Preparation and characterization of active carbon using palm kernel shells for industrial effluent purification

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Abstract

Activated carbons were prepared from Palm kernel shells. Carbonization temperature was 600°C, at a residence time of 5 min for each process. Chemical activation was done by heating a mixture of carbonized material and the activating agents at a temperature of 70°C to form a paste, followed by subsequent cooling and using the active carbon to purify effluents from a Bottling Company. NaCl, KOH, H_2SO_4 and H_3PO_4 were used as the activating agents at 1M and 2M and 710 µm particle size. The activated carbon samples produced were found to posses properties within the limits of commercial activated carbons. Bottlimg company effluent was purified and the results showed that carbonized materials activated with 2M H_2SO_4 had the best adsorption characteristics. These properties include 1.12% moisture content, 2.50 % ash content, 57.00 % yield of activated carbon, 93.65 % fixed carbon, 2.73 % volatile content, 0.97 g/cm^3 bulk density and 0.69 cm^3 pore volume.

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Introduction

Activated carbon is a highly porous, amorphous solid consisting of micro crystallites with a graphite lattice, usually prepared in small pellets or a powder. Raw material such as coconut shell, palm kernel shell and fruit stones are very popular for many types of activated carbon. This is because of their relatively high density, hardness and low volatile content which are ideal for the manufacture of hard granular activated carbon. Coconut shells, together with peach and olive stones are used commercially for the production of microporous activated carbons useful for a very wide range of applications. Generally, the raw materials for the production of AC are those with high carbon but low inorganic contents such as softwood, hardwood, lignite, nutshells, lignin, soft coal, petroleum coke, semi hard coal and hard coal (Nurul'ain, 2007). In this work, palm kernel shells which are a local agricultural waste will be used to produce activated carbon due to their availability and low cost and also it has high carbon and low inorganic content (Nurul'ain, 2007). Activated carbon materials have been used in the past as catalytic supports, battery electrodes, capacitors and for biomedical engineering applications. They are also used for adsorption of organic substances and non-polar adsorbates and for waste gas (and waste water) treatment. It is the most widely used adsorbent. Its usefulness derives mainly from its large micropore and mesopore volumes and the resulting high surface area after activation. The manufacture of activated carbon consists of two phases, carbonization and activation. The raw material is carbonized to obtain the char or carbonaceous material, which is activated to yield the highly porous final product. Typically, surface areas ranging from 500 – 1400 m^2/g are obtained for the activated material. The activated carbon particle has two types of pores existing in it by which adsorption takes place. These are the macropores (diameter >10.1 µm) and the micropores (diameter 10.3 – 10.1 µm) (Lartey *et. al*, 2003). The methods of activation widely used in activated carbon production are physical and chemical activation methods. Chemical activation reduces the formation of tar and other by-products thereby increasing carbon yield (Martinez *et. al.* 2003). Physical activation with steam or CO_2 as activation agent is simple in process. The discharge of industrial effluents into our environment is an ongoing problem that needs to be tackled because these effluents – be it liquid or gaseous, pollutes the environment and makes it difficult for man and other living organisms to survive in. Also, the dumping of agricultural waste materials such as coconut and palm kernel shells also deface and pollute the environment. The activated carbons derived from agricultural wastes are important due to the fact that it is inexpensive, have been shown to be adequate to remove organic and inorganic contaminants from wastewater and are locally available (Nourouzi *et. al.* 2009). Therefore the development of activated carbon from abundant palm kernel shells in the southern parts of Nigeria has become necessary to reduce the cost of imported activated carbon for water and effluent treatment.