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Anaerobic Treatment of Dye Wastewater using Upflow Anaerobic Sludge Blanket Reactor

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Abstract: ***The textile dye wastewater removal in the environment is a greater problem by its harmful reasons. Dyes which obstruct the penetration of light leads to damage the quality and produce the poisonous effect in the aquatic ecosystem. Several studies were proved that the physicochemical methods were employed for treating the textile dye wastewater. Hence the biological processes are employed for treating the textile dye wastewater due to its cost effectiveness and less toxic effects. Bio filter can be an effective solution for producing high quality water and saving water for recirculation. In this article fujino spirals were mainly focusing as media in the reactor and operated at a hydraulic retention time (HRT) of 24h. The purpose of this study to analysis the overall performance of the UASBR which is achieved the maximum COD removal at 24hrs HRT respectively. From this study results, percentage of COD removal is directly related to the HRT. Hence the UASBR is suitable for treating real textile dye wastewater even upto 1000mg/l efficiency.***

Keywords: Color, Decolourisation, Fujino spiral media, HRT, UASBR.

I. INTRODUCTION

The wastewater management has become critical due to the increase of worldwide population. Hence water quality should be preserved for upcoming generations. Technology for Wastewater treatment has been improving nowadays and it is possible to treat wastewater to a high immensely level efficiently and in a cost constructive way. The real cotton textile dyeing wastewater includes various acute color dyes. The wastewater dyeing processes is not just an aesthetically unpleasant. Color interfere aquatic ecosystem of receiving water bodies. Color carrying away of outflow from the several physico-chemical treatments such as advanced oxidation, biological process and the combination of processes is pertain to treat the regulatory discharge extremity [1]. Anaerobic treatment for real textile waste is a challenging procedure. Anaerobic digestion of real cotton textile wastewater is an auspicious process since it is economical and safe.

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Dyes usually degrade under suitable condition resulting in color removal which is due to the cleavage of the bond. Later the remaining substances can be processed by [2, 3].

In anaerobic condition Color removal can be achieved by dyestuff biodegradation using azo reductase activity [4] and nonenzymatic azo reduction of dyestuff [5, 6].The existence of color in industrial wastewater or in domestic which is considered to be unacceptable. Apart from the circumstance of several coloring agents such as dyes, inorganic pigments, tannins and lignin which are the chief contributor for environmental substance with predominant dyes waste. Dyes are extensively utilized in several manufacturing units such as textile dyeing, food, cosmetics, paper printing, leather and plastics. From all above sources textiles is the major waste producing units when compared to all other units. [7]

UASB reactor need time to achieve an equilibrium condition. This based on wastewater concentration that is nothing but the organic load. The main purpose is to achieve the start-up of high rate anaerobic reactors and to perform in adequate homogenous anaerobic organisms. In current year, immobilization of microbial cells has expanded in the wastewater treatment. This system significantly upgrades the efficiency of the bioreactor. Immobilized cells system has likely to reduce the poisonous chemicals compound faster than conventional wastewater treatment systems [8, 9]. Bio filter is a biological filter with attached biomass on the filter-media. The microorganism attaches on the surface of media and grows up to biofilm will degrade the organic compounds present in the water. Bio filter can be an effective solution for producing high quality water and saving water for recirculation UASB reactor need time to achieve an equilibrium condition which is based on wastewater concentration. Fujino spirals were revolutionary parrying media of synthetic material comparing of several winding of‘s’. [10]. Dye wastewater treatment can be done by several Anaerobic treatment methods [11]. UASBR is observed as resistant reactor among all anaerobic reactors to eliminate the poisonous substance which is present in the waste water

II. MATERIAL AND METHODS

The real textile dye wastewater was collected from Lakshmi textile process at Tirupur, Tamilnadu, India. The Fujino spirals media was placed and the reactor was run at a hydraulic retention time (HRT) of 24h. To attain the percentage of chemical oxygen demand (COD) reached at a constant level the reactor was allowed to run for 35 days.

This time duration was noted and this study was observed as study period. In the initial stage the least microbial population was found and later bacterial growth was gradually enhanced and enriched by Fujino Spirals media.

A. Experimental Set Up

The experimental setup has a fixed film upflow anaerobic sludge blanket reactor with an effective volume of 0.02m^3. The experimental setup of the reactor which is used in this experiment was designed and fabricated in the Table.1 and Fig-1.

Table 1: Physical features of UASBR

1.	Volume of reactor	0.03m^3
2.	Effective volume of reactor	0.02m^3
3.	Diameter of reactor	0.15 m
4.	Height of reactor	1.42m
5.	Effective height of reactor	1.17m
6.	Pump used for the influent feed	Peristaltic pump PP-15model (Miclin's product)
7.	Media	Fujinos Spirals, (PVC material), 16mm
8.	Specific area of media	500 m^2/m^3
9.	Void ratio of the media	87%
10.	Material of the reactor	Plexi glass

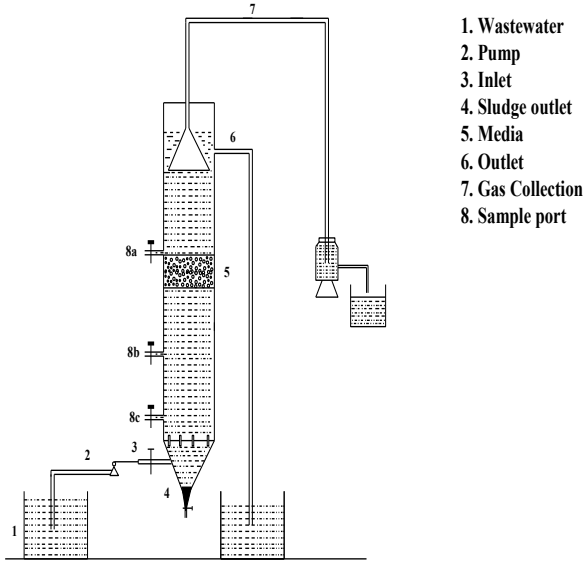


Fig. 1. Schematic Diagram of UASBR

B. Initial Start-up Process

After attaining the steady state condition within 35days, the experiment was initiated with the feeding of domestic wastewater for the acclimatization process, textile dye effluent was fed into the reactor combined with domestic wastewater with the increasing ratios of municipal wastewater and real textile dye wastewater for reducing the shock load for further acclimatization for the real time run.

C. Experimental Run

The COD of the real textile dye wastewater was determined by standard method whose value was 890mg/L which is exceeding the permissible limit of 250mg/L of BIS standards of IS-10500. The operational parameters were the HRT. The operational parameters HRT was varied as 24hrs, 20hrs, 16hrs and 8hrs for the inlet COD concentration subsequently. By keeping the COD were constant the samples were collected regularly by changing the HRT values from inlet and outlet of the reactor for the analytic evaluation. The evaluation is depends on the HRT Vs % COD removal.

D. Analytical method

For each COD concentration of 1000mg/L, 1250mg/L, 1500mg/L and 2000mg/L from the inlet and outlet of the reactor samples were collected and noted at 24hrs, 20hrs, 16hrs and 8hrs for the analysis. Using closed reflux method COD removal was evaluated.

Percentage of COD removal= (A-B/A) ×100

Whereas, A indicates Inlet COD removal and B indicates Outlet COD.

E. Fujinos spiral media

Various studies and literatures reviewed the advantages of fujino spirals in removal efficiencies when compared to others medium. Hence selected Fujino spirals for the present study. In the present study, locally available PVC based support media is used. The PVC spiral packing media comprises of countless windings (or) S-shaped portions. The specific surface area of the fujino spirals media which is ten times greater than the other conventional media. The packed portion function as the binary purpose of retaining the suspended sludge within the reactor and employ the polishing effect on the waste water through the biofilm development on the packing material. Spirals allowed the maximum high loading rate with maximum efficiency and provided notably to the mass transfer performance [12].

III. RESULTS AND DISCUSSION

A. Effect of HRT Vs COD

The HRT of the reactor is a very important parameter influenced by the influent flow rate. As the flow rate increases the HRT decreases which forms the base for the various biological process and have been experimented. Higher the HRT higher will the removal efficiency but substrate inhibition and the substrate concentration will alter the removal efficiency. The COD removal efficiency for the HRT of 24hrs, 20hrs, 16hrs and 8hrs respectively for the COD concentration of 1000mg/l

Table .2 HRT Vs %COD removal (average influent COD 1000mg/l)

S.No	HRT Hrs	Inlet COD mg/l	Outlet COD mg/l	% COD Removal	Gas collection m^3/kg COD
1.	8	970	738	76	0.18
2.	16	970	776	80	0.19
3.	20	970	796	82	0.20
4.	24	970	825	85	0.22

The higher TDS of the real textile dye wastewater exceeds the permissible Indian effluent standards of 2100mg/l for the disposal of the inland surface source. The high pH which exceeds the permissible limit of Indian effluent disposal standards of 5.5-9.0 by IS-10500. The highly colored characteristic of the real textile dye wastewater affects the transparency and affects the aquatic eco-system. The simulated synthetic textile dye effluent exhibit alkaline characteristics. The influent which has high pH ranging from 8 to 11.5 got reduced after treatment to the range of nearly neutral condition of 6.4 to 7.2 The COD removal efficiency rate during the first five days was low in the range of 5-20%. After 25th days the COD removal efficiency is above 60% and the real textile wastewater was gradually supply to the reactor. Due to the shock loading of real textile wastewater, the COD removal efficiency suddenly decreased to 38% and VFA concentration increased 900mg/L. However the operation parameter HRT was maintained at 24hr for stabilizing the reactor. At 35th days the COD removal efficiency is above 80%. Fig-2 shows the performance of the real textile dye wastewater by using the designed UASB reactor. The result showing the reduction of 89% of COD with HRT of 20hrs. This is satisfactory when considered with any forms of conventional textile dye wastewater treatment methods.

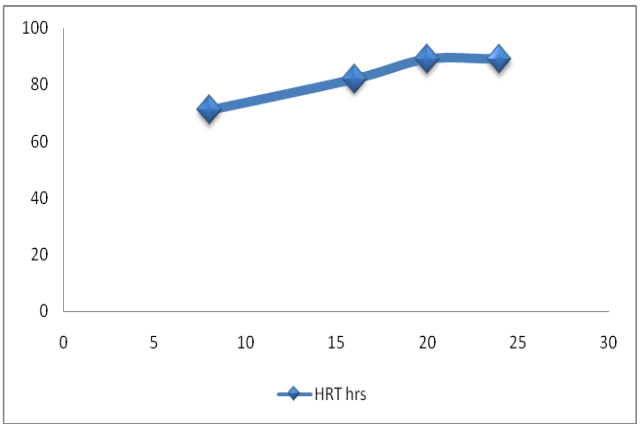
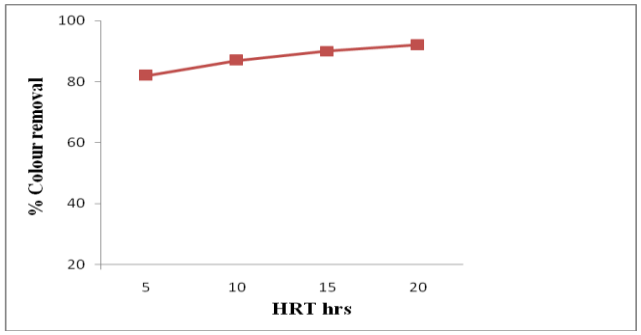


Fig. 2. HRT Vs % COD removal (average influent COD 1000mg/l)

B. Effect of HRT Vs Color

HRT and color were the functioning variables and the procedure was mainly run for COD concentration. The operational parameters HRT were varied as 24hrs, 20hrs, 16hrs and 8hrs. Color concentration materials were frequently gets together depending to the HRT varying period for the analysis from inlet and outlet of the reactor. The evaluation is based on the % color removal. The color removal efficiency for the HRT of 24hrs, 20hrs, 16hrs and 8hrs respectively for the COD concentration of 1000mg/l. Babu et al,(2016) Investigated that anaerobic digestion of textile dye wastewater using mixed culture obtained from cow dung. The optimum condition was found for the maximum decolourization and COD removal efficiency. Gnanapragasam et al,(2016) stated that decolourize the real textile wastewater can be decolourised by adding co-substrate as starch effluent in hybrid bi-phasic UASB reactor by changing the temperatures as 35, 40, 45 and 50 0C. The entire procedure were operated at the optimum recycle ratio of 70:30



In general the upflow anaerobic sludge blanket reactor functions combined with adsorption and biodegradation the highest COD removal value of 95%, 91%86% and 81% for the COD concentration at 22 hrs HRT of 1000mg/l respectively. The obtained results proved that the percentage of COD reduction is directly proportionate to the HRT. 80% of COD removal is achieved for the optimum 20 hrs HRT for the COD concentration of 1000mg/l. The operational parameters HRT were varied 24hrs, 20hrs, 16hrs, and 8hrs.

IV. CONCLUSION

UASBR was observed to be more successful in treating the real textile dye wastewater with a high COD removal efficiency of 89% to the COD concentration of 890mg/L for 20hrs HRT, which is satisfactory in removing the organic impurities present in the textile dye wastewater comparing to the conventional treatment methods. The experiment work on UASBR model is found to be successful for treating textile dye wastewater with higher of % COD removal and % color removal. The overall performance of the UASBR achieved maximum COD removal of 76% 80% 82% and 85% for the COD concentrations of 1000mg/l at 24hrs HRT respectively. The obtained results proved that the percentage of COD reduction is directly proportionate to the HRT. 80% of COD removal is achieved for the optimum 20 hrs HRT for the COD concentration of 1000mg/l. Hence the UASBR was observed to be more successful in treating the even upto 1000mg/l efficiency. The upflow anaerobic sludge blanket reactor was found to be more effective in decolourisation of real textile dyeing effluent for a COD concentration of 1000mg/l at 24hrs HRT. Several studies were proved for treating high strength industrial wastewater like pharmaceutical, dairy, sago wastewater using UASB reactors. From the above results it was confirmed that an UASB reactor can be found to efficiently removal of wastewater.

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