REMOVAL OF DYE FROM WASTEWATER USING AGRICULTURAL WASTE AS LOW COST ADSORBENT

V.B. Mane [1], Sampanna Benkar[2], Sanket Bhavsar[3], Aditya Bandhankar[4]
[1]Assistant Professor, [2]Bachelor of Engineering Student,
[1]Department of Chemical Engineering,
[1]Bharati Vidyapeeth College of Engineering, Navi Mumbai, India.

ABSTRACT

Dyes are widely used in industries such as textiles, rubber, plastics, printing, leather, cosmetics, to colour their products. As a result, they generate a considerable amount of coloured wastewater. Colour removal from textile effluents on a continuous industrial scale has been given much attention in the last few years, not only because of its potential toxicity, but also mainly due to its visibility problem. Discharge of dye from wastewater into natural streams and rivers poses severe problems to the aquatic life, food chain and causes damage to the nature of the environment. Dyes absorb and reflect sunlight entering water and so can interfere with the growth of bacteria and affects photosynthesis in aquatic plants. The problems become greater due to the fact that the complex structures of the dyes remain ineffective in the presence of heat, light, microbes and even oxidizing agents that affects degradation of the dyes. Hence, these pose a serious threat to human health and water quality, there by becoming a matter of vital concern. There have been various promising techniques for the removal of dyes from wastewater. Different types of advanced methods are used for the degradation of the dyes. Aim of this project is degradation of dyes from industrial waste water using advanced methods.

KEYWORDS; Colour, Dyes, wastewater.

1. INTRODUCTION

Dyes possess colour because they: - 1] absorb light in the visible spectrum, 2] have at least one colour-bearing group, 3] have a conjugated system, 4] exhibit resonance of electrons, which is a stabilizing force in organic compounds. When any one of these features is lacking from the molecular structure the colour is lost. In addition to chromophores, most dyes also contain groups known as colour helpers, examples of which are carboxylic acids, sulfonic acids, amino and hydroxyl groups. While these are not responsible for colour, their presence can shift the colour of the colourants and they are most often used to influence dye solubility. Dyes are coloured compounds which are widely used in textiles, printing, rubber, cosmetics, plastics, leather industries to colour their products result in generating a large amount of coloured wastewater. Mainly dyes are classified into anionic, cationic, and non-ionic dyes. Among all the dyes using in industries, textile industries placed in the first position in using of dyes for coloration of fibre. Dyes are chemical compounds which attach themselves to fabrics or surface shells to impart colour. Depolarization of waste water from textile and manufacturing

industries is a major challenge for environmental managers as dyes are water soluble and produce very bright colours in water with acidic properties. Dyes are mainly derived from natural sources without any chemical treatment such as plants, insects, animals and minerals. Dyes derived from plant sources are indigo and saffron, insects are cochineal beetles and lac scale insects, animal sources are derived from some species of shellfish, and minerals are ferrous sulphate, ochre. Industries such as textile, printing, paper, carpet, plastic, and leather use dyes to provide colour to their products. These dyes are always left in industrial waste and consequently discharged into the water body and leather use dyes to provide colour to their products. These dyes are always left in industrial waste and consequently discharged into the water body. Dyes are widely used in industries such as textiles, rubber, plastics, printing, leather, cosmetics, etc., to colour their products. As a result, they generate a considerable amount of coloured wastewater. Discharge of dye-bearing wastewater into natural streams and rivers poses severe problems to the aquatic life, food web and causes damage to the aesthetic nature of the environment. Dyes absorb and reflect sunlight entering water and so can interfere with the growth of bacteria and hinder photosynthesis in aquatic plants. The problems become graver due to the fact that the complex aromatic structures of the dyes render them ineffective in the presence of heat, light, microbes, and even oxidizing agents and degradation of the dyes become difficult. Hence, these pose a serious threat to human health and water quality, thereby becoming a matter of vital concern. Keeping the essentiality of colour removal, concerned industries are required to treat the dye-bearing effluents before dumping into the water bodies. Thus, the scientific community shoulders the responsibility of contributing to the waste treatment by developing effective dye removal technique.

2. LITERATURE REVIEW

In (2005) V.K. Garg; studied that the removal of methylene blue from simulated wastewater using activated carbon, sulphuric acid treated saw dust and formaldehyde treated saw dust is investigated under different experimental conditions in batch mode. He also studied that the adsorption of methylene blue was dependent on adsorbent surface characteristics, adsorbent dose and methylene blue concentration in the wastewater. He studied that maximum dye was removed within 30 min of the start of every experiment and the pH had very little effect on the methylene blue removal. He also studied that activated carbon is an expensive material and regeneration is essential, whereas sulphuric acid treated saw dust and formaldehyde treated saw dust are cheap so regeneration is not necessary According to this study, the data may be useful for designing and fabricating an economically cheap treatment process using batched or stirred-tank flow reactors for the removal of methylene blue from dilute industrial effluents.

In (2005) Renmin Gong; studied that that the powdered peanut hull is a promising bio sorbent for the removal of anionic dyes from aqueous solution. He also studied that since the raw material peanut hull was easily

available in large quantity and the treatment method of biomaterial seemed to be economical. He studied that at initial pH 2, three dyes studied could be removed effectively. The isothermal data of bio sorption followed both Langmuir and Freundlich models. He also studied that the extensive use of dyes often poses pollution problems in the form of colored wastewater discharge into environmental water bodies and the sorbents can be used once and then disposed as fuel for power generation or as ferment substrate to produce high protein animal feed. Aim of this study is to experiment the conducted in duplicate and the negative controls were simultaneously carried out to ensure that sorption was by peanut hull biomass and not by the container.

In (1997) Gang Sun; studied that the Sunflower stalks adsorbents is used for removal of different dyestuffs in dyeing effluents with equilibrium isotherms and kinetic adsorptions. He also studied that the maximum adsorption capacities of anionic dyes on sunflower stalks are lower with 37.8 mg of Congo red dye and 26.8 mg of Direct Blue dye per gram of the adsorbents. He studied that the sunflower stalks have two prominently different components, pith and skin. Pith is a soft and porous cellulosic material, while the skin has a cellulose-based and layered fibrous structure. He also studied that the particle sizes of sunflower stalks also affect the adsorption of dyes. The adsorption rates of two basic dyestuffs are much higher than that of the direct dyes. Aim of this study is that the higher adsorption rates of cationic dyes on the adsorbents were obtained with over 80% removal of dyestuffs in the effluents.

In (2005) K. S. Bharathi; he studied that the wide range of agricultural waste materials, as low-cost adsorbent and the use of these low-cost bio sorbents is recommended since they are relatively cheap or of no cost, easily available, renewable and show highly affinity for dyes. He also studied that the process of bio sorption requires further investigation in the direction of modeling, regeneration of bio sorbent and immobilization of the waste material for enhanced efficiency and recovery. According to this study the more interest should be concentrated by the researchers to predict the performance of the adsorption process for dye removal from real industrial effluents.

In (2007) S. Raghu; studied that the treatment systems consisted of the chemical or electrocoagulation followed by ion-exchange process. Polymeric chemical coagulant and electrochemical treatment methods were employed in the present study to investigate the effectiveness of treatment of industrial dye effluents. He studied that the case of chemical coagulation, maximum COD reduction of about 81.3% was obtained at 300 mg/l of coagulant whereas in electrocoagulation process maximum COD removal of about 92.31% was achieved with energy consumption of about 19.29 kWh/kg of COD and 80% COD removal was obtained with energy consumption of about 130.095 kWh/kg of COD at iron and aluminum electrodes, respectively. According to this study the increase in the current density increases the power consumption and hence the optimization of energy consumption of the treatment methods studied that the maximum COD removal 92.31% with minimum energy consumption could be achieved at electrocoagulation using iron electrode.

In (2006) C. Namasivayam; studied that the coir pith carbon is an effective adsorbent for the removal of Congo Red from aqueous solution and the adsorption followed both the Langmuir and Freundlich isotherms. He also studied that the kinetic data follows secondorder kinetic model and the adsorption capacity was found to be 6.72 mg/g. According to this study the complete removal of the dye can be achieved using an appropriate dosage of the adsorbent and pH for wastewaters and the results would be useful for the fabrication and designing of wastewater treatment plants for the removal of dye.

In (2006) Vinod Kumar Gupta: studied that the wheat husk was found to be an effective adsorbent for the removal of react fix golden yellow and it has good adsorption capacity which is comparable with the other low-cost adsorbent reported for the removal of similar and other ionic dyes using low-cost adsorbents. He also studied that the wheat husk is cheap and easily available material thus it is a better replacement of activated carbon. He also observed that wheat husk is a waste product and hence it is use as an adsorbent on one hand would solve its disposal problem and on the other hand would provide an effective adsorbent for the removal of dye. According to his study thermodynamic parameters indicate that the process is spontaneous and feasible.

In (2008) Chih Huang Weng; studied that the adsorption of MB (Methylene Blue) into PLP (Pineapple Leaf Powder) is favored at high pH, lower temperature, and low ionic strength. He also studied that the adsorption kinetics followed a pseudo-second order kinetic model and intra-particle diffusion was involved in the adsorption process. He also studied that the fitting of Langmuir isotherm data showed that the maximum adsorption capacity increases with increasing pH and decreasing temperature. According to his study the PLP (Pineapple Leaf Powder) can be used as an economical natural based adsorbent to remove MB (Methylene Blue) dye from aqueous solution.

In (2005) A.G. Abdullah; studied that the sugarcane bagasse is a common biomass waste material and is easily available at a small price and which is used for removal of methyl red from simulated wastewater using chemical treatment of sugarcane bagasse with sulphuric acid and formaldehyde. He also studied that the adsorption of methyl red was dependent on the adsorbent dose and the methyl red concentration in the wastewater. He studied that the results show that as the amount of the adsorbent was increased, the percentage of dye removal increased and higher adsorption percentages were observed at lower concentrations of methyl red. According to his study sulphuric acid treated sugarcane bagasse showed a better performance compared to formaldehyde treated sugarcane bagasse and sugarcane bagasse is an attractive option for dye removal from dilute industrial effluents.

In (2019) Md. Aminul Islam; studied that the use of a wide range of MnOs as potential sorbents for removing dyes and Manganese-based coatings of composites have exhibited superior dye removal capacity and faster initial kinetic rate for the oxidation of dye as compared to the pure substrate. He also studied that the reactivity of MnOs coatings of composites and their importance in the natural environment has long been recognized and in case of cationic dye the little or no adsorption was observed at low pH while notably higher adsorption was achieved at higher pH depending on the surface charge of adsorbents. He observed that the opposite behavior

was remarked for anionic dyes and in most cases, adsorption edges and isotherm models have been applied extensively to complete dye removal mechanism. According to this study the Pseudo-second-order kinetic and Langmuir models fitted dye removal data nicely in most studies and most of the previous studies proposed that dye degradation involved a Fenton-like oxidation mechanism proceeding hydroxyl radicals produced by photo catalysis or from peroxide.

In (2017) P. Mohandas; studied that the removal of MB dye onto the SCLC (Citrus Limonum waste) was investigated under various conditions. He also studied that the adsorption process was studied under parameters like pH, contact time, initial dye concentrations and adsorbent doses and the maximum dye removal occurred at pH 6 within 60 minutes' time intervals. He concluded that the experimental data fitted well with Langmuir isotherm data than the other isotherm data, which indicates the monolayer adsorption. According to his study the Langmuir constant and Freundlich constant both are favored the adsorption system and SCLC could be employed as a best suitable low cost adsorbent for the efficient removal of MB dye molecules.

In (2018) Sangeeta Sharma's; studied that the various methods such as adsorption, electrocoagulation, advanced oxidation method, solvent extraction and biological

methods have been compared for the treatment of textile waste water. He concluded that the removal of dyes with adsorption technique using low cost or no cost adsorbent materials like naturally occurring, agricultural and industrial waste materials, has been found to be more effective with better removal efficiency. He also studied that the utilization of waste discharged residues as adsorbents thereby, would improve textile industry economically and for the removal of Methylene Blue dye, Bentonite Clay one of the naturally occurring adsorbents has been found to be more effective with 99.9% removal efficiency.

According to this study the removal of Safranin-O dye, Red mud one of the industrial adsorbents and activated rice husk, agricultural adsorbent, have been found to more effective with 93.2% and 82% removal efficiency respectively.

3. METHODS

[1] Adsorption-Adsorption method is used for colour removal from wastewater as it offers the most economical and effective treatment methods. Adsorption is a phenomenon in which gas or liquid molecule gets adsorb on the surface of solid.

[2] Membrane Filtration-Membrane filtration has become the essential part of the advanced treatment plant for removal of dye from wastewater. The method is used for the understanding of the membrane fouling process.

[3] Chemical coagulation / flocculation-The process in which the chemicals are added that cause the small particles suspended in the water to come together. Chemicals are added to the water to bring the non-settling particles together into larger, heavier of solids called floc.

[4] Ion Exchange-Ion exchange is an exchange of ions between two electrolytes. In the exchange of cations during wastewater treatment, positive charged ions that come into contact with the ion exchange resin.

[5] Photocatalytic degradation-In this process, various catalyst is used for removal of dye from wastewater. The various dyes include Congo red, Indigo Carmine, Crystal violet, Methyl yellow, etc.

[6] Ozonation-Ozone is the powerful oxidant agent for water and wastewater. The process is depended on the dye concentration for the removal of dye to take place.

4. AGRICULTURAL WASTE

1.Groundnut Shell:

Groundnut shell is use for the removal of dye from the water. This powder is mostly use for the removal of dye from aqueous effluent. The industrial waste water is the main aqueous effluent use for the removal of dye from it. For the preparation of Groundnut shell activated carbon, first these shells were washed with water and dried in hot air oven at 120^0C for 3 hours or in sunlight. After that grounded into fine particles for easy activation. The activation was carried out in a beaker by taking 100g of the dried sludge of groundnut shell in 100ml of concentrated sulphuric acid and then heated to 200^0C for 1 hour with continuous agitation. After 1 hour the solution started to solidify producing a carbon like material.

2. Coconut Shell:

Coconut shells are converted into small particles for easy to use for the adsorption of the dye. With the help of grinder and shifted through the sieves with a mesh diameter of 5mm. the shell powder were rinsed with water. After that placed in 2ml in NaOH for 24 hours. After that again washed with water and maintain the pH – 7. The coconut shell powder was ready for study after drying at 105^0C.

3. Saw Dust:

Wood sawdust with the particle size range of 125-200um was used in the experiment as a fixed bed. Aqueous solution of the dye that we were using as effluent was separated using the cationized sawdust. This sawdust was prepared by taking sawdust with mesh size of 125-200um was mixed with the required amount of NaOH in a 100ml.

4. Pomelo:

Pomelo peels collected from market were first clean with water, then washed out the impurities present on it and then cut into small pieces for drying it in oven at constant temp at 105^0C. by using pulveriser small pieces were converted into fine powder. By using pomelo powder the removal rate of 140 mg/l dye solution with 100 ml could reach more than 83% under the optimum conditions, which were as follows: 0.4g pomelo peels powder, reaction temperature 30^0C, Ph value 8 and time was 60 min. pomelo peels powder had proven to be economical adsorbent under favourable conditions in dye wastewater treatment.

5. EXPERIMENTAL PROCEDURE:

1.In the experiment, waste water samples from the textile industry (jean factory) were taken.

2.The parameters in the study of this paper includes Ph, COD, Transparency, Turbidity and TDS.

3.For the removal of dye from this waste water samples agricultural waste were used such as pomelo, groundnut shell, coconut shell and sawdust.

4.These agricultural waste was converted into fine powders for more surface area for adsorption process.

5.Equipment was designed in such a way that the agricultural waste was arranged in series on a mesh plates which has some pores for dye water to pass on.

6.In between both the mesh plates a pipe outlet was given under each agricultural wastes for getting individual effects of agricultural waste for removal of dye water. The outlet of pipe was given values for controlling the flow of dye water.

7.Dye water was passed through the dome shaped at the hopper for water to spread all over and the samples was collected to study the parameters which was used for the removal of dye.

6. PARAMETERS:

1] PARAMETERS FOR WASTE WATER SAMPLE: -

PARAMETERS	READINGS
Temperature (*C)	27.6
pH	5.26
TDS (ppm)	560
COD (mg/l)	130
TURBIDITY (NTU)	80.3

2] PARAMETERS FOR SAMPLE TREATED WITH ACTIVATED CARBON: -

PARAMETERS	READINGS
Temperature (*C)	27.6
pH	7.16
TDS (ppm)	430
COD (mg/l)	400
TURBIDITY (NTU)	19

7. EXPECTED RESULT: -

1] PARAMETERS OF SAMPLE TREATED WITH GROUNDNUT SHELLS: -

PARAMETERS	READINGS
Temperature (*C)	27.9
pH	6.9
TDS (ppm)	400
COD (mg/l)	258
TURBIDITY (NTU)	18.8

2] PARAMETERS OF SAMPLE TREATED WITH COCONUT SHELL: -

PARAMETERS	READINGS
Temperature (*C)	27.9
pH	7.05
TDS (ppm)	320
COD (mg/l)	200
TURBIDITY (NTU)	17

3] PARAMETERS OF SAMPLE TREATED WITH SAW DUST: -

PARAMETERS	READINGS
Temperature (*C)	27.7
pH	6.8
TDS (ppm)	290
COD (mg/l)	180
TURBIDITY (NTU)	16.8

4] PARAMETERS OF SAMPLE TREATED WITH POMELO: -

PARAMETERS	READINGS
Temperature (*C)	27.7
pH	7.15
TDS (ppm)	230
COD (mg/l)	110
TURBIDITY (NTU)	15

7. CONCLUSION:

we concluded that among the various methods and technologies used for removal of dye from agricultural waste, adsorption is the cheapest and one of the most effective method for removal of dye using agricultural waste as low cost adsorbent. There is abundant amount of agricultural waste in our surrounding which can be used as low cost adsorbent for treatment of industrial waste water. The agricultural waste such as groundnut shell, coconut shell, sawdust and pomelo gives more surface area for the removal of dye by adsorption process. We study the parameters which are considered for the removal of dye from the waste water such as Ph, TDS, COD and transparency.

8. REFERENCES:

1. Recent advances for dyes removal using novel adsorbents: A review. Yanbo Zhou; Jian Lu; Yi Zhou; Yongdi Liu [2019]

2. Efficient removal of methylene blue dye by a hybrid adsorption-photo catalysis process using reduced graphene oxide/titanate naotubes composites for water reuse. Chi Hieu Nguyen; Ruey-Shin Juang [2018].

3. Dual-functional ultrafiltration nano-enabled PSf/PVA membrane for the removal of Congo red dye. Nomcebo P. Khumaloa; Gcina D. Vilakatib; Sabelo D. Mhlangaa [2019]

4. Adsorption kinetics, isotherm and reusability studies for the removal of cationic dye from aqueous medium using arginine modified activation carbon. Mu Naushad, Ayoub Abdullah Alqadami; Zeid Abdulla AlOthman [2019]

5. Feasibility of industrial-scale treatment of dye wastewater via bio-adsorption technology. Wei Li; Bingnan Mu; Yiqi Yang [2018]

6. Adsorption and identification of traces of dyes in aqueous solutions using chemically modified eggshell membranes. IuriCustodio; Montes Candido; Juliana Mikaelly; Dias Soaresb [2019]

7. Sorption studies of methyl red removal using lemon grass (Cymbopogoncitratus). MohdAzmier Ahmad; Nur AdilahBinti Ahmed; KayodeAdesinaAdegoke [2019]

8. Ultrafast and efficient removal of anionic dyes from wastewater by polyethyleneimine modified silica nanoparticles. Yuling Tang; Minghui Li; Bi Shi [2019]

9. Removal of dye from polluted water using novel nano manganese oxide based materials. Md. AminulIslama; Imran Alic; S.M. Abdul Karimb; Md. Shakhawat Hossain Firozd [2018]

10. Photocatalytic and adsorption studies on the removal of dye Congo red from wastewater. Rajeev Jain and Shalini Sikarwar [2006]

11. Biomimetic Dynamic Membrane for Aquatic Dye Removal. Wensong Chen; Jiahao Mo; Xing Du; Zhien Zhang; Wenxiang Zhang [2018]

12. Adsorption studies of textile dye from aqueous solutions using activated sawdust. Muhammad Waqar Ashraf; Nidal Adbulibdeh and Abdus Salam [2019]