RESEARCH ARTICLE

International Journal of Science, Technology and Society (IJSTS)
Vol. 5, No. 1 & 2 (2020-21): 44-47

A Comparative Study of UASB and Fluidized Bed Reactor for Anaerobic Waste Water Treatment of Different Waste Concentration

Rubina Chaudhary[1*], Sumit Devraye[2], Lalit Yadav[3]

[1]Professor, School Of Energy And Environmental Studies, Devi Ahilya University, Takshashila Campus, Khandwa Road, Indore-452001, M.P., India
[2,3]M.Tech Student, School of Energy and Environment Studies DAVV, Takashashila Campus, Indore- 452017 (M.P.) India.

Publication Info

Article History:
Received: 26-07-2019
Accepted: 02-02-2021
DOI: 10.18091/ijsts.5128

Keywords:
Anaerobic waste water treatment,
Chemical Oxygen Demand (COD),
Fluidized Bed Reactor (FBR),
Synthetic waste water,
Upflow Anaerobic Sludge Blanket (UASB),

Corresponding Author:
Rubina Chaudhary
Email:
rubina_chaudhary@yahoo.com

ABSTRACT

The objective of this work was to comparatively investigate the performance of two anaerobic waste water treatment reactors namely UASB and fluidized Bed Reactor (FBR). Two lab scale models were erected and experiments were carried on both the reactors for different substrate concentration of COD 16800mg/L and 2880mg/L for UASB and FBR respectively. Effect of HRT on degradation of organic matter was studied through estimating COD at regular time intervals, COD removal rates for FBR and UASB were found to be 108mg/L/day and 231mg/L/day respectively, The COD removal for UASB and FBR was 60% and 57% of the initial value respectively.

INTRODUCTION

The effective treatment of industrial and domestic wastewater is very crucial keeping in view the limited resources of fresh water and their continuous contamination with various kinds of industrial and domestic waste. The conventional aerobic processes of waste water treatment are very effective but have some inherent disadvantages (R.C. Leitao 2004; Carlos Augusto de Lemos Chernicharo). They consumed a lot of electrical Energy and at the same time produced excess waste sludge which is difficult to dispose off safely.

By contrast the anaerobic waste water treatment processes consume less energy and are in fact net energy producers, They produce less sludge to be disposed off and the end products are in more stable form. The anaerobic sludge does not die at low temperatures and can be stored at temperatures below 15℃ (Carlos Augusto de Lemos Chernicharo).

In this work we have focused on studying comparatively the effectiveness of two anaerobic reactor technologies in treating waste water with organic substrate, namely Upflow Anaerobic Sludge Blanket (UASB) and Fluidized Bed Reactor (FBR). The performance of both studied for different substrate concentration and HRT by continuously evaluating the Chemical Oxygen Demand (COD) of the waste. The UASB reactor was operated for 45 days while the FBR operated for 16days.

The UASB reactor was introduced by Dr. Gatze Lettinga & (colleagues in 1970's). The UASB is operated as a suspended growth system (Basu *et. al*. 2019). where microorganisms attach themselves to each other or to small particles of suspended matter to form agglomerates of highly settle-able granules that forms an active sludge blanket at the bottom of the reactor.

On the other hand fluidized bed reactor technology works on the principal of attached growth system (Basu *et. al*. 2019). The reactor was filled with supporting medium which provides surface for the microorganism to grow. The research work in this field has shown that this technology can effectively handle varying loading rates and can be used to treat waste with considerably low strength.

MATERIALS AND METHODS

The Experimental work was carried out at the Environmental laboratory, School of Energy and Environmental studies, DAVV Indore (M.P.) India. Two lab-scale bioreactors were erected as shown in Figure 1, both the rectors were operated at room temperature which varied between 25-30^{0}C during the months of October and November 2016. The operational condition followed in this paper are presented in Table 1 by The synthetic waste water was prepared at the laboratory by adding glucose to distilled water along with the macro and micro nutrients, for which the details are provided in Table 2.

The total volume of the Fluidized bed reactor was 4 liters, three sampling ports were provided, charcoal particles of 2mm mean diameter and 2.1 g/cm^3 density were used as bed material, the bed was fluidized by recirculation flow by set a two pumps with the flow rate set to 1320 L h^{-1}, this resulted in a upflow velocity of 264 m h^{-1} with 350% of bed expansion (Table -1).

Microorganisms and Reactor Startup

The initial original inoculums was obtained from a real scale UASB treating industrial waste water the industrial scale UASB reactor treated waste water of COD 18500 mg/L originating from starch processing . This activated sludge was mixed in to the synthetic waste water which was prepared by adding the various macro and micro nutrients presented in Table 2.

The desired COD for the synthetic waste water was obtained by adding theoretically calculated COD value of glucose . It has been estimated through stoichiometric calculations that 1.07 gm of oxygen is consumed for every 1 gm of glucose that is chemically oxidized.

Analytical Methods

The COD concentration was determined by using close reflux method (Basu *et. al*. 2019) , First of all a suitable dilution factor was applied to the sample, after that

Figure 1: Photographic view of (a) Fluidized bed reactor and (b) UASB

Table 1: Characteristics and operating conditions of the rectors studied

Parameters	*UASB*	*Fluidized Bed Reactor*
Dimensions	Diameter=23cm; height=20cm	Diameter=8cm; height=90cm
Volume	8.3 Liters	4.5 Liters
Carrier material	NA*	Charcoal ; particle size: 2mm Density 2.1gm/cm^3
Fluidization Percentage	NA	350%
Static Bed height	NA	5cm
Expanded bed height	NA	17cm
Sludge depth	5cm	Not applicable
Pumping power required	NA	58 Watts
Number of pumps	NA	2

Table 2: Nutrients added to synthetic waste water

Nutrient compound Name	*Chemical formula*	*Concentration mg/L*
Copper chloride	$Cucl_2.2H_2O$	0.0536
Chromium nitrate	$Cr(NO_3)_3$	0.007
Lead chloride	$PbCl_2$	0.01
Nickel sulphate	$NiSO_4.6H_2O$	0.0336
Ferrous sulphate	$FeSO_4.6H_2O$	0.58
Magnesium phosphate	$MgHPO_4.3H_2O$	2.09
Zinc chloride	$ZnCl_2$	0.0208
Manganese sulphate	$MnSO_4.H_2O$	0.0108
Ammonium chloride	NH_4Cl	1.275
Potassium phosphate monobasic	KH_2PO_4	2.34

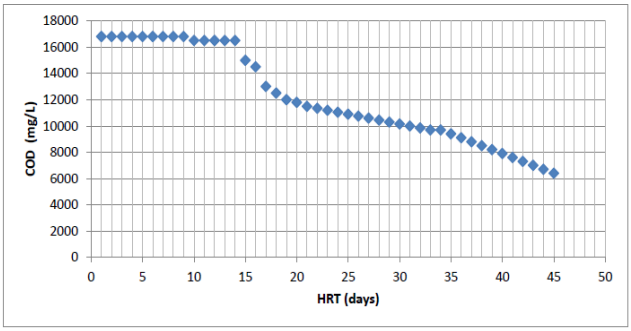

Figure 2: Removal of COD with HRT (UASB)

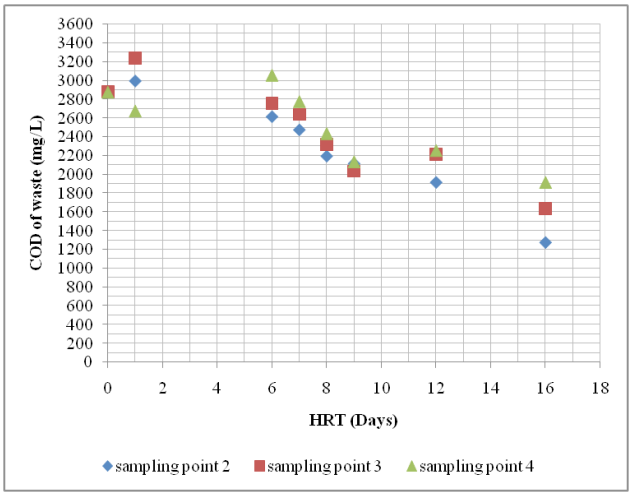

Figure 3: Removal of COD with HRT (Fluidized Bed Reactor)

2.5 ml of sample was taken. and 1.5ml of potassium dichromate was added to the sample in a culture tube and after that 3.5 ml of concentrated sulphuric acid was added to the solution.

The culture tube was closed with aluminum foil and was placed in the oven at 160°C for two hours. The organic substrate present in the sample is completely oxidized and the remaining potassium dichromate is titrated against Ferrous Ammonium Sulphate (FAS) using few drops of ferroin indicator. A blank sample was simultaneously run with the sample and the difference between the FAS consumed for blank and sample gives the COD value.

Reactor Performance

Both the reactors were started with the same inoculum obtained from industrial UASB. The reactors were operated in batch mode and the COD was measured at regular time intervals. The UASB was started with high initial COD of 16800mg/L after completion of 45 days of reactor operation the COD concentration was reduced to 6400 mg/L. The total reduction in COD was 10400 mg/L.

The Fluidized bed reactor was operated with low initial COD of 2880mg/L after 16 days of reactor operation the COD concentration had reduced to 1260 mg/L. showing total COD reduction of 1620 mg/L.

Based on amount of COD degraded, volume of methane produced was calculated theoretically Carlos Augusto de Lemos Chernicharo (20,21). Total COD removal in the UASB reactor was 53.12gm and volume of methane produce = 20 Liter. Total COD reduction in the fluidized bed reactor was 5.06gm and volume of methane produced 1.94Liter.

RESULTS

The COD removal rate for Fluidized bed reactor and UASB was 108 mg/L/day and 231 mg/L/day respectively. The COD reduced by 57% in fluidized bed reactor and 60% in UASB. The COD removal efficiency for FBR is almost at par with UASB reactor despite the UASB reactor having high concentration of COD than the FBR. Figure 2 and Figure 3 show the COD removal trends for FBR and UASB reactor respectively.

CONCLUSION

The mixing conditions play an important role in substrate COD concentration reduction. The FBR provides good mixing conditions leading to COD removal of 57%, while the UASB has a COD removal efficiency of 60%. The UASB operated for 45 days starting with initial substrate concentration of 16800 mg/L and FBR operated for 16 days starting with a substrate concentration of 2880 mg/L. The results show that fluidized bed reactor has treated low concentration waste with almost same COD removal rate as UASB reactor. This shows effectiveness of FBR in treating waste with low substrate concentration. The effluent originating from the UASB and FBR are 6400 mg/L and 1260 mg/L of COD after completion of whole operational cycle, which are fairly high values compared to CPCB standard for maxim COD discharge limit to inland surface waters of 250 mg/L (Schedule-VI,2017; Anjali Barwal and Rubina Chaudhary 2016; Anjali Barwal and Rubina Chaudhary 2016). The effluent from both the reactor will have to be given secondary treatment to bring down the COD value of the discharge. However FBR shows the possibility producing low concentration discharge due to it different design providing proper mixing of the substrate and the microorganisms.

REFERENCES

1. Carlos Augusto de Lemos Chernicharo, *Biological Wastewater Treatment Series*, Volume -IV, Anaerobic Reactors, Department of Sanitary and Environmental Engineering Federal University of Minas Gerais, Brazil.
2. Carlos Augusto de Lemos Chernicharo, *Biological Wastewater Treatment Series*, Volume -IV, page(20-21), Anaerobic Reactors, Department of Sanitary and Environmental Engineering Federal University of Minas Gerais, Brazil.
3. Feasibility study for the treatment of municipal wastewater by using a hybrid bio-solar process, Anjali Barwal and Rubina Chaudhary, *Journal of Environmental Management*, (Elsevier),

177, (2016): 271-277

4. Guide manual : *Water and waste water analysis*, Dr. D.D. Basu, Scientist 'E' & Sh. J.S.Kamyotra, Dr. Reeta Kori, Expert Resource Person, Mrs. Suniti Parashar, SSA, CPCB , Ministry of Environment Forest& Climate Change Government of India,2019.
5. General standards for discharge of environmental pollutants, *Schedule-VI*, The environment protection rules (1986)
6. Performance of integrated bio-solar process for domestic wastewater treatment: A sustainable approach to scale up wastewater management, Anjali Barwal and Rubina Chaudhary, *Water Utility Journal*, (2016) 13:83-90, European Water Publications, ISSN: 1792-748X
7. R.C. Leitao, Robustness of UASB reactors treating sewage under tropical conditions. *Ph.D. thesis*, Wageningen University, 2004, Wageningen, The Netherlands.