A Study on Sugarcane Wastewater Using High Rate Anaerobic Digester

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Abstract

The biodegradable industrial waste stream, with inhibiting COD concentrations for aerobic treatment requires anaerobic treatment in the first step. Anaerobic Fixed Bed Fixed Film Reactor (AFBFFR) is one of the simpler and high rate digesters in wastewater treatment. Synthetic fill media is used to hold the active bio mass in packing of fixed bed fixed film reactor. Sugar industry is one of the agro based industries located in rural areas. This reactor can be an appropriate option to upgrade the efficiency of the existing treatment plant. The present study was an experimental work carried out with a laboratory model on Anaerobic FBFF reactor for evaluating the biochemical processes and kinetic processes for treating biodegradable industrial waste streams. The study was conducted specifically for wastewater from sugar industries. The experimental results were used to evaluate the COD removal efficiency of the Anaerobic FBFF reactor and mathematical models were developed to characterize the biochemical process kinetics to enable the design of the Anaerobic FBFF reactor.

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

Introduction

Biological treatment methods are very less costly and evolve less toxic by - products compared to the physico - chemical treatment methods. The sugar industry's effluent is the best biodegradable waste stream. Such industries are water intensive with a huge requirement of water for utilizing boiler and grey areas like washings, cleanings, groundwater recharge, green belt etc.

The “zero waste” frame work requires the best of anaerobic process that can provide high COD removal efficiency, in the top most place of the treatment hierarchy for treating high COD waste streams in the agro based industries such are require zero discharge plants so as to reclaim water for recycle.

Fixed Bed Fixed Film (FBFF) reactor is based on a modular anaerobic process requires evaluation of its bio kinetics which is waste-specific. The treatment efficiency depends on the media for biomass attachment and its hydro dynamics in the process of treatment in the reactor.

Literature Review

Conducted a feasibility study on the use of fibrous material as a fixed medium for wastewater treatment utilising the fibre from coconut coir. The purpose of this study was to assess the possibility for organic and nutrient removal utilising coconut coir as a fixed bed of naturally occurring fibrous media. The medium was run in batch mode for 24 hours while grab samples were taken to treat the domestic wastewater. In this research effort, coconut coir was used with two different packing densities of 40 kg/m3 and 70 kg/m3, and media depths of 120 mm and 150 mm, respectively (Sudharani S. V. *et al.* (2016)).

FBFF Reactor - Laboratory Model

The FBFFR model, which is designed for flexi glasses, is part of the experimental setup. The reactor's cylindrical part has a diameter of 0.2 m and a height of 1.05 m. In order to prevent any air fit-up, the reactor's top was hermetically sealed. 41% by volume of polypropylene microbiological support media is placed within the reactor. A peristaltic pump of Miclin's brand (model pp-15) is used to feed the reactor from the inflow (sugarcane wastewater) tank. Pumps are used to pump the effluent upward while it travels through packed material at the bottom. To maintain anaerobicity, the top was closed and two ports were provided: one for desludge at the bottom and another for sample at the bottles. Additionally, it hinders any potential natural aeration system.

The model was run using sugarcane effluent that was introduced into the reactor in batch mode starting on the 94th day after the actual date of reactor commissioning. The model was fed with real-time effluent from sugarcane wastewater, which was made to pump slowly in phases of 20%, 40%, 60%, 80%, and 100% over the course of two weeks. The real-time effluent was then mixed with synthetic effluent and replaced over the course of the following two weeks in increments of 20%, 40%, 60%, 80%, and 100%.

As the treated wastewater began to emerge as a clear, colourless liquid, the observations on the laboratory model began with COD removal, and the biogas generation was noted at a maximum of 0.29 m^3 per kilogramme COD removed.

Environmental Impact of Untreated Sugarcane Effluent

i. The Climatic change.
ii. The waste stream from sugarcane is rich in organic materials. The high strength organic ingredients have high BOD, COD, and SS levels, are dark green in colour, have an acidic pH, and are acidic in nature, which causes low DO (Dissolved Oxygen) in water bodies and deleterious effects on aquatic life.
iii. Additionally, the photosynthetic activity is decreased by high strength organic components because they prevent sunlight from penetrating rivers, lakes, and bonds.
iv. Directly impact the development of plants and animals, as well as indirectly impacting people.

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.

Considering the evaluation of the reactor model in respect of the % of COD removal the experimental model results were accounted for HRT. The appropriate graphs were presented in **Fig 1.1 to Fig 1.5.**

Considering the evaluation of the reactor model in respect of HRT, the experimental model results were accounted for bio-gas generation m^3/kg of COD removed. The respective graphs were presented in **Fig 1.6 to Fig 1.10.**

The maximum % of COD removal was observed at 85.16% for an operating HRT of 48 hrs. The minimum COD removal efficiency was observed at 65.59% for operating HRT of 9.6 hrs.The maximum bio-gas generation was observed for 0.309 m^3/kg of COD removed that correspondent HRT of 48 hrs and the % of COD removal was observed 75.85 %.

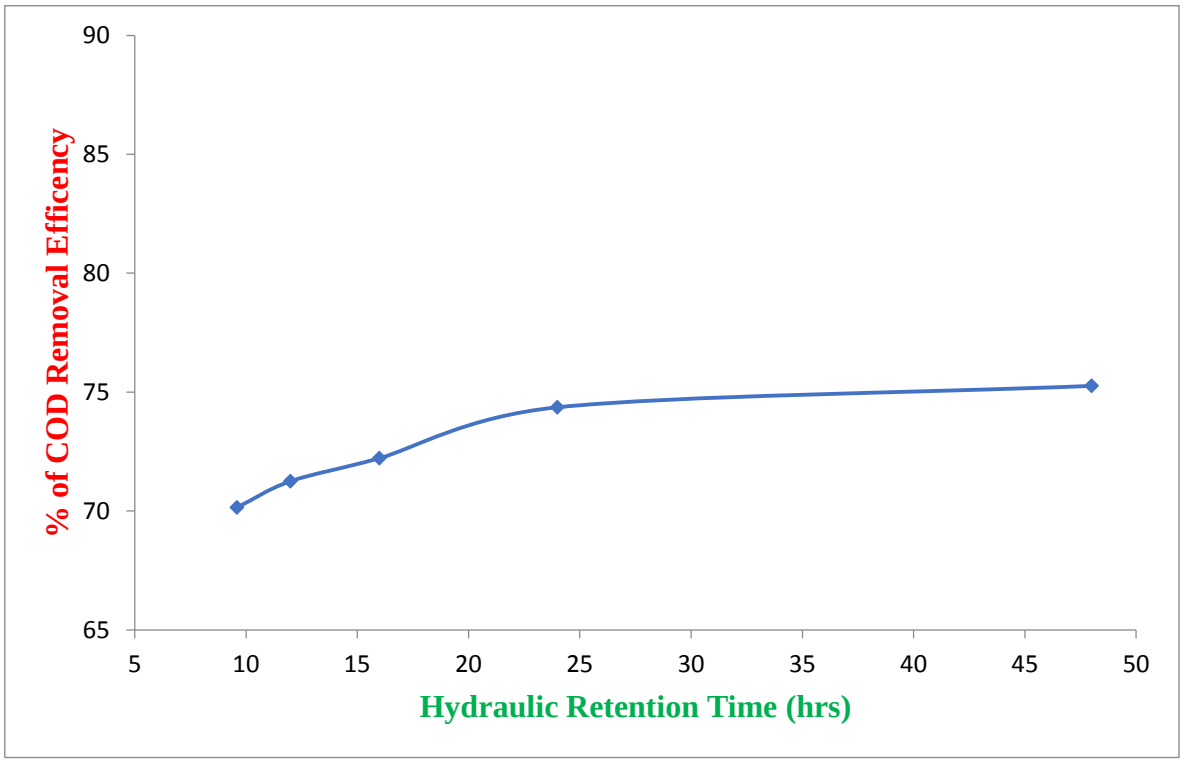

Fig 1.1 shows the HRT 9.6 to 48 hrs at % of COD removal.

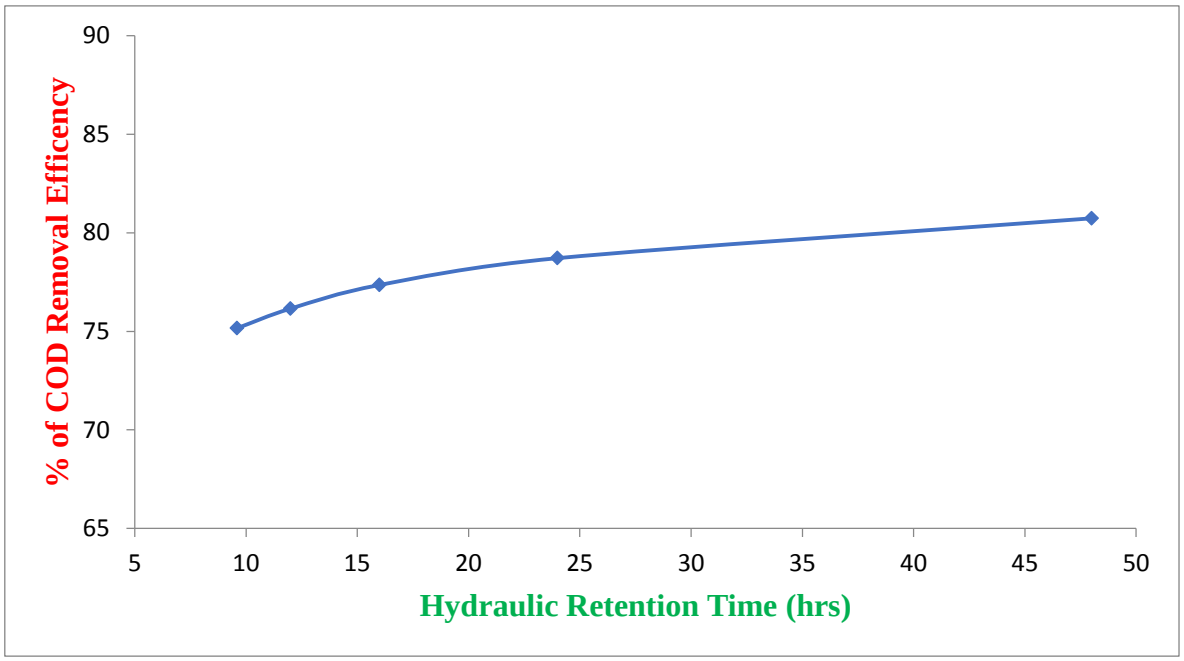

Fig 1.2 shows the HRT 9.6 to 48 hrs at % of COD removal.

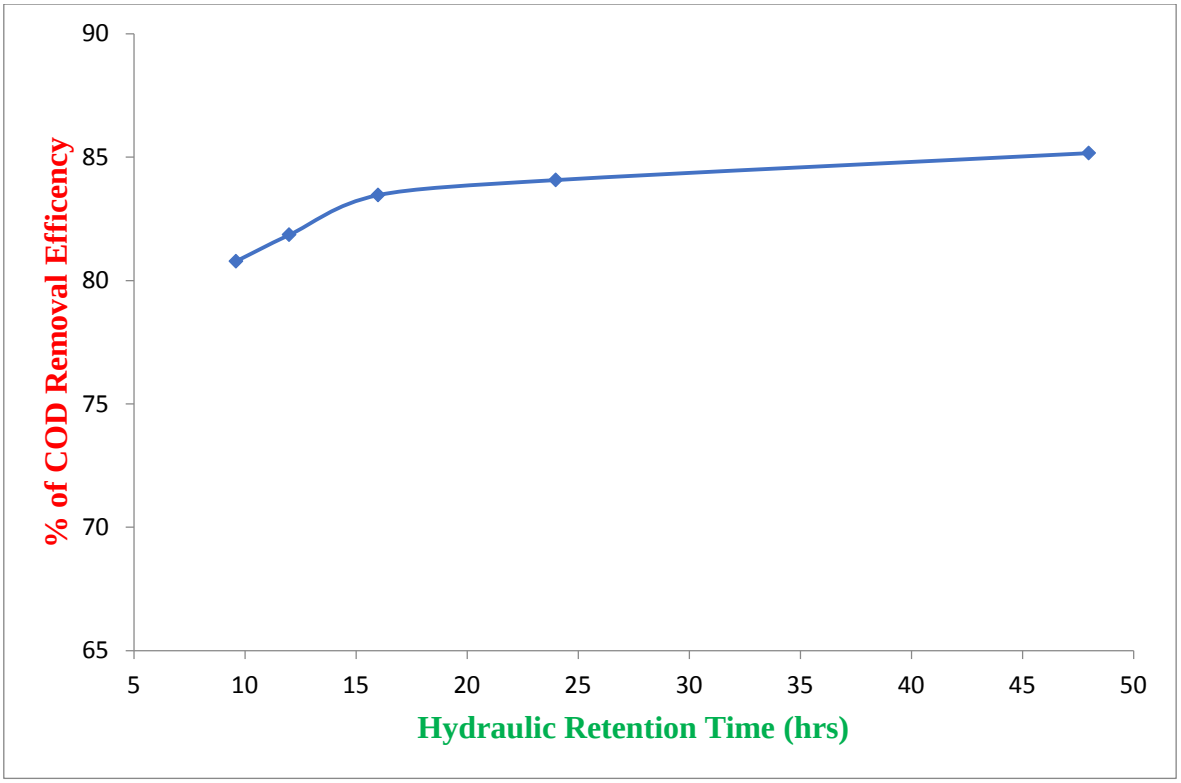

Fig 1.3 shows the HRT 9.6 to 48 hrs at % of COD removal.

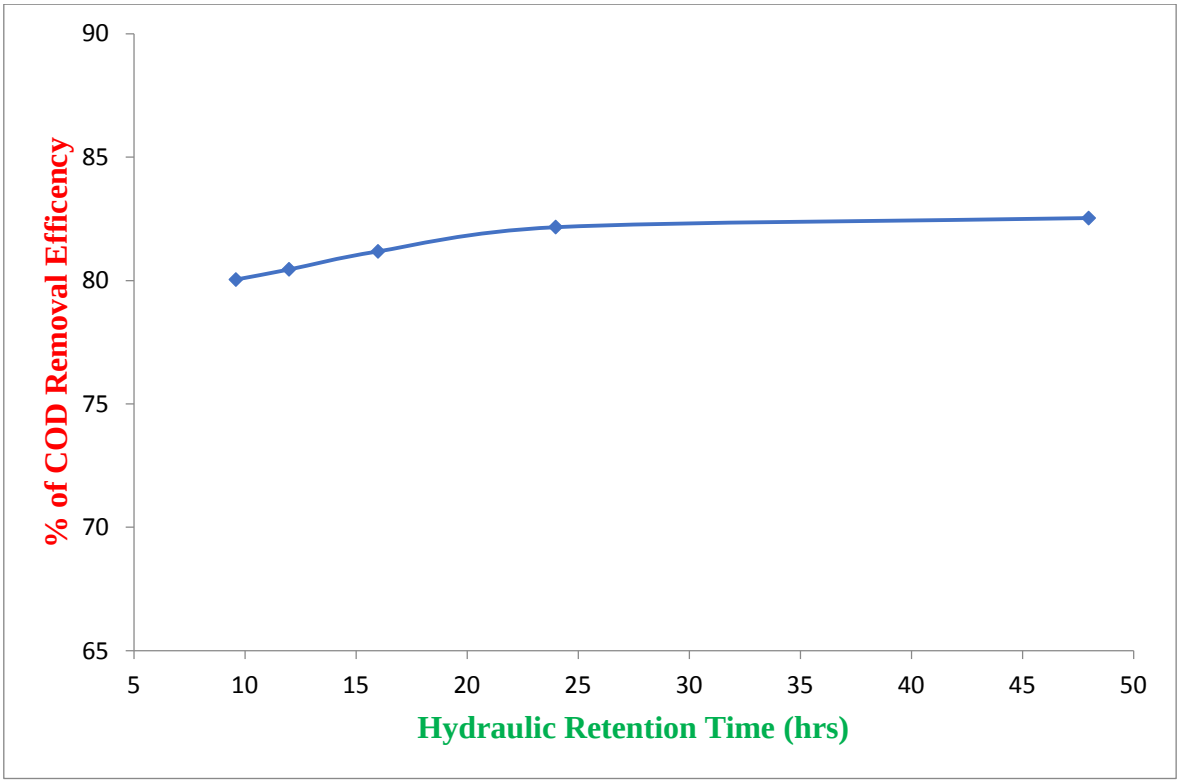

Fig 1.4 shows the HRT 9.6 to 48 hrs at % of COD removal.

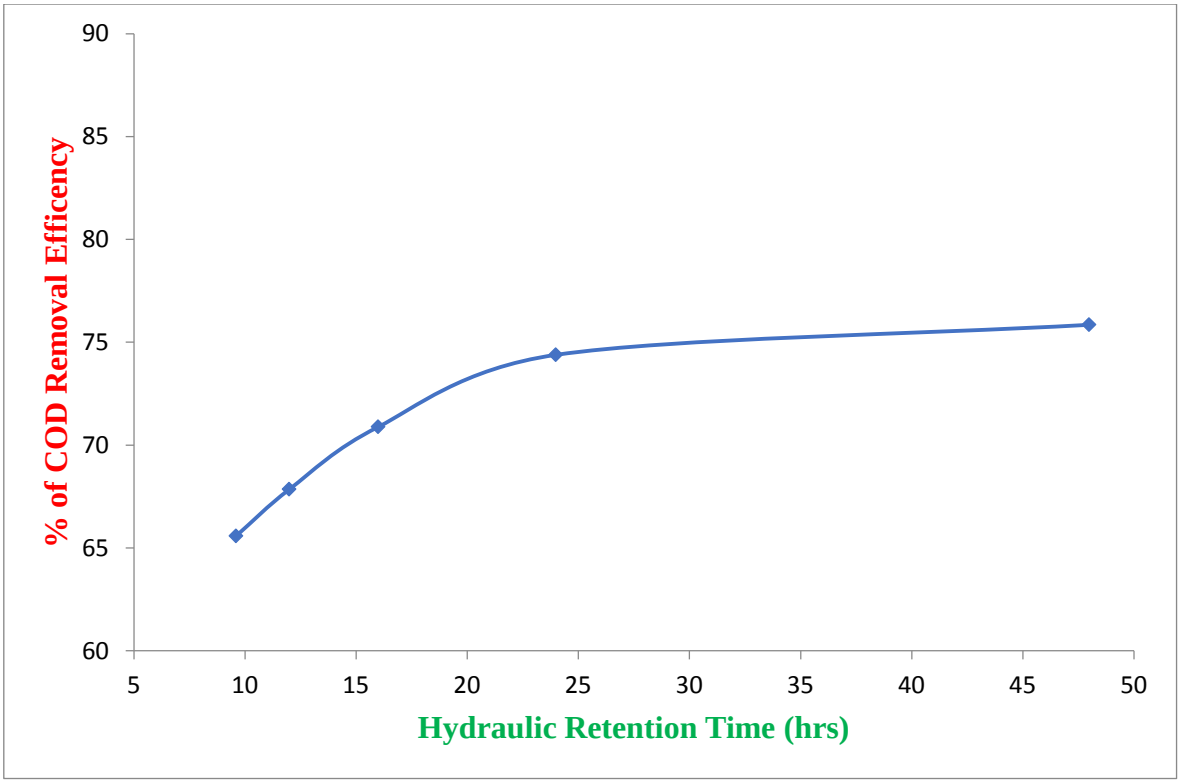

Fig 1.5 shows the HRT 9.6 to 48 hrs at % of COD removal.

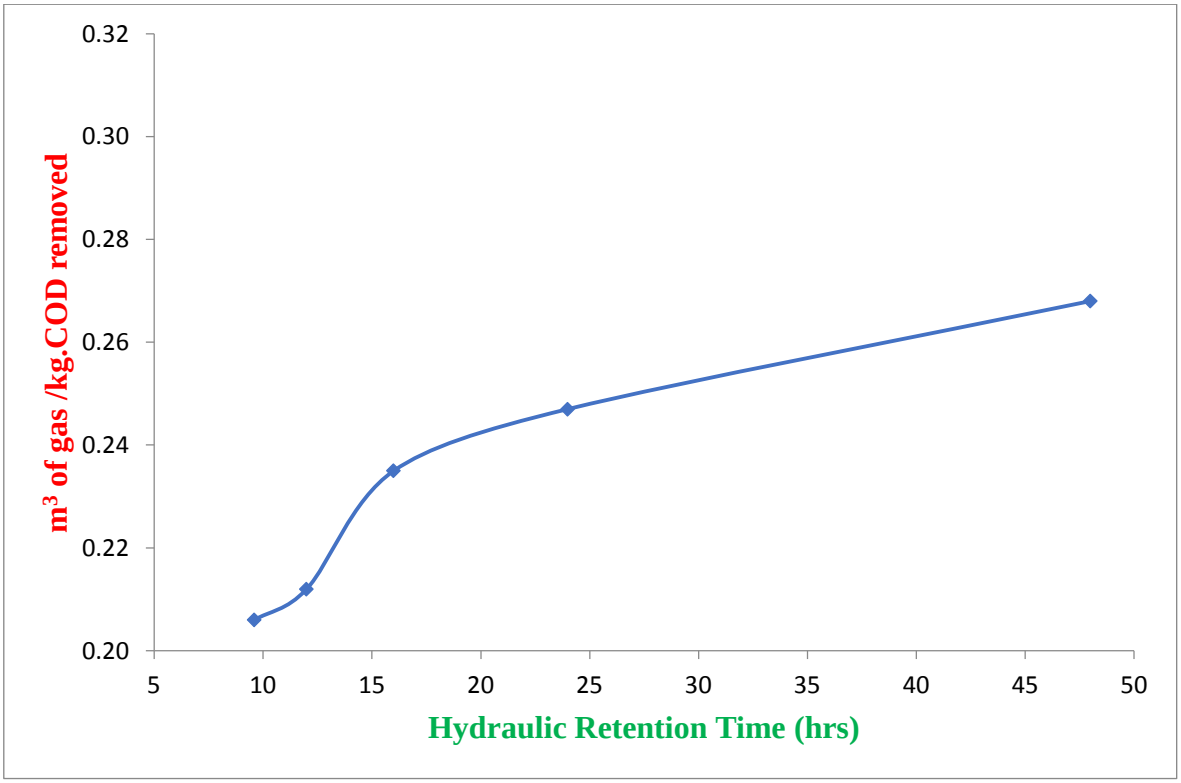

Fig 1.6 shows the HRT 9.6 to 48 hrs at 0.206 to 0.268 m^3 of gas / kg.COD removed.

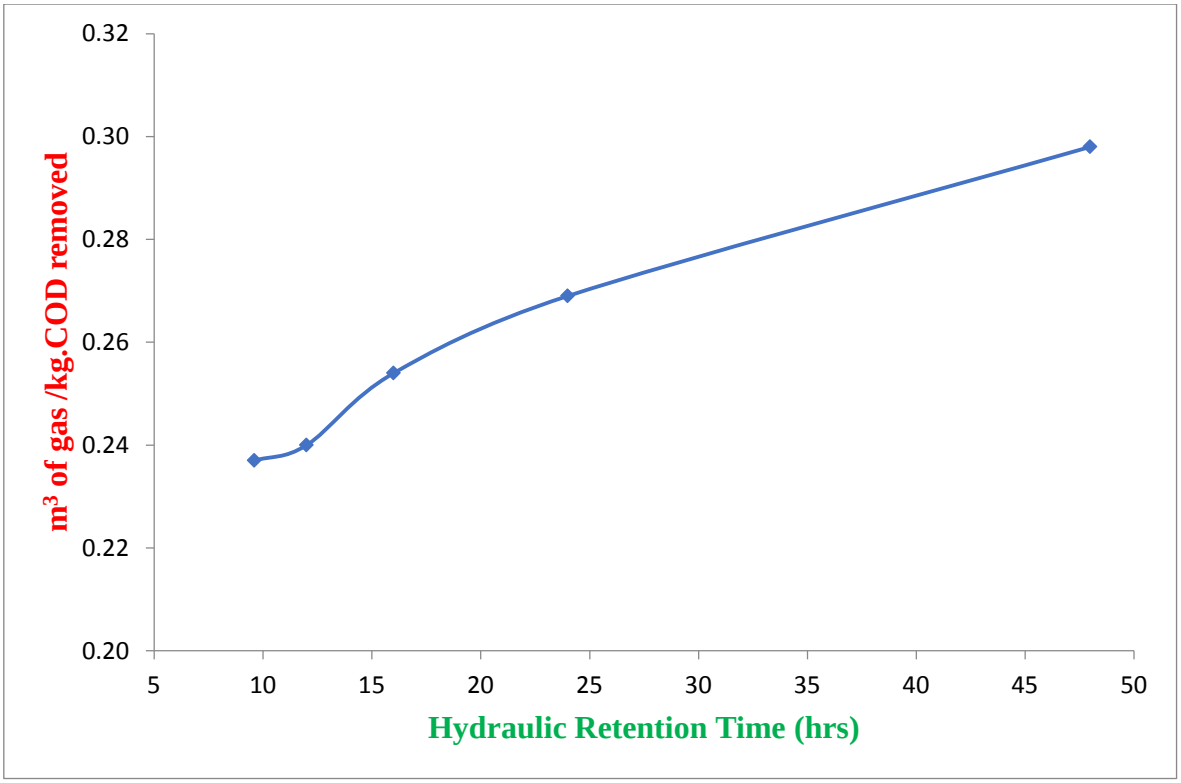

Fig 1.7 shows the HRT 9.6 to 48 hrs at 0.288 to 0.298 m^3 of gas / kg.COD removed.

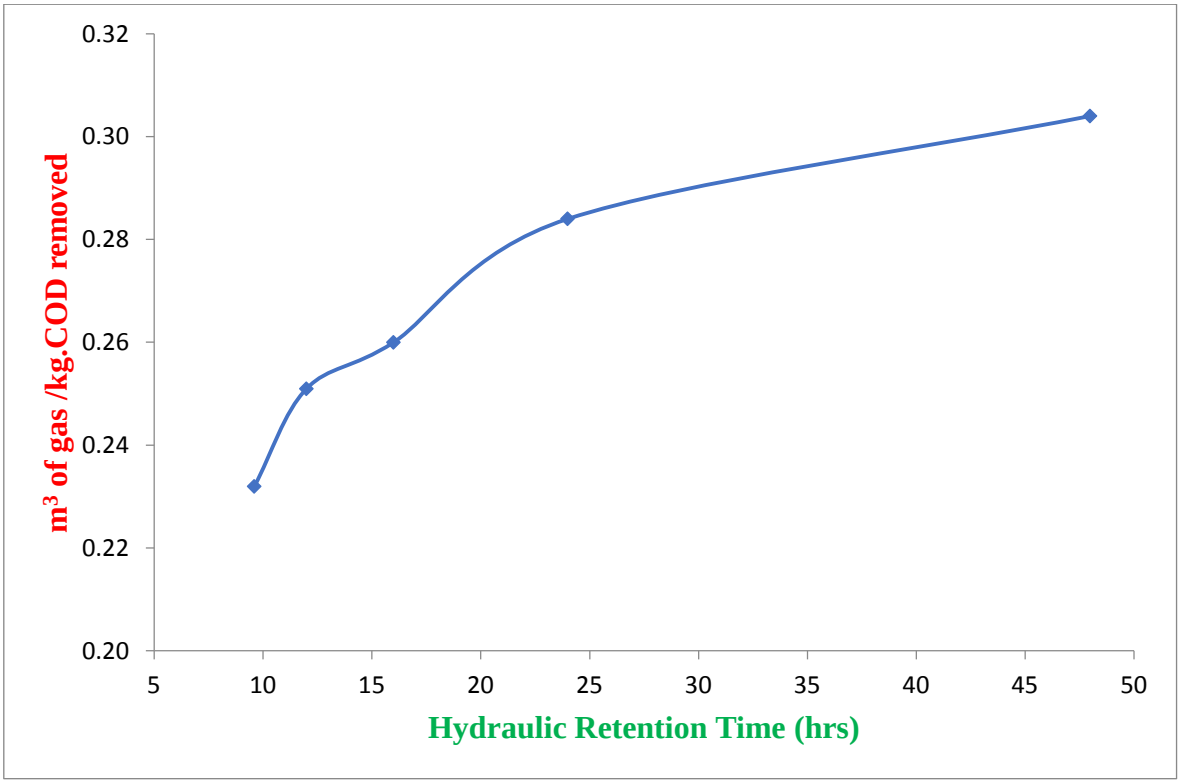

Fig 1.8 shows the HRT 9.6 to 48 hrs at 0.232 to 0.304 m^3 of gas / kg.COD removed.

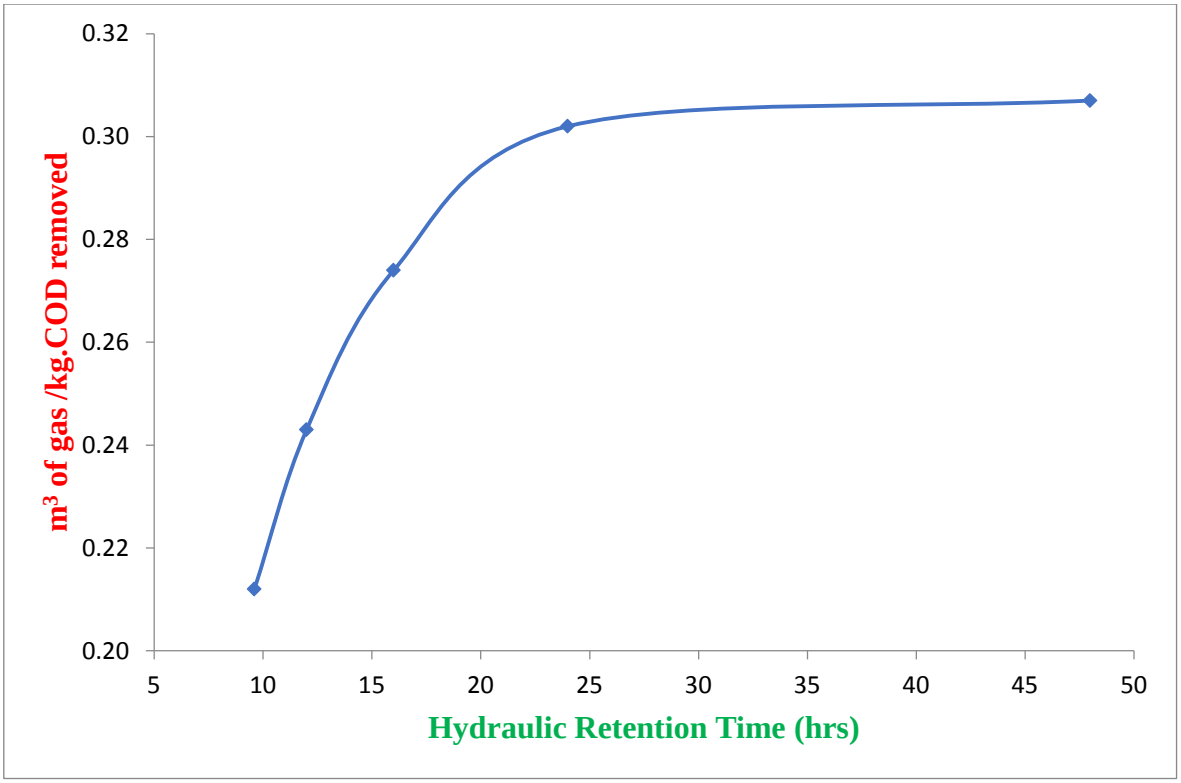

Fig 1.9 shows the HRT 9.6 to 48 hrs at 0.212 to 0.307 m^3 of gas / kg.COD removed.

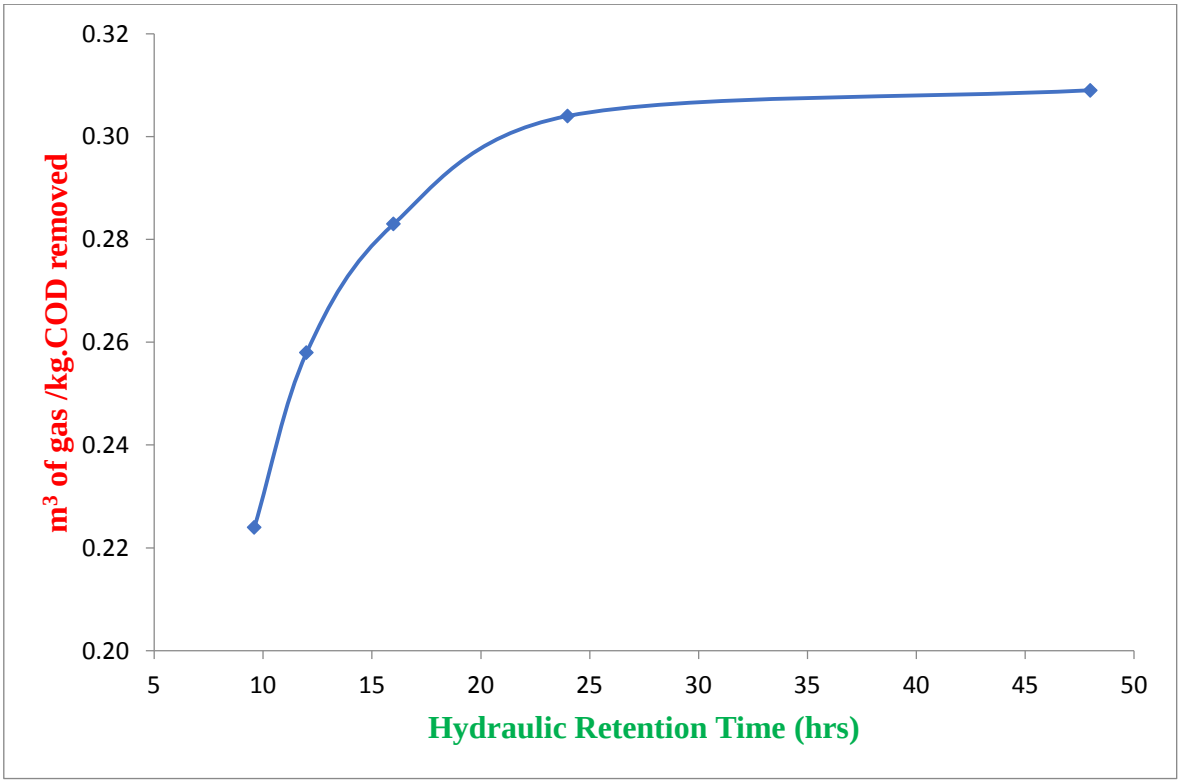

Fig 1.10 shows the HRT 9.6 to 48 hrs at 0.224 to 0.309 m^3 of gas / kg.COD removed.

Conclusion

The FBFF reactor is designed to process sugarcane effluent with a maximum COD removal efficiency of 85.16% and a COD removal rate of 0.309 m^3/kg. As a result, it can be utilised to reduce COD in sugarcane effluent by up to 85%.

The experiment was run with a variety of influent flow rates (lit/hr) and organic loads (influent COD, mg/lit t). Treatment effectiveness was measured in terms of COD elimination efficiency as a percentage for each condition. Throughout the experiment, samples were regularly taken from the reactor to track the kinetics of the process by looking at the concentration of biomass there.

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