TREATMENT OF DYE EFFLUENT WITH WASTE LEAVES AND BANANA TRUNK

Submitted in partial fulfilment of the requirements for the award of the degree of

B.TECH

by

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DECEMBER – 2022

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CERTIFICATE

This is to certify that the thesis entitled "**Treatment of dye effluents with waste leaves and banana trunk** " submitted by **RAJULAPATI NAVEEN (208W1A03F7), GUDURU VENKATA MARUTHI ABHIRAM (208W1A03C9), MUTHYALA SAI KIRAN (208W1A032E8), MOHAMMAD ABDHUL HAADEE IRSHAD (208W1A03E5) and THUMU BHARATH KUMAR (198W1A03B7)** to V. R. Siddhartha Engineering College, Vijayawada under the jurisdiction of JNTU Kakinada in partial fulfillment of the requirements for the award of the degree of **Bachelors of Technology** is a record of bonafide research work carried out by us under our supervision and guidance. This work has not been submitted elsewhere for the award of any degree.

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ACKNOWLEDGEMENT

We would like to express my deepest gratitude and appreciation to my supervisor **Dr.M.BALAJI** who inspired, encouraged and supported us at all levels of this study.

We would like to thank the Scrutiny Members of the Mechanical Engineering Department, **Dr. V L KRISHNAN, associate professor** Department of Mechanical Engineering, V. R. Siddhartha Engineering College and **Dr. G. JAMUNA RANI, associate professor** Department of Mechanical Engineering, V. R. Siddhartha Engineering College and **Dr. R.V. KIRAN KUMAR, associate professor** Department of Mechanical Engineering, V. R. Siddhartha Engineering College and **Dr. N. VIJAYA SAI, Professor & HOD**, Department of Mechanical Engineering, V. R. Siddhartha Engineering College, Vijayawada for their support and suggestions during the reviews.

This study was carried out at the Department of Mechanical Engineering and Department of Civil Engineering, V. R. Siddhartha Engineering College.

We would like to thank to our beloved parents for their continuous support and we wish to appreciate and heartfelt thanks to my classmates for their support for carrying out this project.

Finally I thank one and all who have directly or indirectly contributed for the successful completion of this research work.

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CONTENTS

ABSTRACT

The present work investigates the removal of synthetic dyes from aqueous solutions with the help of activated carbon prepared by chemical activation of waste leaves and banana trunk. With the rapid development of industrialization and globalization in recent years, more quantity of textile dye wastewater has been discharged into the environment. Now a days technology of wastewater treatment has difficulty in meeting all the practical requirements of harmless wastewater discharge and therefore, the exploration and development of new technologies to treat various types of waste water are vitally needed. The main objective of the work is to prepare an activated adsorbent from waste leaves and banana trunk for removing the color from effluent. To evaluate the efficiency of the activated waste leaves and banana trunk, column adsorption technique is selected in the removal of synthetic dye. Finally, the challenges and prospects of wastewater treatment are summarized.

Key words: Decolorization, Dyes, wastewater, Scavengers, Activated carbon, Chemical Activation , Adsorption Capacity.

LIST OF FIGURES

TABLES

NOMENCLATURE

Symbol	Caption
MB	Methylene Blue
AOP	Advanced Oxidation Process
AOS	Average Oxidation State
COD	Chemical Oxygen Demand
TOC	Total Organic Carbon
EC	Electrocoagulation
pH	Potential of Hydrogen
EDTA	Ethylenediamine tetraacetic acid

Chapter 1

INTRODUCTION

1.1 Introduction :

Nowadays due to population and urbanization demand for resources is increasing. To fulfill the demands industrial growth takes place which leads to increased wastewater generation. The dying process discharges around fifteen to twenty percent of colors with effluents. Colors contain natural toxins, whose potential is carcinogenic. Classification of dyes can be done based on their application and chemical structure. The treatment of textile wastewater is considered a challenging process, representing a major threat for water receiving bodies due to the chemical composition and the high concentration of dye in the wastewater. Complex effluents are generated by industries such as textile, cosmetics, pharmaceutical, paper and food among others.

Figure 1.1: Textile wastewater

The treatment of dye wastewater from textile and dyestuff industries is not easy. Dyes have a synthetic origin and complex aromatic molecular structures. These structures make them more stable and more difficult to biodegrade. Aside from the degradation of dyes or dye waste, the decolorization of wastewater is also important. Because the color in dye wastewater is highly visible, it has to be treated. The major treatment methods for dyes and dye wastes are biochemical and physiochemical methods.

Basic dyes, which are water-soluble in an aqueous solution, yield colored cations. The available physical-chemical and biological technology for dye removal are very expensive and cause secondary pollution as they lead to sludge formation. The textile dyes are reactive toward the chemical functions present on the fiber surface.

In recent years, the application of plant peroxidases for dye decolorization has received significant attention as a cost-effective approach. Various studies have revealed that enzyme-based treatment approaches offer several advantages over conventional methods. In the present study, the decoloration of methyl blue, methyl orange, and monoazo dye, was studied using crude peroxidases extracted from low-cost agricultural wastes of different plant sources: waste leaves and banana trunks. The effects of reaction parameters such as reaction time, pH, temperature, enzyme dosage, and initial dye concentration were investigated and optimized.

Figure 1.2: Wastewater discharge

Colour removal from waste water has been a matter of concern, both in the aesthetic sense and health point of view. Colour removal from textile effluents has been given much attention because of its potential toxicity and its visibility problem. There have been various promising techniques for the removal of dyes from waste water. However, the effectiveness of adsorption for dye removal from waste water had made it an ideal alternative to other expensive treatment methods.

Dyes are extensively used in many industries such as textiles, leather, paper, wool, printing and cosmetics. The release of waste water containing dye compounds into water resources has caused severe environmental impact. Methylene Blue (MB) used in some of the textile industries has adverse impact on the flora and fauna and aquatic ecosystems. Therefore, it is essential to minimize the number of dyes to the lowest possible limit approved by the environment and health agencies.

1.2 Textile Wastewater Characteristics:

Textile industries use various chemicals, dyes, acids and starches that produce harmful wastewater. Textile wastewater has the following hazardous characteristics:

- **Toxicity:** Chemicals used in textile processes are highly hazardous to the environment and human health.
- **Corrosivity:** Many chemicals used in manufacturing textiles are corrosive. Chemicals such as lye and bleach can damage vulnerable materials.
- **Oiliness:** Oil is used as lubrication in textile processes, resulting in oily wastewater.
- **Reactivity:** Certain chemicals can react with one another and create hazardous substances. The textile industry releases many chemicals that can react when they combine in wastewater.
- **Flammability:** Many substances used in textile production are highly flammable.

Textile wastewater pollution poses a serious threat to environmental and human health. To keep the environment and our water systems safe, textile wastewater treatment removes the following contaminants from water:

Chemicals

Many chemicals are used in the textile industry. Chemicals help to create the following textile finishes:

- Anti-microbial finish
- Fire-resistant finish
- Crease-resistant finish
- Anti-static finish
- Easy-care finish
- Hydrophilic finish
- Non-slip finish

Dyes

Textile dyeing also poses a need for wastewater treatment. Synthetic dyes are non-biodegradable and toxic, posing a significant threat to the environment. They are present in textile wastewater and seriously affect human health, soil fertility and crop production. The textile industry uses the following dyes:

- Anthraquinone dyes
- Azo dyes
- Xanthene dyes
- Indigo dyes
- Phthalocyanine dyes

- Diphenylmethane and triphenylmethane dyes
- Nitrosated and nitrated dyes
- Polymethinic dyes
- Cationic or basic dyes
- Reactive dyes

Fabrics

Textiles and fabrics contain fibers that can produce contaminated wastewater. Textile plants can create many different fabrics, including the following:

- Denim
- Velvet
- Felt
- Mohair
- Fleece
- Muslin
- Brocade
- Gabardine

Acid

Textil production also produces wastewater with harmful acids. Some of the acids used in the textile industry include the following:

- Hydrochloric acid
- Sulfuric acid
- Phthalic acid
- Citric acid
- Formic acid
- Acetic acid
- Nitric acid
- Liquid ammonia
- Oxalic acid

1.3 TREATMENT OF INDUSTRIAL TEXTILE DYE WASTEWATER :

Textile dye wastewater is an important component of industrial wastewater. It is estimated that approximately 70,000 tons of dye are used in the textile industry each year, and approximately 40 % will eventually become pollutants and endanger environmental health. Wastewater from the textile dye industry accounts for 17 %–20 % of total industrial wastewater.

Chemical textile dyestuffs have complex compositions, easy synthesis, stable chemical structures, and difficult decomposition characteristics. Most textile dyestuffs have biological toxicity, carcinogenicity, and teratogenicity. Among industrial wastewater, textile dyestuff wastewater is one of the most difficult to decompose, and has high chroma, high biochemical oxygen demand, and a high content of dissolved solids.

Most dyes are highly resistant to biodegradation because of the need to maintain color and structural integrity in the application, and in particular, azo dyes are easily converted into dangerous aromatic amines under hypoxic conditions.

The treatment methods for textile wastewater include physical treatment, oxidation, and biological treatment. Currently, most textile dye wastewater treatments use a secondary treatment process, which is mainly composed of a biochemical process (anaerobic system) and a physicochemical process (coagulation sedimentation or air flotation).

However, new dyes and technologies have significantly changed the composition and properties of wastewater and increased textile wastewater treatment difficulties. The degradation efficiency of traditional wastewater treatment decreases markedly, and there is a pressing need to explore high-efficiency wastewater treatment technologies. AOPs are widely used in waste- water treatment because of their advantages.

In real printing and dyeing industrial wastewater, there are many kinds of ions, such as chloride ions, sulfide ions, and UV quenching substances, or free radical scavengers that can affect the oxidative degradation process.

The untreated effluents released by the textile industry contain a diverse range of organic pollutants, the most prevalent of which are textile. Azo dyes, which contain one or more azo groups structurally, are the largest class (above 60%) among the various groups of textile dyes and the most widely used dyes in the textile industry. Inefficient textile dyeing processes cause 15–50% of azo dyes that are not bound to fibers and fabrics to be released into generated wastewater. Some textile factories treat their wastewater to degrade the free azo dyes released into the environment, while others discharge untreated industrial effluents directly into bodies of water, posing serious ecotoxicological threats as well as toxic effects on living organisms. Farmers in developing countries used to irrigate their agricultural lands with wastewater containing untreated industrial effluents, which had a negative impact on soil quality and crop germination rate.

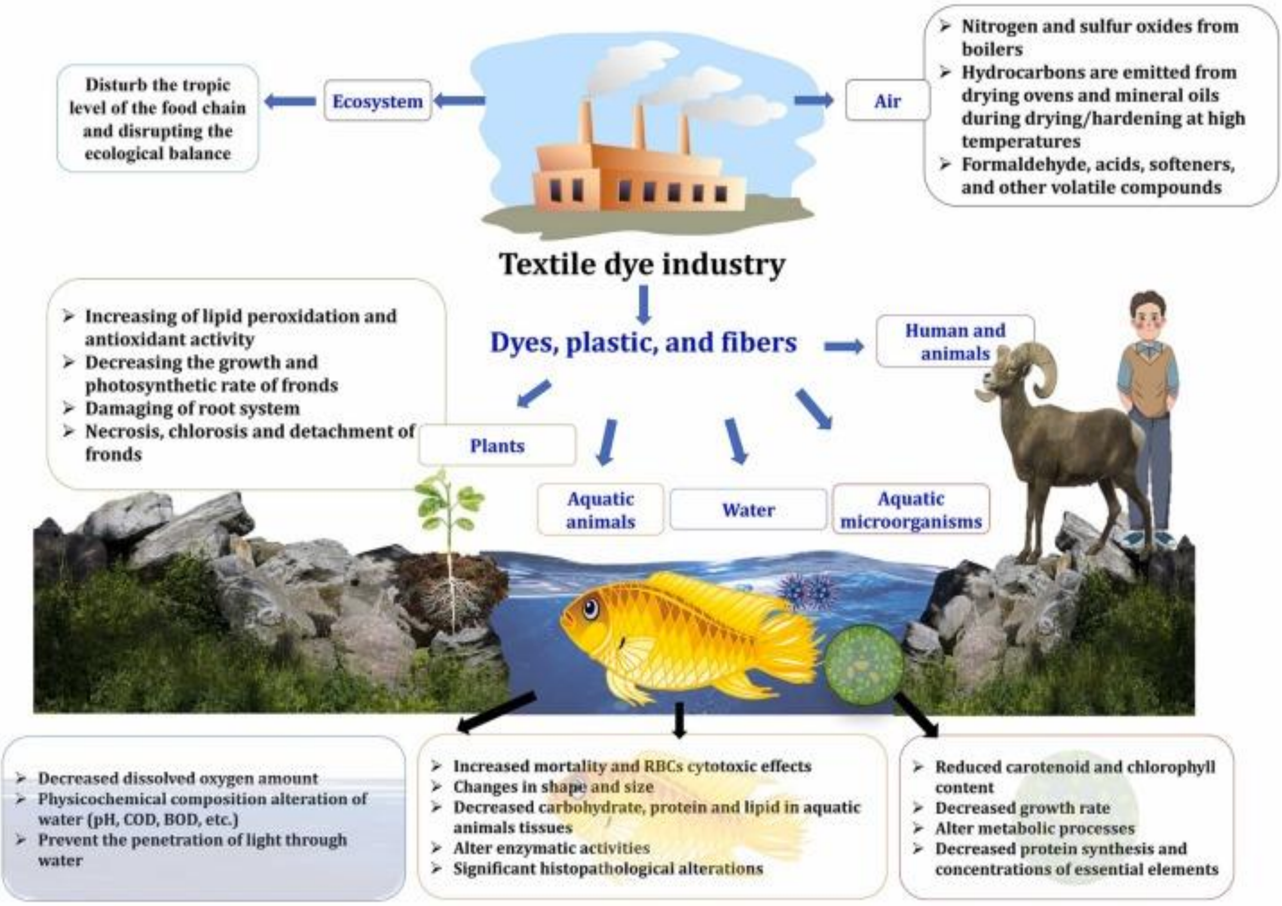

Figure 1.3: **Ecotoxicological impacts of dye-containing textile wastewater on the environment and living microorganisms**.

1.4 OBJECTIVE :

- To Prepare the activated adsorbent from waste leaves and banana trunk.
- To study and evaluate the efficiency of the activated waste leaves and banana trunk in the removal of synthetic dye through this project.
- To analyze the adsorption isotherm and the suitable isotherm.
- To improve the quality of water
- To educate people about water treatment methods.

1.5 PROBLEM STATEMENT :

Existing Technology:

Conventional technologies for textile wastewater treatment mainly comprise biological treatment, precipitation, coagulation/flocculation, oxidation.

Gap:

High process costs, such as energy, the value of inputs demanded in high doses and due to the complexity of the operation, requires a qualified technical operation.

Solution:

- Colour removal from waste water
- Minimising the number of dyes to the lowest possible limit approved by the environment and health agencies.

1.6 PROCESS OF ACTIVATED ADSORBENT PREPARATION:

- Teak leaves were collected near the house and washed repeatedly until the dirt was eliminated and was left for sundry.
- The banana trunk collected in the was farm and it was cut to smaller pieces and was left to sundry.
- Then after completely achieving dry state.
- They were placed at muffle furnace for 410℃ and 470℃ for teak and banana trunk respectively. Time for teak was 40 min and banana trunk was 90 min.
- Low cost carbon was prepared from the Teak Leaves and Banana trunk .
- Then the powdered carbon is sieved using 150 micron sieve, to the required particle size .
- The adsorbent in powdered form was washed with distilled water to remove dust particles.

Figure 1.4: Textile dyeing wastewater treatment

1.7 MATERIALS USED :

Adsorbents

- Teak leaves (Tectonagrandis)

Figure 1.5: Teak leaves

- Banana Trunk (Musa) Chemicals

Figure 1.6: Banana Trunk

- Methylene blue dye

Figure 1.7: Methylene Blue Dye

- H_3PO_4 (orthophosphoric acid)

Figure 1.8: Orthophosphoric acid

1.8 APPARATUS :

Apparatus

- Muffle furnace

Figure 1.9: Muffle furnace

- Stirrer

Figure 2.0: Stirrer

Chapter 2

LITERATURE SURVEY

L. Bilinska, M. Gmurek, S. Ledakowicz, Comparison between industrial and simulated textile wastewater treatment by AOPs – biodegradability, toxicity and cost assessment: Despite the fact that there are many literature reports concerning textile wastewater treatment by advanced oxidation processes (AOPs), mostly they are not oriented on the industrial applications. The research focused on Reactive Black 5 (RB5) and its industrial form (Setazol Black DPT), which, despite being hazardous, is still one of the most commonly used dyestuffs in industrial practice. Several ozone-based AOPs (e.g., O3, UV/O3, O3/H2O2, and O3/UV/H2O2) and H2O2/UV processes have been compared in terms of their effectiveness in removing RB5 (purified and commercial form) from simulated and industrial textile wastewater. The color, COD, TOC and BOD reduction were considered. Almost completely color reduction was achieved for the simulated as well as industrial wastewater, but only in case of ozone-based AOPs. The H2O2/UV processes were found highly not effective for industrial application. For industrial wastewater the COD and TOC decrease were not very high (10% of COD and 20% of TOC) in contrast to simulated one (90% and 50%, respectively). However, the mineralization, biodegradability and Average Oxidation State (AOS) assessment indicated that the application of AOPs resulted in more oxidized by-products. The toxicity assessment based on V. fischeri bacteria proved extremely high toxicity of BR5. All of the tested ozone-based AOPs increased biodegradability and decreased toxicity, proving that oxidation should be performed before biological treatment. The cost analysis and the obtained results showed that O3 and O3/H2O2 (0.005 M) can be effectively used in the industry.

E. Hu, S. Shang, A.K. Chiu, Removal of reactive dyes in textile effluents by catalytic ozonation pursuing on-site effluent recycling, Molecules: The textile wash-off process consumes substantial amounts of water, which generates large volumes of wastewater that pose potential pollution issues for the environment. In the present study, catalytic ozonation was applied to degrade residual dyes present in rinsing effluents from wash-off processes towards the aim of recycling the waste effluents. A magnetic catalyst was prepared for promoting dye degradation by catalytic ozonation. Via a hydrothermal reaction, highly magnetic manganese ferrite ($MnFe_2O_4$) particles were successfully loaded on carbon aerogel (CA) materials ($MnFe_2O_4$@CA). The results showed that the developed catalyst strikingly promoted the degradation of dye contaminants by catalytic ozonation, in terms of color removal and reduction of chemical oxidation demand (COD) in rinsing effluents. COD removal efficiency in catalytic ozonation was enhanced by 25% when compared with that achieved by ozonation alone under the same treatment conditions. Moreover, we confirmed that after catalytic ozonation, the rinsing effluents could be recycled to replace fresh water without any evident compromise in the color quality of fabrics. The color difference between fabrics treated with recycled effluents and water was not more than 1.0, suggesting that the fabrics treated with recycled effluents displayed acceptable color reproducibility. Although colorfastness and color evenness of fabrics treated with recycled effluents were slightly poorer than those of fabrics treated with water, they were still within the acceptable tolerance. Therefore, the present study validated that catalytic ozonation was a promising technology for saving water and wastewater elimination in textile dyeing. It provides a feasibility assessment of catalytic ozonation for recycling waste effluents to reduce water dependence in textile production. Furthermore, we show a new perspective in on-site recycling waste effluents by catalytic ozonation and enrich the knowledge on feasible approaches for water management in textile production.

L. Bilinska, K. Blus, M. Foszpanczyk, M. Gmurek, S. Ledakowicz, Catalytic ozonation of textile wastewater as a polishing step after industrial scale electrocoagulation, J. Environ. Manage: The main objective of this study was to develop the treatment system to change wastewater into a reliable source of recyclable water within the textile plant. Therefore, a highly polluted industrial wastewater originated in the dyeing of cotton was subjected to a multi-step treatment. The raw wastewater was characterized by the concentration of Reactive Black 5, the azo dye, as high as 842 mg/L, extreme alkalinity (pH 11.26) and salinity (NaCl concentration 52,290 mg/L). Correspondingly, the chemical oxygen demand (COD) was equal to 3440 mg/L and the total organic carbon (TOC) was 1790 mg/L in this wastewater. This salty, hardly degradable wastewater underwent the electrocoagulation (EC) on an industrial scale in the first step of the treatment. Although the industrial EC resulted in 84% of color removal in a very short time of 8 min, the wastewater was still characterized by an extremally high absorbance which corresponded to 100 mg/L of RB5. Moreover, EC resulted in the occurrence of burdensome by-products, of which one was identified in this study as an aniline derivative. The by-products contributed to high residual COD and TOC after EC (2120 mg/L and 1052 mg/L, respectively). Consequently, the catalytic ozonation was used by us as a second, the polishing, step of the treatment. The catalytic ozonation was found efficient in the removal of the residual color and colorless by-products. The wastewater after catalytic ozonation was colorless and the final COD and TOC decreased to 1283 and 695 mg/L, respectively. The average oxidation state (AOS), spectra analysis, and the toxicity assay showed catalytic ozonation efficient in the by-products oxidation. Consequently, the catalytic action of activated carbon (AC) was proved for the ozonation of textile wastewater. Ultimately, the recycling of purified wastewater into dyeing resulted in a very good color quality of textile samples.

B. Kamarehie, A. Jafari, M. Ghaderpoori, M. Amin Karami, K. Mousavi, A. Ghaderpoury, Catalytic ozonation process using PAC/γ-Fe2O3 to Alizarin Red S degradation from aqueous solutions: In the catalytic ozonation process used in this study, adsorption and chemical reactions were performed at the catalyst surface. This process can increase the efficiency of plain ozonation. The main aim of this study was to investigate the efficiency of the catalytic ozonation process in removing Alizarin Red S dye from colored water by Fe_2O_3 coated on PAC. In this work, activated carbon powder/γ-Fe_2O_3 nano-composite was modified. The BET results showed that the surface area in PAC and PAC-γ-Fe_2O_3 nano-composite was 654 and 450 m^2 g^{-1}, respectively. In this study, the best pH for removal of ARS was found to be 9. At a higher pH, the efficiency of the process decreased gradually. According to studies, catalysts increase surface area and active sites for more ozone degradation. Also, the characterization of the catalyst will play a very important role in the COP. Also, the maximum removal efficiency was observed in catalyst dose 1.1 g l^{-1}. The study results showed that the highest mineralization rate in ARS degradation was related to O_3/PAC/γ-Fe_2O_3. The amount of mineralization in the SOP, O_3-PAC, and O_3/PAC/γ-Fe_2O_3 was 13, 25, and 40%, respectively. The finding of mineralization of ARS using the SOP reflected the low power of the ozonation process for the mineralization of pollutants.

G. Asgari, J. Faradmal, H.Z. Nasab, H. Ehsani, Catalytic ozonation of industrial textile wastewater using modified C-doped MgO eggshell membrane powder, Adv. Powder Technol: This effort demonstrates preparation and characterization of carbon-doped magnesium oxide (C-MgO) doped on an eggshell membrane powder (C-MgO-EMP) as a catalyst. The catalytic activity of C-MgO-EMP was assessed in a catalytic ozonation process (COP) for treating a real textile wastewater. A 43 full factorial design (FFD) was conducted to plan an experimental series in the catalytic treatment of the textile wastewater via a C-MgO-EMP catalyst. In the catalytic treatment process with the as-prepared catalyst, the test conditions were optimized at an ozone flow rate = 0.4 L/min, a catalyst dose = 0.23 g/L, and reaction time = 10 min. The catalytic efficiency of the C-MgO-EMP catalyst in the degradation (decolorize based on ADMI color unit) and mineralization (TOC removal) of the real textile wastewater was calculated to be 93% and 78%, respectively. The prepared catalyst had better potential catalytic activity (synergetic effect = 52%) than the commercial activated carbon (CAC) and O3 in TOC removal. Based on the kinetic study, the ratio of K-overall(TOC) c MgO EMP/K-overall(TOC)-CAC was indicated to be 1.584. Kinetic results demonstrated that the mineralization rate in COP with C-MgO-EMP catalyst is 9.05 times higher than the CAC/O3 process.

H. Selcuk, J.J. Sene, M.V.B. Zanoni, H.Z. Sarikaya, M. Anderson, Behavior of bromide in the photoelectrocatalytic process and bromine generation using nanoporous titanium dioxide thin-film electrodes, Chemosphere: In this study, the photo electrocatalytic behavior of bromide and generation of bromine using TiO2 was investigated in the separate anode and cathode reaction chambers. Our results show that the generation of bromine begins around a flat band potential of -0.34 V vs. standard calomel electrode (SCE) at pH 3.0 under UV illumination and increases with an increase in positive potential, finally reaching a steady-state concentration at 1.0 V vs. SCE. Maximum bromine formation occurs over the range of pH 4-6, decreasing sharply at conditions where the pH>7.

N. Baycan, E. Thomanetz, F. Sengul, Influence of chloride concentration on the formation of AOX in UV oxidative system, J. Hazard. Mater: In this study, the effects of chloride ion concentration and pH on UV oxidation treatment were examined. Acetone and sodium dodecyl sulfate (ABS) were used as organic substances. The treatment efficiencies of these chemicals by UV/H(2)O(2) oxidation using a laboratory scale UV-free surface reactor (UV-FSR) with or without Cl(-) addition at different pH values was compared. Results of this study indicated that Cl(-) concentration and the chemical structure of the substances are more decisive than pH in the oxidation process. There was no AOX at the start of the experiments but as a result of oxidation a de novo synthesis of AOX was observed, and these AOX(de novo) compounds were destroyed during the treatment. Treatment was followed by TOC and AOX measurements. Approximately 98% and 95% TOC removal efficiencies were obtained for the treatment of acetone and ABS containing wastewaters, respectively.

A.-Q. Wang, Y.-L. Lin, B. Xu, C.-Y. Hu, S.-J. Xia, T.-Y. Zhang, W.-H. Chu, N.- Y. Gao, Kinetics and modeling of iodoform degradation during UV/chlorine advanced oxidation process: Iodoform (CHI_3) is an emerging disinfection by-product (DBP) that may be formed during pre-oxidation or disinfection processes in drinking water treatment. Degradation kinetics, modeling and mechanism of CHI_3 by combined UV/chlorine advanced oxidation processes (AOPs) were studied in this manuscript. CHI_3 was effectively removed by UV/chlorine process with the reactions followed pseudo-first order kinetics. The contributions of direct UV photolysis as well as indirect photolysis (hydroxyl radicals (.OH)) to CHI_3 degradation during UV/chlorination under different experimental factors were investigated and determined as 20.3% and 79.7% at pH 5 to 97.1% and 2.9% at pH 9, respectively. Chlorine dosage and CHI_3 concentration had slight effects on the contributions of different degradation pathways. NOM and bicarbonate have negative effects on CHI_3 degradation. The degradation model of CHI_3 during UV/chlorine processes was established, and the satisfactory match of the model calculation results and the experimental data were found. The reaction rate constant between CHI_3 and UV light as well as CHI_3 and OH were determined as 3.43×10^{-3} s^{-1} and 7.7×10^{9} M^{-1} s^{-1}, respectively. On the basis of the iodine species (such as IO_3^-, HOI, I_2 and I_3^-) mass balance analysis, the degradation pathways of CHI_3 were proposed and IO_3^- contributed 13.7% of the total liberated iodine species during UV/chlorination. These results demonstrated that UV/chlorination process is a promising AOP technology for the treatment of water containing CHI_3.

Y.A. Oktem, B. Yuzer, M.I. Aydin, H.E. Okten, S. Meric, H. Selcuk, Chloride or sulfate? Consequences for ozonation of textile wastewater, J. Environ. Manage: Ozonation of chloride-rich textile wastewater is a common pretreatment practice in order to increase biodegradability and therefore meet the discharge limits. This study is the first to investigate ozone-chloride/bromide interactions and formation of hazardous adsorbable organic halogens (AOX) in real textile wastewater. Initially effect of ozonation on chloride-rich real textile wastewater samples were investigated for adsorbable organic halogens (AOX) formation, biodegradability and toxicity. After 15 min of ozonation, maximum levels of chlorine/bromine generation (0.3 mg/l) and AOX formation (399 mg/l) were reached. OUR and SOUR levels both increased by approximately 58%. Daphnia magna toxicity peaked at 100% for 10 min ozonated sample. Considering adverse effects of ozonation on chloride-rich textile industry effluents, we proposed replacement of NaCl with Na_2SO_4. Comparative ozonation experiments were carried out for both chloride and sulfate containing synthetic dyeing wastewater samples. Results showed that use of sulfate in reactive dyeing increased biodegradability and decreased acute toxicity. Although sulfate is preferred over chloride for more effective dyeing performance, the switch has been hampered due to sodium sulfate's higher unit cost. However, consideration of indirect costs such as contributions to biodegradability, toxicity, water and salt recovery shall facilitate textile industry's switch from chloride to sulfate.

W. Wang, Y. Li, Z. Kang, F. Wang, J.C. Yu, A NIR-driven photocatalyst based on α-NaYF 4:Yb,Tm@TiO 2 core–shell structure supported on reduced graphene oxide, Appl. Catal: The development of near-infrared (NIR) light-driven photocatalysts is needed to utilize the large portion of NIR energy in sunlight. In this work, a new strategy to fabricate advanced upconversion-based NIR-driven photocatalysts was developed by integrating core–shell nanostructure of α-$NaYF_4$:Yb,Tm@TiO_2 with reduced graphene oxide (RGO) nanosheets. This new α-$NaYF_4$:Yb,Tm@TiO_2/RGO composite was synthesized by a facile wet chemical method. The product exhibited significantly enhanced photocatalytic activity than bare α-$NaYF_4$:Yb,Tm@TiO_2 and α-$NaYF_4$:Yb,Tm/TiO_2/RGO physical mixture for the degradation of various organic pollutants, including methylene blue (MB), methyl orange (MO) and phenol, under NIR (980 nm laser) irradiation. Highly reactive hydroxyl radicals (

OH) were found to be the major reactive species. It was revealed that the core–shell structure of α-$NaYF_4$:Yb,Tm@TiO_2 improved the upconverison UV energy transfer, while the incorporation of RGO facilitated the photo-generated e^-–h^+ separation after excited by the upconversion energy. Our discovery highlights the potential of developing NIR-driven photocatalysts by taking advantage of the synergic effects of core–shell upconversion materials combined with graphene for environmental and energy-related applications.

2.1 CONCLUSIONS DRAWN FROM LITERATURE SURVEY :

Since the dawn of civilization humans have been fascinated by color. In the primitive era humans explored the natural resources of dyes available in flora and fauna for the coloration of textile fiber, marking the beginning of colorful life style and what followed the next was the invention of the first synthetic dye Maure (Maureine) by Parkin (1856). This event created renaissance and is often associated with pioneering times of British Chemical Industry. As a consequence of all the developments, at present there are more than 1,00,000 dyes available commercially (of which azo dyes represent about 70% on weight basis) and over 1 million tons of dyes are produced per year, of which 50% are textile dyes.

In India alone dyestuff industry produces around 60,000 metric tons of dyes, which is approximately 6.6% of total colorants used worldwide. The largest consumer of the dyes is textile industry accounting for two third of the total production of the dye. Industrialization is the back bone for the development of any country, but the pollution caused by these industries are matter of concern.

Due to the prevailing demands, it has led to large scale production which in-turn ads to the effluents produced. These effluents are highly toxic and deleterious. Dyes are extensively used in many industries such as textiles, leather, paper, wool, printing and cosmetics.

Methylene blue (MB) is used in some of the textile industries has adverse impact on the flora and fauna and aquatic ecosystems. Therefore ,it is essential to minimize the number of dyes to the lowest possible limit approved by the Environment and Health agencies .

Some of the references are Hayelom Dargo, Nigus Gabbiye, and Adhena Ayalew: Removel of Methylene Blue Dye from Textile Wastewater using Activated Carbon Prepared from Rice Husk., International Journal of Innovation and Scientific Research., Vol. 9., No. 2.,(2014), pp. 317-325. Kamaljit Singh and Sucharita Arora: Removal of Synthetic Textile dyes from Wastewaters: A Critical Review on Present Treatment Technologies. National Agricultural Library, Information Systems Division, Maryland USA., pp.1-4 (Critical Reviews in Environmental Science and Technology. Vol.41., (2011), pp.807-878 . These references helped us to move forward.

Chapter 3

SPECIAL APPARATUS USED

3.1 CONICAL FLASK :

An Erlenmeyer flask, also known as a conical flask or a titration flask, is a type of laboratory flask which features a flat bottom, a conical body, and a cylindrical neck. It is named after the German chemist Emil Erlenmeyer, who created it in 1860.

Erlenmeyer flasks have wide bases, with sides that taper upward to a short vertical neck. They may be graduated, and often spots of ground glass or enamel are used where they can be labeled with a pencil. It differs from the beaker in its tapered body and narrow neck. Depending on the application, they may be constructed from glass or plastic,[4] in a wide range of volumes.

The mouth of the Erlenmeyer flask may have a beaded lip that can be stopped or covered. Alternatively, the neck may be fitted with ground glass or other connector for use with more specialized stoppers or attachment to other apparatus. A Büchner flask is a common design modification for filtration under vacuum.

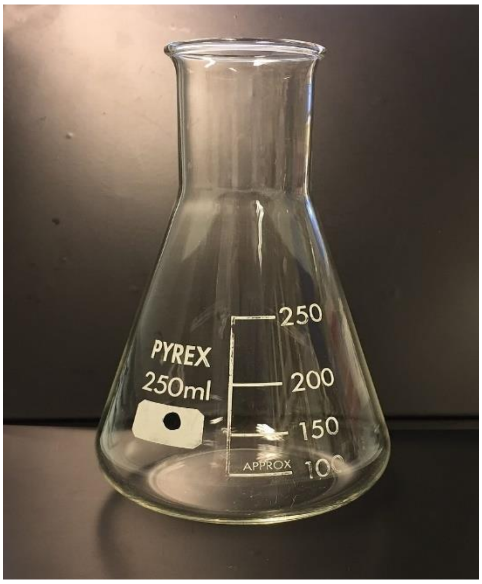

Figure 3.1: Muffle furnace

3.2 GLASS BEAKERS :

Beakers are useful as a reaction container or to hold liquid or solid samples. They are also used to catch liquids from titrations and filtrates from filtering operations. Laboratory Burners are sources of heat. Burets are for addition of a precise volume of liquid.

Figure 3.2: GLASS BEAKERS

3.2 PLASTIC FUNNEL:

Used in transferring liquids in small containers. -Used for pouring liquids or powder through a small opening and for holding the filter paper in filtration. Features: -Has set benchmark in offering Laboratory Plastic Funnel.

Figure 3.3: PLASTIC FUNNEL

3.4 MUFFLE FURNACE :

Muffle furnace refers to a type of jacketed enclosure that is used to heat a material to significantly high temperatures while keeping it contained and fully isolated from external contaminants, chemicals or substances.

Muffle furnaces are usually lined with stainless steel, making them largely corrosion resistant.

Muffle furnaces were designed to combat the associated outcomes of heating via combustion. Such outcomes include a variety of unwanted byproducts such as ash, soot and gas fumes. The generation of these byproducts often present as impurities to the material being heated. As such, it became vital to develop a housing medium to combat this.

Muffle furnaces are capable of reaching and holding temperatures as high as 1800°C (3270°F). They are used in a variety of applications, including lab materials to conduct experiments, brazing and soldering.

Figure 3.4: MUFFLE FURNACE

Muffle Furnaces are used for high-temperature testing applications such as loss-on-ignition or ashing. Muffle Furnaces are compact countertop heating sources with insulated firebrick walls to maintain high temperatures.

Chapter 4

SYNTHESIS OF ADSORBENT

4.1 PROCESS OF PREPARATION:

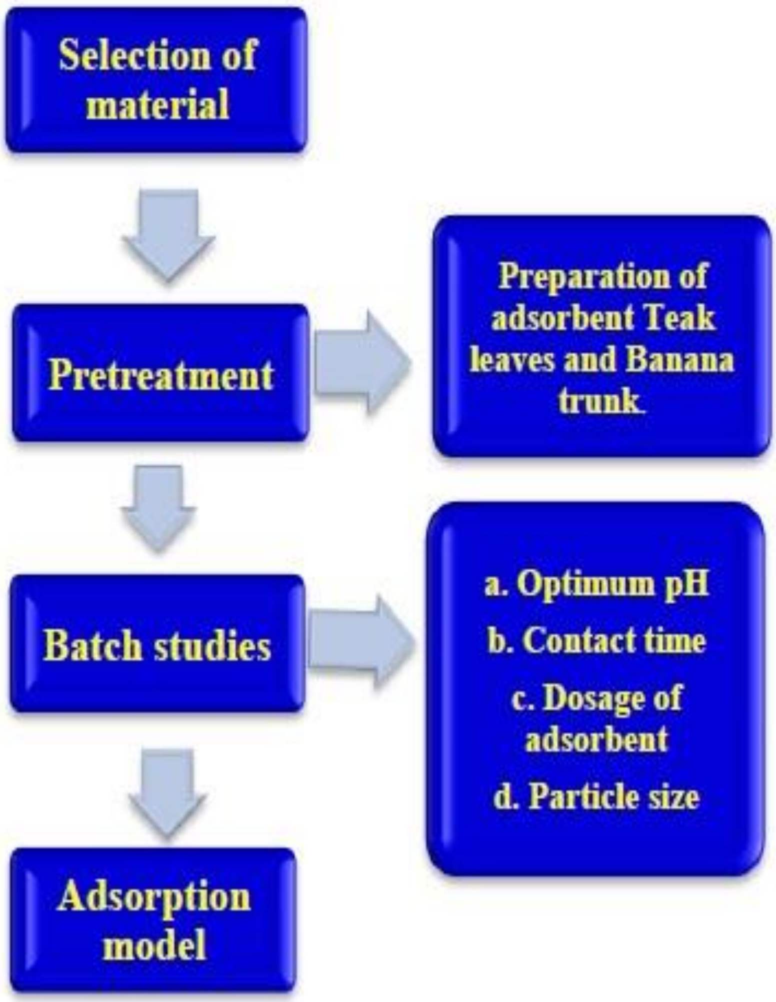

Figure 4.1: Showing the Flow chart of the experiment conduction

4.1 TEAK LEAVES POWDER:

1. Teak leaves were collected from neat the house and washed repeatedly until the dirt was eliminated.

Figure 4.2: TEAK LEAVES NEAR THE HOUSE

2. This leaves were left for sundry.

Figure 4.3: TEAK LEAVES NEAR AFTER SUNDRY

3. After completely achieved dry state. They were sieved using a grinder.

Figure 4.4: TEAK LEAVES POWDER

Figure 4.5: ACTIVATED ADSORBENT FROM TEAK LEAVES

4.3 BANANA TRUNK POWDER:

Figure 4.6: BANANA TRUNK KEEP FOR SUNDRY

Figure 4.7: BANANA TRUNK POWDER

Figure 4.8: ACTIVATED ADSORBENT FROM BANANA TRUNK

Chapter 5

METHODOLOGY

5.1 Methylene Blue Adsorption Study :

A 1000 ppm methylene blue (C16H18ClN3S, Molar mass: 319.85 gm/mol, procured from R & M Chemicals, Malay-sia) dye solution was prepared in 1 L and used as a stock solution. The desired concentrations were prepared by the dilution of the stock solution. In this experiment, 20 mL of 150 ppm methylene blue dye solution were used with 0.05 g of activated carbon (adsorbent dose 2.5 g/L), kept it for constant agitation for 24 h. After filtration, the solid activated carbon was separated, and the liquid was tested for methylene blue concentration removal.

5.2 Schematic representation of banana trunk drying :

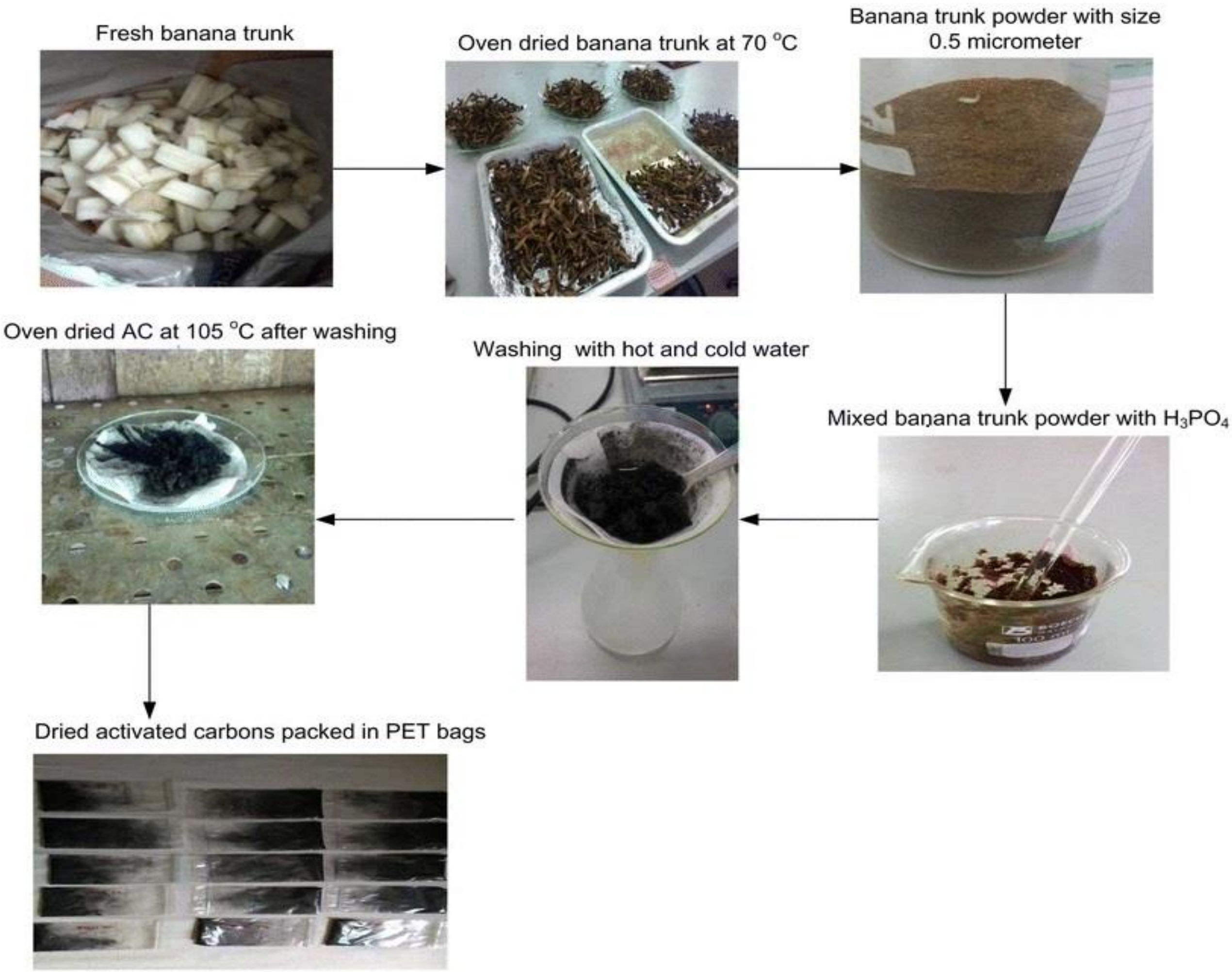

Figure 5.1: Schematic representation of banana trunk drying and its conversion into activated carbon

5.3 Tectona Grandis as Low-Cost Adsorbent:

The phosphate present in detergent industrial wastewater by using indigenously available natural resources such as teak leaves (Tectona Grandis) as a low-cost adsorbent. The physical and chemical characteristics of teak leaves adsorbent were analyzed such as particle size, surface area, etc. Further, characteristics of detergent wastewater were also studied to find out the contaminants level. Herewith, the adsorption study was conducted on fundamental parameters such as pH, dosage and contact time etc. From the above study and obtained results, it has been found that the percentage adsorption of phosphate from detergent wastewater such as 91.41% was achieved for 6gm of activated teak leaves adsorbent within 1 hour at pH 2 and COD was removed about 92.2 % using teak leaves as adsorbent which was another important issue which was addressed. Overall, the conducted study confirms the benefits for the sake of whole environment.

5.4 Collecting water from river:

Figure 5.2: River water with Colour traces

Figure 5.3: Contaminated water from the river

5.5 Activated Adsorbent:

Figure 5.4: Activated Adsorbent

Chapter 6

RESULTS

Figure 6.1: LEVELS OF WATER PURIFICATION

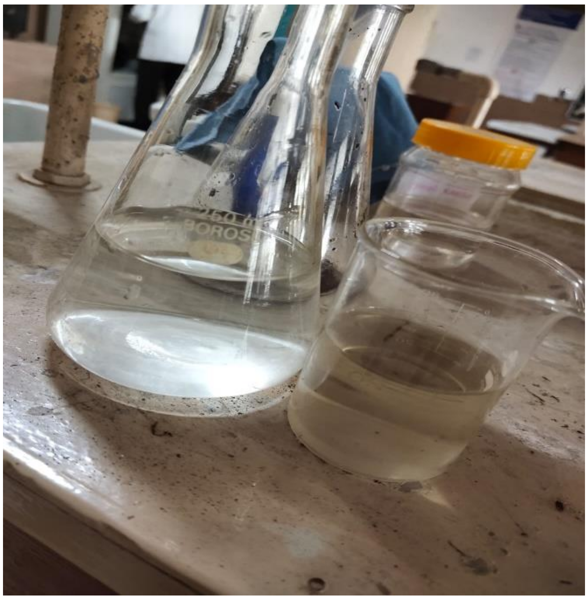

Figure 6.2: COLOURLESS WATER

Chapter 7

TESTING OF TREATED WATER

It’s important for textile factories to have an effective wastewater effluent treatment plan. Textile production processes are water-intensive and release harmful chemicals, dyes, acids and starches into the water. Textile effluent can cause significant water pollution that threatens human health and damages the environment. The textile industry uses many industrial processes and substances that require physio-chemical treatment of the water used in those processes. Since textile wastewater is so harmful, textile plants must have an appropriate effluent treatment system to treat water effectively while saving time, space and money. The most effective wastewater treatment method is the mixing of activated adsorbent prepared from waste leaves and banana trunk. This method is the best wastewater treatment for the textile industry because it’s efficient, cost-effective, long-lasting and beneficial to the environment. Water quality parameters include chemical, physical, and biological properties and can be tested or monitored based on the desired water parameters of concern. Parameters that are frequently sampled or monitored for water quality include temperature, pH, turbidity, Hardness, colour, and odour.

7.1 TEMPERATURE :

For both treated and untreated water the temperature is 30 degrees Celsius.

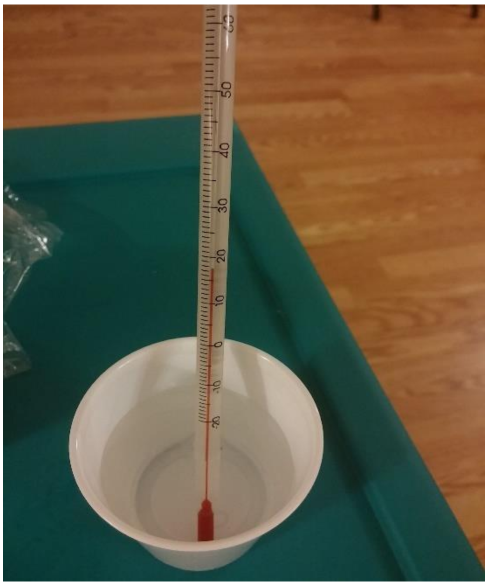

Figure 7.1: Measuring temperature of treated water

7.2 POTENTIAL OF HYDROGEN (pH):

pH is a measure of how acidic/basic water is. The range goes from 0 to 14, with 7 being neutral. pH of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. The pH of water is a very important measurement concerning water quality.

7.2.1 pH using litmus papers:

Figure 7.2: pH using litmus papers

- Untreated water pH is in between 10-11 (Basic)
- Treated water pH is in between 7-8 (Neutral)

7.2.2 pH using pH meter:

Figure 7.3: pH meter

- Calibrate the pH meter to pH 7

Figure 7.4: Buffer Capsules

Figure 7.5: Calibrate to pH 7.00

- Calibrate the pH meter to pH 4

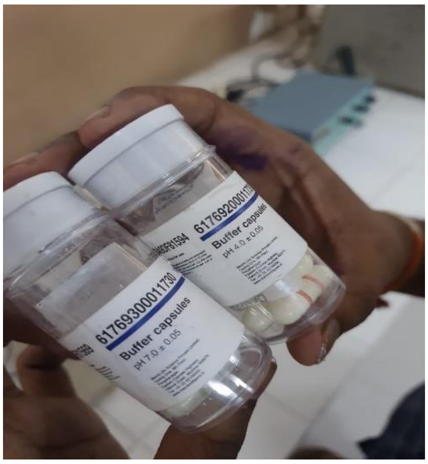

Figure 7.6: Buffer Capsules

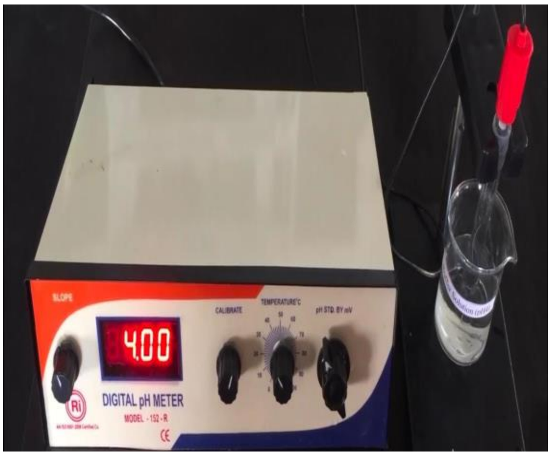

Figure 7.7: Calibrate to pH 4.00

- pH of the treated water

Figure 7.8: pH of treated water

7.3 Turbidity:

Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky. Particulate matter can include sediment - especially clay and silt, fine organic and inorganic matter, soluble colored organic compounds, algae, and other microscopic organisms.

Figure 7.9: Nephelometer

Figure 7.10: Turbidity of water sample

Figure 7.11: Inserting Sample in Nephelometer

7.4 Hardness:

Hard water has high mineral content. It is formed when water percolates through the deposits of chalk and limestone which are made up of magnesium and calcium carbonates. It does not lather with soap, so it is not suitable for laundry purposes.

The hardness of water is harmful to the boilers as the deposition of salts occurs, which reduces the efficiency of the boiler. Hard water is safe to drink but using over a long interval of time can lead to many problems like:

- Strains in skin
- Water appliances work harder resulting in higher water bills
- Spots appear on clothes and linens

The estimation of hardness is based on complexometric titration. Hardness of water is determined by titrating with a standard solution of ethylene diamine tetra acetic acid (EDTA) which is a complexing agent.

Figure 7.12: Hardness of water test

Observations:

Untreated Water

S.No	Sample details	Volume of solution used	Burette Reading		EDTA(mL)
			Initial	Final	
1	Total hardness	50mL	19	35	16
			20	36	16
			20	37	17
			19	35	16

AVG : 16 mL

Table 7.1: Record of Observations for Untreated Water

Total hardness (mg/l) = (EDTA used / vol of sample) * 1000

= (16/50)*1000 = 320 mg/l

Treated Water

S.No	Sample details	Volume of solution used	Burette Reading		EDTA(mL)
			Initial	Final	
1	Total hardness	50mL	36	43	7
			30	23	7
			36	43	7
			30	22	8

AVG : 7 mL

Table 7.2: Record of Observations for Treated Water

Total hardness (mg/l) = (EDTA used / vol of sample) * 1000

= (7/50)*1000 = 140 mg/l

7.5 Colour:

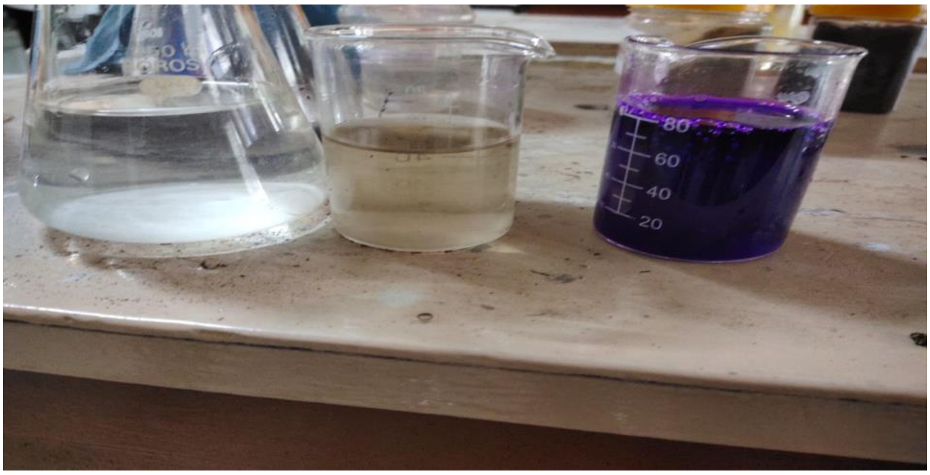

Figure 7.13: Colour of treated and untreated water

Chapter 8

Comparison of Treated and Untreated Water

S.No	QUALITY TEST	UNTREATED WATER	TREATED WATER
1	Temperature	**30**° C	**30**° C
2	pH	10.5	7.01
3	Turbidity	200 NTU	0.02 NTU
4	Hardness	320 ppm	140 ppm
5	Colour	Dye colour	Water colour
6	odour	Odour less	Odour less

Table 8.1: Comparison of Treated and Untreated Water

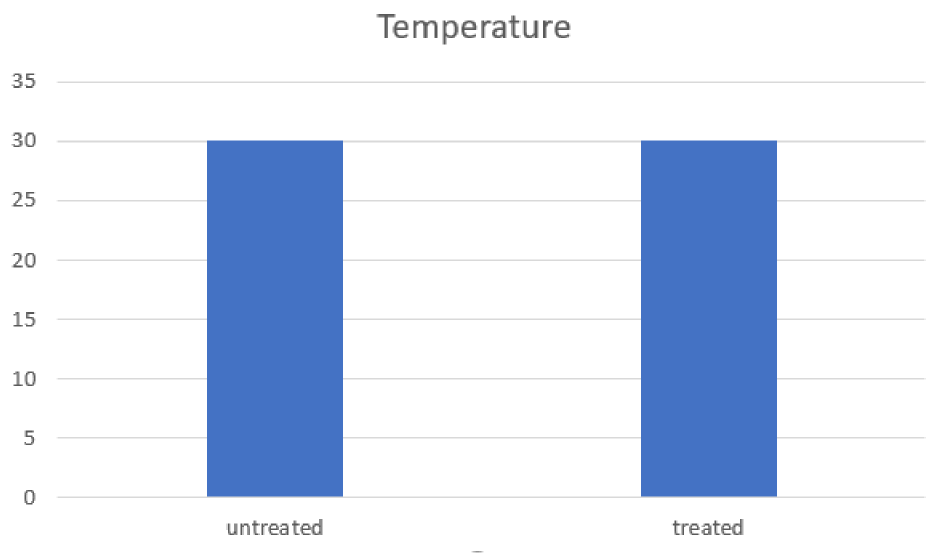

Figure 8.1: Temperature(Untreated Vs Treated)

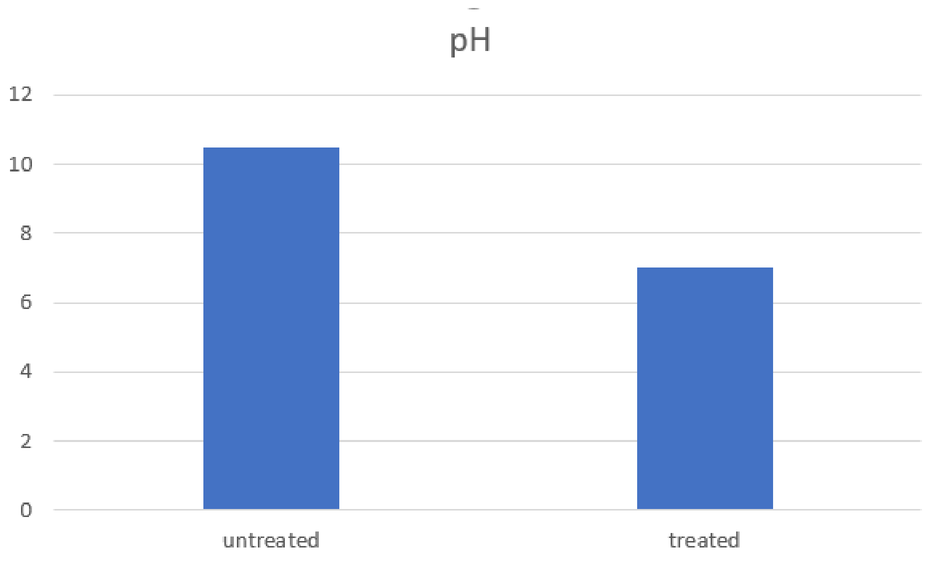

Figure 8.2: pH(Untreated Vs Treated)

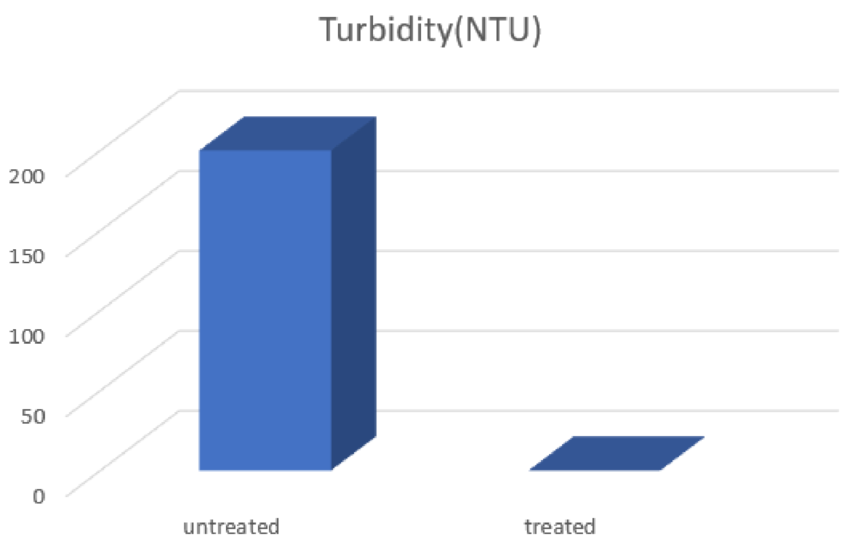

Figure 8.3: Turbidity(Untreated Vs Treated)

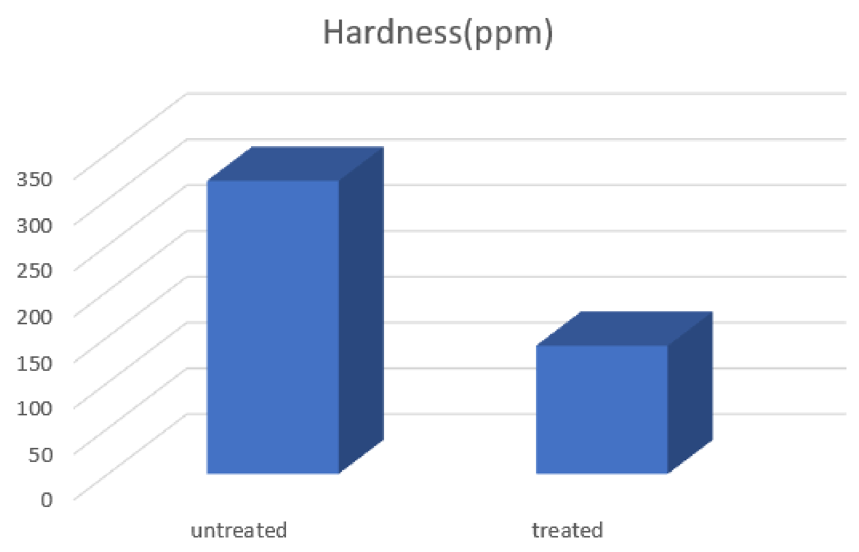

Figure 8.4: Hardness(Untreated Vs Treated)

Chapter 9

SUMMARY AND CONCLUSION

Waste water is a major environmental impediment for the growth of the textile industry besides the other minor issues like solid waste and resource waste management. Textile industry uses many kinds of synthetic dyes and discharge large amounts of highly colored wastewater as the uptake of these dyes by fabrics is very poor. This highly colored textile wastewater severely affects photosynthetic function in plant. It also has an impact on aquatic life due to low light penetration and oxygen consumption. So, this textile wastewater must be treated before their discharge. Hence in this project, treatment method to treat the textile wastewater have been presented.

It is concluded that the activated carbon produced from teak leaves and banana trunk can be effectively used for the dye removal from industrial effluent . The efficiency of banana trunk (Musa)is comparatively higher than that of teak leaves(Tectonagrandis). So that the ratio of teak leaves and banana trunk (2:1) shows higher colour removal efficiency. Thus the treated water is used for construction, laundering, farming, drinking, and many more.

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