



Preparation of Activated Charcoal from Coconut Shell and its Domestic Applications

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Abstract

Our project focuses on the use of activated charcoal for household and domestic purification purposes. This activated charcoal can be made from organic waste matter such as coconut shells and agricultural waste materials which are generated in most households. This is a cost-effective way to optimize agricultural and domestic refuse. This project makes use of non-conventional methods to create activated charcoal that can be used for a variety of household applications. This project explores the versatility of activated charcoal as it is an economical substitute to expensive chemicals.

Introduction

Adsorption has appeared as one of the promising methods for CO₂ and heavy metals cauterization and sequestration due to its low energy consumption, cost-effectiveness, relatively simple technological process, non-corrosive to the equipment's and it is applicable over a relatively wide range of temperatures and pressures. Zeolites or activated charcoals are good adsorbents that are used for capturing CO₂ and heavy metals physical adsorption, due to its porous structure. The extensive use of activated Charcoal is used now days, due to its large micro porosity and large specific surface area. The activated charcoal is black in color and has large micro porosity. Activated charcoal adsorption also used for treating low concentrations of wastewater streams at extremely low cost. The removal efficiency of activated charcoal is very high for harmful pollutants. Activated charcoals can be prepared by either physical or chemical methods. It is produced from a large number of Charcoalaceous raw materials like coal, lignite, wood and some agricultural products like rice husk, nut shell, coconut shell, pea nut, sugarcane bagasse, tamarind wood, saw dust, and industrial waste products. The cost of agricultural wastes is very low, so it is considered to be a very important feedstock for preparation of AC.



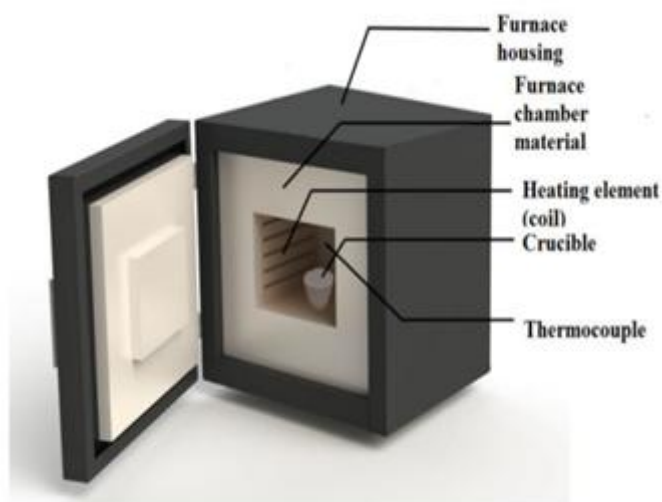
Materials and Methods

Required Materials:

- Raw Materials: Coconut Shell
- Chemicals: $ZnCl_2$

Preparation of Activated Charcoal: -

- Coconut shells collected from nearby place and cut into small pieces.
- Then washing with simple tap water for removal of dust adhered to it. Then it is dried in the sunlight for 15-20 days.
- Dried materials are kept inside the furnace at $150^{\circ}C$ for 24 hours for removal of moisture and other volatile impurities. After that it is crushed with a locally made crusher and sieved to 300-700 μm size range.
- Chemical activation of the powdered precursor is done with $ZnCl_2$ to make the Impregnation Ratio (Activating agent/Precursor) 100% (500 gm of dried precursor is well mixed with 3000 ml of concentrated solution of $ZnCl_2$ that contains 500 gm of $ZnCl_2$).
- The slurry form of powder precursor is properly mixed and kept for 24 hours for proper soaking of $ZnCl_2$ on its surface. The slurry is kept inside the oven at $100^{\circ}C$ for 24 hours.
(Here we have used $ZnCl_2$ because it acts as dehydration reagent that lowers the carbonisation temperature during chemical activation and restricts the formation of tar as well as promotes charring of charcoal).
- The resulting chemical impregnated samples are kept inside the muffle furnace after putting inside a galvanized iron pipe. The material inside the furnace is heated at a heating rate of $10^{\circ}C\ min^{-1}$ to the final carbonization temperature of $650^{\circ}C$ under the Nitrogen flow rate of $120\ cm^3\ min^{-1}$ STP. The material was kept inside the furnace for 1 hour at $650^{\circ}C$. Then it is cooled under the constant flow of Nitrogen gas till it is completely cooled.
- The dried material is washed with 0.5 N HCl for 2-3 times and then washed with warm distilled water to remove different residual organic and mineral matter. Then it is finally washed with cold water till the solution becomes neutral.
- Finally, the sample is dried for 24 hours at $100^{\circ}C$ inside an oven and packed in an air tight container.



Muffle Furnace



Prepared Activated Charcoal

Activated Charcoal as a sound absorber (Window Curtains)

Number of vehicles is increasing with every single day and so is sound that is causing pollution. Moreover, India being very rich and diverse culturally, we celebrate various festivals. Festivals only make this sound pollution problem worse. This is a major problem that troubles senior citizens, infants and mainly students.

Activated charcoal, activated coal, carbo activates or an “AC filter”, is a form of charcoal processed to have small, low-volume pores that increase the surface area available for adsorption or chemical reactions. Activated charcoal fibres also contain a considerable amount of nanopores but are light-weight and easier to use as they do not need containers. Regarding the ability of activated charcoal to effectively absorb sound, two factors contribute to this. They are:



- (i) They have three scales of heterogeneities: millimetric grains, micrometric and nanometric inner-grain pores.
- (ii) The presence of sorption in nanometric pores leads to a decrease of static bulk modulus and, consequently, of the effective low-frequency sound speed.



Activated Carbon on Wood



Activated Carbon on Metal Sheet

Activated Charcoal as an odour absorber

Activated charcoal can also act as an odour absorber. It can act as a healthy alternative to chemical odour absorbers and air fresheners.

Activated charcoal has more amount of oxygen which increases porosity i.e. surface area of the material. This increased porosity helps foul odours to be adsorbed on its surface. This is a very efficient method to deal with the problem of foul odours in the home. It can be implemented by placing granules or small pieces of activated Charcoal in a jute bag. This bag can be placed in places of foul odour like the refrigerator, bathroom or shoe racks. Its functioning is considerably different from that of an air freshener.

A gram of activated charcoal has a surface of about 500 square metres. The odours are neutralised because they are adsorbed on the surface of the activated charcoal. The bad odour is made of gas particles and these particles are adsorbed in the pores of the charcoal. The process of capturing these odours is very complex. It almost works like a vacuum cleaner. Just as a vacuum suck in the dust, activated charcoal filters suck in the odours from the air that passes through the freshener bag. The odours then become attached to the Charcoal pores and are trapped inside the filter, just like the dust in the vacuum cleaner bag.

One of activated charcoal's biggest advantage is that it does not make a mess. The charcoal once reaches its maximum adsorbing capacity it can easily be thrown away. Since this charcoal is made out of coconut, it is organic and does not cause any harm to the surrounding environment.



A jute bad containing activated charcoal

Microscopic View of Activated Charcoal

Filtering water impurities

Clean Water is a basic necessity of life, but it still remains a dream for many households, not only in our country but worldwide. Homemade activated charcoal provides a solution to this problem.

Many water filtration systems use activated charcoal to help eliminate impurities in the water, as it traps solvents, industrial waste, pesticides and other chemicals. While it doesn't trap hard water minerals, bacteria or viruses, systems that use activated charcoal filters can remove some fluoride from water. Avoiding this substance, and detoxing, helps support your immune system, and your kidneys and liver.

Most tap water comes laden with toxins, chemicals, and fluoride, things which shouldn't be ingested a whole lot of, which is why activated charcoal filters can be so beneficial to health.

Process

Adsorption of impurities from aqueous solution is far from being a straightforward process. Since most pesticides are organic chemicals, activated charcoal can effectively be used to deactivate or "tie up" these products in soil. Once the pesticide has been adsorbed onto activated charcoal, it is biologically inactive and cannot cause injury.

The factors that mainly control the extent of adsorption on AC are:

- (i) the chemistry of the metal ion (speciation) or metal ion complex;
- (ii) the solution pH and the point of zero charge of the surface;
- (iii) the surface area and porosity (narrow and wider micro porosity);
- (iv) the surface composition (oxygen functionality)

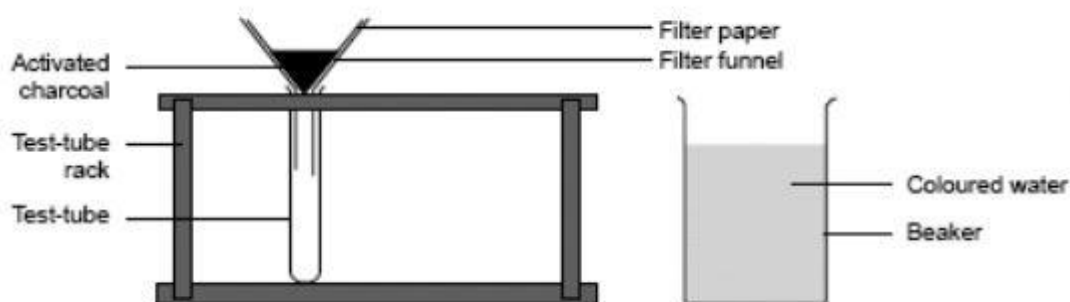
This is the basic procedure of how Activated Charcoal is used to purify water:

- a) Fold a piece of filter paper, place it in a funnel, and put the stem of the funnel into a test-tube in test-tube rack.
- b) Add about five spatulas of activated charcoal to the funnel.
- c) Add one drop of ink or food colouring to 100 cm³ of water in a beaker.



d) Carefully pour some of the coloured water on to the charcoal in the filter paper. Note whether the drops of liquid in the test-tube have lost the original colour.

e) Repeat the activity with another test-tube, this time pour 100cm³ of vinegar through the charcoal. f) Note whether the filtered liquid has lost some of its original strong smell.



Basic procedure of how Activated Charcoal is used to purify water

References

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