Turkish Journal of Computer and Mathematics Education Vol.12 No. 11 (2021), 3060- 3065
Research Article

Performance Evaluation on Fluidized Bed Reactor for the Treatment of Domestic Waste Water

S.Ramesh [a], Meena Dhayalan[b]

[a,b] Department of Civil Engineering, SRM University, Kattankulathur, Chennai, 603203, Tamilnadu, India
[a] shanthameenakshi@gmail.com

Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 10 May 2021

Abstract: The study was undertaken to study the performance of a Fluidized Bed Reactor in a sewage treatment plant and its efficiency to reduce the BOD, COD and TSS level. The physico-chemical parameters of the effluents like pH, Sulphate, Phosphate, Ammoniacal nitrogen, BOD, COD, TSS. TDS were analysed. Incorporating Fluidized Bed Reactor in the Sewage treatment plant allows the micro organisms to attach with the media in the bed resulting in accelerating the growth of organism thus increasing the degradation process of the organic waste improving the efficiency of STP. A physical model of STP with FBR was constructed – equalization tank, aeration tank, sedimentation tank and clear water tank. It is seen from the experimental work in the designed physical model of sewage treatment plant, the fluidized bed in aeration tank removal efficiency of BOD from 70-80 % . The removal efficiency based on the performance of FBR removal of COD ranges from 70 – 81 % and TSS ranged from 70- 85%. The colour of the effluent varied from dark brown to colourless. The overall evaluation of FBR treating the collected domestic waste water samples varies from 70 – 80% hence, the designed FBR is efficient.

Keywords: Fluidized Bed Reactor, Sewage treatment plant, microorganisms, physico-chemical parameters

1. Introduction

A physical model of Fluidized Bed Reactor was incorporated in the sewage treatment plant of the dimension, Length is 1.55 m, Breadth is 0.6 m, Depth is 0.5m dimension of the STP is 1.55m x 0.6 m x 0.5 m. The Sewage Treatment Plant was divided into four tanks prototype Equalization tank, Aeration tank, Settling tank and Cleaner water tank. Incorporating Fluidized Bed Reactor in the Sewage treatment plant allows the micro organisms to attach with the media in the bed resulting in accelerating the growth of organism thus increasing the degradation process of the organic waste improving the efficiency of STP.

This project aims at, inter alia , to bring out the results conducted in an experimental physical model of Fluidized Bed Reactor to treat the domestic waste water and test the physiochemical parameters such as pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonical Nitrogen, Nitrate , Phosphate, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) in the treated effluent.

The sewage treatment model consists of four tanks equalization tank, aeration tank, sedimentation tank, clear water tank. Raw sewage of 100 litre / day was fed into the STP operating for 20 hours/day. Optimum temperature of 28-30 degree celcius was maintained.12-15 days was gives for the cultivation of media in fluidized bed reactor for the microorganisms initially. In equalization tank the different parameters of water such as BOD and flow rate are brought to equilibrium and to overcome the flowrate variations and operational difficulties.

In the aeration tank a fluidized Bed Reactor consists of bio plastic media where the microorganisms stay coated, it exists in the state of suspension in waste water which in turn is sufficiently aerated to keep the gas, liquid and solid particles well mixed. Which inturn removes the organic pollutants present in sewage. Through the diffusers and air mortar the air is blown into the aeration tank to provide oxygen for the microorganisms to further breakdown the organic pollutants and to increase the nutritional value of the effluent.

In the settling tank floating particles settle down by gravity and the steady flow of water. Further the water moves into the clear water tank where the treated effluent is taken for the testing of physio-chemical parameters.

2. Materials and Methods

Thick fibre glass was used to construct the Sewage Treatment Plants and the Fluidized Bed Reactor. The Tank was divided into four tanks such as Equalization tank, Aeration tank, Settling tank and Cleaner water tank divided by glass plates. The water moved by gravity into the subsequent tanks where the raw sewage was fed into the Equalization tank initially. The Fludized Bed in the Aeration tank was provided with a bioplastic media acting as supporting bed for the microorganisms to grow on. The air was blown into the aeration tank by providing aeration through air mortar connected to the diffuser. Further valves were provided to adjust the flow of sewage as required using PVC pipes.

The residential buildings along the Tambaram area 12.9249° N, 80.1000° E, starting from Selaiyur to Medavakkam in Chengapattu District of Tamil Nadu was chosen for this project. The waste water from various

residential buildings were collected whose physic-chemical characteristics of the domestic waste water were tested.

The untreated domestic waste water in collected from various residential complex along Tambaram, Chennai Tamil Nadu. The collected samples are treated using the designed Fluidized Bed Reactor incorporated in STP and the physicochemical parameters such as pH, BOD, COD, Phosphate, Sulphate, Ammoniacal Nitrogen, TSS and TDS for the treated effluents are tested.

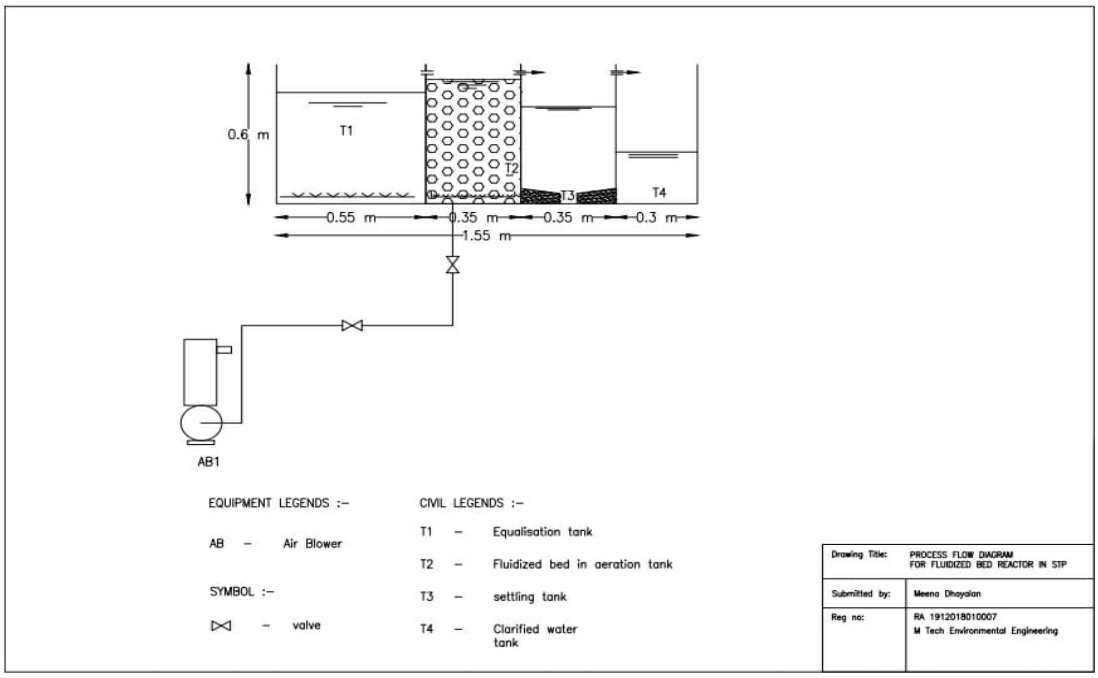

Fig. 1 Line diagram of Fluidized Bed Reactor in Sewage Treatment Plant

Fig. 2 Fluidized Bed Reactor in Sewage Treatment Plant

Contruction of Sewage Treatment plant prototype

(a) **(b)**

(a) Air blower, valve, diffusers and tube
(b) Valves and pipe fittings

3. Results and discussion

The influent sewage was fed into the sewage treatment plant 100 litre/ hour with retention time of 20 hours. The final treated sewage effluent 40 litre from which sample was collected and analyzed for physicochemical parameters and results are represented in the following table of treated waste water.

BOD depends on the level of dissolved oxygen required by the microorganisms to break down the organic matter. These bacteria feed on and consume organic matter in the presence of the oxygen. The results obtained from the samples after incubated at 27 degree celcius for 3 days ranging from 40-60 mg/l .

The Chemical Oxygen Demand (COD) represents the amount of oxygen in milligrams required to oxidize all the organic pollutants present in the water to carbon dioxide and water. COD the measure of water and wastewater quality. The COD test is often used to monitor the efficiency of water treatment plant. The sample results obtained ranged from 200-300 mg/l.

Wastewater contains large quantities of suspended organic and inorganic material that must be removed trough screening, filtration of settling/floatation methods prior to environmental discharge. The result obtained from various samples showed TDS ranged from 30-10mg/l. The suplate levels of the samples ranged from 40- 60 mg/l. The result obtained from various samples showed ammoniacal ranged from 10-20mg/l. The result obtained from various samples showed phosphate ranging from 0.5-1.2 mg/l. The result obtained from various samples showed TDS ranged from 500-630mg/l.

Sample.No	pH	BOD (mg/L)	COD (mg/L)	Sulphate (mg/L)	Ammonaical Nitrogen (mg/L)	Phosphate (mg/L)	TDS (mg/L)	TSS (mg/L)
1	7.5	44	291	62	19	1.4	581	46
2	7	54	256	53	12	0.4	585	31
3	7.3	60	230	47	17	1	590	47
4	7.7	57	196	44	15	1.6	592	42

Table. 1 Effluent parameter of treated water sample

4. Conclusion

The outcome of the study is to reduce the COD, BOD and TSS from the collected sewage waste water sample using Fluidized Bed Reactor. It is seen from the experimental work in the designed physical model of sewage treatment plant, the fluidized bed in aeration tank removal efficiency of BOD from 70-80 % . The removal efficiency based on the performance of FBR removal of COD ranges from 70 – 81 % and TSS ranged from 70-85%. The colour of the effluent varied from dark brown to colourless. The overall evaluation of FBR treating the collected domestic waste water samples varies from 70 – 80% hence, the designed FBR is efficient.

The FBR media used was found to be ecofriendly, the prototype is compact in nature hence it is economically efficient and requires less space. At a suitable proportionate level this STP can be used in rural areas to directly discharge the effluent. The FBR with the additional Carbon Filter results in clearer water.

Sample No.	Inlet BOD (mg/l)	Outlet BOD (mg/l)	Efficiency (%)	Inlet COD (mg/l)	Outlet COD (mg/l)	Efficiency (%)	Inlet TSS (mg/l)	Outlet TSS (mg/l)	Efficiency (%)
1	438	44	90	1078	291	73	185	46	75
2	412	54	87	1063	256	76	192	31	84
3	394	60	85	1045	230	78	173	47	73
4	402	57	86	1029	196	81	188	42	78

Table. 2 Inlet and outlet characteristics of BOD, COD and TSS and its efficiency

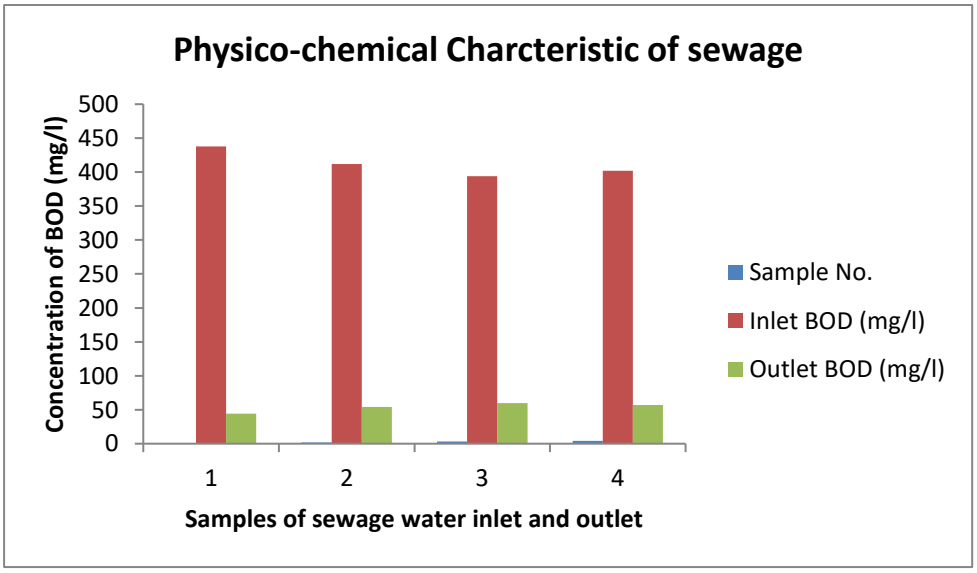

Fig. 3 The graph shows the efficiency of BOD removal

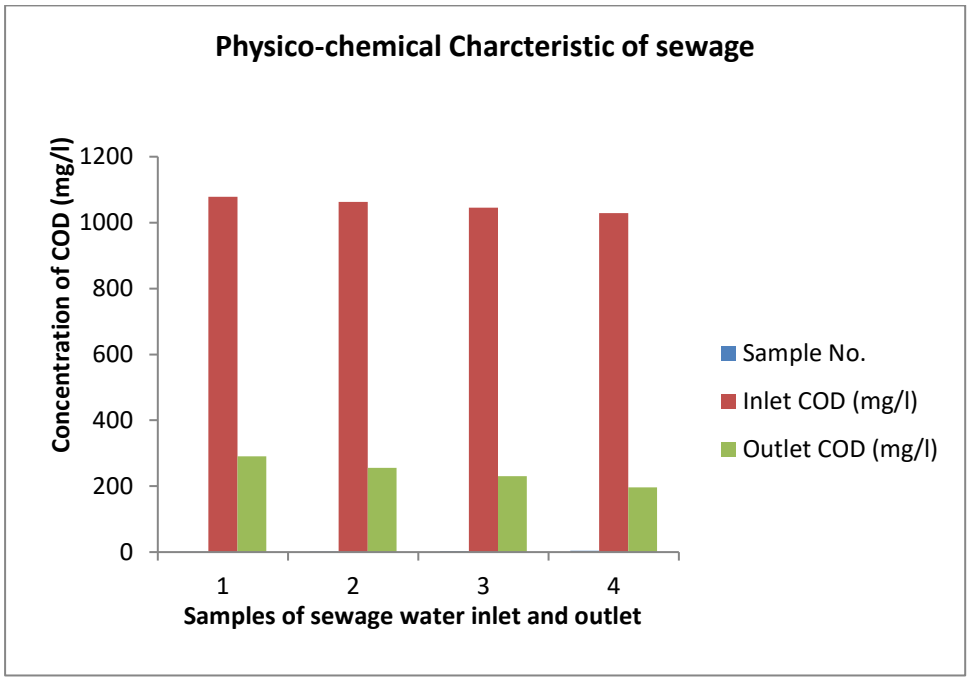

Fig. 4 The graph shows the reduced COD level after treatment of sewage water sample

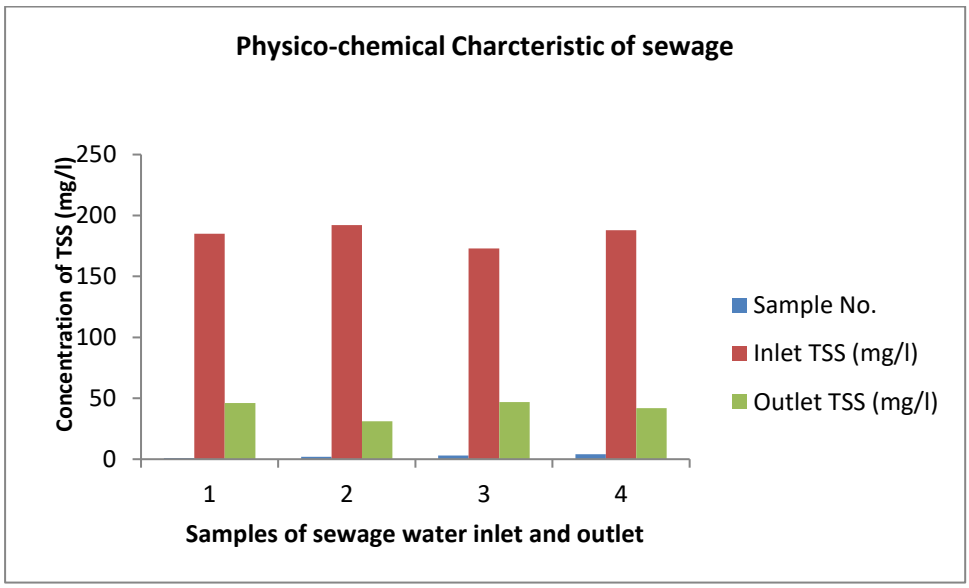

Fig. 5 The graph shows the reduced TSS level after treatment of sewage water sample.

References

1. N.M. Mendonça, C.L. Niciura, E.P. Gianotti and J.R. Campos (2004), "Full scale fluidized bed anaerobic reactor for domestic wastewater treatment: performance, sludge production and biofilm" water science and technology, Bioeng. 50,643-654
2. Chun-Sheng Wu and Ju Sheng Huang (1996), "Bioparticle characteristics of tapered anaerobic fluidized bed bioreactor" War. Res. Vol. 30, No. 1, pp. 233-241
3. J.Bae, R. Yoo, E. Lee and P. L. McCarty (2013), "Two-stage anaerobic fluidized-bed membrane bioreactor treatment of settled domestic wastewater", Water Science and Technology, Biosour.Technol 120 ,133-139
4. N.Sundaram and L.Philip (2008), "Performance evaluation of various aerobic biological systems for the treatment of domestic wastewater at low temperatures", Water Science and Technology(2008), 58 – 67
5. Emmanuel E. O. Odjadjare and Anthony I.Okoh (2010), "Physicochemical quality of an urban municipal waste water and its impact on the receiving environment", Environ Monit Assess (2010) 170, 383-394.
6. K. Haribabu & V. Sivasubramanian (2016), "Biodegradation of organic content in wastewater in fluidized bed bioreactor using low-density bio support", Desalination and Water Treatment, Water Sci. Technol. e-ISSN:1944-3968 57,(2016) 4322- 4327

7. Kenji Kida, I Sigeru Morimura, Yorikazu Sonada, Masaki Obe and Tatsuro Kondo (1990), "Support Media for Microbial Adhesion in an Anaerobic Fluidized-Bed Reactor" , Journal of Fermentation and bioengineering , Bioeng., Vol. 69 No.6 Pp 354-359
8. P.Marin, D. Alkalay, L. Guerrero, R. CAhamy and M.C Schiappacasse (1999), "Design and startup of an anaerobic fluidized bed reactor",Wat.Sci. Tech Vol.40, No.8, Pp 63-70.
9. Sonune NA , Mungal NA and Kamble SP (2016), "Support Media for Microbial Adhesion in an Anaerobic Fluidized-Bed Reactor",Int.J.Microbiol.App.Sci 4(1);533-536.
10. Jeonghwan Kim, Kihyun Kim, Hyoungyoung Ye, Eunyoung Lee, Chungheon Shin, Perry L.Mccarty and Jaeho Bae (2011)," Anaerobic Fluidized Bed Membrane Bioreactor for Wastewater Treatment", Environ. Sci. Technol 67, 457-690.
11. Jian Yu, Min Ji and Po Lock Yue (1999), "Three phase fluidized bed reactor in the combined aerabic/unaerobic trearment of wastewater" Journal of Chemical Technology and Biotechnolog , Bioeng., 74, 619-626
12. R. R. Souza , I. T. L. Bresolin , T. L. Bioni , M. L. Gimenes and B. P. Dias-Filho2 (2004), " The performance of three phased fluidized bed reactor in treatment of wastewater with high organic load", Journal of Chemical Engineering Vol. 21, No. 02, pp. 219 – 227.
13. Aishwarya J M (2016), Performance evaluation of sewage treatment plant at a residential building", Int J. Environment and Sustainability Development, Vol.15 No.3 (2016)
14. Michael Wagner and Alexander Loy (2002), Bacterial community composition and function in sewage treatment systems, Bio. Technol 13, 218-227.
15. Sachichida Nanda Singh, Gaurav Srivastav and Arun Bhatt, "Physico Chemical in waste water Dheradhun", Curr. World Environ, Vol. 7(1), 133-138.
16. Emmanuel E. O. Odjadjare and Anthony I.Okoh (2010), "Physicochemical quality of an urban municipal waste water and its impact on the receiving environment", Environ Monit Assess (2010) 170, 383-394.
17. R. Sowmeyan and G. Swamianthan (2007)," Performance of inverse anaerobic fluidized bed reactor for treating high strength organic aste water during startup phase", Biosource Technol. 99 (2008) 6280-6284.
18. Wen K. Shieh and Yen Hsu (1995), "Biomass loss from an anaerobic fluidized bed reactor", Wat. Res. Vol.3 No.5 Pp. 1253-1257.
19. Raatnatamskul, O. Wattanayommanaporn and K.Yamamoto (2015), " An on site prototype two staged anaerobic digestor for co-digestion of food waste and sewage sludge for biogas production oh high-rise building", International Biodeterioration and Biodegradation (2015) 1-6.
20. Xiaohong Zhou, Yuanyuan Wu, Hanchanf Shi, Yanquing Song (2013),"Evaluation of oxygen transfer parameters of fine-bubble aeration system in plug flow aeration tank of waste water treatment plant, Journal of Environmental Sciences 2013, 25(2) 295-301.