CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Hope Lee

Project Number

S1016

Project Title

A Novel Method to Immobilize Ionic Liquid in Alginate-Gelatin Polymer Beads for Heavy Metal(s) Removal

Abstract

Objectives/Goals

The purpose of this scientific study was to design a novel, effective, and highly efficient immobilized ionic liquid approach towards removal of heavy metal(s) from an aqueous environment. It was predicted that increased amounts of ionic liquid would remove a greater proportion of the Cu2+ from the aqueous environment and that the system would be superior to traditional LLE in terms of efficiency, economic feasibility, and environmental impact.

Methods/Materials

This project was divided into three phases: (1) creation of immobilized polymer beads, (2) traditional Liquid-liquid extraction (LLE) to serve as a baseline for comparison for later phases, and (3) extraction with immobilized ionic liquid polymer beads. Viscosity and phase separation were selected as design of experiment (DOE) responses of the IL-alginate-gelatine system and achieve a stable and homogeneous solution. The JMP statistic software was used to construct response surfaces for both characteristics.

The ionic liquid chosen was trihexyl (tetradecyl) phosphonium bis (2,4,4-trimethylpentyl) phosphinate (CYPHOS IL 104), a synthesized organic compound which consists of ions of both charges and is liquid at room temperature. For this study, copper ion (Cu2+) was selected as a model system to demonstrate the immobilized CYPHOS IL 104 concept. Gelatin and sodium alginate were selected to immobilize and stabilize IL in a polymer matrix.

Results

The optimized composition for the immobilized ionic liquid solution was identified through a DOE model as approximately 0.33% gelatin (w/w), 0.33% sodium alginate (w/w), and 33% IL (w/w). The immobilized IL beads ultimately removed a maximum of over 98% of Cu2+ from 6 mL of 50 mM Cu2+ solution. No extraction efficiency was compromised through immobilization. The immobilized IL beads were successfully stripped and regenerated by 1N NaOH and was able to remove over 98% of Cu2+ from 6 mL of 50 mM Cu2+ solution when used again.

Conclusions/Discussion

Ultimately, it was concluded that the novel immobilized IL-alginate-gelatin method did not compromise the extraction efficiency of the ionic liquid. This new approach, in comparison to LLE, greatly saved time, energy, and materials and prevented the IL contamination of water during extraction. This research has great potential in the field of water treatment and rare earth metal(s) extraction and adheres to the USEPA principles of green chemistry.

Summary Statement

The purpose of this scientific study was to design a novel, effective, and highly efficient immobilized ionic liquid approach towards removal of heavy metal(s) from an aqueous environment.

Help Received

Father supervised while working at home