

COPPER ION ADSORPTION BY USING CARBON AEROGELS FROM AQUEOUS SOLUTION

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ABSTRACT

This paper reports the results of copper ion adsorption of two types of carbon aerogels. The aerogels were produced by using resorcinol and formaldehyde as main reactants. Two different types of catalyst i.e. sodium carbonate, and sodium hydroxide were used in this study. The characterisation study using x-ray diffraction (XRD) showed there is no difference in the appearance structure of both carbon aerogels after $2\theta=10^{\circ}$. Both aerogels are amorphous, and have the same structure of carbon aerogel that prepared using resorcinol and furfural. Aerogel produced by sodium carbonate aerogel gives higher removal percentage (77.03%) compared to sodium hydroxide aerogel (46.98%). The higher removal was due to higher pore volumes and pore distribution as confirmed by scanning electron microscopy (SEM).

INTRODUCTION

The rapid growth in science and technology has improved the quality of life and changes the style of human activities. In the other hand, some of the technologies could also lead to serious environmental pollution problems (Mihfahg 1993). As a result of increasing industrialization more heavy metals such as copper have been continually released into the environment. Some of the industries that released copper are mining, metallurgical, fibre production, pipe corrosion and metal plating industries. Copper can cause neurotoxicity commonly known as "Wilson's disease" and continued inhalation of copper-containing sprays are linked to an increase in lung cancer among exposed workers (Barrell 1975)

Carbon aerogel can be used as adsorbent material, but its application for removing inorganic (specifically metal ions) has not widely been studied yet (Jyotsna et al. 2006). Carbon aerogels are unique porous materials with controllable pore size distribution ($\leq 50\text{nm}$) (Jyotsna et al. 2005; Rana et al. 2004), high surface area ($400\text{-}900\text{m}^2/\text{g}$), and high pore volume ($1\text{-}3\text{ cm}^3/\text{g}$).

This paper reports the study of copper ion removal using two types of carbon aerogels that produced by two different types of basic catalyst i.e. sodium carbonate (Na_2CO_3), and sodium hydroxide (NaOH).

MATERIALS AND METHODS

Two types of carbon aerogel were prepared using resorcinol, formaldehyde, water, and two different types of catalyst i.e. sodium carbonate (Na_2CO_3), and sodium hydroxide (NaOH).

The preparation of the carbon aerogels required three basic steps. First step; hydro gel was prepared by stirring resorcinol, formaldehyde, water, and the chosen catalyst to produce homogeneous solution. The solution was kept in an oven at $85\pm 3^\circ\text{C}$ for 7 days to produce resorcinol formaldehyde (RF) aquagel. Second step; the water left in the RF aquagel was removed by immersing the aquagel in acetone. Then this RF aquagel was super critically dried in order to extract the acetone using supercritical fluid extraction unit (SFE). Then the aquagel was carbonized at 800°C in an inert atmosphere using fixed bed activation unit (FBAU); this is to avoid the material to be oxidize or burn. The developed carbon aerogel is characterized using XRD and SEM.

Batch mode adsorption studies were conducted to determine the concentration of Cu (II) before and after removal using the developed materials. The samples were analyzed using flame atomic absorption spectrophotometer with air-acetylene flame.

RESULTS AND DISCUSSION

To elucidate the structural appearance of the developed carbon aerogels, the X-ray diffraction was carried out and the experimental results are shown in Fig.1. From the observation of Fig.1 it is clear that the developed carbon aerogels are amorphous materials. There is no difference in the appearance structure of both of carbon aerogels after $2\theta=10^\circ$. By comparing the XRD pattern with the carbon aerogel that produced from resorcinol and furfural, reported by Wu et. al (2005) it can be observed that both have a large peak at $2\theta=23^\circ$ and a small peak at $2\theta=43^\circ$.

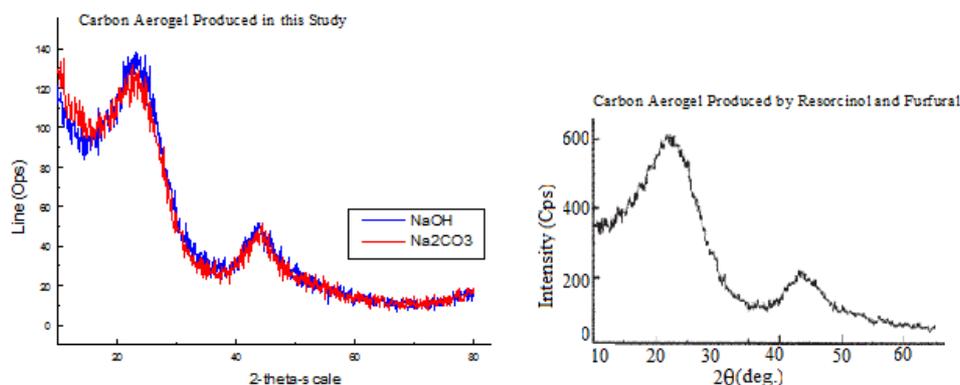


FIGURE 1 Comparison of the XRD Pattern for Two Types of Carbon Aerogels Developed in this Study with Aerogel Produced by Resorcinol and Furfural.

Batch mode adsorption studies were made at fixed conditions. The pH of the solution was 5.5 ± 0.05 and the temperature was 60°C at 160 rpm. The carbon aerogels produced in this work are capable to remove copper and results are shown in Fig. 2. From the graph, it can be observed that sodium carbonate aerogel has higher percentage removal (77.03%) compared to sodium hydroxide aerogel (46.98%). This difference in the removal percentage may be attributed to surface morphology of each one.

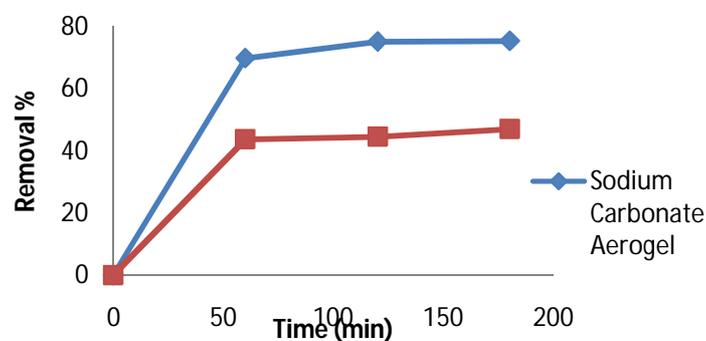


FIGURE 2 Copper Ion Removal by Using Two Types of Carbon Aerogels.

In order to understand more on the surface characteristic, SEM images study were carried out. As shown in Fig. 3, at micrometer scale, the surface morphology of the carbon aerogel prepared using sodium carbonate differs from sodium hydroxide in both pore distribution and size. It appears that the sodium carbonate aerogel has more pores than sodium hydroxide aerogel, which made the percentage removal of copper higher. However further analysis need to be done to confirm the observation by using BET analysis.

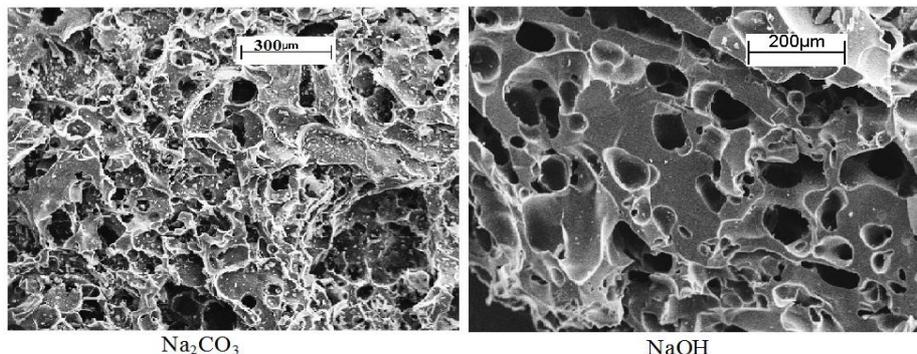


FIGURE 3 SEM Picture for Carbon Aerogels Produced Using NaOH, and Na_2CO_3 .

CONCLUSIONS

Porous carbon aerogels were successfully produced by using Na_2CO_3 , and NaOH as the main catalysts. XRD analysis confirmed that both types of carbon aerogels are amorphous materials, which have similar carbon structural of resorcinol-furfural carbon aerogel. The removal of copper ion by both carbon aerogels showed that the sodium carbonate aerogel gives better removal with 77.03%, where by sodium hydroxide aerogel gives only 46.98%. This difference in the removal percentage may due to differences in pore volume.

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