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Preparation and characterization of Activated Carbon from Iraqi Corns Stalks

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Abstract

In this paper, Activated Carbon was successfully prepared from local Iraqi material namely corns stalks .Zinc chloride ZnCl2 was used as activating agent with different concentrations (20%, 40%, 60%) for 72 hours. followed by carbonization at 450 C for (2) hour. UV-Spectrophotometer used for measuring absorbance of methylene blue solutions before and after adsorption. the maximum amount adsorbed for methylene blue material of the prepared activated Carbon was studied by Langmuir adsorption isotherm. Other characteristics of the resulting activated Carbon also discussed, such as pH, Moisture Content and ash content. Finally Activated carbon prepared in this work has good properties compared to the standard samples in such a way it could be used in industrial activities due to the fact that the corn stalks available locally in our country.

Keywords: activated carbon, Corns Stalks, Adsorption , Zinc chloride .

Introduction.

Activated carbon is a black solid substance resembling granular or powdered charcoal[1]. Activated carbons are high porosity, high surface area materials manufactured by carbonization and activation of carbonaceous materials[2] . Active carbons in the form of carbonized wood charcoal have been used for many centuries. The Egyptians used this charcoal about 1500 BC as an adsorbent for medicinal purposes and also as a purifying agent. The ancient Hindus in India purified their drinking water by filtration through charcoal. The first industrial production of active carbon started about 1900 for use in sugar refining industries. This active carbon was prepared by the carbonization of a mixture of materials of vegetable origin in the presence of metal chlorides or by activation of the charred material by CO2 or steam. Better quality gas-adsorbent carbons received attention during World War I, when they were used in gas masks for protection against hazardous gases and vapors[3].Activated carbons are non-specific adsorbents and therefore find wide application in the removal of colour, odour toxic gases etc. Activated carbons are now in use for the treatment of potable water and wastewater. particularly for the removal of heavy metals [4]. Activated carbon also used gold recovery, production of pharmaceuticals and fine chemicals, catalytic processes, off gas treatment of waste incinerators, automotive vapor filter[5].

Several activating agents have been reported for chemical activation process; however the most important and commonly used activating agents are phosphoric acid, zinc chloride and alkaline metal compounds. Phosphoric Acid and Zinc Chloride are used for the activation of lignocelluloses materials[6].

Activated Carbon has been prepared using an Iraqi raw materials Corn Stalks. We used Zinc chloride as

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chemical activation agent. Adsorption the methylene Blue on the surface of the prepared activated carbon was studied also some important physical and chemical properties were also studied.

Material and Methods:

2.1) Chemicals Used

1. Zinc Chloride (BDH Chemicals LTD England).
2. Hydrochloricacid(BDH) Chemicals LTD England).
3. Methylene Blue (MERCK).

2.2) Instruments Used

1. Electronic Balance.
2. Oven.
3. Muffle Furnace.
4. pH Meter.
5. UV Spectrophotometer.
6. Orbital Shaker.
7. Centrifuge.

2.3) Raw Materials.

Corns Stalks was used as source for preparation of Activated carbon obtained from Saglawea city in Anbar, Iraq.

2.4) Preparation of Activated carbon

We use sequence of processes to prepare the Corns Stalks to be used as a raw material. These steps can be outlines as bellow:

1. Cut Corns Stalks into small pieces (0.5- 1.0 cm) in length.
2. Washing and drying them in oven at (120 ℃) for (48) hours.
3. Weight (10) gm of the sample.
4. Mixing the samples above with $ZnCl_2$ by different concentration (20%, 40%, 60 %) for (72) hours (taking three samples for each concentration).
5. Each weighted sample was transferred to muffle furnace heated at 450 ℃) for (2) hours.
6. The resulting Activated carbon was washed with (0.1 M) HCl followed by distilled water until traces of Chloride ions no longer detected.

2.5) Methylene Blue (MB) adsorption(1).

To determine the decolorizing power of the prepared Activated carbon, (25 ml) of prepare methylene blue solution with different concentrations (80-600 ppm) in conical flask containing (0.5 gm) of Activated carbon, shaken them vigorously by Shaker for (30 minute) and then separated by Centrifuge.

We compare the color of the filtrate samples with standard concentrations at (1,2,3,4 PPM)fig(1) using UV-Visible measuring the adsorption at 660nm.

2.6) pH Measurements.

Determination of pH was performed by mixing (1 gm) of Activated carbon with (10 ml) distilled water.And measured by pH meter.

2.7) Ash Content[7].

0.5 gm of prepared Activated carbon was heated at (500 C) for (4) hours. Then cooled in a desiccators and weighted.

2.8) Moisture Content[8].

(0.5 gm) of Activated carbon was put in oven at (110 C) for (48) hour, then cooled in a desiccators and-p]o weighted.

Results and Discussions

3.1) Yield of Activated Carbon

. In this study, the yield of activated carbon increased as the concentration of ZnCl2 increased ,It was in the range (38% - 41%) similar results was also obtained by other studies [9], (42.15% -65.25%) for Activated carbon from Jack Fruit Peel Waste,(42%-51%) for Activated carbon from Cellulose. The yield of Activated carbon obtained by chemical activation obtained using Zinc Chloride as activation agent is higher than fixed.

Corns Stalks consists of complex composite material formed of natural polymers .In activation or carbonization at high temperature, these polymeric structures decompose and liberate most of the non-carbon elements, mainly hydrogen, oxygen and nitrogen in the form of liquid (called tars) and gases, leaving behind a rigid carbon skeleton in the form of aromatic sheets and strips. The presence of Zinc chloride during activation promotes depolymerization, dehydration, and redistribution of constituent biopolymers, and also favoring the conversion of aliphatic to aromatic compounds thus increasing the yield of activated carbon [10]

3.2) pH Determination.

Surface acidity of active carbons and carbon blacks has been the subject matter of a large number of investigations because of its importance in determining several decomposition reactions, catalytic reactions, and absorbent properties of these materials [1]. The pH of Activated carbon can be defined as the pH of suspension of carbon in distilled water. The pH value of prepared Activated carbon in this work was between (6.1 – 6.3). The surface acidity due to the presence of carbon-oxygen surface chemical structures that have been postulated as carboxyl's and lactons. The activation process increased the surface area and porosity as well as the surface basicity of activated carbon.

3.3)Ash Content Determination.

Ash is non carbon of mineral additives, which is not chemically combined with the carbon surface. The prepared activated carbon has very low ash content with (4.74%-4.90%) which indicates that the activated carbon has high purity. High ash content is undesirable for Activated carbon since it reduces the mechanical strength of carbon and affects adsorptive capacity [1].

3.4) Moisture Content Effect.

It is known that permissible range of moisture content of activated carbon should be less than (10%) [5]. In our produced activated carbon, the moisture content was(1%) which indicates very good result.

3.4) Methylene Blue Adsorption.

The methylene blue material adsorption is the simple and fast adsorption to determine the adsorptive capacity of activated carbon for adsorption process [11]. The activated carbon prepared from corns stalks has high adsorptive capacity as noticed from the absorbance values in table(2), also absorbance values recorded between (0.011 - 0.036) for the concentrations (80, 100, 200, 300, 400, 500, 520) ppm, that indicates activated carbon adsorbed completely the material(MB)and the blue color of methylene disappears during the adsorption process, while the concentration from (540-600 ppm) adsorbed from activated carbon with absorbance values from 0.158 to 0.615 (Table 2) .the adsorptive capacity indicates that the prepare activated carbon has high surface area .

3.4.1) Adsorption Isotherm

Equilibrium studies that give the capacity of the adsorbent and the equilibrium relationships between adsorbent and adsorbate are described by adsorption isotherms which are usually the ratio between the quantity adsorbed and the remaining in solution at fixed temperature at equilibrium. The earliest and simplest known relationships describing the adsorption equation are the Langmuir isotherms [12].

The following equation represents the Langmuir adsorption isotherms in simplex form.

$$\left[\frac{Ce}{Cs} = \frac{1}{Cm \cdot Kl} + \frac{Ce}{Cn}\right] \quad \ldots(1)$$

Where (Ce) is equilibrium concentration in solution, (Cs) is adsorbed concentration, (Cm) is maximum amount adsorbed and (Kl) is Langmuir adsorption coefficient (bending energy coefficient.

By using Matlab toolbox as stated in Appendix (A), we fit Ce/Cs versus Ce for Zncl2 concentrations (20%, 40%, 60%) after fitting process, as shown in figure(1,2,3), the resultant maximum amount adsorbed is (598.18,601.32,601.322) Mg/ml and the Langmuir adsorption coefficient is (6.554,6.244,6.333) respectively.

From these results, it is clear that the best concentration of Zinc Chloride is 20% because it gives us maximum amount adsorbed equal to (598.18) and Langmuir adsorption coefficient (6.554) which close to other concentrations used which mean reduction of Zinc Chloride consumption. Finally from these results it is obvious that Iraqi corn stalks sample have high surface area due to high pores inside the bulk of activated carbon. This result agrees with result obtained by other studies [13].

Conclusions:

1- Due to the fact that Corn Stalks widely available and very cheap and as shown in this work, the produced Activated carbon has high adsorption capacity therefore it can be used in commercial production of activated carbon.

2- The optimal conditions for Activated Carbon production in our work was (Zinc chloride concentration is 20%, Temperature is 450 C).

As recommendation of this work, it is economically fruitful to incorporate the process of production of activated carbon from Iraqi corn stalks in a mass production factory of activated carbon.

Acknowledgement.

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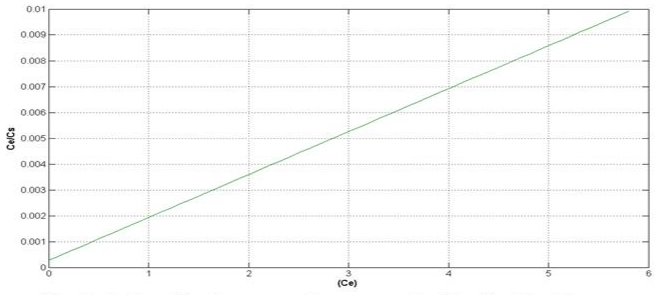
Table (1)Adsorbent concentrations and absorbance values of Activated Carbon in Zncl2 consternation =20%.

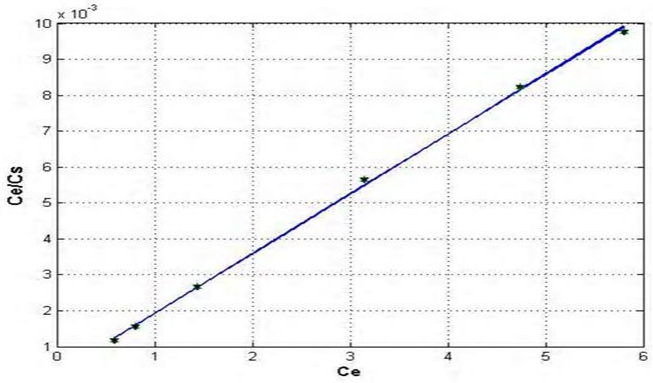
No	C_{intial} (ppm)	Absorbance	Ce	Cs	Ce/Cs
1	500	0.068	0.6	499.4	1.201×10^{-3}
2	520	0.0932	0.84	519.16	1.618×10^{-3}
3	540	0.158	1.46	538.54	2.711×10^{-3}
4	560	0.337	3.17	556.83	5.693×10^{-3}
5	580	0.503	4.75	575.25	8.257×10^{-3}
6	600	0.615	5.81	594.19	9.778×10^{-3}



Figure(1). Relationship between Ce versus Ce/Cs for Zncl2 consternation =20%.

Table (2) Adsorbent concentrations and absorbance values of Activated Carbon in Zncl2 consternation =40%.

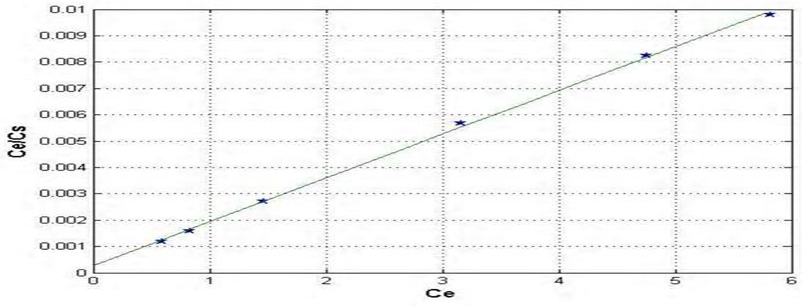
No	C_{intial} (ppm)	Absorbance	Ce	Cs	Ce/Cs
1	500	0.068	0.59	499.41	1.181394×10^{-3}
2	520	0.0932	0.81	519.19	1.560122×10^{-3}
3	540	0.158	1.44	538.56	2.673797×10^{-3}
4	560	0.337	3.15	556.85	5.65682×10^{-3}
5	580	0.503	4.74	575.26	8.239752×10^{-3}
6	600	0.615	5.8	594.2	9.761023×10^{-3}



Figure(2). Relationship between Ce versus Ce/Cs for 40% Zncl2 constration.

Table (3) Adsorbent concentrations and absorbance values of Activated Carbon in Zncl2 consternation =60%.

No	C_{intial} (ppm)	Absorbance	Ce	Cs	Ce/Cs
1	500	0.068	0.59	499.41	1.181394×10^{-3}
2	520	0.0932	0.83	519.17	1.598706×10^{-3}
3	540	0.158	1.46	538.54	2.711034×10^{-3}
4	560	0.337	3.16	556.84	5.67488×10^{-3}
5	580	0.503	4.75	575.25	8.257279×10^{-3}
6	600	0.615	5.82	594.18	9.795012×10^{-3}



Figure(3). Relationship between Ce versus Ce/Cs for 60%Zncl2 constration.

Appendix (A)
Line Regression Function used to find Least Square for (Ce,Ce/Cs)

```
function final(Ce_x,Ce_Cs_y)
f_ = clf;
figure(f_);
set(f_,'Units','Pixels','Position',[440.667 131 680 484]);
legh_ = []; legt_ = {};   % handles and text for legend
xlim_ = [Inf -Inf];       % limits of x axis
ax_ = axes;
set(ax_,'Units','normalized','OuterPosition',[0 0 1 1]);
set(ax_,'Box','on');
axes(ax_); hold on;
% --- Plot data originally in dataset "Ce_Cs_y vs. Ce_x"
Ce_x = Ce_x(:);
Ce_Cs_y = Ce_Cs_y(:);
h_ = line(Ce_x,Ce_Cs_y,'Parent',ax_,'Color',[0.333333 0 0.666667],...
     'LineStyle','none', 'LineWidth',1,...
     'Marker','.', 'MarkerSize',12);
xlim_(1) = min(xlim_(1),min(Ce_x));
xlim_(2) = max(xlim_(2),max(Ce_x));
legh_(end+1) = h_;
legt_{end+1} = 'Ce_Cs_y vs. Ce_x';
% Nudge axis limits beyond data limits
if all(isfinite(xlim_))
   xlim_ = xlim_ + [-1 1] * 0.01 * diff(xlim_);
   set(ax_,'XLim',xlim_)
end
% --- Create fit "fit 1"
ok_ = isfinite(Ce_x) & isfinite(Ce_Cs_y);
ft_ = fittype('poly1');
% Fit this model using new data
cf_ = fit(Ce_x(ok_),Ce_Cs_y(ok_),ft_);
% Or use coefficients from the original fit:
if 0
   cv_ = { 0.001662503861002, 0.0002684267985881};
   cf_ = cfit(ft_,cv_{:});
end
% Plot this fit
h_ = plot(cf_,'fit',0.95);
legend off;  % turn off legend from plot method call
set(h_(1),'Color',[1 0 0],...
     'LineStyle','-', 'LineWidth',2,...
     'Marker','none', 'MarkerSize',6);
legh_(end+1) = h_(1);
legt_{end+1} = 'fit 1';
% Done plotting data and fits.  Now finish up loose ends.
hold off;
leginfo_ = {'Orientation', 'vertical'};
h_ = legend(ax_,legh_,legt_,leginfo_{:}); % create and reposition legend
set(h_,'Units','normalized');
t_ = get(h_,'Position');
t_(1:2) = [0.662255,0.924242];
set(h_,'Interpreter','none','Position',t_);
xlabel(ax_,'');               % remove x label
ylabel(ax_,'');               % remove y label
```

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تحضير الفحم المنشط من مادة سيقان الذرة ودراسة خصائصه

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الخلاصة

تم في هذا البحث وبنجاح تحضير مادة الكاربون المنشط من مادة محلية عراقية متوفرة وهي مادة سيقان الذرة العراقية. إذ أستخدمت في عملية التنشيط الكيمياوية مادة كلوريد الزنك Zncl2 وبتراكيز مختلفة (20%,40%,60%) وبمدة زمنية مقدارها (72)ساعة لكل تركيز . أجريت بعد ذلك عملية الكربنة بدرجة حرارة (450) درجة مئوية وبزمن (2) ساعة .ثم قيست الأمتصاصية لمحاليل مادة المثيلين الزرقاء وبتراكيز مختلفة (80-600 pm) قبل وبعد عملية الأمتزاز . أستخدمت معادلة لانكمير لحساب كمية الأمتزاز الأعظم ايضا. ثم أجري قياس عدد من الخواص المهمة الأخرى للفحم المنشط مثل الـ pH ومحتوى الرماد ومحتوى الرطوبة. أخيرا ,وجد أن الفحم المنشط المحضر في هذا البحث ومن خلال الفحوصات يمتلك خصائص مقاربة للفحم القياسي الموجود صناعيا مما يمكن إستخدامه في الصناعة لتوفر المادة الأولية محليا (سيقان الذرة) في قطرنا الحبيب .