

Preparation of activated carbon by chemical activation using Z. Spina-Christi fruits nuclei as raw material

Susan F. Jabbar

Moayad N. Khalaf

Raed Khadum

Chemistry department –Basrah University

Abstract

The research work involves preparation and study of the adsorption characteristics of activated carbon to remove dyes from aqueous solutions . Z. Spina-Christi fruits nuclei were processed chemically using Phosphoric acid as chemical activator. The parameters (such as initial pH , contact time,..etc) affecting the adsorption capacity of activated carbon toward dyes removal from aqueous solutions were investigated.

Key words: Activated carbon , adsorption , Congo red dye .

تحضير الكربون المنشط بواسطة التنشيط الكيميائي باستخدام نوى النبق كمادة أولية

رائد كاظم زيدان

مؤيد نعيم خلف

سوزان فرج جبار

قسم الكيمياء - كلية العلوم - جامعة البصرة

الخلاصة

في هذه الدراسة حضر الكربون المنشط من مواد أولية محلية وذلك بمعاملة نوى البمبر مع حامض الفسفوريك المركز بنسبة (1:1) ثم معاملتها حرارياً بدرجة (500C°) لمدة ساعة واحدة للحصول على نوع جديد من الكربون المنشط . وحسبت المساحة السطحية الداخلية للكربون المنشط المحضر بطريقة إمرار النيتروجين (BET)، فضلاً عن ذلك قيست كفاءة الامتزاز من خلال استخدام الكربون المنشط المحضر لامتزاز صبغة الكونكو الحمراء (congo red) من محلولها المائي ودراسة تغيير الدالة الحامضية ، ووجد ان المساحة السطحية الداخلية للكربون المنشط المحضر (992.734 m²/g)، ويلاحظ ان كفاءة الامتزاز عند زمن 120 دقيقة . وتقل كفاءة الامتزاز بزيادة الدالة الحامضية اذ كانت اعلى قيمة لكفاءة الامتزاز عند (pH=2) ، وعند زيادة كمية المادة الممتزة المضافة تزداد النسبة المئوية للامتزاز الى 91% .

كلمات مفتاحية : كربون منشط ، امتزاز ، صبغة الكونكو الحمراء .

Introduction

Activated carbon is the most popular absorbent and has been used with great successes for many decades^[1] Activated carbons are commonly used in the treatment of waste water^[2], because of their high porosity and large surface area.^[3] The removal of dyes and heavy metals is one of the importance of the activated carbon , in addition Activated carbon used in the food industry to de-colorization and taste removal , it is also used in medicine for adsorption of harmful chemicals and drugs^[4] , as well as in making oral carbon tablets.^[5] Various carbonaceous materials are used to make activated carbon by thermal decomposition followed by activation process,^[6] like banana bark,^[7] coconut shells,^[8] lignite^[9] coal^[10], and, recently, many other agricultural byproducts have been used as raw material for preparing activated carbons like, date stones [11],

olive stones [12], cherry stones [13], oil palm stones [14], and many other agricultural residues.

Activated carbon is generally produced by two ways the first is physical activation and the other is chemical activation, physical activation is done by two methods:

- In the first way the raw material treated in isolation from air at present of gas like Argon or nitrogen.
- In the second way material processing at high pressure and temperature as well as oxidizing with oxygen or steam.

While the chemical method is done by the treatment of raw materials using one of known activated substances before the carbonization step, and the most important factors used for activated concentrated phosphoric acid and zinc chloride or potassium salts of magnesium, sodium and potassium carbonate as well as ferric chloride.^[15] The figure (1) shows two types of

activated carbone nano powder (plant as raw materials) from US Research Nanomaterials ,Inc .

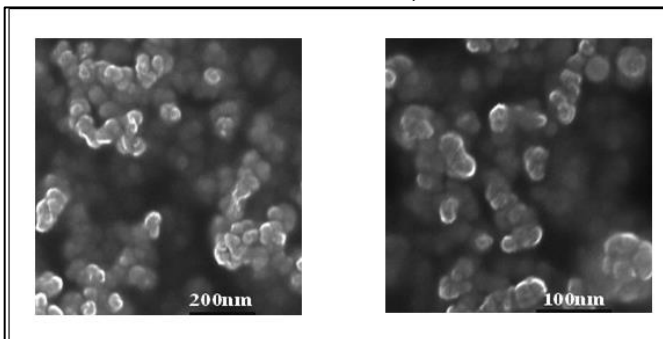


Fig (1): Activated Porous Carbon Nanopowder (Plant as Raw Materials)

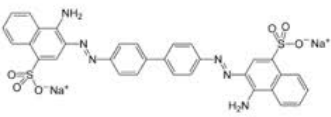
2- Experimental:

2-1 Adsorbent:

The stones of Ziziphus Spina – Christi used in this study were washed several times with distilled water then dried at 120°C for 24 hour. An amount of the stones were added to a volume of conc. H_3PO_4 (in a ratio of 1gm stones: 1ml conc. H_3PO_4) then heat treated at 500°C to 1hr in air atmosphere. ^[16] The activated carbon produced was washed with distilled water till it is pH equal 5 then dried in an oven at 110°C. ^[17]

2-2 Adsorbate: Congo Red used to determined activation properties to the new activated carbon. The chemical formula and other specific characteristics of the Congo Red are listed in table (1).

Table (1): Congo Red chemical characteristics

Chemical formula	$C_{32}H_{22}N_6Na_2O_6S_2$
Molecular weight	696.66 g/mol
λ max	497 nm
Molecular structure	

2-3 The measurement of specific surface area of activated carbon

Specific surface area have been measured by used the Single Point BET Analysis) as table (2) shows.

Table (2) Single Point BET Analysis

Single Point BET Analysis Report Generated by Quantachrome TPRW in v1.0	
File name: 98010164.qtb	Description: S1
Number of peaks: 5	Sample Weight: 0.010 gm
Adsorbate : Nitrogen	Attenuation : 32
Baseline :0.000	Ambient Temp.: 298.00K(24.85°C)
Flow rate : 20	Detector current : 150.0 mA
Ambient Pressure : 650.00 mmHg	
Relative Pressure(P/P ₀) : 0.30	
Absorbed Volume (V _{stp}) : 3.01	
BET Transform : 0.14	Slop : 0.47

Adsorption studies:

Adsorption properties for the activated carbon were carried out at room temperature (20°C). The contact time, adsorbent amount, pH, and temperature effects have been studied. The changes in the adsorbed amount with contact time were studied for period of time (5-120 min). The initial concentration of Congo Red dye was (50 mg/l), the dosage of activated carbon that used was (0.5 gm/ 150ml). The effect of temperature on the adsorption of the dye was determined at 30,40,50 °C , under constant contact time 120 min and adsorbent amount 0.5 gm/150 ml. ^[18] The concentration of the dye was measured using (Biotech Engineering Management Co.LTD . (UK)) at wave length (497 nm).

3- Result and Discussion:

3-1- surface area

The surface area of the activated carbon has been measured using nitrogen adsorption method. Table (3) shows the values of total and specific area and we can see that the total surface area (9.2273m²) and the specific surface area (992.73 m²/g).

Table (3) the specific surface area

Monolayer Uptake Volume	2.12 CC
Total surface area	9.2273 m ²
Specific Surface area	992.7340 m ² /g

3-2 Effect of contact time

The figure (2) shows the effect of the contact time on the adsorption ability. We can see that q_e increased with the time increasing and the equilibrium was reached after 120 min. ^[19]

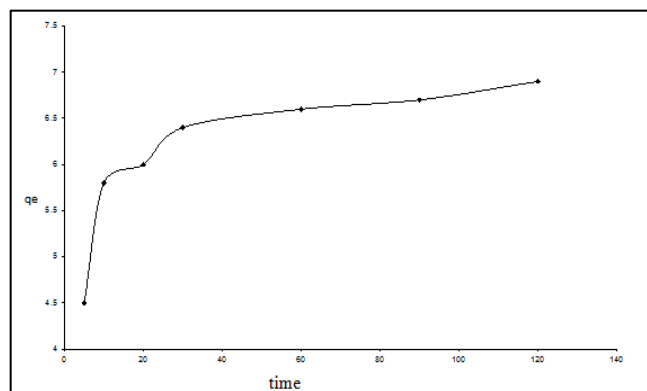


Fig (2): Effect of contact time on Congo Red adsorption

3-3 Effect of initial pH of the solution

The figure (3) shows the influence of the pH value on the adsorption of Congo Red dye by the new activated carbon was studied by varying the pH value from 2 to 10. We can see that the adsorption capacity increase with the decreased of the pH. ^[20, 21]

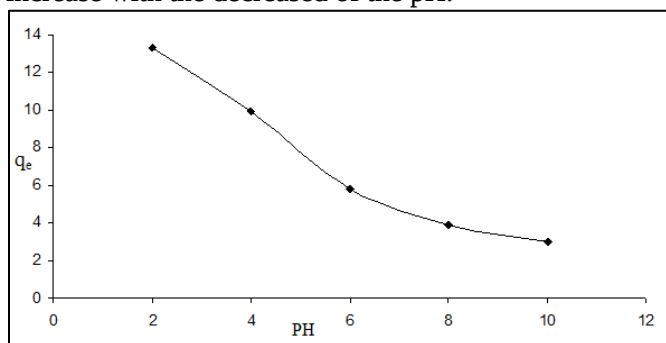


Figure (3): Effect of pH value

3-4 Effect of temperature:

The adsorption capacity of the activated carbon decreased with increase the temperature ^[22] from 30 to 50°C as we can see in figure (4). It is clear that the adsorption capacity reaches to over than 70% in 30°C while it equal to 63%, 58% in 40 and 50°C.

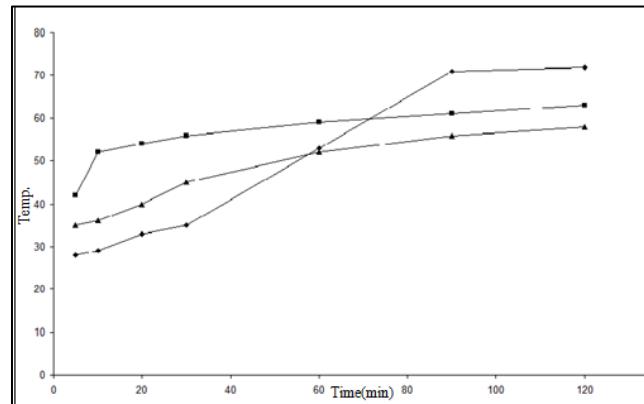


Figure (4): Effect of temperature

3-5 Effect of adsorbent dosage:

From figure (5) we can see the effect of the adsorbent dosage on the adsorption of Congo Red onto the activated carbon. It can be seen that the percentage of the adsorbed amount increased when the dose of the adsorbent increased. ^[23]

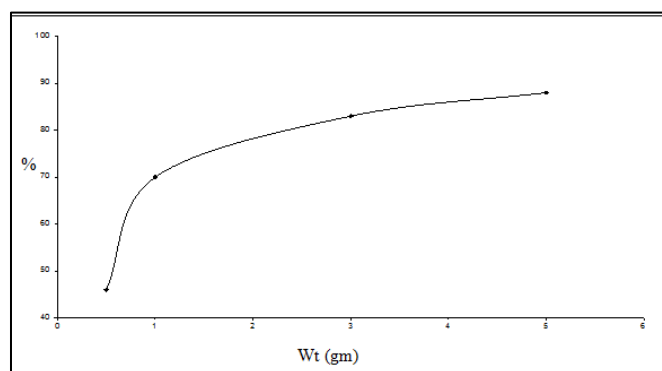


Figure (5) : Effect of adsorbent dosage

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