CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Seyvonne Ip

Project Number

S1011

Project Title

Functionalization of Polyacrylonitrile Nanofibers for Adsorption of Aqueous U(VI) Ions

Abstract

Objectives/Goals

The objectives of the research were to determine the effectiveness of uranium removal via electrospun nanofibers by verifying significantly increased adsorption of U(VI) ions on the amidoximated polyacrylonitrile nanofibers and to ascertain the greatest amount of U(VI) ions that could be adsorbed onto the nanofibers. The engineering goal was to facilitate the filtration of U(VI) ions from aqueous solutions and thus reduce radioactive contamination in the environment.

Methods/Materials

The polyacrylonitrile nanofibers were functionalized through wet chemistry by placing them in solutions of 0.375 g of hydroxylamine hydrochloride and 0.375 g of sodium hydroxide. To initially verify the effectiveness of uranium removal via functionalizing nanofibers, four experimental categories were used: deionized water, functionalized nanofibers in uranium-238 solution, unfunctionalized nanofibers in uranium-238 solution, and uranium solution with no nanofibers. After verification, to ascertain the greatest amount of uranium that could be adsorbed, the nanofibers were placed in concentrations of 50 ppb, 100 ppb, and 250 ppb uranium-238 solutions, and the same four experimental categories were used. Uranium uptake was given in counts per minute by Packard 1600CA Tri-Carb Liquid Scintillation Analyzer, and the percentage of uranium adsorbed was determined for each nanofiber mat.

Results

The functionalized nanofibers adsorbed an average of 94.10% of the uranium in solution over three trials, whereas the unfunctionalized nanofibers adsorbed 16.54% of the uranium. As the concentration of uranium increased from 50 ppb to 100 ppb to 250 ppb, the percent adsorption of the uranium on the functionalized mats decreased from 100% to 90% to 53%, respectively, indicating the existence of a loading capacity. The loading capacity of the functionalized nanofibers was determined to be 0.15 - 0.20 mg of uranium per 1 mg of nanofibers.

Conclusions/Discussion

The amidoximated nanofibers were effective sorbents for the removal of U(VI) ions from solution with more than five times the level of adsorption compared to the level of adsorption of the unfunctionalized nanofibers and adsorbed 0.15 - 0.20 mg of uranium per 1 mg of nanofibers. Further optimization of these versatile nanofibers will lead to significantly more efficient filtration of U(VI) ions, leading to their copious novel functions in the future.

Summary Statement

My project focused on functionalizing polyacrylonitrile nanofibers to adsorb U(VI) ions and ascertaining the loading capacity to facilitate the filtration of U(VI) ions in the environment to reduce radioactive contamination.

Help Received

Participant in Secondary Student Training Program at University of Iowa under Dr. Tori Forbes