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**GREEN APPROACH FOR DEGRADATION OF AZO DYE RICH TEXTILE
EFFLUENT USING BACTERIA: REVIEW**

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ABSTRACT

Water pollution from textile effluent is now one of the major problems all over the world. Treatment of effluent from dye-based industries processes a major problem but biological treatment of bacteria with sawdust seems to be a viable option. Textile and dyestuff industries are major contributors to industrial pollutants – dyes. Azo dye is a key component of textile effluents. A dye is used to impart color to materials of which it becomes an integral part. The amount of azo dyes concentration present in wastewater varied from low to high concentration that leads to colored dye effluent causing toxicity to ecosystem. There are various types of physiochemical methods and biological methods that are used for treating textile effluent. Physiochemical methods lack in environment friendly and cost-effective, hence become commercially unattractive. In the biological methods, different taxonomic groups of bacteria, fungi, actinomycetes, and algae have been reported for their ability to decolorize azo dyes. Thus, the biodegradation technique approach will be eco-friendly with no secondary hazard. The factors affecting decolorization and degradation of azo dye compounds like, pH, temperature, dye concentration, effects of carbon dioxide and nitrogen, agitation, effect of dye structure, electron and enzymes involved in microbial decolorization of dyes have been discussed. The enzyme can be utilized to develop healing processes that are ecofriendly than the conventional techniques. The enzymatic mechanisms involved in the bacterial degradation of azo dyes, are also

investigated for toxicity level of the Bacterial decolorization and degradation of azo dyes, and enumerate the role of this inaction for the treatment of textile dye effluent.

Keywords: Azo dyes, degradation, environmental pollution, effluents

INTRODUCTION

Environmental pollution has been recognized as one of the major problems all over the world [10]. Many colored effluents that contain dyes are released from leather, textile, food, dyestuff, and dyeing industries. The textile industry largely produces effluent contaminated with dyes [15]. Approximately 80,000 – 90,000 tons of dyestuff and pigment are produced in India [12, 15]. Synthetic dyes are used in extensive amounts in textile, food, paper, plastic, leather, pharmaceutical, cosmetics, etc. These synthetic dyes, which are either discharged directly or processed incompletely and discharged into the waterbody, are highly visible and affect the water transparency, and gas solubility of the water. Some toxic substances in the dyes are dangerous for human health [7]. The Synthetic dyes are chemically diverse, and with regard to their industrial application divided into azo, triphenylmethane, anthraquinone, or heterocyclic/polymeric structure. Anthraquinone dyes are the second most important in usage after azo dyes because of its low price, easy availability, and good dyeing performance. Anthraquinone dyes have a complex and are

more toxic to organisms. Triphenylmethane dyes are synthetic compound are widely used in various industries and their removal from wastes are tough, due to their higher degree of structural complexity. The textile effluent directly indicates the water has been polluted, and this highly colored effluent is completely responsible for polluting the receiving water. Dye wastewater are treated physically and chemically by flocculation, coagulation, membrane filtration, perception, adsorption, irradiation, ozonization and Fenton's oxidation [4]. Most synthetic dyes highly resistant to degradation due to their complex chemical structure. The wastewater contains acids, alkalis and common salt, heavy metals, sulfides, chlorine, and mineral oil [10]. There is an urgency of an eco friendly, cost effective and systematic approach of degradation textile dyes [11].

The textile dye is degraded under aerobic conditions with a coordinated effect of bacteria isolated from the textile dye effluent. Nutrients such as carbon and nitrogen sources and physical parameters (pH, temperature, and inoculum size) have a significant effect on dye decolorization.

Recent fundamental work has advised that the existence of a wide variety of microorganisms belonging to a different taxonomic group of bacteria, fungi, actinomycetes, and algae have the ability to decolorize azo dyes [6]. Bacterial degradation of these dyes is done by intracellular enzyme while fungi degrades this by the extracellular enzymes. The organisms are used in most of the studies of *Staphylococcus* sp, and *pseudomonas* sp, in bacteria.

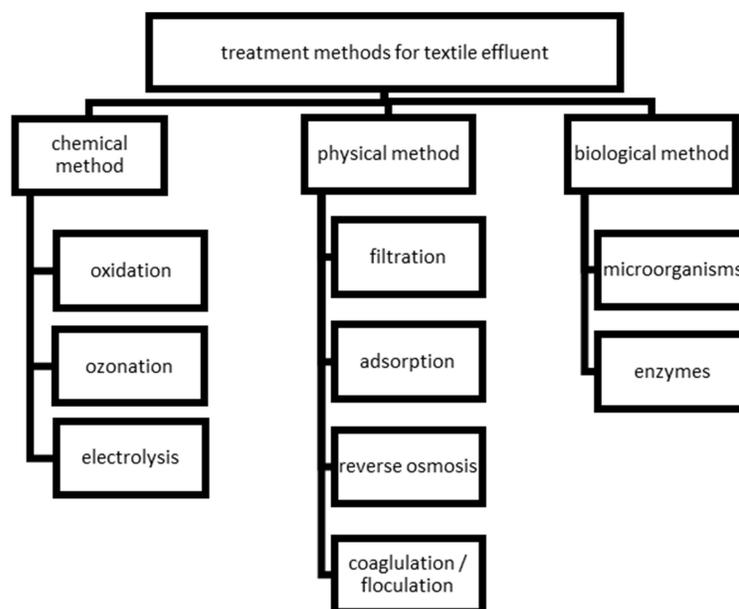
Azo dyes represent the largest and most adaptable class of synthetic dyes. These dyes are poorbiodegraded because their structures and treatment of wastewater containing dyes usually involve physical and chemical methods such as adsorption, coagulation, flocculation, oxidation, filtration, and electrochemical method [12]. Dye from waste water are difficult to remove of standard treatment method as they are stable to light and oxidizing agent are resistant to aerobic adsorption [16]. Biological decolorization has been investigated as a method to degrade or mineralize azo dyes. Such decolorization and

degradation are environmentally friendly and cost-competitive to the chemical decomposition process. Most of the azo dye is recalcitrant to aerobic degradation by bacterial cells. There are few known organisms that have the ability to reduce the cleave zone bonds under aerobic conditions.

2. IMPORTANCE OF BIOLOGICAL TREATMENT RELATIVE TO PHYSICO-CHEMICAL METHOD

Dye house effluent typically contains 0.6-0.8 g/l dye, but the pollution it causes is mainly due to locality of the dyes in the waste water. Therefore it is necessary to search for and develop effective treatments and technologies for the decolorization of dyes in such effluents. Various physical/chemical methods, such as adsorption, chemical precipitation, photolysis, chemical oxidation and reduction, electrochemical treatment, have been used for the removal of dyes from wastewater [18]. Biological methods are used for decolorization and degradation of azo dyes by microorganisms and enzymes treatment.

Treatment methods for the removal of dyes from wastewater effluent



2.1 Physical and chemical methods

Physical methods based on coagulation and flocculation of dyes are effective for the removal of mainly Sulphur and disperse dyes, but show lower coagulation-flocculation capacity for acid, direct, reactive and vat dyes. In addition, the lower color removal efficiency and larger amount of sludge produced limits the application of these techniques. Adsorption methods have attracted due to their higher efficiency for the removal of a wide range of dyes [2]. Filtration methods such as ultrafiltration, nanofiltration and reverse osmosis have been used for water reusage purpose and chemical recovery. In the textile industry, the use of membranes provides possibilities for the separation of hydrolyzed dyestuffs and dyeing auxiliaries that simultaneously reduce the color, BOD, and COD of wastewater, and

they have also been found useful for dyeing and bleaching it [18]. The selection of the types and porosity of the filter depends upon the chemical composition of the wastewater and the specific temperature required for the process [2].

Chemical oxidation methods enable the destruction or decomposition of dye molecules, and such approaches use various oxidizing agents, such as ozone, hydrogen peroxide and permanganate. Modification in the chemical composition of a compound or a group of compounds takes place in the presence of oxidizing agents, and thus the dye molecules become susceptible to degradation. Ozonation has been found to be effective due to its higher reactivity with many azo dyes, the lack of alteration of the reaction volume due to its gaseous state, and good color removal efficiencies. In advanced

oxidation processes, oxidizing agents such as O_3 and H_2O_2 or heterogeneous photocatalysts are used with catalysts, such as, ZnO_2 , Mn and Fe in the presence or absence of an irradiation source which generates radicals for the destruction of hazardous dye pollutants [2].

The various physical and chemical methods for dealing with dye wastewater presented above reveals that all of them have some drawbacks, such as being economically unfeasible, unable to completely remove the recalcitrant azo dyes and their organic metabolites because of the color fastness, stability and resistance of azo dyes to degradation, generating a significant amount of sludge that may cause secondary pollution problems and increasing the cost of these treatment methods, and involving complicated procedures.

2.2 Biological methods

Bioremediation of microbial techniques to deal with pollution, is a key research area in the environmental sciences. In such approach microbes acclimatize themselves to the toxic wastage and new resistant strains develop naturally, which then transform various toxic chemicals into lesser harmful forms. Azo dyes are xenobiotic in nature and recalcitrant to biodegradation, and the use of microbial or enzymatic treatment methods for the

complete decolorization and degradation of such dyes from textile effluent and has the following advantages: (1) being environmentally friendly, (2) being cost competitive, (3) producing less sludge, (4) yielding end products that are nontoxic or have complete mineralization and (5) requiring less water consumption compared to physicochemical methods. The isolation of potent species and thereby their degradation is one of the important biological aspects of effluent treatment. A wide variety of microorganisms are capable of decolorizing a wide range of dyes including; bacteria, fungi, yeasts, actinomycetes, algae and plants. Moreover, these are even capable of completely mineralizing many azo dyes under environmental conditions [30].

3. CLASSIFICATION OF TEXTILE DYE

A dye always depends on the nature of the fiber. Thus, no single category of dye can provide color to all fiber i.e., dyes color specific fiber. The classification of azo dyes has become mandatory due to the increase in the annual global production of dyes. They are estimated at several million tones [13]. In the past century, most of the dye is obtained from plants e.g. indigo and alizarin dyes [14]. The presence of synthetic dyes is used which is considered more effective and provides a variety of shades in colors. The organic dyes

are generally aromatic in nature. They are different in the number of rings as well as the nature of linkages present [14].

Dyes have a chromophore group which imparts color to the dyes and auxochromes to intensity the color when introduced into colored molecule. The important auxochromes are amine, carboxyl, sulfonate, and hydroxyl. The main class of dyes is acid, basic, direct, reactive, disperse, vat, Sulphur, and mordant, and according to the chemical structure and types of the chromophore present in molecular.

The classification of dyes is suitable for one or more textile fibers. High fastness means the lower amount of dyes released by washing causing lesser water pollution. The dyes may be classified to the methods of application or point to view as

1. Direct dyes
2. Acid dyes including metal complex
3. Basic or cationic dyes
4. Chrome mordant dyes
5. Azoic dyes
6. Sulphur dyes
7. Vat dyes
8. Solubilized vat dyes
9. Reactive dyes
10. Disperse dyes
11. Pigment color

1. Direct dyes

The dyeing with direct dyes needs salts, that hamper eco-friendliness. Energy is required to heat the dyebath for boiling purpose. The effluent from this method contains salt, a dye-fixing agent, and about 5% to 20% residual colour. Some direct dyes are made up of an element compound referred to as chemical group dyes. They are sometimes red, brown, or yellow and make up concerning half the direct dyes made. They are notable to allow off a spread of malignant neoplastic disease amines.

Direct dyes are reclassified according to many parameters like group fastness properties or application characteristics. The main chromophoric varieties like chemical group, phthalocyanine, stilbene, dioxazine, and alternative smaller chemical categories like formazan, anthraquinone, and thiazole. Recently are simple to use and their wash fastness performance is merely moderate [17].

2. Acid dyes

These dyes are typically applied under acidic conditions with a degree of acidity depending upon individual dyes' properties. Acid dyes are typically bright with a variable fastness to washing. The defining feature of the group is that the presence of the sulphurated group, this provides water solubility. Further bonding

interaction is provided by Van der Waals forces. The degree of interaction and thus, the degree of colorfastness varies directly with dye molecule size. Acid dyes are low molecular dyes sometimes with a monoazo, diazo, or anthraquinone structure and are known for their capability to perform bright shades. Their tiny sizes permits them to diffuse speedily into advanced materials like animal skin. They are typically cited as penetrating dyes. The dyeing method concerned an acidic step, the name of this category. Along with materials like silk, leather, paper, and food.

3. Basic dyes

Numerous styles of dyes molecules can have cation functionally, although it's most typical in chemical group dyes and methine dyes. These dyes are sometimes applied to acrylic, paper, and nylon substrates, but can also use in some changed polyester substrate. Basic dyes are applied which slow down due to their poor migration properties at the boil, the basic dye is water soluble and produces colored cationic in solution, this cationic is attracted electrostatically to substrate with a negative charge. The basic or cation dye will have either the charge localized on an ammonia group, or it will be distributed as a delocalized charge over the dyes cation as

found in several triarylmethane, xanthenes, and acridine dyes.

4. Azoic dyes

Azo dyes are assessed to be concerning one million tons. It is found in numerous forms and natures and over a pair of, 2000 essentially completely different azo dyes are presently in use. The azo bond linkage may be present more than once, mono azo dyes have one azo linkage there are 2 linkages in cation dyes and 3 in trazodone hydrochloride severally. Dyestuff is wide utilized in textile, cosmetic, leather, pharmaceutical, paper, paint, and food industries the azo dyes contain nanogram sulfonate groups as substituent are called as sulphurated azo group dyes. The azo group in conjugation with aromatic substituents or penalizable teams build a complex structure that ends up in the massive expression of variation of colors in dyes.

5. Vat dyes

These are one of the oldest dyes used by human and any society on earth [14]. Vat dyes are basically insoluble in water. The dye is treated by alkaline liquor that reduces it to a leuco which has a good affinity to cotton and cellulose fibers. Once dyes are oxidized, color is developed. Certain dyes like indigo are applied once, alkaline reduction and classed as vat dyes. The effluent from

this method contains residual colour, as well as reducing agent further reductant, oxidizer, detergent, and salts. Vat dyes have the smallest amount impact on the atmosphere, while resistance to light and wash are highest.

6. Sulphur dyes

Sulphurdyes are comparatively low-cost technique of getting good color strength and acceptable fast of dyeing. Sulphur dye are readily soluble in the solution of sodium slushed but insoluble in water [14]. It is used for the inexpensive material of dyeing and clothes like operating textile. Environmental speaking, it's free from heavy metal and alternative toxicant material, thus it's not too bad when compared to reactive dyes, that 90% of all Sulphur dyes make use of atomic number sodium sulphide, that makes the effluent a lot of toxicant than others.

7. Reactive dyes

The development of reactive dyes had a major impact on the dyeing industry, with its colorfastness and outstanding wash fastness properties. They create it doable to get high wet strength, but their use is not always possible because of difficulty in obtaining good unison. The chlorine fastness is slightly lower than that of vat dyes, as is that the light fastness below extreme conditions. The reactive dyes furnish a wide

gamut of shades of good light fastness and excellent wash fastness on cotton, such properties place this category of dyes at the standard finish of the market. Reactive dyes are applied at comparatively lower temperatures (30-70°C) than direct dyes (100°C) saving energy. But they require good amounts of salt and alkali.

8. Disperse dyes

The disperse dyes are synthetic colorants for hydrophobic substrate and are commonly applied as commercial mixtures in textile coloration. They are typically utilized in good quantities and due to the massive quantity of water concerned within the associated dyeing method and therefore the high proportion of the dyes that is still within the water bath, large volume of effluent will be generated. This dye was historically applied to polyester at a boil with the inclusion of a carrier within the dye's bathtub to the expedited diffusion of the dye into the substrate.

4. MICROORGANISM DECOLORIZATION AND DEGRADATION OF DYE

It is very much importance to understand well the mechanism by which azo dyes decolorization is obtain [8]. The microorganism degradation of effluent was the mainly focused on various decolorization strains for degradation and adsorption of

dyes in effluent, genetically modified microorganism, and different other technology. The azo dyes will be decolonized by a wide type of microorganisms, together with microorganism, fungi, algae, actinomycetes. Thus, it is of great significance to know the mechanism of decolorization and degradation of various microorganisms for making an acceptable atmosphere for microorganisms. The decolorization of acid-base indicator by *Bacillus circulans*. The recently isolated salt-tolerant stain azo reductase, NADH-DCIP reduce and laccase were concerned about the degradation of acid-base indicator. Additionally, the strain may degrade aromatic amines, thereby reducing the toxicity of the dye. Salt-tolerant yeast, G1 was isolated, that may decolorize various azo dyes, therefore, it is necessary to screen the dominant stain of economical degradation of dyes for the decolorization of dye effluent [3].

5. FACTORS AFFECTING DURING DEGRADATION OF DYE

It is terribly tough to get rid of the textile industrial effluent by commonly used physical and chemical methods mainly due because of their high biological oxygen demand, chemical oxygen demand, heat, pH, and presence of metal ions [9]. In dyes

decolorizations the pH has been a major impact on the performance. Biodegradation of synthetic dye and other chemical textile effluent depends on the physiochemical and biological processes [5].

pH

In dye decolorization the pH has a major effect on the efficiency. The best pH for color removal in microorganism is commonly 6.0 to 10.0. The tolerance to high pH is very important especially CVBN typically performed below the alkaline conditions for industrial processes victimization reactive azo dyes [9].

Temperature

Temperature is additionally an awfully necessary issue for the remedy of water and soil for these processes related to microorganism vitality including, it was also additionally discovered that the decolorization rate of radical dyes will increase up to the best temperature and decolorization activity.

Generally, photocatalysis is not temperature-dependent. However, a rise in temperature will have an effect on the quantity of surface assimilation and help the reaction to finish a lot of with efficiency with negatron -hydrogen recombination, that the variations discovered weren't important by the impact of temperature at 20°C the

proportion to paint removal was 88.2 ± 1.2 whereas for 55°C its was 87.9 ± 2.0 . in several systems inside an outlined vary that depends on the system rate of color, removal will increase with increasing temperature [9].

The concentration of the dyes

The molecules with completely different structure increasing the concentration of the dyedecrease the decolorization rate, most likely because of the toxiceffect of dyes with relation to the individual microorganism and inadequate biomass concentration, also as blockage of activity sites of radical enzyme.

Completely different concentrations of azo dyes reactive red vary from 50, 100, 200, 400, 500, mg/liter,has been taken for the determination of the impact of dye concentration on decolorization. It is been found that with a rise in dye concentration the dye's decolorization efficiency of the microorganism strain decreases. The maximum decolorization was found on 50 mg/lit concentration and minimum decolorization was found on 500mg/liter concentrations [9].

Other factors

The effect of incubation conditions specifically shaking and stationary condition on decolorization of reactive red, that static condition was most suitable for

decolorization, wherever the activity was found to be 95% and shaking condition it had been 84.83%. The data suggest that in static condition is a lot of applicable for the decolorization of the dyes by the bacteria [9].

Aerobic and Anaerobic conditions

A reduction of the bond within the molecules is discovered throughout anaerobic degradation. Then, aerobic condition is needed for the whole mineralization of the reactive dye molecule. The hydrocarbon made by the initial reduction is degraded via hydroxylation and electron reduction of O_2 to water in addition to the reaction of synthetic resin compounds are shown to be economical in degradation numerous dye molecular. Enzyme system that permits the degradation of varied toxic compounds, including thatcontain aromatic amine in structure [9].

In recent years analysis depends on PCR primarily based methodology for the analysis of 16S rRNA sequence directly from environmental samples, Eschenhagen et al.reported that by culture methodology, 16 rRNA cistron base surveys clearly demonstrate the broader scope of microorganism diversity has resolved the matter to an excellent extent than indirect. The metagenomics is that the microorganism orders accustomed analyze that assorted dye

degrading microorganism diversity either by expression or on sequencing the genome [9].

CONCLUSION

The properties of dyeing effluent enhance complicated composition, large chromatically, strong acidity, basicity, and high chemical oxygen demand. It is therefore important to biodegrade once it contains a matrix of dyes. Textile effluent needed applicable treatment before it unharnesses into the atmosphere. Residual dyes have complicated structure compositions that are dangerous for the organism in soil and water of the affected and possible methodology to treat their effluent, once added into the water bodies. Among the economical technology of dye removal, the microorganism system was the most practical in running expenses and manpower requirement. Several treatments will be economical in decolorization but, it is necessary to evaluate whether there is configuration to toxic product throughout the treatment method. Microbial decolorization of dyes has recently received a lot of attention because it could be a cost-efficient methodology for dye removal. Recently, studies are shifting towards used of mixed microorganism culture compared to individual strain. It is was established that pollution lowers the standard of life in

numerous aspects, and health and lifetime, therefore biodegrading of pollutants for reduction of their dangerous impact is of prime importance. In future studies, we could introduce microorganism or catabolic genes to observe the method of optimization through operation on full scale treatment systems.

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