A Brief Review "Production of Activated Carbon from Wood Waste (Biomass)"

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Abstract— Pine Wood (Biomass) is typically used for furniture manufacture because of its high durability, light and easy to work. During furniture manufacturing process, large amount of waste is generated causing disposal environmental problems. In this paper, the residual waste is transformed into an activated material using pyrolysis. The chemical composition of biomass (C and T) can be determinate by TGA (Thermogravimetric Analysis). Activated materials can be characterized by its surface area following the BET (Brunauer, Emmett and Teller) method, morphology using SEM (Scanning Electron Microscopy) and to know their functional groups a FTIR (Fourier Transform Infrared Spectroscopy) analysis can be done. A significant amount of Activated carbon can be produce form biomass [1], [5], [9]

Index Terms— Activated Carbon, Biomass, SEM, TGA, BET, Pine Wood, Pyrolsis.

1 Introduction

ACTIVATED commercial carbon is a very typical adsorbent to remove gaseous and aqueous contaminants. However, due to the high cost during its production and the environmental problems (it comes from fossil fuel) it is necessary to look for new sources to produce these materials. In a study coal reserves will only 50 years (since 2006). Therefore, agroindustry wastes from oil palm, potato, wood become in good sources to produce activated carbon. Wastes without any use, which makes the sawdust as a potential precursor for activated carbon. Activated carbons produced from wood wastes are recognized for their good pore development, large surface area and high removal capacities. They are typical used as separators and purifiers in both gases and aqueous solutions, catalyst supports and, adsorbents to dyes removal or solvents recovery. In this study, the production of activated carbon from Pine wood waste is reviewed. Its chemical composition, morphology and textural properties were determined using different analysis techniques. [2], [5], [8]

2. Overview of Biomass

Biomass is biological material derived from living, or recently living organisms. It most often refers to plants or plant-based materials which are specifically called lignocellulosic biomass. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by different methods which are broadly classified into: thermal, chemical, and biochemical methods. [23]

Wood remains the largest biomass energy source to date; examples include forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and even municipal solid waste. In the second sense, biomass includes plant or animal matter that can be converted into fibers or other industrial chemicals, including biofuels. Industrial biomass can be grown from numerous types of plants, including miscanthus, switch grass, hemp, corn, poplar, willow, sorghum, sugarcane, bamboo and a variety of tree species, ranging from eucalyptus to oil palm (palm oil).Plant energy is produced by crops specifically grown for use as fuel that offer high biomass output per hectare with low input energy. Some examples of these plants are wheat, which typically yield 7.5–8 tonnes of grain per hectare, and straw, which typically yield 3.5–5 tonnes per hectare. The grain can be used for liquid transportation fuels while the straw can be burned to produce heat or electricity. Plant biomass can also be degraded from cellulose to glucose through a series of chemical treatments, and the resulting sugar can then be used as a first generation biofuel. [15], [24]

Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and biodiesel. Rotting garbage, and agricultural and human waste, all release methane gas—also called "landfill gas" or "biogas." Crops, such as corn and sugar cane, can be fermented to produce the transportation fuel, ethanol. Biodiesel, another transportation fuel, can be produced from left-over food products like vegetable oils and animal fats. Also, biomass to liquids (BTLs) and cellulosic ethanol are still under research. There is a great deal of research involving algal, or algae-derived, biomass due to the fact that it's a non-food resource and can be produced at rates 5 to 10 times faster than other types of land-based agriculture, such as corn and soy. Once harvested, it can be fermented to produce biofuels such as ethanol, butanol, and methane, as well as biodiesel and hydrogen. The biomass used for electricity generation varies by region. Forest by-products, such as wood residues are common. Agriculture waste is common sugar cane residue, rice husks; such as poultry litter are common [3], [13], [14], [15], [23].

3. Biomass Sources

Historically, humans have harnessed biomass-derived energy since the time when people began burning wood to make fire. Even in today's modern era, biomass is the only source of fuel for domestic use in many developing countries. Biomass is all biologically-produced matter based in carbon, hydrogen and oxygen. The estimated biomass production in the world is 104.9 petagram (104.9 * 1015 g) of carbon per year, about half in the ocean and half on land. Wood remains the largest biomass energy source today; examples include forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and even municipal solid waste. [4]

Wood energy is derived by using lignocellulosic biomass (second generation biofuels) as fuel. This is either using harvested wood directly as a fuel, or collecting from wood waste streams. The largest source of energy from wood is pulping liquor or "black liquor," a waste product from processes of the pulp, paper and paperboard industry. In the second sense, biomass includes plant or animal matter that can be converted into fibers or other industrial chemicals, including biofuels. Industrial biomass can be grown from numerous types of plants, including miscanthus, switch grass, hemp, corn, poplar, willow, sorghum, sugarcane, bamboo. [6], [7]

Based on the source of biomass, biofuels are classified broadly into two major categories. First generation biofuels are derived from sources such as sugarcane and corn starch etc. Sugars present in this biomass are fermented to produce bioethanol, an alcohol fuel which furthermore can be used directly in a fuel cell to produce electricity or serve as an additive to gasoline. However, utilizing food based resource for fuel production aggravates food shortage problem. [10]

Second generation biofuels on the other hand utilize non-food based biomass sources such as agriculture and municipal waste. It mostly consists of lignocellulosic biomass which is not edible and is a low value waste for many industries. [23]

Plant energy is produced by crops specifically grown for use as fuel that offer high biomass output per hectare with low input energy. The grain can be used for liquid transportation fuels while the straw can be burned to produce heat or electricity. Plant biomass can also be degraded from cellulose to glucose through a series of chemical treatments, and the resulting sugar can then be used as a first generation biofuel. [21]

The main contributors of waste energy are municipal solid waste (MSW), manufacturing waste, and landfill gas. Energy derived from biomass is projected to be the largest non-hydroelectric renewable resource of electricity. [22]

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There is a great deal of research involving algae, or algae-derived, biomass due to the fact that it's a non-food resource and can be produced at rates 5 to 10 times those of other types of land-based agriculture, such as corn and soy. Once harvested, it can be fermented to produce biofuels such as ethanol, butanol, and methane, as well as biodiesel and hydrogen. Efforts are being made to identify which species of algae are most suitable for energy production. Genetic engineering approaches could also be utilized to improve microalgae as a source of biofuel [16].

2. Materials & Experimental Methods

Materials

To produce activated carbon from wood waste mainly two methods are being used like physical activation & chemical activation. Characteristic of activated carbon can be identified & analysied by comparing these two methods. Physical activation is done by means of pyrolysis with the help of vacuum pump. [17], [18]

Experimental Methods

Preparation of Saw Dust Powder

All the chemicals and reagents used are of analytical grade. One should also consider all the experiments with the help of distilled water. The collected waste wood from saw mill sundried for few days and followed by preliminary stages such as crushing, grinding and sieving through specific sized sieve. Thus obtained sawdust powder was used as a precursor for the preparation of activated carbon. [17], [18], [19]

Preparation of Activated Carbon by Pyrolysis Method

The fine powdered (Biomass) of specific amount is heated for two hours under the vacuum, in the absence of oxygen. The heating is carried out at diffenent temperature from 500^{o}C to 800 ^{o}C. The carbonized samples were cooled to room temperature. The product sample is then tested. [17], [18], [19]

Sample characterization

The proximate analysis of the precursor is in terms of moisture, volatile matter, fixed carbon, and ash contents identified. Along with that Scanning Electron Microscopy (SEM) to study surface morphology, X-ray Diffraction (XRD), Surface area determination by BET is carried out. [17], [18], [19]

3 CONCLUSION

In this brief review, activated carbon produced from agricultural waste materials has been presented. Its availability, relatively low-cost, promising results and effectively produced could be our priority to replace nonrenewable commercial activated carbon to be used in many applications. It is understandable that more detailed studies on the production and application of activated carbon from renewable resources are deeply required to prove its values. Activated Carbon can be used in the application of Water purification and sewage treatment.The present study revealed that valuable adsorbents could be recovered from wood given renewable, cheap abundant source of this waste. Result of this study could provide activated carbon with cost effective and environment friendly alternative sources. [20], [21], [22]

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