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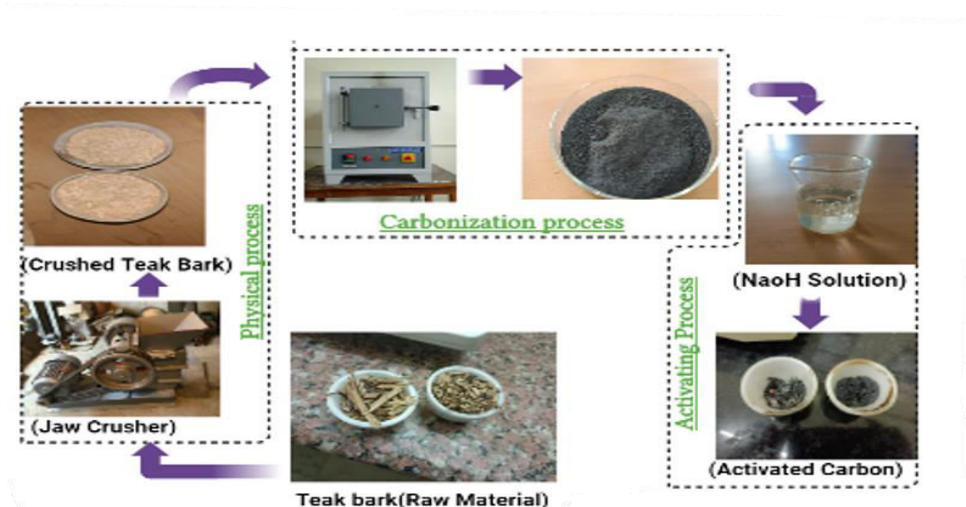
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Synthesis of Adsorbent from Teak Bark (Tectona Grandi)

Archit Jat, Satyam Singh Solanki, Sriman Bidhubibhusan, Rudra Pratap Singh Dhir, Prarthna, Dr
Deepak Tiwari

Department of Chemical Engineering, Chandigarh University, Punjab, India

ABSTRACT: A heterocyclic aromatic chemical called methylene blue (MB) is employed as a drug or a synthetic textile dye. Researchers are looking into how the adsorption process can mitigate its ecotoxicity. This project's goal is to evaluate a carbon-based adsorbent's effectiveness for MB dye uptake based on its highest adsorption capacity. The adsorbent is a new and promising carbon material for dye adsorption for the industrial waste produced by textile industries due to the combination of high surface area and large pore volume. By carbonising the affordable Teak Bark and then activating it with NaOH, it was possible to successfully create nitrogen-enriched carbon adsorbents with large surface areas. Techniques for SEM characterisation were employed to figure out the structure. The optimised activated sample was discovered to have a remarkable surface area and a high absorption capacity. Over 500 studies on MB adsorption have been published (within the past 5 years were analysed). Utilizing UV spectroscopy, it has been determined how effective teak bark powder is as a cheap adsorbent for removing the cationic dye methylene blue (MB) from aqueous solution.



KEYWORDS: Teak Bark, NaOH activation, Methylene blue, UV- Vis spectroscopy.

I. INTRODUCTION

The most challenging environmental problems of the twenty-first century are water scarcity and pollution, which rank right up there with climate change. The demand for textile products is rising proportionally with the population growth. Colors coupled with different contaminants in varied amounts are found in textile effluent[1]. Textile businesses are to blame for one of the worst environmental pollution issues in the world because they produce unwanted dye effluents. As a result, environmental legislation generally mandates that textile factories purify these effluents before releasing them into receiving watercourses. For processing, the textile industries need a lot of colourants, water, and other chemicals. Dispersible, difficult to manage, high volume, and hazardous and toxic waste are the four basic classifications for textile waste[2]. Additionally, there is a different class of compounds, called dyes or colourants. The majority of dyes used by the textile industry today are synthetic. Due to their high stability, dyes can linger in water bodies for an extended period of time before being deadly to aquatic life[3]. These colouring compounds or dyes directly interfere with light and prevent it from penetrating to the bottom of the water, which causes aquatic plants to produce less oxygen and negatively impacts the ecosystem as a whole. In addition, a lot of colours are known to have mutagenesis consequences, skin irritation, infections, and other disorders[4].

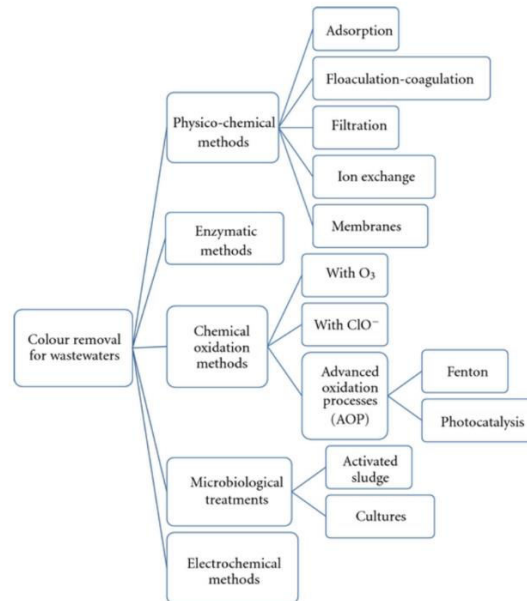


Figure 1: treatment method for textile wastewater¹

There are various conventional methods of removing dyes including coagulation and flocculation [5], oxidation or ozonation [6] and membrane separation [7]. However, these methods are not widely used due to their high cost and economic disadvantage. In contrast, an adsorption technique is by far the most versatile and widely used. The most common adsorbent materials are: alumina silica [5], metal hydroxides [8] and activated carbon [9]. As proved by many researchers [10], removal of dyes by activated carbon is economically favorable and technically easier. Activated charcoal can also be made from teak wood. Ash, total extractives, lignin, and suberin made up the teak bark's average chemical make-up in the order: 18.5%, 10.7%, 20.0%, and 1.9%. A carbon-rich, stable variety of charcoal called activated charcoal can be applied to agricultural land for agronomic or environmental goals, for the adsorption of heavy metals from dyes, or even in the pharmaceutical and cosmetic sectors. All types of biomass can be carbonised in a pyrolysis reactor with little to no oxygen to produce activated charcoal. Any organic waste can be converted into an extremely stable form of carbon that can be used to create activated carbons through the pyrolysis process. The use of activated charcoal in various fields are shown in Figures 2.

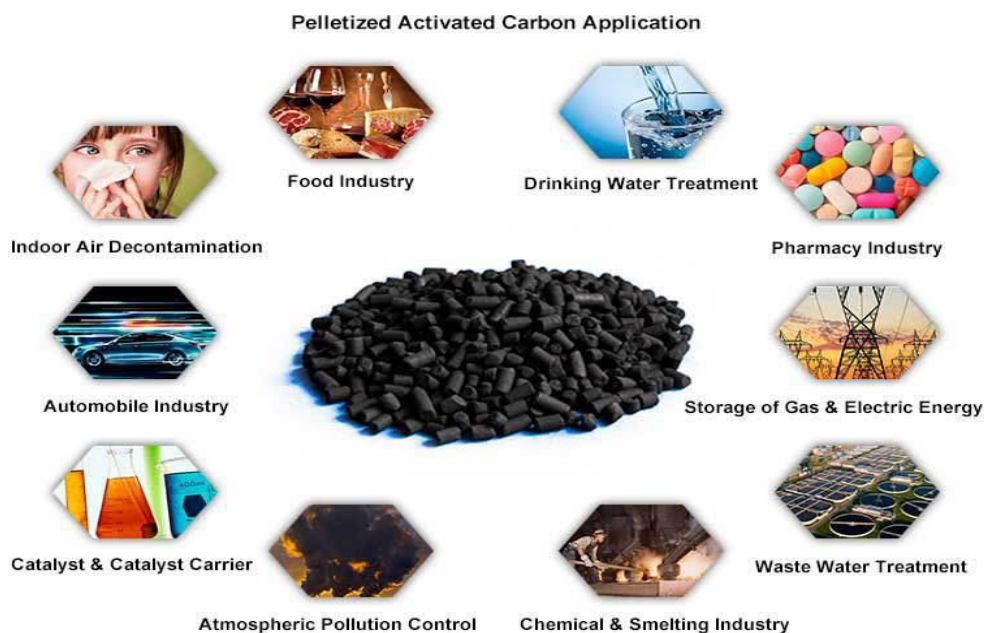


Figure 2: application of Activated charcoal [4].

It is possible to accomplish pyrolysis under several sorts of reaction circumstances. The primary constituents of biomass are long polymeric chains of cellulose, hemicellulose, and pectin, along with some additional substances like volatiles. The amount of each product varies depending on the temperature, residence duration, heating rate, pressure, the kind of precursors we're utilising, and the configuration and architecture of the reactor. Dehydration, drying, or the elimination of moisture happens at temperatures below 200°C. Hemicellulose begins to break down between 200 and 280 °C, which produces some syngas and a negligible amount of bio-oil. The cellulose degrades in a wide range of 240 to 350 °C, and when cellulose degrades it again creates some syngas, some additional bio-oil, and some biochar, which is the solid residue that will be left out. Temperatures above 350 °C and up to 400 to 500 °C cause lignin to break down primarily into charcoal and a small quantity of bio-oil.

Muñoz et al., 2003 [12] used to activate pine sawdust with phosphoric and boric acid. It was discovered that pine sawdust was combined with the activating agent solution in a ratio of 1.5 solids to 1 solution for 72 hours in the phosphoric acid solution and for 13 hours in the boric acid solution. Ismadji et al., 2005 [13] generated activated carbon from vacuum pyrolysis-derived teak sawdust char. It was observed that the char's maximum interfacial area was reached at 850 °C and began to decline as the temperature rose. Açıkyıldız et al., 2014 [14] used three different forms of precursors to make activated carbon, including cornel seed (*Cornus mas L.*), rose seed, and pine (*Pinus sylvestris*) sawdust. In samples manufactured from pine sawdust, rose seed, and cornel seed, it was discovered that zinc chloride produced the optimum adsorptive properties at 400–500 °C, an impregnation ratio of 1.5, and an impregnation time of 1-2 h.

Teak Bark will be turned into carbonised material for this project, which will then be further processed and turned into activated carbon with the right activating chemicals (chemical activation). The surface of the adsorbent needs to have a lot of holes so that dye particles can attach. Microporous pores are those that are less than 2 nm, mesoporous pores that are between 2 and 50 nm, and macroporous pores that are larger than 50 nm. The pore size that is generated on the surface of the adsorbent will also be evaluated; ideally, the pore size should be large enough to trap the dye molecules; if the pore is too small, efficient adsorption cannot occur. An appropriate activating agent and impregnation ratio can provide the desired pore size. The impregnation ratio is calculated by dividing the mass of the organic material to be converted into activated carbon or non-activated porous carbon by the mass of the activating agent (NaOH, KOH, etc.).

II. MATERIALS AND METHODOLOGY

Teak bark(TB) was used for this experiment which was received from a farm in Hoshiarpur district of Punjab , where the cutting down of Teak cultivation was taking place. Eucalyptus bark is an essential bark that contains volatile active compounds. To slow down the process of releasing such volatile compounds, a binding agent such as a polymer matrix is needed. 97% pure NaOH was used which was bought from Loba Chemie Pvt. Ltd. Methylene blue(Microscopical stain) was used and it was bought from Isocheime Laboratories Pvt. Ltd.

Methodology

Preparation of carbonized sample

Collection of raw teak bark was done from the farmlands of Hoshiarpur district in Punjab. Since there were several dust particle in the collected raw material ,it had to be eliminated by through cleaning with distilled water. The raw material was then transferred to a jaw crusher for the fine crushing of the material after it had dried naturally ,we rinsed the sample with distilled water before putting it through a sieve shaker probably jaw crusher was rusted and the tiny iron particles may have gotten into our sample.

The smaller Teak bark particles were then placed in a muffle furnace for two hours at a temperature of 400 degrees Celsius to carbonize the material. After our material underwent partial combustion, the sample was taken out of the muffle furnace and placed in a desiccator to prevent moisture buildup before being placed in an airtight container.

The carbonised sample was then used for the activation procedure, in which 3g of our carbonised sample were combined with 0.1 N of a NaOH solution until a slurry was created. It is determined that the impregnation ratio is (3:4). After being swirled with a magnetic stirrer for an hour, the slurry reached overall uniformity in terms of the activating agent NaOH. The homogenous slurry was prepared and then kept for two hours at a temperature of 400 degrees Celsius in a muffle furnace. Then the activated carbon was neutralised.

From a stock solution of 1000ppm of methylene blue, various ppm solutions of the dye were now created. The stock solution was used to create solutions of 200, 300, and 350 parts per million.

The activated and unactivated carbon were separately put in the different ppm solution of the dyes and later the absorbance curve were found using UV spectrometry and the adsorption capacity was found using our standard equation($y=0.1485x+0.0209$).



CHARACTERIZATION

UV spectrometry

UV spectrometry (also known as UV spectroscopy) is a technique used to measure the absorbance or transmission of ultraviolet (UV) radiation by a sample. It involves passing a beam of UV light through a sample and measuring the amount of light that is absorbed by the sample as a function of the wavelength of the light.

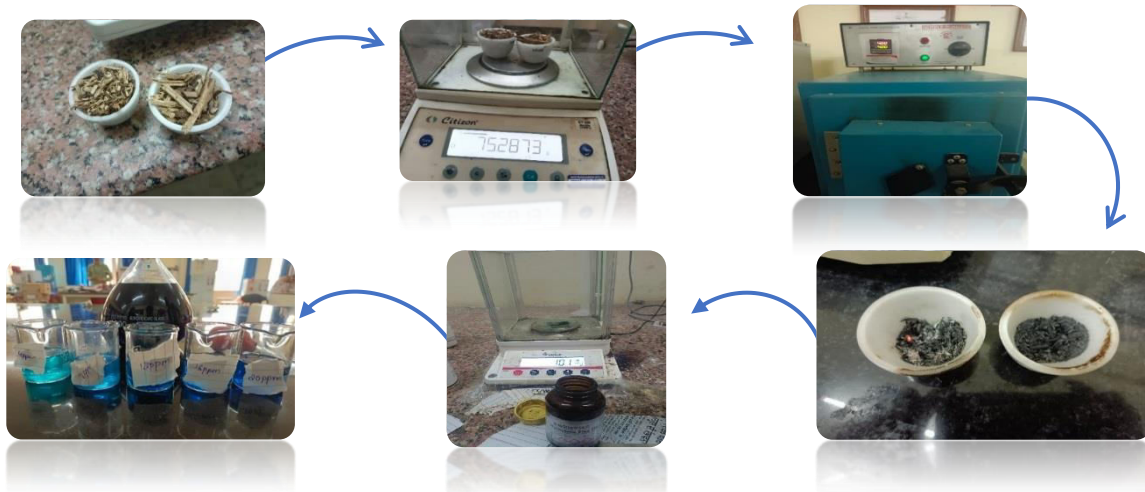
SEM (scanning electron microscope)

A scanning electron microscope (SEM) is an instrument used to analyze the surface structure of materials at high magnification. The SEM works by using a focused beam of electrons to scan the surface of a sample and detecting the electrons that are scattered or emitted from the sample to generate an image.

XRD (X Ray Diffraction)

XRD peaks provide valuable information about the structure and properties of a carbon sample. Here are some key insights that can be obtained from XRD i.e. Crystal Structure, Phase Identification, Crystallite Size and Strain, . Degree of Graphitization and Preferred Orientation.

Pictorial Representation Flowsheet





Flow diagram of experimental procedure

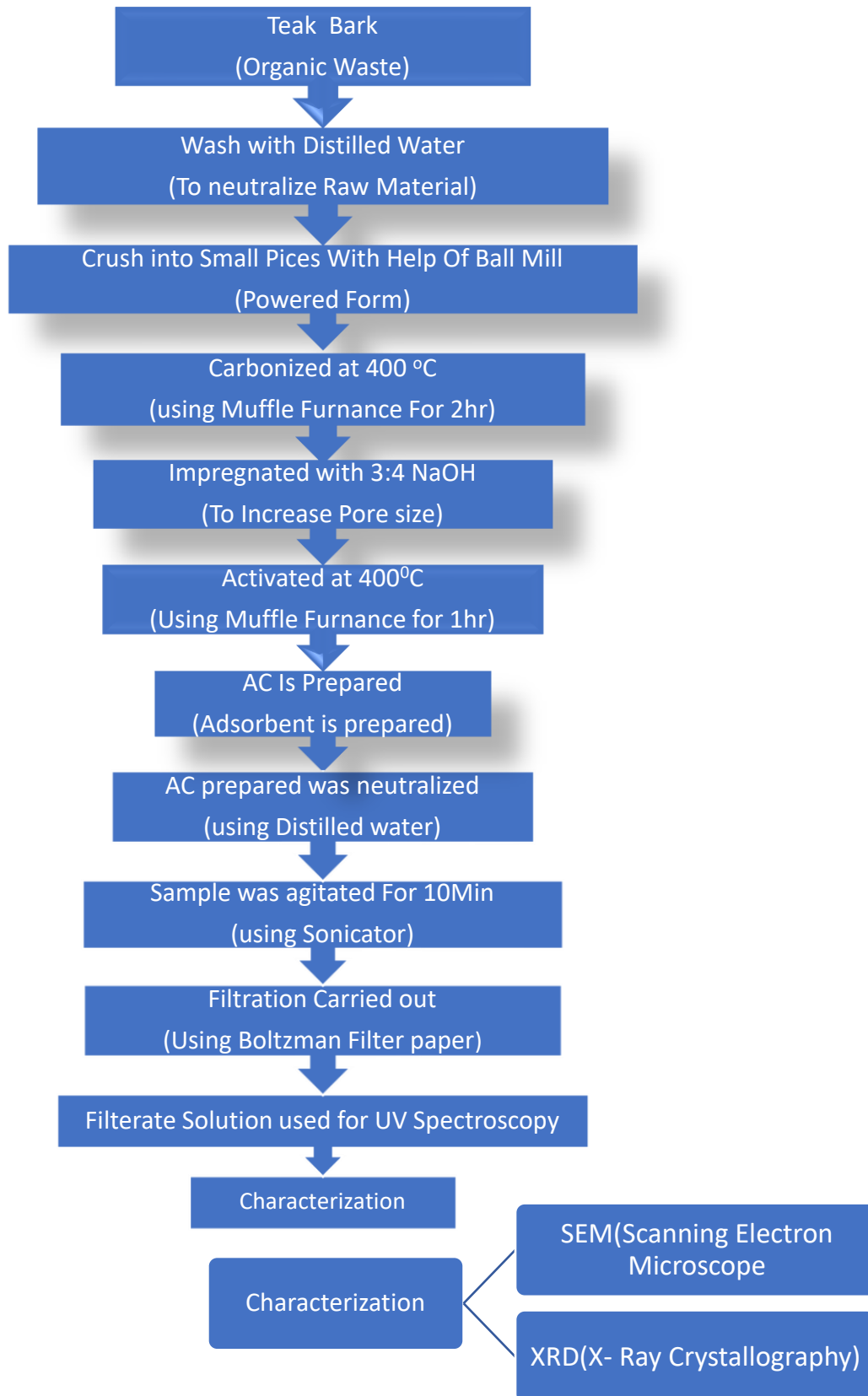


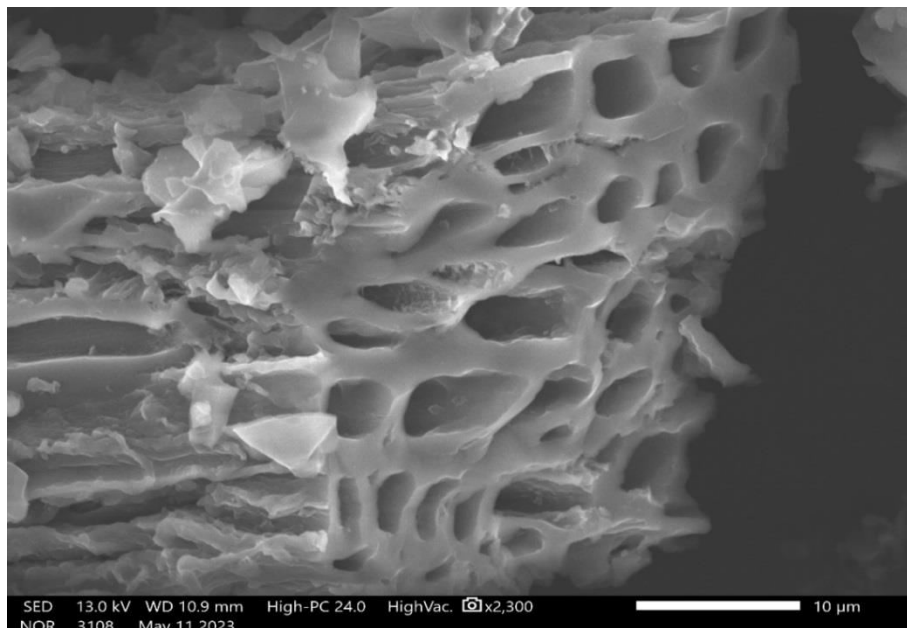
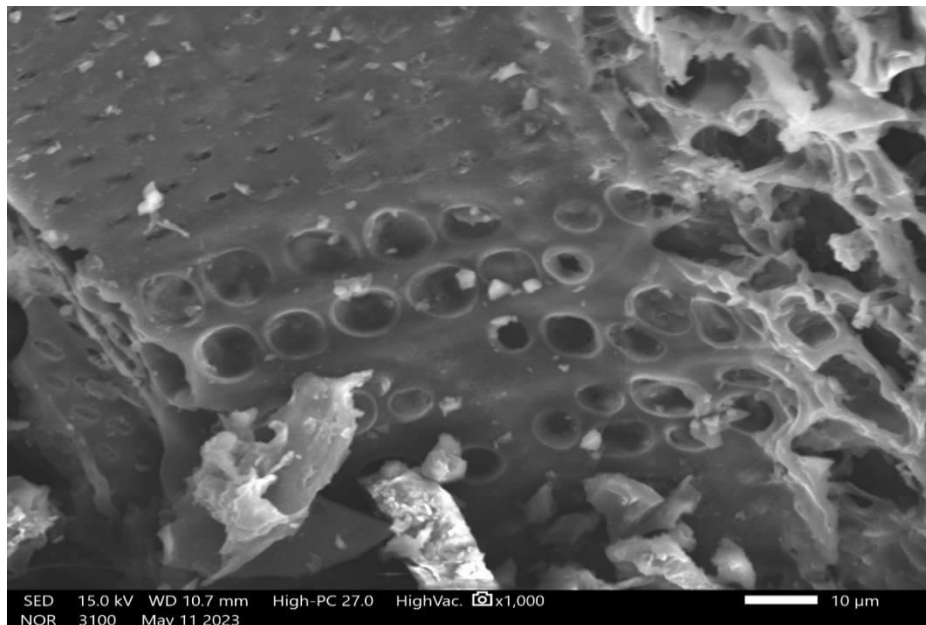
Fig 4 : Flow diagram of experimental procedure



IV. RESULT AND CONCLUSION

SEM CHARACTERIZATION

SEM images are very useful to obtain accurate details about pore structure of carbonized sample and activated carbon and the comparison between carbonized sample and activated carbon. The surface morphology of carbonized sample, activated sample, and activated sample without slow pyrolysis have been shown using the SEM analyzer. The SEM images revealed noteworthy changes in the surface morphology of carbonized was seen after activation in both cases. The surface of activated carbon shows an irregular structure, which is loaded with crystalline salt on inorganic matter such as sulfur, nitrogen, and oxygen. However, it is evident from the Figure that carbonization at 400 °C causes the elimination of volatile matter from the sample resulting in a rough and partially porous surface of the carbonized sample. Subsequently, a highly porous surface is observed on the activated carbon in the presence of NaOH after carbonization at 400 °C produced as shown in figure12(a,b).





UV- visible Spectroscopy

An analytical technique called UV-vis spectroscopy determines how much of various visible and ultraviolet light wavelengths a sample transmits or absorbs. The methylene blue absorption curve was plotted in the first stage. To determine the wavelength that the methylene blue solution absorbs, a full wavelength scan was carried out. The maximal absorbance was measured at 655 nm, thus samples will be further examined at this wavelength. Three samples of 4, 8, and 12 ppm of methylene blue were created from a stock solution with 1000 ppm of the dye for the purpose of plotting curves. In a UV spectrophotometer, the diluted samples were examined, and the corresponding absorbance was noted.

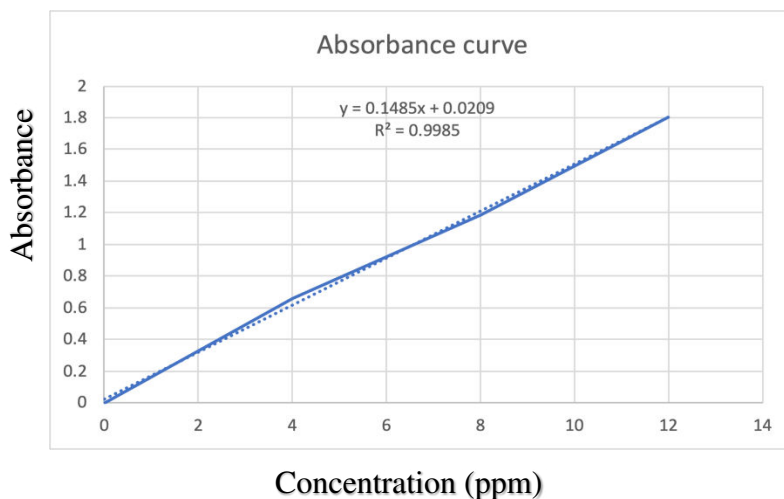


Table 1: Adsorption capacity of Un-activated carbon

Sr No.	Initial concentration	Absorbance after adsorption	Concentration after adsorption	Dye Adsorbed (mg of dye/g of adsorbent)
1	200	0.725	4.74	4.88
2	300	2.850	15.71	7.107
3	350	0.762	4.99	8.625

Table 2: Adsorption capacity of activated carbon

Sr No.	Initial concentration	Absorbance after adsorption	Concentration after adsorption	Dye Adsorbed (mg of dye/g of adsorbent)
1	200	0.026	0.034	4.99
2	300	1.327	8.79	7.28
3	350	2.95	19.72	8.25

V. CONCLUSION

An activated carbon was prepared using a carbonized sample which was activated using NaOH. The well-developed pore structure of carbon resulted in increased specific surface area and changes in surface chemistry. The textural structure and surface chemistry of activated Carbon could be controlled by adjusting the activation conditions, such as activation temperature and impregnation ratio. The optimum activation condition was determined to be 3:4 impregnation ratio and 400°C activation temperature. The activated carbon had the large external surface area and pore volume which is exhibited by SEM images which depicted high porosity as pore got higher enlargement. Activated carbon exhibited the good adsorption capacity for Methylene Blue of **(6.84 mg/g)**, which was far greater than that of untreated Carbonized sample.

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