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RESEARCH ARTICLE

Decolourisation of Dyeing Effluent by the Fungal Biomass in a Fluidized Bed Reactor

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ABSTRACT

Decolourisation of dyeing effluent attracts more researchers for the past two decades. The reason is that yet now no appropriate solution for the decolourisation was found for the industrial application. Even though the past one decade the physicochemical treatment methods like Chlorination, Oxidation, Ozonation, Coagulation and Membrane adsorption methods are giving the maximum decolourisation of 90%-100%. The by-products resulted through these process are very harmful to the environment by its sludge and the toxicity present in it, above all it is very costly method and not economical hence many researchers are undergoing their research towards the biological treatment process for its eco-friendly and the cost effectiveness process. This study investigates the immobilized Whit Rot Fungus (WRF) biomass consortium in an aerobic fluidized bed reactor for the decolourisation and biodegradation of synthetic dye effluent. Fujinos spiral media was used as a carrier material for the immobilized fungal biomass, which offers a very good surface area of 500 $m^2/m^3$and voids space of 87%. Four different pure culture Fungal Species were obtained from MTCC, Chandigarh, India. The operational parameters taken were the HRT and OLR for different COD. The evaluation is done on the basis of % COD removal and the % Colour removal. It had been observed through this study that 95.2% colour removal and 89.4% COD removal were achieved.

Key words: Colour, Decolourisation, Dye Effluent, Fluidized Bed Reactor, COD, HRT, OLR and WRF.

1. INTRODUCTION

Synthetic dyes are mostly used in the textile dyeing industries. Over 7×10^5 tonnes of about 10,000 different types of dyes and pigments are produced annually worldwide [1]. Large quantities of these dyes remain in the dye bath after the dyeing process and their release into wastewaters can range from 2% of the original concentration for basic dyes to as high as 50% for reactive dyes [2,3]. The presence of dyes in the receiving streams, affects the photosynthetic activity and the aesthetic appearance of it [4]. It is very difficult to decolourise the dyeing effluent due to the presence of the dyes which are complex in their chemical structure. Many physicochemical treatment methods, including coagulation, flocculation, precipitation, oxidation, irradiation, incineration, and membrane adsorption, have been used for the treatment of dye-contaminated effluents [5-8]. Due to high cost in treatment, toxic bye products and the sludge generations make those physicochemical treatments inefficient in treating the textile dyeing effluent hence researchers are currently seeking to develop more effective treatment strategies for the treatment of dye wastewater.

Microbial decolourisation is an environment friendly and cost-competitive alternative to other treatment processes, i.e., chemical decomposition [9]. White rot fungi have been evaluated for their potential to treat coloured wastewaters [10,11]. In the last two decades, white-rot fungi (WRF) have received much attention because of their ability to degrade xenobiotic compounds. Owing to extracellular non-specific free-radical-based ligninolytic system of WRF, they can completely eliminate a variety of xenobiotics, including synthetic dyes, giving rise to non-toxic compounds [12]. Immobilization of living microorganisms has been described by several investigators to be useful in biological wastewater treatment [13]. It is widely known that immobilized cells offer a lot of advantages: reusability of the

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same biocatalyst, control of reactions, and the non contamination of products [14].This study aims for the evaluation of the decolourisation of dyeing effluent by the white rot fungal biomass consortium in an Aerobic fluidized Bed reactor. Parameters analysed in this study for the evaluation were the COD and the Colour.

2. MATERIALS AND METHODS

2.1. Experimental Set Up

The experimental setup consists of a fixed film aerobic Fluidized bed reactor having an effective volume of 0.02 m^3. The specification of the experimental set up is given in (**Table 1**) and schematic is shown in (**Fig 1**).

Table 1: Physical features and process parameters

S. No	Specifications	Details
1	Volume of Reactor	0.03 m^3
2	Effective volume of Reactor	0.02 m^3
3	Diameter of Reactor	0.15m
4	Height Of Reactor	1.17m
5	Height of packed bed before fluidization	0.25m
6	Flow Distributer	2nos
7	Pump used for the influent feed	Peristaltic Pump PP-30 model
8	Media Packed	Fujino Spirals, (PVC material)
9	Specific area of filling media	500m^2/m^3
10	Void ratio of the media	87%
11	Expansion of bed Restricted by the top flow distributor	50% i.e. ,0.5m from the bottom Flow distributor
12	Air blower	270 L/min (as 16.2m^3/sec)
13	Air Supply	0.025m/s
14	Sample Port	2no.

Fig 1: Fluidized bed reactor

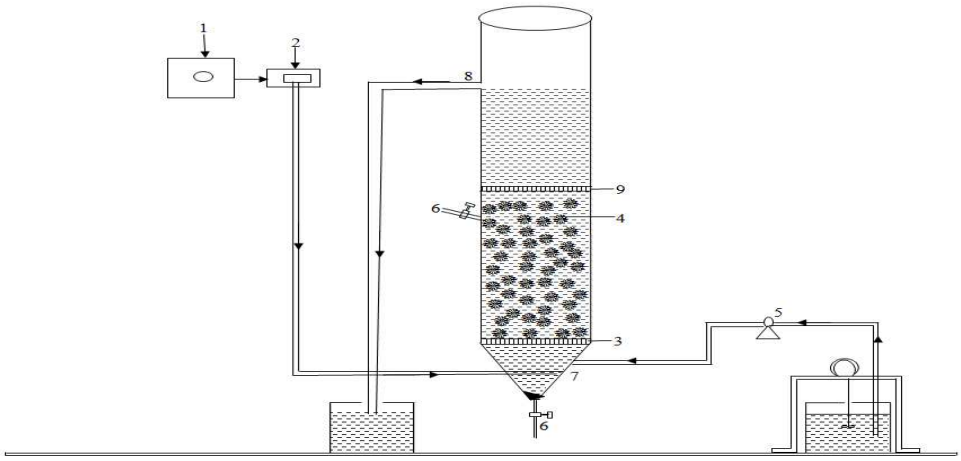

Figure: 1 Experimental Model of Aerobic Fluidized Bed Reactor

1Air Blower 2. Flow meter 3. Bottom Flow Distributor 4. Spiral Media 5. Miclin's pump 6. Sample port 7. Inlet 8. Outlet 9. Top Flow Distributor

2.2 Microorganism and Culture medium

Pure culture of four different fungal species of *Pleurotus ostreatus* MTCC No: 1804, *Pleurotus sajor-caju* MTCC No: 141, *Trametus versicolour* MTCC No: 138 and *Trametus Hirsute* MTCC No: 136 obtained from MTCC, Chandigarh, India. The cultures were grown separately in the PDA (Potato Dextrose Agar) slants and subculture for every 30 days. The reactor was fed with 5% inoculums of the above fungal species to the effective volume of the reactor.

2.3. Preparation of Synthetic wastewater

The synthetic wastewater was simulated towards the characteristics of a real textile dying effluent. Three different reactive dyes namely Drimarene Red X 6BN, Drimarene Blue X 3LR CDG and Drimarene Yellow X4RN were purchased from Colour Chemicals Pvt. Ltd. (Erode, India). Dyes were mixed in equal proportions with various chemicals like sodium chloride, sodium carbonate, soap oil, wetting agent, acids, alkalis and hydrogen peroxide.

2.3. Start up Process

Initially, 5% inoculums was fed into the reactor and operated continuously with the sufficient nutrient of COD: N: P as (100:5:1) ratio. Synthetic wastewater was fed into the reactor. Once the steady state condition was achieved within 5 days, the experiment was run for the evaluation. HRT and OLR were taken as the operational parameters for the varying COD concentrations.

2.4 Experimental Run

The experiment was run for five different COD concentrations of 750 mg/L, 1000 mg/L, 1250

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mg/L, 1500 mg/L and 2000 mg/L. The operational parameters HRT were varied as 26 hrs, 20 hrs, 13 hrs, and 10 hrs for each COD concentration subsequently. With respect to the COD concentrations and the influent flow rate the OLR is varied from 0.648 Kg.COD/ m^3.day to 4.816 Kg.COD/ m^3.day. Samples were collected regularly according to the HRT varying period from inlet and outlet for the analysis. The evaluation is based on the % COD removal and % colour removal. The experiment was run under the room temperature of 30°C.

2.5 Analytical Methods

Samples were collected from the inlet and outlet of the reactor at 26 hrs, 20 hrs, 13 hrs and 10 hrs for each COD concentrations of 750 mg/L, 1000 mg/L, 1250 mg/L, 1500 mg/L and 2000 mg/L for the analysis. COD was measured by the closed reflux method and colour was determined by measuring the absorbance (OD) @ 600 nm using UV-VIS spectrophotometer by standard methods [15]. The % Colour removal is obtained from the following equation (1),

$$\% \text{ Colour Removal} = \frac{A - B}{A} \times 100 \text{ -------- (1)}$$

Where, A = Inlet OD; B = Outlet OD

3. RESULTS AND DISCUSSION

From the observed results the graphs were plotted. (**Fig 2a & Fig 2b**) shows the biodegradations and colour removal with respect to the HRT and (**Fig 3a & Fig 3b**).show the biodegradations and colour removal with respect to the OLR by the fungal consortium. From the above results, it was found that the maximum colour removal by the fungal consortium was very high at about 95.2% and the maximum biodegradation was achieved as 89.4%. The efficiency in removal of Colour and the COD were continued up to a higher COD concentration of 2000mg/L of about 89.3% and 88.2% respectively at 26hrs HRT.

Fig 2a: HRT vs %COD removal

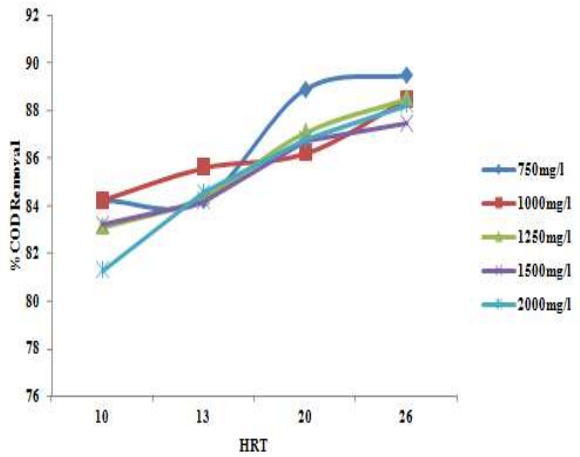


Fig 2b: HRT vs %Colour removal

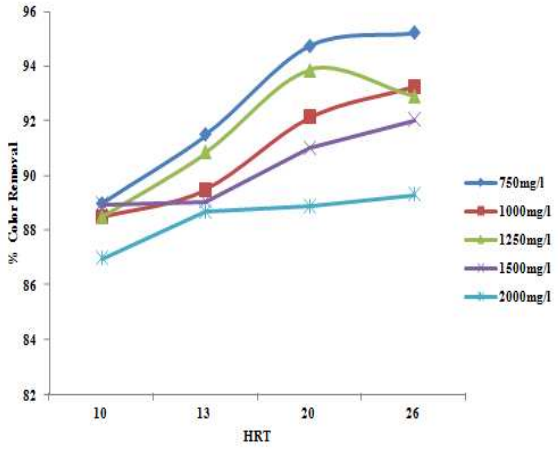


Fig 3a: OLR vs %COD removal

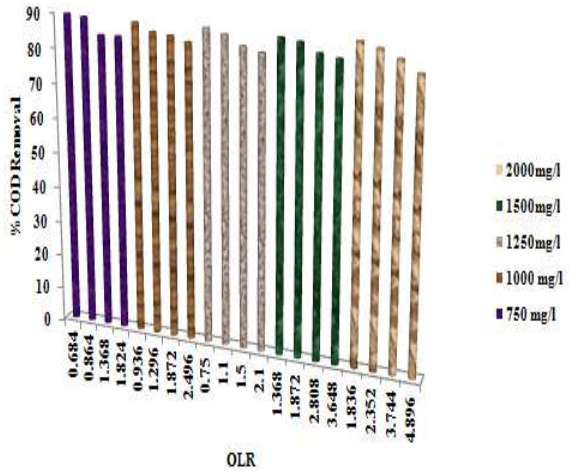
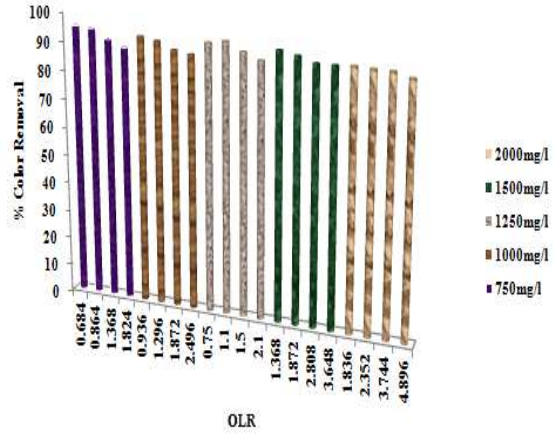


Fig 3b: OLR vs %Colour removal



CONCLUSION

The Aerobic Fluidized bed Reactor acclimatized with the specific colour removing fungal biomass consortium can be employed for treating the textile dyeing wastewater in achieving higher efficiency of colour removal and biodegradation. This Aerobic Fluidized bed Reactor acclimatized with the fungal biomass consortium of *Pleurotus ostreatus* MTCC No: 1804, *Pleurotus sajor-caju* MTCC No: 141, *Trametus versicolour* MTCC No: 138 and *Trametus hirsute* MTCC No: 136 was found to be more efficient in treating the textile

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dyeing effluent by achieving 95.2% of colour removal and 89.4% COD removal.

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