ADSORPTION OF ERIOCHROME BLACK T (EBT) USING ACTIVATED CHARCOAL

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CERTIFICATE

This is to certify that the project entitled "**Adsorption of Eriochrome Black T (EBT) using activated charcoal**" is a bonafide work carried out by Miss **NIDHI M MENON** (Reg.NO: **190011010511**) 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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06/08/2021

DECLARATION

I, **NIDHI M MENON,** do hereby declare that this dissertation entitled “**ADSORPTION OF ERIOCHROME BLACK T USING ACTIVATED CHARCOAL”** 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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Date:

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Above all, I thank Almighty God for all the grace he has bestowed upon during this work.

NIDHI M MENON

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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.

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 26meV) 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.

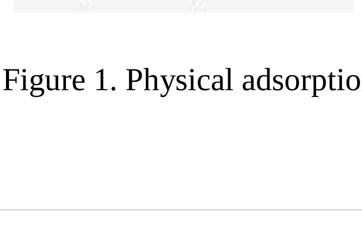


Figure 1. Physical adsorption

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, 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.

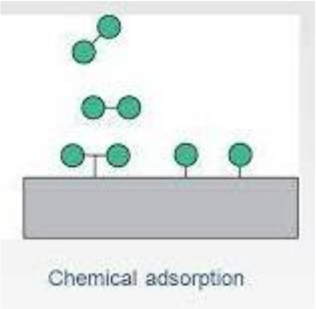
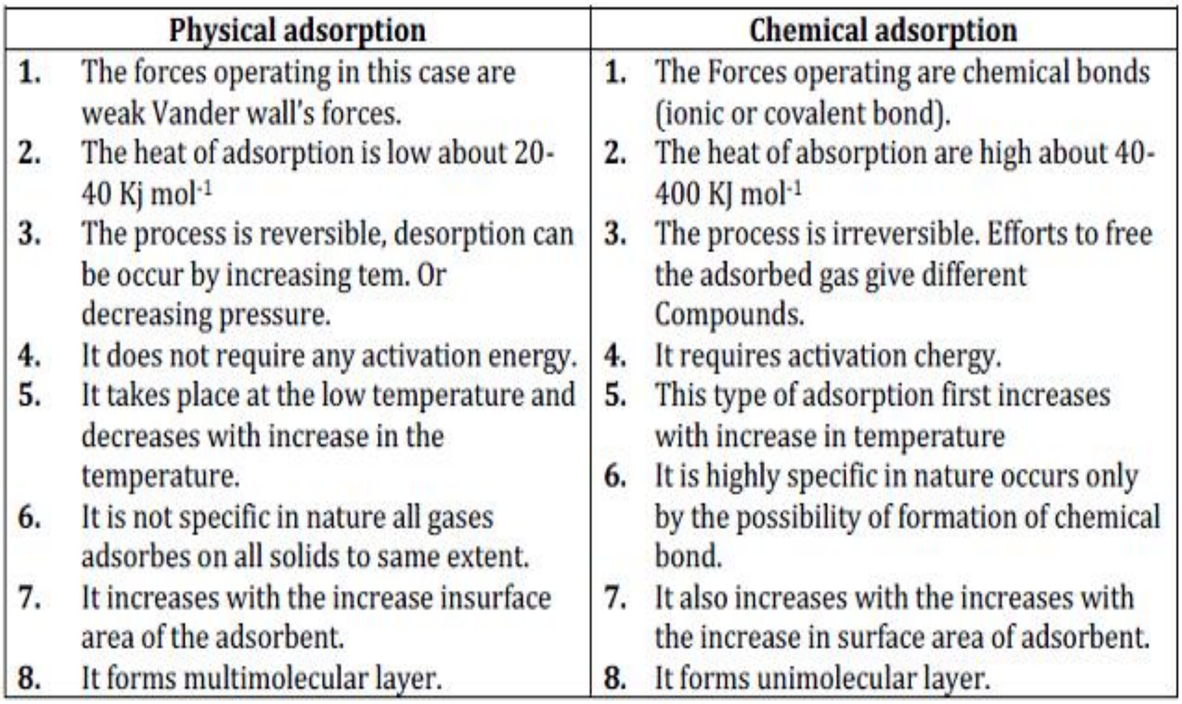


Figure 2. Chemical adsorption

1.1.3 COMPARISON BETWEEN PHYSISORPTION AND CHEMISORPTIONS



Physical adsorption	Chemical adsorption
1. The forces operating in this case are weak Vander wall's forces.	**1.** The Forces operating are chemical bonds (ionic or covalent bond).
2. The heat of adsorption is low about 20-40 Kj mol^{-1}	**2.** The heat of absorption are high about 40-400 KJ mol^{-1}
3. The process is reversible, desorption can be occur by increasing tem. Or decreasing pressure.	**3.** The process is irreversible. Efforts to free the adsorbed gas give different Compounds.
4. It does not require any activation energy.	**4.** It requires activation chergy.
5. It takes place at the low temperature and decreases with increase in the temperature.	**5.** This type of adsorption first increases with increase in temperature
6. It is not specific in nature all gases adsorbes on all solids to same extent.	**6.** It is highly specific in nature occurs only by the possibility of formation of chemical bond.
7. It increases with the increase insurface area of the adsorbent.	**7.** It also increases with the increases with the increase in surface area of adsorbent.
8. It forms multimolecular layer.	**8.** It forms unimolecular layer.

1.2 FACTORS AFFECTING 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.

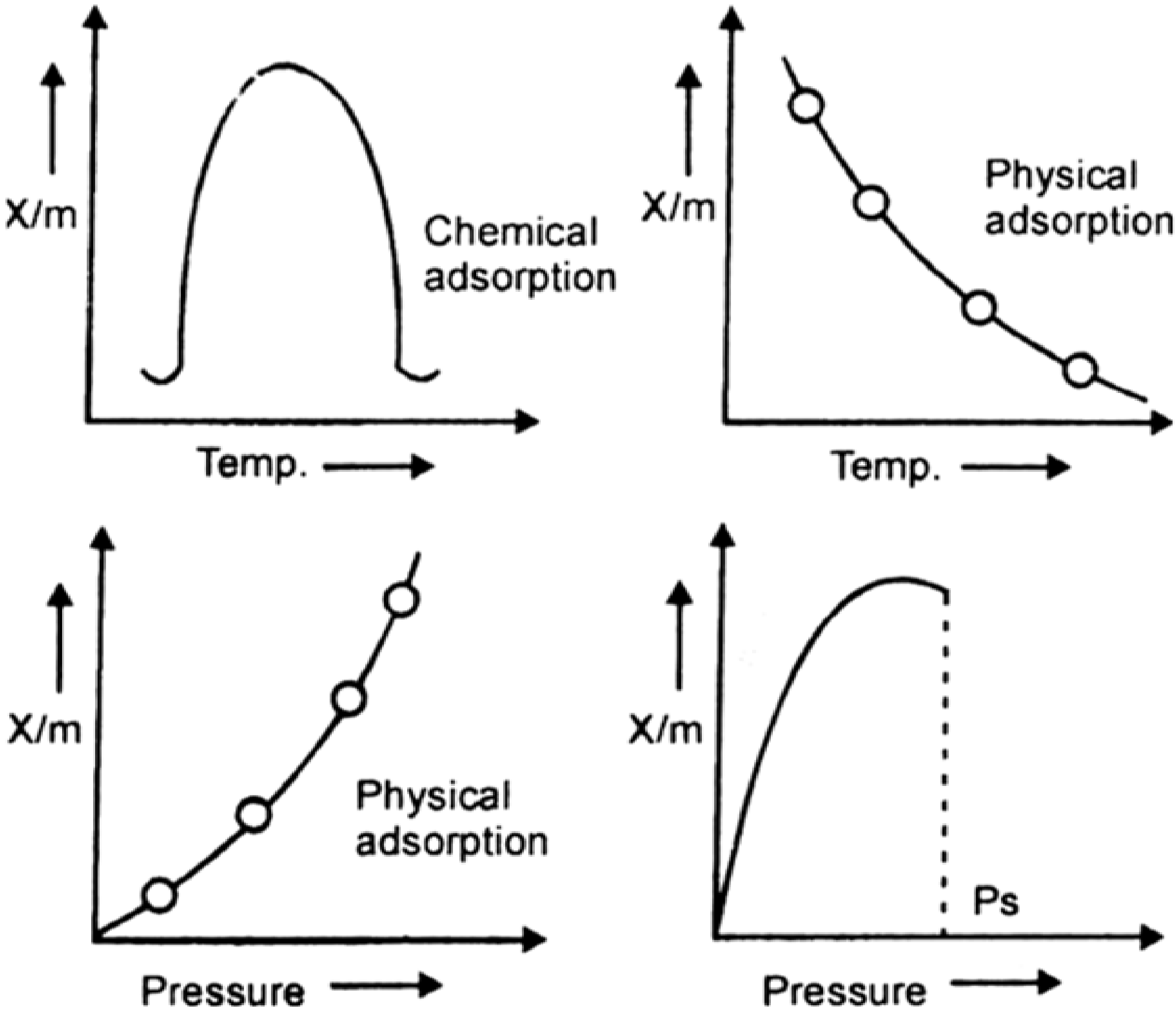


Figure 3. Factors affecting adsorption

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., Co_2, NH_3, Cl_2 and SO_2 etc. are adsorbed to a greater extent than the elemental gases eg.H_2, O_2, N_2, 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**

   - 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 MECHANISM OF 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.

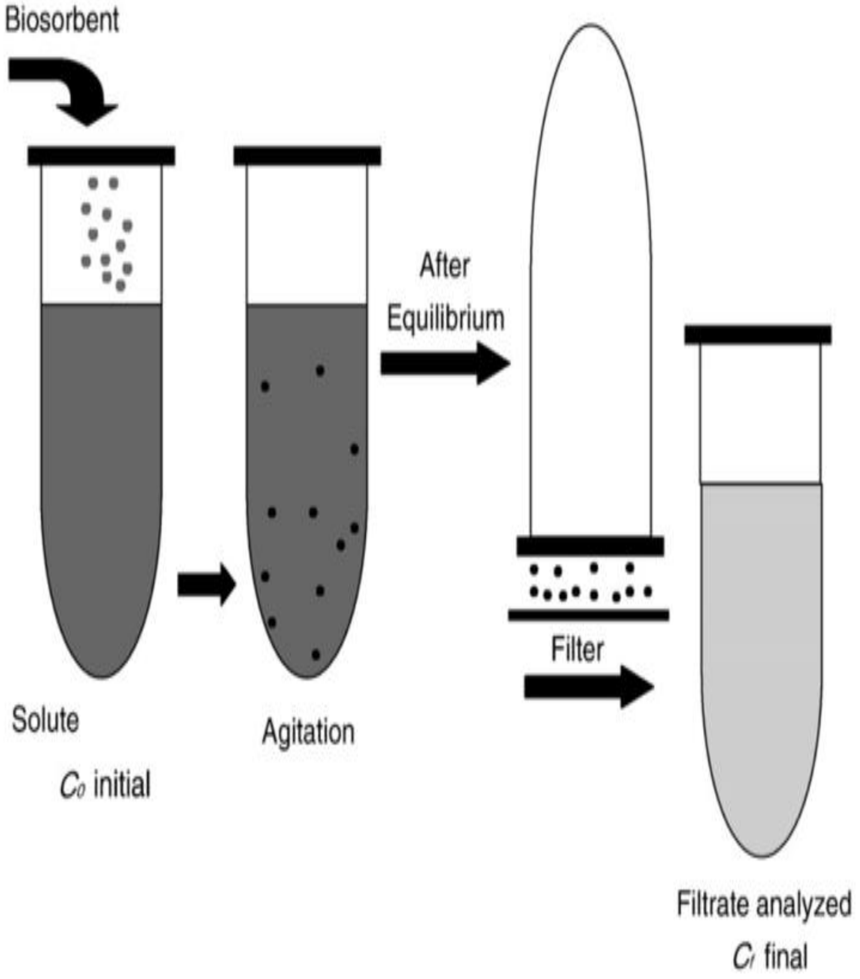


Figure 4. Schematic representation of adsorption process

1.4 APPLICATIONS OF ADSORPTION

1) AIR POLLUTION MASKS:

These consists of silica gel or activated charcoal powder, when dust or smoke are paused through them, those particles get adsorbed on the surface of these materials.

2) SEPARATION OF NOBLE GASES BY DEWAR'S FLASK PROCESS:

A mixture of noble gases of Ne, Ar, Kr is passed through Dewar's flask in presence of heated coconut charcoal. Argon and Krypton gels adsorbed leaving Neon.

3) PURIFICATION OF WATER:

By the addition of alum stone to the water, impurities get adsorbed on the alum and water gets purified.

4) REMOVAL OF MOISTURE AND HUMIDITY:

Moisture in the air is removed by placing silica gel on which water molecular gets adsorbed.

5) ADSORPTION CHROMATOGRAPHY:

It is used to separate pigments and hormone.

6) ION EXCHANGE METHOD:

In this method of removing the hardness of water, calcium and magnesium ions get adsorbed on the surface of ion exchange resin

7) IN METALLURGY:

In the froth floatation process of concentration of ore, the particle gets adsorbed on the froth.

1.5 DYES AND CLASSIFICATION

Dyes are coloured 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 Dyes

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.

1.6 ERIOCHROME BLACK T

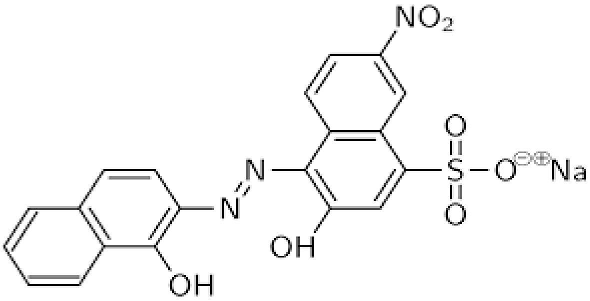


Figure 5. Eriochrome Black T

Eriochrome Black T is used as an indicator for complexometric titrations. It functions as an acid-base indicator. (e.g. in the water hardness determination process). It is an azo dye Eriochrome Black T forms complex with Ca^{2+} and Mg^{2+}, but it binds more strongly to Mg^{2+} ions.

Eriochrome Black T is a hydroxyl-arylazo dye and is generally supplied as a monosodium salt. This dye exists as a dark violet powder with green metallic sheen. Eriochrome Black T is soluble in water and alcohol, but insoluble in common organic solvents. It is mainly used as an indicator in ethylenediaminetetraacetic acid (EDTA) method to determine hardness of water.

- Molecular formula: $C_{20}H_{12}N_3NaO_7S$
- Molar mass: 461.380
- Appearance: black powder
- In its deprotonated form, Eriochrome Black T is blue. It turns red when it forms a complex with calcium, magnesium, or other metal ions

Figure 6. EBT is blue in a buffered solution at pH 10. It turns red when Ca^{2+} ions are added.

CHAPTER 2

LITERATURE SURVEY

Adsorption is a process that occurs 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, 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 colour their products. Ever since the synthesis of the first metallizable azo dye, alizarin yellow, from diazotized 4-nitroaniline and salicylic acid by the German chemist Rudolf Nietzki in 1887, followed by the synthesis of the first metallizable 2-2'-dihydroxy azo dye by E. Bergmann and O. Borgmann in 1893 dyes formed as a result of the chelation of a metallic ion by an aromatic o, o-dihydroxy azo compound have generated continuous commercial interest. Famous for their light fastness (great resistance to fading in sunlight), the so-called “metal-complex dyes” have a great number of applications. Apart from a few restrictions affecting a handful of synthetic fibres, the dyeing industries are satisfied that virtually all substrates can be printed or dyed by them, with a dull shade. In fact, many shades of yellowish-green can be attained by mixing these dyes. The dyeing industries continually search for new shades by mixing different dyes and observing the resulting color. New metal azo dyes are continuously being synthesized and reported, e.g., Myek et al. synthesized a new azo dye and its iron complex with the organic ligand being 3-

aminophenol produced a set of novel complexes of bispyrazole azo dyes for chemical fibers, each dye containing one of these metallic ions: Ag^+, Fe^{3+}, Co^{2+}, Ni^{2+} or Cu^{2+}; Hussain, El-Wakiel. Herbst & Hunger illustrated the two theoretical structures of an azo-metallic chelate. The nitrogen atom bonded to the least nucleophilic aromatic moiety is usually the one that donates its lone pair of electrons to the metallic ion.

All dyes enter natural ecosystems by three routes: during the synthesis and manufacturing of dyes including wastewaters, during dyeing of textiles, and during the use of finished products. The fate of the metal-azo moiety in the natural environment is largely unknown. This is a difficult task because the major degradation processes are influenced by many environmental variables. Conventional “wisdom” is such that dyes are adsorbed onto activated sludge during sewage treatment and anaerobic reduction in the sediment is a relatively rapid process. In the specific case of metal-azo dyes, it remains unknown whether the metallic ions are released or stays within the complex structure with modified ligands, but refractory metal-azo dyes will find their way into natural bodies of water.

Eriochrome Black T (also known as Mordant Black 11, and hereafter abbreviated to EBT) is a water-soluble mono-azo dye and also a complexing ligand for metallic ions. EBT has many applications, reported that EBT is used to dye silk, wool and nylon after treatment with Cr (III) salts. In fact, it is highly likely that the chelated complex Cr (III)-EBT will form. Non-complexed EBT can be obtained commercially (as its sodium salt), the IUPAC name of which is 3-hydroxy-4- (1-hydroxy-2-naphthylazo)-7-nitro-1-naphthalene sulfonic acid, and its anion (the dye) is shown in Figure 7. EBT is triprotic, the dissociation of the sulfonic acid group being complete. An aqueous solution is red when $pH < 6$, blue at $pH = 7$ to 11, and orange when $pH > 12$. These colorations can be readily observed in the laboratory on titration with NaOH.

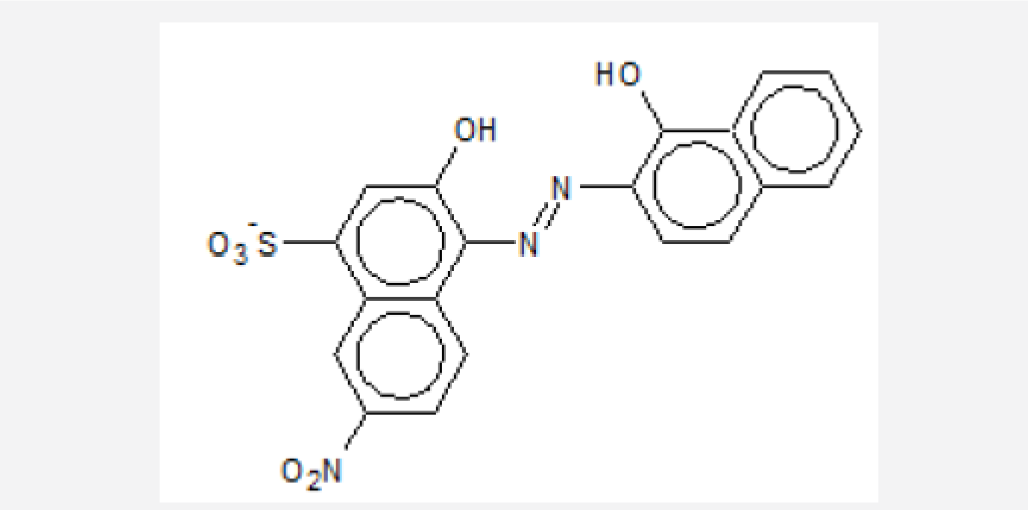


Figure 7. Molecular Structure of EBT

Potential exposure to EBT can cause

- Eye: Causes eye irritation.
- Skin: May cause skin irritation.
- Ingestion: May cause irritation of the digestive tract.
- Inhalation: May cause respiratory tract irritation.
- Chronic: Prolonged or repeated skin contact may cause dermatitis.

In this study, the adsorptive removal of Eriochrome Black T (EBT) from aqueous solution using coconut shell activated carbon was investigated. And the dependence of variable parameters on the adsorption of Eriochrome Black T on biochar was studied.

CHAPTER 3

MATERIALS AND METHOD

MATERIALS REQUIRED

All chemicals in this world were of analytical grade without any further treatment. Eriochrome Black T was purchased from Nicechemicals PvtLtd (India). And Activated charcoal was purchasd from Carbon Solution LLC.

INSTRUMENTS REQUIRED

Hot plate, Hot air oven, Muffle furnance and Electrical shaker.

3.1 COCONUT SHELL 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.

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.

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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.

Figure 8. Extruded Pellets from wood, coconut shell, bituminous coal

3.2 DYE

A dye is a colored substance that chemically bonds to the substrate to which it is being applied. This distinguishes dyes from pigments which do not chemically bind to the material they color. 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 insoluble with the addition of salt to produce a lake pigment. The color of a dye is dependent upon the ability of the substance to absorb light within the visible region of the electromagnetic spectrum (380-750 nm). An earlier theory known as Witt theory stated that a colored dye had two components, a chromophore which imparts color by absorbing light in the visible region (some examples are nitro, azo, quinoid groups) and an auxo chrome which serves to deepen the color. This theory has been superseded by modern electronic structure theory which states that the color in dyes is due to excitation of valence π-electrons by visible light.

3.3 ERIOCHROME BLACK T

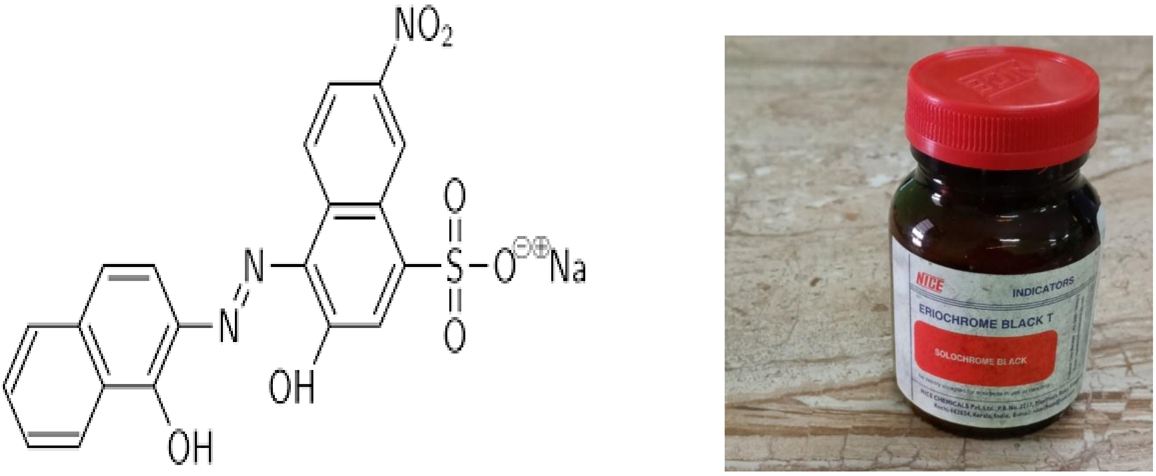

Figure 9. Eriochrome Black T

Eriochrome Black T is used as an indicator for complexometric titrations. It functions as an acid-base indicator. (eg. in the water hardness determination process). It is an azo dye Eriochrome Black T forms complex with Ca^{2+} and Mg^{2+}, but it binds more strongly to Mg^{2+} ions.

Eriochrome Black T is a hydroxyl-arylazo dye and is generally supplied as a monosodium salt. This dye exists as a dark violet powder with green metallic sheen. Eriochrome Black T is soluble in water and alcohol, but insoluble in common organic solvents.

3.4 ADSORPTION EXPERIMENT

Stock solution of Eriochrome black T dye was prepared in 0.001M (1 mM) concentration. The experimental solutions were prepared by diluting the stock solution with distilled water to the required concentration. The adsorption behavior was examined using a batch adsorption method, (3 different concentration of activated charcoal had been taken) which permits a convenient evaluation of the parameters that influence the adsorption process, such as the concentration of dye, chemical contact time and adsorption dosage.

The adsorption experiment, 0.03 g of adsorbent was added to varying concentrations of the dye solutions and shaken mechanically to the required time. After adsorption, the residual concentration of the dyes in the filtrate was determined using a colorimeter at the wavelength corresponding to the maximum absorbance of 546nm. The experiment is repeated by varying the concentration of dye, adsorbent dosage and the contact time. Each time the filtrate is tested using the Colorimeter.

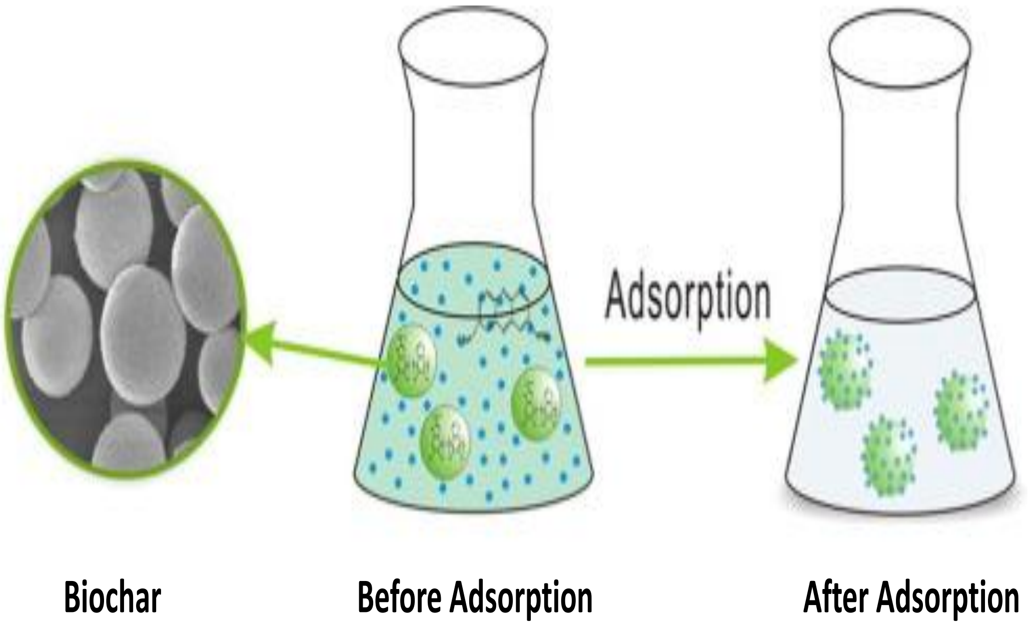

Figure 10. Batch adsorption process of Eriochrome Black T

CHAPTER 4

INSTRUMENTATION

The instruments used for making the bio char, surface modification, and batch adsorption include,

1. HOT AIR OVEN

Laboratory ovens are ovens for high-forced volume thermal convection applications. Those ovens generally provide uniform temperatures throughout. Process applications for laboratory ovens can be for annealing, die-bond curing, drying, polyimide baking, sterilizing, and other industrial laboratory functions. Typical sizes are form one cubic foot to 0.9 cubic meters (32 cu ft) with temperatures that can be over 340 degrees Celsius.Laboratory ovens can be used in numerous different applications and configurations, including clean rooms, forced convection, horizontal airflow, inert atmosphere, neutral convection, and pass through.

2. MUFFLE FURNACE

A muffle furnace (sometimes report furnace in historical usage) is a furnace in which the subject material is isolated from the fuel and all of the products of combustion, including gases and flying ash. After the development of high-temperature electric heating elements and widespread electrification in developed countries, new muffle furnaces quickly moved to electric design. Today, a muffle furnace is (usually) a front- loading box-type oven or kiln for high- temperature applications such as fusing glass, creating enamel coatings, ceramics, and soldering and brazing articles. They are also used in many research facilities, for example by chemists in order to determine what proportion of a sample is non-combustible and non-volatile (i.e., ash). Also advances in materials for heating elements, such as molybdenum disilicide, can now produce working temperatures up to 1,800 degrees Celsius, which facilitate more sophisticated metallurgical applications.

The term muffle furnace may also be used to describe another oven constructed on many of the same principles as the box-type kiln mentioned above, but takes the form of a long, wide, and thin hollow tube used in roll- to-roll manufacturing processes. Both of the above mentioned furnaces are usually heated to desired temperatures by conduction, convection, or blackbody radiation from electrical resistance heating elements. Therefore, there is (usually) no combustion involved in the temperature control of the system, which allows for much greater control of temperature uniformity and assures isolation of the material being heated from the byproducts of fuel combustion.

3. 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.

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.

4. COLORIMETER

A colorimeter is a device used in colorimetry. In scientific fields the word generally refers to the device that measures the absorbance of particular 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.

Digital Colorimeter

Cuvettes: In a manual colorimeter the cuvettes are inserted and removed by hand. An automated colorimeter (as used in an AutoAnalyzer) is fitted with a flowcell 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.

CHAPTER 5

RESULTS AND DISCUSSION

FACTORS AFFECTING ADSORPTION OF DYE

There are many factors affecting dye adsorption such as solution pH, temperature, initial dye concentration, etc. Thus, the effects of these parameters are to be taken into account. Optimization of such conditions will greatly help in the development of industrial-scale dye removal treatment process. In this section, some of the factors affecting adsorption of dyes are discussed below:

- **Effect Of Initial Dye Concentration**

About 0.001 M (1 mM) initial Eriochrome black T concentrations of 0.625, 1.25, 2.5, 5 and 10 ml were used in conjunction with 0.05g of adsorbent (bio char) at room temperature and orbital shaker speed of 200rpm. The Eriochrome black T solutions were made upto 10 ml by water. The initial absorbance of the dye was noted at using colorimeter.After 30 minutes of shaking, aliquots were withdrawn, filtered and their absorbance was measured. The experiment was repeated three times.

The amount of adsorption for dye removal is highly dependent on the initial dye concentration. The effect of initial dye concentration depends on the immediate relation between the concentration of the dye and the available sites on an adsorbent surface. In general, the percentage of dye removal decreases with an increase in the initial dye concentration, which may be due to the saturation of adsorption sites on the adsorbent surface. On the other hand the increase in initial dye concentration will cause an increase in the capacity of the adsorbent and this may be due to the high driving force for mass transfer at a high initial dye concentration.

Stock solution of Eriochrome black T dye was prepared in 0.001M (1 mM) concentration. The experimental solutions were prepared by diluting the stock solution with distilled water to the required concentration. The adsorption experiment, 0.1g of adsorbent was added to varying concentrations of the dye solutions and shaken mechanically to the required time. After adsorption, the residual concentration of the dyes in the filtrate was determined using a colorimeter at the wavelength corresponding to the maximum absorbance of 670nm. The experiment is repeated by varying the concentration of dye, adsorbent dosage and the contact time. Each time the filtrate is tested using the Colorimeter.

- **Effect Of Amount Of Adsorbent.**

About 10 ml of 0.001 M (1 mM) Eriochrome black T solution was placed in 250ml Erlenmeyer flask and used in conjunction with 10, 20 and 30 mg of adsorbent (biochar) at room temperature and orbital shaker speed maintained at 200rpm. Aliquots were then withdrawn after 30 minutes filtered and their absorbance measured using colorimeter.

Adsorbent dosage is an important process parameter to determine the capacity of an adsorbent for a given amount of the adsorbent at the operating conditions. 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 the amount of the adsorbent. The effect of adsorbent dosage gives an idea for ability of a dye adsorption to be adsorbed with a smallest amount of adsorbent, so as to recognize the capability of a dye from an economical point of view.

- **Effect Of Contact Time**

About 0.05g (50 mg) of adsorbent (biochar) with 10ml of 0.001M (1 mM) initial Eriochrome black T concentration was kept constant for batch experiments at room temperature in a 250ml Erlenmeyer flask placed on an orbital shaker preset at 200 rpm. The initial absorbance of the dye was noted using colorimeter. After every 10 minutes aliquots were withdrawn, filtered and their absorbance was measured. The experiment was done for 30 minutes contact time and repeated three times.

Table 1 Colorimetric transmittance value of Eriochrome Black T aqueous solution before and after adsorption by coconut shell bio char.

TIME (Minutes)	**TRANSMITTANCE (%)**	
	Before adsorption	**After adsorption**
0	26	26
10	26	45
20	26	57
30	26	75
40	26	83
60	26	85
80	26	84

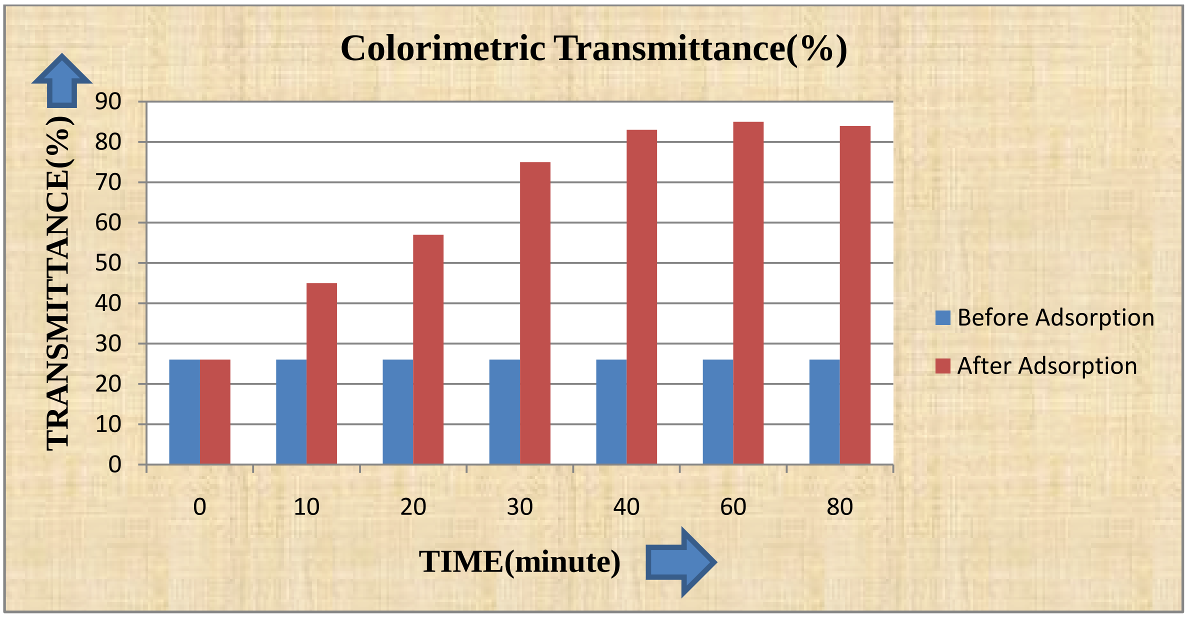

Figure 11. Colorimetric transmittance value of Eriochrome Black T with time

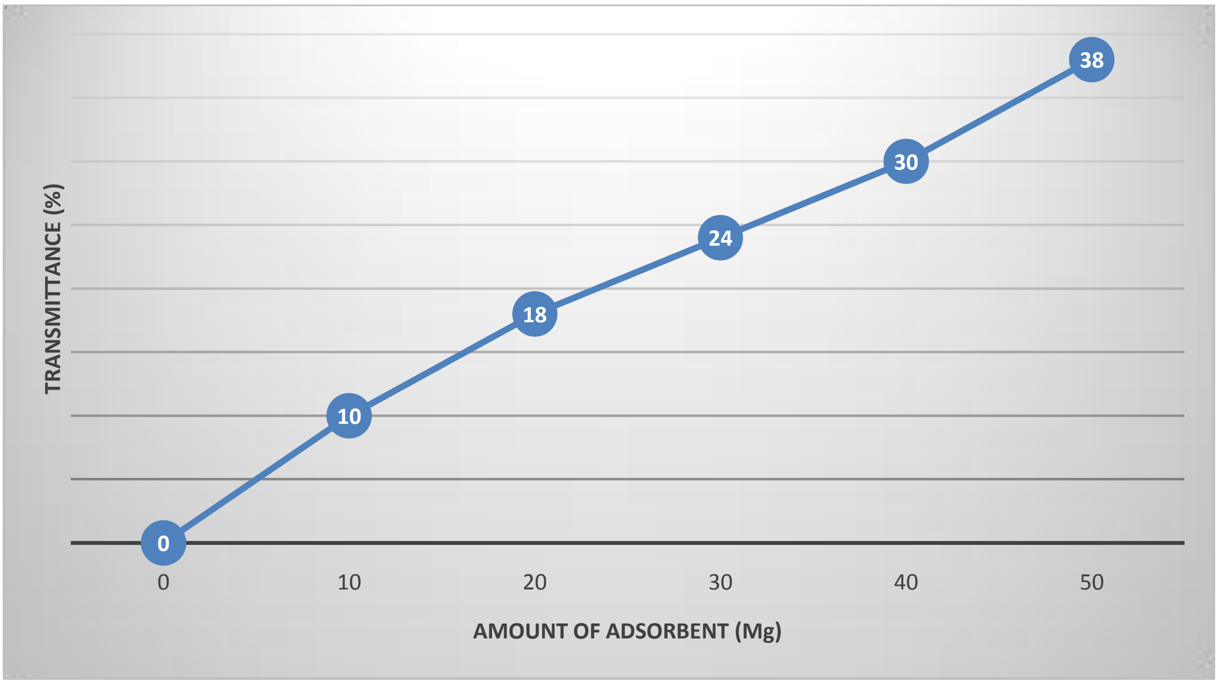

Figure 12. Colorimetric transmittance value of Eriochrome Black T with amount of adsorbent

Generally the percentage of dye removal increases with increasing adsorbent dosage where the quantity of adsorption sites at the surface of adsorbent and the time of adsorption So the rate of adsorption increases with increase in time and increase in adsorbent dosage.

CHAPTER6

CONCLUSION

The project deals with study of determination of adsorption of Eriochrome black T on bio chars .Absorbance were analysed by using colorimetry**.** Initially calibrated the concentration of dye solution and observed the minimum amount as 0.001Mm for getting reliable result. The different adsorption experiment with this concentration of and varying adsorb amount resulted 30mg is a minimum amount for getting a consistent result. Kinetics of this adsorption abridged the fast adsorption capacity of the activated charcoal. Eriochrome black T adsorption parameters discussed above have been supported the efficiency of activated charcoal towards adsorption from aqueous solution.

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