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Research Paper

Preparation and Characterization of Activated Carbon Made From Palm-Kernel Shell, Coconut Shell, Groundnut Shell and Obeche Wood (Investigation of Apparent Density, Total Ash Content, Moisture Content, Particle Size Distribution Parameters

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Abstract: *The following locally available materials viz: palm kernel nut shell, coconut shell, and groundnut shell and obeche wood were collected from various locations within Delta state. These materials were carbonized for one hour in a muffle furnace at different optimum devolatilization temperature of between* 250^0C *and* 750^0C*. They were chemically activated for 15 minutes at different temperature range of between* 500^0C *and* 1000^0C *by the mixture of activating agents of potassium trioxocarbonate [IV] [*K_2CO_3*] and sodium hydrogen trioxocarbonate [IV] [*K_2CO_3*] at the ratio of 1:1.The activated carbons were washed with 0.5M acetic acid, rinsed with distilled water until the pH is within 6 - 7 and dried. The activated carbons thus obtained were smoothened and characterized based on the following parameters viz apparent density,moisture content, total ash content, particle size distribution and average particle size distribution. The results of the characterization show that apparent density falls between 0.36 – 0.5mg/1, total ash content falls between 1.54 - 6.20%, moisture content falls between 3.57 - 7.14%, particle size distribution falls between 6.0 - 40% and average particle size distribution falls between 14.29 – 33.33%. The results were compared with standard specification range for American society for Testing and materials (ASTM) and they were found to fall within the range recommended by ASTM. Hence, the activated carbons characterized were found to be suitable for the treatment of effluent water and gases. The higher apparent density, lower moisture content and lower ash content of palm-kernel shell and coconut shell activated carbon showed that they are fairly better than groundnut shell and Obeche wood activated carbon. Palm-kernel shell and coconut shell are also fairly better in term of particles size distribution.*

Keywords: Activated carbon, Surfacearea, Adsorbent, Purification, Effluent.

Introduction

Activated carbon is a class of materials having highly developed internal surface area (as high as $3000m^2/g$) and porosity. Hence, it has a large adsorbent capacity. Activated carbon varies widely in pore sizes and distributions. It is produced mainly from carbonaceous solid materials with spectrum of diameters ranging from 5 to $100,000A^0$.

Activated carbons are derived from solid organic substances by one or two general methods of manufacture, each of which includes thermal decomposition of the starting materials [2]. It has been well established the fact that activated carbons have over many years being for the separation of gases, the recovery of solvent, the removal of organic pollutants from drinking water and as well as catalyst medoyikosupport. Coats and ligno – cellulose materials are commonly used as the starting raw materials for preparing activated carbon.

Polyacrylonitrile is considered to be best precursor for making performance carbon fibres.

However, for making activated carbon fibres, cellulose materials have an edge over polyacrylonitrile as precursor because of the inherent porous structure of cellulosic materials. These cellulosic materials in the fibrous form can be gotten from vegetation and agricultural wastes. Therefore, the development of methods to reuse waste materials is greatly desired and the production of activated carbons from waste offers a promising future. The major or common materials used for the manufacturing of activated carbon are coconut shell, wood, bituminous coal, lignite petroleum byproduct, banana stem, palm kernel shell, and many others.

On the average, wood is considered as the cheapest raw materials, which develops higher mesoporousity than ligno-cellulose materials.

Basically, there two types of activation. They are physical and chemical activations. The carbonization of the selected materials in the presence of chemical agents such as $ZnCl_2$, KOH, H_3PO_4, NaOH, K_2CO_3 etc is termed as chemical activation. This is done at a lower temperature than physical activation and with better result [1].

Activated carbon are generally recognized safe when in use and they are used as decolourizing agents, taste and odour removing agents, purification agents in food processing etc.

Even though, the primary use of activated carbon is in the treatment of water [4].

Activated carbons have non-food uses e.g. activated carbon is used to filter tobacco smoke so also in a number of applications related to purification in clothing and textile, cosmetics and pharmaceutical industry, veterinary and medical such as detoxification. It is used in agriculture as a soil conditional and amendment by controlling acidity and alkalinity of the soil.

More also, it is used as agent in gas masks, pollution control devices such as car catalytic converter and flue gas desulphurization [3].

The fundamental properties of activated carbons, which are the basis of their characteristics behaviour, are dependent on the activated carbon starting materials and processing method.

These properties are measured in terms of the parameters such as apparent / Bulk density, total ash content, moisture content, particle size distribution, pore volume distribution, specific surface area, permeability or filterability etc.

In this research work, some of these parameters could not be determined due to lack of availability of equipment. The measurements of these parameters are of vital interest to the manufacturers and user of the activated carbon because it gives more insight about the standard of such activated carbon vis-à-vis its future effectiveness when in use [6].

The selection of activated carbon products can be made by comparing specification values. Unfortunately, this may not be the case always because there are no valid theories that allow selection of the best activated carbon without experimentation.

Under laboratory condition, we have observed that similar two brands of activated carbon with similar specification give vastly different adsorption rates and capacities. But the best way to evaluate a carbon product is by using the same pollutants under specified condition in addition to laboratory bench work. Removal of single pollutant is not adequate test for an activated carbon product.

Another way of knowing a good activated carbon is that, it releases no bubbles at all when placed in water [2,5].

Material and Methods

Raw material: The materials for the activated carbon were collected from different locations in Delta State.

Obeche wood was collected from timber industry at Sapele while coconut shell was gotten from Igbudu market in Warri. Also groundnut shell and palm-kernel shell were collected from Effurun market and Sapele respectively.

The samples were collected freely from the sources mentioned above, properly oven-dried and crushed into small chips prior to carbonization process.

Carbonization: The sampled materials for the activated carbon namely coconut shell, obeche wood, groundnut shell and palm-kernel shell were further oven-dried for one hour at 105^0C and carbonized according to the method reported elsewhere [7].

The crushed samples were carbonized for one hour in muffle furnace at different optimum devolatilization temperature of between 250^0C - 750^0C depending on the type and nature of the materials used. They were grounded into powder; pass through 0.22mm mesh size [7].

Activated: Chemical activated was carried out on each of the carbonized samples. A weighed quantity of 30g of potassium trioxocarbonate (iv) [K_2CO_3] and 30g of sodium hydrogen trioxocarbonate (iv) [$NaHCO_3$] were dissolved in 30ml of distilled water. The carbonized sample was weighed and mixed thoroughly with the prepared solution of K_2CO_3 and $NaHCO_3$ mixture.

This was activated for 15 minutes at different temperature range of 500^0C - 1000^0C depending on the sample. The activated carbon samples were washed with 0.5M acetic acid, rinsed with distilled water until the pH is within 6–7 and dried. The activated carbons thus obtained were finally smoothened, stored in well-fitted airtight corked bottles and properly labeled before being characterized.

Results and Discussion

The table (1) contains the five parameters considered for the characterization of activated carbon samples, these are apparent density, total ash content, moisture content, particle size distribution and average particle size distribution. The standard values are given in table (2).

When the results in table (1) were compared with the standard values in table (2), the values of the result of the parameters determined fall within the standard values. The apparent density of 0.50g/ml is got from the activated carbon of palm-kernel shell while 0.46g/ml, 0.40g/ml and 0.36g/ml are for activated carbon of coconut shell, groundnut shell and obeche wood respectively. The total ash content is in the order of 6.20%, 2.62%, 2.15% and 2.04% for groundnut shell, coconut shell, palm-kernel shell and obeche wood respectively.

The activated carbon derived from groundnut shell has the highest moisture content of 7.14%. This is followed by obeche wood activated carbon with 5.71% and coconut shell activated carbon with 4.29%. The moisture content of activated carbon from palm-kernel shell has the least value of 3.57%. The particle size distributions are within 6 – 46% but the activated carbons from palm-kernel shell and coconut shell are more finely distributed in sizes than activated carbon of groundnut shell and obeche wood. The average particle sizes distribution of all the activated carbons are found to fall within 14.29% - 33.33%.

Conclusion

The characterizations of activated carbon from palm-kernel shell, coconut shell, groundnut shell and obeche wood in terms of apparent density, total ash content, moisture content, particle size distribution and average size distribution were found to fall within the specifications recommended by American Society for Testing and Materials (ASTM).

This shows that activated carbons from all these materials are good enough for the treatment of any kind of liquid and gaseous effluents. The results also indicate that activated carbon from palm-kernel shell and coconut shell are fairly better than groundnut shell and obeche wood because they have higher apparent density, lower moisture content and lower ash content. They are also more finely distributed in sizes.

Table 1
The Results Obtained From the Characterization of Activated Carbon Derived From Local Materials

Local materials for Activated Carbon	Parameters for characterization of Activated Carbon				
	Apparent Density (g/ml)	Total Ash Content (%)	Moisture Content (%)	Particle Size Distribution (%)	Average Particle Size Distribution (%)
Palm-kernel Shell	0.50	2.15	3.57	6,7,8,11,17,24,29	14.29
Coconut shell	0.46	2.62	4.29	7,9,11,18,24,31	16.67
Groundnut Shell	0.40	6.20	7.14	14, 20, 27, 39	25
Obeche Wood	0.36	2.04	5.71	23, 31, 46	33.33

Table 2
The Standard Specification Values by ASTM on the Determined Parameters

Parameters	Unit	Specified Range for Activated Carbon
Apparent Density	G/ml	0.36 – 0.74
Total Ash Content	%	≤ 8 max
Moisture Content	%	3 – 10 max
Particle Size Distribution	%	5 – 50
Average Particle Size Distribution	%	14 – 50

Source: American Society for Testing and Materials (ASTM)

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