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BIODEGRADATION OF TEXTILE WASTE BY BACTERIAL STRAINS

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Abstract

Harmful effects of textile industry effluents are a huge problem for now a days. It creats many problems at different level of ecosystem. The textile industry generates a high volume of waste products. Approx. seventy tons of dye is used annually. A big portion of such amount is discharged in a huge amount of water which affects the quality of water. They are cause of high BOD, COD sulphate, low dissolve oxygen and strong colour, which is the most serious problem of today. The treatment and reuse of industrial waste is now an attractive option as because of the sustainable development of environment and also because of the increasing demand for water and decrease in supply. The removal of waste from the textile effluent has been carried out by physical, chemical and biological methods. The physical and chemical techniques are electrochemical destruction , anion exchange resin, , ozonation, floatation, flocculation, electro floatation, reverse osmosis, irradiation, adsorption, coagulation, nano filtration, ultrafiltration and microfiltration fungal discolouration. The ability of microorganisms to degrade and metabolize a wide variety of compounds has been recognized and exploited in various biotreatment processes. This studyhelps in investigating the chemical, physical along with the biological treatment techniques focusing on the potential of bacterial strains for biodegradation of textile industrial waste.

Key words: *Biodegradation, textile waste, bacterial sp., microorganism, dyes etc.*

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INTRODUCTION

Development of any country based on increasing establishment of different industries. At the time of development we have established numerous industries without caring about sustainable development. The major constituent of total industrial set up of any nation is by textile industry . Discharge of different complex dyes releasing from textile industry is a major cause of worry these days. Annually 700,000 million tons of dyes is being used in textile industry [58]. Wide variety chemicals of complex structure like dyes having azo dyes, aromatic and heterocyclic groups, surfactants, toxicants and salts are being released in the effluent of the industry. Sufficient amount of water is consumed in the discharge of these harmful chemicals. Harmful effects of these chemicals have been a challenging issue. These chemicals have high value of COD & BOD causing depletion of dissolved oxygen. Azodyes are carcinogenic in nature (IARC 1982). Approx. 10% of commercial sample and 27% effluent of textile industry are mutagenic in Ames test [23]. Elements such as chromium are highly toxic for aquatic life. Degradation of these chemicals so as to reuse water is attracting researchers these days. Different chemical and physical processes are being used for the effluent treatment these chemical processes are floatation [47], flocculation [15], adsorption, anion exchange resin [19], irradiation [56], electro floatation, electrochemical destruction [39], ozonation [11]. Few researchers have also considered some dead end filtration processes like reverse osmosis [44], nano filtration, microfiltration and ultrafiltration techniques [9] for the removal of waste from the effluent. We are looking for biological treatment an alternative to these physico-chemical processes. These biological processes, including aerobic and anaerobic bacteria and fungi, for dye degradation and as a result wastewater reutilization have been developed [7]. Biological treatment methods are attractive due to their diverse metabolic pathways, versatility of microorganisms [2, 40, 24, 49, 33] cost effectiveness.

PHYSICO-CHEMICAL TECHNIQUES:

Coagulation–flocculation treatments: Flocculation & **C**oagulation are the process which are used to remove fine suspended solid and colloidal particles. This process form flocks which are larger in size so that they can precipitate easily. Alum,ferrous sulphate, ferric sulphate, ferric chloride and lime are used as coagulating agents. In sedimentation, only 50-70% of the total suspended matter and 30-40% of the organic matter settles but in coagulation and flocculation 80-90% of the total suspended matter and 80-90% of the bacteria can be removed. This process effectively eliminates insoluble dyes [8], still its value is doubtful due to the cost of treating the sludge and the increasing number of restrictions concerning the disposal of sludge.

Membrane separation processes: Membrane separation processes are proving to be promising for textile effluent treatment. Effluent quality is being found to be very improved. . Biologically treated water was found to have good COD and BOD removal efficiency but mineral parameters were not found to be in good limit. Membrane separation is a good alternative in this concern. Due to presence of different solid particles in effluent fouling is one of the major problems. To decrease the fouling problem different pretreatment are being considered. Filtration with normal filter paper was used before microfiltration to reduce fouling problem, which also increases the membrane life [42]. Physicochemical pretreatment like flocculation and coagulation were used before Nano filtration and reverse osmosis [9]. Sometimes combination of two or more processes was considered. Ultrafiltration is effective for secondary textile waste water and nanofiltration is good for low molecular weight species separation. While using nanofiltration as a treatment procedure membrane fouling occurs as a major problem. To overcome this problem ultrafiltration is taken as pretreatment, which was found to be more effective [8]. Direct ultrafiltration and ultrafiltration after microfiltration were compared and the second one had given better result [33]. Nanofiltration is found to produce reusable permeate [42].

BIOLOGICAL PROCESSES:

Different microorganisms have thedifferent natural capability to metabolize the harmful pollutant and convert them to more acceptable form which is less hazardous to the environment. Different biological processes are considered these days to treat the textile industry effluent. Many microorganisms have been investigated to have ability to degrade different harmful chemical of textile effluent. Different metabolic mechanisms which are involved in decomposition of dye have been studied by different researchers. Biological treatments are depends on the presence or absence of oxygen [3].

Activated sludge process gives approx. 90% removal [32], activated slug was used by Muhammad Khalid Iqbal to treat textile effluent. Reduction of pollutant was measured in terms of TSS,TSD, BOD. Reduction in the parameter was found to be 80%, 78%, 48% and 79% respectively [14].

Only 47% of 87 of dyestuff are biodegradable [31]. To degrade remaining dyes other process are needed to be combined with biological treatment. Merce` Vilaseca et al., in 2010 showed that electrochemical treatment before activated slug processes reduced COD more than simple activated slug process [52]. Few researchers used to combined the process including biological pretreatment, electrochemical oxidation, chemical coagulation. COD & Color were found to be reduced by95.4% & 98.5% respectively [17]. In case of biological treatment systems should be adsorbents, such as activated carbon or bentonite clay are added in order to eliminate the non-biodegradable or microorganism-toxic organic substanceswhich are produced by the textile industry [32, 21, 42]. The adsorption on activated carbon without pretreatment is impossible because the suspended solids rapidly clog the filter [22]. This procedure is therefore feasible in combination with flocculation–decantation treatment or a biological treatment. The combination permits the reduction of suspended solids and organic substances, as well as there is slight reduction in the colour [37], but the cost of activated carbon is more. Some of the pretreatment steps are also considered to improve the results of biological decomposition. T There are wo major classes of microorganism which are widely used for treatment are as follows:

Fungal biodegradation: Some fungus is known to decolorize dyes. Enzymatic degradation is the major mechanism in most cases. Enzymes like manganese peroxidase, lignin peroxidase, laccase are known to have ability to degrade dyes [36, 10]. *Penicillium chrysosporium* lignin peroxidase is also responsible for decolorisation of dyes. Laccase activity for the decolorisation is found in *T. versicolor* [54].

A fungal isolated from textile industry *Aspergillus terreus* SA3 was efficiently used for the removal of dye such as Sulfur black from textile effluent. In the Stirred tank reactor system (STR) overall color, COD & BOD were removed by, 66.50 & 84.53 is 75.24%, .The removal efficiency of the reactor decreased as the concentration of the dye was increased. This STR system was found very effective for efficient treatment of textile waste water (up to 200 ppm Sulfur black dye) by the fungal strain *Aspergillus terreus* SA3 [1].

The removal of azo dyes from aqueous solution by *Schizophyllum commune* (50 μm) concentration showed 96.86% of the color removal in congo red, 97.57% in methyl orange and 97.40% in Erichrome black-T on fourth day respectively. *Lenziteseximia* decolorized congo red by 95.50%, methyl orange by 94.79% and Erichrome black-T by 95.36% at 50 μm concentration respectively on fourth day. The Removal of textile dye effluent in batch mode showed 76.15% decolorization and continuous mode showed 55.92% decolorization on 5th day by *Schizophyllum commune.* In *Lenziteseximia*54.60% & 75.23% of decolourization was observed in batch and continuous mode respectively on 5th day [38].

Bacterial biodegradation :

The microbial degradation and decolourazition has showed as an environmentally friendly and cost-effective process compare to chemical decomposition processes [33, 50, 25, 53, 16, 5, 30]. Bacterial strains are able to decolourize azo dyes under aerobic (Xenphylus azovorans KF46F, Staphylococcus sp., Kerstersia sp. strain VKY1 and Bacillus strain) and anaerobic conditions (Eubacterium sp., Butyrvibrio sp ,Sphingomonas xenophaga BN6, or Bacteroides sp.) Clostridium sp., have been extensively reported [33, 35, 18, 43, 4, 29, 6, 51, 12].

Many researchers used sulphate reducing bacteria (SRB) for the textile effluent bioremediation for reducing sulphate [44, 55], for total mineralization the concept of single reactor has been applied for the facultative anaerobic and aerobic non-sulphate reducing bacteria [27, 48]. Sulphate reducing bacteria (SRB) has capability to decolourize textile dyes which are grown in primary sludge [55]. Sulphate reducing bacteria (SRB) consortium was used to degrade Orange II (O II) into 1-amino-2-naphthol and sulphanilic acid which gave 95% decolorization. The latter was degraded steadily (from 290 to 43 μM) over 20 days while 1-amino-2- naphthol disappeared from the reactor within two days. Other Azo dyes, , Reactive red 120, Reactive blue 2 , an anthraquinone dye, Remazol Brilliant violet 5R, Reactive black 5 , and an industrial azo dye mixture were successfully degraded with the exception of Amino black 10B [46]. Few more researchers treated reactive azo-dye (reactive red 22) by Pseudomonas luteola and investigated kinetics of azo-dye decolourization. Biological Activated Carbon- reactor was used to remove reactive red 22; it almost removed 89% reactive red 22 by P. luteola biofilm [20].

A facultative *Staphylococcus arlettae* bacterium was used by the researcher which was able to successfully decolourize four different azo dyes under microaerophilic conditions by 97% [7]. Effluent adapted strains of *Acinetobacter, Bacillus* and *Legionella* were found to have potentials of colour removal and strains of *Acinetobacter, Bacillus and Pseudomonas* have potentials of chemical oxygen demand (COD) removal activities [4].

N. Murugalatha showed that metabolite produced by *Bacillus* species has the ability to degrade dye at higher rate at higher dilution of effluents. He found that rate of degradation was increased from 34 to 98 units when dilution was increased to 90% [26].

Anaerobic and aerobic bacterial processes are requires for complete azo dye mineralization. Azo bonds are reduced leading to generation of aromatic amines under anaerobic conditions.

For the aerobic azo dye reduction laccases can be used and they polymerise the aromatic amines leading to secondary colour development and pollutant build-up [26]. Few researchers have reported that aromatic amines are completely degraded under aerobic conditions as they are toxic, carcinogenic and recalcitrant to anaerobic degradation [57, 28, 34]. The co-cultures of facultative anaerobic and aerobic bacteria are used to mineralize the textile waste [33, 13, 45].

However, artificial media is costly which are supplemented in reactor [45] and pure cultures have a narrow range of substrates [28], which limits such reactors to laboratory scale. Therefore there is a need for cheaper biological methods because they are environment friendly and can be readily adapted for textile effluent treatment.

DISCUSSION

For the sake of sustainable development the waste water treatment is a huge challenge of the day. Different techniques have their advantages and disadvantages with them. Chemical methods remove only the selective range of pollutants but they demand further for the treatment which remove chemicals. Flocculation & Coagulation remove insoluble component with high efficiency. The Membrane separation techniques is more promising today's. Biological treatment also has many technique for the treatment.. Enzymatic degradation is a nice choice because it leaves nothing to treat after the processes. A wide range of variety of microorganism and their enzymes are available in nature. In the same time as it is natural process it do not have any ill effect. Before the biological treatment non-biodegradable can be treated by different chemical techniques which convert them in biodegradable form. The biological treatment mainly bacterial sp is widely used for the removal of textile dyes from the waste effluents which produced from the textile industry. This biological technique is cost effective as well as it helps in sustainable development of environment by reducing the sludge produced during the treatment.

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