Research Paper

ROTATING BIOLOGICAL CONTACTOR FOR THE TREATMENT OF TEXTILE INDUSTRY WASTEWATER

Priya AK[1*], S. Nagan[2], Rajeswari.M[3],Nithya.M[4], Priyanka.P.M[5] ,Vanitha R[6]

Address for Correspondence

[1,3,4,5]Assistant Professor, Department of Civil Engg., KPR Institute of Engineering and Technology, Coimbatore - 641 407, Tamilnadu, India.

[2]Associate Professor, Department of Civil Engg., Thiagarajar College of Engineering, Madurai - 625 015, Tamilnadu, India

ABSTRACT

Rotating biological contactor (RBC) equipment is frequently used for domestic and mining effluent treatment. This study conducted to treat the textile industry effluent in effective way using filamentous microbes. Textile wastewater contains contaminants such as suspended and colloidal solids also have starch and dextrin. Effective microorganisms which are capable in removing concentrated contaminant were launched for the treatment process which enhances the effeciency of RBC. Indigenous effective microbes were isolated and inoculated for present study. To manage the problems during the operation of RBC, detention time, surface for attached growth, shaft rotation and disc submerged level are to be monitored and maintained to optimum level. Textile wastewater treatment results showed that, at 40% disc submergence level after 88 hours with 15 rpm rotational speed the COD removal efficiency is efficient for this optimum condition. Idegenous organism identified is Pseudomonas sp and used for treatment using RBC. 95.5% of COD was removed effectively using RBC operating at optimum condition.

KEYWORDS: Dextrin, filamentous microbes, *Pseudomonas sp,* Rotating biological contactor, wastewater.

INTRODUCTION

Textile industry is divided into three divisions based on the raw material usage, suh as cotton, woollen, and synthetic fibres. The cotton textile industry is one of the aged industries in nation with more than 1000 industries primarily centred in Mumbai, Surat, Ahmedabad, Coimbatore, and Kanpur (Babu et al., 2000). Depending upon the processing procedure the water usage and wastewater production varies in textile industries (Chunhui Zhang et al.,2015). Textile mill can be defined into two groups based on wastewater production, such as Dry processing mill and Woven fabric finishing mills (ISPCH, 1995). Most of the cotton textile mill have high concentration of BOD,COD, color and pH (ISPCH, 1995). Wastewater from dyeing and printing division loaded with color, reactive dyes and chemicals, have soaring BOD and COD concentration. The lethal property of dyes and extra macrobiotic composites, as well as acidic and alkaline impurities, commencing from manufacturing organization on the wide-ranging community are extensively established. Currently, the dyes are chiefly aromatic and heterocyclic complexes, with color-display cluster and polar clusters. The formation is new, complex and steady, ensuing in better complexity to humiliate the printing and dyeing wastewater (Shaolan Ding et al.,2010).

Effluent from textile industry also includes chromium, which has a mounting end product, and superior potential for inflowing into the food sequence. Owing to practice of dyes and chemicals, effluents are shady in color, which enlarges the turbidity of water body. This in twirl obstruct the photosynthesis development, causing amendment in the habitat (Joseph Egli,2007). Natural handling is protected and cost effectual technique for manage of contamination. Colored waste water from textile industry is mentioned as the majority contaminates in nearly all industrialized division. More than 10,000 dissimilar textile dyes and stains are in frequent utilize and the whole humanity, organic colorant fabrication are additional than 100,000 tons/year (Easton, 1995; McMullan et al., 2001). Enormous quantity of dyes in textile segments are incessantly being fatigued in wastewater streams due to their unfortunate absorbability to the fiber (Wagner, 1993; McMullan et al., 2001). Dyes have ecological insinuation, since up to 50% of the primary dye accumulation (up to or beyond 800 mg L^{-1}) used in the dyeing practice remnants in the depleted dye bath in its hydrolyzed form which no longer has an similarity for the fabric and thus cannot be reused in the dyeing progression (Laszlo, 1995). A rotating biological contactor (RBC) is an aerobic and anaerobic rigid layer biological treatment. This treatment is

extensively used as secondary treatment of manufacturing and household wastewater (Chunhui Zhang et al., 2015). In this scheme the disc fraction is partially flooded in wastewater and practically exposed in ambiance. The revolution of the method leads to constant augmentation of microbes and the creation of biological slime sheet on the exterior of the discs notorious as biofilm is developed on the revolving disc.

The invariable revolution of the disc origins blend of the liquid. throughout the submergence unrefined material is detached even as during emersion exposure to air of the culture is accomplished. RBC was established, on the origin that the Dissolved Oxygen (DO) in the reactor did not have implication on treatment competence since sufficient quantity of oxygen could be supplied through the air disclosure cycle necessary for metabolism of microbes (Kubsad et al, 2004). Organic loading rate is extremely significant and chief aspect in manipulating RBC. The competence of RBC depends essentially on organic loading rate relatively than on the organic attentiveness or flow rate. Substrate utilization rate (organic removal rate) augmented with rising the Organic Loading Rate (OLR) to certain maximum which after it, mounting the load has no or incredibly partial collision on the deduction rate (Ahmady, 2005). This research present work focus on showing reduction in color, COD, Hardness, Chlorides, TDS, TSS and sulphate form textile effluent using RBC. the efficiency of RBC in treating textile effluent specifically in COD reduction was identified. This study also focuses on odor reduction and minimizing the sludge production.

MATERIAL AND METHOD

Sample collection

The textile effluent samples were collected from VT Mills Ltd, Virudhunagar and was stored at 4ºC for further studies.

Microbial analysis of the effluent

1ml of the raw effluent was added to 99mL of sterile distilled water (10^{-1}). A series of tubes containing 4.5 mL of sterile distilled water was taken. 0.5mL of the sample was transferred from 10^{-1} dilution to the distilled water in the tube and the sample was serially diluted using sterile pipettes from 10^{-1} to 10^{-6} dilution. Nutrient agar medium and Potato dextrose agar medium was prepared and sterilized. The serially diluted samples (10^{-5} and 10^{-6}) were plated on agar plates and the plates were incubated at 37ºC for 24 hours.

Isolation of Organisms

The incubated plates were observed for the predominant types of organisms. Different organisms with different colony morphology were isolated from the effluent sample by streaking on Nutrient agar plates. The organisms were purified by repeated streaking on Nutrient agar plates.

Treatment in shake flask condition

The organisms isolated from the effluent and were identified biochemically and then the purified isolates were used for the treatment. For treatment shake flash method was carried out in lab scale. To 100mL effluent various bacteria and fungi such as *Sacchromyces cerevisiae, Pseudomonas glumae, Bacillus, Aspergillus niger, Aspergillus flavus, Pencillium, Trichoderma reesei* and combinations were inoculated. Various different trials were tried for identifying the effective microorganism for treatment process. Trials were performed in shaking condition for validating the best condition that suits for effective degradation rate.

Design criteria of RBC

The design of the entire unit is determined by performing various experimental trials. Based on the trial efficiency, the modification in the design is carried out. The factors which is considered in the design are depth of submergence of the disc, rotational speed, Organic load of the effluent, Volume of the effluent and detention time. In this study the reactor volumetaken as 40 L, thickness of the each disc is taken as 0.5 cm and the spacing between the disc is 1.5 cm shown in figure 1.

Figure 1: Lab-scale Rotating Biological Contactor

RESULTS AND DISCUSSION

Isolation of Organisms

The predominant colonies with different cultural characteristics were selected randomly from the isolation plates. The organisms were purified by repeated streaking on Nutrient agar plates. Gram staining technique were performed and viewed under microscope. The observed bacteria are gram negative rods.

Treatment in shake flask condition

In shake flask treatment trials various microorganism were tested for their degradation efficiency, individual organism showed better efficiency than combinations. Among the various bacteria tested *Bacillus* and *Sacchromyces cerevisiae* showed better efficiency and *Pseudomonas sp* was comparatively less effective. Generally fungi were effective on biodegradation and all fungi which were used in the treatment trials showed better reduction efficiency. Among them *Pencillium* and *Aspergillus niger* was found to be very effective in the reduction of COD and *Trichoderma sp* was better. The result from treatment of effluent using microbial consortia clearly shows that, *Bacillus, Sacchromyces cerevisiae, Pseudomonas sp, Pencillium* and *Aspergillus niger* and their combinations were more effective in the reduction of COD of the effluent. The compensation of utilizing varied cultures (microbial consortium) as contrasting to pure cultures in bioremediation have been established (Agarry *et al*., 2008).

VALIDATION OF TREATMENT EFFICIENCY

The degradation efficiency of each of the isolates was studied. Both the individual isolates and the combination of isolates were used for the treatment and the results are shown in table 1.

Table 1: % Reduction in shake flask treatment trials

Organism used	Parameter	Raw effluent value(mg/L)	After treatment	% Reduction
Aspergillus niger	hardness	1360	1020	25
	chloride	200	170	15
	COD	1920	998	48
Aspergillus flavus	hardness	1360	394	71
	chloride	200	247	-
	COD	1920	1267	34
Pencillium	hardness	1360	408	70
	chloride	200	272	-
	COD	1920	1248	35
Pseudomonas sp	hardness	1360	584	57.14
	chloride	200	162	19
	COD	1920	1200	37.5
Trichoderma	hardness	1360	1264	7.1
	chloride	200	166	17
	COD	1920	547.2	71.5
Bacillus	hardness	1360	881.6	35.71
	chloride	200	305	-
	COD	1920	460	76.27
Sacchromyces cerevisiae	hardness	1360	408	70
	chloride	200	160	20
	COD	1920	384	80.3

From the treatment trials in shake flask method, it was found that *Bacillus* and *Sacchromyces cerevisiae* was effective in COD reduction. Five effective organisms were identified form the shake flask trials and were used in RBC trials. Pourbabaee *et al*. (2006) and Andleeb *et al*. (2010) experiential comparable diminution in COD and BOD in their investigation of aerobic biotreatment of Terasil black in textile effluent by a recently isolated *Bacillus* sp. and sulfur black by *Aspergillus terreus* SA 3, correspondingly. Elevated COD decline in the treatment of textile effluent by *Pseudomonas* species has also been documented (Olukanni *et al*., 2006).

TREATMENT TRIALS IN RBC

Treatment trials in RBC were carried out in batch process. The organism was inoculated in 40 L of effluent and the experiment was done for various organisms. RBC trials were carried out for selected organisms from the shake flask trials. The microbes used were *Bacillus sp, Aspergillus niger, Trichoderma sp, Pencillium* and *Sacchromyces cerevisiae.* Figure 2 shows the percentage reduction of various parameters with different microbes incubation. Numerous microbes may appear to have a

impending for dye decolourization and deprivation. Nevertheless, it has been accounted that extremely a small number of strains can endure the surroundings of dyeing effluents (Maier, 2004).

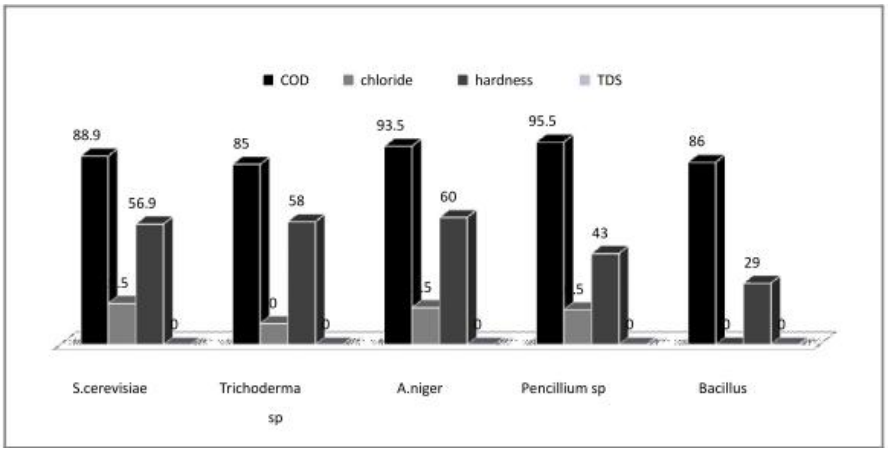

Figure 2: Comparison Chart for % Reduction of parameters for various microbes

The competent utilize of dissimilar *Aspergillus* species (*A.niger, A. foetidus, A. fumigates* and *A. terreus*) for decolourization of diverse types of dye has been ientified (Sumathi and Manju, 2000; Ali *et al*., 2007;Jin *et al*., 2007; Andleeb *et al*., 2010). The consequences of HPLC analyses (not shown) in use for the raw and treated samples established the part of degradation system in the dye color exclusion fact. It has been investicated that decolourization of dye effluents is as a outcome of dye degradation system (Glenn and Gold, 1983; Wesenberg *et al*., 2002; Ramya *et al*., 2007).

CONCLUSION

Species that were likely present in the effluent were *Aspergillus niger*, *Pseudomonas* and *Trichoderma reesei*, *Pencillum sp, Sacchromyces cerevisiae,* and *Bacillus sp*. Through a series of experiments, it was shown that some of these isolates were capable of effective pollution load reduction from the effluent, in the laboratory setting. However, COD reduction characteristic was not consistent and seemed to vary greatly from experiment to experiment while using various different microorganisms. Based on the identification, the species possibly involved in effective COD reduction were *Pencillium sp*., *Bacillus sp., Aspergillus niger., Sacchromyces cerevisiae* and *Trichoderma reesei.*This research focused on an effective secondary treatment system to treat the peaks of high COD that are well within the acceptable levels. There was only trace amount of sludge production from this process also very effective odor reduction. Fungi are found to be effective in COD reduction than bacteria. New RBC reactors comprises arrangement for energy production for unswerving current production. Concerns such as scale up stay behind demanding for the prospect relevance of RBC equipment and focus such as phosphorus exclusion and denitrification still need advance research.

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