

A project report on

WATER TREATMENT USING CHEMICALLY ACTIVATED COCONUT CHARCOAL

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CERTIFICATE

This is to certify that the work entitled, **WATER TREATMENT USING CHEMICALLY ACTIVATED COCONUT CHARCOAL**, in partial fulfillment of the requirements for the award of degree of Bachelor of Technology in Chemical Engineering submitted in school of Chemical Engineering of Galgotias University, Greater Noida, is an authentic record of my own work carried out under the supervision “Dr. Gagnesh Sharma” refer works by other researchers that are properly cited in the reference section. This project's subject area has not been proposed for any other degree from this or any other university.

This is to attest that, to the best of my knowledge, the aforementioned claim made by the candidates is accurate and true.

Dr. Gagnesh Sharma

ACKNOWLEDGEMENT

Without the participation and support of a great number of people, many of whose names may not be listed, this undertaking would not have been able to be completed. We truly appreciate and gladly acknowledge their contributions.. We would like to thank our faculty for their endless support in the completion of this research.

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ABSTRACT

The removal of suspended particles and microbiological pathogens from water sources is the main focus of water treatment technologies in the poor countries. However, as industry ¹⁸ spread into developing nations, chemical contaminants like colouring chemicals have entered drinking water sources and have been connected to a number of health-related problems. The present simulation was inspired by the fact that there hasn't been a lot of research done in this area. Activated carbon can remove these substances from water sources since the objectives for water use and the chemical constituents differ greatly. The goal of the current project is to purify water using activated charcoal powder made from coconut husk.

By introducing calcium chloride solution, the material is chemically activated. Three solution samples are decolorized using shell-based activated carbon (Blue). To determine the moisture, volatile, ash, and fixed carbon contents of the charcoal, the sieve examination of the coconut husk is conducted first. Prior to and during sample treatment with the generated activated charcoal, maximum absorbances at three normalities (0.01N, 0.02N, and 0.03N) of the aforementioned three samples are compared. A few results are shown in abstract form to help with colour removal.. Figures 1 and 2 show a comparison of the maximum absorbance of a potassium permanganate solution at various normalities and a close-up study of coconut charcoal, respectively. It has been seen that the sample's maximum absorbance changes for various normalcy solutions and is lower than before it was treated with activated charcoal. It can also be inferred from earlier findings that the graph created for the maximum absorbance vs. various solution normalities is linear.

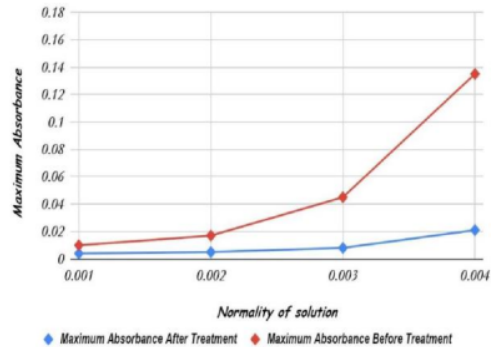
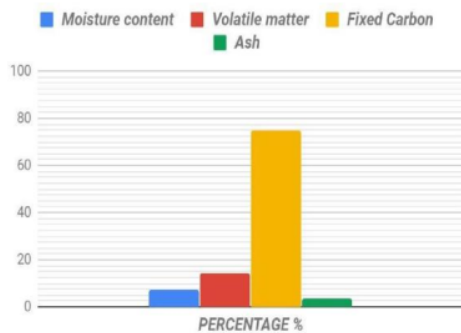


Figure. 1 Proximate analysis of coconut charcoal **Figure.2 Comparison of Maximum Absorbance of Potassium Permanganate solution at different normalities**

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CHAPTER 1: INTRODUCTION

Population growth has fueled the expansion of numerous companies, which has resulted in the release of pollutants into water bodies. The textile, culinary, cosmetic, and paper sectors are among those that cause dye leaks that require prompt care. Different organic substances give water its colour, preventing sunlight from penetrating the water's surface and harming the aquatic ecosystem. Many researchers have published various approaches to solve this problem, including decantation, coagulation and Chemical oxidation, membrane filtration, and flocculation. One of these processes is a tried-and-true method for dealing with dye removal. Carbon black is one such adsorbent..

Color contamination in wastewater has negative environmental effects that may directly affect our business. Organizations face pressure to adhere to stringent trade or discharge effluent restrictions or else risk receiving hefty fines. The sustainability of manufacturing practises has also received a lot of attention in recent years, with water contamination and scarcity taking centre stage.

Customers are now choosing to spend their money with businesses that operate sustainably and with consideration for the environment. Negative press has been directed at manufacturing plants for failing to clean tainted, discoloured wastewater, harming their reputation and decreasing customer loyalty. From a different angle, colour directly affects drinking water provided by local utilities since consumers desire an always-clear, aesthetically beautiful supply.

What causes coloured water?

Natural dissolved organics as natural tannins, humic and fulvic acids, as well as synthetic chemical dyes can all contribute to the colour of water. The impacted water supply must have the colour removed in order to be suitable for consumption and industrial processes.

Different manufacturing processes might contribute to the occurrence of colour in wastewater. The aesthetic value of water can be impacted by colour, however if coloured wastewater is released into the environment, photosynthetic activity is reduced, which has been shown to have a negative impact on aquatic ecosystems.

You can prevent regulatory penalties and reputational harm by employing an innovative onsite treatment procedure to get rid of difficult-to-treat dyes and color-causing compounds. Businesses that utilise water in their production processes are obligated to make sure that any water discharged into the environment or municipal sewer has been treated and complies with applicable discharge laws or guidelines.

In water, suspended and dissolved particles affect colour. Water bodies may have suspended particles as a result of both natural and human-caused factors. Low productivity is indicated by transparent water that has little dissolved material accumulation and appears blue. A yellow or brown tint can result from debris, such as decomposing plant matter. Reddish or dark yellow waters are caused by some algae or dinoflagellates. Phytoplankton and other algae-rich waters typically have a green appearance. Various shades of yellow, red, brown, and grey are produced by soil runoff. The amount of naturally occurring dissolved organic acids, such as tannins and lignins, which give water a tea colour, may also have an impact on colour. These are created when organisms progressively break down plant matter into incredibly minute particles that dissolve in water.

The most prevalent type of tannins found in lakes and streams are those that range in colour from yellow to black and can significantly affect the colour of water. Pine needles that fall to the ground move quite slowly, so deteriorate, lakes surrounding by coniferous forests (Evergreen trees like fir, spruce, hemlock, and pine) are often brown in hue.

In marshes that surround lakes, where plants decay very slowly, this is also true. Groundwater and surface water may have naturally occurring organic substances like tannins and lignins, which are produced during the breakdown of plant and animal matter, that can give them a musty smell and a tea-like yellow-brown colour. This is why some water is referred to as "root beer" coloured. The tannins from decomposing plants and tree roots that seep into runoff water give the area its dark hue. This colour is typical and is visible in environments like marshes or still ponds. By putting some leaves in a bucket of water and letting it sit for a few weeks, one can make it.

Millions of litres of this effluent, which is rich in colour and organic compounds from dyeing and finishing salts, are released by mills as hazardous toxic waste. The effluent is extremely dangerous due to the presence of Copper, arsenic, lead, cadmium, mercury, nickel, and cobalt are examples of heavy metals. as well as additional auxiliary chemicals such as soaps, naphthol, acetic acid, nitrates, vat dyes, and others. Other dangerous substances that may be found in the water include non-biodegradable colouring products, hydrocarbon-based softeners, and formaldehyde-based colour fixing agents.

Additionally, the mill effluent frequently has a high pH and temperature, both of which are quite harmful. The presence of colloidal matter, in addition to colours and oily scum, raises the turbidity and impairs the appearance and odour of the water. It blocks sunlight from penetrating, which is important for the photosynthesis process. This disrupts the process for oxygen transfer at the air-water contact. The most serious impact of textile waste is the depletion of dissolved oxygen in water because dissolved oxygen is crucial for marine life. Additionally, this makes it more difficult for water to purify itself. Additionally, when this effluent is allowed to run in the fields, it plugs the soil's pores, reducing the productivity of the land. The soil's texture changes.

The sewerage pipes become corroded and incrustated by the effluent that passes down the drains. Allowing it to flow in rivers and drains degrades the drinking water quality in hand pumps, rendering it unsafe for human consumption. Additionally, it causes leaks in drains, which raises the expense of maintenance. Such contaminated water can serve as a haven for bacteria and viruses to reproduce. Water impurities have a variety of effects on the textile processing. When they bleach and scrub white fabric, they give it a yellow tint. Metallic ions in the water can occasionally mix with the dyes during the dyeing process, dulling the colours. Significant amounts of environmental damage and human illness are brought on by textile wastewater.

A recognised carcinogen, chlorine, is organically bonded in around 40% of colourants used worldwide. Since they react with many disinfectants, particularly chlorine, all the organic compounds found in wastewater from the textile sector are a major concern in the water treatment process. Chemicals can affect infants even before birth since they can vaporise into the air we breathe or be absorbed through our skin and manifest as allergic reactions.

Similar to graywater, which is wastewater from sinks, dishwashers, showers, hand basins, bathtubs, and washing machines, greywater contains bacteria, dangerous chemicals, bleach, and hazardous fats and oils that are harmful to human health. High bacterial load, nutrient discharge, biological oxygen demand, and salinity effects can all have an influence on water quality and public health when greywater is not treated. Greywater that has not been treated has less than 24 hours to become septic.

Although greywater discharge from ships contributes relatively little to the overall quality of the aquatic environment, it is an important localised source of pollution that can and should be avoided. There are increasing number of boats that offer high-end amenities with significant greywater output, including ensuite bathrooms, dishwashers, washing machines, and even spa baths.

The receiving aquatic ecosystem can be harmed by the greywater produced from these sources,

particularly in marinas, mooring places, and protected bays where an increase in overnight vessels with wastewater-producing facilities leads to a larger concentration of wastewater. When discharged close to shore in estuaries, bays, rivers, and marinas, it raises the most alarm.

Greywater discharge plumes have the potential to stick to the water's surface and collect contaminants (especially nutrients) near the source vessel or nearby vessels. Algae is known to pose challenges for ship operators, especially in marina basins, and is fueled by an excess of nutrients..

1.1 LITERATURE REVIEW

In this age of water scarcity, recycling water has become a common practise around the world. The idea of using greywater as a source of water for some uses originated because of the rise in population and the resulting rise in water demand. Greywater flow from a residence typically makes up 65 percent of the overall flow. The meaty (mesocarp) portion of a coconut is either consumed or utilised to process oil, while the husks are typically dumped and are considered waste. In this study, calcium chloride was employed as the activating agent and coconut husks were carbonated in order to create activated carbon.

Fog, groundwater, and drinkable water are all treated using the same method used to make charcoal from coconut shells and other shell-based materials. Additionally, the activated charcoal created can be utilised to remove colour from liquids (ISSN (Online):2278-5299, 2015). Chemical activation transforms coconut shell carbon into activated carbon. The 2017 ISSN (Online): 2319 - 6734 study examined the characteristics of coconut shell activated carbon, including pH, moisture content, ash content, volatile matter content, and fixed carbon. In a related study by Das et al. (2015), activated carbon was produced using green coconut shell, and various physical characteristics, including bulk density, moisture content, volatile matter content, ash content, surface area, and porosity, were measured. It was utilised to take CO₂ out of flue gas.

The absorbance of five concentrations of potassium dichromate at eight wave lengths in the UV region are discussed by R. W. Burke and R. Mavrodineanu (Vol. BOA, No. 4, July-August 1976). This information is helpful in comparing the maximum absorbances of coloured sample solutions before and after being treated with activated carbon. Coconut charcoal derived from agricultural waste was intended to be used as an adsorbent for dye removal from textile effluent in MATEC Web of Conferences 119, 01019 (2017). Basic yellow13 and basic red14 were employed as representative dyes used in textile manufacturing factories, while coconut shell charcoal was used as a dye adsorbent..

Greywater treatment employs activated charcoal filters, and the quality of the processed water was assessed in ISSN 1652-6880 against Jordanian irrigation water standards (2013). A number of tests looked at how artificial greywater could be treated to reduce BOD, COD, phosphate, nitrogen, disease markers, and tracer bacteria.

Review of low cost greywater treatment technologies for Kushvarta Kund tank water reuse in daily life is included in the 2019 edition of e-ISSN: 2395-0056, which also served as a case study for the project. The features of grey water , along with information on 22 greywater treatment technologies and norms and recommendations for wastewater reuse.

One of the most plentiful resources is water. Around 700 million Indians experience a water scarcity, and 200000 people die annually as a result of insufficient access to clean water, making this the biggest water disaster in India's history. Greywater offers a great deal of possibilities for reuse and recycling. To enhance reuse behaviours at the local level, greywater treatment technologies must be developed.

CHAPTER 2: PRODUCTION OF ACTIVATED CARBON

A particular class of carbonaceous material is activated carbon. Its form is very crystalline, and its interior pore structure is well developed. Internal pore networks that impart specific surface chemistries (functional groups) into each particle are produced as a result of activation. Thus, carbon acquires its distinctive properties that contribute to its high surface area, porosity, and increased strength. The size of the molecule being adsorbed and the pore size of the adsorbent are both factors in the adsorbent's absorptivity. Unburned hydrocarbons from auto exhaust, dangerous gases from the atmosphere, and undesired colours from some items are all removed using adsorption by charcoal.

Because they are affordable, simple to manufacture, and offer the option of customising qualities, composition, primarily utilised in adsorption operations. Investigating efficient and affordable activated carbon may help to promote environmental sustainability and provide advantage for upcoming commercial uses. When compared to the price of commercial activated carbon, the cost of activated carbon made from biomaterials is quite low.

In addition to its many other uses, activated carbon is used in the storage of methane and hydrogen, the decaffeination of coffee, the purification of gold and metals, the filtration of compressed air used in gas masks and respirators, the whitening of teeth, the production of hydrogen chloride in the dark, and many other processes.

Industrial application

Utilizing to clean is a significant industrial use. For instance, it is the primary method of purification used to eliminate organic contaminants from solutions used for brilliant nickel plating. To improve the deposit attributes of plating solutions and to enhance features like brightness, smoothness, ductility, etc., a range of organic compounds are added.

Organic additions cause unintended breakdown products to be produced in solution as a result of flow and the electrolytic processes of anodic oxidation and cathodic reduction. They can have a negative impact on the physical characteristics of deposited metal and the plating quality. Such contaminants are eliminated during activation carbon treatment, which also returns plating performance to the optimum level.

Medical applications

Following oral intake, activated carbon is used to treat poisonings and overdoses. Many nations utilise tablets or capsules of activated carbon as an over-the-counter remedy to alleviate diarrhoea, indigestion, and gas. But if the poisoning was brought on by the consumption of corrosive substances such as alkalis and strong acids, iron, boric acid, lithium, petroleum products, or alcohol, activated charcoal has no effect on intestinal gas and diarrhoea and is typically unsuccessful medically. These compounds won't be stopped from entering the body by activated carbon.

It is particularly unsuccessful when used to treat poisonings caused by cyanide, iron, lithium, arsenic, strong acids or alkalis, methanol, ethanol, or ethylene glycol. Inappropriate application (such as into the lungs) causes pulmonary aspiration, which can occasionally be fatal if prompt medical attention is not sought.

Analytical chemistry applications

In low-pressure chromatographic separation of carbohydrates (mono-, di-, and tri-saccharides) utilising ethanol solutions (5 to 50 percent) as mobile phase in analytical or preparative methods, activated carbon is utilised in a 50 percent by weight combination with celite as the stationary phase.

Direct oral anticoagulants (DOACs) including dabigatran, apixaban, rivaroxaban, and edoxaban can be

extracted from blood plasma samples using activated carbon. It has been created with this in mind. for converting 1ml samples into "mini pills," each containing 5mg of activated carbon (DOAC Stop, www.haematex.com). Since heparin, most other anticoagulants, and blood clotting factors are unaffected by this activated carbon, a plasma sample can be examined for anomalies that the DOACs would normally influence.

Applications for activated carbon include the purification of municipal drinking water, food and beverage processing, odour elimination, and industrial pollution control. Carbonaceous source materials, including coconuts, nutshells, coal, peat, and wood, are used to make activated carbon. Any organic material with a high carbon content serves as the main source material for activated carbon.

Adsorption is a technique used to remove a soluble component from water using a solid. The material used in this procedure is activated carbon. In order to create a relatively large interior surface (between 500 and 1500 m²/g), activated carbon is particularly synthesised. Active carbon is excellent for adsorption because of its large interior surface. Granular activated carbon (GAC) and powder activated carbon (PAC) are the two different types of active carbon (GAC). The GAC variant can absorb the following soluble compounds and is typically used in water treatment.

The nearest chemical structure to that of activated carbon is that of pure graphite. The weak van der Waals forces that hold the layers of fused hexagons that make up the graphite crystal together. Bonds between carbon atoms keep the layers together. Activated carbon is a disorganised type of graphite because of impurities and the preparation method used to make it (activation Procedure). The raw material and production process have a significant impact on the pore structure that develops in the activated carbon and, consequently, the final qualities of the material.

A palm tree family member noted for its many applications is the coconut. The coconut shell contains cellulose, lignin, charcoal, tar, tannin, and other materials. The trunk of coconut trees is smooth, columnar, light grey-brown, with a mean diameter of 30 to 40 cm and a terminal crown of leaves on top. Tall selections can grow to a height of 24–30 m. Shell charcoal is a significant byproduct of coconut shell extraction. Shell charcoal is a common fuel for homes and businesses.

Additionally, goldsmiths, laundries, and blacksmiths employ it. Activated carbon is also created using shell charcoal. As the raw material may absorb certain molecular species, coconut shell activated carbon has several unique benefits..

2.1 MATERIAL REQUIRED

There are several different basic materials from which activated carbon can be produced. The main need is that there should be a significant amount of carbon in the raw material. Other factors, like as ash content and trace impurities, are also significant because they affect the qualities of the finished product and are included in it.

From a wide range of raw materials, activated carbon can be created primarily using two techniques: physical activation, chemical activation, or a combination of the two. The feed materials utilised and the method of activation affect the adsorption capabilities of activated carbon. By selecting a cheap raw material and carrying out an appropriate production procedure, production costs can be reduced..

Wastes from biomass residues, including those from agriculture and forestry, could be used as acceptable raw materials for the synthesis of activated carbon. Different agricultural leftovers, including hard apricot stone shells, almond, walnut, and hazelnut shells, rice hulls, and liquorice residues, were used as predecessors in the current work. The activation was performed using phosphoric acid under the same conditions. The results showed that at the selected experimental conditions, the type of biomass as well as the final activation temperature, heating rate and impregnation rate of the chemical agent had the greatest influence on the quality of activated carbon.

Iodine number reflecting surface area was used to assess the activated carbon's quality. The findings showed that the hardest apricot stone shells' activated carbon had the best adsorption qualities and the most surface area.

Coal (including anthracite, bituminous, sub-bituminous, and lignite), coconut shells, wood (both soft and hard), and peat are the most often utilised raw materials. Numerous alternative raw materials, including (wal-) nutshells, olive stones, and palm kernels, have been investigated; however, the supply of these raw materials is generally their commercial restriction.

Raw materials like coconut shell are used in this project. Additionally, sewage waste water is used for purification.

- **Chemicals**

Calcium chloride and Distilled Water

- **Instrumentation**

Oven,uffle Furnace, Weighing Scale, and Roller Crusher

- **Proximate analysis**

The measurement of moisture, volatile matter, fixed carbon, and ash content using approved procedures is known as proximate analysis..

2.2 Procedure

PROXIMATE ANALYSIS OF CHARCOAL

The proportion of a fuel that burns in a gaseous state (volatile matter), in a solid state (fixed carbon), and as inorganic waste (ash), as determined by proximate analysis, is crucial for the use of biomass as a source of energy.

While the volatile content and ash have a negative association with charcoal yield, fixed carbon from biomass has a positive link with it. Thus, it is expected that with greater biomass volatile content lead to greater gas production instead of the solid phase.

Moisture Content

The amount of water that is present in a substance, such as soil (also known as soil moisture), rock, ceramics, crops, or wood, is referred to as its water content or moisture content. In a wide variety of scientific and technological fields, the term "water content" is used. It is stated as a ratio and can range from 0 (totally dry) to the porosity of the material at saturation. It can be administered either voluminously or massively (gravimetrically).

Less than 1% of freshly kilned charcoal includes moisture, which is extremely low. Even with well-burned charcoal, quick air's and gradual moisture acquisition over time—which can occur even in the absence of rain—can raise the moisture content to between 5 and 10 percent.

Moisture is that reduces the ability to heat things up. When charcoal is sold by weight, dishonest sellers frequently wet the charcoal to maintain a high moisture level. The addition of water scarcely alters the amount or appearance of charcoal. Because of this, buyers in bulk of charcoal prefer to purchase, such as through a laboratory test before adjusting the price. Sales are frequently made piecemeal in tiny marketplaces.

For one hour, dried coconut husk is cooked in an oven at 110 °C. The silica crucible was taken out after heating and cooled in a dessicator. The dried sample's weight was determined after cooling.

Fixed carbon content

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Charcoal has a constant carbon content that ranges from a low of approximately 50% to a high of about 95%. So, the major component of charcoal is carbon. The percentages of all other parts are subtracted from 100 to determine the "difference," which is typically understood to be the percentage of "pure" or "fixed" carbon. The most crucial component in metallurgy is the fixed carbon content since it is fixed carbon that reduces the iron oxides in iron ore to make metal. To achieve optimal blast furnace performance, the industrial user must balance the greater strength of charcoal with a lower fixed carbon and higher volatile matter content against the friable quality of high fixed carbon charcoal.

➤ FORMATION OF ACTIVATED CHARCOAL

- A. To remove any dust that has adhered to the coconut shell, it is first gathered, split into little pieces, and then washed with plain water. After that, it was let to dry in the sun for 15 to 20 days.
- B. With the aid of a roll crusher, these fragments are reduced to coconut husk powder.
- C. The moisture in this powdered material is then removed by heating it in an oven for 2:30 hours at 110°C.
- D. The muffle furnace was used to remove moisture and other volatile contaminants from dried materials by holding it at 150°C for two hours. As a result, fixed carbon was created (charcoal).

- E. For the first batch of fixed carbon, the complete piece is heated to 300 °C in a muffle furnace to create ash for close inspection. Other batches were just stopped at step D, and chemical activation came next.
- F. For 24 hours, 100 grammes of activated carbon from coconut shells were carbonised in 100 ml of a 25 percent CaCl₂ solution. To get rid of any remaining chemical residue, the soaked sample was put into a drain pan and repeatedly rinsed with distilled water. The cleaned sample was placed in an oven set at 110°C for three and a half hours, cooled, and then placed in storage.
- G. 11 coconuts are used to prepare 180 g of charcoal over the course of 9 batches.



Figure 1: Roll Crusher



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Figure 2: Oven



Figure 3: Coconut Husk



Figure 4: Activated Charcoal



Figure 5: Muffle Furnace



Figure 6: Dessicator



Figure 7: Ash Content



Figure 8: Cleaning of Activated Charcoal

2.3 PROCESS USED

To increase the amount of water vapour adsorbed at low relative pressure (P/P_0), activated carbons (AC) coated with the hygroscopic salt CaCl_2 were created. Desiccant air conditioners and adsorption heat pumps are two potential uses for these materials. Since the addition of CaCl_2 makes carbon more hygroscopic, increasing the surface area of pores also increases the likelihood for chemical and physical adsorption.

2.3.1 ADSORPTION

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The adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface is known as adsorption. Through this procedure, an adsorbate film is formed on the adsorbent's surface. In contrast to absorption, which occurs when a liquid or solid (the absorbent) dissolves or permeates a fluid (the absorbate), this procedure doesn't include absorption. In contrast to absorption, which affects the entire volume of the substance, adsorption is a surface PROCESS.

Adsorption occurs naturally in a variety of physical, biological, chemical, and physical systems. It is frequently used in industrial settings for things like activated charcoal, heterogeneous catalysts, capturing and using waste heat to create cold water for air conditioning, and other Procedure requirements. The treatment of waste gases (and waste water) and the adsorption of organic compounds and non-polar adsorbates are two common uses for activated carbon.

The majority of its chemical (such as surface groups) and physical (such as pore size distribution and surface area) features may be adjusted depending on the application, making it the most used adsorbent. Its huge surface area and big micropore (and even mesopore) volume are additional factors that contribute to its utility.

CHAPTER 3: TREATMENT OF COLOUR SAMPLES

Manganese oxide ore and potassium hydroxide are combined to form the common chemical compound potassium permanganate. In 1857, it was created for the first time as a disinfectant. Since then, a range of skin disorders, including fungus infections, have been successfully treated with it. You'll need a prescription from your doctor in several nations, including the United States, in order to get potassium permanganate.

When potassium permanganate is applied to skin, it kills bacteria by releasing oxygen when it comes into contact with substances in your skin. Additionally, it functions as an astringent, a drying agent.

The following are a few of the conditions that potassium permanganate can aid in treating:

Eczema with a virus. Drying them out with potassium permanganate can help open wounds with blisters. For blistering or pus-oozing sores on the surface of your skin, potassium permanganate is applied wetly both impetigo and athlete's foot. Athlete's foot and impetigo are examples of bacterial and fungal skin illnesses that can be treated with potassium permanganate.

Potassium permanganate needs to be diluted because a pure solution could burn people. Even when diluted, it can still irritate the skin and, when used repeatedly, can burn. Generally speaking, potassium permanganate is safe, but it can leave a brown stain on your skin and nails that will go away in a day or two. Additionally, it could leave a difficult-to-remove stain in your bathtub, which is why many people avoid it.

Before using potassium permanganate on your skin, you must dilute this strong solution. It can harm your skin, as well as the mucous membranes in your nose, eyes, throat, anus, and genitals, if it is not diluted.

Inorganic substances with the chemical formula $\text{CuSO}_4(\text{H}_2\text{O})_x$, where x can range from 0 to 5, are copper(II) sulphate and copper sulphate. The most prevalent form is the pentahydrate ($x = 5$). Older names for this substance include Roman vitriol, copper vitriol, blue vitriol, and bluestone.

The most frequent salt found is the pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), which is a vivid blue colour. It exothermically dissolves in water to form the octahedral molecularly shaped aquo complex $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$. The solid pentahydrate structure reveals a polymeric structure in which copper is once more octahedral but is now coupled to four water ligands. Sulfate anions link the $\text{Cu}(\text{II})(\text{H}_2\text{O})_4$ centres

together to create chains. The powder form of anhydrous ²⁷ copper sulphate is grey.

The inorganic substance with the formula K_2CrO_3 is potassium chromate (K_2CrO_4). The potassium salt of the chromate anion is represented by this yellow solid. It is a typical laboratory substance, whereas sodium chromate plays a significant role in industry. It includes hexavalent chromium, which makes it a class two carcinogen.

It is known to exist in two crystalline forms, both of which resemble the equivalent potassium sulphate. The typical form of K_2CrO_4 is orthorhombic, however beyond $66\text{ }^\circ\text{C}$, it transforms into a -form. Despite the sulphate adopting the conventional tetrahedral geometry, these formations are complicated.

When an anhydrous salt is required, potassium salt is typically employed in laboratories rather than the more affordable sodium salt. In organic synthesis, it functions as an oxidising agent. It serves as a colorimetric test for silver ions, for example, in qualitative inorganic analysis. As potassium chromate glows red in the presence of an excess of silver ions, it is also employed as an indicator in precipitation titrations with silver nitrate and sodium chloride (they can be used as standard and titrant for each other).

3.1 MATERIAL REQUIRED

Chemicals: Solutions of $KMnO_4$, $CuSO_4$, and K_2CrO_4 at .001N, .002N, .003N, and .004N concentrations

Instrument: U.V Spectrophotometer

3.2 Procedure

- Each of $KMnO_4$, $CuSO_4$, and K_2CrO_4 had 100 ml samples made for .001N, .002N, .003N, and .004N concentrations.
- UV spectrophotometers are used to measure their absorption.
- Following a 3 gm treatment with activated charcoal, a uv spectrophotometer is used to detect the maximum absorbance of the samples.
- The maximum absorbance vs. normalities for each sample solution's before- and after-treatment is presented on a graph.



Figure 10: Spectrophotometer



Figure 11: Filtration after Treatment of KMnO_4

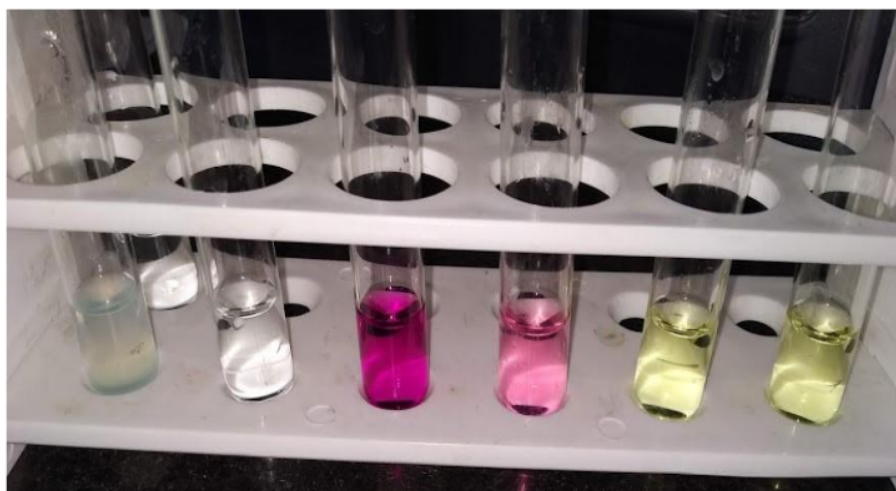


Figure 12: Comparison of samples is given (from left side) Untreated CuSO_4 , Treated CuSO_4 , Untreated KMnO_4 , Treated KMnO_4 , Untreated K_2CrO_4 , Treated K_2CrO_4 .

3.3 PROCESS USED

Adsorption is the property of all solids to draw molecules of gases or liquids to their surfaces when they come into contact. The molecules that are adsorbed are typically referred to as the adsorbate, and the solids employed to do so are known as adsorbents. The charcoal found in gas masks, which is used to filter toxins or other contaminants from an air stream, is an outstanding example of an adsorbent. The elements' colours are here adsorbing in the gaps between the pores of the activated carbon. Adsorption therefore happens more frequently as a result of CaCl₂'s hygroscopic nature.

2.4 TESTS APPLIED

23 > COD

The chemical oxygen demand (COD), a useful indicator of how much oxygen can be used by processes in a measured solution, is used in environmental chemistry. It is frequently stated as the mass of oxygen consumed over the volume of the solution, or milligrammes per litre (mg/L), in SI units. It is simple to determine the concentration of organics in water using a COD test.

Quantifying the amount of oxidizable contaminants present in surface water (such as lakes and rivers) or wastewater is the most typical application of COD. In terms of water quality, COD is helpful because it offers a metric to assess how an effluent would affect the receiving body.

A powerful oxidising agent is often used for chemical oxygen demand testing. In an acidic environment, organic matter oxidises into carbon dioxide and water.

Calculating the amount of organic matter or the demand for oxygen involves figuring out how much of an oxidising agent was used during the test.

Testing for chemical oxygen demand is frequently done on wastewater. By counting the amount of organic matter in the water, the contamination level is determined.

The environment where wastewater is discharged may suffer if there is too much organic material in the water.

Both chemical and biochemical oxygen demand calculations are used to determine the oxygen demand of a water sample. The difference between the two is that while biological oxygen demand solely accounts for the oxygen required by living things, chemical oxygen demand measures everything that can be oxidised.

The laboratory standard procedure known as the Dichromate-Method and the COD (Chemical Oxygen Demand) are closely connected. Using this technique, the chemical oxygen requirement for the chromic acid breakdown of organic loads in waste water is calculated.

The COD became a widely utilised sum parameter in waste water analysis as a result of this methodology. It is used to plan waste water treatment facilities, monitor cleaning effectiveness, and compute waste water taxes.

PROCEDURE:

- a. Add the following in order to 15 ml COD digestion tubes that have been previously cleaned with diluted H₂SO₄
- b. Transfer either a 1.00 ml treated sample or a 0.50 ml wastewater sample (inlet).
- c. Slowly pour in 2.5 ml of the normal potassium dichromate digestion reagent and stir.
- d. Through the sides of the tubes, add 3.5 ml of sulfuric acid reagent and allow it to settle to the bottom.
- e. Wear gloves since the contents are quite hot and cap before mixing and cooling
- f. Transfer tubes to the 150 C preheated COD digester and let them sit for two hours to digest.
- g. Run three blank tests by replacing the sample with DW, then proceed exactly as the sample.

Put the COD digesting tube's contents in a 100 ml beaker. In order to make the volume 50 ml, add distilled water. Titrate the mixture against a 0.05 M solution of ferrous ammonium sulphate using 1-2 drops of ferroin indicator.

$\text{COD as mg O}_2/\text{L} = (\text{A}-\text{B}) \times \text{M} \times 800 \text{ ml sample, with ml FAS used as the blank.}$

sample volume: ml FAS

M. FAS molarity



Figure 13: Digestion tubes



Figure 14: Digester

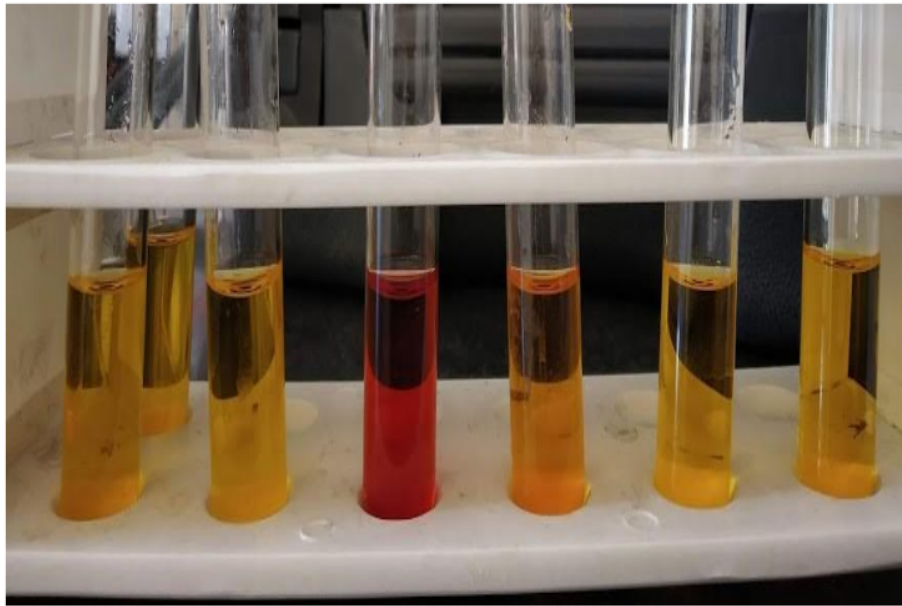


Figure 15: COD Procedure of samples. Comparison of samples is given (from left side) Untreated CuSO_4 , Treated CuSO_4 , Untreated K_2CrO_4 , Treated K_2CrO_4 . Untreated KMnO_4 , Treated KMnO_4 ,

CHAPTER 4: TREATMENT OF GREYWATER

Greywater is any domestic wastewater that is produced but does not include sewage. The organic loading is the primary distinction between greywater and sewage (or blackwater). Greywater has a substantially lower organic burden than sewage..

Because kitchen wastewater has a relatively high organic loading in comparison to other kinds of wastewater like black water, some people also classify it as "blackwater." The quality and type of the water supply, the type of distribution net for drinking water, the type of distribution net for greywater, household activities, the installation from which greywater is drawn (kitchen sink, bathroom hand basin, or laundry wash), the location, the demographics and level of occupancy, the amount of water used in relation to the amount of substances discharged, and many other factors determine the composition of greywater.

Greywater may be handled effectively by being separated from its source of origin because it is less polluted than blackwater. Greywater needs to be treated before it can be used again, even though it is less filthy than blackwater or sewage. In actuality, none of the features of untreated greywater conform to the norms and guidelines for reuse.

In the current situation, technologies are created solely to evaluate the effectiveness of a specific system. Technologies must be developed with specific reuse in mind, such as agriculture, gardening, flushing, and washing. As a result, a flow diagram combining a variety of technologies by focusing on the type of reuse is required. It has been noticed that a single approach or technology cannot satisfy all reuse requirements. In order to improve grassroots response techniques, it is also necessary to build technologies at the household level.

In nations where phosphorus-containing detergents have not yet been outlawed, powdered laundry detergents are the biggest polluters of greywater. These are frequently quite alkaline, have a high salt concentration, and frequently still include phosphorus. Greywater typically has a N/P ratio of 2, which is far lower than the N/P ratio of 10 that would be ideal for plants to absorb nutrients. If greywater is utilised for irrigation, this is crucial..

Plants with low phosphorus requirements experience limited development as a result of the ongoing usage of recycled greywater with high phosphorus concentration. Powdered laundry detergents have a number of alternatives. These include pure soap flakes, such as Lux soap flakes, or ceramic discs. Liquid detergents, such as Ark, are also an option (e.g. Tri-Clean laundry disks).

In general, relatively little is known about the microorganisms that can be found in greywater. Viruses, bacteria, protozoa, and intestinal parasites are the four main categories of pathogens that can exist. However, while examining microbiological parameters, it can be anticipated that the main health danger is caused by microbial communities of faecal origin in greywater.

Greywater has similar levels of phosphorus, heavy metals, and xenobiotic organic pollutants as

blackwater in terms of concentrations, but it has lower quantities of organic matter, some nutrients (such as nitrogen, potassium), and microbes. Blackwater is any waste from toilets or urinals.

The advantages of reusing greywater are increasingly becoming more widely recognised.

Greywater can be effectively used if treated. These include watering plants, flushing the toilet, and washing clothes. Greywater that has been treated can be used to water plants that produce both food and non-food items. These plants benefit greatly from the nutrients in the greywater, such as phosphate and nitrogen.

- Reusing water does not lower our quality of life, but it can have many positive effects.
- Greywater utilisation has two key advantages:
- lowering the requirement for fresh water Utilizing less fresh water can drastically lower residential water bills while also benefiting the larger community by easing pressure on the public water supply.
- lowering the volume of wastewater that enters sewage networks or on-site treatment facilities. Once more, both the specific household and the larger community can gain from this.

Greywater can be treated in a variety of ways so that it can be reused. The various techniques must not only be environment- and health-harming, but also safe. One of them is the use of activated carbon made from coconut shells to treat greywater and reuse it for various uses.

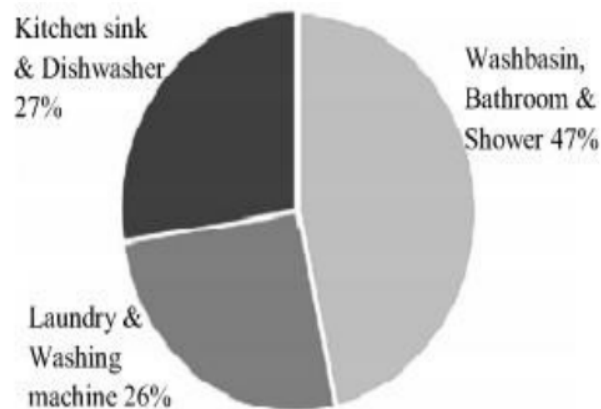


Figure 16: Distribution of Grey Water

References-ACT, 2007; Al-Mughalles et al., 2012; EA, 2008; Friedler,2004; Jamrah et al., 2011; NSW Health, 2000; Prathapar et al., 2005; QLD, 2008; WSDH, 2009

Type of Reuse	Reclaimed water quality	References
Urban Reuse: All types of Landscape irrigation, toilet flushing, fire protection, commercial air conditioners	pH = 6-9 ,BOD ≤10 mg/L ,Turbidity ≤ 2 NTU , FC=No detectable faecal coli/100 ml, Chlorine(Cl ₂ = 1 mg/L residual (minimum)	USEPA, 2004
Restricted Access Area Irrigation - Sod farms, areas where public access is prohibited	pH = 6-9 ,BOD ≤ 30 mg/L ,TSS ≤ 30 mg/L ,FC ≤ 200 faecal coli/100ml , Cl ₂ = 1 mg/L residual (minimum)	
Agricultural Reuse – Food Crops Not Commercially Processed - Surface or spray irrigation	pH = 6-9 ,BOD ≤10 mg/L, Turbidity ≤2 NTU,FC=No detectable faecal coli/100 ml, Cl ₂ = 1 mg/L residual (minimum)	
Construction -Soil compaction, dust control, washing aggregate, making concrete	BOD ≤ 30 mg/l, TSS ≤ 30 mg/L, FC < 200 faecal coli/100ml, Cl ₂ = 1 mg/L residual (minimum)	
Indirect Potable Reuse - Groundwater recharge by injection into potable aquifers	Includes, but not limited to, the following: pH = 6.5 - 8.5 ,Turbidity ≤ 2 NTU ,TC= No detectable total coli/100 ml, Cl ₂ = 1 mg/L residual (minimum), TOC ≤ 3 mg/L, TOX ≤ 0.2 mg/l, Meet drinking water standards	
Discharge into inland surface water	SS < 100 mg/L, pH-5.5to9.0, O&G < 10mg/L, Ammonical nitrogen (as N) < 50 mg/L, BOD < 30 mg/L, COD < 250mg/L, As < 0.2mg/L,	CPCB, 1986
Discharge into land for irrigation	SS < 200 mg/L, pH- 5.5 to 9.0, O&G < 10mg/L, BOD < 30 mg/L, As < 0.2 mg/L,	
Restricted irrigation	Helminth eggs < 1/litre, E.coli < 100,000 (relaxed to 10,00,000 when exposure is limited or regrowth is likely)	WHO, 2006
Unrestricted irrigation of crops	Helminth eggs < 1/litre, E.coli < 1000 (relaxed to 10,000 for high growing leaf crops or drip irrigation)	

Wastewater Reuse guidelines and standards

India ^(d)	Calicut, Kottayam, Ponnami (Urban Area)	Yes	162	79	0.49
	Athiyannoor, Omassey, Azikode (Rural Area)	No	159	77	0.48

Water Consumption and wastewater generation

Sullage water was treated using the manufactured activated charcoal, and numerous tests were carried out to assess how the treated water would be used in daily life. These tests included those for turbidity, pH, hardness, dissolved solids, methyl orange alkalinity, and phenolphthalein alkalinity.

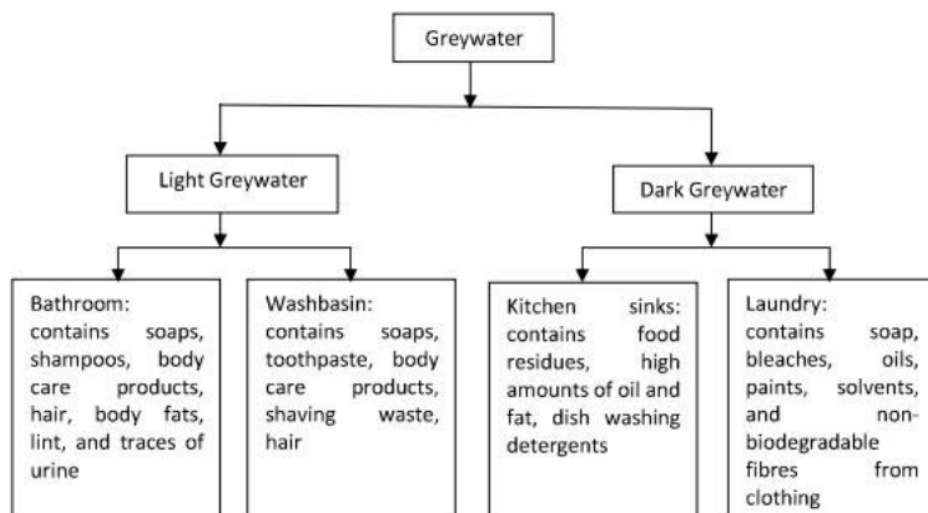


Figure 17: Grey Water and its Constituents

4.1 MATERIAL REQUIRED

Chemicals: methyl orange, phenolphthalein, ammonia, HCL, and grey water Tools include a flask, a pH metre, a nephelometer, an indicator for ferrouin, EDTA, etc.

4.2 Procedure

- ❖ After washing it with distilled water, place 100 cc of grey water in a beaker.
- ❖ Add 3.5gm of chemically activated charcoal to the grey water.
- ❖ Keep it undisturbed for 20 minutes.
- ❖ Utilizing a funnel and beaker, filter the combined sample with whatman filter paper.

4.3 TESTS PERFORMED

> ²¹ BOD

The amount of dissolved oxygen required (i.e., requested) by aerobic biological organisms to decompose organic material present in a given water sample at a particular temperature over a certain time period is known as the biochemical oxygen demand (BOD). The BOD value, which is frequently used as a proxy for the level of organic pollution in water, is typically given in milligrammes of oxygen used per litre of sample during 5 days of incubation at 20 °C.

The effectiveness of wastewater treatment facilities is measured by BOD reduction. The short-term effect of wastewater effluents is indicated by the BOD of the wastewater.

Chemical oxygen demand and BOD analysis both evaluate the concentration of organic molecules. However, because it counts all chemically oxidizable materials rather than simply amounts of biologically oxidised organic matter, it is less precise.

Small amounts of organic molecules are present in the majority of natural waters. Some of these substances have been adapted for use as food by aquatic microbes. Dissolved oxygen is used by microorganisms that live in oxygenated waters to oxidatively break down organic molecules and release energy for growth and reproduction. These bacteria' populations grow directly or indirectly of accessible. An oxygen requirement resulting from this microbial metabolism is proportional to the quantity of organic molecules that can be used.

The quantity of oxygen needed for microbial metabolism of organic molecules in water is known as the biochemical oxygen demand. Depending on temperature, nutrient concentrations, and the enzymes readily available to local microbial populations, this need happens over a varying amount of time. Total biochemical oxygen demand is the quantity of oxygen needed to totally oxidise organic compounds to carbon dioxide and water over generations of microbial development, death, degradation, and cannibalism (total BOD). Water quality is less important to food webs than total BOD. The initial aquatic microbial population boom in reaction to a substantial amount of organic material is most likely when dissolved oxygen deprivation first becomes noticeable. If the water loses oxygen due to the microbial population,

The 5-day BOD is the most popular test for detecting organic contamination in both wastewater and surface water (BOD5). In order to make this assessment, dissolved oxygen that microorganisms consume in the metabolic oxidation of organic materials must be measured. The BOD5 represents the total oxygen that microorganisms ingested during the first five days of biodegradation. The oxidation of nitrogen molecules like ammonia and the biodegradation of the carbonaceous part of wastes are both related to oxygen consumption. The biodegradation process is made simpler by the following equations:
Microorganisms, O₂, and organic materials → CO₂ plus new microbial cells and water
Ammonia plus oxygen plus microbes → NO₃ plus water and fresh microbial cells

Procedure:

Devices: Air compressor, 20°C incubator, 300mL incubator bottle

Manganese sulphate solution, Alkali-iodide-azide reagent, Sulfuric acid, Starch solution, Standard sodium thiosulfate titrant, and Standard potassium bi-iodate solution are among the reagents for measuring DO. Standardization: In an Erlenmeyer flask, dissolve 2 g of KI free from iodate in 100 to 150 mL of distilled water. Then, add 1 mL of 6N H₂SO₄ or a few drops of conventional H₂SO₄, together with 20.00 mL of standard bi-iodate solution. Titrate liberated iodine using thiosulfate titrant after diluting to 200 mL, adding starch when a pale straw colour is attained. The amount of 20.00 mL 0.025M Na₂S₂O₃ needed when the solution is equal. Adjust the Na₂S₂O₃ solution to 0.025M if necessary.

Dissolved oxygen (DO) (in mg/L) = mL of sodium thiosulfate (0.025N) consumed.

BOD:

Prepare dilutions of BOD. Use dilution water (which contains nutrients; Standard Methods indicate its precise composition): nothing (just water for dilution); 5 mL sample in a 300 mL BOD container, 15 mL sample in a 300 mL BOD bottle, and 20 mL sample in a 300 mL BOD bottle, all of which should be filled with dilution water.

Fill the BOD bottle with a 300 mL sample. Make two identical sets of this sample. Keep one set for day 0 of the DO analysis (i.e., Sample 0 Day) and another sample for five days at 20° C in the BOD incubator (Sample 5 Day).

At t=0, measure the DO in various samples.

Samples must be kept at 20 °C for five days.

After five days, return to the lab and record the amount of dissolved oxygen. Calculate the sample's 5-day BOD value at 20°C:

T-day BOD is equal to $[DO_t - DO_0]/(P)$, where P is the dilution factor of 300 mL. (sample volume in mL)
150 mg/L for untreated sewage water 50 mg/L for treated sewage water

> COD

Chemical oxygen demand (COD), also known as oxygen equivalence, is the quantity of a certain oxidising agent that reacts with a sample under controlled circumstances. This metric, which is usually higher than the biochemical oxygen requirement, reflects the degree of organic matter contamination in water (BOD). It helps determine the overall organic load to the receiving body and is used to signal organic matter contamination.

The amount of oxygen that can be consumed by reactions in a measured solution is indicated by the term "chemical oxygen demand" (COD). It is frequently stated as the mass of oxygen consumed over the volume of the solution, or milligrammes per litre (mg/L), in SI units. It is simple to determine the concentration of organics in water using a COD test. Quantifying the amount of oxidizable contaminants present in surface water (such as lakes and rivers) or wastewater is the most typical application of COD. Similar to biochemical oxygen demand, COD is helpful for assessing the quality of water by providing a metric to assess how an effluent will affect the receiving body (BOD).

Values for COD are always greater than those for BOD. Because BOD only includes the oxidation of biodegradable organic materials utilising dissolved oxygen by microbes, while COD includes the digestion of both biodegradable and non-biodegradable compounds.

Procedure ::

- a. Add the following in order to 15 ml COD digestion tubes that have been previously cleaned with diluted H₂SO₄
- b. Transfer either a 1.00 ml treated sample or a 0.50 ml wastewater sample (inlet).
- c.
- d. Slowly pour in 2.5 ml of the normal potassium dichromate digestion reagent and stir.
- e.
- f. Through the sides of the tubes, add 3.5 ml of sulfuric acid reagent and allow it to settle to the bottom.
- g.
- h. Wear gloves since the contents are quite hot and cap before mixing and cooling
- i.
- j. Transfer tubes to the 150 C preheated COD digester and let them sit for two hours to digest.
- k.
- l. Run three blanks precisely like the sample, but with DW in place of the sample.

Put the COD digesting tube's contents in a 100 ml beaker. In order to make the volume 50 ml, add distilled water. Titrate the mixture against a 0.05 M solution of ferrous ammonium sulphate using 1–2 drops of ferroin indicator.

$\text{COD as mg O}_2/\text{L} = (\text{A} - \text{B}) \times \text{M} \times 800 \text{ ml sample}$, where A. ml FAS is used as the blank. Sample was taken in B. ml FAS. M. FAS molarity

380 mg/L for untreated sewage

water 100 mg/L for treated sewage

water

> **TOTAL HARDNESS**

The amount of calcium and magnesium salts dissolved in water is measured as water hardness. Water hardness does not pose a health risk, but it does lead to scale buildup and less effective soap lathering. Hard water shouldn't be used in water heaters, kitchen appliances like coffee makers, or for washing clothes because it decreases the efficacy of detergents (that can be destroyed by scale). Additionally, fish tanks should not use it.

But there are certain advantages to hard water as well. Humans require minerals to keep healthy, and according to the World Health Organization (WHO), drinking water may be a source of calcium and magnesium for people who do not consume enough of these elements in their diets.

High mineral content water is referred to as hard water. When water percolates through limestone, chalk, or gypsum deposits, which are mostly composed of calcium and magnesium carbonates, bicarbonates, and sulphates, hard water is created.

In industrial settings, where water hardness is regulated to prevent expensive breakdowns in boilers, cooling towers, and other water-handling equipment, hard drinking water may offer modest health benefits, but it can also present serious difficulties.

When soap is agitated in water, hard water is frequently indicated by a lack of foam creation, as well as by the buildup of limescale in kettles and water heaters. Water softening is frequently utilised to lessen the negative impacts of hard water wherever it is an issue.

Polyvalent metallic cations can produce hardness, but divalent cations like calcium and magnesium cations are typically the main culprits. Additionally, the ions Fe^{2+} and Mn^{2+} are responsible for hardness. For instance, insoluble calcium carbonate (CaCO_3) is created when heated hard water reacts with bicarbonate (HCO_3^-) ions (Eq. 1). Scale, a precipitate that coats hot water containers, is what causes the mineral deposits on your cooking utensils. Magnesium hardness is presented in Equation 2.

When total hardness > alkalinity:

Total hardness = Carbonate hardness (mg/L) (2b)

"Non-carbonate hardness" (NCH) is the term for the amount of hardness over this. These are connected to nitrate ions and sulphate chloride. In order to compute it, use Eq (2c):

Total hardness x Carbonate hardness = NCH (mg/L) (2c)

The capacity to quickly ascertain water hardness is crucial for a variety of applications.

One of the better methods for determining the overall amount of water hardness is complexometric titration.

Procedure :

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To a 250 mL Erlenmeyer flask, add precisely 50 mL of water.

Use hydrochloric acid to acidify the mixture.

Cool after bringing to a boil.

Using ammonia, alkalize

Through filter paper, filter the solution.

A pH 10 ammonia buffer is added in 1 mL.

Add three drops of the eriochrome black t solution or a pinch of the compound that has been powdered with sodium chloride.

Titrate the 0.01M EDTA solution until the colour shifts from violet to blue.

Untreated Sewage water : 120 mg/L

Treated Sewage water : 125 mg/L

➤ CHLORIDE CONTENT

Because sodium chloride is a typical dietary component that goes through the digestive system unaltered, the chloride concentration in wastewater is higher than in raw water. Because of salt water intrusion into the sewage system along the seacoast, chloride may be present in high concentrations. Industrial practises could possibly make it worse.

Chloride concentration can cause a salty taste in drinkable water, and this flavour varies depending on the chemical makeup of the water. Due to its non-reactive nature and prevalence in sewage and drinkable water, chloride is also a valuable and trustworthy chemical indicator of river and groundwater faecal contamination.

Chloride is a common tool used by water regulation organisations to monitor the pollution levels in rivers and other sources of potable water.

Excessive chlorides can cause difficulties with taste as well as corrosion. Iron, steel, and plumbing metals tend to corrode more quickly in environments with high chloride concentrations, especially when combined with low alkalinity. A person with a sensitive palate can taste chloride in drinking water at concentrations as low as 150 mg/l, while levels higher than 250 mg/l may give the water a strongly salty taste. However, if there isn't another source of water accessible, people may have to consume water that has substantially greater chloride levels in dry or semi-arid regions. Chlorides are not eliminated by traditional water treatment techniques.

If a water's chloride concentration needs to be lowered, desalination of some sort must be used. A high chloride level can harm growing plants as well as metallic pipelines and structures. The salinity of various water sources can be determined using the detected chloride ions. Certain studies indicate that fish are less vulnerable to chloride exposure than small, free-floating planktonic crustaceans, with certain exceptions.

Procedure:

Fill a conical flask with a 25 ml sample. pH of the sample.

the indicator solution in 1.0 ml

Titrate with a typical silver nitrate solution until the endpoint is pinkish yellow, and record the volume of titrant used. Measure the pH of the sample as well.

Untreated Sewage water : 1199.62 mg/L

Treated Sewage water : 537.33 mg/L



Figure 18: Determination of Chloride Content

➤ ALKALINITY

The ability of water to absorb H⁺ ions without significantly changing pH is known as alkalinity. Alkalinity, then, is a measurement of water's ability to act as an acid buffer.

One way to describe alkalinity is as follows:

$$\text{Alkalinity (mol/L)} = [\text{HCO}_3^-] + 2 [\text{CO}_3^{2-}] + [\text{OH}^-] - [\text{H}^+]$$

Using specific indicators such as phenolphthalein and methyl orange, titration against a standard acid solution can be used to quantify the alkalinity attributable to certain ions independently. Using specific indicators such as phenolphthalein and methyl orange, titration against a standard acid solution can be used to quantify the alkalinity attributable to certain ions independently.

Numerous natural water and wastewater treatments and uses depend on alkalinity. Since many surface waters contain carbonates, bicarbonates, and hydroxides, alkalinity is thought to be a sign of these substances as well. A important factor in assessing whether water is suitable for irrigation is alkalinity that is greater than alkaline earth metal concentrations. Measurements of alkalinity are used to evaluate and manage water and wastewater treatment processes.

The ability of water to withstand pH changes that would cause the water to become more acidic is known as alkalinity. (Basicity, which is an absolute measurement on the pH scale, should not be confused with this.) The strength of a buffer solution made up of weak acids and their conjugate bases is known as alkalinity. It is calculated by titrating the solution with a monoprotic acid, such as HCl, up to the point at which the pH rapidly changes or hits a predetermined endpoint. Determining a stream's capacity to neutralise acidic wastewater contamination requires measuring its alkalinity.

Methyl Orange Alkalinity

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i) Pipette two drops of phenolphthalein indicator were added to 20 mL of the water sample, and the solution was then titrated against (N/10) HCl until the colour of the solution changed from pink to colourless. The phenolphthalein end point is shown by the corresponding burette reading (V1).

Untreated Sewage water : 290 mg/L

Treated Sewage water : 295 mg/L

Phenolphthalein Alkalinity

- i) In a conical flask, pipette 20 mL of the water sample once more and add 2 drops of the methyl orange indicator. The solution's colour changes to yellow. Till the colour turns red, keep titrating against the (N/10) HCl solution. The methyl orange end point is represented by this burette reading (V2).

Untreated Sewage water : 0 mg/L

Treated Sewage water : 40 mg/L

> TURBIDITY

Turbidity is a measurement of how much of the suspended particles in the water either absorbs or scatters light. Surface water turbidity is caused by colloidal particles eroding from soil, including clay, sand, rock fragments, and metal oxides. Vegetable fibres and microorganisms can also cause turbidity.

Before being used for public water supply, drinking water supplies need to undergo particular treatment, including chemical coagulation and filtration.

Coagulants can be added to this mixture to reduce the turbidity to the desired level. When coagulants are added to water, they create the gelatinous substance known as floc, which traps the colloidal and tiny suspended particles. The increased size of these halted particles will cause them to settle quickly.

Relevance: Waters with turbidity are unsightly and are not permitted for household usage. Turbidity-related colloidal matter offers adsorption sites for chemicals and biological agents that may be toxic or produce unpleasant tastes and odours. Since the colloids partially hide organisms from the disinfectant, disinfecting the turbid waters is challenging and unsatisfactory. 10 to 25 NTU are the IS values for drinking water.

Because of turbidity, the suspended particles in the water absorb heat from the sun, making the water warmer and lowering the amount of oxygen present (oxygen dissolves better in colder water). Additionally, some creatures cannot endure in warmer water.

Nobody loves the way dirty water looks, thus the main effect is purely aesthetic. But it's also crucial to get rid of the turbidity in the water if you want to effectively disinfect it for consumption. The expense of treating surface water supplies goes higher as a result. Additionally, the heavy metals and several other harmful chemical compounds and pesticides are more easily attracted to the suspended particles.

The light is scattered by the suspended particles, which reduces the photosynthetic activity of plants and algae and lowers the oxygen concentration.

Nephelometric Turbidity Units, or NTUs, are used to measure turbidity. Nephelometers or turbidimeters are the tools used to measure it, and they measure how much light is scattered at an angle of 90 degrees as it travels through water.

- Procedure :

Calibration of Nephelometer:-

- i) Choose the appropriate NTU range on the nephelometer.
- ii) Use the knobs supplied for zero setting to reset the Nephelometer reading by adding distilled water to the test tube.
- iii) Calibrate the nephelometer using the reference turbid solution (40 NTU) (i.e. adjust the Nephelometer reading to 40 NTU using calibration knob)



Figure 19: Determination of Turbidity

Figure 20: pH Determination

> pH DETERMINATION

The pH of water is a measurement of the concentration of hydrogen ions in the water. It establishes whether the water is acidic or alkaline in nature. Potential of hydrogen is referred to as pH. The pH range for water, according to the World Health Organization (WHO), is 6.5 to 8.5.

The pH scale determines how acidic or basic water is. The range is 0 to 14, with 7 representing neutrality. Acidity is indicated by pH values below 7, whereas baseness is shown by pH values above 7. The pH of water is a crucial indicator of the purity of the water. Actually, pH is a measurement of the proportion of free hydrogen and hydroxyl ions in water. More free hydrogen ions make water acidic, whereas more free hydroxyl ions make it basic. Since chemicals in the water can change pH, pH is a crucial sign that the chemical composition of the water is changing. "Logarithmic units" are used to report pH. Each number corresponds to a 10-fold difference in the water's acidity or basicity. Ten times more acidic is water with a pH of five than is water with a pH of six.

Chemical components such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). For instance, pH affects not just how much and in what form phosphorus is most prevalent in the water, but also whether aquatic life can utilize it. In the case of heavy metals, their toxicity is based on how soluble they are. Because they are more soluble at lower pHs, metals tend to be more hazardous.

The mathematical formula for pH is $\text{pH} = -\log [\text{H}^+]$.

The pH range for acids spans from 1 to 7. Alkaline will range in pH from 7 to 14.

Procedure :

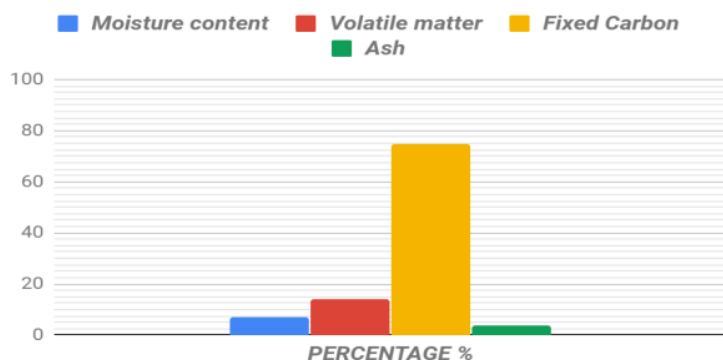
- (a) Make up buffer solutions as directed, being careful to keep the tablets whole until usage.
- (b) Separate 50 mL beakers should contain 30 mL of each buffer solution as well as the sample.
- (c)
- (d) Put one or more pH metre electrodes into each buffer solution in turn. Adapt the device, if necessary, to the pH of the specific solution.
- (e) Insert the electrode(s) into the sample, then note the pH reading displayed on the metre.

Untreated Sewage water : 7.45

Treated Sewage water : 8.43

CHAPTER 5: RESULTS

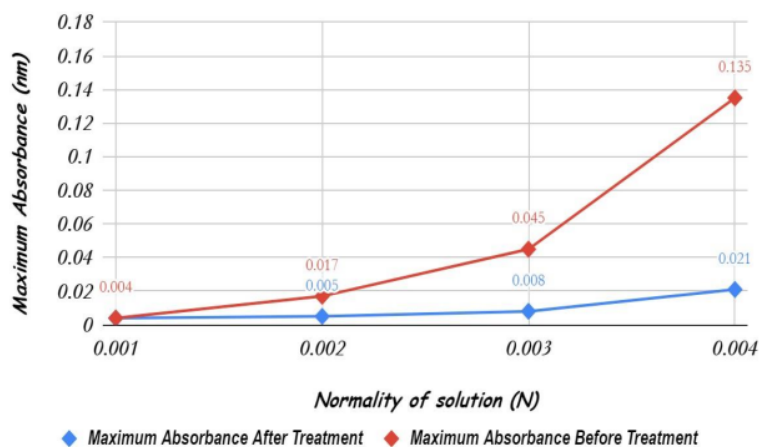
1. Chemically Activated Charcoal is prepared by Coconut husk using physical and chemical treatment.
2. Proximate Analysis of Charcoal is done.



As part of its approximate analysis, chemically activated charcoal is found to include 7.25 percent moisture, 14.18 percent volatile matter, 74.89 percent fixed carbon, and 3.68 percent ash. The amount of fixed content in the raw material should be as high as possible for the production of charcoal since it is the carbon content of fixed content that causes the creation of tiny pores during activation.

3. Maximum absorbance of various samples at various normalities is compared. It is noted that the sample's maximum absorbance differs for various normality solutions and is lower than before it was treated with activated charcoal..

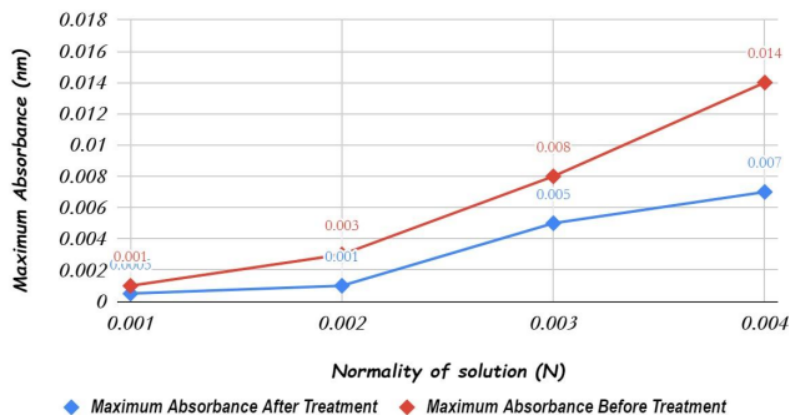
For Potassium Permanganate Solution



The graph of maximum absorbance in relation to the normality of the solution for potassium permanganate is shown above. Comparing treated and untreated samples, the absorbance drops for the treated sample. As can be seen, the minimum difference is at 0.001N, while the largest difference is at 0.004N. This demonstrates that activated charcoal performs better at higher coloured material concentrations than at lower concentrations. Both the treated and untreated samples exhibit a linear

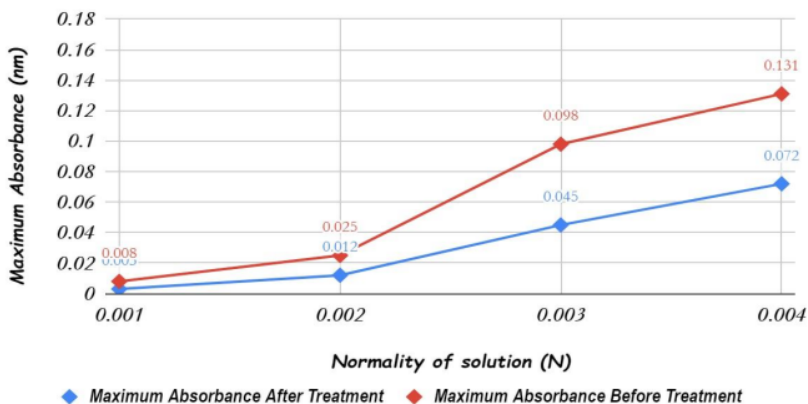
change in absorbance..

For Copper Sulphate Solution



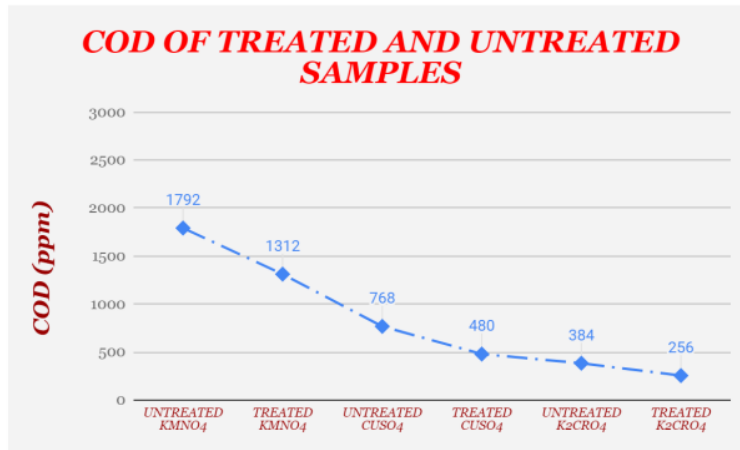
The graph of Copper Sulfate's maximum absorbance in relation to its normality is shown above. Comparing treated and untreated samples, the absorbance drops for the treated sample. As can be seen, the minimum difference is at.001N, while the largest difference is at.004N. The disparity between the two samples' plots diverges over time. This demonstrates that activated charcoal performs better at higher coloured material concentrations than at lower concentrations. Both the treated and untreated samples exhibit a linear change in absorbance..

For Potassium Chromate Solution



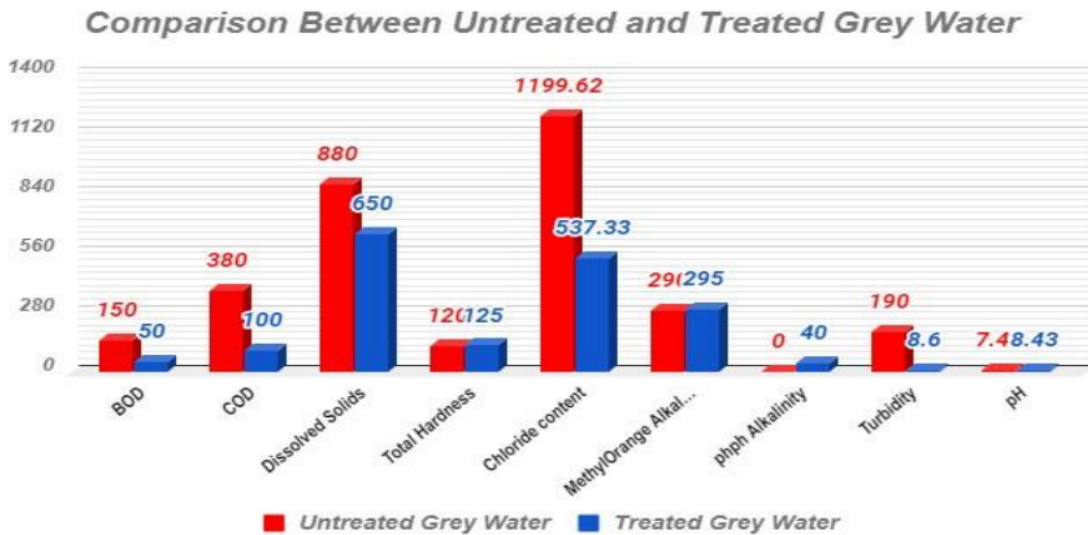
The graph of the maximum absorbance in relation to the normality of the potassium chromate solution is shown above. Comparing treated and untreated samples, the absorbance drops for the treated sample. As can be seen, the minimum difference is at.001N, while the largest difference is at.004N. The disparity between the two samples' plots diverges over time. This demonstrates that activated charcoal performs better at higher coloured material concentrations than at lower concentrations. Both the treated and untreated samples exhibit a linear change in absorbance.

4. Before and after comparison of COD for several samples.



The COD concentration of treated and untreated samples is shown in the above plot. As seen in the graph, the treated samples' plot is less than the untreated samples' plot. The minimum COD is around 250ppm, whereas the maximum COD is untreated potassium permanganate, or 1700ppm..

5. Sewage water is cleaned using it, and the cleaned water can be utilised for irrigation.



The BOD of treated water is 100 less than untreated water, as indicated in the graph above. Whereas Chloride Content, which changed the most, went from 1199.62 to 537.33. The total hardness only increased slightly, from 120 to 125. COD, however, decreases from 380 to 100, or almost 200 percent.

CHAPTER 6: CONCLUSION

Greywater is produced in a variety of ways and has a wide range of properties. Greywater may be handled effectively by being separated from its source of origin because it is less polluted than blackwater.

Greywater needs to be treated before it can be used again, although being less filthy than blackwater or sewage. In actuality, none of the features of untreated greywater meet the norms and guidelines for reuse.

The technologies in use now, by focusing on the ⁶⁶ type of reuse (viz. agriculture, gardening, flushing, washing). As a result, a flow diagram combining a variety of technologies by focusing on the type of reuse is required. It has been noticed that a single approach or technology cannot satisfy all reuse requirements.

Additionally, technology development is necessary.

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