MANTECH Publications

Journal of Water Resource Engineering and Pollution Studies
Volume 6, Issue 3, September-December, 2021

Removal of Dyes from Textile Industry Effluent: A State of Art

P.G.Yadav[1], N. W. Ingole[2]

Research Scholar[1], Prof. & Dean (R&D)[2]

Department of Civil Engineering

Prof. Ram Meghe Institute of Technology and Research, Badnera

Corresponding Author's E-mail: *pg.yadav91@gmail.com[1],nwingole@rediffmail.com[2]*

Abstract

The Indian textile industry is one of the fastest growing sectors of the Indian economy. It is a sector that provides livelihood to around 100 million people directly or indirectly. The textile manufacturing involves the use of various synthetic dyes and toxic chemicals which are the major cause of the pollution. These dyes that are use in the manufacturing process are complex in nature and are found to have detrimental effects on the human health and the environment. Also, these dyes reduce the penetration of the sunlight and thus affect the photosynthetic activity. Considering the toxic nature of the effluents and the strict environmental norms, it has become necessary to treat this highly loaded effluent before discharging it or its disposal. The aim of this paper is to review the various available methods for the treatment of textile waste and particularly used for the removal of dyes. Various methods such as physical, chemical and biological methods are discussed in this paper for their suitability and adaptability.

Keywords: - *Dyes, Textile wastewater, Carcinogenic, Toxic, Synthetic dye*

INTRODUCTION

Background

The Indian textile industry is one of the most developed and diversified sector in the world. It is one of the largest raw materials providing base and manufacturing strength across the globe. India contributes to around 5% share in the global trade. The textile and apparel industry in India provides direct employment to around 45 million people

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

and provides livelihood to around 100 million people indirectly (MoT 2021).

The textile manufacturing process involves various steps. And in almost each step, huge amount of water is consumed and wastewater is generated. The Textile industry has been listed in the Schedule I, of the Ministry of Environment and Forest, and is classified as one of the major polluting industries. The textile wastewater is often highly loaded with chemicals, organic content, acid, bases, dyes, metal ions and other such pollutants. The treatment and disposal of wastewater is of environmental concern.

The textile industry involves the use of various types of dyes, Synthetic and natural. The dyes released from the dyeing and finishing process pose threat to the aquatic ecosystem. These residual dyes not only act as aesthetic pollutants, but also interfere light penetration in the water bodies. These dyes often contains chemicals, are carcinogenic, mutagenic, and toxic in nature.

Although the dyes are widely used in the textile industry, there are several other sectors such as the Pharmaceutical, food, paper, cosmetic and plastic industries that involve the use of dyes.

Various Process involved in textile Industry

Textile manufacturing is a far-reaching and giant industry having a complex procedure. It undergoes a number of stages for converting fibre into yarn, yarn into fabric and so on ending up with finished clothing as a final product. These fabrics are run through several stages of wet processing. In textile dyeing process, a portion of unfixed dyes get washed along with the water. In dry process, much solid wastes are generated as compared to wet process. The flowchart shown below shows the general process involved.

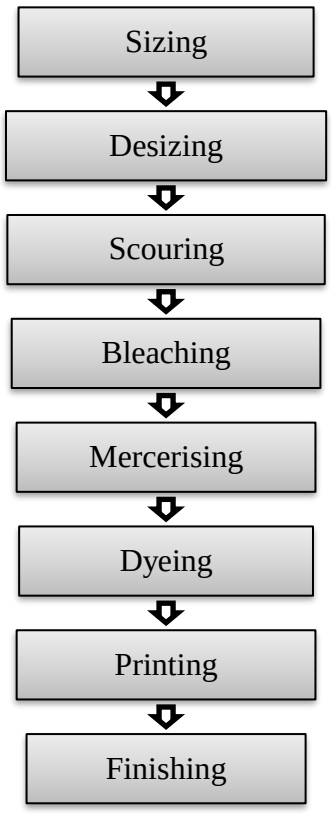


Fig. Shows the flowchart of the Wet Process

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

Characteristics of the Wastewater

The characteristics of textile wastewater generally depend on the process adopted, textile manufactured and chemicals involved in manufacturing it. On a regular basis, the textile wastewater has high concentrations of organic and inorganic content resulting in high BOD, COD, odour, colour, total solids and chemicals which are hazardous to the environment as well as human health. The textile wastewater also contains trace metals like Cu, Zn, Cr and As. The distinctive characteristics of textile effluent are shown in Table 1. The sources of pollutants from the various processes is shown in Table 2

Table:-1 Shows distinctive characteristics of textile effluent

S. No	Parameter	Range
1	pH	6-10
2	BOD (mg/L)	80-6000
3	COD(mg/L)	150-12000
4	Temperature ◦C	35-45
5	Colour	50-2500
6	TDS(mg/L)	8000-12000
7	TSS(mg/L)	15-8000
8	Oil and Grease(mg/L)	10-30

Adopted from Ghaly et al. (2004)

Table:-2 Shows sources of pollutants from the various processes

Process	Possible Pollutants
Desizing	Sizes, enzymes, starch, waxes, ammonia
Scouring	Disinfectants,& insecticides residues, NaOH, soaps, fats, waxes, oils,enzymes, etc
Bleaching	H_2O_2, AO_X, sodium silicate, high pH
Mercerisi-ng	Caustic soda
Dyeing, Printing	Dye stuff, mordant, reducing agents, metals, salts, urea, solvents, sulphide

Adopted from Mani et al.(2010)

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

Classification of Dyes

Dyes are broadly classified into two categories namely Natural Dyes and Synthetic Dyes. Natural dyes are those derived from natural sources like plants, animals and minerals. Synthetic dyes are extensively used in various of industries amongst which textile processing industries are the major consumers (Yadav et al.).

The textile industries today, predominantly use synthetic organic dyes. Large variety of dyes, chemicals and combinations are used in an attempt to get a particular shade and vibrant colour. (Mathur et al.).

Hazardous effects of Dyes

Lellis et al. (2019)studied the various toxicological effects of dyes on human health and environment some of which are listed as under:

- irritations to the skin and eyes
- dermatitis,
- allergic conjunctivitis,
- rhinitis,
- occupational asthma or other allergic reactions
- DNA damage,
- Mutagenic & Carcenogenic
- respiratory and renal failure

TREATMENT TECHNOLOGIES

Different methods are used to treat the textile Industry effluents. Each of them has its own Pros and cons. In the following section the main treatment methods and their advantages and disadvantages will be discussed.

Table: - 3 Show the Classification of Dyes.

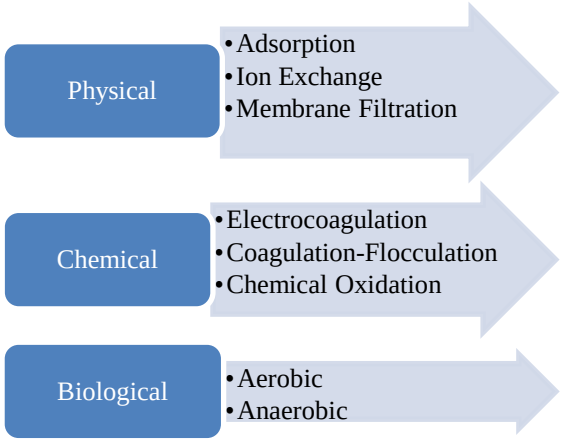
Type	**Type of Fabric**
Reactive	cotton, rayon, silk, linen, wool and nylon.
Acid	wool, silk and animal hair
Azo	Cotton
Disperse	nylon and polyster
VAT	cotton, rayon and silk
Direct	natural fibers, rayon, nylon, paper and leather
Basic	fur, leather, silk and cotton

Adopted from Yadav et al. (2014).

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

The most current dye removal methods/ techniques can be classified into three major categories:

- Physical methods
- Chemical methods
- Biological methods



The above diagrammatic representation shows the various methods adopted for the treatment of textile wastewater.

Adsorption

Adsorption is referred as the concentration of substances on the surface of a solid boundary. Adsorption primarily deals with the utilization of the solid bodies and is a surface phenomenon. Adsorption is one of the widely employed methods involving use of adsorbents for the removal of dissolved organic pollutants like dyes from industrial wastewaters, especially those that not removed by the conventional biological treatments. Adsorption is a physio-chemical technique and is found to be one of the most economical and appropriate technique for the removal of dyes from the textile industry effluent. This process has become widely used due to its simplicity, sludge free operation and easy handling. Various biowaste and agricultural waste materials have been studied for their application in dye removal (Rehman et al. 2019).

Adsorbents are mainly derived from the natural, industrial and agricultural sources such as zeolites, charcoal, clays, ores, and other waste resources. Recently, adsorbents extracted from agro-based resources such as coconut shell (Ayub and Chagani 2014), wheat husk (Banerjee et al. 2013), rice husk(Ahmed 2018), banana and potato peels(Rehman et. Al 2019) etc. have garnered the attention of researchers.

Rabia Rehman et al.(2018) studied, the performance of Musa acuminata and Solanum tuberosum peels was studied for the removal of Emerald green dye. Batch method was used to study various factors such as pH, agitation speed, concentration, time of contact etc. The S. T. P.P showed maximum removal of 96% when the pH of the dye solution was 3. The effect of contact time showed better results for M. A. P.P as compared to S.T.P.P.

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

Getasew Nibret et al. (2019) in this work, the activated carbon of the water hyacinth was used as an adsorbent to study the removal of mythelene blue from a synthetic dye solution. The maximum percentage removal was found at pH=10.The maximum percentage removal was 98.6% at an initial dye concentration and 87.58% at an initial dye concentration of 45mg/l.

Ahmed T. et al. (2018) aimed at evaluating the performance of low cost adsorbents for the elimination of dyes from tannery waste water. In the study activated carbon generated from rice husk was used as adsorbents in laboratory batch experiments with methylene blue and tannary waste effluent. The experiments were conducted for different contact time and initial concentrations. The maximum colour removal efficiency was found to be 94.13%. In case of tannery effluents, the adsorbent dosage was 0.2mg per 100ml and the maximum removal efficiency was found to be 77 % , at initial concentration of 300 Pt-Co units.

Ion Exchange

Ion exchange is a process in which ions of a particular species in solution are replaced by ions with a similar charge but of different species attached to an insoluble resin. In essence, ion exchange is a sorption process and can also be considered a reversible chemical reaction.

These ion exchange resins are either naturally occurring inorganic zeolites or synthetically produced organic resins. The synthetic organic resins are the predominant type used today because their characteristics can be tailored to specific applications. Since the ion exchangers cannot accommodate a wide range of dyes, thus this method has not been widely used for the treatment of textile wastewater effluents. It can be only used to remove the undesirable cationic (basic dyes) or anionic (acid, direct, and reactive dyes) from wastewater (Mani et al.) This methodology can be applied for both cationic as well as anionic dyes with several advantages (such as efficient removal of soluble dyes, recovery of solvent after usage, and no regenerative loss of the adsorbent) (Ahmad et al., 2015).

N. M. Marin et al.(2018) The persistent pollutant azo dye, Acid Orange 10, was removed from the environment by an Amberlite IRA 400 anion exchange resin and then biodegraded by two bacterial strains. The biodegradation and the ecotoxicity effect of Acid Orange 10 have been monitorized on two bacterial strains such as Salmonella enterica (gram-

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

negative bacteria) and Enterococcus faecalis (grampositive bacteria). Experimental data detected from ion-exchange studies showed that the strongly basic anion-exchange resin Amberlite IRA 400, can removed efficiently up to 96.8% at 10−2 M of Acid Orange 10 concentration. Moreover, 10−2 M Acid Orange 10 induced in 1 h a significant 50% growth inhibition on S. enterica, but not on the E. faecalis.

Lin and Chen (1997) Treatment of wastewater effluent from the secondary wastewater treatment plant of a dyeing and finishing mill is investigated for possible reuse. The treatment system employed in the present study consists of an electrochemical method, chemical coagulation and ion exchange. Experimental results throughout the present study have indicated that the combined chemical treatment methods are very effective and are capable of elevating the water quality of the treated waste effluent to the reuse standard of the textile industry.

Yunhan Jia, Lei Ding et al.,(2019) In this study, the adsorption behaviors of methyl orange (MO) and congo red (CR) on the magnetic ion-exchange (MIEX) resin were investigated by batch experiments. Attaining adsorption equilibrium of MO and CR takes 90 and 150 min, respectively. The equilibrium adsorption capacity of MO (42.32 mg mL−1) on the MIEX resin is much larger than that of CR (30.57 mg mL−1). The MIEX resin can well remove MO (80%) and CR (50%) at pH 5.0−9.0. Ion exchange dominates the mechanism of CR adsorbed on the MIEX resin. For MO, however, physical adsorption plays a role to some extent besides ion exchange.

Membrane Filtration

Membrane filtration method has emerged as a possible alternative method used for the removal of dyes from industrial effluent effectively and has proven to be cost-effective and has less water consumption (Koyuncu 2002). Thus, the method at the same time reduces the coloration and BOD or COD of wastewaters.

The benefit of membrane filtration method is its quick processing with minimum requirements, but due to its soaring cost, clogging possibility and regular replacement of membrane affect its applicability (Bizuneh 2012).

A. H. Hassani (2008) study nanofiltration process was used for removal of different dyestuffs from solutions. The rate of dye

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

removal by spiral wound nanofiltration membrane in film thin composite MWCO=90 Dalton, was evaluated for four classes of dyes acidic, disperse, reactive and direct in red and blue dyes medium. Dye absorbance was measured by spectrophotometric method (2120 Standard Method 1998). Effects of feed concentration, pressure and total dissolved solids concentration were also studied. Results showed that increasing dye concentration lead to higher color removal up to 98 % and at different pressures for acidic and reactive blue were up to 99.7 %.Chemical oxygen demand removal efficiencies for reactive blue, disperse blue, direct and disperse red dyes were also approximately 100 %.

Muhammad Syaamil Saad etal. (2020) investigated the efficiency of the celestine blue dye removal from simulated textile wastewater by electrocoagulation (EC) method using iron (Fe) electrodes through an electrolytic cell, integrated with nylon 6,6 nanofiber (NF) membrane filtration for the separation of the flocculants from aqueous water. Based on the results, the integrated system achieves a high dye removal efficiency of 79.4%, by using 1000 ppm of sodium chloride as the electrolyte and 2 V of voltage at a constant pH of 7 and 10 ppm celestine blue dye solution, compared to the standalone EC method in which only 43.2% removal was achieved.

Levent Semiz (2019) In this study, polyacrylonitrile-co-poly(2 ethylhexylacrylate) copolymer (PAN-co-P2EHA) membranes with various acrylonitrile/2-ethylhexylacrylate (AN/2EHA) ratios were synthesized and tested for the removal of reactive black 5 dye from wastewater with the aid of filtration method. The copolymer with a AN/2EHA ratio of 92/8 demonstrated the best filtration performance. Also, it was blended with different polyaniline (PANI) loadings in order to functionalize pores. Moreover, effects of permeate pH and concentration were also analyzed. It was observed that, after functionalization of pores, filtration performance became pH dependent and better results were observed at acidic medium. PAN(92)- co-P2EHA(8)/PANI(15) membrane having AN/2EHA molar ratio of 92/8 with 15 weight% PANI loading showed the best dye rejection performance at pH 2 by 99.5%, 98.4% and 90.5% for permeate concentrations of 100, 200 and 300 ppm, respectively.

Hongyu Liu et al. (2020) in this work, filtration of membrane and reduction of

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

iron nanoparticles (FeNPs) was coupled to remove dyes with different molecular weight. The FeNPs–Calcium alginate (CaAlg) composite membrane was biosynthesized using green tea. The FeNPs–CaAlg composite membrane was characterized by series of instruments. The results indicate that the FeNPs-CaAlg membrane has an excellent performance in filtrating dyes, nearly the same filtration flux with purified water and almost no flux reduction with filtration time.

Electrocoagulation

"Electrolysis" literally means to breakdown substances by passing electric current. The process occurs in an electrolytic solution, water or a salt melting solution that gives a medium for the transfer of ions between the two electrodes. When an electric current is applied the, the positive ions i.e anions move towards cathode and the negative ions i.e cations move towards the anode. The Electrocoagulation (EC)is carried out in a reactor in which electrodes are placed. In the simplest form, an (EC) reactor is made up of an electrolytic cell with one anode and one cathode. The electrodes can be of the same or different material. Generally, Aluminium, iron, stainless steel have been used most frequently.

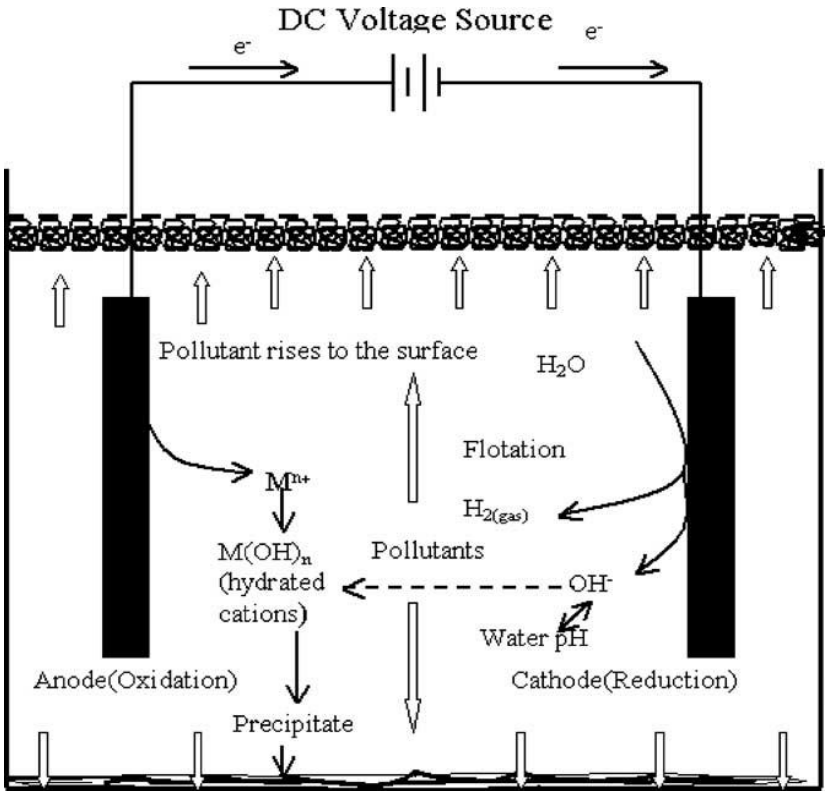


Fig. Shows the electrocoagulation setup(Adopted from Mollah Y. A. Et al. 2004)

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

In the EC process, the coagulating ions are generated in-situ at the anode by electrolytic oxidation. The various stages carried out during the electrocoagulation process are as under:

- Electrolytic oxidation of the 'sacrificial anode' resulting in the formation of coagulants.
- Destabalization of the suspended or dissolved pollutants and breaking of the emulsions.
- Formation of Flocs.

Ningning L. and Yunhai W. (2019) investigated the removal of methylene blue by the electrocoagulation method using aluminum electrodes. The experimental results showed that the electrocoagulation method is significantly efficient in the removal of methylene blue. The maximum dye removal efficiency achieved was 99.37% under the following operating conditions: current density of 5 mA/cm2 , electrolysis time of 30 min, initial solution pH value of 7, and sodium chloride concentration of 0.2 mol/L.

Victoria D., D., et.al(2019) The aim of this study was to evaluate the performance of high purity magnesium and the magnesium-aluminum-zinc alloy AZ31 as sacrificial anodes in an electrocoagulation process with polarity change for the treatment of synthetic indigo carmine solution. The best results were 80% and 96% removal for non-purgeable organic carbon and dye content respectively at room temperature, by using turbulent regime, initial dye concentration of 100 mg L−1 and 50 A m−2 as current density with AZ31 alloy as electrodes. Particularly, high purity magnesium reached 75% in non-purgeable organic carbon removal and 86% in dye removal at the conditions described above.

S. Aoudj et.al. (2010) performed an experimental investigation on the removal of an azo textile dye (Direct red 81), using the electrocoagulation method. Aluminium electrodes were used as anode and cathode. The optimal value of pH was found to be 6. The current Density plays an important role in EC. Higher efficiency was obtained at current density of 1.875mA/cm2. The optimum interelectrode distance was 1.5 cm. It was also concluded that lower the dye concentration better is the removal efficiency.

M. Kobya et.al (2006) carried out a study to investigate the decolorization of a reactive textile dye ,Levafix Orange E3 GA, in aqueous solution. Four monopolar electrodes, two anodes and two cathodes of the same dimensions made up of

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

aluminium (99.53%) were used as cathode and anode. Almost 99.9% removal efficiency was observed at 100A/m2 current density ,pH 3 and 15 min operating time.

O.T. Can et.al (2006) investigated the effect of initial addition of a chemical coagulant such as alum or polyaluminum chloride (PAC) on the COD removal efficiency of EC treatment of textile wastewaters. The two salts showed the same performance in chemical coagulation, but in the combined electrocoagulation (CEC), PAC was found to be superior in terms of the COD removal rate and efficiency, depending on the amount of the total aluminum supplied, by initial addition and electrochemical generation. A comparative operating cost analysis was also performed and it was found that with the same operating cost per mass of COD removed, CEC performance was 80%, in contrast to 23% with EC, in 5 min of operation.

Coagulation and Flocculation

Coagulation and flocculation is simple and rapid technique and the most often used pre-treatment techniques for treating the textile effluent. Coagulation and flocculation technique is well known for its operation and its maintenance. The choice of coagulant aids based on suitability of particular waste, availability and the cost of coagulant.

Flocculant settling refers to a rather dilute suspension of particles that coalesce, or flocculate, during the sedimentation operation. As coalescence or flocculation occurs, the particles increase in mass and settle at a faster rate. The amount of flocculation that occurs depends on the opportunity for contact, which varies with the overflow rate, the depth of the basin, the velocity gradients in the system, the concentration of particles, and the range of particles sizes.

In the recent years, natural coagulants derived from plants such as Plantago extract, Moringa olefira seed extract (Agrawal et al. 2019),(Parmar and Shrivastava 2019) Cactus extract and Aloe vera extract(Kolhe and Ingole 2020), mango seed powder, Pineapple leaf powder, sugar beet pulp(Sasirekha et al. 2017) etc. have been used. Research has also been carried out on animal based coagulant viz. Chitosan (Abu Hassan et al.). The sludge derived from the waste water treatment plant (Shankar et al 2019), Diatomeceous earth etc. has also been successfully used as coagulants.

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

T. Zarei Mahmoudabadi (2018) evaluated the effectiveness of Plantago major seed extract as a natural coagulant in removal of Reactive Blue 19 dye from industrial wastewater. In this experimental study, the effects of different factors, including pH (5–11), coagulant dose (0.02–2 g/L), dye concentration (10–100 mg/L), settling time (15–90 min), and temperature (26–76 °C), were tested. The results showed that pH, coagulation dose, initial concentration of dye, settling time, and optimal degrees of temperature were, respectively, 9, 1.2 g/L, 40 mg/L, 60 min, and 56 °C for removal of Reactive Blue 19 dye using the extract of Plantago major seed. In these conditions, the highest removal efficiency was 35%, 54.5%, 60.66%, 64%, and 69% respectively. In the conditions that all parameters were in optimal mode, the removal rate was about 70%.

Obi C. J. Et al. (2019) The adsorption performances of polymer coagulants were studied for color removal from the aqueous dye solution. The coagulation behaviour of tiger nut powder and alum was studied onto Naphthalene black and Alizarin red dye from synthetic waste water. The study showed that increase in dye initial concentration from 50mg/L to 500mg/L at room temperature with tiger nut decreased the removal efficiency from 63.74% to 34.9% for naphthalene black and alizarin red from 70.12% to 42.00%. Also, for dye concentration above 100mg/L with alum, the removal efficiency of both dyes started decreasing from 59.22 to 27.34% for naphthalene black and from 62.46 to 33.50% for alizarin red. The maximum dye removal efficiency occurred at a pH of 2 for both naphthalene and alizarin red with tiger nut but occurred at pH of 5 for both dyes with alum. Coagulant dosage from 100 to 1000mg/l with tiger nut increased the removal efficiency of naphthalene black and alizarin red from 44.08% to 94.43%; and 50.10% to 96.55 respectively while with alum it increased from 25.18% to 67.90% for naphthalene black and 35.74% to 78.89% for alizarin red.

Mahmoudabadi T.(2019) aimed to investigate the effectiveness of Alcea rosea root extract in Disperse red 60 and Reactive blue 19 dyes removal from synthetic sewage. The results showed that the maximum of removal efficiency of Disperse and Reactive dyes in optimum conditions including (pH=11, coagulant concentration=200 and 250 mg/L, dye concentration 40 and 20 mg/L, speed 60 rpm, during 15 min with settling time 60 min and temperature 60 °C obtained 86%

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

and 68%, respectively. According to the result, the Alcea rosea coagulant has the best ability in removing dyes from aqueous solutions and sewage, especially Disperse dyes.

Kristianto, H. Et al.(2019) performed a resesrch study on the extraction and use of a potential natural coagulant (Leucaena leucocephala) seed kernel as natural coagulant. Leucaena seed kernel was extracted at various NaCl concentrations (0–5 mol L−1). Extract with highest protein content obtained at NaCl concentration of 3 mol L−1 was further used to treat a synthetic wastewater model substance (Congo red solution) at various pH (2–10) and dosage (2–40 mL L−1). This natural coagulant successfully removed 99.9% of the color at pH 3 and dosage 10 mL L−1, with only half sludge volume discharged when compared to alum. The result suggested that leucaena is a promising natural coagulant for water and wastewater treatment.

Chemical Oxidation

Chemical method is one of the conventional methods that have been applied for decolorization process. It is a method that involves chemical operations and reactions. Chemical treatment processes can also be applied alone in combination with physical treatment methods (Mani et al.). Ozone and hydrogen peroxide is the chemical generally used owing to their cheap commercial availability. Fenton's Reagent process is also one of the oxidation processes. In case of the textile wastewater these oxidants either react with the pollutants present to form salts or neutralize them giving a bleaching effect on the dyes.

V. Preethi et al.(2008) carried out Ozonation of leather dye effluent for removal of color and COD reduction covering wide range in operating parameters The influence of parameters such as influent pH, ozone flow rate and initial effluent concentration on ozonation efficiency was critically examined. It has been observed in investigation that a maximum of COD removal efficiency of 92% has been achieved under optimum operating conditions.

Selene Maria de Arruda Guelli Ulson de Souza (2010) studied the combined treatment of ozonation and subsequent biological degradation with a biofilm, to reduce the color and chemical oxygen demand (COD). The experimental part of the study consisted of two phases. The first phase was the ozonation process; the

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

results obtained demonstrated that the ozonation of Remazol Black B dye at pH values of 3–11, was effective, partially oxidizing and completely decolorizing the effluent, even at relatively high concentrations of the dye (500 mg/L). Color removal efficiencies greater than 96% were obtained in all cases. The degradation kinetics of ozone is a pseudo-first-order reaction with respect to the dye concentration.

M.F. Sevimli and C. Kinaci (2002) investigated the effect of some operational parameters on the efficiency of ozonation and Fenton's process for decolorization and COD removal. Acid Red 337 and Reactive Orange 16 dye solutions and the effluents of acid and reactive dye-bath effluents were used in the experiments. high color removal efficiencies (60–91%), limited COD removal efficiencies between 9–17% at 30 minutes ozonation time were obtained. In the Fenton oxidation experiments, the effects of pH, temperature, dosage of ferrous sulfate and hydrogen peroxide, and the proper ratio of Fe(II)/H2O2 were studied. The result indicates that up to 99% color removal and 82% COD removal can be obtained by Fenton's oxidation.

Aerobic Process

Aerobic process treats the wastewater by decomposing the pollutants and reducing the unpleasant odours with the help of aerobic and facultative microorganisms. Dyes are generally resistant to biodegradation, as one of the most important properties of commercial dyes is resistance in fading caused by chemical and photo-oxidation (Karuna et al. 2017) In India, the Activated Sludge process is most widely adopted for the treatment of industrial wastewater. The conventional aerobic treatment systems are oxidation ditch, stabalization ponds, aerated lagoons, trickling filters etc.

Anaerobic Process

The anaerobic bacteria are utilized in anaerobic treatment process, which decompose the organic matter in anaerobic conditions. At present, anaerobic digestion method is successfully used in the biological treatment of the textile effluent. Some other processes such as upflow anaerobic sludge bed (UASB), upflow anaerobic fluidized bed (UABF), anaerobic baffled reactor (ABR), anaerobic biological filter, and so on are used in the treatment of textile dyeing wastewater (Mani et al.).

Recently, researches have been carried out on removal of dyes by algae, fungi and bacteria.

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

Table 4 shows the performance of Bacterial species (Fulekar M H et al.2013).

Colour	Bacterial strain	Percent Removal
Methylene Blue	*Pseudomonas*	69
	Pseudomonas aeruginosa	82
	Aeromonas hydrophila	40
	P. plecoglossicida	34
	Lysinibacillus fusiformis	25
	P.monteilli	47
	Comamonas testosteroni	40
Rhodamine-B	*Pseudomonas putida*	55
	Aeromonas hydrophila	50
	P.plecoglossicida	55
	Lysinibacillus fusiformis	46
	P.monteilli	56
	Comamonas testosterone	56

Table 5 shows the performance of Fungal species (Abdallah and Taha S. 2012),(Wang et al. 2015)

Colour	Fungi Species	Percent Removal
Methylene Blue	*Aspergillus fumigates*	80
Rhodamine-B	fungi *Rhizopus oryzae*	90

Table 6 shows the performance of Algal species (Khataee AR, et al.2009)

Colour	Algae Species	Percent Removal
Malachite green	*Chlorella sp.*	92
	Cosmorium sp	91
	Euglena sp.	87

CONCLUSION

The textile industry is one of the major source of pollution, as the effluent has an elevated BOD, COD, TDS, TSS, rate of colour, and complex composition of dye compounds, and large emission and is difficult to degrade. If these effluents are directly discharged into the environment

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

without treatment, it causes serious damage to environment. Therefore, it becomes necessary to treat the effluents upto the prescribed norms. This paper has reviewed the various methods for the treatment of textile effluent, the following conclusion are drawn from the study:

- Various conventional methods such as physical, chemical and biological methods are employed for the treatment of textile effluent. However, no particular treatment methodology is appropriate or universally adoptable for all kinds of textile effluents.
- The methodology adopted depends upon the working parameters, such as ambient temperature, volume of effluent, cost requirement etc.
- Physical and chemical oxidation methods are efficient for the remediation/removal of dye in textile wastewater only if the textile effluent volume is small. This restricts the usage of physical and chemical methods to lab-scale units and small scale industries.
- Adsorption and Electrocoagulation methods have good results, but there is a need to come up with adsorbents and materials that can be easily regenerated.
- Cost of membrane filtration makes its application for the industrial use impractical.
- Biological methods finds its practical application and can be used to treat large volume of effluents along with providing satisfactory results. But the only problem is the longer retention time required for the treatment.

ACKNOWLEDGEMENT

The authors are very much thankful to Principal Dr. A. P. Bodkhe and Dr. P.S. Pajgade, Head, Department of Civil Engineering, Prof. Ram Meghe Institute of Technology and Research, Badnera, Amravati, for providing the necessary facilities, for carrying out research on the above topic.

REFERENCES

1. Annual Report of Ministry of Textiles,2020-2021.
2. Ghaly AE, Ananthashankar R, Alhattab M, Ramakrishnan VV (2014) Production, characterization and treatment of textile effluents: a critical review. J Chem Eng Process Technol 5(1):1–19
3. Sujata Mani, Pankaj Chowdhary, and Ram Naresh Bharagava (2019), Textile Wastewater Dyes: Toxicity Profile and Treatment Approaches, Emerging and Eco-Friendly Approaches for Waste Management,,219-244.

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

4. Anuj Kumar Yadav, C.K. Jain* and D.S. Malik, (2014) Toxic characterization of textile dyes and effluents in relation to human health Hazards, Journal of Sustainable Environmental Research, 3 (1) 95-102.
5. N. Mathur, P. Bhatnagar, P. Bakre, (2006) Applied Ecology and Environmental Research, 111–118.
6. Bruno Lellis, Cíntia Zani Fávaro-Polonio, João Alencar Pamphile, Julio Cesar Polonio, (2019) Effects of textile dyes on health and the environment and bioremediation potential of living organisms, Biotechnology Research and Innovation 1-16.
7. Rehman R., Farooq S., and Mahmud T., (2018) Use of Agro-waste Musa acuminata and Solanum tuberosum peels for economical sorptive removal of Emerald green dye in ecofriendly way, Journal of Cleaner Production , 819-826
8. Sohail Ayub and Fezlollah Changani, (2014) Adsorption process for wastewater treatment by using coconut shell, International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development, Vol. 4, Issue 3, , 21-34.
9. Sushmita Banerjee, Mahesh C. Chattopadhyaya, Uma, Yogesh Chandra Sharma, (2013), Journal Of Hazardous, Toxic, And Radioactive Waste,111-137.
10. T. Ahmed;,S. I. Promi, and I. J. Rumpa, (2018),Color Removal from Tannery Wastewater Using Activated Carbon Generated from Rice Husk, World Environmental and Water Resources Congress, 312-321.
11. Nibret G., Ahmad S., Rao D. G., Ahmad I., Ashfaq S. M. and Rehman Z. U., (2019) Removal of Methylene Blue Dye from Textile Wastewater using Water Hyacinth Activated Carbon as Adsorbent: Synthesis, Characterization and Kinetic studies, International Conference on Sustainable Computing in Science, Technology & Management, 1959-1969.
12. N. M. Marin et al., (2018) Removal of the Acid Orange 10 by ion exchange and microbiological methods, International Journal of Environmental Science and Technology
13. Sheng h. Lin and ming l. Chen, (1997) Treatment of textile

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

wastewater by chemical Methods for reuse, war. ResVol. 31, no. 4, pp. 868-876.

14. Yunhan Jia, Lei Ding, Peiyue Ren, Meiying Zhong, Jiangya Ma, and Xiaoran Fan.,(2019) Performances and Mechanism of Methyl Orange and Congo Red Adsorbed on the Magnetic Ion-Exchange Resin, Journal of Chemical & Engineering Data, https://dx.doi.org/10.1021/acs.jced.9b00951
15. Koyuncu I (2002) Reactive dye removal in dye/salt mixtures by nanofiltration membranes containingvinyl sulphone dye: effects of feed concentration and cross flow velocity. Desalination 143:243–253
16. Bizuneh A (2012) Textile effluent treatment & decolorization techniques. Chem Bulg J Sci Educ
    a. 21:434–456
17. Hassani, A. H.; Mirzayee, R.; Nasseri, S.; Borghei, M.; Gholami, M.; Torabifar, B. (2008), Nanofiltration process on dye removal from simulated textile wastewater. International Journal of Environmental Science & Technology, 5(3), 401–408.
18. Saad, Muhammad Syaamil; Balasubramaniam, Lila; Wirzal, Mohd Dzul Hakim; Abd Halim, Nur Syakinah; Bilad, Muhammad Roil; Md Nordin, Nik Abdul Hadi; Adi Putra, Zulfan; Ramli, Fuad Nabil (2020). Integrated Membraneâ□“Electrocoagulation System for Removal of Celestine Blue Dyes in Wastewater. Membranes, 10(8), 184–.
19. Levent Semiz (2019) Removal of reactive black 5 from wastewater by membrane filtration, https://doi.org/10.1007/s00289-019-02896-8.
20. Liu, Hongyu; Zhang, Jun; Lu, Ming; Liang, Lin; Zhang, Huan; Wei, Junfu (2020), Biosynthesis based membrane filtration coupled with iron nanoparticles reduction process in removal of dyes, Chemical Engineering Journal, 387, 124202
21. Mohammad Y.A. Mollah, Paul Morkovsky, Jewel A.G. Gomes,Mehmet Kesmez, Jose Parga, David L. Cocke (2004), Fundamentals, present and future perspectives of electrocoagulation, Journal of Hazardous Materials B114 (2004) 199–210.

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

22. Ningning L. and Yunhai W. (2019) Removal of methylene blue by electrocoagulation: a study of the effect of operational parameters and mechanism, Ioniocs, 22-30.
23. Victoria D., D., et.al(2019) Removal of indigo carmine dye by electrocoagulation using magnesium anodes with polarity change, Environmental Science and Pollution Research.
24. S. Aoudj, A. Khelifab, N. Drouichea, M. Hecinia,b, H. Hamitouche, (2010) Electrocoagulation process applied to wastewater containing dyes from textile industry Chemical Engineering and Processing 49 1176–1182
25. M. Kobya, E. Demirbas, O.T. Can, M. Bayramoglu, (2006) Treatment of levafix orange textile dye solution by electrocoagulation, Journal of Hazardous Materials B132, 183–188.
26. O. T. Can, M. Bayramoglu, and M. Kobya, Decolorization of Reactive Dye Solutions by Electrocoagulation Using Aluminum Electrodes, (2003) Ind. Eng. Chem. Res, 42, 3391-3396
27. Agarwal V., Dixit D., and Bhatt M., (2018) Use of Moringa oleifera Seeds as a Primary Coagulant in Textile Wastewater Treatment, Waste Management and Resource Efficiency, 1231-1236.
28. Parmar N. and Srivastava J. K., (2019) Treatment of Pharmaceutical Waste Water by Coagulation Process Using Moringa Oleifera as a Natural Coagulant, International Conference on Recent Advances in Interdisciplinary Trends in Engineering & Applications.
29. Kolhe P. P and Ingole N. W., Colour removal from textile industry wastewater by Coagulation Flocculation Technique, (2020),Journal of water resource engineering and pollution studies,Volume 5, Issue 1, 20-47.
30. P. Sasirekha, S. Shankar Krishna, S. Vembhukumar, and L. Vignesh, EcofriendlyDecolorization oftextile wastewater by Natural coagulant, (2017) Asian Journal of Engineeringand Applied Technology,Vol. 8(2),41-54.
31. 31. .Mohd Ariffin Abu Hassan, Tan Pei Li, Zainura Zainon Noor, Coagulation And Flocculation Treatment Of Wastewater In Textile Industry Using Chitosan, Journal of Chemical and Natural

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

Resources Engineering, (2015) Vol.4(1), 43-53.

32. Shankar S. Y., et.al (2018) Utilization of Water Treatment Plant (WTP) Sludge for Pretreatment of Dye Wastewater Using Coagulation/Flocculation. Advances in Waste Management, 107–121.
33. Seidmohammadi A., et.al (2019) A Comparative Study for the Removal of Methylene Blue Dye from Aqueous Solution by Novel Activated Carbon Based Adsorbents, Prog. Color Colorants Coat. 12, 133-144.
34. Obi C. J., Onukwuli O. D., and Obiora-Okafo I. A., (2019) Removal of dyes from synthetic waste water by coagulation technique using natural coagulants, Equatorial Journal of Engineering , 1-5.
35. Mahmoudabadi T., Z., Talebi P. and Mahrokh Jalili (2019) Removing Disperse red 60 and Reactive blue 19 dyes removal by using Alcea rosea root mucilage as a natural coagulant, AMB Express.
36. Kristianto, H., Rahman, H., Prasetyo, S., & Sugih, A. K. (2019) Removal of Congo red aqueous solution using Leucaena leucocephala seed's extract as natural coagulant, Applied Water Science, 9(4).
37. V. Preethi et al(2008), Ozonation of tannery effluent for removal of cod and color, Journal of Hazardous Materials 166 (2009) 150–154.
38. Selene Maria de Arruda Guelli Ulson de Souza, Karin Angela Santos Bonilla,Antônio Augusto Ulson de Souza (2010), Removal of COD and color from hydrolyzed textile azo dye by combined ozonation and biological treatment, Journal of Hazardous Materials 179 (2010) 35–42.
39. M.F. Sevimli and C. Kinaci (2002), Decolorization of textile wastewater by ozonation and Fenton's process, Water Science and Technology Vol 45 No 12 pp 279–286
40. Karuna Singh, Pankaj Kumar And Rajani Srivastava(2017), An Overview Of Textile Dyes And Their Removal Techniques: Indian Perspective, Pollution Research,790-797
41. Fulekar MH, Wadgaonkar SL, Singh A.,(2013) Decolorization of dye compounds by selected bacterial strains isolatedfrom

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved

dyestuff industrial area, International Journal of Advancements in Research & Technology, 2(7):182–92.

42. Abdallah R, Taha S., (2012) Biosorption of methylene blue from aqueous solution by nonviable Aspergillus fumigates, Chemical Engineering Journal; 195:69–76.
43. Wang MX, Zhang QL, Yao SJ. A, (2015) Novel bio-sorbent formed of marine derived Pencillium janthinellum mycelia pellets for removing dyes from dye containing wastewater, Journal of Chemical Engineering.; 259:837–44.
44. Khataee AR, Dehghan G, Ebadi A, Zarei M, Pourhassan M., (2009) Biological treatment of a dye solution by macro algae Chara sp.: Effect of operational parameter intermediates, Identification and artificial neural network modelling. Bioresource Technology.; 101(7):2252–58.

Page 104-124 © MANTECH PUBLIATIONS 2021. All Rights Reserved