Phosphorus removal from water by polyolefins activated with Al_2O_3

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Keywords: eutrophization, phosphorus, polyolefins, aluminium oxide (Al_2O_3)

Eutrophization of aquatic ecosystems due to high phosphorus concentrations is associated with algal blooms which lead to poor water quality (Ribeiro et al, 2008; Martins et al, 2008). Processes used in remediation of water bodies include removal of P from the water column by precipitation and P inactivation in sediments (sediment capping). Remediation solutions have been tested for a long time but with limited success. Chemical precipitation of P with aluminium, iron, and calcium salts added to the water column has several disadvantages, namely is inadequate to remove low concentrations of phosphorus, contaminates water with high concentrations of sulphate and chloride ions, and generates large quantities of flocs that settle to the sediment (Ramm and Scheps, 1997; Lijklema et al, 1993; Jin et al, 2006). A sediment capping layer would remain in place indefinitely, unless disturbed by ebullition of sediment gases or some major seismic or climatic disturbance. Potential problems with sediment capping are bioturbation and wave action (Hano et al,1997; Donnert and Salecker 1999). For this reasons, we propose a new method for phosphorus removal based in polyolefins activated with a sequestering agent (Al_2O_3).

Polyethylene (PE) and polyethylene grafted with two different concentrations of maleic anhydride (PE-g-MA and PE-g-MA^+) activated with Al_2O_3, were tested for phosphorus removal from an aqueous solution with an initial phosphorus concentration of 100 µg/L. Kinetic experiments were carried out in glass beakers under static conditions using polymeric plates with similar areas, 10.5 cm^2 (4.0 cm × 1.0 cm × 0.2 cm), at room temperature for 3 months (Figure 1). Samples were taken regularly and phosphorus content was measured. Experiments were carried out in triplicate. The effect of the polymeric matrix in the adsorption process was analysed carring out experiments with granulated PE, PE-g-MA^+ and Al_2O_3. In this trial, the solutions were continously shaken in an orbital shaker at 100 cicles per min at 22 ºC for 7 d. Samples were taken at the begining and at the end.

A very high percentage of phosphorus removal was obtained for the three tested materials as well as a very low remaining phosphorus concentration in solution (below 10 µg/L), as depicted in Figure 1. The kinetics of P uptake was faster for PE-g-MA^+ (polyethylene enriched with MA), more than 50 % of P was removed in the first two days. This result seems to indicate that polymers with higher polarities have more affinity to P. Kinetic essays carried out with granulated PE, PE-g-MA^+ and Al_2O_3 indicated that PE and PE-g-MA^+ remove about 40 % and Al_2O_3 about 100 % of P from a 100 µg/L aqueous solution. Granulated Al_2O_3 reached the maximum uptake only in 3 days. The adsorption of phosphorus into activated polyolefins plates was influenced by the pH of the solution, the amount removed was higher at pH 3 for PE, pH 4 for PE-g-MA and pH 6 for PE-g-MA^+. Activated polyolefins effectively removed phosphorus from an aqueous solution which indicates that this material can be used for remediation of eutrophic water. The possible recovery of phosphorus for reused and absence of precipitation make this a very interesting process for water remediation.

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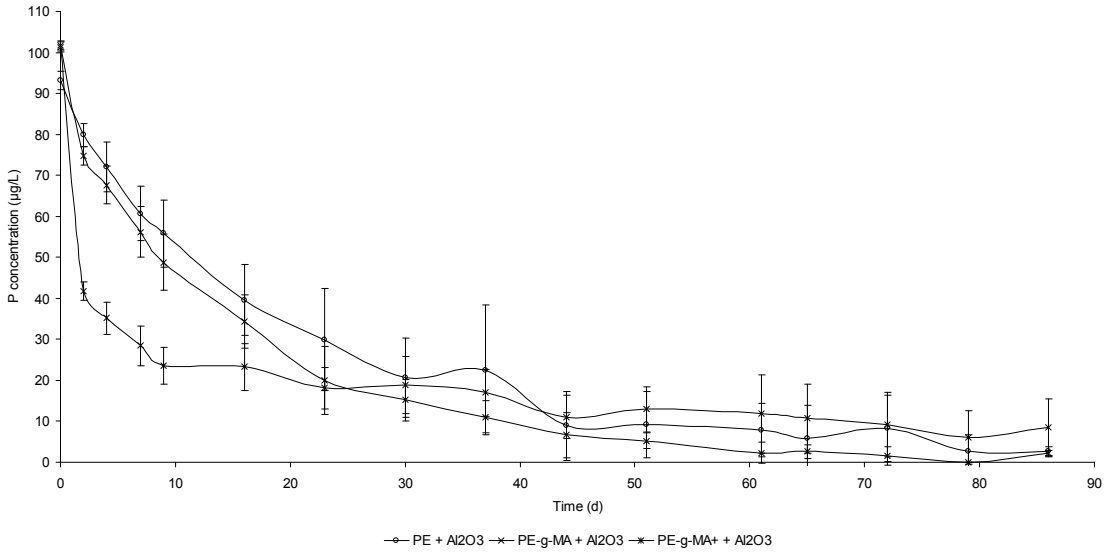

Figure 1 – Phosphorus concentration along time.

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