ADSORPTION OF METHYLENE BLUE FROM AQUEOUS SOLUTION USING BIOCHAR

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BY

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CERTIFICATE

This is to certify that the project entitled "**Adsorption of Methylene Blue from Aqueous solution using biochar**" is a bonafide work carried out by Miss **APARNA BABU** (Reg.NO: **190011010498**) under guidance of Dr. ANEESH MATHEW, PG Department of Chemistry, Pavanatma College, Murickassery, for partial fulfillment of the requirement for the award of Degree of Master of Science in Chemistry of Mahatma Gandhi University during the year 2019-2021.

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09/12/2021

DECLARATION

I, **APARNA BABU**, do hereby declare that this dissertation entitled "**ADSORPTION OF METHYLENE BLUE FROM AQUEOUS SOLUTION USING BIOCHAR**" is a bonafide work carried out by me during 2019-2021 at Pavanatma College, Murickassery under the supervision and guidance of **Prof. Dr. Surendran Parambadath** and **Dr. Aneesh Mathew**, and no part therefore has been submitted for the award of any degree, diploma or recognition of university.

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ABSTRACT

Water is one of the basic needs of human beings to live. After oxygen the most essential thing for our life is water. Now-a-days we are challenged with the environmental problem related to the waste water. Still we are not able to solve the problem associated with the removal of contaminants from the waste water effectively. Currently there exist so many processes that are used to solve this problem. But they are too expensive or may make hazardous by-product.

In this project, we tent to solve the above mentioned problem in an ecofriendly and cost effective manner. Here we are focusing on the removal of dyes from water. The dyes are colored compounds used in textiles, printing, cosmetics, rubber etc. These dyes result in the wastage of a large amount of water. This type of colored waste water can be purified through the adsorption technique using ecofriendly and low cost bio-char.

To study the results, we use colorimetric technique and record the transmittance value before and after adsorption. Added to these we also study the effect of amount of bio-char used and also the effect of contact time on adsorption. Through this project we expect the adsorption of dye by the bio-char and increasing of transmittance value as the adsorption process takes place.

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Chapter 1
INTRODUCTION

1.1 ADSORPTION

Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent. This process differs from adsorption in which a fluid (the adsorbate) is dissolved by or permeates liquid or solid (the absorbent), respectively. Adsorption is a surface phenomenon, while absorption involves the whole volume of the material. The term sorption encompasses both processes.Increase in the concentration of a substance at the interface of a condensed and a liquid or gaseous layer owing to the operation of surface forces.

Note: 1. Adsorption of proteins is of great importance when a material is in contact with blood or body fluids. In the case of blood, albumin, which is largely predominant, is generally adsorbed first, and then rearrangements occur in favour of other minor proteins according to surface affinity against mass law selection (Vroman effect).

Note: 2: Adsorbed molecules are those that are resistant to washing with the same solvent medium in the case of adsorption from solutions. The washing conditions can thus modify the measurement results, particularly when the interaction energy is low.Similar to surface tension, adsorption is a consequence of surface energy. In a bulk material, all the bonding requirements (be they ionic, covalent or metallic) of the constituent atoms of the materials are filled by other atoms in the material. However, atoms on the surface of the adsorbent are not wholly surrounded by other adsorbent atoms and therefore can attract adsorbates. The exact nature of the bonding depends on the details of the species involved, but the adsorption process is generally classified as physisorption (characteristic of weak van der Waals forces) or chemisorptions (characteristic of covalent bonding). It may also occur due to electrostatic attraction.

Adsorption is present in many natural, physical, biological and chemical systems and is widely used in industrial applications such as heterogeneous catalysts, activated charcoal, capturing and using waste heat to provide cold water for air conditioning and other process requirements (adsorption chillers), synthetic resins, increasing storage capacity or carbide-derived carbons and water purification. Adsorption, ion exchange and chromatography are sorption processes ion which certain adsorbates are selectively transferred from the fluid phase to the surface of insoluble, rigid particles suspended in a vessel or packed in a column.Pharmaceutical industry applications, which use adsorption as a means to prolong neurological exposure to specific drugs or parts thereof; are lesser known.

1.1.1 Physisorption

Physisorption also called physical adsorption is a process in which the electronic structure of the atom or molecule is barely perturbed upon adsorption. The fundamental interacting force of physisorption is caused by van de Waals force. Even though the interaction energy is very weak. (10-100 meV), physisorption plays an important role in nature. For instance the van der Waals attraction between surfaces and foot- hairs of geckos provides the remarkable ability to climb up vertical walls. Van der Waals forces originate from the interactions between induced permanent or transient electric dipoles.In comparison with chemisorptions, in which the electronic structure of bonding atoms or molecules is changed and covalent or ionic bonds form, physisorption, generally speaking, can only be observed in the environment of low temperature (thermal energy at room temperature 26 meV) and the absence of the relatively strong chemisorptions. In practice, the categorization of a particular adsorption as physisorption or chemisorptions depends principally on the binding energy of the adsorbate to the substrate.

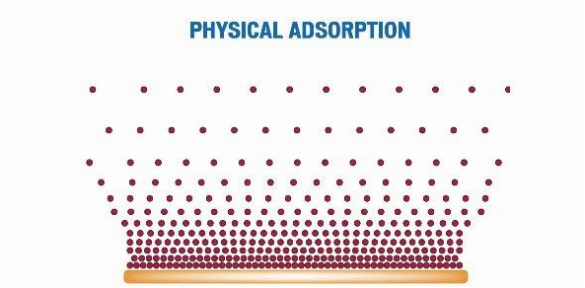


Figure 1. Physical adsorption

1.1.2 Chemisorption

Chemisorptions is a kind of adsorption which involves a chemical reaction between the surface and the adsorbate. New chemical bonds are generated at the adsorbent surface. Examples include macroscopic phenomena that can be very obvious, like corrosion, and subtler effects associated with heterogeneous catalysis. The strong interaction between the adorable and the substrate surface creates new types of electronic bonds.

In contrast with chemisorptions is physisorption, which leaves the chemical species of the adorable and surface intact. It is conventionally accepted that the energetic threshold separating the binding energy of physisorption from that of chemisorptions is about 0.5eV per adsorbed species. Due to specialty, the nature of chemisorptions can greatly differ, depending on the chemical identity and the surface structure. Activated carbon is used as an adsorbent.

Adsorbents are used usually in the form of spherical pellets, rods, moldings, or monoliths with a hydrodynamic radius between 0.25 and 5 mm. They must have high abrasion resistance, high thermal stability and small pore diameters, which results in higher exposed surface area and hence high capacity for adsorption. The adsorbents must also have a distinct pore structure that enables fast transport of the gaseous vapours.

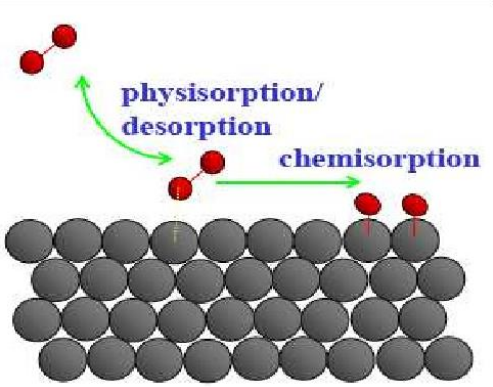


Figure 2. Adsorption process

Most industrial adsorbents fall into one of three classes:

- Oxygen- containing compounds – are typically hydrophilic and polar, including materials such as silica gel and zeolites.
- Carbon- based compounds- are typically hydrophobic and non-polar, including materials such as activated carbon and graphite.
- Polymer- based compounds- are polar or non-polar functional groups in a porous polymer matrix.

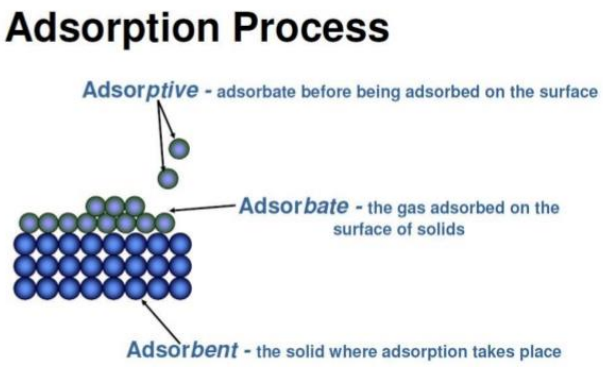
Comparison between physisorption and chemisorptions

Physisorption	Chemisorptions
Low heat of adsorption usually in the range of 20-40 KJ mol-1	High heat of adsorption in the range of 40-400kJ mol-1
Force of attraction are van der wall's forces	Forces of attraction are chemical bond forces
It usually takes place at low temperature and decreases with increasing temperature	It takes place at high temperature
It is reversible	It irreversible
It is related to the ease of liquefaction of the gas	The extent of adsorption of adsorption is generally not related to liquefaction of the gas
It is not very specific	It is highly specific
It forms multi –molecular layers	It forms monomolecular layers
It does not require any activation energy	It requires activation energy

1.2 FACTORSAFFECTING ADSORPTION

The extent of adsorption depends upon the following factors:

1. Nature of adsorbate and adsorbent.
2. The surface area of adsorbent.
3. Activation of adsorbent.
4. Experimental conditions. E.g. Temperature, pressure etc.



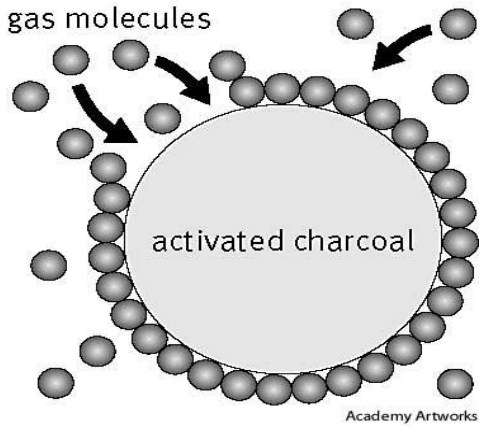


Figure 3. Adsorption process

The following are the factors which affect the adsorption,

Nature of the adsorbate; (Adsorption process is usually studied through graphs known as adsorption isotherm. That is the amount of adsorbate on the adsorbent as a function if its pressure or concentration at constant temperature. The quantity adsorbed is nearly always normalized by the mass of the adsorbent to allow comparison of different materials.

1) Adsorbate (gas) and adsorbent (solid)

i) In general, easily liquefiable gases e.g., Co2, NH3, Cl2 and SO2 etc. are adsorbed to a greater extent than the elemental gases eg.H2, O2, N2, He etc. (While chemisorptions is specific in nature)

ii) Porous and finely powdered solid eg. Charcoal, fuller's earth, adsorb more as compared to the hard-porous materials. Due to this property powdered charcoal is used in gasmasks.

2) Surface area of the solid adsorbent

i) The extent of adsorption depends directly upon the surface area of the adsorbent, ie, larger the surface area of the adsorbent, greater is the extent of adsorption.

ii) Surface area of powdered solid adsorbent depends upon its particle size. Smaller the particle size, greater is its surface area.

3) Effect of pressure on the adsorbate gas

i) An increase in the pressure of the adsorbate gas increases the extent of adsorption

ii) Al low temperature, the extent of adsorption increases rapidly with pressure.

iii) Small range of pressure, the extent of adsorption is found to be directly proportional to the pressure.

iv) At high pressure (closer to the saturation vapour pressure of the gas), the adsorption tends to achieve a limiting value.

4) Effect of Temperature

i) As adsorption is accompanied by evolution of heat, so according to the Le-Chatelier's Principle, the magnitude of adsorption should decrease with rise in temperature.

1.3 MECHANISMOF ADSORPTION

It is an exothermic process which means that energy is liberated during this process. The amount of heat that gets evolved when one mole of the adsorbate is adsorbed on adsorbent is known as enthalpy. The change in enthalpy is denoted to be negative. The reason behind this is that when adsorbate molecules are adsorbed on the surface, freedom of movement of molecules become restricted and this results in a decrease in entropy. At constant temperature and pressure, adsorption occurs spontaneously.

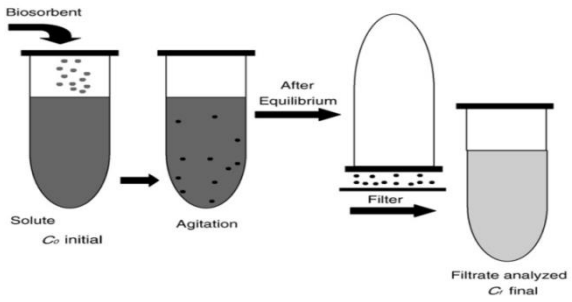


Figure 4. Schematic representation of adsorption process

- **Adsorption, Adsorbent and Adsorbate**

Figure 5. Unimolecular adsorption

Adsorption is the deposition of molecular species on to the surface. The molecular species that gets adsorbed on the surface is known as the adsorbate. Common examples of

adsorbents are clay, silica gel, colloids, metals etc. Thus, adsorption is a surface phenomenon. The process of removal of adsorbent from the surface of adsorbate is known as desorption.

1.4 APPLICATIONS

The phenomenon of adsorption finds a number of applications. Important applications are given as follows:

1) Production of high vacuum

In gas masks: This apparatus is used to adsorb poisonous gases eg. O2, CO2, oxide of sulphur etc.) And thus purify the air for breathing.

For desiccation or dehumidification: These substances can be used to reduce/remove water vapours or moisture present in the air. Silica gel and alumina are used for dehumidification in electronic equipment.

Removal of colouring matter from solution: (i) Animal charcoal remove colours of solutions by adsorbing colored impurities. (ii) Animal charcoal is used as decolorizer in the manufacture of cane sugar.

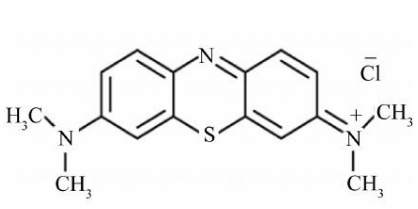
Heterogeneous catalysis: Mostly heterogeneous catalytic reactions proceed through the adsorption of gaseous reactants on solid catalyst. For example, finely powdered nickel is used for the hydrogenation of oils. Finely divided vanadium pentoxide is used in the contact process for the manufacture of sulphuric acid. Separation of inert gases: Due to the difference in degree of adsorption of gases by charcoal, a mixture of inert gases can be separated by adsorption on coconut charcoal at different low temperatures.

Dyes and Classification

Dyes is a colored substance that has an affinity to the substrate to which it is being applied. The dye is generally applied in an aqueous solution, and may require a mordant to improve the fastness of the dye on the fiber. Both dyes and pigments are colored, because they absorb only some wavelengths of visible light. Dyes are usually soluble in water whereas pigments are insoluble. Some dyes can be rendered in soluble with the addition of salt to produce a lake pigment.

Dyes are classified according to their solubility and chemical properties, 1) Acid dye and 2) Basic Dyes. Acid dyes are water-soluble anionic dyes that are applied to fibers such as silk, wool, nylon and modified acrylic fibers using neutral to acid dye baths. Attachment to the fiber is attributed, at least partly, to salt formation between anionic groups in the dyes and cationic groups in the fiber. Acid dyes are not substantive to cellulosic fibers. Most synthetic food colors fall in this category. Examples of acid dye are Alizarin Pure Blue B, Acid red 88 etc. Basic dyes are water-soluble cationic dyes that are mainly applied to acrylic fibers, but find some use for wool and silk. Usually acetic acid is added to the dye bath to help the uptake of the dye onto the fiber. Basic dyes are also used in the coloration of paper.

METHYLENE BLUE



Methylene blue, also known as methylthioninium chloride, is a medication and dye. As a medication, it is mainly used to treat methemoglobinemia. Specifically, it is used to treat methemoglobin levels that are greater than 30% or in which there are symptoms despite oxygen

therapy. It has previously been used for cyanide poisoning and urinary tract infections, but this use is no longer recommended. It is typically given by injection into a vein. Common side effects include headache, vomiting, confusion, shortness of breath, and high blood pressure. Other side effects include serotonin syndrome, red blood cell breakdown, and allergic reactions.

Use often turns the urine, sweat, and stool blue to green in colour. While use during pregnancy may harm the baby, not using it in methemoglobinemia is likely more dangerous. Methylene blue is a thiazine dye. It works by converting the ferric iron in hemoglobin to ferrous iron. The maximum absorption of light is near 670 nm. The specifics of absorption depend on a number of factors, including protonation, adsorption to other materials, and metachromasy-the formation of dimers and higher-order aggregates depending on concentration and other interactions.

Chapter 2
OBJECTIVES

In this project the main objective of study is to remove the methylene blue dye from the aqueous solution by adsorption technique using eco-friendly coconut shell bio-char and also discuss about,

i. The effect of amount on adsorption.

ii. Effect of contact time on adsorption.

Chapter 3
LITERATURE SURVEY

Adsorption is a process that occur when a gas or liquid solute accumulates on the surface of a solid or a liquid, forming a molecular or aromatic film (the adsorbate). Adsorption is operative in most natural physical, biological and chemical system, and is used in industrial applications such as activated charcoal, synthetic resins and water purification. Among these methods, adsorption is currently considered to be very suitable for waste water treatment because of its simplicity and cost effectiveness. Synthetic dyestuffs have been an important class of pollutants, which are extensively utilized in many fields such as textiles, paper, plastic, leather, cosmetics, and food processing, wool and printing. The residual dyes in the waste waters have posed a serious threat to the environment due to their high visibility, recalcitrance, and adverse efforts on both the aquatic biota and human health.

Dyes are an important group of chemicals that are widely used in industries such as textiles, paper, rubber, plastics, cosmetics, etc., to color their products. They are invariably left in the industrial wastes and consequently discharged mostly in surface water resources and are visually detected even at low concentrations. As per various surveys around the globe, 8000 tons of dyes annually are used by food, textile, and cosmetic industries out of which 10 to 15% are discarded to environment. Commercially there are around 10,000 verities of dyes available and production rate are 7 x 105 tons per year. Basically dyes are use due to its characteristic like long term durability, solubility, rapid binding action and effective even in less concentration. These are also main characteristic which makes it pollutant, when it interacts with environment. They also affect the aquatic life and food web. Aesthetic pollution, eutrophication and perturbation in aquatic life are basically due to colored water.

The contamination of water bodies by synthetic dyes has created a serious environmental problem worldwide. A considerable amount of dyes is released into the aquatic ecosystems

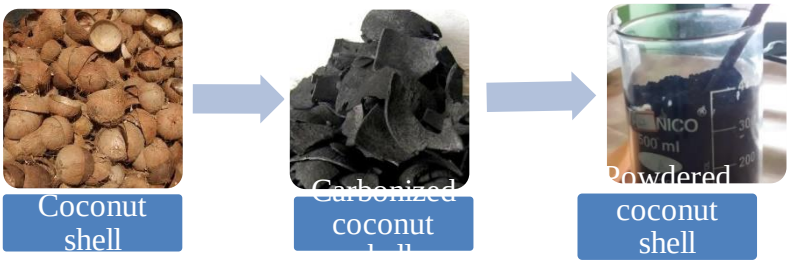
through the wastewater streams of industries such as textile, carpet, leather, paper, printing, food, cosmetics, paint, pigments, petroleum, solvent, rubber, plastic, pesticide etc. Dye residues affect photosynthetic activity by preventing light penetration in aquatic life and produce toxic chemicals of aromatics, metals, amines and chlorides, having a detrimental effect on flora, fauna and human beings.

Some physicochemical methods, such as advanced oxidation and biological process, coagulation, membrane filtration, electrochemical, and adsorption techniques have been proposed to satisfy the above requirements. For both environmental and health reasons, it is essential to remove these dyes completely before they reach the effluent stream to the discharge water supply. Among the different dye removal strategies, adsorption has attracted considerable attention owing to its low cost and high efficiency. Recently, modified porous materials were introduced for the adsorption study.

Chapter 4
MATERIALS

4.1 COCONUT SHELL BIOCHAR

The eco-friendly and less expensive coconut shell bio-char is made by converting coconut shell to charcoal by carbonization and then crushing it to powder. This process of converting shell to charcoal includes removing of all the moisture from the raw material in a limited supply of air



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4.2 CHEMICALS

- Methylene blue- NICE CHEMICALS (P) LTD.
- Distilled water.

4.3 APPARATUS

- 250 ml beaker
- Conical flask
- Glass rod
- 20ml pipette
- Funnel
- Whatsmann filter paper
- Spatula
- Test tube

Coconut shell activated charcoal is made from coconut husk. It is a vapour-activated material, so it does not contain chemical agents that can contaminate or react with the medium where it is used. They are characterized by having a large amount of micro to mesopores (5nm-50 nm) suitable for the removal of small molecules; contains a neutral PH, can be manufactured in any particle size.

Coconut shell charcoal is super stiff, hard and resistant. Most manufacturers base the quality of activated coconut charcoal on the adsorption capacity that is directly related to the contact area, and they generally perform adsorption tests with an iodine solution.

By rule: greater iodine number = better quality of activated carbon = greater adsorption = greater duration and useful life of the activated carbon.

The key is in the activation process used (by steam or chemical reaction), in addition to the residence time, temperature, pressure, in general, the operating conditions. Therefore, activated coconut shell charcoal can be used in air purification, eliminating odors and a good number of organic gases or solvents. It helps in the purification of natural gas, adsorbing highly toxic hydrogen sulphide.

What is Coconut Shell Activated Charcoal?

Coconut is a fruit, obtained from the coconut palm, the most cultivated palm in the world. The leading producers are The Philippines, Indonesia and India. In its growing stage, it can reach a height of approximately 25 meters. Activated carbon is obtained from the coconut shell, in which it goes through physical or chemical activation processes.

Coconut shell activated charcoal tends to be microporous and adsorbs more efficiently the low molecular weight organic pollutants that are most present in well water. All activated carbon of vegetable or mineral origin contains inorganic salts and elements, some of which are soluble in water.

How Activated Coconut Shell Charcoal is Prepared?

Coconut shell charcoal comes from the coconut shells. It is ecological since the husks of the small coconuts are used that would otherwise go to waste. To activate it, the coconut shell is heated to more than 1000 degrees Celsius without the presence of oxygen. Activated means that it has its 100% adsorption characteristic and maximum porosity.

Activated carbon works by using the adsorption process. Do not confuse absorption with adsorption. Adsorption is a process whereby atoms, ions, gas molecules, liquids or dissolved solids are trapped or retained on a surface while absorption is a phenomenon of volume.

Composition:

Coconut activated carbon is composed of 70 to 80% carbon, is practically pure, and the ash content varies between 5 to 10%.

Use:

Activated coconut shell charcoal has multiple applications. It is used to treat acute poisoning in people and for gastrointestinal problems. It is also used for water purification, deodorization and purification of air and water, for the removal of organic substances, solvent recovery and as a catalyst.

Benefits of Using Activated Coconut Shell Charcoal:

1. Natural Detoxificant

Coconut shell charcoal helps in detoxification processes. It is used as one of the ingredients in colon cleansing therapies and detoxifying products. It can absorb toxins and eliminate them intestinally so that it will be an essential cleaning system.

2. Treats Poisoning

Activated charcoal is used as an adsorbent agent to treat poisoning and overdose by oral ingestion. Prevents from absorbing poison in the stomach. Coal absorbs the toxins from the stomach and intestine.

3. Helps Reduce Cholesterol Levels

Activated carbon reduces the levels of cholesterol, lipids and triglycerides in the blood.

4. Stomach Relief

Relieves the stomach by removing excess gas from the digestive tract.

5. Rejuvenating Effect

It is also used to counteract the results of the passage of time in the body since it assists in the processes of the liver, kidneys and adrenal glands avoiding excessive cell aging.

6. Skin Care

Activated coconut charcoal has been lately used in many beauty products. This is because it is effective in eliminating bacteria, chemicals and impurities. It is regulatory sebum and very useful in cases with acne and skin blemishes. But they also use it to control LDL cholesterol, reduce flatulence and promote renal function by reducing the number of waste products that the kidneys must filter.

Like everything, they have their precautions. It should not be taken within two hours after administration of vitamins, medications or supplements, as it will prevent the body from absorbing them.

Activated Coconut Charcoal Is Odorless, Tasteless and Non-Toxic.

It is an ingredient that we love and use in almost all our beauty and personal care products are activated carbon. In recent years it has become a trend and controversy at the same time. However, Ayurvedic medicine used this black powder for thousands of years. Its first registered use dates back to 1550 BC. It is also well established in medical literature as a powerful antidote that adsorbs most toxins.

Activated carbon is a substance, usually bamboo, wood, coal, or coconut shell that is activated with high temperatures and an inevitable process. It is essential to know that activated

coconut shell charcoal is not the same coal used for the grill or charred wood of fire. Please do not try to replace or do it yourself!

Chapter 5
INSTRUMENTATION

5.1 LABORATORY SHAKER

A shaker is a piece of laboratory equipment used to mix, blend, or agitate substances in a tube or flask by shaking them. It is mainly used in the fields of Chemistry and Biology. A shaker contains an oscillating board that is used to place the flasks, beakers, or test tubes. Although the magnetic stirrer has lately come to replace the shaker, it is still the preferred choice of equipment when dealing with large volume substances or when simultaneous agitation is required.

Figure 1 .Laboratory shaker

A platform shaker has a table board that oscillates horizontally. The liquids to be stirred are held in beaker, jars, or Erlenmeyer flasks that are placed over the table, or sometimes, in test tubes or vials that are nested into holes in the plate. Platform shakers can also be combined with other systems like rotating mixers for small systems and have been designed to be manufactured in laboratories themselves with open source scientific equipment.

5.2 COLORIMETER

A colorimeter is a device used in colorimetric technique. In scientific fields the word generally refers to the device that measures the absorbance of particulate wavelengths of light by a specific solution. This device is commonly used to determine the concentration of a known solute in a given solution by the application of the Beer-Lambert law, which states that the concentration of a solute is proportional to the absorbance.

Figure 2 Colorimeter

Cuvettes: In a manual colorimeter the cuvettes are inserted and removed by hand. An automated colorimeter (as used in an Auto Analyser) is fitted with a flow cell through which solution flows continuously.

Output: The output from a colorimeter may be displayed by an analogue or digital meter and may be shown as transmittance (a linear scale from 0-100%) or as absorbance (a logarithmic scale from zero to infinity). The useful range of the absorbance scale is from 0-2 but it is desirable to keep within the range 0-1, because, above 1, the results become unreliable due to scattering of light. In addition, the output may be sent to a chart recorder, data logger, or computer.

5.3 ANALYTICAL BALANCE

Figure 3 Analytical balance

An analytical balance (or lab balance) is a class of balance designed to measure small mass in the sub-milligram range. The measuring pan of an analytical balance (0.1 mg resolution or better) is inside a transparent enclosure with doors so that dust does not collect and so any air currents in the room do not affect the balance's operation. This enclosure is often called a draft shield. The use of a mechanically vented balance safety enclosure, which has uniquely designed acrylic airfoils, allows a smooth turbulence-free airflow that prevents balance fluctuation and the measure of mass down to 1 μg without fluctuations or loss of product. Also, the sample must be at room temperature to prevent natural convection from forming air currents inside the enclosure from causing an error in reading. Single pan mechanical substitution balance is a method of maintaining consistent response throughout the useful capacity of the balance. This is achieved by maintaining a constant load on the balance beam and thus the fulcrum, by subtracting mass on the same side of the beam as which the sample is added.

Chapter 6
EXPERIMENTAL ANALYSIS

6.1 ADSORPTION EXPERIMENT

About 0.023g of Methylene blue is weighed and transferred into 250 ML beaker, and it is diluted to 250 ML using distilled water. About 20 ML of made up solution is transferred into 3 different conical flask and then 0.30gm of charcoal is added to each of the conical flask. It is then placed on heavy rotary shaker for 5hrs.It is then taken out and filtered using whatsmann filter paper and then the absorbance is measured using calorimeter. This method is repeated for 6, 12,24hrs respectively

Figure 4 Added two drops of methylene blue in distilled water

Figure 5 methylene blue –distilled water complex solution

6.1.1 PROCEDURE-I

- 20 ml of methylene blue complex solution pipetted out into three different conical flask.

Figure 6: methylene blue complex solution in three conical flask

Added 100 mg, 300 mg, 500 mg of coconut shell biochar to each of the conical flask.

Figure 7 Added different amount of coconut shell biochar

- Kept three conical flask on mechanical Shaker for 40 minutes to mix well

Figure 8 Shaking for 40 minutes on a mechanical shaker

- After 40 minutes the solution is filtered with whatsmann filter paper and transferred to test tubes.

- Figure 9 Filtering process
- To record transmittance, the solution is taken in cuvette and placed in calorimeter and noted the percentage of transmittance for different amount of biochar before and after adsorption.

6.1.2 PROCEDURE- II

- 20 ml of methylene blue complex solution is pipetted out into conical flask.
- Added 500 mg of coconut shell biochar to the conical flask.
- The solution is mixed at regular intervals of 10 minutes.
- After mixing, it is filtered out using whatsmann filter paper and the filtrate is taken in a cuvette and recorded the percentage of transmittance of solution for different time.
- Percentage of transmittance before and after adsorption is noted.

Chapter 7
RESULTS AND DISCUSSIONS

7.1 FACTORS AFFECTING ADSORPTION OF DYE

There are many factors affecting dye adsorption such as solution pH, temperature, effect of amount etc. The effects of these parameters are to be taken in account. In this section some of the factors affecting adsorption of dyes are discussed below.

7.1.1 EFFECT OF AMOUNT OF ADSORPTION

Here taken constant volume of methylene blue distilled complex in each conical flask and the amount of biochar is varied from 100 mg to 500 mg. after shaking for 40 minutes, filter the mixture and its transmittance measured using calorimeter.

Generally, the percentage of dye removal increases with increasing adsorbent dosage, where the quantity of 'sorption sites' at the surface of adsorbent will increase by increasing amount of the adsorbent. Here transmittance value seems to increase as the amount of biochar increased. Transmittance measure the amount of light that passes through a material.

7.1.2 EFFECT OF CONTACT TIME

To find the effect of contact time of adsorbent on adsorbate, the amount of adsorbent and volume are kept constant. Here also the transmittance increases as the contact time increases.

The time of stirring on a mechanical Shaker had changed. After every 10 minutes the solution was withdrawn, filtered and their transmittance value was measured.

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TIME (Minutes)	TRANSMITTANCE (%)	
	Before adsorption	After adsorption
10	36	57
20	36	70
30	36	83
40	36	92
60	36	92
80	36	93

CONCLUSION

In this study we have analyzed the absorption of methylene blue from aqueous solution using coconut shell biochar. The coconut shell biochar is less expensive and eco-friendly biochar. Here we used it as an absorbent for adsorption of methylene blue from aqueous solution is a triphenylmethane dye and it is used as an acid-base indicator.

From my study, the effects of amount and contact time of adsorbent were checked. The adsorption parameters discussed above have been supported the efficiency of coconut shell biochar towards methylene blue adsorption from aqueous solution.

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