

Reuse of decolorized wastewater in textile waste off process

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ABSTRACT

The purpose of conducting the research was to remove dyes from textile wastewater by using electrocoagulation process. It is the wastewater reuse method; the study was executed out on two reactive dyes i.e., C.I. Reactive Red 221 and C.I. Reactive Yellow 145. Wastewater was prepared in the laboratory and then treated and reused. The technique used for this purpose was electrocoagulation technique. Dyes of concentration 1%, 3%, 5% were studied for C.I. Reactive Red 221 and C.I. Reactive Yellow 145. pH was controlled and standard wastewater was maintained at three pH levels (4, 7 and 10). After isothermal dyeing, the dyed fabric was shifted to conventional process of wash-off. The water resulted in the dyeing wash-off process duration was treated by electrocoagulation technique and further it was reused in next washing process of dyeing.

Electrocoagulation treatment method proves highly effective in color removal of textile wastewater. The best results were observed of 1% shade of C.I. Reactive Red 221 that was up to 98% within a time interval of 15-20 minutes. For C.I. Reactive Yellow 145, the efficiency was up to 96% after time interval of 20 minutes of 1% shade.

The dye removal was extremely influenced with the variation in pH. pH has significant effect on electrocoagulation method for the removal of dyes from wastewater. The efficiency of electrocoagulation on pH 4 resulted minimum color removal that was less than 84%. When pH reaches to maximum alkaline level, the excellent removal proficiency was achieved. It was indicated that when pH changed from 7 to 10 of coloring wastewater, the removal proficiency was improved.

Color measurements were also observed for both reactive dyes. Results of color measurement showed that color difference values of Sample C (fabric treated by pH 10 wash-off) were found to be within the acceptable range that were from 0.38 to 1.50 of all dyes and shades (5%, 3%, 1%) because the best removal efficiency of dyes were observed in alkaline pH. Sample A having pH 4 of all the dyes has a large color difference and shows quite large CMC values. Sample A values were found between 2.44 to 13.48 that were not within acceptable limit i.e., ≤ 1 . Sample B (fabric treated by pH 7 wash-off) values were found to be intermediate as compared to Sample A and Sample C.

CHAPTER 1

INTRODUCTION:

Water pollution is a global issue that requires consideration. The water resources decreased by drought and population growth have pledged authorities to manage water resources. Water contamination is primarily resulted by the dramatic effect of industrialization (Rasmi Patnaik *et al.*, 2017).

Annually, many people lost their life and millions of us are at risk. Achieving clean water and sanitation have become crucial elements for developing countries. Water pollution accounts for third highest risk factor for disease and disability (Gibson J.M. 2019). It demands frontal attack to eliminate these diseases.

Industrialization changes the human life from an urban society to developed one by social and economic revolution. It is a huge transformation method where technological modernization leads to high economic growth. It removes the barriers to success but have some adverse effect on environment. Most of the industries are implemented near to rivers, streams or water bodies thus creating a way to water pollution. Industries dispose tons of waste products into nearby water bodies. Therefore, sustainability demands different ways to minimize the water pollution caused by industries. The manufacturers should think about the water management. Over the past few decades, a policy has been established to reduce water pollution. The most important directive for industries is the presence of the Integrated Pollution Prevention and Control Directive (IPCC) and the Water Framework Directive (Evrard *et al.*, 2016).

Textile industry is the leading industry in many countries in the world. A textile industry needs to reuse the water due to high water consumption in washing and dyeing process. Globally, one in three people do not have access to clean water. Shortage of water and growing demands of clean water, urge textile industries to treat water. Being an expressive consumer of water, textile dyeing is carried out in different aqueous baths and yields polluted wastewater. Wastewater from textile industry comprises of different dyes and chemical additives, as some are difficult to degrade.

The potential contaminants of textile wastewater are non-biodegradable organic and inorganic compounds such as metals, phenols, color, pesticides, phosphates and certain surfactants. This contaminated textile wastewater is not only dreadful for humans but also for aquatic life as aquatic life cannot survive in polluted media. The suspended solids present in polluted water clogs in fish's gills resulting in retarded growth and often leads to death. Therefore, the search for an effective treatment method for treating textile wastewater is essential. Various techniques have been used for wastewater treatment based on biological, physical and chemical processes. Wastewater from textile industry shows high coloration and low biodegradability, hence making it difficult to treat with natural, chemical and organic treatment processes.

Table 1.1 Techniques in Wastewater Treatment

Techniques Name	Dye Removal Efficiency	Drawbacks	References
Chemical Coagulation	44.5%	<ul style="list-style-type: none">• High variance of water composition• Difficult to process multiple contaminants at once• It is an additive process• High operational costs	Verma et al., 2012
Advanced Oxidation	98%	<ul style="list-style-type: none">• Relatively high capital and operating costs• Removal of residual peroxide may need to be considered• Complex chemistry tailored to specific contaminants	Azbar et al., 2014
Wetlands	94%	<ul style="list-style-type: none">• Land take is high• Little reduction in run volume• Requires base flow• Limited depth range for flow attenuation	Olejniak, D., & Wojciechowski, K. (2012).

Generally conventional biological treatment methods are efficient for high chemical oxygen demand COD, but least color removal efficiencies in discoloration are observed as a result of the chemical steadiness and endurance to biological attack of the dyes (Bes Pia *et al.*, 2005). Chemical coagulation can completely remove the color of dyes but limited due to additional treatment for its massive sludge. Advanced oxidation processes have emerged as an effective water treatment method for oxidizing various organic pollutants, including those that cannot be treated with conventional techniques but form complex structure with reactive dyes (Oller.I. *et al.*, 2011). Wetlands are built up for wastewater treatment but are not effective in color removal and require large area. Electro coagulation is acting as a problem solver in treating textile industry wastewater.

Restricted water consumption, source reduction and treatment have become crucial factors for sustaining water. Among the most important environmental problems related to removal of dyes from wastewater is the one because it was observed that only 87% of its components can be decayed (Pagga, U. *et al.*, 1986). The major concern of textile industry's wastewater is the color of dyes obtained from textile industry (Willmott, N.J. *et al.*, 1998). The primary reason color appearance in the textile wastewater is due to the use of excessive amounts of reactive and vat dyes. Commonly, reactive dyes are used for dyeing fibers that are made of

cellulose as more than 50% of cotton products are colored with reactive dyes. In wastewater more than 15% dyes are introduced in streams during the dyeing process. A better way is to try to regenerate the wastewater dye for reuse.

Reusing textile wastewater after decolorization is essential for large water utilization in textile industry. Textile wastewater can be reuse in its decolorized form. For treating textile wastewater, a technique that is cost effective with efficient color removal is required. Electro coagulation is a diversified treatment technology that deals with wide range of contaminants. Removal of total suspended solids (TSS), heavy metals, bacterial content and all above color takes place from wastewater. Wastewater obtained from textile industry is treated with electrocoagulation process as it is a convenient and less expensive way to recycle water. After recycling, water can be reuse in the dyeing process as it is decolorized now. Recycling by electrocoagulation method not only reduce the pollution level but also lowers the consumption of fresh water. Reusing will ultimately ends up zero or less water discharge. Electrocoagulation caused the pH to normally shift toward the neutral and minimum time is required for suspended solids to settle down. Electrocoagulation is more efficient as compared to other techniques as it removes even the fine particles or impurities from water. Therefore, the sample can be reused with an electromotive force that causes the chemical reaction in wastewater. It triggers the forces and bonds of dyes and removes the color from dyes. Decolorized water can further be used safely in textile industry.

1.1 Aims and Objectives:

The objectives of this research are as follows:

- To initiate a method for decolorizing liquid in the wash off process.
- In comparison to the excellence of dyeing in overall color difference of coagulant treated fabric according to generally washed fabrics.
- To analyze the parameters effecting the decolorization in electro coagulation process for different reactive dyes.

1.2 Textile Industry Process

There is a wide range of machinery and procedures involved in the formation of required shape and final product. A large amount of effluents is released during various steps for instance sizing, de-sizing, bleaching, scrubbing and mercerization. They are generated during coloring, printing, and completing. Composition of these effluents mainly involves dye residues, salts, acids, bases, various chemical agents, and byproducts. Various salts were obtained as a byproduct such as Sodium Chloride (NaCl) and Sodium Sulphate (Na_2SO_4) in the neutralization during wet processing in textile industry.

1.3 Methods for the Treatment of Wastewater

Various methods are used in treating wastewater. These methods are divided into different categories.

Many conventional methods that are used to treat the textile wastewater. These methods include physical, physiochemical, or biological method. Because textile wastewater has variability in their composition, so these conventional methods are not sufficient or adequate to remove all organic or inorganic matter from the water. It is essential for every industry to release their effluent in less toxic form to achieve quality of specified standards. The cost of treating the textile wastewater is rapidly increasing in recent years.

Chemicals release from the industries has complex structure, so they require specific handling in removing them. Due to increasing demand of treated water industries requires simple, efficient and cost-effective treatment method. It should be manageable in less space and chemical consumption to avoid secondary pollutant production. Electro coagulation is electrochemical process that removes pollutants without any additional chemical and proved to be cost effective.

1.4 Electro Coagulation Process

The Electro coagulation is a treatment method in which suspended solids, colloidal solids and dissolved solids, emulsified oils and colors of dyes present in wastewater are treated. Electro coagulation method helps to remove the insecticides, contaminants, and toxic microbial content present in the water. Electrocoagulation process comprises of two iron or aluminum electrodes scattered in handling wastewater. Direct Current is used as a source of power supply. When Electrocoagulation process is operated, it dissociates the metal ions

located on electrode in aqueous media. The hydroxide OH obtained at appropriate pH are not soluble in water hence separated. As additional chemicals are not required, secondary pollutant will not produce. Electrocoagulation produces less sludge.

Electrocoagulation technique is selected over conventional or biophysical method due to its simple design. Electrocoagulation treatment is cost effective approach to a healthy environment. Organic and inorganic content is removed from wastewater to protect the environment. Use of two reactive dyes that are red 221 and yellow 145 at pH 4, 7 and 10 are used, analysis revealed that at high alkaline medium which is pH 10 the electro coagulation technique showed excellent results.

1.5 Dyes and Its types

Dyes are distributed in filaments of the cotton or dyeing cloth by introducing chemical, conventional technique or by dispersion method. Dyes are reluctant to nature and resilient for many mediators. It relies on their similarity with various cloths and their reaction to detergents and solubility.

There are two types of artificial and natural dyes. Artificial dyes are categorized depending on their chemical structure and dose used during dyeing. While comparing, natural dyes are distributed into three categories, natural dyes that are obtained by floral content are known as indigo and the other that are obtained from fauna are called cochineal. Dyes that are obtained from reserves are called meteorites.

1.5.1 Alkaline Dyes

This is the first synthetic dye extracted from the derivatives of coal tar. They are used for printing and for making leather, paper, wood, and straw. Recently they have been effectively used in some ready-made yarns, particularly acrylics.

1.5.2 Direct Dyes

The anionic dyes are easily soluble in aqueous media by incidence of electrolytes. These dyes have great bonding to cellulose fibers. They are mainly used in process of fabric dyeing and regeneration of other components. Most of the dyes from this category are compounds of poly azo. Wash fastness is increased by often chelation with salts that are introduced with various dyes. Direct dyes are alkaline dyes that are used as they do not demand the additional use of any binders in dyeing fabric.

1.5.3 Acid Dyestuff

Acid dyestuff is diverse and an essential group of dyes. Although, it is mainly formed by the combination of acidic substances rather alkaline dyes originates from the natural organic base.

1.5.4 Premetallized Dyes

It is an acid dye. It has metal complex structure for improving fixation to wool and nylon

groups in the presence of light.

1.5.5 Sulfur Dyes

Sulfur dyes provide are darker in shades but are resistant to solar radiations. These dyes are used both for cotton and rayon fabric, but are less bright. Use of Sulfur dyes causes problem as they make the fabrics less strengthen and change in its structure. Therefore, sulfur dyed fabric must usually be treated with a base to neutralize the acid that has been formed.

1.5.6 Azo Dyes

These colored dyes are mainly used in bright red tones for dyeing and screening purpose, because some other types of fast dyes lack good red dyes color. In industry they are said to be Naphthol Azo dyes.

1.5.7 Vat Dyes

These are probably the most widely used dyes because they have comprehensive wash ability and fastness in daylight for cotton and rayon fabrics. The word vat has been originated from old indigo dyeing process: Indigo must be restored to light color. They are successfully used for all kinds of fabrics.

1.5.8 Chemical Fiber Dyes

Manmade dyeing fibers such as cellulose acetate, poly acid, Polyester and Acrylic have proved to be a great task for dye users. Each new fiber must be carefully examined and verified for its response to by taking different dyes, when obtained from the laboratory. This process has been continuously tested and new developments have continued.

1.5.9 Alizarin Dyes

These are vegetable dyes, originally from alfalfa plants. They are used for various types of fabrics. In addition to other colors, they also produced brilliant Turkey Red.

1.5.10 Chromium Dyes

These are special type of dyes to dye wool and the worsted fabrics from animal fibers. They react easily with metals that are present on fabric such as chromium. When fabric is dyed with this process they make color dull, but it gives more light fastness and the washable fastness.

1.5.11 Neutral Dyes

Neutral dyes are acid dyes that include metals. At the time of manufacturing neutral dyes, the metals are added in it. These are metal-containing acid dyes, and metal is added at the time of manufacturing.

Table 1.6.1 Properties of C.I Reactive Red 221

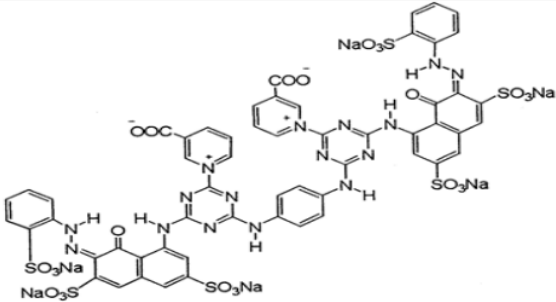
Dye	C.I. Reactive Red 221
Molecular Structure	
Molecular Formula	$C_{37}H_{35}N_{16}Na_6O_{24}S_6$
Molecular Weight	1699.34 g/mol
Solubility	Soluble in water
Maximum Wavelength	520nm

Table 1.6.2 Properties of C.I Reactive Yellow 145

Dye	C.I. Reactive Yellow 145
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Molecular Structure	
Molecular Formula	C ₂₈ H ₂₀ ClN ₉ Na ₄ O ₁₆ S ₅
Molecular Weight	1026.25
Solubility	Water Soluble
Wavelength	419nm

CHAPTER 2

LITERATURE REVIEW:

Textile industry wastewater comprised of complex components that includes artificial dyes, bases, acids, salts, and oil (Pelosi *et al.*, 2014). Dye effluent released from textile industry has chemicals and other toxic substances which cause carcinogenicity, mutagenicity. Different processes of treatment are used to remove dyes from wastewater for example chemical oxidation, biophysical methods, electrochemical and conventional methods.

Reactive dye wastewater is colored due to addition of dyes, with higher content of salt and highest values of chemical oxygen demand and total organic compound. When this wastewater gets contaminated with water bodies, degrades water quality progressively. Various treatment methods are used to remove dye color for reuse purposes. To study these techniques and methodologies and their significance in removal of such effluents that acts as triggering force in water reuse, fifteen papers have been studied and reviewed.

The use of water in wet processes is much higher than other processes such as spinning and weaving. Requirement of water for textile industry are greater as all dyeing and finishing procedures are operating in water bath hence. Textile industry generates gallons of dye wastewater consumption on daily basis (Shaikh, 2009). Study conducted to reuse the wastewater generated from industries using electrochemical treatment of effluents by avoiding the introduction of chloride was studied for effluents removal, dye from textile industry. Mainly used for dyeing cotton in textile industry. It was estimated that consumption of dyes by these industries are more than 100,000 various dyes resulting the generation of up to 700,000 tons per year (A. S. Arun Prasad., *et al* 2010).

The study reported that the reuse of decolorized water after treatment of electrochemical method can be possible in dyeing process. Researchers used four consecutive dyes for this purpose and compared the color variation with simple water and treated water. All other parameters including TOC, COD AOC were also studied. Results evaluated revealed that treating through electrochemical method provide water that can be reused in industry. The results of color similarity in the fabrics that are dyed in its reuse for four times were less than the highest acceptance level in color differences for textile industry which is one "1" (F. Orts *et al.*, 2019).

General dyes that are used in process of process that are distributed varying on their chemical structure, basic dyes, acid dyes and diffused dyes. (Phalakornkule *et al.*, 2010). The dye molecules containing aromatic rings are replaceable by the traditional treatments for degradation. (Orts F. *et al.*, 2019). Wastewater released from the textile industries can contain up to 200 mg/L of dye that is a massive amount for degrading environment and a mixture of other organic and inorganic chemicals and additives (Jamee.R and Siddique.R, 2019).

An alternative technique is advanced oxidation rather than conventional treatment methods for the degradation of industrial waste effluents and organic compounds present in it. Advanced oxidation process produces reactive and non-oxidizing ions which have much higher ability to oxidized. In this oxidation method, no external chemicals are added, and least sludge is generated in comparison to the other biological processes. It requires high-cost mediators and maximum energy sources like UV-Radiations (Azbar, *et al.*, 2004).

A study was carried out for treating synthetic wastewater that contains dyes using anaerobic method and COD technique. In the microbial process, a simple method was performed. The results clearly experienced that by expanding its time and introduction of microbial content had clear effects on the removal of dyes (A.B. Dos Santos., *et al.*, 2006). In this process, factors that are affected are wastewater structure, time, yeast extract's quantity, untreated water flow rate and the introduction of microbes were observed. High level of efficiency was resulted by the microbial addition that up to 89%.

Rather microbiological method is an eco-friendly method, but its treatment demands a huge time interval to guarantee the variation of microorganisms. Hence, Electrocoagulation being a fast process, proved to be a proficient treatment method in decolorizing wastewater and to achieve highest removal capacity. From economic perspective, the use of microorganisms for synthetic dyes is reliable due to cost effectiveness.

Bioremediation is an environment-friendly and an effective alternative to conventional methods for textile wastewater treatment (Jamee.R and Siddique.R, 2019). Decolorization of textile wastewater through bacterial consortium, many reports are studied for decolorizing the dyes by using yeast consortia and fungal consortia, by biodegradation mechanism, which cannot be done by biosorption or bioaugmentation (Sghaier I. *et al.*, 2019). Bacterial degradation is used for the degradation of synthetic dyes. Decolourization of dyes under anoxic, aerobic and anaerobic conditions was studied. Microbial degradation generates byproducts that are much more toxic. Azo dyes after microbial degradation produces moderate organic compounds and aromatic amines that are concerned as mutagens and carcinogens (Sghaier I. *et al.*, 2019).

The process of Adsorption is also used for treatment of textile wastewater. Dye industry is known as the tenth most polluting industry to river's water, as about 17–20% of the industrial water pollution is consumed by the textile treatment and process. Removal of anionic textile dyes is an effective method by using adsorbent synthesized coffee waste was studied and evaluated. For adsorbent in this adsorption process was synthesis coffee waste

because it is the most suitable adsorbent due to high consumption of coffee by consumers. Researchers removed two dye colors for this research, Congo red and Reactive Black 5.

Study investigated that contact time, temperature, solution pH, adsorbent dose, and dyes adsorption into coffee waste. The high pH value indicates the maximum adsorption of dye that was 8.57. The structure of Coffee Waste is typically three-dimensional carbon structure having rough surface. Contact time of Sample adsorption was observed. Findings revealed that the maximum adsorption contact time for RB5 was 50 minutes and CR was 106 minutes. Percentage Removal evaluated 86% and 99% Congo Red and RB5 respectively. The kinetic evaluation was conducted by setting the investigational records to the pseudo-first and second-order of pseudo kinetic models. Finding reveals the adsorption of blue and red dyes onto coffee waste is controlled by process of chemisorption (Wong S. *et al.*, 2020).

A study was conducted to remove the indigo carmine dye that is used in industrial denim dyeing processes. For conducting this, an integrated advanced oxidation process was used by combining electrocoagulation and ozone. (M. A. García, Morales, *et al.*, 2013). Effluents containing dye's effluents could prevent light from penetrating into lagoons, rivers, or lakes, inhibiting biological processes depending on photosynthesis. Furthermore, these effluents contain chemicals that are even more toxic, carcinogenic, mutagenic in case of many microbiological or animal species.

The kinetics of the reaction for decolorization and turbidity in the ozone-electrocoagulation process indicated that the accuracy obtained in the integrated process highly depend on the ozone and electrocoagulation treatments. (Morales, G. *et al.*, 2003) As a result of this treatment, the low intensity level between the untreated wastewater and the treated wastewater indicates oxidation by removal of the organic compound in the process. This result was constant with the cyclic voltammograms resulted as ozonation was highly demanding for wastewater treatment because ozone was soluble in water and could rapidly degrade in the form of free radicals reacting with any organic compound such as dyes. The entire research reported that both processes that was ozone and electrocoagulation were combined in Sample reactors to increase the decolorization efficiency of denim dyeing compared to a single treatment.

Ionization radiation is a well-known technique for decolorization of textile water. The radiation technology methods generally uses a strong oxidizing species OH radicals that have higher electrochemical oxidation potential causing a chain of reactions for breakdown of macromolecules of dye into simple and less toxic substances (A.N.M. Bagyo *et al.*, 2001). Energy that have higher radiations are produced which can transform energy from excited electrons to orbital electrons. Absorbed energy not only disturbs the electron system of the molecule but also cause the breakdown of interatomic bond. This breakage results the ionization of water molecules into H_2O^+ .

Textile wastewater is decolorized by using gamma radiation and reusing treated water in dyeing revealed the possibility of reusing textile wastewater in dyeing cotton fabric after decolorization that will ultimately reduce the wastewater generation and consumption of

wastewater. Sample of wastewater were collected and four different doses of radiations (3kGy, 5kGy, 8kGy, 12 kGy) were provided without any dilution. The electromagnetic radiations were emitted from Cobalt 60. Color removal efficiency and pH of wastewater and irradiated water were analyzed and compared. The pH value was decreased from 9 to 7- 7.5 near to neutral, whereas the pH reduction for each dose was also observed. The color reduction percentage increased with the increase of increment of radiation dose. High color removal was observed at high dose. Results indicated that it would be a satisfactory method in reusing textile wastewater.

Study conducted by J.A.Chicatto *et al.*, 2017, revealed that by decolorizing textile industry wastewater in solid form is efficient approach by fermenting with peach palm (*Bactris gasipaes*) residue. Wastewater is decolorized in two processes, by W.R.F and adsorption of dyes through solid matrix by using the residue of peach palm. White rot fungi are generally recognized due to its capability to decompose lignin and a huge number of xenobiotic contaminants which are found in various media such as soil and waterbodies by accumulation of dyes, PAH, PCBs, and insecticides (Asgher *et al.*, 2012).

Ganoderma lucidum is among the most widely used Water Root Fungi all over the world. Many studies conducted on *G. lucidum* primarily focused and concerned due to its ability to produce laccase and its feasibility for decaying dyes and organic components (Rivera-Hoyos *et al.*, 2015; Kuhar *et al.*, 2015; Zhou *et al.*, 2012). Wastewater obtained from a textile industry used in processing of textile fibers, residual dye bath effluent and wastewater effluent. The sheath that was consumed during this research was an agricultural industrial waste that was produced by palm tree mining and dehydrated at 60 °C for time interval of 24 hours. Next 14 days of controlled procedures, the components present in the measuring bottles was standardized such that a LE was arranged by adding 8g of taster with 50 mL of purified water in laboratory. Solids present in the wastewater were then separated from the liquid extract through a process of centrifugation for duration of at least 15 minutes up to 4 °C. Then this mixture was further used in process of adsorption. The greatest percentages of 75% and 74% were obtained by fermentation using the finishing discharge and of sheath obtained from peach farm.

Above study provided innovative initiative for upgrading the decolorization of wastewater using WRF and peach sheaths. These sheaths performed accurately in fermentation by developing fungal hyphae with the generation of various procedures of oxidative enzymes. Results suggested that palm sheaths have remarkable potential in the process of Remazol Brilliant Blue. Dye removal by decomposition using microbial enzymes.

Removal of reactive dyes was studied by Amour *et al.*, (2015) and resulted those results can be achieved by uninterrupted electro-coagulation technique. The factors under consideration were density of current, inlet flow rate, conductivity rate. The dye concentration observed was below 300mg/l and 35 minutes as residence time. Considering these parameters, the best results were achieved at 89% for turbidity and 98% for color removal. Electrocoagulation process was suggested to be effective and much more reliable process.

Charoenarl and Choyphan studied the efficiency of electro coagulation in Sample mode. Electrocoagulation was used for the treatment of this wastewater. After treatment color removal or variations were evaluated. Researchers carried out t Test to analyze the mean of water quality between water normally used or reused water. All other parameters conductivity, turbidity, suspended solids and water hardness were studied. Electrocoagulation is the most effective techniques in removing color and organic pollutants from wastewater (K. Charoenarl and W. Choyphan, 2017).

From few decades, highly demanding method for treating colorized wastewater generated from textile industry is electrocoagulation due to its cost effectiveness and high efficiency. Electrocoagulation is highly efficient treatment method according to its environmental compatibility, less energy requirement, little cost without additional cost of chemical and reduces the retention time as well. Electrocoagulation process is demanded over physiochemical or any other biological treatment method by its simple operating system. The material that is used in Electrocoagulation treatment is budget freindly. Organic and inorganic content is removed from wastewater to protect the environment.

CHAPTER 3

MATERIALS AND METHODS

In this chapter, the materials that were used, experimental set up arranged and analytical procedures that were used in this research work are briefly described.

3.1 Materials:

Materials that are used in the present study mainly includes fabric and cloth, various chemicals, different dyes, and other laboratory instruments.

3.1.1 Cloth/ Fabric:

For conducting this research, knitted, bleached cotton fabric that was 100% pure and approximately 200 grams per square meter was used.

3.3.2 Dyes:

Reactive dyes were preferred over other types of dyes because of their vast application in textile dyeing especially when cotton fabric is dyed. These dyes are assessable, much more convenient to use and have excellent fastness properties. The dyes which are used in conducting this research were Red 221 and Yellow 145.

3.1.3 Chemicals:

Chemicals such as sodium carbonate (Na_2CO_3) and sodium chloride (NaCl) were used due to their exhausting and fixing properties respectively. Acetic Acid (CH_3COOH) was used in neutralization process during wash-off procedure.

3.1.5 Soaping agent:

Soaping agent is used in soaping step.

3.2 Instruments

3.2.1 UV-Spectrophotometer:

UV-spectrophotometer instrument which uses visible spectrum of ultraviolet light in the laboratory to study simple and complex compounds. Decolorization and its variation in color was observed with respect to absorbance by using visible spectrophotometer.

Firstly, it was calibrated as taking refined water in cuboid before observing actual reading.

3.2.2 Portable Digital pH meter:

To measure pH at different treatment steps, a portable pH meter having digital readings was used.

3.2.3 Weighing Balance:

To measure the weight of the materials, a weighing balance is used.

3.2.4 Digital Thermometer:

For the measurement of the temperature of the dye bath, digital thermometer was used.

3.2.5 Thermostatic Water Bath:

To heat up the dyeing container at required temperature this water bath was used.

3.2.6 Glass Stirrer:

A glass stirrer was used during the experiment to stir the cotton fabric in the dyeing process.

3.2.7 - 5% Dyeing Depth Shade

While preparing 5% dye, 50 ml of water, 0.25g of reactive dye, 1g of sodium bicarbonate Na_2CO_3 and 4g of salt that was NaCl were used in a sequence. A fabric was dipped in the dye and water solution and placed it in the water bath. After 20 minutes of constant heat, 4g of NaCl were added and after the interval of 10 minutes, add 1g of Na_2CO_3 in the dyeing solution while avoiding direct contact with fabric. Soda was added when temperature reached up to 60-70°C and stirred the sample continuously for duration of 45 minutes to avoid dark spots. The liquor ratio maintained for dyeing was 1:10.

3.2.8 - 3% Dyeing Depth Shade

Preparation of 3% dye required 50 ml of water, 0.15g of required reactive dye, 1g of Na_2CO_3 and 4g NaCl . Firstly, prepared a solution of dye and water then dipped the fabric in the solution and placed it in the water bath for further proceedings. After 20 minutes of continuous stirring, 4g of NaCl were indirectly added in the solution by avoiding contact with the fabric. After 10 minutes 1g of Sodium bicarbonate was introduced in aqueous solution once it is heated up to 60-70°C and mixed it for 45 minutes to avoid dark spots. The liquor ratio for dyeing was controlled as 1:10.

3.2.9 - 1% Dyeing Depth Shade

For preparing 1% of dye, 50 ml water, 0.05g of desired reactive dye, 1g of Na_2CO_3 and 4g of NaCl were used in a series. A solution was prepared by mixing dye and water. Then, dipped the fabric in prepared solution and placed it in the water bath for next procedure. After 20 minutes of continual stirring, added 4g of NaCl and after 10 minutes, further added 1g of Na_2CO_3 in the dyeing solution by removing fabric for a while to avoid direct contact. It was done when temperature was 60-70°C and stirred the sample for 45 minutes continuously to avoid irregular dark spots. The ratio of liquor was 1:10.

3.3 Description of Method

Samples of wastewater were all prepared in Industrial Wastewater Lab located at CEES, University of the Punjab, Lahore. In this study, two dyes i.e; Red221 and Yellow 145 were used.

Then 1% of stock solution was arranged with addition of 10 g of both dyes Red 221 and Yellow 145 to a flask of volume 1000 milliliter in sequence and fill it to the point by adding distilled water. For selected two dyes, 25 millimeters was prepared standard solution and 50 millimeters of water was introduced in a beaker. The capacity of solution prepared was marked up to 75 ml. After preparing the required volume the beaker was placed in a hot bath and set at 60°C.

5g of regular shaped fabric were dipped in the dye solution and then dipped accurately. When the temperature reached to 60°C, 1g of Na₂CO₃ was added to the solution while removing fabric for a while being stirred it uninterrupted for about 40- 45 minutes to evade irregular spotted dyeing.



After dyeing, to remove unfixed dye the fabric was followed by wash-off process. The wash-off process was carried out in various steps following one by one. Each step required ten minutes. In the first step, the dyed fabric was rinsed for a while with the tap water. For further five different steps of wash off process five different beakers were selected having 50 millimeter of water in every beaker. In the next step, neutralization was carried out. For this purpose, three to four drops of acetic acid were introduced in water containing beaker and dyed fabric was endlessly stirred for approximately ten min.

In the next step, the temperature variation of the water present in the beaker was controlled and adjusted at 50°C and dyed fabric was used and mixed for ten min. In its fourth step, the water in the beaker was kept at 80°C and few drops of any moderate soaping agent were added. Then the cloth was dipped in the prepared solution and stir up continuously for 10 minutes. Forwarding to the next step, heat present in the beaker maintained at 50°C and fabric was dipped completely and stir up constantly for ten minutes. For final step, fabric dipped in the beaker where water temperature was set at normal temperature and stirred it again for approximately ten minutes. Fabric that was dyed in uncontaminated, non-treated water was known as standard. Overall, an average of five samples examined in wastewater wash-off of each dye used in this research.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS:

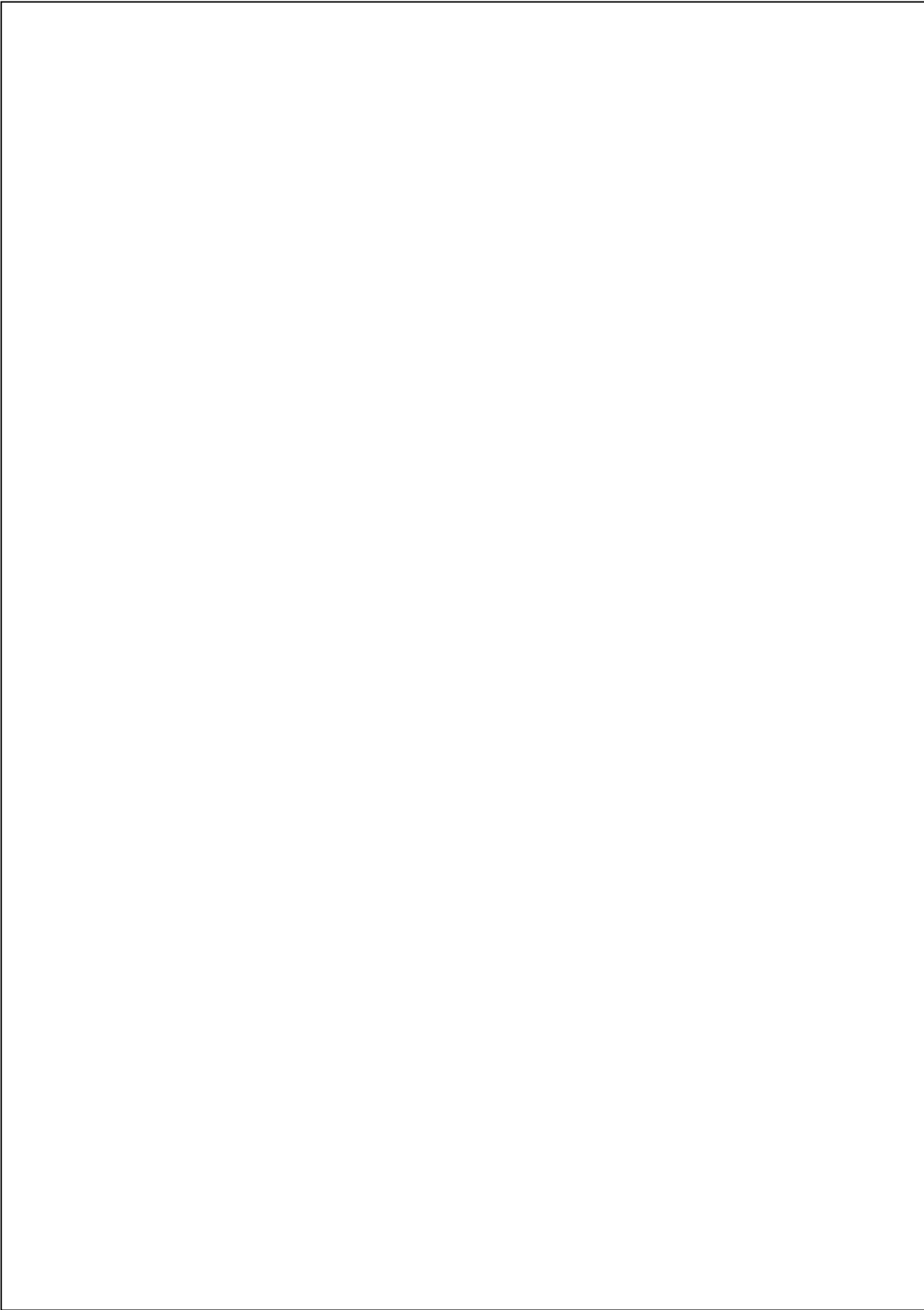
5.1 Conclusion:

The conducted study examined the possibility of reusing the dye baths after decolorizing and degrading of wastewater resulted from various dyeing processes of reactive dyes by using electrocoagulation. The conclusion drawn from this study suggested that

- Electrocoagulation is the most promising technique in reuse of textile wastewater by dye removal.
- Electrocoagulation process is an effective process to treat the textile wastewater. The purpose of conducting the procedure was to study color removal proficiency through EC technique and feasible for reuse and to initiate a method to overcome the water paucity issue.
- Dye wastewater was treated at different pH of 4, 7, and 10. Electrocoagulation technique is an effective approach to remove the organic and inorganic content from wastewater that is released from different industries for the protection of environment.
- Maximum Removal efficiency of 96% was observed for C.I. Reactive Dyes. These removal efficiencies were obtained at pH 10 within time interval of 15-20 minutes.
- Under control conditions, electrocoagulation for decolonization of textile wastewater is a sustainable alternative for reuse in dyeing process.
- The procedure helps to prevent the excessive discharge of textile waste water having large amount of salts into the environment hence saves water.
- There was less sludge formation than other treatment methods hence electrocoagulation is environmental friendly, reliable and highly efficient.

5.2 Recommendations

Wastewater discharged from Textile Industries is being treated through various effective methods but still it is a major concern for environment. Industries should have minimal water discharge to less water consumption or reuse. Zero discharge method is the most appropriate way to overcome wastewater challenges. By using this approach, wastewater would be minimized at its source. Zero water discharge is highly recommended as it is a more convenient and environmental friendly way in water management and quality control.



Reuse of decolorized wastewater in textile waste off process

GRADEMARK REPORT

FINAL GRADE

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GENERAL COMMENTS

Instructor

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