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Synthesis Of Adsorbents From Waste Materials Such As Ziziphus Jujube Seed & Mango Kernel

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ABSTRACT

Adsorption has been used as physico-chemical process for many years & is developing as a major industrial separation technique. Activated carbon has been quite successful for removal of impurities from exhaust gas and waste water streams. The special feature of the present research work is to utilise the commonly available waste materials such as mango kernel and seed of ziziphus jujube. These materials have been converted into the activated carbon with thermal treatment & is further utilised for the adsorption of colour from the aqueous solution of methyl red. Various amounts of adsorbent samples were taken for the present work. It is observed that as the amount of sample increases the percentage adsorption also increases. The percentage adsorption is also function of mesh size of the adsorbent sample & the best result is obtained for adsorbent made from ziziphus jujube 14 mesh size. It is concluded that the prepared activated carbon can be used effectively to adsorb coloured solute & other impurities from industrial effluent. There is a tremendous potential in these materials to be explored further as industrial low cost effective adsorbents.

Keywords – **adsorption, activated cabon, mango kernel, methyl red, ziziphus jujube,**

1. INTRODUCTION

Adsorption has been used as physico-chemical process for many years; it is only over the last four decades that the process has developed to a stage where it is now a major industrial separation technique. In adsorption molecules distribute themselves between two phases, one of which is a solid while the other may be liquid or gas. Unlike absorption, in which solute molecule diffuse from the bulk of gas phase to the bulk of liquid phase, in adsorption molecules diffuse through the bulk of fluid to the surface of the solid adsorbent forming a distinct adsorbent phase.

Activated carbon has been quite successful for removal of impurities from exhaust gas and waste water streams. The highly porous nature of the carbon provides a large surface area for contaminants to get deposited. The adsorption takes place because of the attractive force between the molecules. There is wide variety of activated carbons which exhibit different characteristics depending upon the raw materials and the activation techniques used in their synthesis. Agricultural waste materials like straw, leaves, stem, seeds and husk can effectively be converted in to activated carbon. The objective of the present work is to utilize waste materials like Ziziphus Jujube and Mango Kernel.

Most industrial adsorbents fall into one of three classes:

Oxygen-containing compounds, Carbon-based compounds & Polymer-based compounds.

1.1 Conventional adsorbents

The industrial adsorbents include silica gel, zeolites & activated carbon. Silica gel is a chemically inert, nontoxic, polar and dimensionally stable (< 400 °C or 750 °F) amorphous form of SiO_2.Zeolites are natural or synthetic crystalline alumina silicates which have a repeating pore network and release water at high temperature. Zeolites are polar in nature. They are manufactured by hydrothermal synthesis of sodium alumina silicate or another silica source in an autoclave followed by ion exchange with certain cations (Na^+, Li^+, Ca^{2+}, K^+, NH_4^+). Activated carbon is a highly porous, amorphous solid consisting of micro crystallites with a graphite lattice, usually prepared in small pellets or a powder. It is non-polar and cheap. One of its main drawbacks is that it is reacts with oxygen at moderate temperatures (over 300 °C).

1.2 Adsorption equilibrium

Adsorption equilibrium is a dynamic concept achieved where the rate at which the molecule adsorb on to a surface is equal to the rate at which they desorbs. Most of the work related to adsorption is devoted to explain the equilibrium through isotherms, that is, the amount of adsorbate on the adsorbent as a function of its pressure (if gas) or concentration (if liquid) at constant temperature. The combination of adsorbents & adsorbates exhibit different types of adsorbtion isotherms which are, Freudlich isotherm, Langmuir isotherm BET isotherm and many more are reported in literature.

1.3 Synthesis of activated carbon

Activated carbon is carbon produced from carbonaceous source materials like nutshells, peat, wood, coir, lignite, coal and petroleum pitch. It can be produced by physical reactivation involving *Carbonization* carried at temperatures in the range 600–900 °C, in absence of oxygen or *Oxidation by* exposing the carbonised material to oxidising atmospheres at temperatures above 250 °C. The other method of chemical activation involves pre treatment of the raw material with an acid, strong base, or a salt followed by carbonized at lower temperatures (450–900 °C).

Chemical activation is preferred over physical activation owing to the lower temperatures and shorter time needed for activating material.

2 LITERATURE SURVEY

A number of research papers have been published on synthesis of activated carbon from agricultural waste materials. Few are cited here that include, performance of mango seed adsorbents in the adsorption of anthraquinone & azo acid dyes in single and binary aqueous solutions(1), removal of phenolic pollutants from water utilizing *Mangifera indica* (Mango) seed waste & cement fixation(2), jujuba seeds for the removal of anionic dye (Congo Red) from aqueous medium(3), removal of Erichrome Black T from synthetic wastewater by activated Nilgiri leaves(4), remediation study attempts the use of mango seed shells as filters for removing dyestuff from solution(5), use of activated carbons prepared from sawdust & rice-husk for adsorption of acid dyes: a case study of Acid Yellow 36(6), comparative studies of adsorbents prepared from agricultural wastes like bagasse, jackfruit peel & ipomoea fistulosa (beshram)(7), artificial neural network modeling for adsorption of dyes aqueous solution using rice husk carbon(8) and comparative study of topology of ANN models for adsorption of colouring agent from aqueous solutions using adsorbents synthesized from agricultural waste materials(9).

3. MATERIALS & METHODOLOGY

The objective of the work is to prepare the adsorbent from seeds of ziziphus jujube & mango kernel. The samples were collected during the period of April-May as these are summer fruits. The seeds are collected, washed and solar for about several days. The samples after drying are stored in air tight vessel.

3.1 Methodology Synthesis of activated carbon:

The seeds of mango and ziziphus jujube are dried in the oven for 2 hours. After the seeds are dried they are then crushed into various size fractions and are collected in various sizes using sieve shaker set up. The various sizes selected for present study are undersize 14 mesh, 14 mesh and 10 mesh. The samples are stored in air tight bottles.

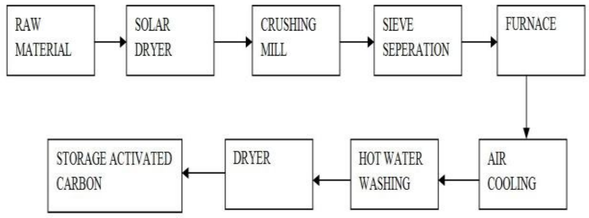

Fig. no. 1: Flowchart for synthesis of the activated carbon using Ziziphus jujube & Mango Kernel

Fig no. 1 shows the flowchart for synthesis of the activated carbon using Ziziphus Jujube & Mango Kernel. First the washed & solar dried raw material is crushed to various size fractions which are separated using sieve separator. It takes several washings in case of Mango Kernel to decolourise it. The weighed amount of raw material is put into furnace at 350^{0}C .The activated carbon obtained is air cooled and given hot water washings. The adsorbent is dried in the oven and stored in air tight containers.

Table no. 1: Showing temperature and time condition for the raw material

Material size	Temperature °C	Time (min)	Initial weight (gm)	Final weight (gm)
Mango 14 mesh	350	35	50	24
Ziziphus jujube (-14 mesh)	300	20	50	20
Ziziphus jujube 14 mesh	350	35	50	22
Ziziphus jujube 10 mesh	400	30	50	28

3.2 Colorimeter reading

The collected solution after the experiment is used for calculating percentage adsorption. At first the reading for water is taken this is blank reading. After this the glass apparatus is washed and dried. In this the initial solution which was prepared is taken and put in colorimeter the reading is taken, this is the reference reading. Now the collected solution which is obtained after adsorption is used to take the colorimeter reading for all the other samples.

3.3 Observation and calculation

The solution of methyl red after adsorption shows following colorimeter reading using various amounts of the samples

3.3.1. Observation

Pure water reading 0.00

Methyl red solution initial colorimeter reading 1.2

Table no.2: Details of Colorimeter readings

Sr. No.	Quantity of Sample (gm)	Colorimeter reading			
		Type of Sample 1	Type of Sample 2	Type of Sample 3	Type of Sample 4
01	1	0.25	0.45	0.16	0.68
02	2	0.13	0.39	0.12	0.63
03	3	0.10	0.23	0.08	0.58
04	4	0.07	0.18	0.03	0.49
05	5	0.06	0.06	0.00	0.40

Table no. 3: Details of Adsorbents

Sample Type	Raw material	Size (Mesh size)
1	Mango Kernel	14
2	Ziziphus Jujube	-14
3	Ziziphus Jujube	14
4	Ziziphus Jujube	10

The table no. 4 below gives the description of the concentration of the solution the ratio of weight of adsorbate and weight of adsorbent. Also it gives relation between the amount of sample and the percentage adsorption.

Table no. 4: Details of percentage adsorption

Sample Type	Concentration (gm/30ml)	Weight of adsorbate / weight of adsorbent	Weight of adsorbent (gm)	% adsorption
01	0.012825	0.0471	1	78
01	0.006	0.0266	2	88.75
01	0.00513	0.01829	3	91.45
01	0.00384	0.0140	4	93 .58
01	0.00299	0.0114	5	95
02	0.0225	0.0375	1	62.5
02	0.01923	0.02038	2	67.93
02	0.0111	0.0163	3	81.3
02	0.0089	0.0127	4	85.03
02	0.00342	0.0113	5	94.3
03	0.00855	0.05145	1	85.75
03	0.0064	0.02679	2	89.3
03	0.004275	0.01857	3	92.8
03	0.00213	0.01446	4	96.4
03	0.00	0.012	5	100
04	0.0342	0.0258	1	43
04	0.032	0.01396	2	46.5
04	0.0299	0.010	3	50
04	0.024	0.0088	4	58.66
04	0.0192	0.00814	5	67.83

The graph is plotted between the concentration and the ratio of weight of adsorbate and the weight of adsorbent.

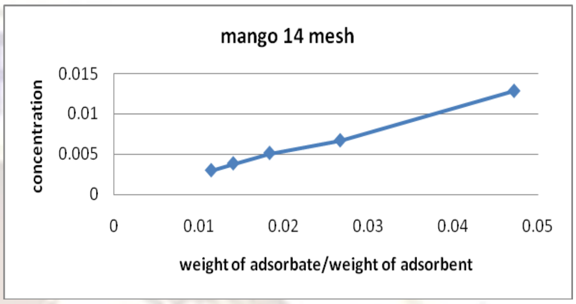

Fig no. 2: Mango 14 mesh

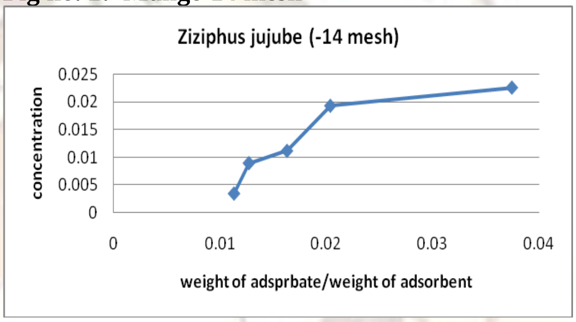

Fig no.3: Ziziphus jujube (-14 mesh)

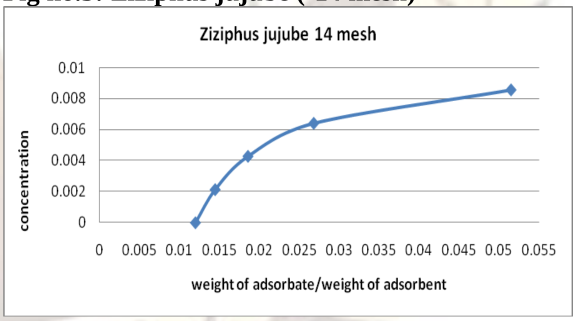

Fig no.4: Ziziphus jujube 14 mesh

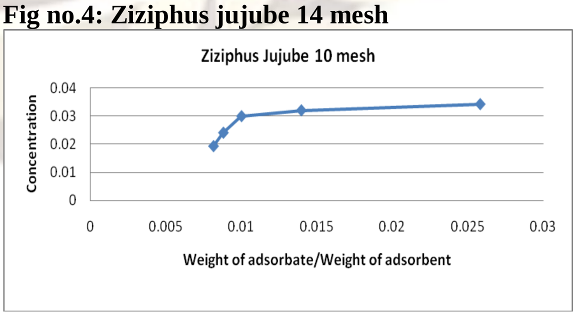

Fig no. 5: Ziziphus jujube 10 mesh

The graph shows the behavior of amount of adsorbent and the percentage of adsorption. It can be evaluated here as the amount of adsorbent increases the percentage adsorption also increases as the surface for adsorption increases.

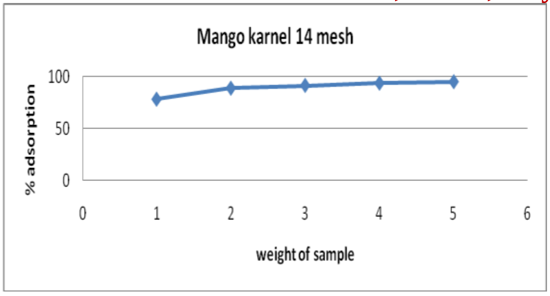

Fig no. 6: Mango 14 mesh

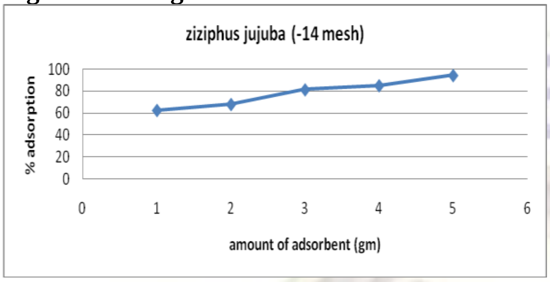

Fig no. 7: Ziziphus jujuba (-14 mesh)

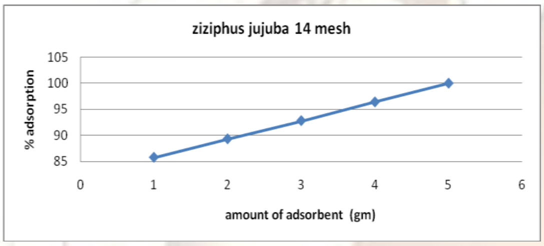

Fig no. 8: Ziziphus jujube 14 mesh

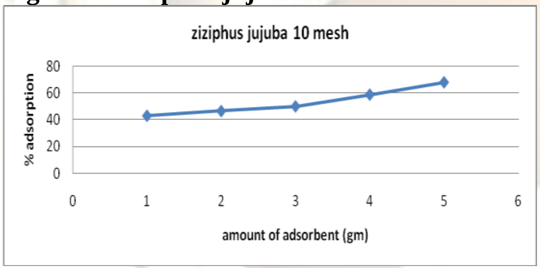

Fig no. 9: Ziziphus jujube 10 mesh

3.3.2 Comparison of the samples

The graph as shown in fig 9 shows the performance of the various size samples of ziziphus jujuba which shows that 14 mesh size shows maximum adsorption of 100% for 5 gm. Minimum adsorption is shown by 10 mesh size of just above 60% for 5 gm sample.

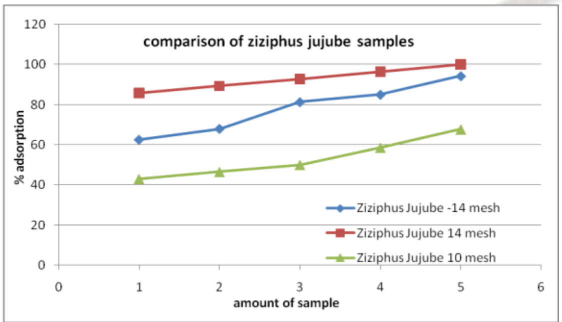

Fig no. 10: Comparison of samples

Ziziphus jujube powder also shows good performance. Here from the fig no. 10 it can be seen that as the amount of adsorbent increases then the percentage adsorption also increases, because for more amount of sample the exposed surface area increases.

4. CONCLUSION

The special feature of the present research work is to utilise the commonly available waste materials such as mango kernel and seed of ziziphus jujube. In the present work these materials have been converted into the activated carbon with thermal treatment & is further utilised for the adsorption of colour from the aqueous solution of methyl red. Various amounts of adsorbent samples were taken for the present work. It is observed that as the amount of sample increases the percentage adsorption also increases. The percentage adsorption is also function of mesh size of the adsorbent sample & the best result is obtained for adsorbent made from ziziphus jujuba 14 mesh size.

Thus from the studies carried out it can be concluded that the prepared activated carbon can be used effectively to adsorb coloured solute & other impurities from industrial effluent. There is a tremendous potential in these materials to be explored further as industrial low cost effective adsorbents.

5. ACKNOWLEDGEMENT

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