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Production & Characterization of Activated Carbon from Date Seeds

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ABSTRACT
Activated carbon sequence (AC) was prepared based on the date seeds that are widely found in Iraq nature. Activated carbon preparation process done by dual-step heating & chemical activations with KOH and $ZnCl_2$ and investigated for the adsorption of vital bacteria from river water. The impact of different preparation conditions, such as temperature and type of chemical agent of carbonization on the final porous texture of the carbons were studied. To describe the pores of carbon samples, an isotherm of nitrogen adsorption-desorption measurements obtained at 77° K was employed. Using a microbial bacterium test, the effectiveness of bacterial adsorption from water by various activated carbons was investigated. It found that the (AC) samples treated with KOH have the highest surface area and are more efficient in bacteria removal. The largest obtained surface area was 1632.3 m^2/g by KOH treatment of coal at 600°C. The bacteria removal efficiency of the activated carbon having the maximum surface area is nearly 90% of total bacterial colonies.

Keywords: AC, activated carbon, physical and chemical treatment activation.

INTRODUCTION

Activated carbon is a particular type of carbon that has a high specific area [1]. Due to large surface area available and its porosity, it is used in different industries for a vast variety of applications such as water treatment and other industrials applications. Activated carbon is extremely good agent for adsorption of chemicals, heavy metals, toxic chemicals, removal of organic pollutants [2]. Most organic compounds can be used to create activated carbon that have high carbon percentage in entire composition such as, bituminous coal [3], fire wood [4], rice husk [5, 6], agricultural waste [7] etc. The most recent studies that deals with activated carbon seek the low cost Commercial activated carbons. Since Activated carbon is expensive therefore, there is a need to search for effective adsorbents for economical wastewater treatment [8], dye removal from wastewater [9], absorbing of chemical compound from aqueous solutions [10]etc. Many chemical and physical therapies have served to convert organic sources that contain a high percentage of carbon into activated carbon [11, 12]. Microwave is also can used in the treatment process in addition of chemical processing [13]. The purpose of chemical and physical therapies is to increase the specific area as well as increase the free radicals that capture minerals or chemical compounds, and these advantages give the effective carbon a great effectiveness in treating water or solutions [14]. The goal of this project to investigate the efficiency of activated carbon made from local materials with water treatment.

EXPERIMENTAL

Materials

In this study dates seeds are used as the raw material because the plenty of this materials in Iraqi nature and the high organic content these materials which have [15]. The dates seeds are collected from "Abo-Alkhaseeb" region in Basra at the southern of Iraq, the seeds were then separated and cleaned to remove the remaining dates,

as well as get rid of dust, after this step, the seeds were entered into oven at 120 °C for 8 hours for the purpose of removing the moisture present in this material as showed in Figure 1 and Figure 2.

After drying process, the seeds were crushing in several stages until the seeds transformed into powder. These powder Sieving through 1x1 mm sieve to ensure the homogenous powder particles size. This stage showed in Figure 3.

After this step the result powder divided into three samples, entered it into the furnace chamber to convert powder into carbon, each sample was

Figure 1. Collecting and washing stage

Figure 2. Moisture removing stage

Figure 3. Crashing and sieving stage

heated in different temperature, the first sample at 400°C, the second sample at 500°C and third sample at 600°C for 60 minutes for each one. During the heating process nitrogen gas pumped to heating chamber to avoid combustion and forming a large quantity of ash that can be made by oxygen gas present, this process showed in Figure 4. The three samples were left to cool to room temperature and it's washed in distilled water to adjust the pH of the samples over 7. Then the samples were entered to oven at 120°C until it's dried this took 2 hours.

Solutions and activation process

Two different solution are prepared ($ZnCl_2$ & KOH) with 1 normally concentrations for each solution. The carbon powder divided into 6 samples, 3 samples immersed into KOH and the rest immersed into $ZnCl_2$, the immersing period took 48

Figure 4. Heating process

hours, then the samples dries again to produce six samples of activated carbon as shown in Table 1.

Surface area test

Pore characterization of carbon samples was analyzed by the isotherm of nitrogen adsorption-desorption data recorded at 77 °K. The Brunauer, Emmet & Teller (BET.) The equation for the area determination of the specific surface is displayed in its simplest form to be:

$$St = K\,(1\text{-}P/Po).\ Va \qquad (1)$$

where: *St* – total surface area of sample being analyzed, *K* – a constant for Nitrogen, assuming "STI" conditions = 4.03, *P/Po* – is 0.294 for a gas mixture of 30% N2/70% He, *Va* – volume of gas (N2) adsorbed.

Every cubic centimeter of N2 adsorbed (then desorbed) by the sample is comparable to a total surface area (St) of 2.84 m of the Specific surface found by dividing St by the Sample weight in the cell in grams. From the above, it can be seen that the surface area measurement of a Sample using the BET principle has to measure the volume of Nitrogen gas adsorbed by the sample at the temperature of the liquid nitrogen. The equation(BET) is valid for the vast majority of materials for the gas mixture's relative pressures (P/Po) below 0.35. The Model 9600 series of analyzers use gas mixtures of 30% N Balance Helium.

Water treatment microbial bacteria test

Water sample was taken from the Local River for the goal of killing microbial bacteria. This sample was treated several times with the six samples to obtain the best-activated carbon for the water treatment. The activated carbon was mixed with water at percent 1:20 by mass, (5 gm) of activated carbon was added to 100 ml of water, then shaken well for 15 minutes, and then Filtered Nomination paper, then sent to the water samples for microbial Bacteria test. The volume sample of 100 ml is used in determining microbial growth. Before precipitation, the 0.02 sample was cultivated on nutrient agar, and the result was recorded (as 5000 MPN). Then after deposit, we took (0.02) from each sample and cultivatable it on nutrient agar, and after that cuddled it in an incubator in the department of engineering techniques of environmental pollution for 24 h at 35Co. To calculated the percentage bacteria colony kills:

$$BCK\% = \frac{NB-NA}{NB} \times 100 \qquad (2)$$

where: *BCK%* – bacteria colony kills percentage, *NB* – no. of colony before treatmen, *NA* – no. of colony after treatment.

Table 1. Sample names

Sample name	Activation solution / temp.
A.C1	KOH/600 °C
A.C2	KOH/500 °C
A.C3	KOH/400 °C
A.C4	$ZnCl_2$/600 °C
A.C5	$ZnCl_2$/500 °C
A.C6	$ZnCl_2$/400 °C

Study the capacity of activated carbon on Dye absorption

In order to investigate the effect of the type of the used AC in the removal of BBG from the aqueous solutions under the same conditions, a series of experiments were performed using 20 mg of each of A.C1, A.C2, A.C3, A.C4, A.C5 and A.C6 at 25° C and under shaking for one hour

RESULTS

Specific surface area results

The specific surface showed that the activated carbon that activated with KOH solution at 600°C was having the highest area of the specific surface with 163 m^2/gm, followed by the other sample submerged with a solution of Zinc chloride at 600°C also with an area of 148 m^2/gm. In order to make comparison between these results the Figure 5 below showed Specific Surface Area results as columns.

Microbial test

Determine microbial growth by using 100 ml of the volume sample. Before precipitation, the 0.02 samples were grown on a nutritious agar. After deposition, took (0.02) from each specimen and cultivatable on nutrient agar, after that cuddling in an incubator in the department of engineering techniques, environmental pollution for 24 h at 35°C and the results are shown below: Where it was found that the first Sample (A.C1) has the best ability to purify water from harmful bacteria with a disinfection rate of up to 89% as shown in Figure

Table 2. Specific surface area results

Sample name	Activation solution / temp.	Specific surface area (m^2/gm)
A.C1	KOH/600 °C	1632.3
A.C2	KOH/500 °C	209.0
A.C3	KOH/400 °C	181.4
A.C4	$ZnCl_2$/600 °C	1480.7
A.C5	$ZnCl_2$/500 °C	396.4
A.C6	$ZnCl_2$/400 °C	164.3

Table 3. Number of bacteria colony killing percentage

Sample name	Activation solution / temp.	NO. of bacteria / 100 ml %
A.C1	KOH/600 °C	88.6
A.C2	KOH/500 °C	56.2
A.C3	KOH/400 °C	41.3
A.C4	$ZnCl_2$/600 °C	64.3
A.C5	$ZnCl_2$/500 °C	59.9
A.C6	$ZnCl_2$/400 °C	44.4

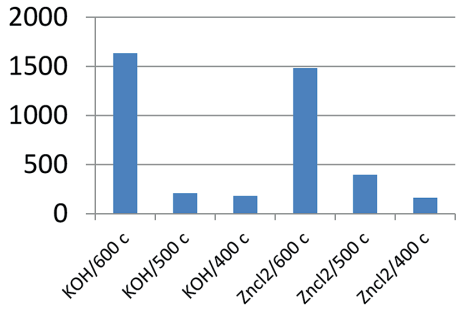

Figure 5. Specific surface area

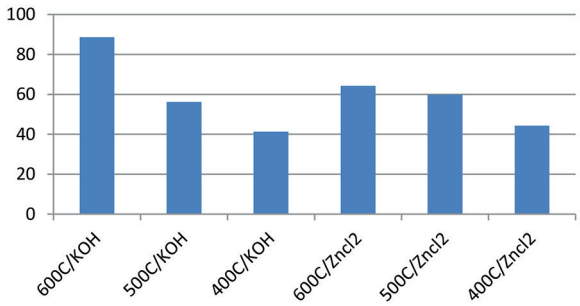

Figure 6. The number of bacteria colony

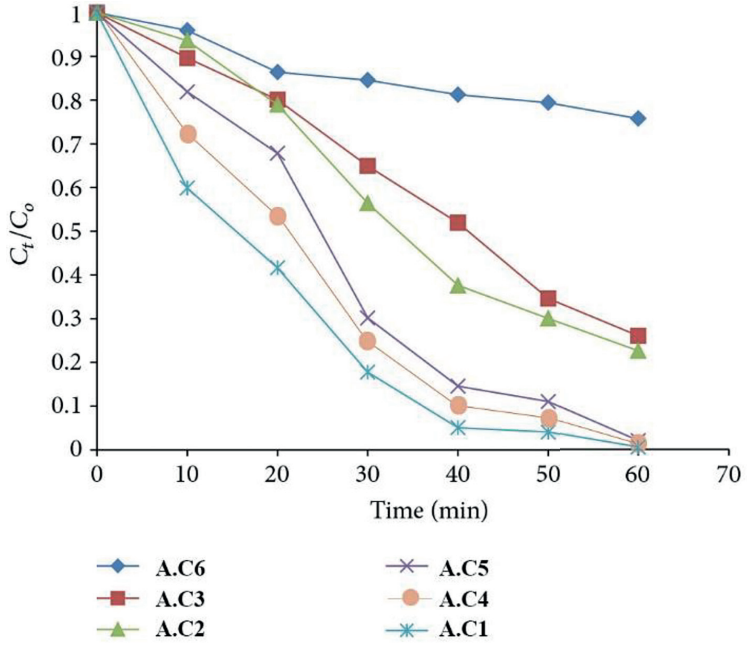

Figure 7. Dyes absorption efficient

6, where it was followed by Sample No.4 (A.C4) with a disinfection rate of about 65%

Dyes absorption

The achieved results showed that A.C1 was more efficient than the other types of AC. The higher effectiveness of A.C1 compared to the other types is probably related to its large specific surface area**.** Figure 7 shows the effect of Dyes removal with time.

CONCLUSION

This study showed that activated carbon; is prepared from raw materials such as date palms that find in Iraqi nature. This activated carbon can use in water treatment as an antiseptic adsorbent. The results in the area of the specific surface test showed that the sample immersed in the solution of potassium hydroxide at a temperature of 600°C has the highest specific surface area with 163 m^2/g followed by the other samples submerged with a Zinc chloride solution at 600°C also with an area of 148 m^2/g.

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