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ORIGINAL ARTICLE **OPEN ACCESS**

Performance of Fixed Bed Fixed Film Reactor Effect of Volumetric Loading Rate

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ABSTRACT
In high COD industrial wastewater treatment, the conventional trickling filters suffer serious operating problems like clogging and partial system coverage which are eventually resulting in sanitary area conditions and also lesser treatment efficiency. The alternative structural components, to replace the conventional stones and pebbles with pre-designed, hybrid plastic modules are expected to overcome the operational problems of trickling filters, with more surface area per volume of module filling (m^2/ m^3).Hence, such systems can be used for higher organic loads and for still better organics removal. Such processes that are envisaged with plastic modules as filling media replacing the conventional porous media are known as Fixed Bed Fixed Film (FBFF) reactor. The active anaerobic microorganisms attached with the surface of the filling media, offers low fill media ratio that will essentially biodegrade the Oxygen Demand (COD) under endogenous phase, resulting in COD removal at more than 78% under high Volumetric Organic Loading Rates (VLR). The loading ranges between0.960 - 15.550kg COD/ m^3.day. The experimental model is designed to have plastic models that have a higher net surface area for attached growth biomass. The model has an effective volume of 24.36 litres with plastic modules filled for 41% of the reactor volume with a total surface area of 5 m^2.The model was fitted with a peristaltic pump that can load influent at 0.5, 1.0, 1.5, 2.0, and 2.5 lit/hr the Hydraulic Retention Time of 48, 24, 16, 12 and 9.6 hrs.
KEY WORDS: *FBFF, COD, VLR, HRT, Plastic Modules, Attached Growth Biomass and Surface Area.*

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INTRODUCTION
Now a day's increase in industrialization, the industrial effluents are generated in huge quantities having high organic content and if treated using appropriate technology can result in the generation of the source of energy [3]. Proper disposal of waste water is very challenge to the environmental engineer's and untreated discharge of industrial effluent to directly affect the eco - system and indirectly affect the human health. Proper treatment and disposal of industrial effluent have become a very essential parameter in conservation of water bodies. Such that surface water and sub - surface water [4-8].
The concept of "Zero - Discharge Plants" for waste water treatment, recycling and reuse the treated effluent, is required advanced treatment options to draw organics removal at more than 99 %.The biodegradable industrial waste streams, with inhibiting COD concentrations for aerobic treatment ,require anaerobic treatment in the first category [1-2].
The reactor model results were used to evaluate the COD removal efficiency of the FBFF reactor and set the mathematical models was drawn to characterize the biochemical process kinetics to enable the design of the FBFF reactor.

MATERIAL AND METHODS
The present research is essentially an experimental work with a laboratory model on the Fixed Bed Fixed Film (FBFF) Reactor. The evaluation of the FBFF model is find out with performance for treating sugarcane Industrial wastewater and biochemical reaction kinetic studies.
The laboratory model of FBFF was constructed based on an empirical design approach for 24.36 litres of effective volume. The dimensions of the experiment is designed to match the size of peristaltic pump and proposed influent COD ranges which were decided in the particular characterization of the respective waste stream.

FBFFREACTOR - LABORATORY MODEL

The treated wastewater is collected from the reactor at top and the gas is collected through the dedicated tube line to the gas collector. The physical dimensions for the model are drawn from the empirical approach.The effective volume of the reactor is 24.36 litres and the overall volume of the reactor is 31.79 litres. . The size of the experiment is designed to match the size of peristaltic pump and proposed influent COD ranges which was depends up on the typical characterization of the respective waste stream.
Two ports are provided one for desludge at bottom and another one for sampling at top. The schematic diagram of the experimental model is presented in **figure 1.1** respectively.

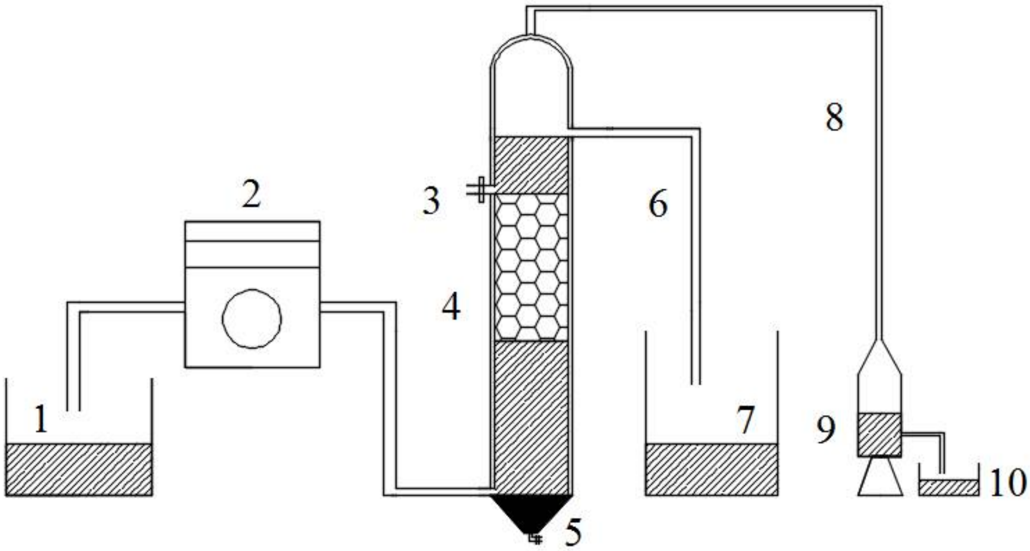

Figure 1.1 Schematic Diagram of Experimental Setup.

1. Influent tank **6.Treated effluent pipe**
2. Peristaltic pump **7.Treated effluent**
3. Sample port **8.Gas pipe**
4. Microbial support media **9. Water displacement reactor**
5. Desludge pipe **10.Displaced water collection jar**

The design of reactor is construct on the basis of Flow Rate, I nfluent COD, Hydraulic Retention Time, Volumetric Loading Rate, Hydraulic Loading Rate, Reactor VSS and Organic Loading Rate.
The physical dimensions and process in parameters for the experimental model of the FBFFR model as represented in the **TABLE 1.1.**

TABLE 1.1 Physical Dimensions with Process Parameters of ExperimentalModel: FBFFR

Specifications	Fixed Bed Fixed Film Reactor (FBFFR)
Total volume of the reactor, litre.	32
Effective volume of the reactor, litre.	24.36
Total height of the reactor, m	1.24
Effective height of the reactor, m	0.87
Effective diameter of the reactor, m	0.19
Height of the microbial support fill media, m	0.36
Diameter of the influent and effluent pipes, mm	8
Peristaltic pump (Miclin's make)	PP-15 model
Mesh or bearing plate hole size mm,	2.5
Operating Parameters	
Influent flow rate, litre/hr.	0.5, 1.0, 1.5, 2.0and 2.5.
Influent COD, mg/lit For synthetic sugarcane effluent, mg/lit	1972, 3022, 4022, 4974, 6024
Volumetric Loading Rate, kg.COD/ m^3.day	0.960 - 15.550
Organic Loading Rate, kg COD/ m^2.day	0.005- 0.075
Hydraulic Loading Rate, m^3/ m^2/day	0.002 - 0.012

The model was run the Sugarcane wastewater which was started from 94th day, from actual date of reactor commissioning by batch mode with domestic wastewater. The model was fed with real time effluent of sugarcane wastewater effluent, slowly in mixed state with sewage in stages of 20%, 40%, 60%, 80% and 100% of real time effluent was made to pump in two weeks time. Then, synthetic effluent was mixed and replaced the real time effluent in the next two weeks in stages of 20%, 40%, 60%, 80% and 100%.

The observations on the reactor model was started with efficiency ofthe COD removal as the treated wastewater started comes out as clear, colourless liquid and the biogas generation was observed for a maximum of 0.29 m^3/ kg COD removed.

RESULT AND DISCUSSION

The reactor was operated five different flow rates viz., 0.5, 1.0, 1.5, 2.0, and 2.5lit/hr. That corresponds to HRT of 48, 24, 16, 12 and 9.6 hrs. The respective Volumetric Loading Rates varies from 0.960 to 15.550kg.COD/ m^3.day.

Considering the evaluation of the model in respect of efficiency of the COD removal, the experimental model results were interpreted for VLR.The appropriate graphs were presented in **Fig 1.2 to Fig 1.6.**

Considering the evaluation of the model in respect of VLR, the experimental results were interpreted for bio-gas generationm^3/kg of COD removed.The respective graphs were presented in **Fig 1.7 to Fig 1.11.**

The maximum % of the COD removal was observed at 85.16% for an operating VLR of 2.005kg COD/m^3.day and HRT of 48 hrs. The minimum COD removal efficiency was observed at 65.59% for an operating VLR of 15.550Kg COD/m^3 day and HRT of 9.6 hrs.

The minimum VLR for which the model was operated is 0.960 Kg COD /m^3.day, for which the % of COD removal is 75.26% and the bio-gas generation was observed for 0.268 m^3/kg of COD removed.

The maximum VLR for which the reactor was operated is 15.550Kg COD/m^3.day for which the % of CODCOD removal in 65.59% and the bio-gas generation was observed for 0.224 m^3/kg of COD removed.

Themaximum bio-gas generation was observed for 0.309 m^3/kg of COD removed that correspondent COD removal efficiency was observed 75.85 %.

The minimum bio-gas generation was observed for 0.206 m^3/kg of COD removed that correspondent COD removal efficiency was observed 70.15 %.

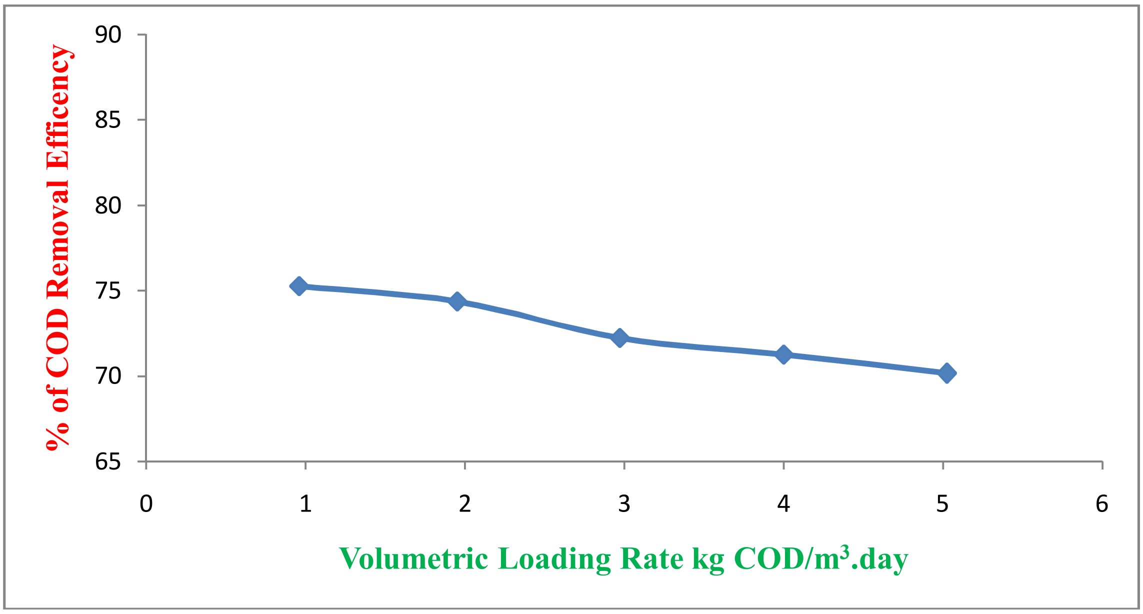

Fig 1.2 shows the volumetric loading rates0.960 to 5.025kg.COD/ m^3.day at % of COD removal.

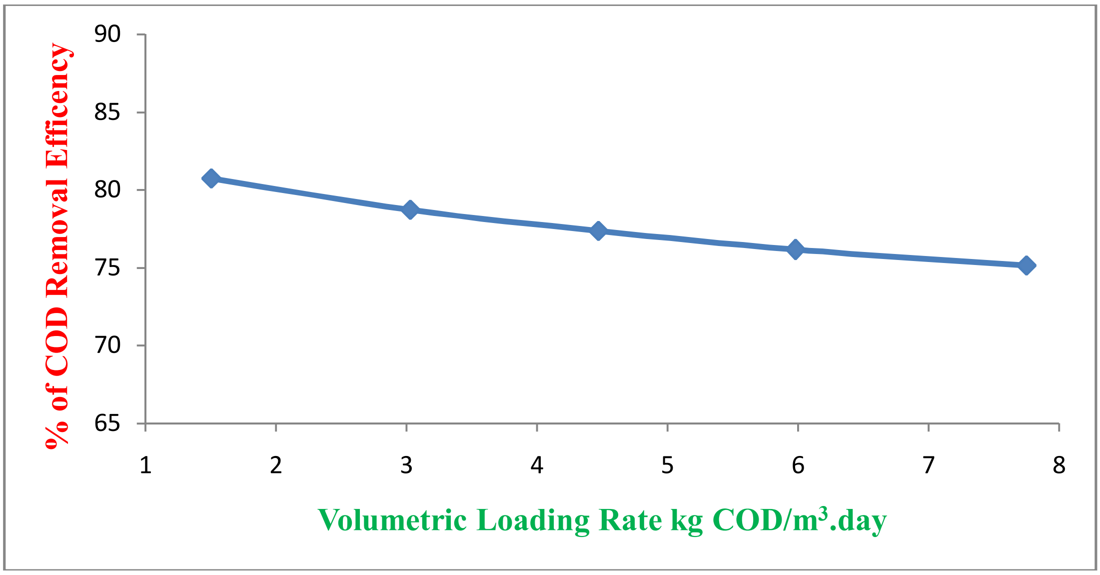

Fig 1.3 shows the volumetric loading rates 1.505 to 7.750kg.COD/ m^3.day at % of COD removal.

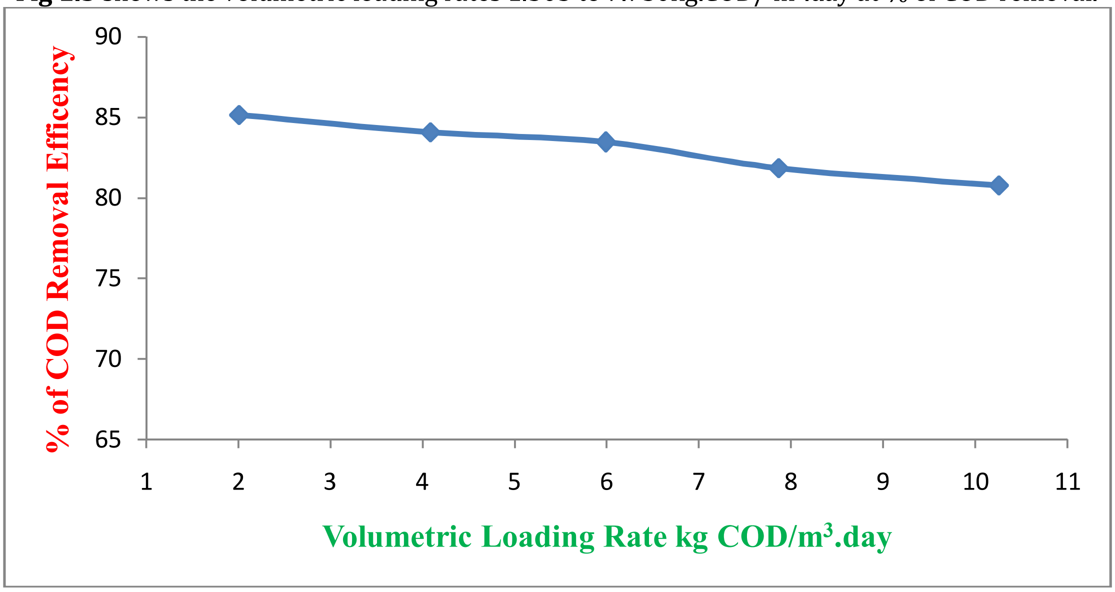

Fig 1.4 shows the volumetric loading rates 2.005 to 10.25kg.COD/ m^3.day at % of COD removal.

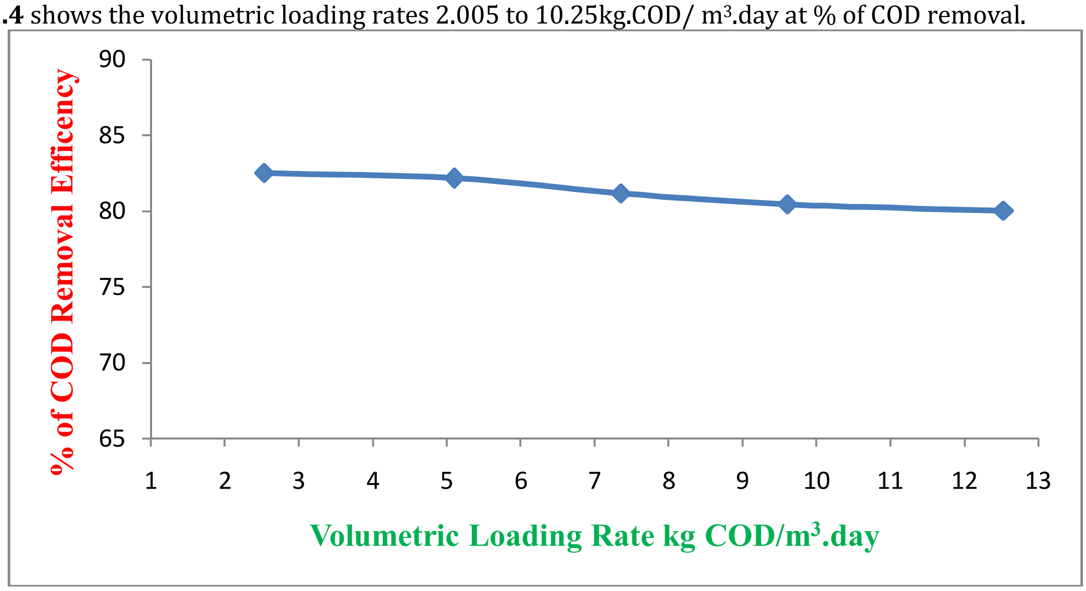

Fig 1.5shows the volumetric loading rates 2.530 to 12.525kg.COD/ m^3.day at % of COD removal.

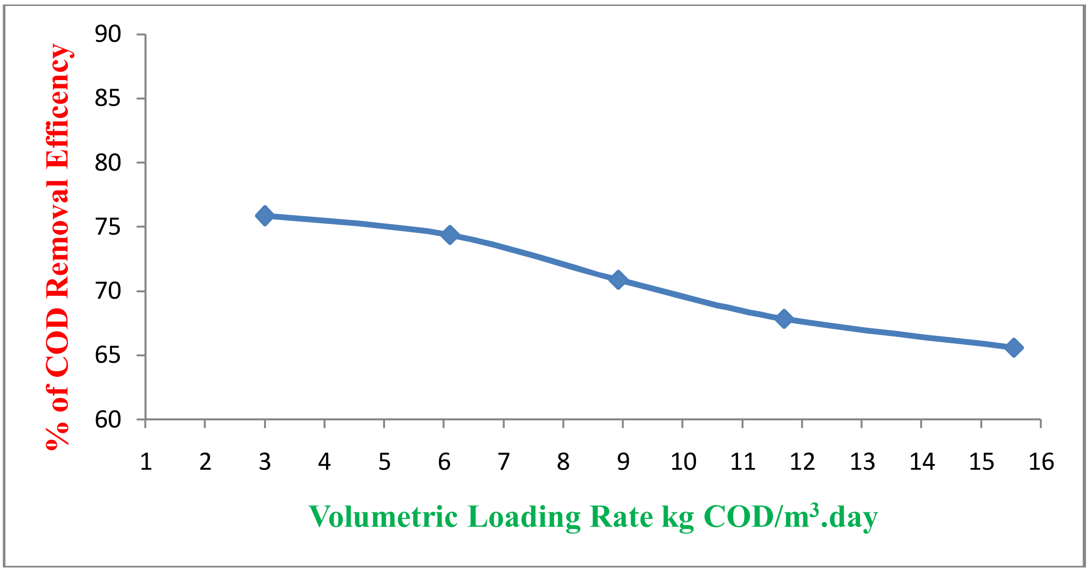

Fig 1.6 shows the volumetric loading rates 3.004 to 15.550kg.COD/ m^3.day at % of COD removal.

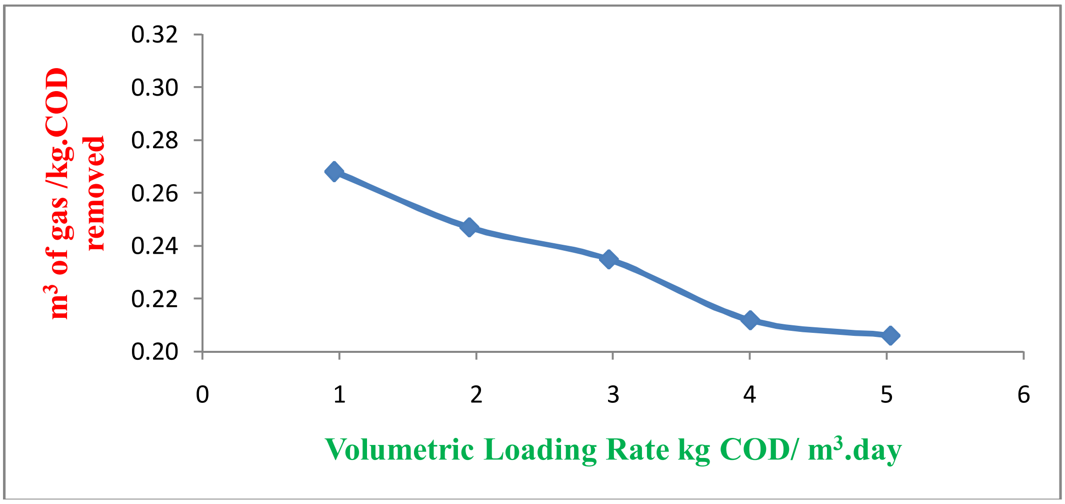

Fig 1.7shows the volumetric loading rates 0.960 to 5.025kg.COD/ m^3.dayat 0.268 to 0.206 $m^3$of gas/ kg.COD removed.

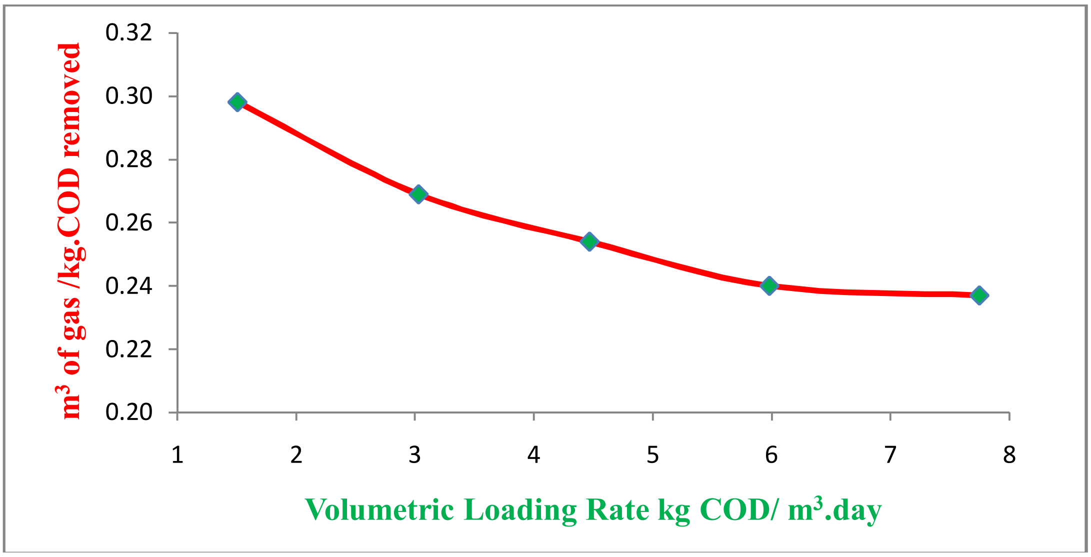

Fig 1.8shows the volumetric loading rates 1.505 to 7.750kg.COD/ m^3.dayat 0.298 to 0.237$m^3$of gas/ kg.COD removed.

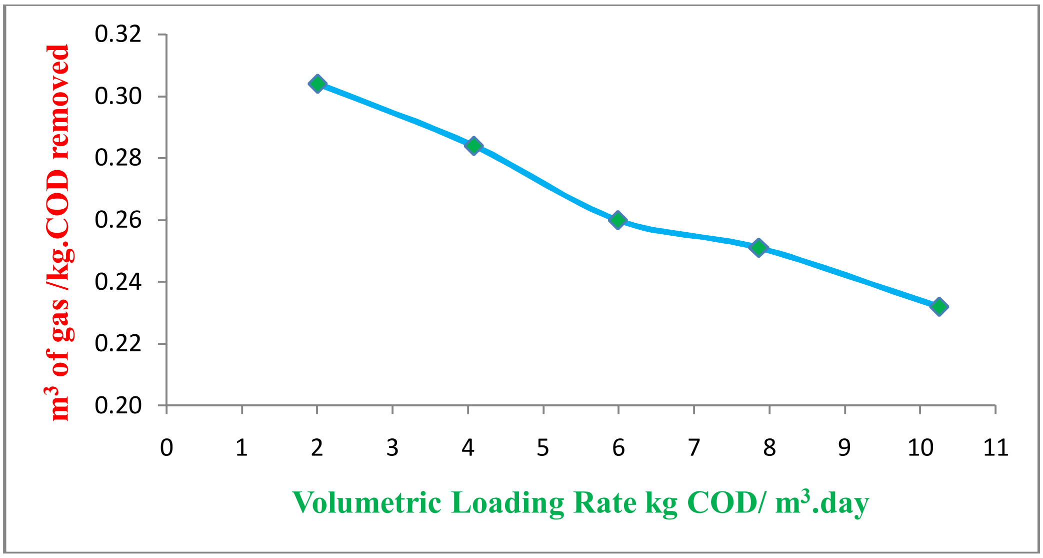

Fig 1.9 shows the volumetric loading rates 2.005 to 10.25kg.COD/ m^3.dayat 0.304 to 0.232$m^3$of gas/ kg.COD removed.

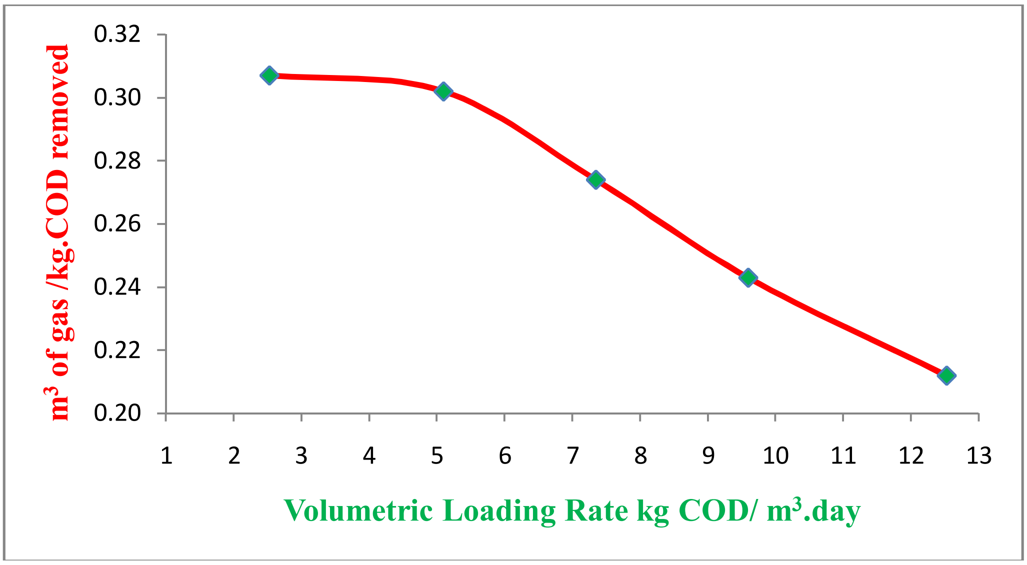

Fig 1.10shows the volumetric loading rates 2.530 to 12.525kg.COD/ m^3.dayat 0.307 to 0.212$m^3$of gas/ kg.COD removed.

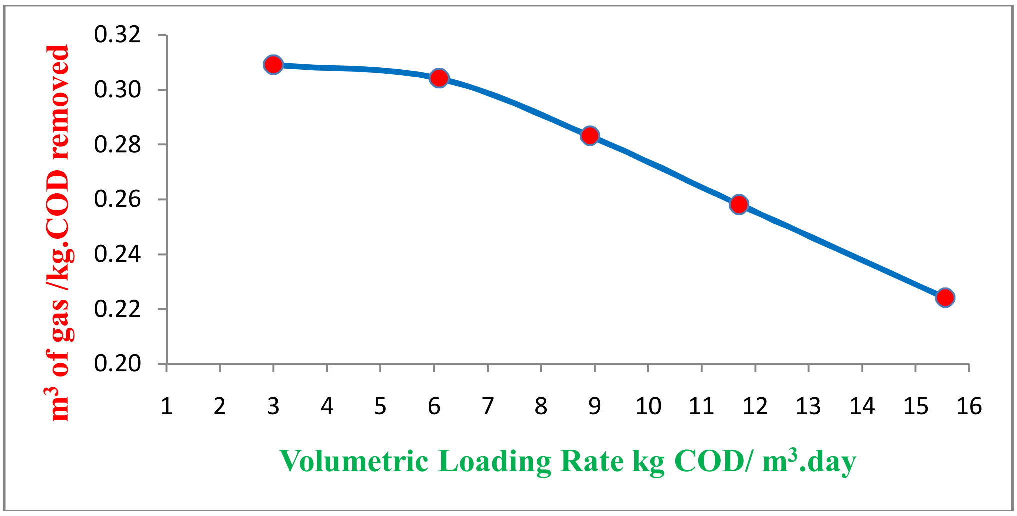

Fig 1.11shows the volumetric loading rates 3.004 to 15.550kg.COD/ m^3.dayat 0.309 to 0.224$m^3$of gas/ kg.COD removed.

CONCLUSION

The FBFF reactor is establish to treat sugarcane effluent for a maximum COD removal efficiency of 85.16 % with 0.309 m^3/kg COD removed. Therefore, it can be used for removing up to 85 % COD in sugarcane effluent.

REFERENCES

1. Danny C. K. Ko, John F. Porter , Gordon Mckay ,(2011). Film-pore diffusion model for the fixed-bed sorption of copper and cadmium ions onto bone char,Wat. Res, Vol. 35, No. 16,15: 3876–3886.
2. DariushElami and Kambiz Seyyedi, (2020). Removing of carmoisine dye pollutant from contaminated waters by photocatalytic method using a thin film fixed bed reactor. Journal of Environmental Science And Health, VOL. 55, NO. 2, Pages 193–208.
3. DuggiralaSrinivas M, Sheth Niraj T, Pawar Ashruti U , Bhatt Nikhil S, (2013). Isolation and characterization of bacteria from dye wastewater treating down flow fixed film reactor (DFFR) ,International Journal of Engineering Research & Technology,Vol. 2, Issue 10, Pages 3270 - 3280.
4. E. Sa Anchez, R. Borja, O. Reyes, M. Cruz, M.F. Colmenarejo, (1997). Treatment of sewage water from tourist areas by anaerobic fixed-bed reactor,World Journal of Microbiology & Biotechnology, vol 13, Pages 315 - 318.
5. G. Skodras Ir. Diamantopouloua, G. Pantoleontosc, G.P. Sakellaropoulos, (2008). Kinetic studies of elemental mercury adsorption in activated carbon fixed bed reactor , Journal of Hazardous Materials, 158 , Pages 1–13.
6. Hardik Patel and DattaMadamwar, (1999). Biomethanation of low pH petrochemical wastewater using up - flow fixed film anaerobic bioreactors,World Journal of Microbiology & Biotechnology ,16,23 Pages 69 - 75.
7. Harvey Gullicks , HasibulHasan, Dipesh Da, Charles Moretti , Yung-Tse Hung (2011). Biofilm fixed film systems,Water,3,31, Pages 843 – 868.
8. Hongguang Jin and Masaru Ishida, (2002). Reactivity Study on Natural-Gas-Fueled Chemical-Looping Combustion by a Fixed-Bed Reactor,Ind. Eng. Chem Res, 41 Pages 4004-4007.

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