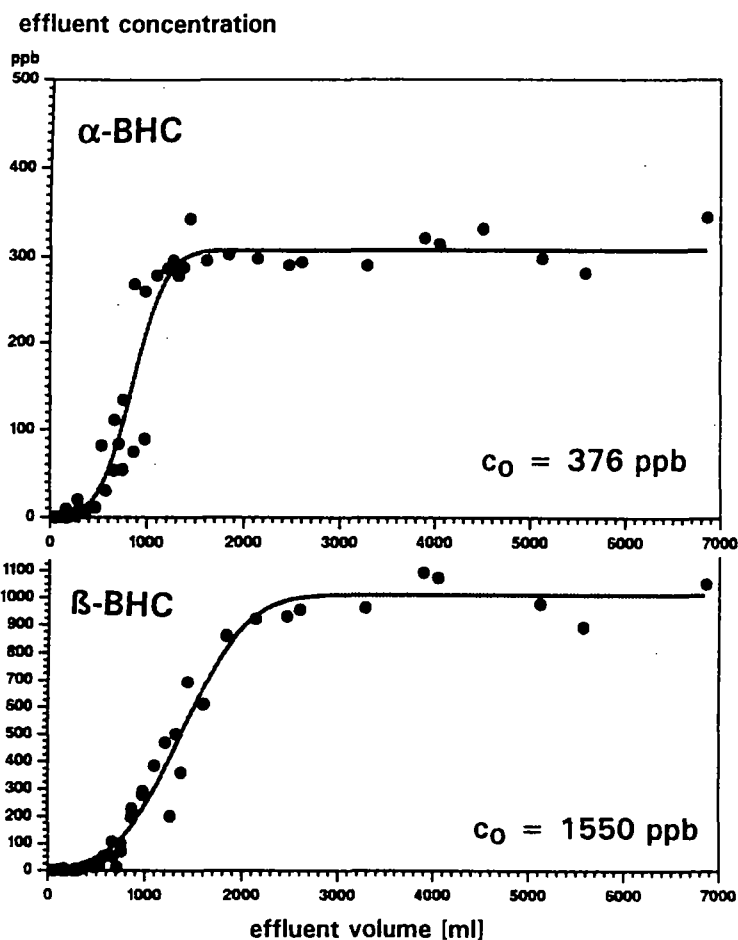


Fig. 2: Breakthrough curves of α - and β -BHC for soil A, as determined without oil

Fig. 2 shows the breakthrough curves for α - and β -BHC, as determined without oil. Analogous behaviour with isomer specific break through was observed for γ - and δ -BHC. The curves represent regression curves, the data are from at least triplicate determinations. At 0,2% of oil, behaviour of all hexachlorocyclohexanes changed completely, characterized by a shift of breakthrough concentrations to larger pore volumes. At the same time, no isomer specific behaviour occurred under influence of oil.

From these findings, the following is summarized: Isomer-specific adsorption was determined for all the BHC-isomers by static methods and dynamic methods. A strong influence of oil on the adsorption of the compounds was observed both from the batch and from column experiments. Maximal decrease of adsorption was determined for all compounds at oil concentrations in the low percent range within the batch experiments. We conclude that for oil contaminated leachates, a change of sorption behaviour of the leachate compounds with respect to the passage through soil has to be expected.

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