Project Leader (PI): El Barbary Hasasn

Co-PI(s): Barakat S.M. Mahmoud

Collaborator(s): Sam Chang; John Bland

Objective(s):

The objective of this proposal is to develop low cost and highly effective natural adsorbent based on CNFs/chitin hydrogel for the removal of heavy metals from fish water ponds to minimize their harmful effect on fish and accordingly on human beings. The efficacy of the prepared hydrogel on the removal of heavy metals from water will be investigated on a laboratory scale. Our long term objective to directly use our low cost adsorbents for the removal of heavy metals, and probably agricultural pesticides, from catfish ponds of Mississippi.

Milestones for FY 2016-17:

Project title: Development of Low Cost Natural Adsorbents for the Removal of Heavy Metals from Fish Water Ponds.

Milestone:

1. Preparation of TEMPO-oxidized cellulose nanofibers (CNFs) from cotton stalks. (Fully met)
2. Preparation and characterization of CNFs/Chitin-based hydrogel. (Fully met)
3. Study the effect of the prepared hydrogel on the removal of different concentrations from heavy metals on the laboratory scale. (Fully met)

Progress Report:

In this work, TEMPO-oxidized cellulose nanofibers (2,2,6,6-tetramethylpiperidine-1-oxyl radical) and chitin based hydrogels with various compositions have been prepared. This was accomplished by dispersing TEMPO-oxidized cellulose nanofibers (TEMPO-CNFs) and chitin in 8 wt% NaOH/4 wt% urea aqueous solution via freezing/thawing method. Six different hydrogels of chitin (100–50 wt%), TEMPO-CNFs (0–50 wt%), and epichlorohydrin (0.2 mL) were cast in an oven at 40 °C for 24 h. The surface morphology and elemental composition of all hydrogels were revealed by scanning electron microscopy (FE-SEM) and elemental analysis. Structural and thermal properties were evaluated by Fourier transmission infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA-DTG). Surface area and pore volume were calculated by BET (Brunauer–Emmett–Teller) method. The prepared hydrogels were tested for the removal of (Pb++) from contaminated water solutions. The effect of time, heavy metal concentration, pH, and the hydrogel amount on the removal efficiency of the different hydrogels was tested.

Accomplishments

A novel and functional chitin/TEMPO-CNFs based hydrogels with various concentrations were prepared using an environmentally friendly casting method. The effectiveness of combining these two precursors and the characteristics of the prepared hydrogels were confirmed with the results of elemental analysis, FTIR, FE-SEM, TGA-DTG, BET surface area, and adsorption experiments. Results of elemental analysis revealed that nitrogen content was relatively decreased by adding higher concentration of TEMPO-CNFs.

FE-SEM analysis clearly explained that nano-sized TEMPO-CNFs were completely embedded in the chitin biopolymer and homogeneously distributed, thus no aggregation was shown. It also shows the existence of a cross-linking reaction between both the biopolymeric chains. Thermographs of DTG-TGA analysis indicated good thermal stability, but there are different pyrolysis behaviors at a high temperature range for all kinds of hydrogels. BET and BJH analysis demonstrated clearly that incorporation of TEMPO-CNFs into chitin polymer has significantly increased the surface area and pore volume of hydrogels that improves their adsorption capacities. Adsorption results showed that the removal efficiency for the prepared hydrogels reached to more than 97% in very short time (3 min).

Significant Activities that Support Special Target Populations:

There are more than 130,000 farm ponds in Mississippi and the elimination of heavy metals from catfish ponds is crucial due to their high toxic activities. Therefore, preparing low cost and effective adsorbents from natural resources such as cellulose and chitin will significantly support the cat fist industry of Mississippi by providing more safe products to the consumers.

Technology Transfer:

None

International Cooperation / Collaboration

No agreements List any agreements (None)

Publications:

Soni, B., Hassan, E., Chang, S. Bland, J. Preparation and characterization of chitin/TEMPO-oxidized cellulose nanofibers based hydrogels. *Carbohydrate Polymers* (submitted).