Synthesis of Carbon Aerogel from Waste Paper for Removal of Heavy Metal Ions in Aqueous Solutions

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Background/Objectives. The introduction of heavy metals into water resources has been a worldwide concern for the last few decades. It is well known that many metals can have toxic or harmful effects on humans and other organisms. Heavy metals that are significantly toxic include (but are not limited to) lead (Pb), manganese (Mn) and arsenic (As). A wide range of absorbent media have been investigated for their use in removing heavy metal ions from contaminated waters. The porous nanostructure of carbon aerogel materials has been identified as having the potential for effectively removing heavy metal ions, which warrants investigation.

Approach/Activities. In this work, we used an inexpensive method for synthesizing carbon aerogel from waste paper in two steps: (1) synthesis of cellulose aerogel by freeze-drying; and (2) synthesis of carbon aerogel by carbonization in an inert atmosphere. The two materials have been characterized by SEM, EDX, XRD, BET methods.

Results/Lessons Learned. The efficacy of Pb (II), As (V) and Mn (II) removal by carbon aerogel has been found to be dependent on concentration, pH, contact time, adsorbent dose, and temperature. The adsorption parameters were determined using both Langmuir and Freundlich isotherm models. The adsorption isotherm studies clearly indicated that the adsorptive behavior of heavy metal ions on carbon aerogel satisfies not only the Langmuir assumptions but also the Freundlich assumptions, i.e., multilayer formation on the surface of the adsorbent with an exponential distribution of site energy. Carbon aerogel demonstrated a maximum adsorption capacity, according to the Langmuir isothermal model, of 22.2 mg/g for As (V); 28.9 mg/g for Mn (II); and 55.5 mg/g for Pb (II). The results of this study indicate that the application of this low-cost material may be an effective approach for effluent treatment. The results also provide strong evidence to support the use of this adsorption mechanism for other contaminants. Future studies are required to investigate the possibility of using these inexpensive porous materials for the removal of chlorine organics.