

# Preparation of Activated Carbon from Wastes Tires by Minerals Hydroxide (LiOH, NaOH and KOH)

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## Abstract:

This work involved preparation of activated carbon from waste tires. The produced carbon from the primary carbonization is activated by using excess amount of mineral hydroxides (LiOH, NaOH and KOH).

The quality of the prepared carbon was tested by measuring its iodine number and ability to adsorb the methylene blue. The density and ash content of the prepared carbon were also evaluated.

The obtained results were compared with a carbon of a commercial grade supplied by the BDH chemical company. The comparison proved that the prepared carbon is of a good quality and comparable to the commercial one.

**Key words:** activated carbon, waste tires, chemical treatment

## Introduction:

Active carbon is defined as a black materials with irregular structure that have a certain defect in angles between the ring atoms in the ring and the rings themselves of the sheets. This may lead to a certain unbalanced forces and to the appearance of activities between the carbon atoms that appear in the form of pores of various types. Active carbon has greater adsorption ability to various chemical if compared to carbon black and other solid adsorbents<sup>(1)</sup>.

A high yield activated carbon is produced from macadamia nutshell charcoal by (i) carbonization of charcoal at 1173 K, (ii) air oxidation of the carbonized charcoal in boiling water at 503-533 K and (iii) activation (a second carbonization) of the oxygenated carbon<sup>(2)</sup>. The surface of activated carbon with its complex character has been conceived in different ways in the literature. The older literature has often emphasized the physical of the carbon interphase<sup>(3)</sup>.

The chemical surface features also contribute to the selectivity of absorption. Some authors have noticed the heterogeneity of the carbon surface and they have presented calculations that offer evidence for this<sup>(4)</sup>. The Merck index divides these charcoals into four basic forms: Animal charcoal is obtained by charring bones, blood, etc., Gas black, and furnace black are obtained by the incomplete combustion of natural gas; Lamp black is obtained by the burning of various fats, oils, resins, etc. and: Activated charcoal is obtained from wood and vegetables<sup>(5)</sup>.

Activated carbon have long been used as industrial sorbents for a wide variety of commercial applications. Such as sugar purification<sup>(4)</sup>, drinking water purification<sup>(6)</sup>, colour removal, and liquids purification, removal of impurities from nutrition product<sup>(1)</sup>.

Activated carbon can be prepared from a large number of sources by many methods. These methods used carbon rich materials which were pyrolysed or carbonized in an inert atmosphere in order to remove volatile organic constituents, leaving behind a highly porous carbonaceous residue, followed by either chemicals steam or gas activation for removal of the pollutants<sup>(7,8)</sup>. Methylene blue has been used for a long time as a model for the adsorption of organic pollutants from aqueous solution. A number of studies on the removal of methylene blue from aqueous solution by using corncobs

is found in the literature<sup>(9,10)</sup>. Among the other raw materials used as precursors to make activated carbon are sawdust, peat, lignite, coal, cellulose residues<sup>(11)</sup>, petroleum coke, spent ion exchange resins<sup>(12)</sup> and old automobile tires<sup>(13)</sup>.

Hamdon et al.<sup>(14)</sup> prepared activated carbon using oxidation condensation process and chemical treatment. The activated carbon was irradiated by gamma rays for different periods of time. The activity of activated carbon was studied by iodine number, methylene blue, density, ash content and humidity before and after irradiation.

Al-Ghannam et al.<sup>(15)</sup> prepared activated carbon from Qhayara crude oil by chemical treatment and studied adsorption of some organic acids from aqueous solution at room temperature.

Aweed<sup>(16)</sup> prepared activated carbon from Qhayara crude oil by oxidation with excess amount of sodium hydroxide at  $550 \pm 25$  °C. Yamaguchi and Sato<sup>(17)</sup> prepared carbon using some alkaline base such as NaOH with lignin.

In this work we aimed to produce activated carbon of a good quality by carbonizing the materials through using excess amount of mineral hydroxide (1:2) (waste tire : mineral hydroxide).

## Experimental:

### 1. Primary carbonization

Certain weight of the waste tires is purified from impurities and mineral pieces, and then carbonized by heating at 350 °C for 3 hrs.

### 2. Final carbonization and activation

The carbon produced from step (1) was carbonized by excess amount of (Li, Na, K) hydroxides at  $550 \pm 25$  °C for 3 hrs.

### 3. Purification of activated carbon

The resultant activated carbon was washed after cooling with distilled water until gives negative test for litmus paper.

The carbon obtained was treated with 10% HCl under reflux for 2 hrs. The mixture was filtered, washed with distilled water and dried at 110-120 °C for 24 hrs.

### 4. Activated Carbon Characterization:

#### A. Measurement of Density

The density of the prepared activated carbon were determined by weighing 10 cm<sup>3</sup> of the carbon using graduated cylinder<sup>(18)</sup>.

#### B. Determination of Ash Content

The ash content was measured by heating one gram of the prepared activated carbon at 1000-1100°C. The remained residue was considered as the ash content<sup>(19)</sup>.

#### C. Measurement of Humidity

One gram of the activated carbon was heated at 150°C for 3hrs. The difference in weight before and after heating was calculated as H<sub>2</sub>O vapour in the sample<sup>(5)</sup>.

#### 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. The solution was shacked for 24 hrs. at 25°C. The absorbance of the solution was determined using (UV-Visible Spectrophotometer) at  $\lambda_{\max}$  665 nm. The procedure was carried out with different types of the prepared samples for comparison purposes. The final concentration of methylene for each activated carbon sample was calculated as the number of milligrams of methylene blue adsorbed by one gram of carbon<sup>(20)</sup>.

#### E. Determination of Iodine Number

1. The iodine number (In), which is the amount (in milligrams) of iodine adsorbed

from its aqueous solution by one gram of activated carbon was determined for each sample using the following equation<sup>(21)</sup>:

$$\text{In} = \frac{X}{m} D$$

Where:

m = is the weight of the activated carbon in grams

X = A - [2.2 B x ml of thiosulfate solution used]

A = N<sub>1</sub> × 12693

B = N<sub>2</sub> × 126.93

N<sub>1</sub> = normality of iodine solution

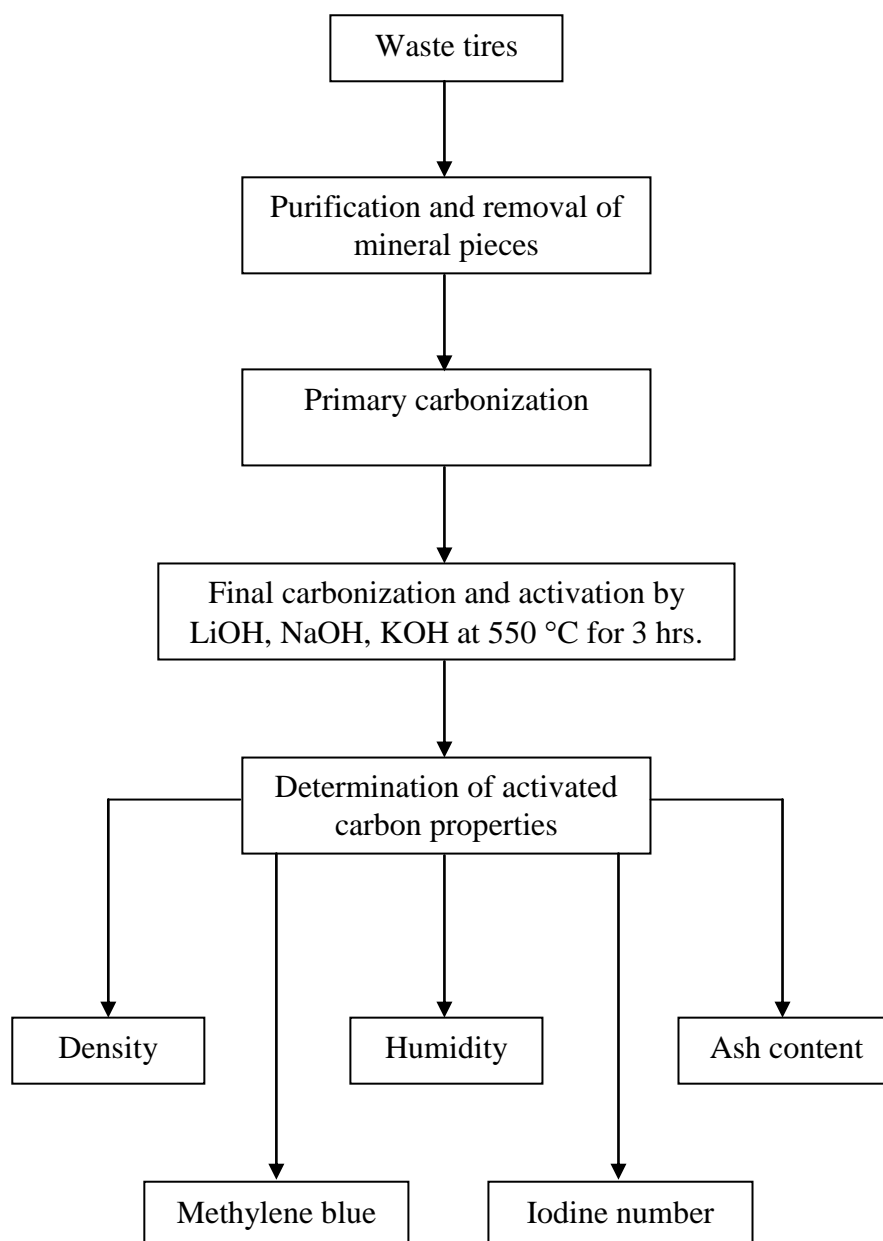
N<sub>2</sub> = normality of sodium thiosulfate solution

D = correction factor

#### Results and Discussion:

Activated carbon in all of its forms whether it was powder or granular plays an important rule in modern civilization and industrial production. Its wide uses and applications encouraged many workers to look for different sources in order to prepare it. From thin point we tried to prepare activated carbon using waste materials (tires) which are cheap and available (from the economical point of view) as well as being a polluted material. The diagram bellow show all the steps which we done it in this study.

The results of the characterization of the prepared carbon as well as the comparison with the commercial carbon are given in the Table (1).

**Table (1): Properties of activated carbon**

Sample	Waste tires : mineral hydroxide (1:2)	Iodine number mg/gm	Adsorption on Methylene Blue mg/gm	Ash %	Density gm/cm <sup>3</sup>	Humidity %
1	LiOH	405	30	3.102	0.380	3
2	NaOH	775	80	3.410	0.327	2
3	KOH	965	95	3.605	0.311	5
B.D.H. A	-	908	90	3.210	0.345	0.8
B.D.H. B	-	445	63.8	1.5	0.356	0.53

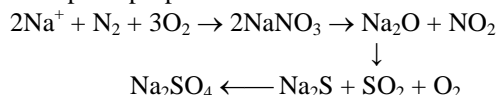
Table (1) we shows that the density and ash content of activated carbon is comparable to that of the B.D.H. (commercial grade), while humidity content is slightly higher than the commercial one. This can be reduced by elevating the temperature to 250 °C without exposure to the air to get little loss in the carbon.

Potassium hydroxide gave the best values of iodine number and methylene blue and this due to minerals hydroxides are etching materials which leads to defect in

the crystalline structure of the materials, (The cation in the hydroxides determines the size of the pores in the activated carbon, while anion (OH<sup>-</sup>) makes as etching agent and leads to defect in the structure of the waste tires) and improve the porosity of activated carbon.

Mixing mineral hydroxide with waste tires may lead to ionization of the functional groups (carboxylic and phenolic) and the cation reacts with the sulphur which is found in the structure of the tires at 100 °C and formed

Na<sub>2</sub>S, Na<sub>2</sub>SO<sub>4</sub>. The removal of sulphur improve adsorption properties of activated carbon<sup>(22,23)</sup>.



Depending on these principles, the produced activated carbon and as indicated by the results listed in Table (1) is found to be of a better quality when compare with commercial one

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## تحضير كاربون منشط من الاطارات التالفة باستخدام هيدروكسيدات معدنية

### (هيدروكسيد الصوديوم، البوتاسيوم والليثيوم)

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## المخلص:

في هذا البحث تم تحضير الكاربون المنشط من الاطارات التالفة باستخدام هيدروكسيدات (الليثيوم، الصوديوم والبوتاسيوم). تم اجراء عملية الكرنية بالتنشيط باستخدام هيدروكسيدات (الليثيوم، الصوديوم، البوتاسيوم) بنسبة (٢:١) (اطارات تالفة:هيدروكسيد معدني) عند ٥٥٠ ± ٢٥ °م لمدة ٣ ساعات. حددت الخواص الفيزيائية للكاربون المنشط الناتج مثل الكثافة، محتوى الرماد، الرطوبة. وقابلية الامتزاز مثل الرقم البودي وامتزاز صبغة الميثيلين الزرقاء. وكانت النتائج جيدة مقارنة بالنماذج التجارية لشركة B.D.H.