Production of Activated Carbon from some Agricultural Wastes by Chemical Tretment

Khalid A. Aweed
Chem. Dept., College of Education, Mosul University

(NJC)

(Received on 25/ 9 /2004) (Accepted for publication on 23/3/2005)

Abstract

In this work activated carbon of good quality prepared by using different types of Agricultural residues (Sunflower Shell, Coconut Shell, Peanut Shell, Harvest Hay and Dates Stones) by using excess amount from $NaOH$ [(1:2) (raw materials: $NaOH$) at 550±25°C for 3hrs. After the carbonization was completed. The reaction mixture was subjected to purification by treatment with 10% HCl and distilled water till it give neutral test to the litmus paper.

The samples were dried at 110-120°C for 24hrs and its physical properties were determined.

الخلاصة

يتضمن البحث تحضير كاربون منشط من مخلفات نباتية (قشور جوز الهند، قشور فستق الحقل، نوى التمر، قشور زهرة الشمس، مخلفات الحصاد) عن طريق مفاعلة هذه المخلفات مع زيادة من هيدروكسيد الصوديوم [(2:1) (مخلفات نباتية: NaOH)] عند 550 ± 25 °م لمدة 3 ساعات، المادة الكاربونية الناتجة يتم تنقيتها عن طريق الغسل بالماء المقطر لحين التعادل ومن ثم المعاملة مع محلول 10% حامض الهيدروكلوريك وباستخدام عملية التصعيد الحراري لمدة ساعة ثم ترشح المادة الكاربونية الناتجة وتغسل بالماء المقطر لحين التعادل.

ثم تجفف عند 110-120 °م لمدة 24 ساعة، يلي ذلك عملية تحديد مواصفات الكاربون المنشط المحضر بمقارنتها مع كاربون منشط تجاري من انتاج شركة .B.D.H.

Introduction

Activated carbon is a highly porous material has various applications in adsorption of both gases and solutes from aqueous solution. It has been well-established the fact activated carbons have over many years been widely used for the separation of gases, the recovery of solvents, the removal of organic pollutants from drinking water and as well as catalyst support(1).

The raw materials most commonly used to crate the carbon are coal, peat, lignite, wood and nutshells, none of these raw materials is pure carbon, although anthracite coal comes close, they contain unwanted hydrogen and oxygen as well, those components are driven off by heating the raw material in the absence extremely hot gas, usually steam at about 1200 °C, which etches tiny passage way through each carbon particle.

The literature contains many research work concerning activated carbon, which may include source of the feed stock, and the nature of carbonization process, type of activation carbon which is given as follow.

Al-Channam *et. Al*(3) prepared activated carbon from (*Mours Nigra*) by using different a mount from sodium hydroxide (NaOH) and heated the mixture at 500±25°C.

Hu and Srinvasan(4) prepared activated carbon by chemical activation of coconut shell with KOH as active agent. The influence of activation parameters on the final products was studied by varying the KOH to shell ratio, activation temperature and pre-heat temperature. The samples were characterize by nitrogen adsorption isotherms at 77K.

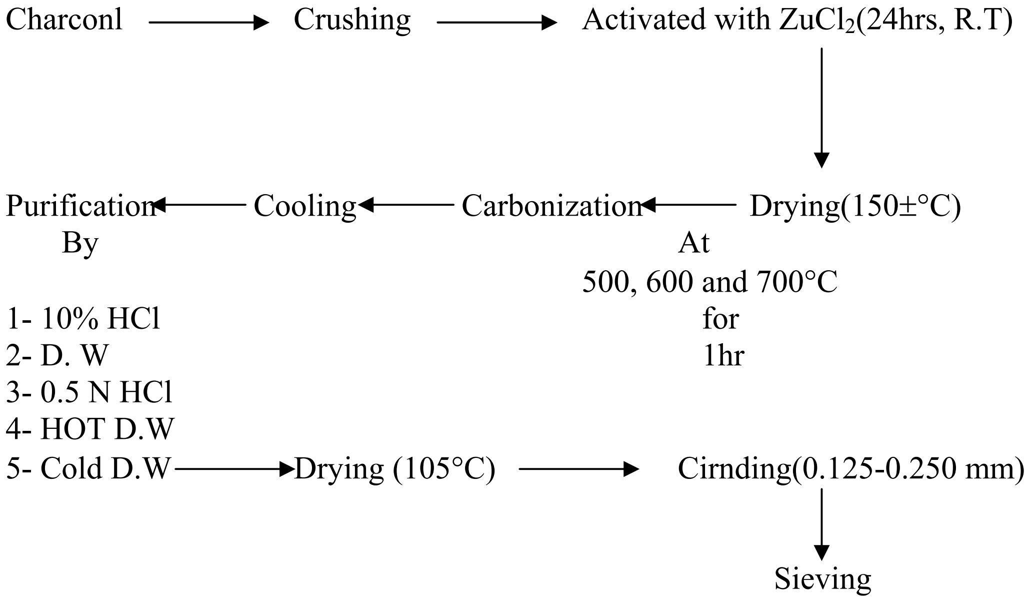
Yamagushi and Sato(5) prepared activated carbon from thio lignine with excess amount from NaOH and KOH at 550±°C for 3 hrs.

Guo *et al.* (6) production activated carbon from rice husks by using KOH has the activating agent. The effects of preparation parameters on the properties of the active carbon were studied and its structure was characterized.

Activated carbon were prepared by Ahmad bour and Do(7) from nutshell by chemical activation with KOH and zinc chloride.

Jeyasselan(8) prepared activated carbon from coconut husk and digestied sewage sludge. The carbonization was conducted by $ZnCl_2$ as activator. The products was purified by 3M HCL solution, washed with deionized water and dried at 130 ±°C for 24 hrs. The activated carbon obtained was tested by application to the adsorption of phenols from aqueous media.

Ceren and Meral(9) prepared activated carbon as given below:



Experimental

1. Carbonization and Activation for Raw Materials

(10)gm from Agricultural Residues mixed with (20)gm from NaOH and heated at 550±25°C for 3hrs.

2. Purification of Activated Carbon

The resultant carbonization materials were washed after cooling with distilled water till neutral litmus paper. The carbon obtained was treated with 10% HCl under refluxed for 2hr. The mixture was filtereted washed with distilled water and dried at 110-120±°C for 24 hr.

3. Activated Carbon Measurements:

A- Measurement of Density

The density of the prepared activated carbon were determined by weighing 10 cm^3 of the carbon sample using graduated cylinder(10).

B- Determination of Ash Content

The ash content was measured by heating burning one gram of the prepared activated carbon sample in a porcelain crucible using an electrical furnace for five hours at temperature of 1000-1100°C. the remained residue was considered as the ash content(11).

C- Measurement of Humidity

One gram (exactly weighed) of the activated carbon was heated in an oven at 150°C for 3hr. The difference in weight before and after heating operation was calculated as H_2O vapour in the sample(12).

D- Determination of Carbon Activity by Methylene Blue Adsorption Method

An exactly weight (0.1 gm) of the prepared activated carbon sample was added to an aqueous solution of 20 ppm methylene blue pigment in a conical flask. The solution was shacked by an electrical shaker for 24 hr at a temperature of 25°C till adsorption of methylene blue from its aqueous solution was completed a state of equilibrium was reached. The absorbance of the solution was determined using (UV-Visible Spectrophotometer) at λmax 665 nm. The procedure was carried out for the different types of the prepared samples for comparison purposes. The final concentration of methylene blue value for each activated carbon sample was calculated as the number at milligrams of methylene blue adsorbed by one gram of carbon(13).

E- Determination of Carbon Activity by Iodine Adsorption Method

The iodine number (In), which is the amount (in milligrams) of iodine adsorbed from its aqueous solution by one gram of activated carbon. The method involves:

1- One gram of the dried activated carbon transferred to 250 ml Erlenmeyer flask.
2- To the flask, add 10 ml of 5% HCl and swirl until the carbon is wetted.
3- Place the flask on hot plate, bring the contents to a boil and allow to boil for exactly 30 minute.
4- Allowing the flask and contents to cool to room temperature add 100ml of standardized 0.1 N iodine solution to the flask.
5- Immediately stopper flask and shake the contents vigorously for 30 minute.
6- Filter by gravity immediately after the 30 minute shaking period through filter paper.
7- Mix the filtrate in the beaker with a stirring rod and pipette 50 ml of the filtrate into 250 ml Erlenmeyer flask.
8- Titrate the 50 ml sample with standardized 0.1N sodium thiosulfate solution until the yellow color has almost disappeared. Add about 1ml of starch solution and continue titration until the blue indicator color just disappears. Record the volume of sodium thiosulfate solution used(14).

$$\text{Iodine number} = \frac{X}{m} \quad D$$

Where:
m= is the weoght of the activated carbon in grams
X= A- [2.2 Bx ml of thiosulfate solution used]
A= N1 x 1269.0
B= N2 x 126.93
N_1= normality of iodine solution.
N_2= normality of sodium thiosulfate solution.
D= correction factor.

Results and Discussion

Active carbon is a very important industrial product due to its uses in various aspect of modern civilization. It's manly produced from highly content carbon feedstock.

The production from the industrial point of view available to the consumer will be protected by secrets and patents owned to some chemical companies in the world.

In this work we aimed to produce activated carbon of good quality by carbonizing the materials with excess a mount of (NaOH) at 550±25°C for 3hrs and the results of the study are given in the table below.

From the table coconut shell (Cocus Nucifera) give the best results due to its high carbon content compared with the other feedstock.

About sodium hydroxide:

Hydroxide ion make etching in the structure of the raw materials and development the porous structure for the raw materials while sodium ion determine the size of the porous(15).

Table: Properties of Activated Carbon

Sample	Density gm/cm^3	Ash %	Humidity %	Iodine number mg/gm	Methylene Blue mg/gm	Activated Carbon %
Sunflower shell	0.498	1.017	0.691	100	10	5
Coconut shell	0.312	1.123	2.251	950	115	28
Peanut shell	0.371	1.521	1.512	350	30	17
Harvest hay	0.372	1.793	1.302	325	24	20
Dates stones	0.374	1.823	1.622	300	25	15
Commercial from B. D. H	0.345	3.200	0.800	908	90	

References

1. Carcia, A. et. Al., Department of Engeretic Engineering and Environmental Control, ***Estrada do Paco do Lumiar,*** 2003, **22**, Ed if, J, 1649-038, Lisbon, Portugal.
2. Stranghan, B., ***from the Calypso fish & Aquaria Club,*** London, England Aquarticles, 2003.
3. Al-Ghannam, A. Aweed, A. and Hamdon, A., ***National Journal of Chemistry***, 2004, Accepted, **6**,
4. Hu, Z. H. and Srinivasan, M., ***Microporous, Mesoporous Materials,*** 1999, **27(1)**, 11.
5. Yamagushi, T., and Sato, Y., ***Kagaku Kaishi,*** 1993, **3**, 271.
6. Guo, Y. et. Al., ***Chemical Journal of Chinese University-Chinese,*** 2000, **21(3),** 335.
7. Ahmadpour, A. and Do. D., ***Carbon***., 1997, **35(12)**, 1723.

8. Jeyaseelan, S. and Chen, X. G., ***CSE Research Bulletin,*** 2000, **13,** Jan, 1.
9. Ceren, K., and Meral, E., Eye University Institute of Nuclear Sciences, 35100, Bornova, Izmir Turky, 2003.
10. ASTM D2854, 70 Standard Test Method for Apparent Density of Activated Carbon.
11. ASTM D2866-70 "Total Ash Content of Activated Carbon", Extracts Were Reprinted With Permission from Annual Book of ASTM Standard Copyright ASTM Race Street, 1916.
12. ISO, 5.62-1981, "Determination of Volatile Matter Content of Hard Coal and Coke", The Full Text Can be Obtained from ISO Central Secretarial Cose Postable 5G, CH-1211: Genera 20 or from any ISO Member.
13. Test Methods for Activated Carbon Rasterbau Int. Engineering GMBM, W.
14. AWWA Standard for Gronular Activated Carbon; B604-74, ***Sec. Approved by J.***, 1974, The American Water Works Association Board of Directors on Jan. **28**.
15. Teng, H. S. and Weng, T. S., ***J. Microporous Mesoporous Mat,*** 2001, **50(1)**, 53.