

Synthesis of activated carbon of lote wood and study its physical properties

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ABSTRACT

The paper focuses on studying activated carbon and its uses then producing activated carbon using lote wood that is available in Iraq through the process of carbonization. In addition, the paper defines the best temperature to produce huge size of coal. Then use the process of carbon activation through Physical activation. The latter process can be done through steam heating or oxygen for 1000 C°. After that, several measurements have been done to measure the efficiency of activated carbon, and other physical checks related to carbon like humidity and percentage of ash.

Keywords: Lote wood; Carbonization; Carbon activation; Iodine

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1-Introduction

Activated carbon is one type of carbons that is synthesized by using carbon-origin materials and it is activated through specific methods to get a wider surface area (400-1600) gm/m². Carbon is a structure full of pores, active and reactive surface. Carbon depends on the process of adsorption in which the gas or liquid molecules stick on the surface of solid material. Somehow, it is similar to magnetic attraction to iron filings. Since activated carbon has high surface area and porous and active surface, so it is an ideal material for adsorption. Adsorption efficiency depends on physical and chemical properties of activated carbon, concentration of polluted material to be removed, PH, contact time between activated carbon and polluted material. Activated carbon has two forms, granules used in adsorption of gases and vapors, and the form of powder used in adsorption of liquids. These unique properties of activated carbon makes it included in several industries as food, medication, carbonated drinks, war masks that capture poisonous gases, water purification and air purification inside factories in addition to cleaning and environmental rehabilitation [1,2].

Activated carbon is used in several industrial applications through purifying materials throughout the whole production process starting from purifying raw materials to improving the product quality. It is included in sugar purification process to get pure crystals. Also, in extracting metals, gold, silver and recovery of solvents. In addition to its use in nuclear technology, oil refining, decolourization, purification of materials used in food, medication and chemical industries. Moreover, it is used to remove odors and oil vapors and other hydrocarbons and compressed air. In addition to use it in potable and pools water purification, masks filters of poisonous gases, odours removers of closed places like hospitals, restaurant, airports, cars and refrigerators. Also, it is utilized as an antidote material [3,4].

Activated carbon and regular one can be differentiated between them through putting piece of carbon in water. If it is activated carbon, bubbles will appear. Or, use turbid water or impurities, in this case, activated carbon will absorb turbidity or fine impurities from water [5,6] (see Figure 1).



Figure 1. forms of carbons (A- black lead B- diamond)

2. Forms of Carbon

Carbon molecules have the ability to connect with each other to form straight, ringed or branch chains. It has the ability to connect with other materials to form certain compounds. There is more than million carbon compounds and it is increasing because we get it from nature or prepared in labs. Forms of carbon (Figure 2) includes [7,8]:

- 1- Black lead or Graphite: it is a smooth and soft compound because each atom of carbon has four connections connected to other carbon atoms.
- 2- Diamond: it is natural material and it is the hardest natural compound, and the reason of hardness is that each carbon atom has three connections only. Therefore, the net atoms is solid and do not move. That is why the melting point of diamond is so high.
- 3- There is no definite form or it has no form at all. It is lately discovered and includes 60 carbon atoms.

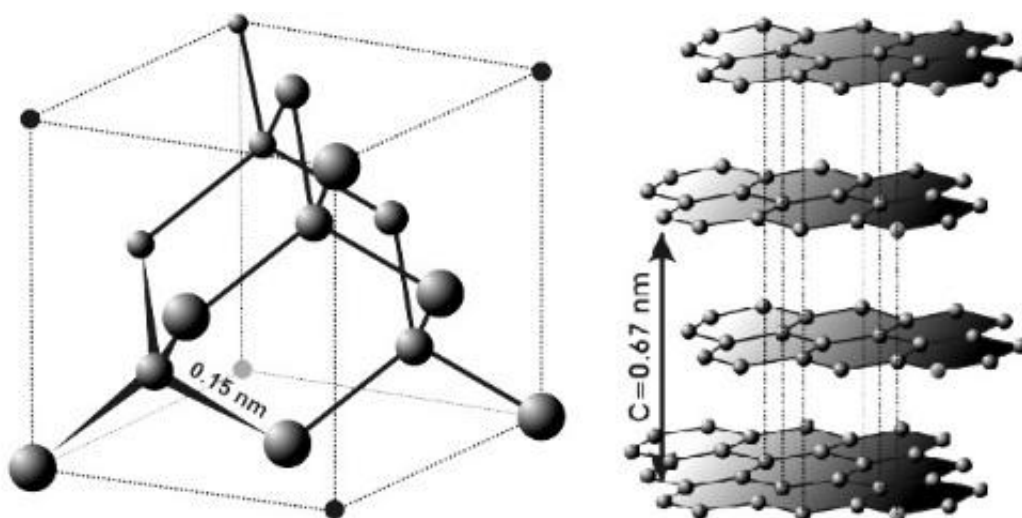


Figure 2. Forms of carbons (A- black lead B- diamond)

3. Manufacturing activated carbon

Several carbonic materials can be used like petroleum coke, sawdust, lignite, coal, peat, wood, charcoal and animal charcoal, hazelnut shells, fruit stones to produce activated carbon. The properties of final material are not determined only by raw materials but the method of activation. The decolourization active carbon is used as powder. That is why materials that have no structure or has fragile structure are used in this process. Sawdust gives such a kind of activated carbon [9].

Adsorbed carbons are used in the form of hard granules and produced from coconut shells or fruit stones, charcoal and animal charcoal. The most prevailing physical property is the surface area.

Activation is a physical process that increases carbon surface enormously through removing hydrocarbons. There are several methods of activation. The widely used method is the treatment of carbonic material with oxidized gases like air, vapour, carbon dioxide, carbonization of raw material with chemical elements like Zinc Chloride or phosphoric acid. Most of activated carbons are made by the method of vapour activation. Chemical activation is still widely used. The production of activated carbon starts with the production of coal and use of carbonization [10,11].

4. Carbonization

The process of transforming lote wood into coal is called carbonization (coal manufacturing) Pyrolysis, which is a chemical decomposition of wood by heating without oxygen.

Through carbonization of lote wood, 70% of volatile constituents that is equal to the mass of the lote wood shell in aerosphere, which produces 30% of lote wood mass as charcoal (Figure 3 represents weight loss over time). The emitted volatile constituents are methane, carbon dioxide, steam and other organic vapours. Carbon made of lote wood is the highest of solidity in comparison to other types of activated carbon (ideal for water purification).

To start carbonization, we take 300 grams of lote wood, cut it and dry it in 150C°. The result of carbonization is a compound of irregular crystals that include holes among them. These holes will be filled with amorphous or disorganized carbon. The product has a weak ability of adsorption because the temperature used is relatively low, so part of tar resulted from Pyrolysis sediment in the pores on the surface of coal. Tar can be removed by heating it at 1000 C° through gaseous currents of vapour or oxygen [11].

In this stage, amorphous carbon is burnt, closed pores among crystals are opened, and amorphous carbon surface becomes more responsive for the process of activation through forming new pores and develop the porous shape of carbon. This is can be achieved through removing walls between micro-pores and expand them. Burning of crystals should be done in another stage and location on the surface. The absence of such reaction will not make any new pores. These two processes were done separately but there are certain studies tend to perform these processes at the same time.

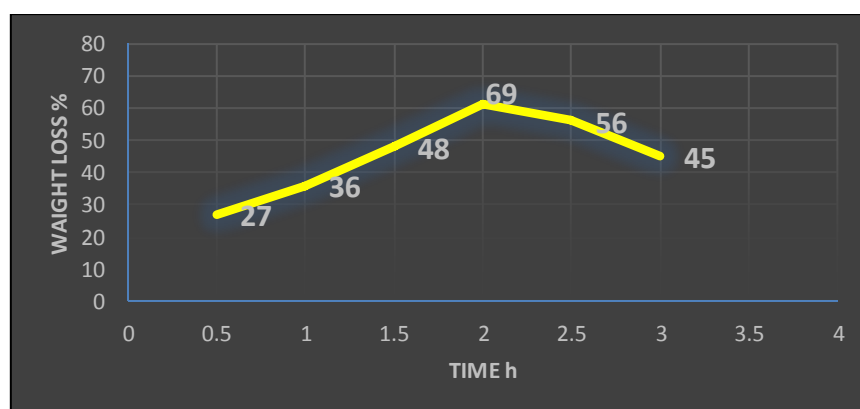


Figure 3. Weight loss over time

5. Specific measurements of activated carbon efficiency

A. Measuring internal surface area by iodine adsorption of its Aqueous solution (15)

This method is a common and known one to give information about internal surface area of activated carbon. This can be expressed in the number of grams of adsorbed iodine of solution by (2) grams of activated carbon, where (2) grams of activated carbon and add (15 ml.) of (%5) HCl. Then it is heated to 45 minutes, cooled down to lab. temperature and add (100 ml., 0.1 N) of iodine. Then stirred for 15 minutes using electrical stirrer and filtered. (50 ml.) is taken of filtrate and titrate with (0.1 N) of

sodium thiosulfate with the presence of starch, and sodium thiosulfate is calculated from burette. Iodine number is calculated by the following equation [11]:

$$I.N.= X/M.D$$

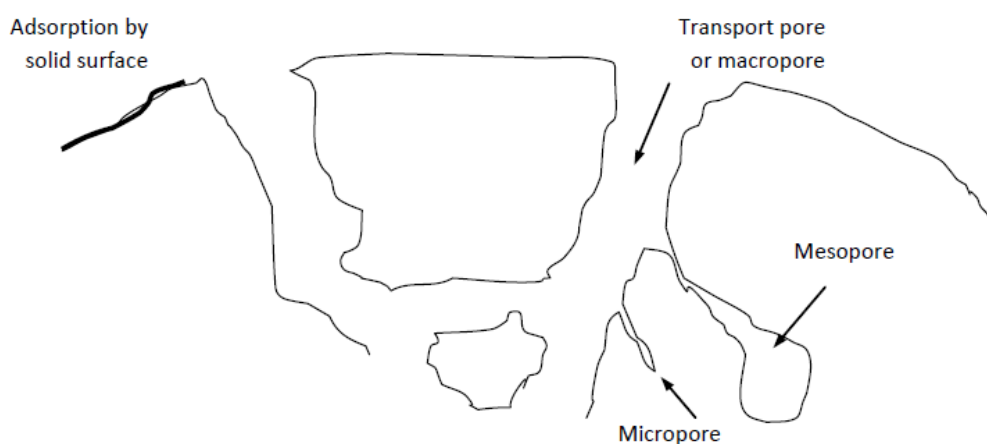
Since X= iodine weight (by mg) adsorbed by activated carbon.

M= weight of used activated carbon

D= Correction coefficient

B. measuring external surface area by adsorbing Methylene blue dye from its aqueous solution

This method is a common one that includes (0.2) grams of activated carbon prepared previously, and put it in conical flask, add (30 ppm) of dye solution than use electrical stirrer for (15) minutes in lab. temperature. It is observed that the colour of dye is vanished. Then, the solution is separated by using decantation method. The clear solution is taken and put in absorption cell and absorption is measured at (600-675 nanometer) wavelength, then adsorbed dye is calculated by the activated carbon through standard curve that will take several different concentrations of blue methylene (5, 10, 15, 20, 25, 30 ppm). Absorption is measured at the same above mentioned wavelength and make a graph of absorption and concentrations value then absorptivity values of adsorbed solutions of dyes are projected by the activated carbon.



6. Measurements of some samples of activated carbon

1. Carbon percentage is calculated through taking samples of previously prepared activated carbon and leave in the lab atmosphere for (24) hours then dried at (110- 120 C°) for three hours, and left to cool down and weigh. Depending on the difference of two weights, the percentage of humidity is calculated [8,9].

2. Measuring the percentage of ash

We take (1) grams of activated carbon, and heat in a furnace for (800- 1000 C°) for one hour then it is cooled down to lab temperature in a dry container. The weight of the residual sample represents the weight of ash and based on this, the percentage is calculated [10,11].

3. Measuring density of activated carbon

A quantity of activated carbon is put in a volumetric flask of (10 ml.) noting that the particles of carbon are on the same level to the mark. Then press gently to get rid of pores among particles so as the activated carbon takes its full size and level activated carbon [3]. Then, the activated carbon in the bottle is weighed with a sensitive balance, and density is calculated according to the following equation:

$$\text{Density} = \text{mass} / \text{size (gram/cm}^3\text{)}.$$

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