CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

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Project Number

S0625

Project Title

Application of Micro and Nano Sized Magnetic Beads for the Purification of Water

Abstract

Objectives/Goals

The preparation of low cost, non-toxic chitosan coated magnetic nanoparticles and their application for heavy metal ion removal from water are the main goals. The nanoparticles are made to have fast adsorption and slow settling rate while keeping fast magnetic separation from water.

Methods/Materials

The raw magnetic nanoparticles were prepared via glycothermal synthesis. The magnetic nanoparticles were coated with SiO2 and then covalently coated with chitosan via a cross-linker. A dynamic light scattering instrument determined the size distribution of the beads. The Zincon colorimetric reagent determined the presence of trace amounts of metal ions. Each metal ion (Cu2+, Hg2+, Zn2+) complex with Zincon were first characterized through their absorption spectra. The concentrations of the metal ions in water before and after beads treatment were determined based on their absorption v. concentration graphs. A kinetics procedure determined the adsorption capacity of the beads.

Results

Nanoparticles had slow magnetic sedimentation, resulting in decreased separation efficiency. The estimated optimal bead size range is 500-1000nm. Beads with size ~800 nm had fast adsorption (<1min for 0.5 mM Cu^2+, Hg^2+, Zn^2+, slow sedimentation rate (>60 min), and fast magnetic separation (<1 min for 1cm x 1 cm x 1cm volume solution). Magnetic beads adsorption capacity ~30-40 mM heavy metal ion per gram of dry weight beads.

Conclusions/Discussion

There is a size limitation for chitosan coated magnetic nanoparticles. Small size such as 150 nm leads to slow magnetic sedimentation rate. Large particles such as 1.5 um resulted in fast natural sedimentation rate, which decreased the efficacy in heavy ion adsorption. An optimal range of about 500 nm-1000 nm is best for this application. The trace amounts of heavy metals such as Cu^2+, Hg^2+, and Zn^2+ can be spectrometrically determined via Zincon as a colorimetric reagent.

Summary Statement

The removal of heavy metal ions, such as mercury, from water by using chitosan coated magnetic micro and nano particles.

Help Received

This project was done with Dr. Luo at the UC Davis School of Medicine Cancer Center during summer 2010.