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The retention profile of phosphate ions in aqueous media onto ion pairing immobilized polyurethane foam: Kinetics, sorption and chromatographic separation

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Abstract

A strategy for enriching, separating and determining the inorganic phosphate ions in water based on the use of polyurethane foam (PUFs) physically immobilized with some ion pairing or basic dyes has been reported. The retention of inorganic phosphate from the test aqueous solution containing molybdate ions onto untreated- and ion pairing reagent e.g. crystal violet (CV) or tetrabutylammoniumtetrafluoroborate (Bu4N+center dot BF4-) impregnated PUFs solid phase extractor was followed the order: unloaded < CV < Bu4N+center dot BF4- treated PUFs sorbent at pH 3.5-4.5. The kinetics of analyte sorption onto Bu4N+center dot BF4- treated PUFs at optimized pH (pH 3.4-4.5) was fast and followed first order rate equation with an overall rate constant of 0.062 min⁻¹. Film and intraparticle transport are the main factors controlling the rate of phosphate sorption onto the sorbent from solutions at pH = 3.5-4.5. Phosphate uptake followed Langmuir and Freundlich isotherm models. Thus, a dual-mode sorption involving absorption related to "weak base anion exchanger" and an added component for "surface adsorption" is the most probable retention mechanism for phosphate uptake by Bu4N+center dot BF4- loaded PUFs sorbent. Chromatographic separation of phosphate by Bu4N+center dot BF4- treated PUFs packed column was carried out. The number (N) and the height equivalent to the theoretical plates (HETP), critical and breakthrough capacities were found equal 81 +/- 4, 0.13 +/- 0.02 mm, 2.5 +/- 0.2 and 27.25 +/- 2.06 mg g⁻¹, respectively. These results suggested the use of the proposed Bu4N+center dot BF4- treated PUFs in packed column for separation of trace levels of phosphate in water. The retained phosphate were recovered quantitatively (102.6 +/- 2.4-106.2 +/- 3.2%) with NaOH (0.5 mol L⁻¹) and analyzed. The proposed column was applied for separation and recovery of phosphate ions in waste- and seawater samples. The results were in good agreement with the spiked and expected phosphate concentrations at 95% confidence. (c) 2016 Elsevier B.V. All rights reserved.

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