

PRODUCTION OF ACTIVATED CARBON FROM CHARCOAL USING CHEMICAL ACTIVATION

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Abstract

The study of activated carbon produced by chemical activation method from charcoal using several methods. Firstly, woods were pyrolyzed at about 450°C during 1 hour by the infrared cooker and kept for cooling. When cooled down, the carbonized product was taken into 50% NaCl, 25% and 50% calcium chloride solution. Then it rinsed with clean water and dried it at about 100°C. And then experimented through 0.004% methyl orange solution by taking activated Charcoal and Carbonized product into it and kept inside 24 hours of adsorption. To know the adsorption, absorbance was known through UV Spectrophotometer of carbonized product and other activated carbon's solution. And decided that in favor of 25% calcium chloride solution, carbon activated mostly.

Keywords: Activated Carbon, Chemical activation, pyrolysis, adsorption, absorbance

1. Introduction

Man's use of charcoal extends back as far as human history itself. It was first used more than 30,000 years ago to make some of the earliest cave paintings. Much later, charcoal played an important role in what might be considered mankind's first technology, the smelting, and working of metals. In more recent times, charcoal has remained a technologically important material, primarily as a result of its adsorptive properties. The use of activated charcoal in gas masks during World War I saved many thousands of lives, and today charcoal is used on an enormous scale for the purification of air and water. Activated carbon is obtained from a carefully controlled process of dehydration, carbonization, and oxidation of organic substances. It can be prepared for research in the laboratory from a large number of materials. However, the most commonly used ones in commercial practice are peat, coal, lignite, wood and agricultural by-products such as coconut shell, almond shell, rice husks, etc. The usage of carbon adsorbents depends on their surface area, pore size distribution and chemical surface characteristics. The quality (surface area, pore size distribution, and hence adsorptive properties) of activated carbons are directly related to the nature of starting material, the type of the production method and the temperature of production.

2. Properties

The basic atomic structure of the char is independent of the precursor, although the larger scale morphology may differ. It is important not to confuse charcoal with other forms of impure non-crystalline carbon such as coke and soot. The spaces between the crystallites of activated carbon constitute the micro porous structure with a large internal surface area of 250 m²/g-2500m²/g. Because of the chemical structure of activated carbon, it can preferentially adsorb organic materials and other nonpolar compounds from the gas or liquid streams. Due to these properties, they have been used for the purification of gasses, the separation of gas mixtures, the purification of exhausted air, especially the recovery of solvents, the removal of heavy metals, and the decolorization of solutions and the purification of water for many decades. The elemental composition of activated carbon typically comprises 85-90 % C, 0.5 % H, 0.5 % N, 5 % O, and 1 % S, the balance of 5-6 % representing inorganic (ash) constituents. However, these values cannot serve as a specification for activated carbon's quality or properties

3. Methodology of the study

3.1 Activation Processes (Thermal or Physical)

The porosities of a carbon, as initially prepared by carbonization are not sufficiently developed for most applications and some amelioration is a prerequisite step. This is done in several ways involving the creation of further porosity widening of existing porosity. Modifications to the surfaces of porosities and also modifying the

carbonization process itself. All activation reactions are heterogeneous use is made of either carbon dioxide or steam or mixtures of these two grasses. The classical chemical kinetics of these gasification reactions are applicable.

Carbon atoms can be removed from within porous carbons by gasification using carbon dioxide or water vapor, usually, at 800-900°C. The reaction equation is simple enough, e.g. $\text{CO}_2 + \text{carbon} \rightarrow \text{CO} + \text{CO}$, but the overall kinetics and topographical features (reaction anisotropy) contain additional detail which is relevant to activation processes. Activation by carbon dioxide and steam produce carbons with different porosities. Although discussions of the relevant importance of inhibition by chemisorbed oxygen and hydrogen provide some insight into this aspect.

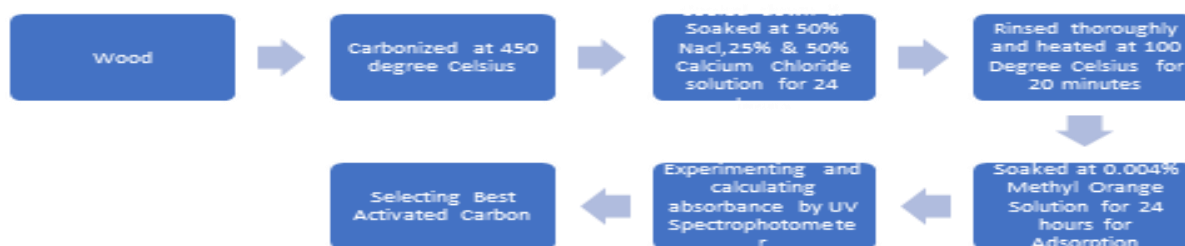
3.2 Activation Processes (Chemical)

In addition to the main processes of activation by carbon dioxide or steam, three other techniques of chemical activation are used, involving co-carbonization with (a) zinc chloride. (b) Phosphoric acid and (c) with potassium hydroxide. Mechanisms for these activations are all different with zinc chloride promoting the extraction of water molecules from the lignocellulose structures of parent materials, and phosphoric acid combining chemically within the lignocellulose structures. There is no selective removal of carbon atoms as during physical activation and carbonization yields are improved. The mechanisms by which potassium hydroxide activates an existing carbon are more complex and involve the disintegration (almost explosively) of the structure following intercalation as well as some gasification by the oxygen of the hydroxide. The presence of oxygen is not essential (but may be helpful) to this form of activation.

4. Methodology

The samples were taken it into Conical Flask and put it over an Infrared Cooker and heated it at 450 degree Celsius. After holding the temperature for 1 hour into the Cooker then the cooker switched off. In the meantime, Samples were carbonized. Then the samples were cooled down. After it's cooled down perfectly the sample was soaked into 50% of Sodium Chloride solution for 24 hours. The experiment was repeated for 25% & 50% Calcium Chloride solution. Then the samples were rinsed thoroughly and heated at about 100 degree Celsius for 20 minutes. The samples were fully dried up. Then the samples were taken into 0.004% Methyl Orange Solution and kept it for 24 hours for adsorption. Samples were taken off and Methyl Orange solution was taken for an experiment in UV Spectrophotometer. The absorbance of Unknown concentration was measured at wavelength 460 nm by UV Spectrophotometer.

Flow chart of Chemical Activation:



4.1 Experimental work

4.1.1 Sample made up:

Samples are made from wood which are nearly same weight and Dimension. Samples were taken to Conical Flask.



Fig. 1: Material Preparation

4.1.2. Set Up for Pyrolysis:

Then Conical Flask were taken over an infrared Cooker where the mouth of conical flask was connected with a copper tube as oxygen do not enter but gasses and impurities flew away outside.



Fig. 2: Pyrolysis set up

4.1.3. Carbonized Product:

After Pyrolysis at 450 degree Celsius at about 1 hour the sample was fully Carbonized.



Fig. 3: Pyrolyzed Product

4.1.4 Soaked into Sodium Chloride and Calcium Chloride Solution:

Then the Pyrolyzed product were taken into 25%, 50% Calcium Chloride and 50% Sodium Chloride Solution and kept it for 24 hours.

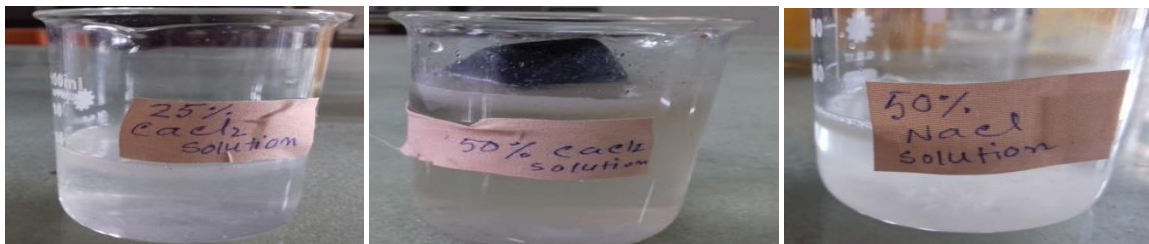


Fig. 4: Pyrolyzed product were soaked at 25%, 50% Calcium Chloride and 50% Sodium Chloride Solution

4.1.5 Soaked into 0.004% Methyl Orange Solution:

Then the Carbonized product which was activated by 25%, 50% Calcium Chloride and 50% Sodium Chloride Solution and the carbonized product were rinse thoroughly, dried up and taken into 0.004% Methyl Orange Solution and kept it for 24 hours.

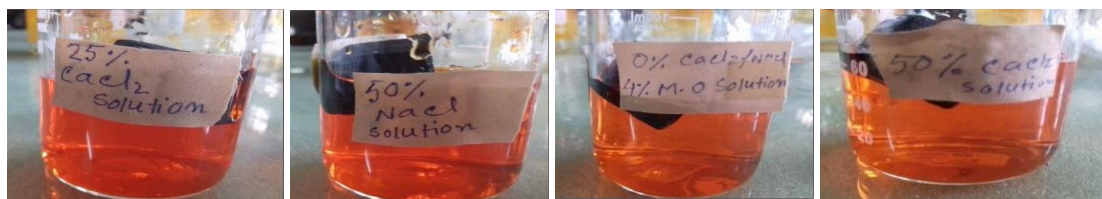


Fig. 5: 0.004% Methyl Orange Solution where Activated Carbon was soaked at 25%, 50% Calcium Chloride, 50% Sodium Chloride Solution and the Carbonized product

4.1.6 Testing Absorbance at Spectrophotometer:

Now, the methyl orange solutions were experimented into the UV Spectrophotometer and absorbance were found.



Fig. 6: Testing Absorbance

5. Calculation

Here firstly wavelength was experimented and shows that at 460 nm the curve gives the best result. So, for 460 nm the absorbance was measured.

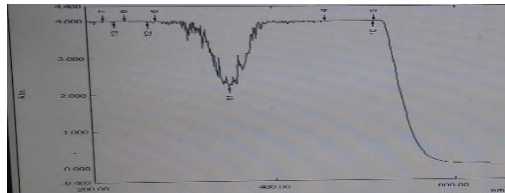


Fig. 7: Absorbance vs Wavelength curve.

The absorbance were presented in the lower segment:



Fig. 8: Absorbance of methyl Orange solution where activated carbon was soaked which is activated by 50% Sodium Chloride Solution



Fig. 9: Absorbance of methyl Orange solution where activated carbon was soaked which is activated by 25% Calcium Chloride Solution



Fig. 10: Absorbance of methyl Orange solution where activated carbon was soaked which is activated by 50% Calcium Chloride Solution

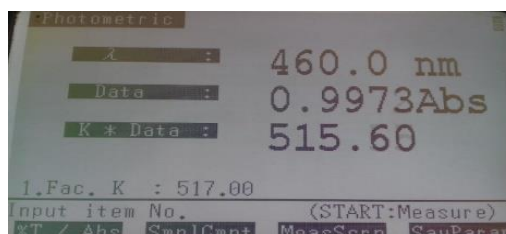


Fig. 11: Absorbance of methyl Orange solution where carbonized product was soaked

Table 1: Absorbance

Sample	Absorbance of 0.004% methyl orange solution at wavelength = 460 nm
0.004% methyl Orange solution where carbonized product was soaked	0.997
0.004% methyl Orange solution where activated carbon was soaked which is activated by 25% Calcium Chloride Solution	0.425
0.004% methyl Orange solution where activated carbon was soaked which is activated by 50% Calcium Chloride Solution	0.711
0.004% methyl Orange solution where activated carbon was soaked which is activated by 50% Sodium Chloride Solution	0.577

For Carbonized Product absorbance was the highest. So, Adsorption was lowest here. At 25% Calcium Chloride Solution absorbance was dramatically reduced. So, the adsorption was highest here.

Absorbance was increasing with a further increase of Calcium Chloride. So, adsorption was decreasing.

At 50% Calcium Chloride Solution absorbance was, of course, high compared with 25% Calcium Chloride Solution. So, adsorption was low

50% Sodium Chloride was taken for availability. Though it gives a better result than 50% Calcium Chloride Solution. So, if Calcium Chloride was not available, then Sodium Chloride can be used.

6. Result

From the experiment we see, charcoal was mostly activated at 25% Calcium Chloride Solution and gave the best porosity.

7. Conclusion

It is the most efficient way to make activated carbon from charcoal. It will be little more costly but most progressive and modern ways of activation. Chemical activation generally takes a little bit time too. As Zinc chloride or calcium chloride will be used as an activator. So waste would not happen and also as per adsorption capability Chloride solution has been chosen as for activation purpose.

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