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THE EXTRACTION AND RECOVERY OF POLYCHLORINATED BIPHENYLS(PCB) USING POROUS POLYURETHANE FOAM

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H. D. Gesser, A. Chow, and F. C. Davis
Chemistry Department, University of Manitoba, Winnipeg Canada

and

J. F. Uthe and J. Reinke
Fresh Water Institute, 501 University Crescent, Winnipeg, Canada

ABSTRACT

A fast and efficient method has been developed for the extraction and concentration of PCB from water. The method uses porous polyurethane foam as the absorption column for the PCB which is eluted with acetone and hexane for G.C. analysis.

INTRODUCTION

The analysis of chlorinated pesticide residues[1] and PCB[2] in water continue to present problems. The extraction of chlorinated pesticides from water with organic solvents[3] is time consuming and can only be done with 95-100% efficiency in a laboratory. The adsorption of PCB on activated carbon[4] is complete but its recovery is variable, inefficient (25-30%) and the recovered material is significantly different from the initial PCB. The reversed liquid-liquid partition filter developed by Ahling and Jensen[5] gave excellent recovery for PCB (93-100%) but was limited by relatively low flow rates (465 ml/min) and required elaborate preparation as well as vacuum or suction to achieve those filtration speeds. A recent review of the subject has been presented by Thornburg.[6]

The recent paper by Bowen[7] on the absorption properties of polyurethane foams presented a new and simple method of concentrating metallic ions from

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dilute aqueous solution.[8] The results suggested to us that the foams have a possible absorption capability for trace organic contaminants in water and we undertook to test this for the analysis of PCB in water.

EXPERIMENTAL AND RESULTS

Preliminary experiments showed that polyurethane foam does extract PCB quantitatively from water. PCB was removed from the foam by Soxhlet extraction with hexane. PCB-hexane solutions were concentrated by slow evaporation to 2 ml and samples analyzed by electron capture gas chromatography. Water spiked with known quantities of PCB gave about 50% recovery for the overall method. The loss was suspected to occur through the open condenser of the Soxhlet extractor. This was verified when a second clean foam was placed in the open end of the condenser and was shown to contain a major fraction of the PCB lost.

A simpler and more efficient method therefore was developed using polyurethane foam plugs designed as culture tube stoppers (diSPo stoppers from Canlab, Winnipeg). These have a higher density (0.027 gm/cm^3) but are more porous than the commercial sheet polyurethane foam (0.022 gm/cm^3) used in preliminary work. The foam plugs (22 mm diameter and 38 mm long) were cleaned by shaking in a 1:1 hexane-acetone solution in a steel tube with a steel ball. The plugs were then pushed down a 20 mm I.D. glass chromatographic column and washed with 25 ml of ethyl alcohol to remove residual solvent and air. This was followed by careful washing with 200 ml of distilled water. The aqueous PCB solution was then passed through the column with a flow rate of about 250 ml/min without the need of pressure or vacuum. It was found that 95% of the PCB was retained by the first plug and a few percent of PCB was retained by a second plug, thus making two plugs a necessary and sufficient column. Water was squeezed from the foam column prior to the extraction of PCB. The PCB was eluted from the polyurethane

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foam column with 20 ml of acetone followed by a 100 ml of hexane, care being taken to wash down the walls of the glass column. It should be noted that at this stage if a significant quantity of H_2O (> 1 ml) has been co-extracted with the hexane then a separatory funnel separation of the two phases is required before the elutant is dried with about 20 g of anhydrous sodium sulfate. The dried elutant was concentrated on a rotary evaporator to 10 ml and a 5 µl sample was analyzed by G.C. The G.C. used was a Hewlet Packard Model 5750, equipped with a ^{63}Ni electron capture detector operated at 260°C using a helium carrier gas and a 90% argon-10% methane purge gas. Pulse time was 50 microsec., range and attenuation was 1 x 128. The 6' x 1/4" glass column was packed with 2% SE-30, 3% QF-1 on 80 - 100 mesh Chromosorb W HMDS treated at a temperature of 200°C. Injection port temperature was 230°C.

The results of extraction and recovery of PCB from water by the urethane foam column are summarized in Table 1 where quantitative calculations are based on the peak height of 13 resolved peaks, with the average and mean deviation for each analysis given.

Similar results were obtained with 2.0 µg/liter of PCB in water. It was also shown that PCB is not washed out of the foam by water. A complete analysis can be done within one hour. The results clearly indicate the method to be both fast and efficient. The extraction can be performed at the water sampling site and the foam plug (if column wall interference

TABLE 1

THE EXTRACTION AND RECOVERY OF PCB FROM 1 LITER OF WATER

PCB ADDED	PCB ANALYZED	% RECOVERY
20 µg.	19.6	98 ± 6
20 µg.	19.0	95 ± 4
20 µg.	18.6	93 ± 14
20 µg.	19.0	95 ± 3
20 µg.	18.2	91 ± 7

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is avoided) or the acetone-hexane solution can be returned to the laboratory for concentration and analysis.

DISCUSSION

The limits of detection and analysis of PCB in water is presumably governed by the amount of water chromatographed through the foam column. The polyurethane foam is not specific to PCB and it will absorb organochlorinated pesticides as well and a complex mixture would require some separation[9,10] prior to G.C. analysis.

The application of this method to inorganic ions will be reported shortly.

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