Uses of Polyurethane Foam for Analytical Applications

Thesis

Submitted in Partial Fulfillment of The Requirements of The Master Degree of Science in Analytical Chemistry

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Title: Uses of Polyurethane foam for Analytical Applications

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Summary of MSc

Solid – Phase extraction (SPE) is one of the most important procedures for the separation, preconcentration and clean up steps of organic and inorganic contaminants from different types of samples.

In this work several trials were made to prepare some novel types of modified PU foam to be used for extraction, preconcentration and separation of some metal ions.

Chapter 1: Introduction

This chapter represents some literature reviews of some chelating resins and other sorbents with special attention for PU foam.

Chapter 2: Experimental

This chapter includes the instruments, chemicals and reagents, methods of preparation of grafted and bonded foams, in addition to the methodology employed in this work.

Chapter 3: Results and Discussion

Part I: polyurethane foam chemically grafted:

This part includes characterization of Safranine - T and Neutral – Red grafted foams. Applications of these two grafted foams in batch method were examined by studying the effect of pH, acidity, thiocyanate concentration, weight of foam, volume of sample, shaking time, extraction isotherm and effect of foreign electrolytes. Safranine –T grafted foam can extract Hg, Cd, Zn and Fe as thiocyanate complexes, and Neutral-Red grafted foam can extract Cu, Co and Mn as thiocyanate complexes from acidic media, after shaking for 15 - 25 min. The thiocyanate concentration was found to be a determinant factor. The amount of foam at maximum sorption was found to be 0.15 and 0.25g. The maximum
extraction capacity of one gram foam are 352.5, 355, 346.5, 315, 390, 355 and 235µg for Hg, Cd, Zn, Fe, Cu, Co and Mn respectively. The addition of foreign electrolytes was found to reduce the percentage extraction of Hg, Cd, Cu and Mn, while Zn and Fe are less affected.

Column technique include studying of break through curve, chromatographic behavior, flow rate effect, preconcentration and separation of examined elements. The retention of Cd (II), and Mn (II) were found to be largely dependent on thiocyanate concentration. Quantitative recovery of Hg (II), Cd (II), Zn (II), Fe (III), Cu (II), Co (II) and Mn (II) were achieved using 5MHCl, 0.1 MHCl, 0.01 MHCl, 0.1M ascorbic acid, 1 M HCl, 0.05 M HCl and 0.01 M HCl respectively. The breakthrough capacity of one gram foam column was determined for each element. The suitable flow rate was found to be 3ml min$^{-1}$ for elution. Preconcentration from 100 up to 1000 ml varies from 100 to 97.5 % recoveries. Mutual separation of synthetic mixtures was effectively conducted by using suitable eluting agents where quantitative recoveries were obtained. The results showed also that grafted foam has greater capacity, sensitivity and selectivity than the untreated (white) foam. Good accuracy and precision were achieved for the separation of Cd, Fe, Zn and Hg, the RSD for these elements are 2.628, 2.51, 1.39 and 2.66 % respectively.

**Part II : Polyurethane foam Coupled to organic compounds.**

In this part we have been succeeded to prepare azo compounds (by coupling with p-cresol or p-hydroxyacetophenon) to the untreated (white) foam which containing hydroxyl groups adjacent to azo groups acting as chelating centers for metal cations. These prepared bonded foams were applied for the extraction, preconcentration and separation of Zn (II), Pb (II), Cd (II), and Hg (II). The results in batch methods showed that P-cresol bonded foam can extract Zn (II), Pb (II), Cd (II), and Hg (II) from neutral or faint alkaline media, after shaking for about 14
min. The breakthrough capacity curves of one gram foam was accurately determined for each element and was found to be less than in case of grafted foams. Elution of these elements was effected using 0.005NHNO$_3$, 0.1 MCH$_3$COOH, 0.1MHCl and 2MHCl respectively. The optimum flow rate was found to be 3 ml min$^{-1}$. Preconcentration with quantitative recovery of the elements from one liter samples were achieved. Chromatographic separation of some synthetic mixtures was carried out quantitatively using the suitable eluting agents.

**Par III: Analytical application of the modified polyurethane foams for the analysis of natural water samples**

This part includes the applications of both grafted foam and bonded foams for the preconcentration and separation of the studied metal ions from natural water samples namely *Qaroun Lake* and *Tap water*. Quantitative recovery of 50 µg of each element spiked into one liter of water samples as thiocyanate complexes using Safranine-T or Neutral – Red grafted foam and p-cresol or P-hydroxyacetophenon bonded foam. Lead generally not quantitatively recovered due to the higher concentrations of chloride and sulfate anions. Mutual separation of mixtures from natural water samples was quantitatively achieved.