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Effect of Hydraulic Retention Time to Removal of Cod and Colour Textile Wastewater Treatment

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Abstract

The textile dyeing effluent has characteristics of alkalinity, strong color, moderate BOD/COD and recalcitrant in nature, low pH, acidity and highly organic in nature. At present individual ETPs are setups by both textiles dyeing which are not treating their effluent to meet out the standards. The feasibility of a biological CETP for both units is tried in this study. Feasibility of a bench scale Upflow Anaerobic Sludge Blanket (UASB) Reactor (20lit) at ambient temperature was fabricated and tested for the anaerobic treatment of wastewater generated from textile dyeing wastewater. The reactor was seeded with sludge obtained from anaerobic digester treating starch wastewater.

The reactor startup lasted for about 3 weeks. The neutralized feed of synthetic starch effluent was initially diluted to about 2200mg/l and was fed at organic loading rate (OLR) up to 0.5kg COD/m^3/d. Low upflow velocities upto 0.08m/hr were maintained and no recirculation was employed to initiate the wash out of lighter fraction of seed sludge. The starch effluent feed concentration and OLR were increased in steps as soon as COD conversion was higher than 70%. By the end of the startup period, VFA concentration in effluent was less than 50mg/l while gas production rate of one liter per day was obtained.

After stabilization, the municipal wastewater will be feed into the reactor for about seven days to acclimatize the existing microbes in the sludge blanket to the new substrate. After successful start up, synthetic simulated textile dyeing effluent were 20%, 40%, 60%, 80%and100% fed into the reactor. An overall COD and color removal efficiency of 80% and 72%, respectively were achieved at organic loading rate of 0.75kg COD/m^3.d & HRT of 22hrs. The maximum biogas production was 0.28 m^3/kg COD at 22HRT. The biogas production at 8hr,16hr,20hr and 24hr were 0.15, 0.18,0.25 and 0.28m^3/kg COD respectively .Spiral packed filter medium in the top of the UASB Reactor was very effective as a Gas-Liquid- Solid-Separator (GLSS) and retained the biomass in addition. The average VSS/TSS of sludge in the reactor during steady state operation was 0.74.The treatment alternative being simple and eco friendly will help the industry to readily adopt and with economic returns for the investment incurred.

Keywords: Textile Dyeing, Neutralized, Gas- Liquid- Solid-Separator

1. Introduction

In diminishing water resources and rapid population growth and industrial development, the treatment and reuse of industrial wastewaters and the recovery of potential pollutants used in industrial process become more critical. This is especially true in arid or semi-arid areas where the potable water and irrigation water must be imported at great expense. The treatment and reclamation may be further justified in view of growing concern over the contamination of water resources by the release of more toxic compounds. Today, lot of research work has been carried out to find an eco-friendly, cost effective and easily manageable treatment programmed for treating of various wastes. Among the various

treatment methods biological processes of treatment are preferred over a biotic methods as they bring about complete mineralization of pollutant harmless end products.

The process of biodegradation can be divided into three stages: biodeterioration, biofragmentation, and assimilation. Biodeterioration is sometimes described as a surface-level degradation that modifies the mechanical, physical, and chemical properties of the material. This stage occurs when the material is exposed to biotic factors in the outdoor environment and allows for further degradation by weakening the material's structure. Some biotic factors that influence these initial changes are compression (mechanical), light, temperature, and chemicals in the environment. While biodeterioration typically occurs as the first stage of biodegradation, it can in some cases be parallel to biofragmentation however, defined Biodeterioration as the undesirable action of living organisms on Man's materials, involving such things as breakdown of stone facades of buildings, corrosion of metals by microorganisms, or merely the esthetic changes induced on man-made structures by the growth of living organisms.

Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion.

Anaerobic digestion occurs naturally in some soils and in lake and oceanic basin sediments, where it is usually referred to as "anaerobic activity".

The digestion process begins with bacterial hydrolysis of the input materials. Insoluble organic polymers, such as carbohydrates, are broken down to soluble derivatives that become available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. These bacteria convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Finally, methanogens convert these products to methane and carbon dioxide. The methanogenic populations play an indispensable role in anaerobic wastewater treatments.

Wastewater from Textile Dyeing Industry

The textile dyeing industry is not a single entity but encompasses a range of industrial units, which uses a wide variety of natural and synthetic dyes, chemicals and fibers to produce various fabrics.

2. Objectives

- To establish USAB reactor for the treatment of wastewater generated from textile dyeing
- To investigate operational parameters such as organic loading rate, hydraulic loading rate, color removal, up flow velocity for textile dyeing effluent.
- To evolve a competent Biological Treatment System for potential energy recovery such as methane generation.
- To study the process performance.

3. 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 operated at a hydraulic retention time (HRT) of 24h. In this stage, the system continued to

run for 35 days until the reduction in the percentage of chemical oxygen demand (COD) reached a constant level. This was considered the acclimatization period. Initially, the microbial population was low and gradually bacterial growth was enhanced and their population enriched by attaching to fully submerged stationary media Fujino Spirals.

A. Experimental Set Up

The experimental setup consists of a fixed film upflow anaerobic sludge blanket reactor having an effective volume of $0.02m^3$. The specification of the experimental setup is given in

Table 1: Details of Hybrid Reactor

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

B. Start-up Process

The experiment was initiated with the feeding of domestic wastewater for the acclimatization process. After attaining the steady state condition within 35 days, real 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. With respect to the COD concentration samples collected regularly by varying HRT from inlet and outlet for the analysis. The evaluation is based on the HRT Vs % COD removal.

The effective volume of the reactor and the flow rate were interpreted for the different retention time. The HRT of the experiment was derived from the volume and flow rate of the reactor. HRT is interpreted with % COD removal and % Color removal in this experiment.

The analytical methods for the analysis of the samples were determined by the standard procedures given in APHA, AWWA &WEF and standard methods for the examination of water and wastewater 21st edition 2005.

The Samples of untreated textile dyeing wastewater were collected from textile processing Pvt. Ltd., in Tirupur, Tamilnadu, India and their characteristics were analyzed and observed values were tabulated in the **Table 2.** The characteristics were analyzed by the standard procedures given in APHA, AWWA & WEF and standard methods for the

Table 2: characteristics of untreated real textile wastewater

Analytical Parameters	**Range**
pH	10.5
BOD_5 mg/l	280
COD mg/l	1360
TDS mg/l	5925
Chlorides mg/l	900
Sulphates mg/l	612
TKN mg/l	65.32
TP mg/l	47.21
Color (OD @600nm)	1.8

The experiment was initiated with the feeding of domestic wastewater for the acclimatization process. After attaining the steady state condition within 38 days. Real textile dye effluent was fed into the reactor by the gradually increase of domestic sewage such as 20%, 40%, 60%, 80% and 100% after allowing the real textile effluent was fed with various concentrations.

4. Results and discussion

Bio gas collection

The daily biogas production was estimated by the water displacement method, analyzed and represented. The maximum biogas production was 0.28 m^3/kg COD at 22HRT. The biogas production at 8hr,16hr,20hr and 24hr were 0.15, 0.18,0.25 and 0.28m^3/kg COD respectively. Effective volume 20L upflow anaerobic sludge blanket reactor present studies it is clearly indicated that whenever the HRT increases, more generation of biogas was observed. Naveed et al, (2015) showed the design to evaluate the treatability performance of a single-stage UASBR at neutral pH and constant mesophilic temperature and to investigate the biogas yield of a single-stage UASBR using textile mill therefore, encouraging such technologies can help to tackle the problem of energy crises.

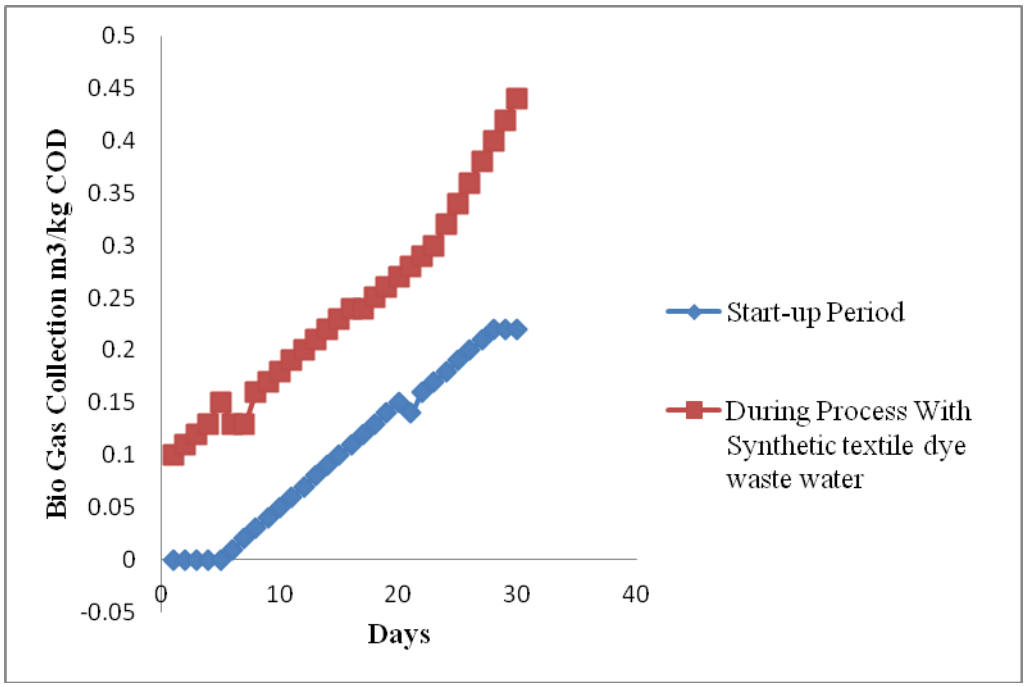

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Fig 1: Start-up period and during process with real textile dye wastewater

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 3: 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

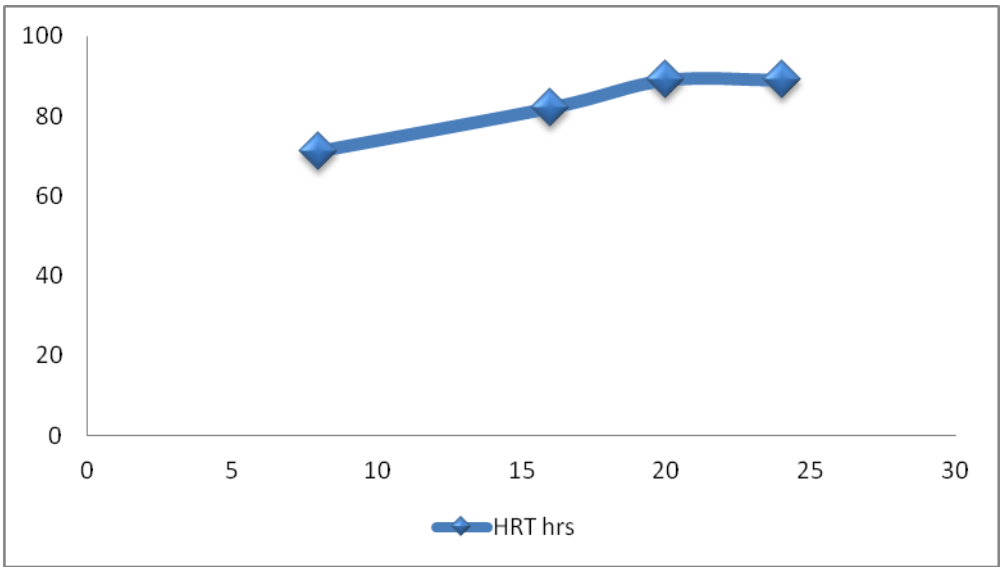

Fig. 2: HRT Vs % COD removal (average influent COD 1000mg/l)

Effect of HRT Vs Color

The operational parameters were the HRT and color. The experiment was run for COD concentration. The operational parameters HRT were varied as 24hrs, 20hrs, 16hrs and 8hrs. Color concentration samples were collected regularly according to the HRT varying period from inlet and outlet for the analysis. The evaluation is based on the % colour removal. The colour 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) Conducted a study on decolorize the real textile wastewater containing textile dye using starch industry effluent as co-substrate in hybrid bi-phasic UASB reactor by varying the temperatures as 35, 40, 45 and 50 0C. The whole processes were operated at the optimum recycle ratio of 70:30

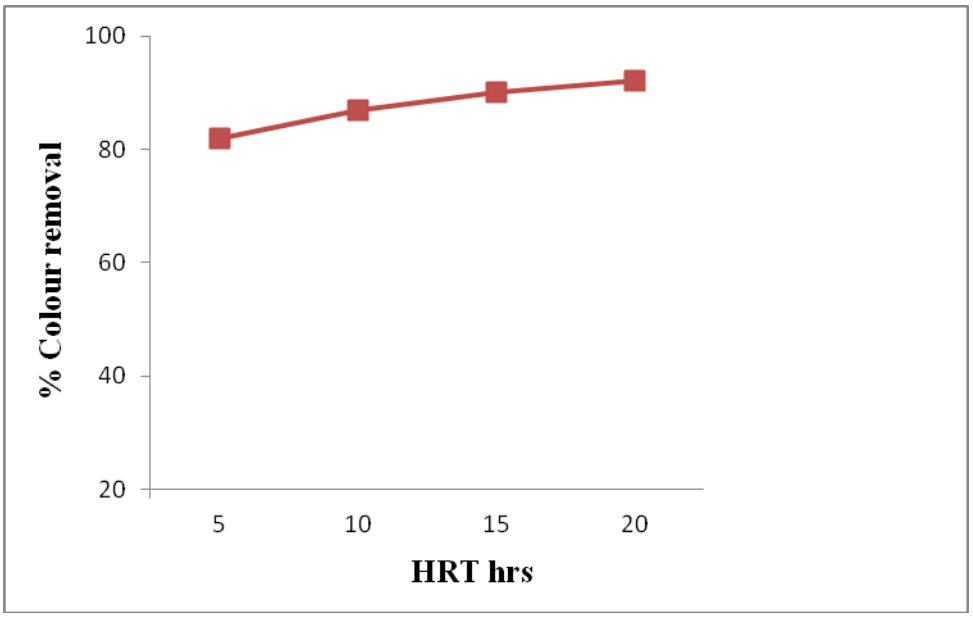

Fig: 3 HRT Vs Color

5. Conclusion

The designed upflow anaerobic sludge blanket reactor was found to be more effective in decolourisation of real textile dying effluent. The present work is envisaged and conducted on an experimental study with a laboratory model UASBR for evaluating the performances in treating the real textile dye wastewater. The efficiency of COD reduction under the HRT are appreciable and showing good efficiency of anaerobic treating for removing COD a maximum of 80% in the real textile dye wastewater

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