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Performance of Fixed Bed Fixed Film (FBFF) Reactor Effect of Organic Loading Rate

S.Prabavathi[1], Dr.N.Manikumari[2], Dr.V.Nehru Kumar[3]

[1]Research Scholar, Department of Civil Engineering, Annamalai University, Annamalainagar-608002, Tamil Nadu.
[2,3]Professor, Department of Civil Engineering, Annamalai University, Annamalainagar-608002, Tamil Nadu.

Email: [1]prabavathi905@gmail.com.

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 Organic Loading Rates (OLR). The loading ranges between0.005- 0.075 kg COD/ m^2.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 theHydraulic Retention Time of 48, 24, 16, 12 and 9.6 hrs.

Keywords: FBFF, COD, OLR, HRT and Plastic Modules.

1. INTRODUCTION

Now a day's increase in industrialization, the industrial effluents are produced in huge amounts having high organic content and if treated using appropriate technology can result in the generation of the source of energy. Proper disposal of industrial effluent 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 the sources of surface water and underground water.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.

Sources of Sugarcane Wastewater

The Sugar cane is collected, cleaned and washed before it is crushed to yield the juice from it. The juice is evaporated for the removal or evaporation of water to get sugar crystals. The sugar cane is first washed with fresh water and then it is shredded using shredding machine in the Mill house and sent for crushing to extract the juice from the sugar cane. About 93% of the juice is extracted and the fibrous residue will be left as Bagasse. The extracted juice is screened for removing the floating impurities. After screening, milk of lime is added to increase the pH from 7.6 to 7.8 in order to prevent from corrosion and to aid clarification by coagulating the colloidal impurities along with the addition of a coagulant aid. The mixture is pre heated using high-pressure steam and allowed to settle. The clarified juice is bleached and sent for evaporation, where the juice is reclaimed. The residue result in the filters is called Pressmud. The concentrated juice after evaporation is fed into a Multiple Effect Evaporator, where the sugar is concentrated. The concentrated syrup is known as massecuite which will be passed into a crystallizer. The crystal and syrup is separated in the Centrifuge systems. The spent liquor is collected as molasses and the sugar crystals are collected and dried as Sugar.

2. EXPERIMENTAL METHODOLOGY

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 isfind out with performance for treating sugarcane Industrial wastewater and biochemical reaction kinetic studies.The reactor model of FBFF was constructed based on an empirical design approach for 24.36 litres of effective volume. The size 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.

FBFF Reactor - Laboratory Model

The treatedeffluent 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 modelare drawn from the empirical approach.The effectivevolume 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 diagram of the reactor is presented in **figure 1.1** respectively.

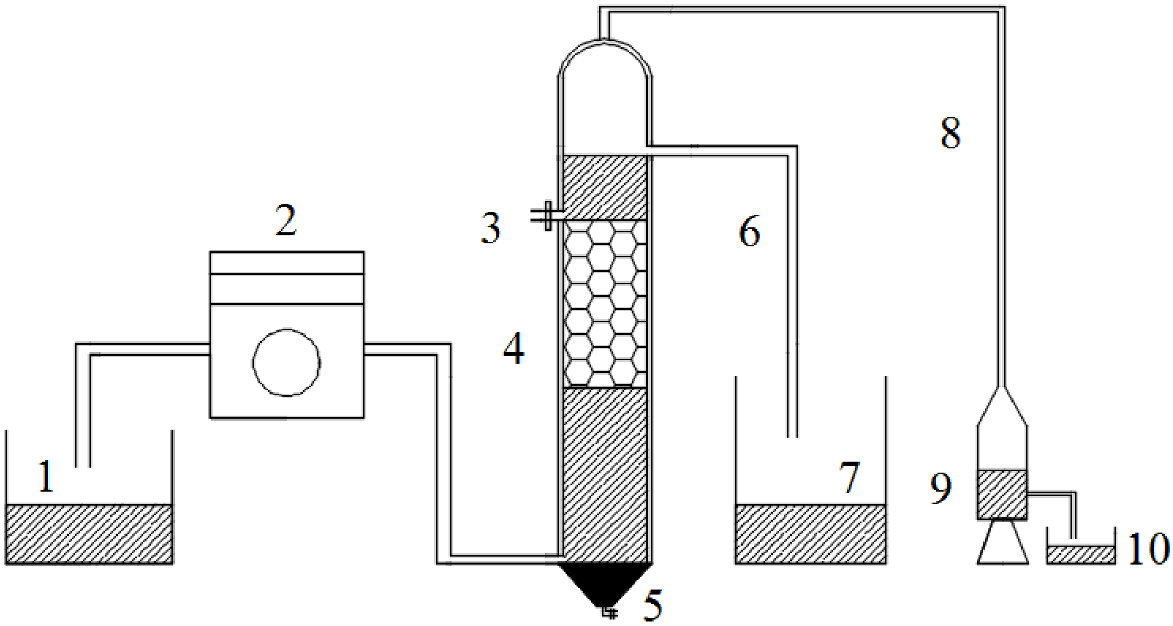

Fig 1.1 Diagram of Experimental Setup.

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

The design of reactor is construct on the basis ofFlow Rate,Influent COD, Hydraulic Retention Time, Volumetric Loading Rate, Hydraulic Loading Rate,ReactorVSSand 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 3.1 Physical Dimensions with Process Parameters of Experimental Model: 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, 2.0 and 2.5.
Influent COD, mg/lit	1972, 3022, 4022, 4974, 6024

For synthetic sugarcane effluent, mg/lit	
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 Sugar Mill effluent 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 laboratory model was started with % of 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.

3. 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 Organic Loading Rates varies from 0.005 to 0.075 kg.COD/ m^2.day.Considering the evaluation of the model in respect of the% of COD removal, the experimental model results were accounted for OLR.The appropriate graphs were presented in **Fig 1.2 to Fig 1.6.**Considering the evaluation of the model in respect of OLR, the experimental model results were accounted for bio-gas generationm^3/kg of COD removed.Theappropriate graphs were presented in **Fig 1.7 to Fig 1.11.**

The maximum % of COD removal was observed at 85.16% for an operating OLR of 0.010 kg COD/m^2.day and HRT of 48 hrs. The minimum COD removal efficiency was observed at 65.59% for an operating OLR of 0.075 Kg COD/m^2 day and HRT of 9.6 hrs. The minimum OLR for which the model was operated is 0.005 Kg COD /m^2.day, for which the % of COD removalis 75.26% and the bio-gas generation was observed for 0.268 m^3/kg of COD removed.The maximum OLR for which the reactor was operated is 0.075 Kg COD/m^2.day for which the COD removal efficiency 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 %.

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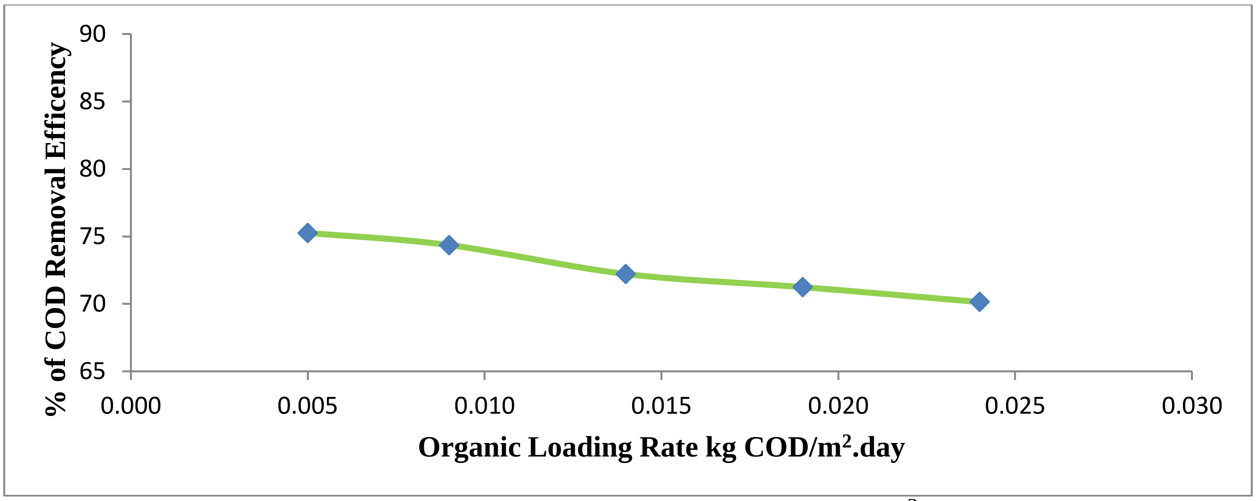

Fig 1.2 shows the organic loading rates 0.005 to 0.024 kg.COD/ m^2.day at % of COD removal.

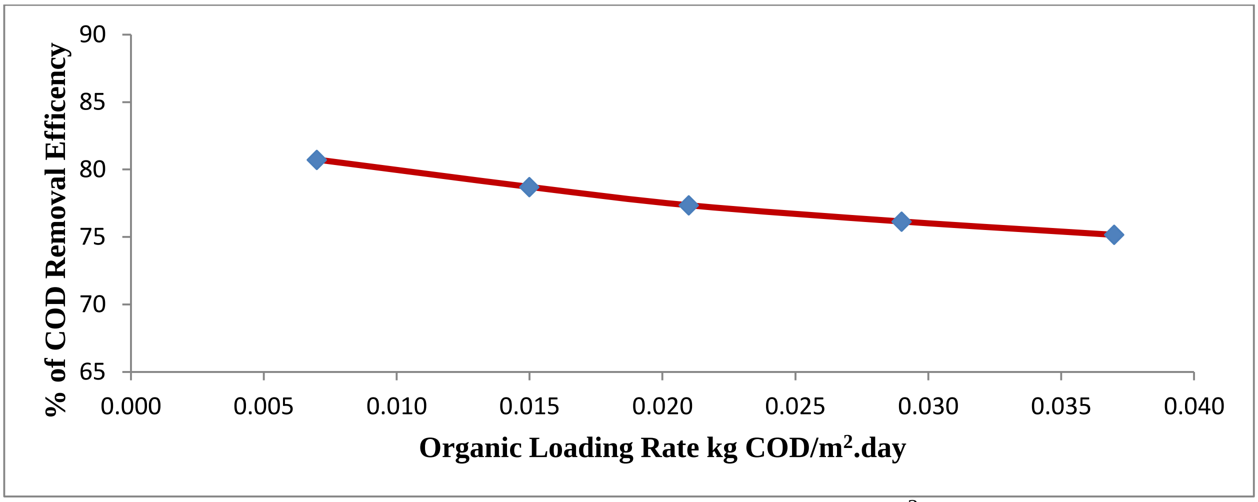

Fig 1.3 shows the organic loading rates 0.007 to 0.037 kg.COD/ m^2.day at % of COD removal

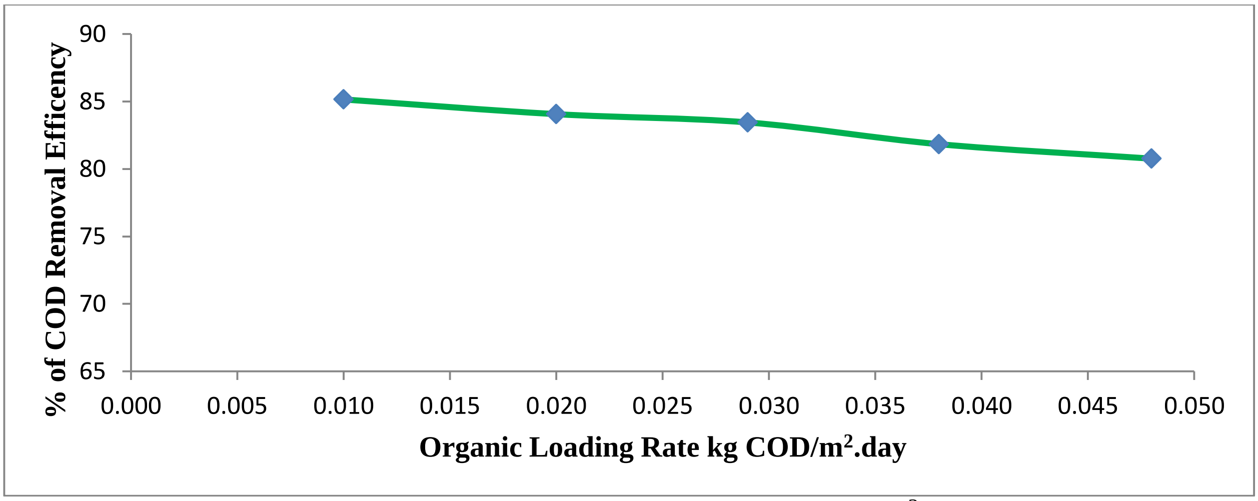

Fig 1.4 shows the organic loading rates 0.010 to 0.048 kg.COD/ m^2.day at % of COD removal.

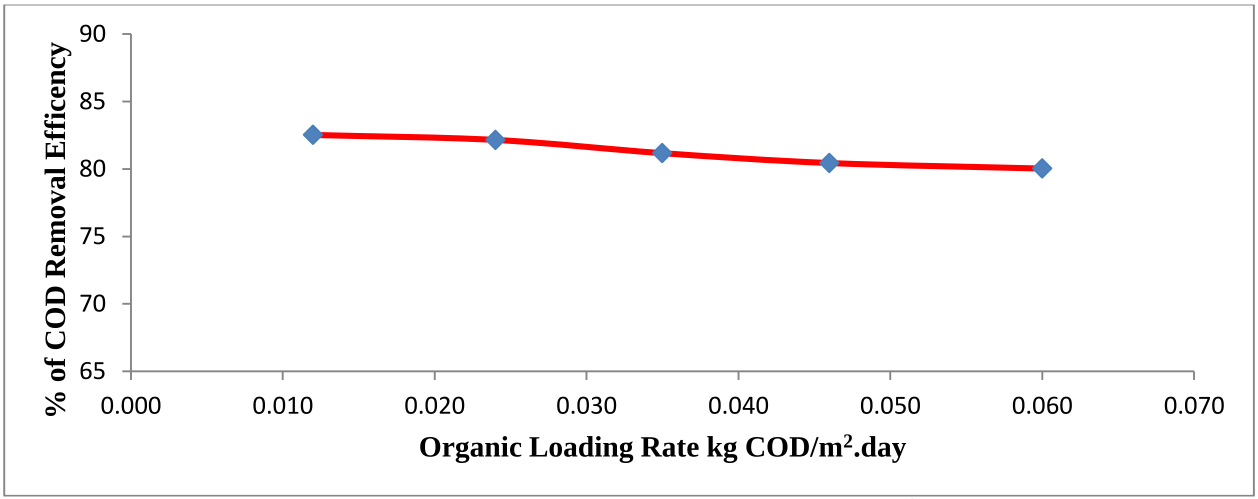

Fig 1.5 shows the organic loading rates 0.012 to 0.060 kg.COD/ m^2.day at % of COD removal.

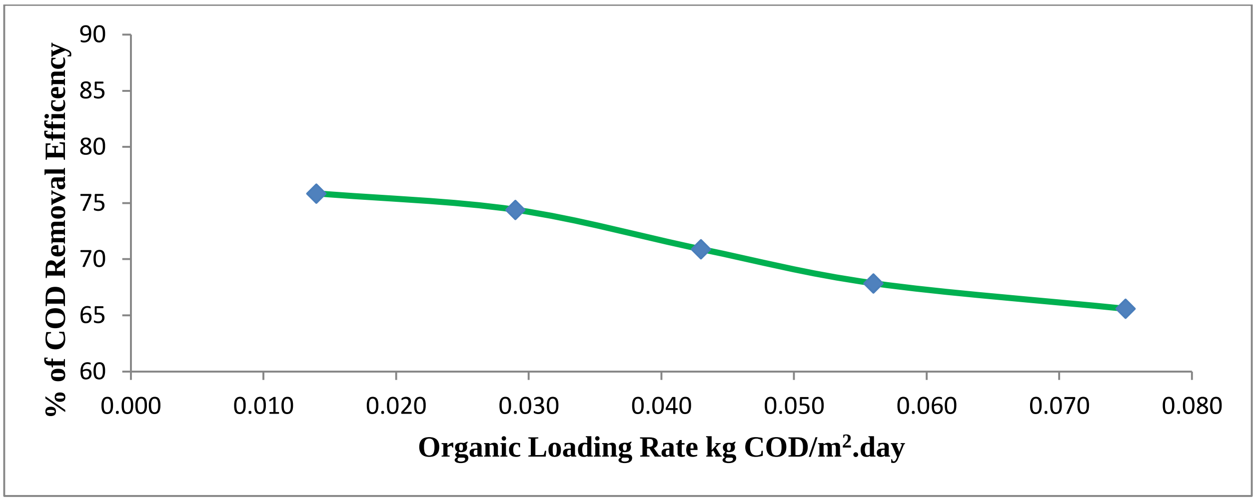

Fig 1.6 shows the organic loading rates 0.014 to 0.075 kg.COD/ m^2.day at % of COD removal.

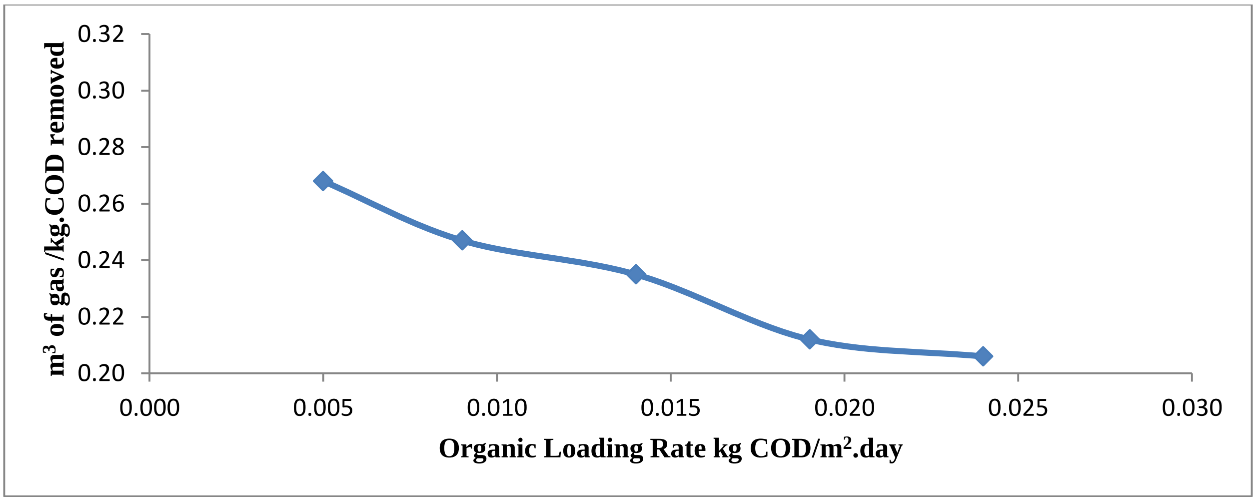

Fig 1.7 shows the organic loading rates 0.005 to 0.024 kg.COD/ m^2.day at 0.268 to 0.206 m^3 of gas/ kg.COD removed.

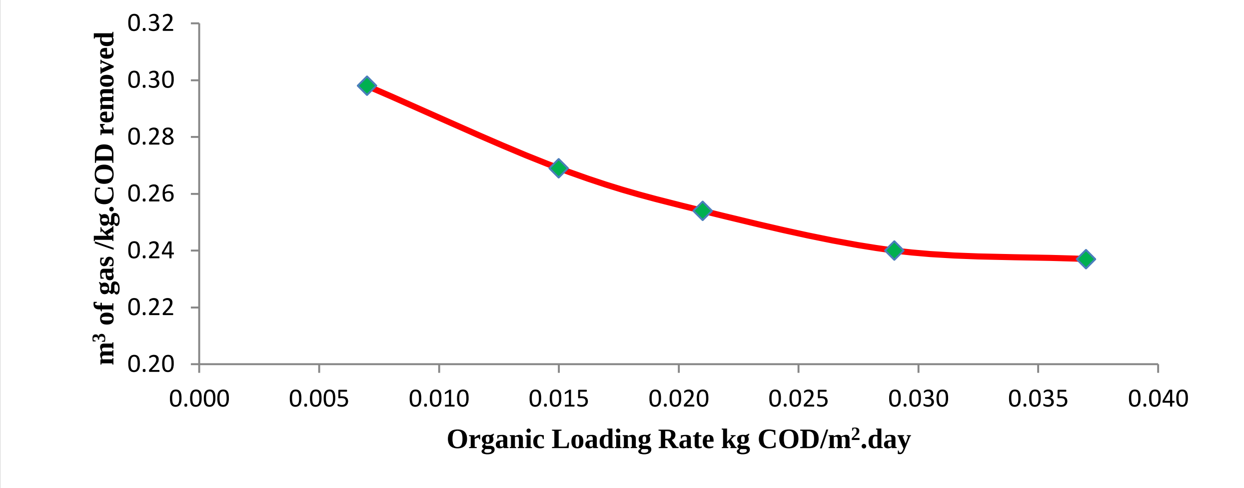

Fig 1.8 shows the organic loading rates 0.007 to 0.037 kg.COD/ m^2.day at 0.298 to 0.237m^3 of gas/ kg.COD removed.

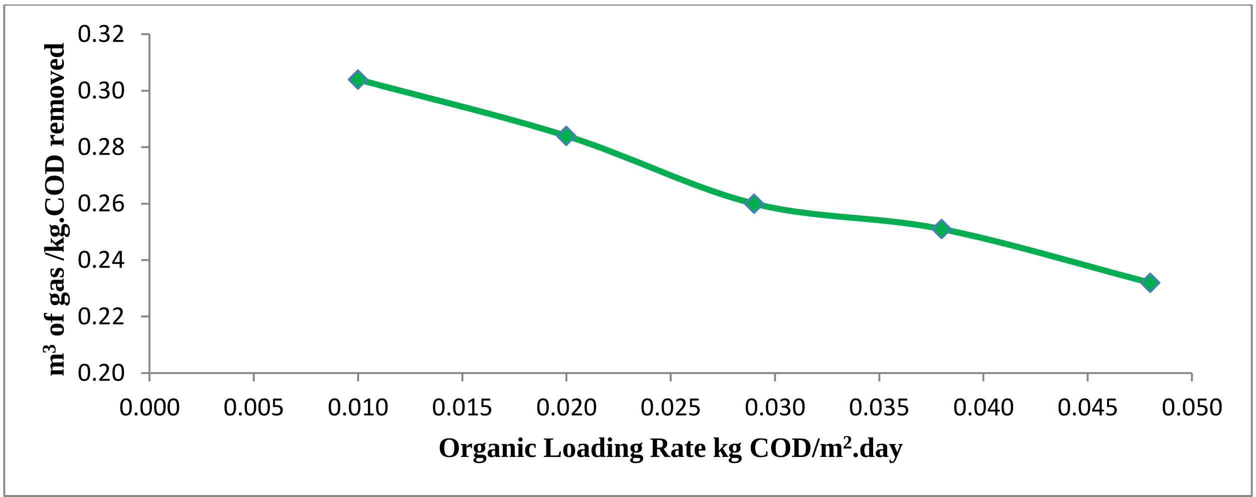

Fig 1.9 shows the organic loading rates 0.010 to 0.048 kg.COD/ m^2.day at 0.304 to 0.232 m^3 of gas/ kg.COD removed.

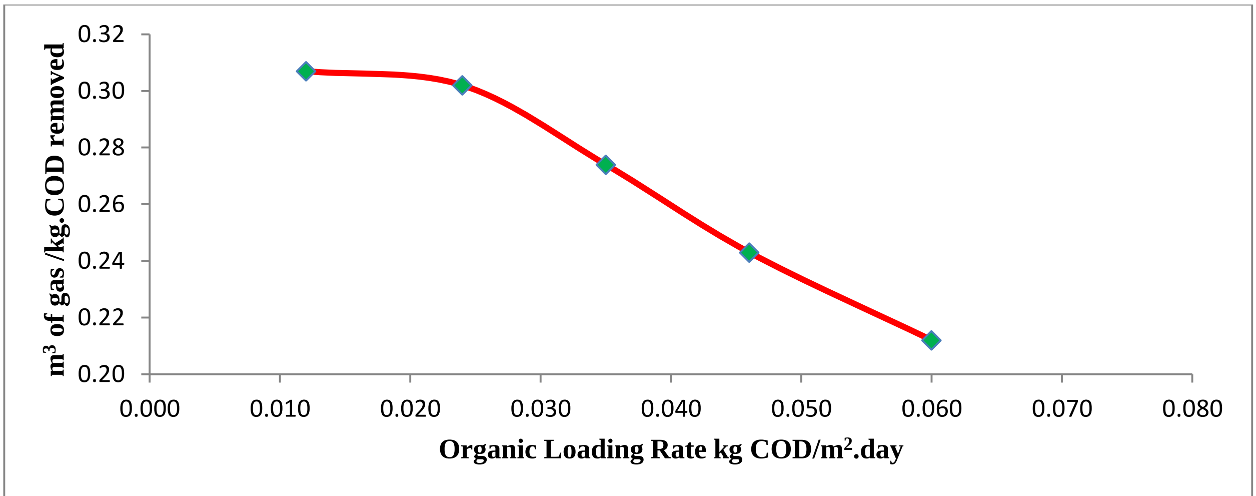

Fig 1.10 shows the organic loading rates 0.012 to 0.060 kg.COD/ m^2.day at 0.307 to 0.212 m^3 of gas/ kg.COD removed.

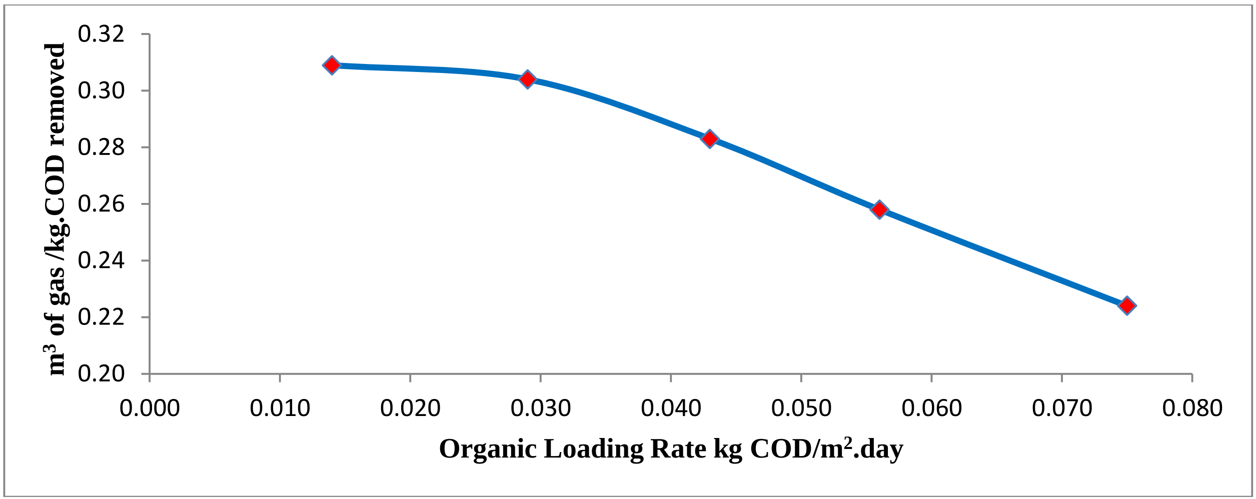

Fig 1.11 shows the organic loading rates 0.014 to 0.075 kg.COD/ m^2.day at 0.309 to 0.224 m^3 of gas/ kg.COD removed.

4. 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.

5. REFERENCES

[1] **Danny C. K. Ko, John F. Porter , Gordon Mckay ,**Film-pore diffusion model for the fixed-bed sorption of copper and cadmium ions onto bone char,Wat. Res, Vol. 35, No. 16,15 February 2001,Pages 3876–3886.

[2] **DariushElami and KambizSeyyedi,**Removing of carmoisine dye pollutant from contaminated waters by photocatalytic method using a thin film fixed bed reactor,Journal of environmental science and health, 2020, VOL. 55, NO. 2, Pages 193–208.

[3] **Duggirala Srinivas M, Sheth Niraj T, Pawar Ashruti U , bhattnikhil s,**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, October - 2013, Pages 3270 - 3280.

[4] **E. Sa Anchez, R. Borja, O. Reyes, M. Cruz, M.F. Colmenarejo,**Treatment of sewage water from tourist areas by anaerobic fixed-bed reactor,World Journal of Microbiology & Biotechnology, vol 13,1997, Pages 315 - 318.