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NOTE

Removal and Preconcentration of Surfactants from Wastewater with Open-Pore Polyurethane

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Abstract

A column of *in-situ* polymerized open-pore polyurethane (OPP) was evaluated for removing and concentrating linear alkylate sulfonate (LAS) from synthetic wastewater. The OPP can be used to remove LAS effectively from wastewater for purification as well as a preconcentration step prior to analysis. Preliminary results of comparisons of breakthrough capacities and elution rates for LAS on OPP, active carbon, and a macroreticular resin are presented.

INTRODUCTION

Much work has been reported on the use of cellular (foamed) polyurethane for the collection, separation, and recovery of inorganic and organic compounds from aqueous solutions (*1*). However, open-pore polyurethane (OPP), a rigid yet very permeable structure of agglomerated spherical particles, has received only limited application in column chromatography (*2*).

Recently, OPP has been evaluated for the collection and preconcentration of polynuclear aromatic hydrocarbons from water (*3*). The good recovery of these substances prompted a study to test OPP for its ability to remove detergents and corrosive anions from wastewater, and to compare OPP to other adsorbents (*4*). The best macroreticular resin and active carbon found in prior work (*4*) was compared to OPP for removing

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and concentrating linear alkylate sulfonate (LAS) from waste water. The results are presented herein.

EXPERIMENTAL

Materials

The OPP was prepared in a glass column (10 cm in length and 0.4 cm in diameter) by *in-situ* polymerization of 60–40 vol-% toluene–carbon tetrachloride solutions of the isocyanate and polyol (*3*). The isocyanate was Mondur MR, Mobay Chemical Co., and the polyol was Union Carbide LA-475. The resulting polymer, made from a monomer formulation with an OH–NCO ratio of 2.2, had a density of 0.20 g/ml. The OPP columns were washed with 20 bv (bed volumes) of hexane, 20 bv methanol, and 200 bv of distilled-deionized water before use.

Amoco GX-31, C-petroleum type active carbon, was dry-sieved to obtain a particle size of 40 to 50 mesh. Amberlite XAD-4, 20 to 50 mesh beads, was supplied by Rohm and Haas.

Columns with an inner diameter of 0.6 cm were filled with a weighed portion of sorbent to give a bed height of 10 cm. Bed volumes were 2.8 ml for the sorbent columns and 1.3 ml for the OPP. Before use, these columns were washed with 20 bv of methanol, 20 bv of 1 *M* HNO_3, and finally 200 bv of distilled-deionized water. All columns of sorbents were stored under water before evaluation.

A 2.5-g/l Pierce laundry detergent solution, adjusted to pH 5.0 with 12 *M* hydrochloric acid, was prepared for use as the synthetic waste stream. This solution was filtered through Whatman #42 paper to remove colloidal particles. The water was acidified slightly to prevent column wall-OPP bond breakage (*3*).

Equipment and Procedures

One-liter quantities of the detergent solution were pumped through each column at an average flow-rate of 5.0 ± 0.3 ml/min. Forty-five fractions of 20 ml each were collected with a Scientific Manufacturing Industries drop-counting fraction collector. A selected number of fractions were analyzed for linear alkylate sulfonate (LAS) by the methylene blue method (*5*).

The elution behavior of the absorbents was studied by pumping anhydrous methanol through these columns at 1.5 ml/min. Five fractions of 2 ml each were collected. The residue remaining after room temperature evaporation of the methanol was redissolved in distilled-deionized water and analyzed for total organic carbon (TOC) and LAS.

TOC was determined by difference of total carbon minus carbonate carbon. Both types of carbon were determined with a Beckman Model 915 Total Organic Carbon Analyzer.

RESULTS AND DISCUSSION

Figure 1 shows the breakthrough capacity and elution behavior of LAS on OPP. OPP has a high capacity for LAS, but allows the LAS to be efficiently eluted with methanol. Thus OPP appears to be an effective sorbent for removing and concentrating LAS from water.

Comparison of OPP to other common sorbents for removing detergents from wastewater was reported (*4*). The best active carbon and macroreticular resin was compared to OPP for removing LAS from water. The results of these comparisons are shown in Table 1.

Breakthrough capacity is defined as the milliliter of detergent solution

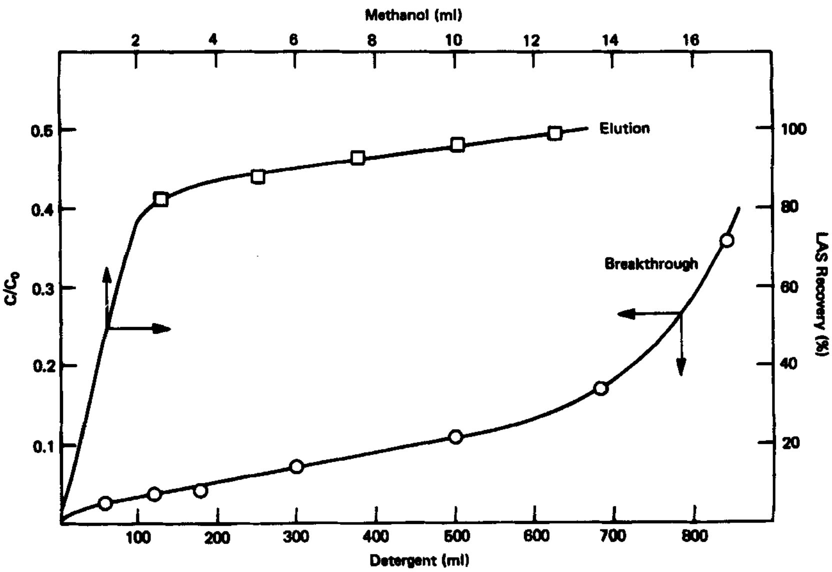

FIG. 1. Breakthrough and elution behavior of linear alkylate sulfonate (LAS) on open-pore polyurethane (C/C^0 = LAS in effluent/LAS in feed).

TABLE 1

Breakthrough and Elution Data for Sorbents[a]

Sorbent	Breakthrough capacity[b] LAS	Breakthrough capacity[b] TOC	Elution[c] TOC
OPP	620	135	2
Amberlite XAD–4	310	20	1
Amoco GX–31	83	70	>12

[a] Average of two determinations; average precision ±30%.
[b] Milliliter of detergent passed per milliliter of sorbent when the ratio of LAS or TOC in the effluent to LAS or TOC in the feed is 0.3.
[c] Milliliter of methanol to elute 30% of TOC from a milliliter of sorbent.

passed per milliliter of sorbent when the ratio of LAS (or TOC) in the effluent to LAS (or TOC) in the feed is 0.3. The elution is milliliters of methanol to elute 30% of the TOC from a milliliter of sorbent.

The data in Table 1 show that OPP has the highest breakthrough capacity for LAS. However, OPP capacity for TOC is the lowest of the three materials tested. This difference in break-through capacities could allow LAS to be separated from TOC with OPP.

The elution data of TOC for the three sorbents are also shown in Table 1. Although OPP shows rapid elution of LAS, Amberlite XAD-4 permits the fastest elution of TOC.

These preliminary results have shown that OPP is a very effective sorbent for removing and concentrating LAS from water. The OPP could be used to remove LAS effectively from wastewater for purification as well as a preconcentration step prior to analysis of LAS.

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