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MICROBEADS DERIVED FROM POST-CONSUMER POLY(ETHYLENE TEREPHTHALATE) BOTTLES FOR ADSORPTIVE REMOVAL OF HEAVY METAL IONS FROM AQUEOUS SOLUTIONS

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Plastic pollution is a significant environmental challenge, with serious consequences for ecosystems and human health. Among synthetic polymers, poly(ethylene terephthalate) (PET) is a major contributor due to its durability and moisture resistance, making it widely used in packaging industry, particularly PET bottles. The objective of this study was to synthesise microbeads from post-consumer PET bottles to evaluate their efficacy in heavy metal ion removal, with bead formation specifically intended to increase surface area. To synthesise microbeads, PET flakes were dissolved in a 1:5 solvent system of trifluoroacetic acid (TFA) and dichloromethane (DCM), using an optimised PET concentration of 15% (w/v). Resulting microbeads with an average diameter of 744.9±38.6 μm were characterised using Fourier transform infrared (FTIR) spectroscopy, thermogravimetric analysis and X-ray fluorescence spectroscopy. The adsorption capacity was evaluated for Cu^{2+}, Cd^{2+} and Pb^{2+}, with residual concentrations quantified using atomic absorption spectroscopy. As Cu^{2+} ions exhibited the highest adsorption among tested ions, subsequent studies were conducted using Cu^{2+} ions. FTIR confirmed interactions between Cu^{2+} ions and oxygen bearing functional groups of PET during adsorption. Batch experiments conducted, in triplicate, to optimise adsorption parameters revealed that most effective removal occurred at an initial Cu^{2+} concentration of 10 mg L^{-1}, pH of 7, and a contact time of 12 min, achieving a maximum removal efficiency of 45%. Regeneration studies with 1 mol L^{-1} HCl achieved a desorption efficiency of 21% via an ion-exchange mechanism. Kinetics studies revealed pseudo-second order behavior, indicating chemisorption as the rate-limiting step. Further, the adsorption data fit well with the Langmuir isotherm model, suggesting monolayer adsorption of Cu^{2+}. These results highlight the potential of recycled PET bottles in microbeads form as low-cost functional materials for environmental remediation, offering a sustainable solution to address both plastic and heavy metal pollution.

Keywords: Heavy metals, Microbeads, Plastic pollution, Poly(ethylene terephthalate)