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TAKING ADVANTAGE OF THE RAPID GROWING WATER HYACINTH PLANT IN THE IRAQI RIVERS

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Abstract

The ability of natural plants to remove contaminants from water can be exploited to produce water suitable for human, plant and animal use. The study is based upon the preparation of solid stationary phases of plants that include a high amount of cellulose water hyacinth plant after several treatments and chemical modifications give many static phases which have been prepared from it and helped in the removal of organic pollutants dyes Methylene Blue. Chemo-therapy is done with acid H_3PO_4. Chemical modifications use oxidizing acids such as HNO_3. The tributary groups, that will compensate for the active carbon surface, are diagnosed by FTIR analysis. To identify the shape of the particles and the nature of the carbon surface, the Scanning Electron Microscope SEM should be used. The surface area of the stationary phases molecules has been measured. Several effects on stationary phases of pH solution, concentration and temperature are studied to determine the efficiency of stationary phases recorded in the removal of contaminants. The absorption rate and the completion of the removal process depend on these effects.

Key words : Water Hyacinth; Activated Carbon; Adsorption; Methylene Blue.

Introduction

Organic pollutants as environmental pollutants have emerged as a focus of global concern in the last few decades, due to their irreparable effects on the environment. Organic pollutants has a big role in environmental pollution, among the important organic pollutants are dyes organic pollutant as methylene blue is important hazardous materials seen in textile, foods, pharmaceutic, plastic and paper industries. Dyes in water flow cause allergy, dermatitis which, at severe case, provoke cancer in addition to mutation for humans (de Lima *et al.,* 2007). The color and the non-biodegradable nature of the spent coloring baths constitute serious ecological problems. Remove of organic pollutants at high concentrations from water can be readily accomplished by chemical precipitation or electrochemical methods. At low concentrations, removal of such pollutants is more effective by ion-exchange or adsorption on solid sorbents such as stationary phases from of activated carbon and dried plant. Activated carbon sorption is the best method and the lowest cost among the others stationary phases prepared from different plants and it is highly effective in the removal of dyes and all others organic pollutants (Acemioðlu, 2005; Gupta, 2009; Pala and Tokat, 2002; Mohan and Karthikeyan, 1997; Gupta *et al.,* 1997; Mohanty *et al.,* 2006). Adsorption processes, using activated, carbon are widely used to remove pollutants from wastewaters and solutions purification for the removal of taste, color, odors and other objectionable impurities from liquids. However, commercial activated carbon is expensive. In the last few years, a special emphasis has been given to the preparation of activated carbon (powdered or granular) from several agricultural. A big care has been given to the low cost activated carbon in treating wastewater. The advantage of using water hyacinth plant, as raw material for manufacturing activated carbon, is that this plant is renewable and potentially less expensive to manufacture.

Water Hyacinth (WH) is natural aquatic plant and available in large amounts in natural swamps and it belongs to the family Pontederiaceae. WH plant can produce approximately 65,000 offspring during a single season. Due to this phenomenal growth rate, 1 acre (0.40 ha) of plants can conceivably produce approximately

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240 Kg of dry weight per day in subtropical climates which far exceeds the yield of most productive agricultural crops. Cellulose and lignin within the composition of this plant form the most important role in the process of adsorption of contaminants. The high percentage of cellulose and lignin in the plant structure are the most efficient in the static phases prepared from the plant in the adsorption process of organic pollutants (Sorieul *et al.,* 2016). Cellulose ratio in plant component: WH fibers composed 53 - 69% cellulose so 23 - 33% lignin (El-Wakil and Awad, 2014).

Economic Feasibility of Work

1. Remove the plant from the waterway in which it is located, and reduce the obstruction of water flow in the riverbed.
2. To get benefit of the plant in water purification.
3. Elimination of environmental pollution caused by plants in water.
4. Purification of water and removal of contaminants with natural and inexpensive materials.
5. To get benefit of the preparatory process in the recycling of industrial discharge water, agricultural drainage and sanitary drainage, if the process is transferred from laboratory to industrial.

Materials and Methods

Experimental

Instrumentation

1. Muffle furnace.
2. Water-distillation.
3. Laboratory oven.
4. pH meter.
5. Digital balance.
6. Filtration pump.
7. Electric shaker (RPM=20-400).
8. Electrical thermostatic water bath shaker.
9. Heating mantles.
10. Fume Hood.
11. Ultraviolet and Visible Absorption Spectrophotometer.

General Reagents

1. HNO_3.
2. HCl.
3. H_3PO_4.
4. NaOH.
5. EDTA

Pollutants

Organic Pollutants

Methylene Blue

Preparation of Stationary Phases (Adsorbent or Activated Carbon)

Chemical Method

The process of chemical activation plays important roles in adsorbent efficiency of obtained AC. The starting materials is marinated in EDTA solution. The activated carbon with acid H_3PO_4 and then oxidation by HNO_3, in the particular form of concentrates solutions usually mixing, this benefits in the degradation with the cellulosic substance. calcination the marinated chemicals the natural substance, which result throughout charring and aromatization associated with the carbon skeleton the creation of a new porous form. After a chemical preparation Activated Carbon of Water Hyacinth (ACWH) sample was produced.

All the previous steps for such preparation were illustrated in an exact sequence shown in Fig. 1.

Methods employed for the determination of pollutants

Pollutant solutions with initial concentration of (100 - 500) ppm are prepared, and amounted in 0.025 g of adsorbent is added to the pollutants solutions amounted in 25 ml using bottle flask. All the adsorption operations are prepared at pH value 8.0 for dyes. This is followed by agitating the solution on a rotary shaker with the speed of 150 rpm After 2 - 4 hours adsorption processes are at temperature range of 25 °C. The absorbance is measured at wave length 662 nanometer against a reagent blank and plot the calibration curve. Using a spectrophotometer conduct reading the absorbent. The amount of MB removal through:

$$\% \text{ Extraction} = \frac{(C_0 - C_e)}{C_0} \times (100)$$

$$Qe = \frac{(C_0 - C_e)V}{m}$$

Qe: Quantity of dye methylene blue mg / g. $C_,$ C_e equilibrium cadmium solution concern of dye methylene blue (mg/g), (V solution of volume), (m weight of stationary phases) (g).

Results and Discussion

The Required Processes of Characterization solid phase

Scanning Electron Microscopy (SEM)

So as to know the composition view of AC, scan elect micro (SEM; JSM, model 6510) is employed to visualize sample morphology, at magnification of 500x,

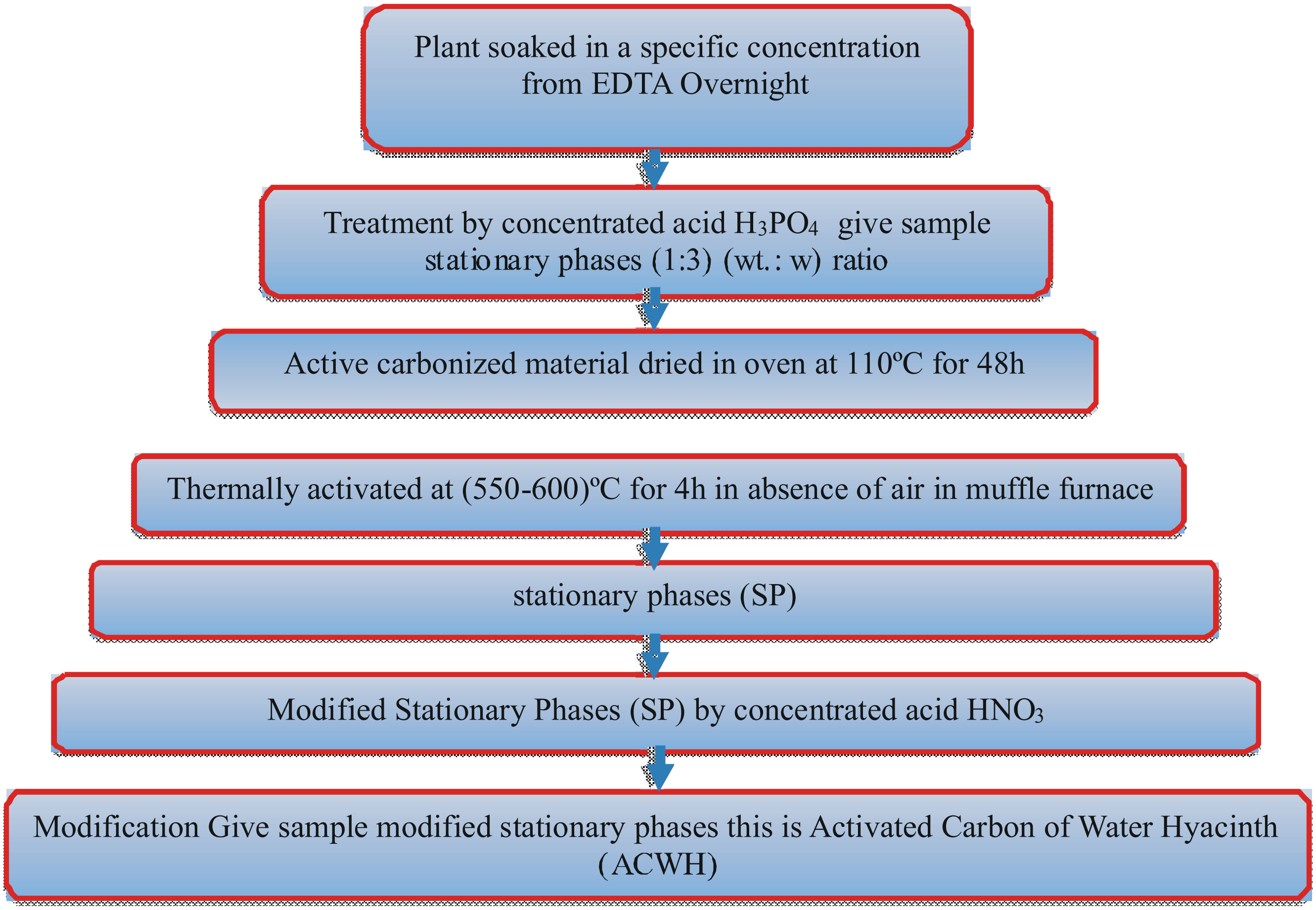

Fig. 1: Schematic diagram of plants biomass-derived stationary phases (SP).

2000x, 3000x and 6000x for (ACWH), respectively. Scanning electron microscopy of ACWH are obtained before the analysis, the samples were dried for 4 h at 110ºC. The porous structure of adsorbent (ACWH) are clearly demonstrated as shown in the above images.

Solid Phase Surface Chemistry

FTIR spectroscopy

The spectra of FTIR is normally between 4000 and 100 cm^{-1}. It can be prepared by mixing 1 mg dried activated carbon sample with 500 mg of KBr (Merck for spectroscopy). The result of mixture is pressed to five tone / cm^2 at five minute and ten tone / cm^2 at five minute in vacuums conditions.

The FTIR spectra of ACWH are taken before the adsorption of MB to ascertain the possible involvement of the functional groups on the surface of ACWH in the adsorption of MB Fig 6.

Study of effects on Methylene Blue

The impact of pH on MB adsorption

The solution's pH is an important factor that affects the adsorption of methylene blue. Effect of pH on the removal of (MB) by ACWH solid phases, shows that the results of the adsorption process increase clearly in removal dye methylene blue from of aqueous solutions of pollute at pH (2-10) (using activated carbon prepared from water hyacinth). It is the highest adsorption percentage at pH = 8 as it is shown in the curve in Fig. 7.

The high adsorption capacity of organic pollutant removal is due to the solid phase recorded from the water hyacinth to the surface of the porous surface as shown in the SEM. As well as the function group bond spectrum could be carboxyl, hydroxyl and carbonyl groups show in use FTIR on solid phase surface compensated on the surface of the solid phase by the chemical treatment and modification that gave the steel phase this high quality in water purification from pollutants the dye. The reason in reducing adsorption of the dye at low pH due to the of presence excess H^+ ions which competing with the dye cations for the adsorption sites of the adsorbent as well as there is electrostatic repulsion, between both highly protonated adsorbent surface and dye molecule, leads to lower removal of dye (El-Waki *et al.,* 2015). At high pH, the number of positively charged H+ ions in solution MB decrease and the number of negatively charged sites

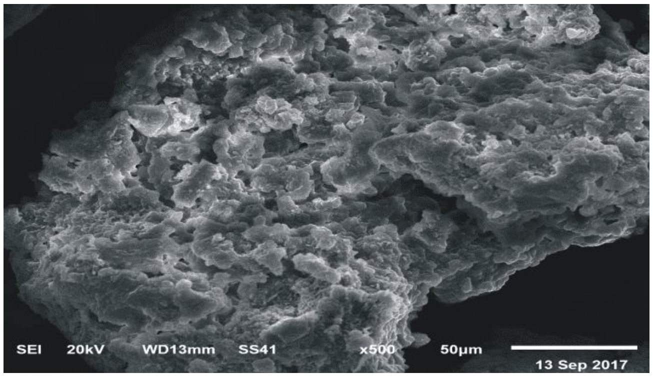

Fig. 2: SEM spectrum of ACWH at500x.

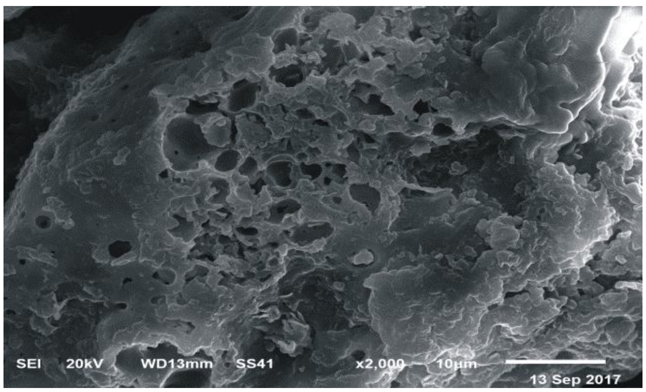

Fig. 3: SEM spectrum of ACWH at 2000x.

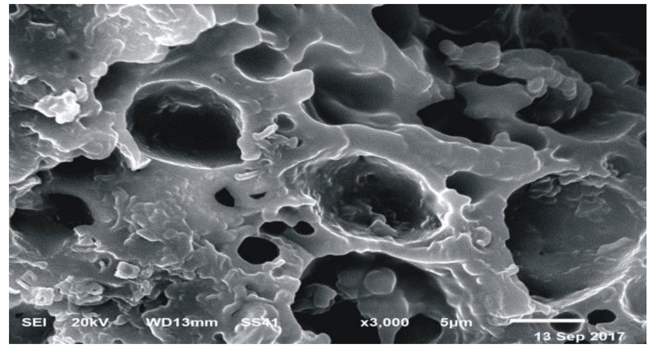

Fig. 4: SEM spectrum of ACWH at 3000x.

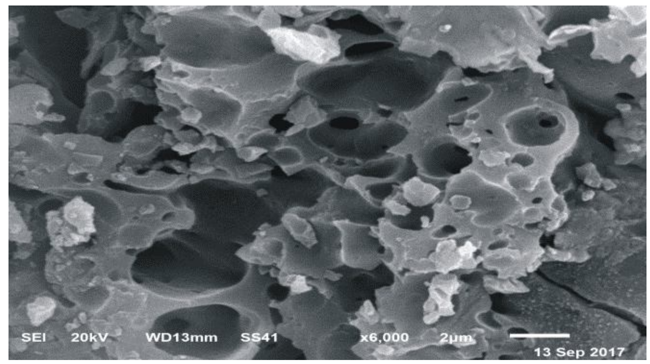

Fig. 5: SEM spectrum of ACWH at 6000x.

Table 1: Shows the appearance of sharp absorption peaks.

No.	Wave Number (Cm^{-1})	Function group
1	3484 - 3443 cm^{-1}	O-H hexagonal group.
2	2920 cm^{-1}	C-H aliphatic hydrocarbon.
3	1709 cm^{-1}	C=O carboxylic acids. Stretching vibrations of carboxyl groups (due to physical adsorption of EDTA).
4	1556 - 1464 cm^{-1}	Broad spectrum C=C extending in aromatic ring .
5	1281 cm^{-1}	C-O bonds spectrum possible to be ether, phenol and ester.

increase on surface AC, so the association of dye cations with negatively charged surface of adsorbent was favored (Omotayo *et al.,* 2014).

Effect of initial Concentration on MB adsorption

According to the study of the dye methylene blue removal by activated carbon, (solid phase) at different concentrations from 100 - 500 mg/L of MB solutions at 25ºC on the sample ACWH, the removal ratio of dye MB by solid phase has reached more than 100 % concentration dye methylene blue at 500 ppm. The optimum adsorption amounts of dye methylene blue (qe) using adsorbent ACWH is increased from 6.45 to 365.44 mg/g. The results have represented presence relation between the concentration of MB and the available binding sites on adsorbent material surface area. The results show higher values in remove for MB concentrations at the beginning of adsorption, then the remove of MB decrease because of the completed available sites. It is observed that when the concentration of the tincture is increased, the dye removal process is reduced by the solid phase. This is due to the occupancy of all sites of the functional groups on the surface of the solid phase by dye MB. This can be attributed to the fact that the increased of the concentration of the dye poses driving forces to overcome the mass transfer resistance of MB between the liquid phases and solid phases (Chowdhury and Saha, 2011).

Effect of temperature on MB adsorption

Fig. 9 Shows the relation between the tempera and the sorption efficiency of dye via ACWH. Results shows that when the temperature at 38°C, sorption efficiency of dye remove using ACWH is increasing more than 80 % concentration dye methylene blue at 500 ppm. This has attributed to the increase in the kinetic energy of MB

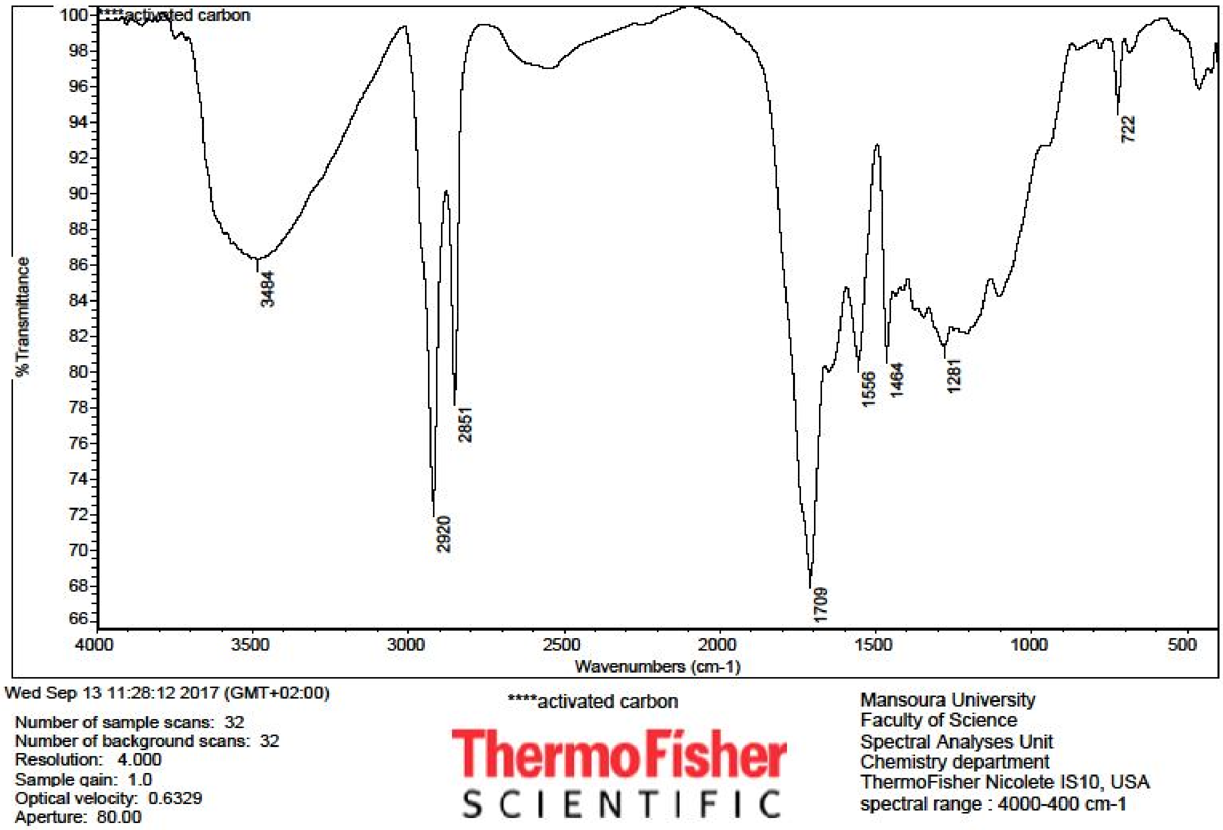

Fig. 6: FTIR spectrum of Activated Carbon Water Hyacinth (ACWH).

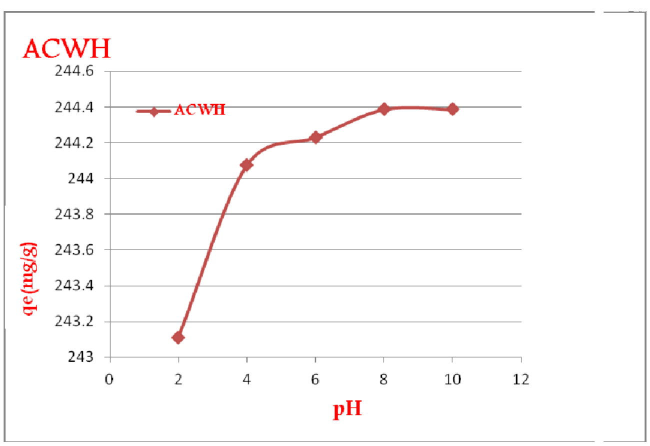

Fig. 7: Effect of the pH values on adsorption capacity of MB by ACWH.

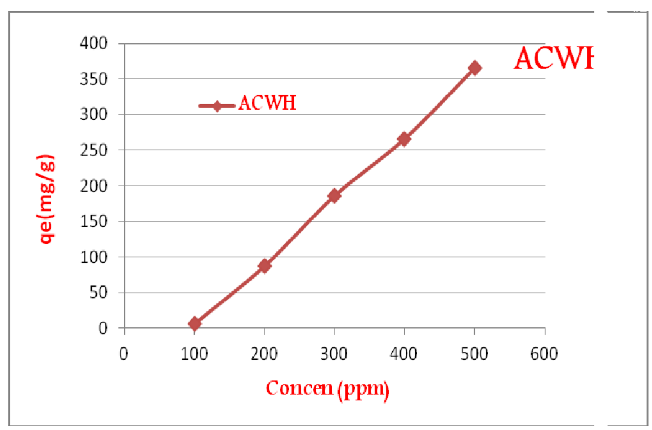

Fig. 8: Impact of concen on removal of methylene blue by ACWH.

with the temperature. The optimum adsorption amounts of dye methylene blue (qe), using adsorbent ACWH, has increased from 22.82 to 396.31 mg/g. Temperature increasing will decrease the viscosity of the solution, leading to the increase in the rate of intra diffusion of dye molecule into the porous structure of adsorbent as temperature increases and activate the adsorbent surface with some functional groups. This is attributed as well as diffusion is an endothermic process so the adsorption increase with temperature. The enhancement of adsorption capacity of the activated carbon at higher temperatures was attributed to the enlargement of pore size (Valix *et al.,* 2004).

Conclusion

Water Hyacinth plant has characterized by high adsorption capacity of organic and inorganic pollutants. The water hyacinth can adsorb about 7-10 % without any chemical treatments or modifications. However, after chemical treatments and modifications, by EDTA, HNO_3

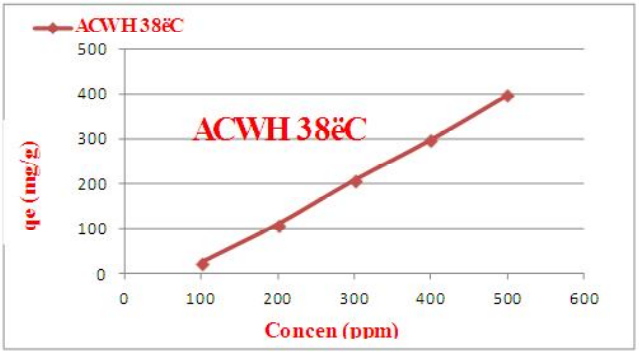

Fig. 9: Impact of temp on sorption efficiency of ACWH adsorbent for methylene blue.

and H_3PO_4 to the production of stationary phases (AC), the adsorption capacity can reach 80 % at pollute concentration 500 mg/L. Highest adsorption percentage at pH = 8. Dye adsorption process increase with temperature. One of these important sediments which prepared from plants is activated carbon. The activated carbon is characterized by a very large capacity to remove MB dye from industrial discharge water, agricultural drainage water or wastewater, leading to the production of healthy water for human, plant or animal use. The increase of the proportion in water hyacinth used its ability to remove organic and inorganic pollutants, and this is what distinguishes the water hyacinth plant in the use of the preparation of activated carbon.

It really is well known that the oxygen-contents function groups upon the AC surface area which plays a significant position in methylene blue adsorption. This determines that different oxygen-content groups with acidly character and different chemical substance properties are present upon the AC surface carboxylic and phenolic hydroxyl. The results show that stationary phases impregnation in mineral acids using the HNO_3 and H_3PO_4, give function group on surface stationary phases OH, CH, C-O, C=O and C=C. Remove the dye from aqueous solutions preparation process relied mainly on the presence of these on the active carbon surface functional groups. Other important factors that determine the adsorption properties of an stationary phases are the pore size distribution, cellulose amount and lignin in water hyacinth.

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