

ABSTRACT

Adsorption has proven to be successful in the recovery of metal ions from dilute solutions. It is a simple, effective, economical and versatile technique, and of late, activated carbon (AC) has been of great interest. The ACs are well known nano-porous carbonaceous materials which have received great attention in recent times due to their relatively high kinetics and adsorption capacity. AC is a universal adsorbent available in a variety of physical forms such as powdered activated carbon (PAC), granular activated carbon (GAC) and activated carbon fiber (ACF). The main structural difference between AC and ACF is in the smaller diameter of the pores in ACF; the ACF mainly have micropores allowing for a greater adsorption rate. For this reason, this study assessed the use of ion exchange resins in the production of ACF, in order to provide a probable solution in the disposal of ion exchange resins (IER). Furthermore, the production of carbon nanotubes (CNTs) from IER was investigated, as they too have unique electrical, mechanical, chemical and physical properties.

The ACF were synthesized by chemical activation conducted at varying temperatures between 600 °C and 1000 °C, and NaOH concentration between 8 and 40 wt%. The produced ACFs were characterized by nitrogen adsorption fitted to the Brunauer-Emmet-Teller (BET) equation, scanning electron microscopy (SEM), thermogravimetric analysis (TGA) and fourier transform infrared spectroscopy (FTIR). The BET analysis showed that mesoporous ACs produced possessing pore sizes in the range of 2.29 to 20.06 nm. Thermally stable, microporous and mesoporous activated carbon fiber (ACF) with a maximum surface area of 217.41 m²/g, were achieved from samples produced at an activation temperature of 800 °C using 40 wt% NaOH. The FTIR results showed that no functional groups were present on the ACF surface.

The produced CNTs were synthesized through chemical vapour deposition (CVD), in which iron was used as the catalyst and different catalyst supports were investigated (unsupported iron, magnesium oxide, aluminium oxide and calcium carbonate) using different carrier gases (nitrogen and argon). For the characterization of the synthesized CNTs, SEM, BET, TGA and Raman spectroscopy techniques were employed. The Raman spectroscopy showed development of single walled carbon nanotubes (SWCNTs) in the case where aluminium oxide was used as a support and multi walled carbon nanotubes (MWCNTs) for the rest of the other supports. The greatest surface area of 70.54 m²/g was achieved by using calcium carbonate as a support and nitrogen as a carrier gas. The use of argon as a carrier gas yielded a greatest G band intensity of 1050.00 a.u, thus suggesting the greatest amount of amorphous carbon formed.

The ACF synthesized with 40 wt % NaOH at a temperature of 800 °C were used for the adsorption experiments. The ACF had a high initial adsorption rate, however, a low adsorption capacity of 0.62 mg/g. The adsorption isotherms indicated that the Langmuir model was a better fit in comparison to the Freundlich model, therefore suggesting that monolayer adsorption of platinum ions on the ACF occurred.