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Novel possibility for utilization of Mahua deoiled cake to prepare low cost activated carbon

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Abstract: As environmental pollution is becoming a more serious problem, the need for activated carbon is growing. Solid waste disposal has become a major problem in India, Either it has to be disposed safely or used for the recovery of valuable materials as agricultural wastes like Mahua seed cake. Activated carbons prepared from agricultural solid wastes by chemical activation processes shows excellent improvement in the surface characteristics.(4,6,7) The surface area of activated carbon prepared from Mahua seed cake is found to be 312 m^2/g. the SEM images of carbon surface shows excellent porosity. This research work has revealed some latent facts about the usefulness and effectiveness of activated carbon produced from waste raw materials. The yield of prepared activated carbon is found out against different operating parameters like carbonization temperature, carbonization time and acid concentration used for chemical activation. The yield of activated carbon was found to be decreases with increase in activation temperature, so the optimum carbonization temperature was found to be 500 deg C. (2, 3, 4) The yield of activated carbon was found to be increases with increase in acid concentration, so the optimum acid concentration was found to be 10 N and the yield of activated carbon was found to be decreases with increase in carbonization time, so the optimum carbonization time was found to be 15 min.(1, 5, 10)
Keywords: Activation with Phosphoric acid, Carbonization, SEM, BET surface analysis, optimization.

1. Introduction:

As environmental pollution is becoming a more serious problem, the need for activated carbon is growing. Solid waste disposal has become a major problem in India, Either it has to be disposed safely or used for the recovery of valuable materials as agricultural wastes like turmeric waste, ferronia shell waste, jatropha curcus seed shell waste, delonix shell waste and ipomea carnia stem. (2, 5, 7) Therefore these wastes have been explored for the preparation of activated carbon employing various techniques. Activated carbons prepared from agricultural solid wastes by chemical activation processes shows excellent improvement in the surface characteristics. Comprising over two third of the Earth's surface, water is undoubtedly the most precious natural divine resource that exists in our planet. Although we, as humans, recognize this fact, we disregard it by polluting our rivers, lakes and oceans. Subsequently, we are slowly but surely harming our planet to the point where organisms will die at a very alarming rate. In addition to innocent organisms are reducing, our drinking water has also become greatly affected. (8, 9, 10) In order to combat water pollution, we must understand the problems and become part of the solution. It has been commonly used for the removal of organic dyes from textile waste waster. The use of charcoal extends far back into history. Ancient Hindus in India used it for drinking water filtration and Egyptians used carbonized wood as a medical adsorbent and purifying agent as early as 1500 B.C. A great deal of interest in the research for the removal of heavy metals from environment has focused on the use of indigenously available materials as adsorbents. Among the heavy metals chromium, cobalt, zinc, copper and iron ingestion beyond permissible quantities, causes various chronic disorders in human

beings. It is well known that heavy metals can damage the nerves, liver and bones and they block functional groups of essential enzymes the use of activated carbons to remove Cr (VI) from water was proposed because of their higher surface area and active functional groups leading a search for low cost adsorbents in recent years. Natural materials that are available in large quantities could be potential low cost adsorbents as they represent unused resources. (4, 6, 8)

2. Experimental set up:

Preparation of activated carbon:

Material:

The materials used for preparation of activated carbon are Mahua oil cake dried for 6 month to remove oil traces and moisture content.

a) Preparation with Natural drying:

Raw material was first dried for 6 months to remove the oil traces in cake and kept at dry place to avoid moisture content.

b) Pulverization:

The dried Mahua seed cake is then pulverized manually, crushing provided smaller particles with increased surface area and also enabled more efficient chemical activation of the raw material.

c) Chemical activation:

Chemical activation of the cake was then done using activating agents like phosphoric acid of different concentration. The 30 gm of sample is digested in 70 ml of phosphoric acid, to ensure a complete reaction between activating agent and cake particles, of the sludge and activating agent were mixed at room temperature.

d) Digestion:

The seed cake is then digested with acid for 24 hr.

e) Washing of digested cake:

The cake is then washed with distilled water for 10 times.

f) Determination of pH:

This method is used for the determination of pH of the carbonized material.

Reagents: Buffer solution of pH (7): the solution is prepared by dissolving one tablet of(7 pH) in 100 ml distilled water.

Procedure:

1. Switch on the pH meter, temperature in the pH meter is set which is equal to that of temperature of distilled water.
2. Calibration of pH meter is done by using buffer solution of 7 pH.
3. After this, directly inserted the pH electrode in the solution.
4. Noted the pH from the meter.

g) Carbonization of the sample:

The sample is kept in stainless steel container which has a lid. This container is kept in another steel container of larger size; the small container is surrounded by fine sand to maintain an inert atmosphere into the container. The container is kept into the muffle furnace for time according to run.

1) Feed container: - The feed container was stainless steel which could sustain temperature 800^0c and above.

2) Bigger container: - The feed container was kept in the bigger container, filled with sand it keeps the activated carbon moisture free and the atmosphere in the container inert.

3) Desiccators: - The activated carbon was kept in the desiccators. It keeps activated carbon moisture free.

3. Result and discussion:

The studies were carried out with potential adsorbent obtained from Mahua oil cake to evaluate its properties as an adsorbent. The parameter chosen for the study and their variation on the adsorption are depicted in the following manner. The parameters are

1. carbonization temperature
2. Concentration of acid used for chemical activation
3. Carbonization time
4. Surface area
5. SEM images of produced activated carbon

Carbonization temperature was selected as 400 deg C, 500 deg C and 600 deg C respectively with the help of muffle furnace. The acid concentration was selected as 5 N, 10 N and 15 N respectively. Also the feed is carbonized for the time of 10 min, 15 min and 20 min respectively.

Table: Run summary of experiment

RUN NO.	WEIGHT OF FEED(gm)	ACID CONCENTRATION (N)	TEMPERATURE (DEG. C)	TIME (MIN)	WEIGHT OF PRODUCTS (gm)	% YIELD
1	4	5	400	10	1.724	43.1
2	4	5	400	15	1.648	41.2
3	4	5	400	20	1.556	38.9
4	4	5	500	10	1.616	40.4
5	4	5	500	15	1.444	36.1
6	4	5	500	20	1.3	32.5
7	4	5	600	10	1.504	37.6
8	4	5	600	15	1.368	34.2
9	4	5	600	20	1.268	31.7
10	4	10	400	10	1.728	43.2
11	4	10	400	15	1.656	41.4
12	4	10	400	20	1.548	38.7
13	4	10	500	10	1.632	40.8
14	4	10	500	15	1.468	36.7
15	4	10	500	20	1.305	32.6
16	4	10	600	10	1.512	37.8
17	4	10	600	15	1.396	34.9
18	4	10	600	20	1.26	31.5
19	4	15	400	10	1.736	43.2
20	4	15	400	15	1.668	41.7
21	4	15	400	20	1.584	39.6
22	4	15	500	10	1.648	41.2
23	4	15	500	15	1.476	36.9
24	4	15	500	20	1.312	32.8
25	4	15	600	10	1.516	37.9
26	4	15	600	15	1.42	35.5
27	4	15	600	20	1.276	31.9

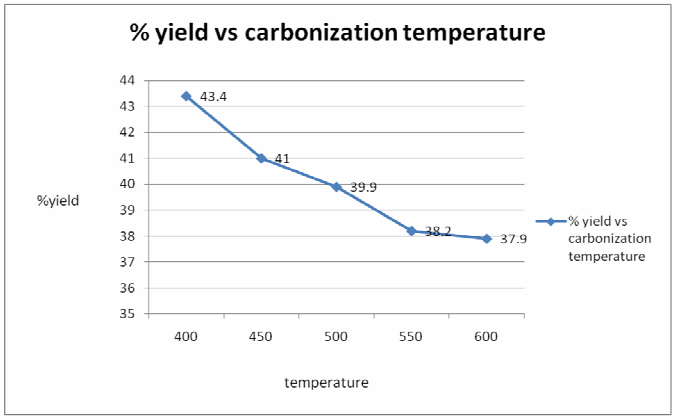


Figure: Effect of Carbonization temperature on yield of activated carbon

The activation temperature is a very influential parameter on the pore structure of activated carbon, which determines the adsorption capacity. The variation in yield of activated carbon product was investigated as a function of activation temperature. Mahua seed cake was used as raw material, acid concentration fixed at 10 N and activation time was fixed at 10 min. the yield decreased progressively with activation temperature, at high temperature the pore walls between adjacent pores were probably destroyed and the micropores were destructed which led to the decrease yield of the activated carbon. At 600 deg C, the graph trend shows that there is no further decrease in yield. Thus, it can be concluded that the optimum temperature for the production of activated carbons from biorefinery waste is approximately 600 deg C.

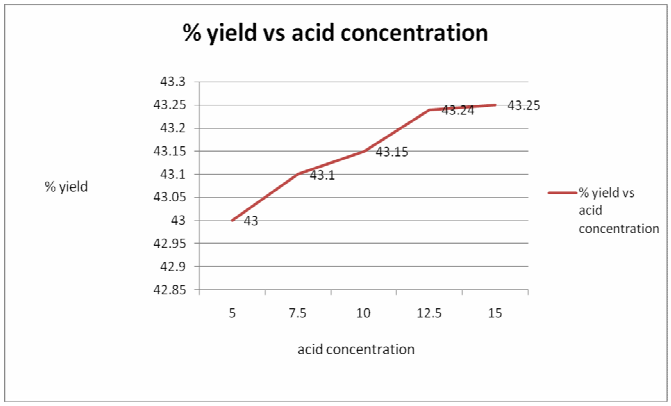


Figure: Effect of acid concentration on yield of activated carbon

The acid concentration is a very influential parameter on the pore structure of activated carbon, which determines the adsorption capacity. The variation in yield of activated carbon product was investigated as a function of acid concentration. Mahua seed cake was used as raw material and acid concentration was varied as 5 N, 10 N and 15 N. the yield increased progressively with acid concentration, at higher acid concentration 15 N, the yield of activated carbon was found to be maximum, further the graph trend shows that the yield of product becomes steady.

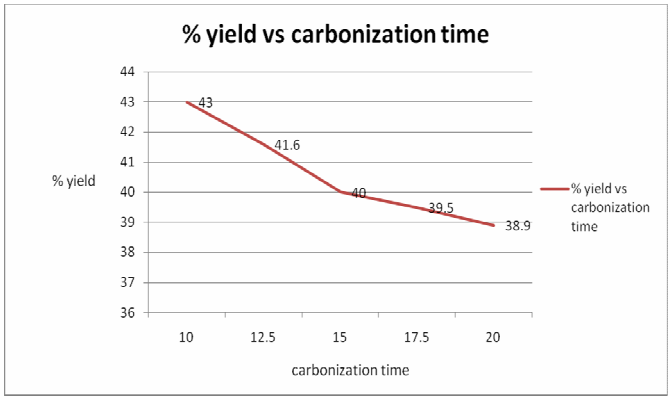


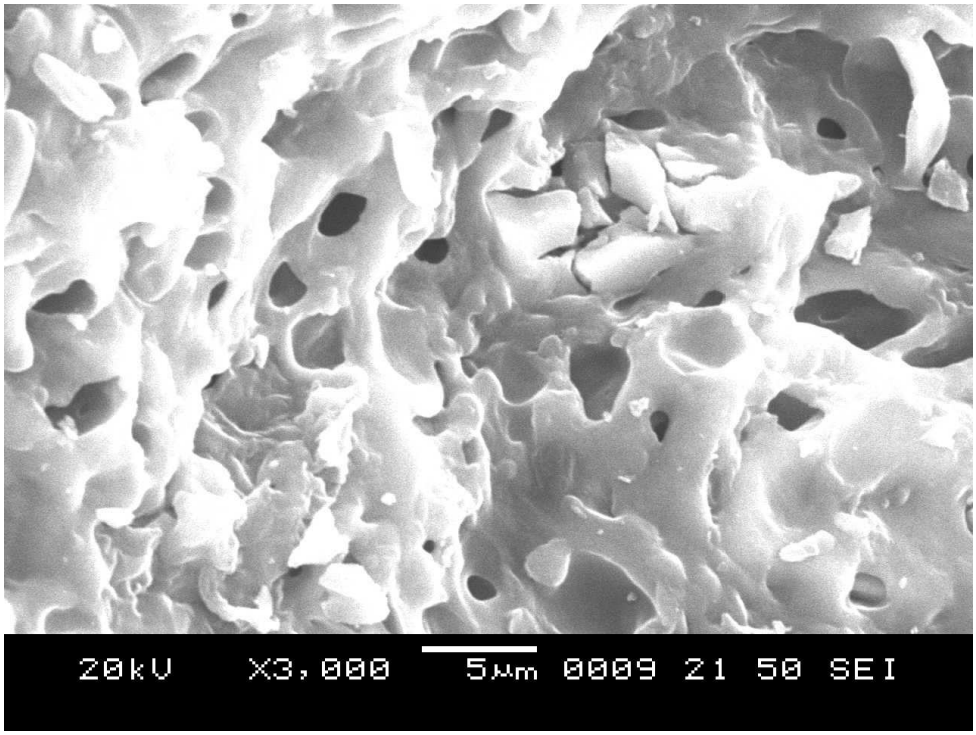
Figure: Effect of carbonization time on yield of activated carbon

The variations in yield of the activated carbon produced from Mahua seed cake versus the activation time. The yield was measured as 43% and 40% and 38.9 % after 10 min, 15 min and 20 min of activation time, respectively. Thereafter, yield gradually. This trend indicates that the yield of activated carbon decreases with increase in carbonization time. But after 20 min graphical trend shows that the yield of activated carbon becomes steady.

Surface area:

The surface area of prepared activated carbon is found to be 312 m^2/gm by BET surface analysis.

SEM images of produced activated carbon:



Pore Volume (V) =d x S_{BET}/4
Pore volume of Mahua seed activated carbon is found to be 187.98 cm^3/g

4. Conclusion:

This research work has revealed some latent facts about the usefulness and effectiveness of activated carbon produced from waste raw materials. The yield of prepared activated carbon is found out against different operating parameters like carbonization temperature, carbonization time and acid concentration used for chemical activation. The yield of activated carbon was found to be decreases with increase in activation temperature, so the optimum carbonization temperature was found to be 500 deg C. The yield of activated carbon was found to be increases with increase in acid concentration, so the optimum acid concentration was found to be 10 N and the yield of activated carbon was found to be decreases with increase in carbonization time, so the optimum carbonization time was found to be 15 min. The BET surface area of activated carbon is found to be 312 m^2/g and from SEM image the pore volume of prepared activated carbon is 187.98 cm^3/g.

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