Sohag University Chemistry Department Faculty of Science

Formation of Nanostructured Activated Carbon from Biomass and its Applications in Water Purification

A thesis

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By

Omar Allam Sadek Allam
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Supervised by
Prof. Kamal M. S. Khalil

Professor of Nano Materials and Surface Chemistry
Faculty of Science
Sohag University

Prof. Rafat M. El Khatib

Professor of Inorganic Chemistry
Faculty of Science
Sohag University

Dr. Mervat A. Hamed

Senior Researcher at Environment Department. Soils, Water and Environment Research Institute, Agricultural Research Centre

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Abstract

Sorghum (Durra stalk) and sugarcane bagasse has been employed as novel carbon precursors for formation of high surface area activated carbons (ACs) by utlizing $ZnCl_2$ activation method. The formation of ACs has been investigated at different pyrolysis temperatures (400, 500 and 600 ºC) and different $ZnCl_2$ impregnation concentrations. The produced ACs were characterized by several techniques such as elemental (C, H and N) analysis, attenuated total reflectance infrared spectroscopy (ATR−FTIR), nitrogen gas adsorption/desorption isotherms at −196ºC, simultaneous thermal analysis (TG−DTA) and scanning electron microscopy (SEM). The results indicated the formation of AC materials with high carbon contents (~ 80%), good thermal stability and large specific surface area (1200−2046 m^2/g). It was found that, $ZnCl_2$ concentrations and pyrolysis temperatures are the key factors to present carbon derived biomass with high surface area and tunable nanoporosity. The environmental applicability of the AC materials was investigated for adsorption/removal of organic pollutants (methylene blue and phenol) from contaminated water without any pre-treatment or pH adjustment. The performance of ACs were evaluated in term of adsorption capacity and kinetic paramateres. The ACs showed a high adsorption capacity towards methylene blue, as high as 385 mg/g in the case of ACs derived from Durra stalks and 411 mg/g in the case of ACs derived from sugarcane bagasse.

The adsorption behaviour of methylene blue was well described by the Langmuir isotherm model and the adsorption process was best fitted by pseudo-second order kinetics. As well as, the prepared ACs exhibited high adsorption efficiencey for phenol molecules with adsorption capacityof 124 mg/g and 133 mg/g for ACs derived sorghum and sugarcane bagasse, respectively. Freundlich isotherm model shows a better description for phenol adsorption for ACs derived from sorghum while, the phenol equilibrium data were better represented by Langmuir than Freundlich models for ACs derived from sugarcane bagasse. The phenol adsorption process was fitted also by the pseudo-second order kinetic. In the light of the vast availability of Sorghum and Sugarcane as sustainable residuals and non-food/non-feed biomass materials, they are very promising resources for production of new classes of ACs with high surface area and tunable pore sizes that could efficiently suited for various environmental and industrial applications.