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Unburned Carbon from Bagasse Fly Ash to Produce Activated Carbon in a Single-Stage Chemical Process

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ABSTRACT: Bagasse ash waste is generated in sugar mills from the use of bagasse as a fuel. This waste frequently noticed, its way to landfilled places where it is disposed. The dumping of biomass wastes caused in numerous agricultural processes is usually an environmental problem as odour and pollutes the soil. Recycling these leftovers for the manufacturing of activated carbon, an adsorbent with numerous uses, including the removal of pollutants, was one option for such a problem. In this work, activated carbon was made from Bagasse ash using a chemical activation process at 800 °C. Fourier Transform-Infrared (FT-IR) spectroscopy, Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD) were used to characterize the sample. The functional groups are confirmed by FT-IR and the existence of hydrocarbons. The SEM and XRD studies show that the generated activated carbon has a low amount of inorganic elements when compared to the precursor. These experimental results suggested that Bagasse ash might be used as a starter in the activated carbon manufacturing method, making it a cost effective resource.

KEYWORDS: Activated carbon, Bagasse fly ash, FT-IR, SEM, XRD.

1. INTRODUCTION

Bagasse is the non-homogeneous fibre residue that remains while crushing sugarcane stalks to get juice. Sugarcane bagasse has become one of the most prolific agricultural wastes, with a yearly output of more than 540 million metric tons [1]. It is estimated that sugar factory produces 3 tons of wet bagasse for 10 tons of sugarcane crushed, which indicates each sugar manufacturing country produces significant amount of bagasse. Even though, it is a byproduct, it has many applications like fuel and paper production. The bagasse is made up of pith fiber, an attempt has been made to produce and understand characteristic of activated carbon from bagasse. As number of raw material may be used to produce activated carbon, bagasse is chosen for the current study because over the recent years production of activated carbon in low cost has prompted a growing interest since it play a vital role in both waste management and pollution control [2-5]. Activated carbon has a long history of usage in the removal of chemical species from aqueous medium generated by the medicinal, agriculture, food and industrial applications [6]. The absorption properties of activated carbon mainly depend on pore volume, porosity and the functional groups presence [2]. The current study, the surface characteristics and the internal pore structure was studied using scanning electron microscope. The presence of functional group and crystalline formation during activation process is analyzed using FT-IR and XRD respectively.

2. MATERIALS AND METHODS

Sugarcane bagasse ash (SBA) used in this work collected after electric power generation in EDI parry sugarcane industry, Nellikuppam, Cuddalore disirct, Tamil Nadu, India. All of the chemicals utilized in this investigation were of analytical reagent (AR) quality. Bagasse ash was dried in a 110 °C oven for 6 hours. Subsequent, it was crushed with a micro hammer blade grinder and mesh sieve to a grain size of 10 or 32 meshes (2.0 mm or 500µm). For the characterization and synthesis of activated carbons, bagasse ash with only a particle size of 500 µm was utilized.

2.1. Single-stage chemical activation and carbonization process

In a glass beaker, 10 g raw material was combined with the chemical reagent at 1:4 ratios. Distilled water was included in an amount equal to ten times the total weight of the combination. The liquid was then mixed and heated to homogenise before being infused at 85 °C until a thick homogeneous powder was formed.

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After that, the specimen was placed in a stainless steel vertical tube reactor and heated. The pyrolysis method was similar to as mentioned in our previous research at 800 °C under the pressure of 1 atmosphere, for 2 h. The final product was chilled to room temperature (30 °C), rinsed with deionized water, and dried at 100 °C oven for 4 hours.

3. RESULTS AND ANALYSIS

3.1 Functional group analysis

The FTIR spectrum shows (Figure1) the activated carbon is clearly revealed that the presence of different functional groups. The broad absorption band at 3385 cm^{-1} attributed to OH group [7]. The absorption band corresponds to 2922 and 2854 cm^{-1} are due to the C-H stretching from polysaccharides [8]. The strong band located at 1571 cm^{-1} is assigned to C=C vibrations in aromatic ring [9]. The broad band existent at 1176 cm^{-1} may be due to C-H stretching bonds in acid, alcoholand phenolic compound, most likely to be a phenolic compound since Bagasse contains this compound in high concentration [1].

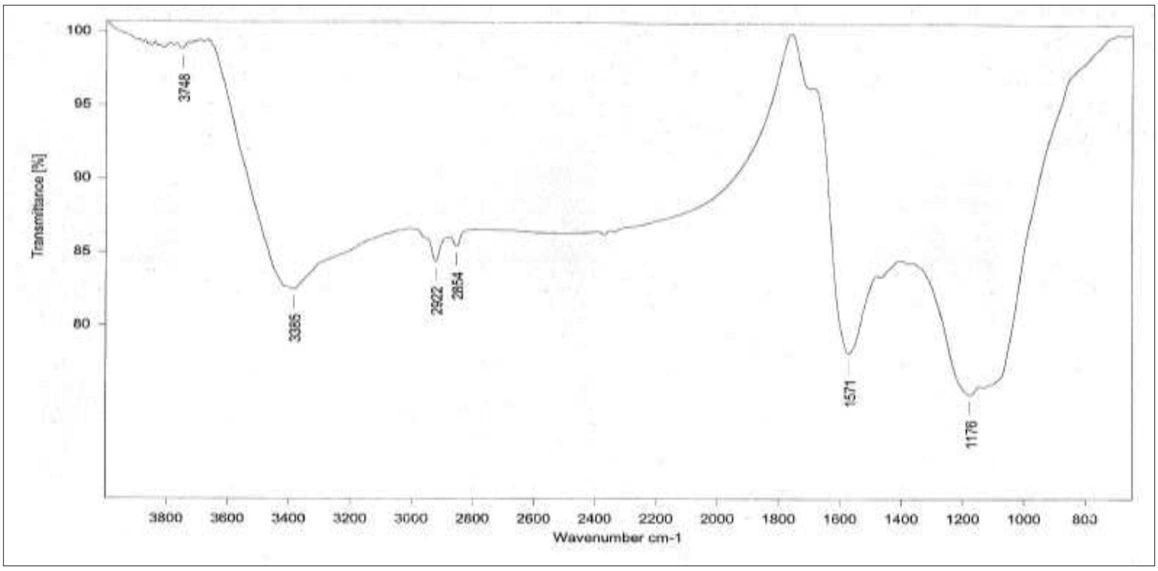

Figure 1. FT-IR spectra of Bagasse ash.

3.2 Visual inspection of SEM image

SEM images of the Bagasse sample in two different spots in same magnification is taken and shown in Figure 2. The SEM image obtained from Bagasse showed well developed pores exhibiting different sizes and shapes mostly circle and oval. The size of the pores ranging from 0.1 to 1 µm. the diameter of the pores may be attributed to surface reaction, rate of gases released, carbonization temperature and heating rate. In both SEM images a very few agglomerates found to be present probably metallic oxides and inorganic material residues giving rise to blockage of few micro pores [10]. It is worth mentioning that the chemical activation might have removed most of the inorganic material residue and no significant glazing effect was found on the surface in both micrograph of the sample indicating the absence of glazing agents in Bagasse which increases the porous structure.

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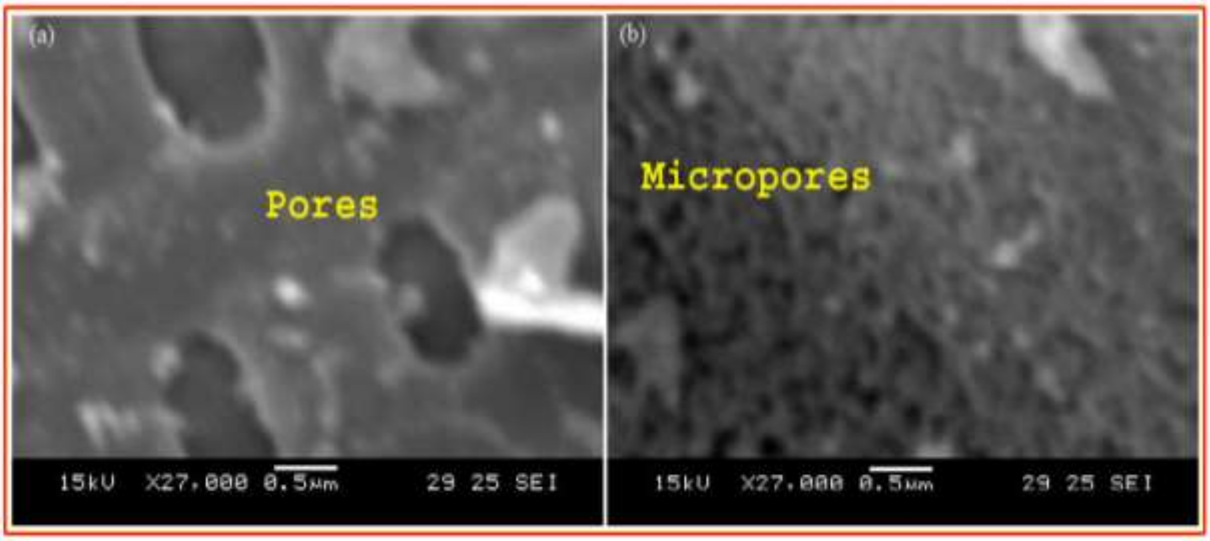

Figure 2. SEM images of bagasse ash

3.3 X-ray diffraction analysis

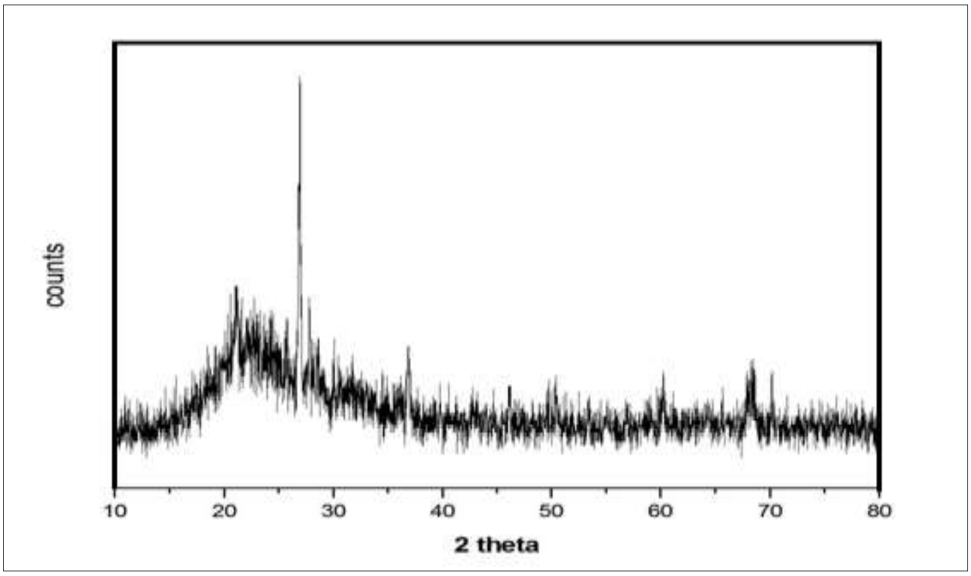

Figure 3. XRD pattern of Bagasse ash.

XRD analysis enables one to analyze and determine the distribution of crystalline orientation. The X- ray diffractograph reveals that the material is poorly crystallized. Figure 3 shows XRD pattern contains of several sharp diffraction peaks which are attributed to α-quartz and cristobalite type of silica crystallite [11]. The strong peak at 28.3° is assigned to the graphite phase with hexagonal structure.

4. CONCLUSIONS

The results show that the bagasse may be used to make activated carbon with a relatively large surface area and pore size. The distribution, concentration, and size of the pores in activated carbon are important factors in defining the end products applicability. The FTIR detects that presence of numerous functional groups such as hydrocarbons, a high quantity of alcohol, and phenolic compounds. The extensive configurations of pore structure in micrographs were clearly shown by SEM analysis, indicates that bagasse may be an excellent waste source for the synthesis of activated carbon. One of the main features of activated carbon is the lack of crystalline forms in XRD. The activated carbon has a suitable surface area for catalyst support applications that required porous carbon. Thus, recovering the carbon portion in fly ash can provide environmental and economic benefits to sugar mills that use bagasse as fuel.

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