Evaluation of Fluidized Bed Reactor in treating Dyeing effluent

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Abstract

Textile dyeing industries one of the complicated industries which use many chemicals like dyes, starch, acids, alkalis, surfactants and refractory organics for their process. As it is a wet process it requires more amount of water ranging 65-104 L/Kg of product and it discharges 52-95 L/Kg of product as wastewater. The COD, BOD, TDS, Colour and SS are the major pollutants from these industries to the receiving streams. Biological treatment is employed mostly when compared to the physicochemical treatment. More sludge, toxic bye products and cost for the treatment are the reasons for not employing the physiochemical treatment processes. Biological treatments like aerobic and anaerobic processes overcome the disadvantages of physicochemical treatment. The present study evaluates the Aerobic Fluidized bed Reactor for the treatment of Dyeing effluent. It has been observed through this study that 89% colour removal and 83.3% COD removal were achieved.

Key words: COD, Colour, HRT, OLR, Decolourisation, Biodegradation, Aerobic.

1. Introduction

Over 7×10^5 tonnes of about 10,000 different types of dyes and pigments are produced annually worldwide (Gupta et al. 2011). 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 (Boer et al. 2004; Khalid et al.2008). Important pollutants in textile effluents are mainly recalcitrant organics, colours, toxicants and inhibitory compounds, surfactants, chlorinated compounds (AOX), pH and salts (Sen and Demirer, 2003). From the environmental point of view, the textile industry is also one of the most water and chemical-intensive industries worldwide (Arslan Alaton et al., 2006). Traditional textile dyeing processes generate a large amount of coloured effluents, because about 100 Lres of water are required to process 1 Kg of dyed fabrics (Abadulla et al. 2000). Moreover, up to 15% of applied dyestuffs are lost to the effluents due to dyeing process inefficiencies (Jarosz-Wilkolazka et al. 2002). The presence of dyes in the receiving streams, affects the photosynthetic activity and the aesthetic appearance of it (Kolekar et al. 2008; Sudarjanto et al. 2006). It makes the water unfit for the use of domestic and irrigation purposes. Numerous physicochemical treatment methods, including coagulation, flocculation, precipitation, oxidation, irradiation, incineration, and membrane adsorption, have been used for the treatment of dye-contaminated effluents (Berberidouet al. 2009; Harrelkas et a. 2009; Singh and Arora 2011;Zhao et al. 2009). Due to major disadvantages like high cost, sludge generation and the handling of the toxic waste generated the physicochemical treatment methods becomes ineffective. The general bio treatment systems (e.g., activated sludge) are also relatively ineffective, due to low biodegradabiLy of the dyes (Parshetti et al. 2007). Due to these limitations, 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 (Fan et al. 2009). Immobilization of living microorganisms has been described by several investigators to be useful in biological wastewater treatment (Zeroual.Y, 2001). It is widely known that immobilized cells offer a lot of advantages: reusabiLy of the same biocatalyst, control of reactions, and the non contamination of products (Engasser, J. M. 1988).This study aims for the evaluation of an Aerobic Fluidized bed reactor carried over at laboratory scale. Parameters analysed in the 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 $0.02m^3$. The specification of the experimental set up is given in Table.1. and schematic is shown in Fig.1.

2.2. Preparation of Synthetic Waste Water

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

The experiment was initiated with the feeding of domestic wastewater and real textile dyeing wastewater for the acclimatization process. The nutrients supplied during the start up process were in the ratio of COD: N: P as (100:5:1). After attaining the steady state condition within 14 days, the synthetic wastewater was fed into the reactor.

2.4 Experimental Run

The operational parameters were the HRT and OLR. The experiment was run for five different COD concentrations of 750mg/L, 1000mg/L, 1250mg/L, 1500mg/L and 2000mg/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^3day to 4.816 Kg.COD/ m^3day. 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.

2.5 Analytical Methods

Samples were collected from the inlet and outlet of the reactor at 26hrs, 20hrs, 13 hrs and 10 hrs for each COD concentrations of 750mg/L, 1000 mg/L, 1250 mg/.L, 1500mg/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) @ 600nm using UV-VIS spectrophotometer by standard methods (APHA 2005). The %Colour removal is obtained from the equation (1).

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

Where, A = Inlet OD
B = Outlet OD

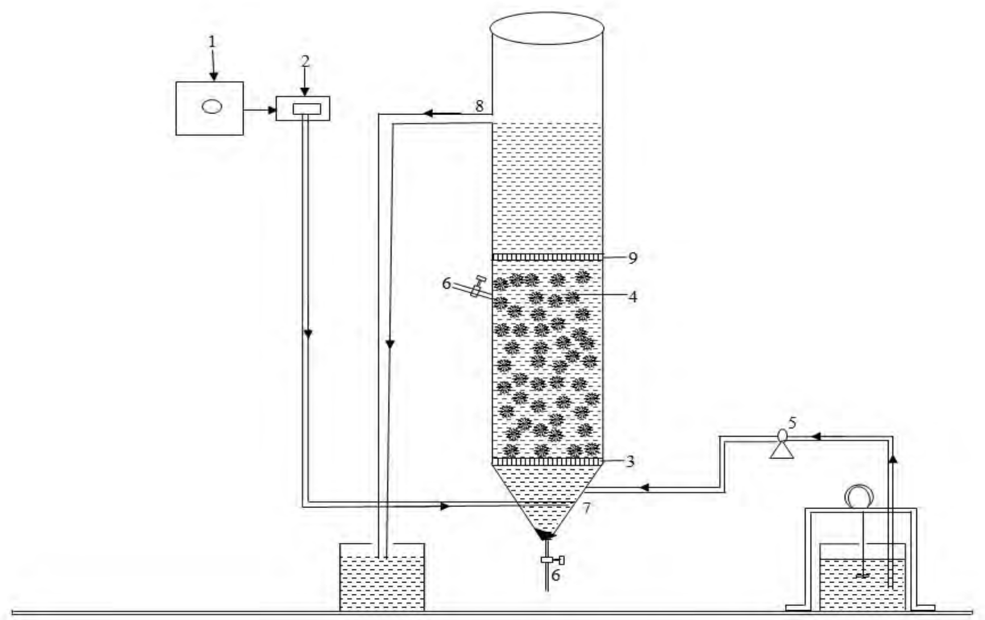

Figure: 1 Experimental Model of Aerobic Fluidized Bed Reactor

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

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	2 Nos.
7.	Pump used for the influent feed	Peristaltic Pump PP-30 model (Miclin's Product).
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% ie. 0.5m From the bottom Flow distributor
12.	Air blower	270 L/min
13.	Air Supply	0.025m/s
14.	Sample Port	2 Nos.

3. Results and Discussion

Fig.2.a. shows the overall performance of the Aerobic Fluidized Bed Reactor with the maximum COD removal of 83.3%, 79.1%, 74.1%, 72.9% and 71.4% for the COD concentrations of 750mg/L, 1000mg/L, 1250mg/L, 1500mg/L and 2000 mg/L at 26 hrs HRT respectively.

Fig 2.b shows the overall performance of the reactor with the maximum colour removal of 89% , 88%, 86%, 85.7% and 83% for the COD concentrations of 750mg/L, 1000mg/L, 1250mg/L, 1500mg/L and 2000 mg/L at 26 hrs HRT respectively.

The above results show that the maximum %COD removal and maximum %Colour removal were achieved at 26 hrs HRT.

Fig.3.a and Fig.3.b shows that %COD removal and %Colour removal shows the gradual decrease towards increasing OLR ranging from 0.648 to 4.896 Kg COD/m3.day. The maximum %COD removal is achieved at lower OLR value and the minimum %COD removal is achieved at higher OLR value.

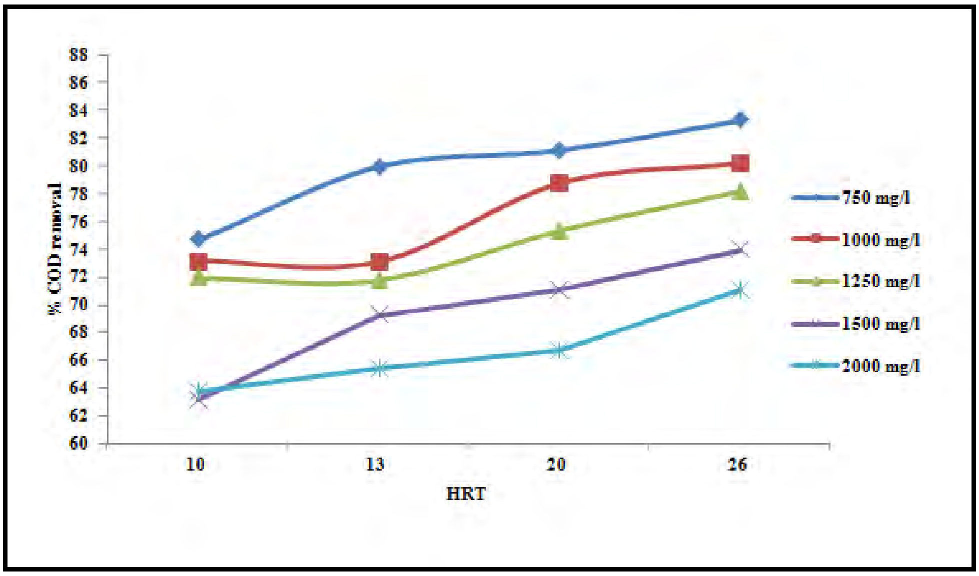

Fig. 2a. HRT Vs %COD Removal

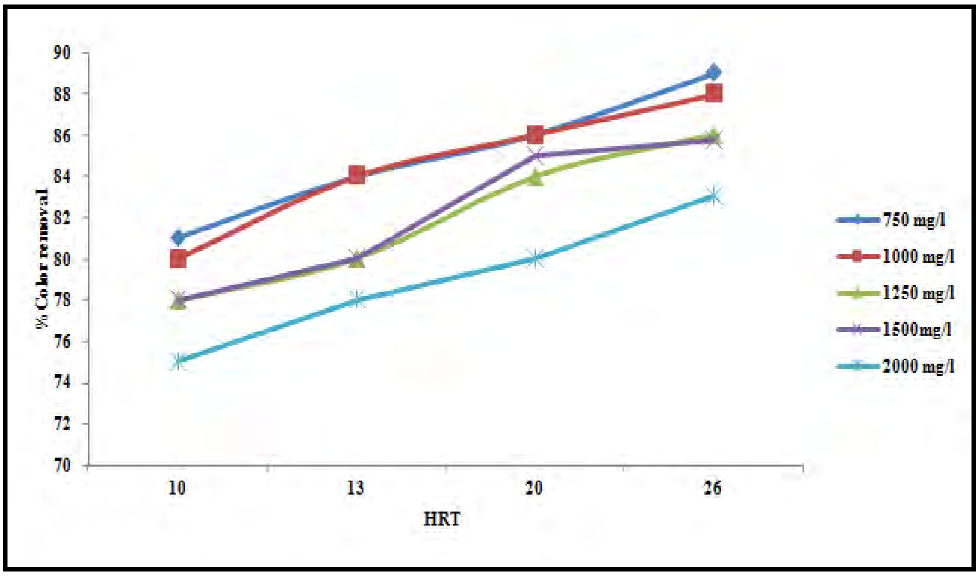

Fig.2b. HRT Vs %Colour removal

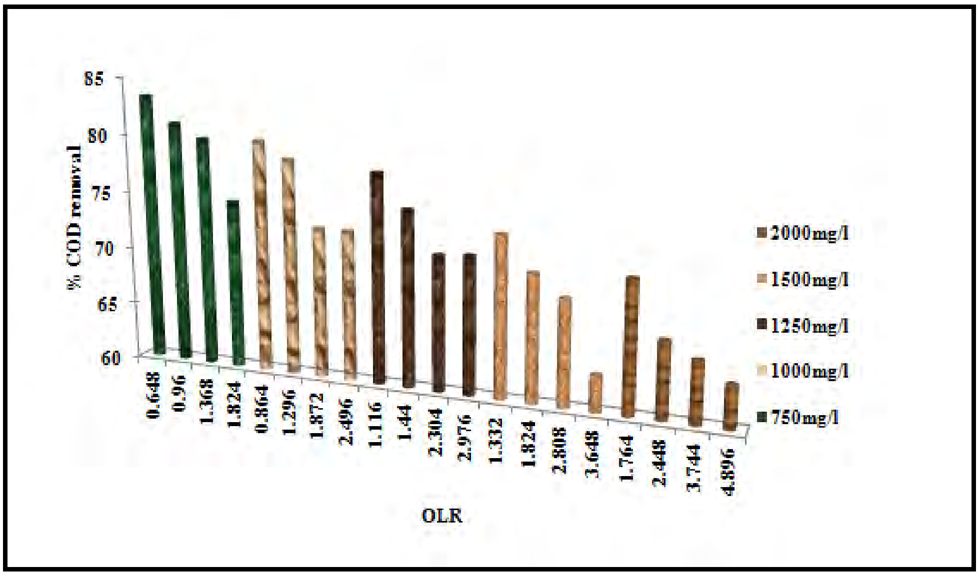

Fig.3a OLR Vs %COD Removal

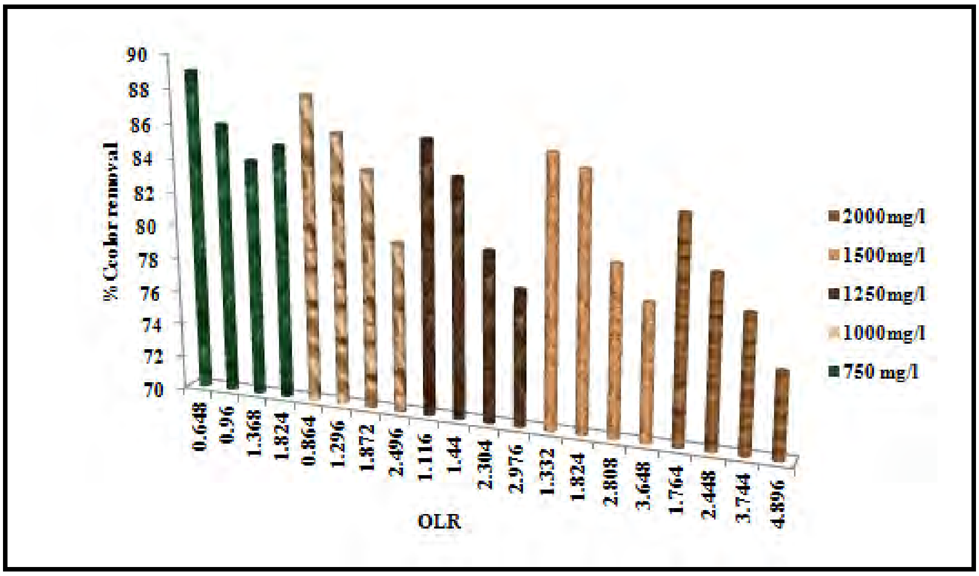

Fig.3b. OLR Vs %Colour removal

Conclusion

The Aerobic Fluidized bed reactor was found to be more effective in treating the textile dyeing wastewater for a maximum COD removal of 83.3% for a COD concentration of 750mg/L and minimum %COD removal of 71.4% for a COD concentration of 2000mg/L. The Colour removal shows that the maximum %Colour removal of 89% and minimum %Colour removal of 83% for a COD concentrations of 750mg/L and 2000mg/L respectively.

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