

# Preparation of Activated Carbon from Coconut Shell

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**ABSTRACT:** Activated carbon is a non-graphite form of carbon which could be produced from any carbonaceous material. Activated carbons are increasingly used as the economic and stable mass separation agent for the removal of surfactants to raise the final product quality many industrial processes. Activated carbons also play an important role in many areas of modern science and technology such as purification of liquids and gases, separation of mixtures and catalysis. The main objective of the study is to produce activated carbon from dry coconut shell and to treat the domestic waste water and to recycle the treated water for home gardens. The higher purity, negative cost, high rate of production and strong carbonaceous structure of coconut shell proves to be a precursor for carbon production. This research will pave way for the recycle and reuse of waste water that could further reduce the level of water pollution.

**KEYWORDS:** Activated carbon, Coconut shell, Waste water, Adsorption.

## I. INTRODUCTION

### a. Background

Increase in population has boosted the growth of different industries leading to discharge of pollutants into the water bodies. Among those industries textile, food, cosmetic and paper industries lead to discharge of dye that needs immediate attention. Color in the water results from various organic chemicals that prevent the sunlight to penetrate affecting the aquatic

system. Aquatic organisms and plants are affected due to the release of toxic organic chemicals. Various methods to address this issue has been published by many researchers such as sedimentation with clarification, coagulation and flocculation, chemical oxidation, filtration using membranes, adsorption, biodegradation etc . Among these adsorption is a well-established technology to deal with dye removal. Methylene blue dye has been used in most of the industries and its removal is a matter of great concern. Low cost adsorbents such as coir pith, sawdust, fruit shell, banana pith, pea nut hull, wheat barn etc has been employed [Vadiyelan et al, 2005; Chandran et al, 2002; Bhattacharya et al, 2005; Kumar et al, 2005; Garg et al, 2003; Hamdaoui et al, 2007]. However due to its less adsorption capacity use of activated carbon as an adsorbent is greatly sorted. Activated carbon is a special type of carbonaceous substance. It has highly crystalline form and extensively developed internal pore structure. Due to activation, internal pore network is created which imparts certain surface chemistries (functional groups) inside each particle. Thus carbon gets its unique characteristics leading to high surface area, porosity and greater strength. The absorptivity of the adsorbent depends on both the size of the molecule being adsorbed and the pore size of the adsorbent. The organic material which has high carbon content is used as the raw material for the synthesis of activated carbon.

**b. Motivation**

There are many cheap, easily available materials such as wheat husk, straw, palm fiber, rubber wood saw dust, bamboo dust, date pits, palm fiber, coconut shell, groundnut shell, oil cake etc which have been used as the source for the synthesis of activated carbon. They are used in the abatement of hazardous contaminants, treatment of municipal and industrial waste water, as catalyst or catalyst support in medicine and the recovery of valuable metals. Thus the aim of this research is to look for a good adsorbent based on their surface characteristics. It also explores the adsorption capacity of the adsorbent for methylene blue dye removal.

**c. Objectives**

- (1) To provide alternate commercial activated carbon with cost effective potential adsorbent.
- (2) Characterization of activated carbon which is synthesized from coconut shell.
- (3) Compare the characteristics of coconut shell activated carbon with other two.
- (4) Predict which activated carbon is better over other two for removal of methylene blue dye.

**II. LITERATURE SURVEY**

Many experiments and studies have been carried out regarding the characterization of the activated carbon which was synthesized from source such as fluted pumpkin seed, groundnut shell, palm oil waste, karanja oil seed, rubber wood saw dust etc.

**K Mallick , 2004**, used Mahogany sawdust to develop an effective carbon adsorbent. This adsorbent was employed for the removal of dyes from spent textile dyeing wastewater. The experimental data were fitted to Langmuir and Freundlich models of adsorption.

**M.M.Nourouzi and T.G.Chuah in 2009**, studied the adsorption behavior on Reactive Black 5 and Reactive Red 3 using Palm Kernel Shell Activated carbon. Applications of batch kinetic data to pore and film surface diffusion models were explored.

**Jun -jie Gao et al., 2013**, produced activated carbon from tea seed shells. They obtained activated carbon of BET surface area 1530 m<sup>2</sup>/g. The precursor was chemically activated using zinc chloride and pyrolysed in a tubular furnace at 500°C for one hour duration at a heating rate 5°C/min.

**Halandemiral et al., 2008**, prepared activated carbon from Hazelnut bagasse through chemical activation technique. The surface area developed was significant 1489 m<sup>2</sup>/g. It was employed to remove Sandolan blue from the water bodies.

Table -1 List of different type of activated carbon which was taken for characterization

DIFFERENT TYPE OF ACTIVATED CARBON USING DIFFERENT PRECURSORS	AUTHORS
Fluted pumpkin seed shell	Verla, A.W, M.Horsfall, E.N Verla, A.I. Spiff, O. A. Ekpete, 2012
Biomass waste	A S Jadhav, Sandeep Salwa, Mangesh Tambe, N H shinde, 2011

**International Journal of Innovative Research in Science, Engineering and Technology**

An ISO 3297: 2007 Certified Organization

Volume 6, Special Issue 7, April 2017

5<sup>th</sup> National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2017)

30<sup>th</sup> & 31<sup>st</sup> March 2017

Organized by

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Groundnut shell	R Mallik, D S Ramteke& SR Wate, 2006
Activated carbon	Hary Marsh, FranciseoRodriguer- Reinoso, 2006
Rice husk & palm fruit shell	JEG Mdoe and L Mkyula, 2002
Oil palm kernel shell & oil palm fibre	Evbuomwan B.O, Agbede A.M, Ataka M.M,2013
Olive cake	Yak out S.M., Sharf, 2011
Rice husk ash	Otaru,A.J., Amech, C.U.,A.S, A.S, OkaforJ.O,Abdulkareem, A.S, and Odigure, J.O 2013

There were some experiments on characterization of different type of activated carbon which were given in the previous table. These activated carbon materials are characterized by their large surface areas and better porosity which was well developed. For these reasons activated carbons are commercially used as adsorbents for the removal of some organic chemicals and metal ions of environmental, potable water, waste water and removal of some gases. Usually the cost of preparation of activated carbon depends on the selection of the precursors.. So from the economical view, to utilize the cheaper raw materials for the production of activated carbon is sorted. Activated carbons are widely used as an economic and stable mass separation agent final or the removal of dye or surfactants and improve the quality of the final product in many industrial processes. Activated carbon is also used for the purification of liquids and gases, separation of mixtures and catalysis. Adsorption capacity of activated carbon is measured by considering the chemical nature of the aqueous phase, the solid phase and the chemical nature of the adsorbing organic. For the analysis of the surface physical properties of the carbon which includes the determination of the total surface area, extent of micro-porosity and characterization of the pore distribution. The total surface area can be measured by using BET method and pore structure can be shown by SEM test. Pore volume and porosity can be obtained from porosimetry. The adsorbent having large pore volume is used as better adsorbent for the adsorption process.

**III. MATERIALS AND METHODS**

**1. Raw material**

For this project the raw materials such as coconut shell activated carbon, activated carbon from rice husk and activated carbon from karanja oil cake was obtained.

**2. Chemicals**

The various chemicals used during this project were hydrochloric acid, sodiumthiosulphate, iodine solution, starch, 1N sulfuric acid, 1N sodium hydroxide etc.

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### 3. Instrumentation

Muffle furnace, oven, weighing machine, Brunner Emmett Teller surface area analyzer, pH meter, mercury porosimetry, scanning electronic microscope, hand shaker, UV spectro-photometer.

### 4. Proximate analysis

According to ASTM D 121, proximate analysis is the determination of moisture, volatile matter, fixed carbon, and ash content by prescribed methods. The proximate analysis of the different type of activated carbon was done using the following procedure.

#### 4.1 Moisture content

Small amount of activated carbon sample (coconut shell) weight was measured and then taken in a petri dish. It was spread nicely on the dish. It was then heated in an oven at a temperature of (105-110)<sup>o</sup>c for 1.5hr. The petri dish was left open or not covered during heating process. After heating petri dish was removed and cooled in a desiccator. After cooling the weight of dried sample was measured.



Fig-1 laboratory hot air oven

Moisture content  $M=100(B-F)/(B-G)$

B=Weight of petri dish +original sample

F=Weight of petri dish+ dried sample

G= Weight of petri dish

Same procedure was also followed for determination of moisture content for activated carbon of rice husk and karanja oil cake.

#### 4.2 Ash content

1 gm of sample was taken in a silica crucible. It was heated in a muffle furnace to 750<sup>o</sup>C for 1.5hr. During this heating process the crucible was left open. After the required heating, the crucible was cooled in a desiccator and then weight of the ash was measured.

Ash content  $A=100(F-G)/(B-G)$

G=Mass of empty crucible

B=Mass of crucible + sample

F=Mass of crucible+ ash sample

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Same procedure was also followed for determination of moisture content for activated carbon of rice husk and karanja oil cake.

### 4.3 Volatile matter content

A known quantity of sample was taken in cylindrical crucible closed with a lid. It was then heated to 925°C for exactly seven minutes in a muffle furnace. Then the crucible was cooled in a desiccator and weighted.

Volatile matter on dry basis

$$VM = 100 \left[ \frac{100(B-F) - M(B-G)}{(B-G)(100-M)} \right]$$

## IV. CONCLUSION

The study required to conduct many characterization techniques like proximate analysis, bulk density, BET surface area, pH, pore volume, iodine number test, blue methylene number test. This is followed by an adsorption experiment to find the better adsorbent for adsorption process. Then SEM test of better adsorbent was performed on the adsorbent and show the pore structure of that adsorbent. Proximate analysis of activated carbon provides a good idea about the physical properties of sample. From this analysis it is found out that, the fixed carbon content of coconut shell activated carbon is higher than other two. It shows that the moisture content of activated carbon prepared from coconut shell is high while the volatile and ash content are the least. This is due to its high fixed carbon, which is a preferred adsorbent in comparison to other two. From the bulk density test we calculated and observed that the bulk density of coconut shell is higher compared to the other two thus implying better flow consistency and packaging quantity of solid fuel material. From the experiments it is found that the BET surface area of coconut shells 1000.15m<sup>2</sup>/gm which is more than the rice husk and the oil cake. From iodine number test we found that the iodine number of coconut shell is 986 mg/gm. This result indicates which sample is better over other two. Iodine number is basically a measure of the micro-pore content of the activated carbon. Iodine number shows a direct proportionality with the micro porosity of the sample, thus, a higher iodine number signifies higher micro-porosity of the sample. Pore volume of the coconut shell activated carbon is larger than the other two from methylene blue number test we found that the methylene blue number of coconut shell 226 mg/g which is higher than the other two. From the adsorption test, we found that coconut shell activated carbon gives the better adsorption of methylene blue dye over the rice husk and oil cake. Following the characterization tests where we found preferable and desired results for the coconut shell activated carbon, the SEM test was carried out to observe pore structure of better adsorbent activated carbon.

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**International Journal of Innovative Research in Science, Engineering and Technology**

*An ISO 3297: 2007 Certified Organization*

*Volume 6, Special Issue 7, April 2017*

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