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PERFORMANCE EVALUATION OF FIXED BED FIXED FILM ANAEROBIC REACTOR FOR TREATING DAIRY EFFLUENT

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ABSTRACT

In recent times, the Dairy industries hrve started incorporating sophisticated processing equipments with CIP cleaning systems and PLC based process automation systems. As a result, the conventional water use pattern of 3:1 is largely reduced to almost less than one against one liter of milk processing. Also, the effluent characteristics were changed with COD restricted to 4000-5000 mg/L, BOD at 2500-3500 mg/L and pH from 5.5 – 8.5. The biodegradability of Dairy effluent is 0.625 to 0.70. Any anaerobic treatment at the first stage of the effluent treatment will greatly reduce the organic load over the subsequent aerobic reactor and ultimately enhance the overall waste removal efficiency and also bring down the cost of treatment. The Fixed Bed Fixed Film anaerobic reactor is evaluated with a laboratory model (42.70 L) for the treatment of Dairy effluent. The experiment was run for three different operating conditions viz., Hydraulic Loading Rates, m^3/m^2.day (0.016, 0.011, 0.008, 0.005, 0.003), Organic Loading Rates, Kg COD/m^2.day (0.013, 0.022, 0.031, 0.035, 0.040) and HRT, hrs (7.30, 10.95, 14.60, 21.90, 43.80). The optimum COD removal was observed for 80.88% and the biogas conversion was 0.318 m^3 per Kg COD removed.

INTRODUCTION

Today, the annual production of processed milk in India is more than 150 Million Tonnes. The water requirement for washing and cleaning opera-

tions is in the range of 0.9 to 2 liters per liter of milk processed. The wastewater is having high COD and it is biodegradable. As such, two stage aerobic reactors are used for wastewater treatment in most of the dairies.

The conventional anaerobic digesters are suspended - growth systems. Certain, patented reactor fill media to support and sustain the microbial growth are brought into the anaerobic digesters, essentially to enhance the waste reduction efficiency. As they offer more area as fixed bed, active microorganisms will grow all over the filling media. These reactors are named as Fixed Bed - Fixed Film Anaerobic reactors. In this study, a system of Fixed Bed-Fixed Film anaerobic reactor is used and evaluated for the removal of COD up to 81%.

EXPERIMENTAL SETUP

The experimental setup consists of a FBFF reactor having 42.70 liters of effective volume. The physical features and process parameters are listed in Table-1. The schematic of the experimental setup is presented in Fig 1.

EXPERIMENTAL METHODOLOGY

The experiment was started for treating the domestic wastewater. The reactor was observed to attain the steady state conditions after 48 days with an average COD removal of 74.45%. Three random samples were obtained from M/s. Hatsun Agro Industries Private Ltd., Karipatti, Salem district, Tamilnadu, and were analyzed for specific parameters.

The real time wastewater was introduced in reactor with an average OLR of 0.021 Kg COD/m^2.day and in stages, mixed with domestic wastewater, in proportion of 20%, 40%, 60% and 100%. The performance of the reactor was studied and the steady-state conditions were observed to attain with COD reduction for an average value of 73.5% after 34 days.

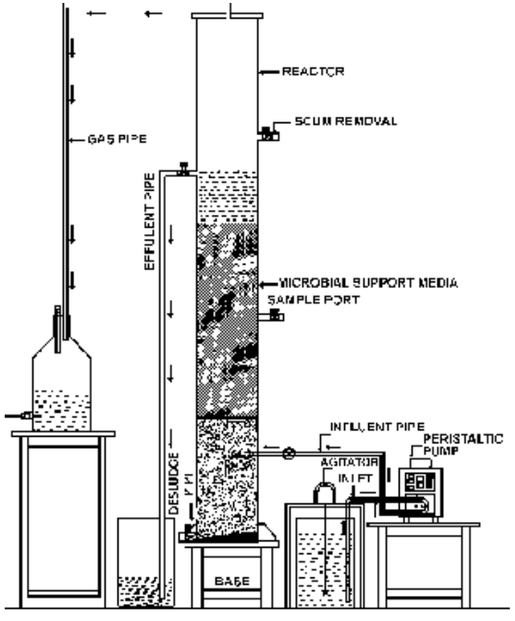

Fig. 1 Experimental model of FBFF reactor

The synthetic dairy effluent is prepared using milk powder and introduced after the process stabilization.

The model reactor was operated under different Organic Loading Rates from 0.004 to 0.073 Kg COD/m^2.day, for the average influent COD of 1559.17, 2605.64, 3557.76, 4116.40 and 4599.68 mg/L and for different Hydraulic Retention Times (HRT) of 7.3, 10.95, 14.60, 21.60 and 43.8 hrs (The corresponding hydraulic loading are 0.016, 0.011, 0.008, 0.005, 0.003 m^3/m^2.day).

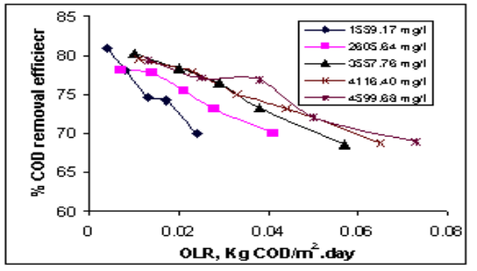

Fig.2 OLR Vs % COD removal

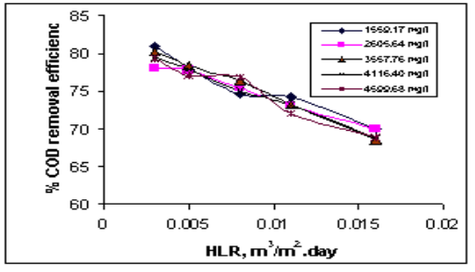

Fig. 3 HLR Vs % COD removal

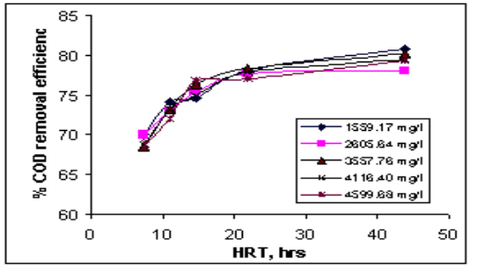

Fig. 4 HRT Vs % COD removal

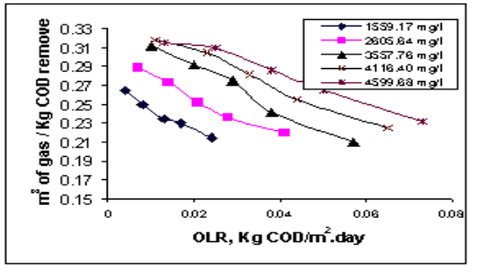

Fig. 5 OLR Vs m^3 gas/kg COD removed

RESULTS AND DISCUSSION

Fig 2 shows the maximum COD removal as 80.88% at 0.004 Kg COD/m^2.day of organic loading rate, which corresponds to 0.003 m^3/m^2 of biofilm area/day of Hydraulic Loading Rate (Fig. 3).

Fig 4 shows the maximum COD removal as 80.88% at the 43.8 hrs of Hydraulic Retention Time.

Fig 5 shows the maximum yield of bio-gas at 0.318 m^3 per Kg COD removed at 0.011 Kg COD/m^2.day of OLR.

Fig 6 shows the maximum yield of bio-gas 0.318 m^3 per Kg COD removed at 43.8 hrs of Hydraulic Retention Time.

CONCLUSION

The FBFF anaerobic reactor is found to treat Dairy wastewater for a maximum COD removal efficiency of 80.88% and 0.318 m^3 of gas production per Kg COD removed. Hence, FBFF anaerobic reactor can be used for removing COD up to 80% and the rest can be removed in the down stream aerobic systems more effectively and economically.

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Table 1
Physical features and process parameters of experimental model.

Type : FIXED BED-FIXED FILM ANAEROBIC REACTOR		
Effective volume of the reactor, L	:	42.70
Total height of the reactor, m	:	2.00
Effective height of the reactor, m	:	1.36
Effective diameter of the reactor, m	:	0.20
Height of the microbial support fill media, m	:	0.70
Fill media (v/v)		
Type A	:	14.71%
Type B	:	36.76%
Surface area of microbial support media		
Type A (Top)	:	500 m^2/m^3
Type B (Bottom)	:	350 m^2/m^3
Peristaltic pump	:	PP-30model (Miclin's make)
Influent flow, m^3/day	:	0.14, 0.04, 0.07, 0.05, 0.02
Hydraulic retention time, hrs	:	7.30, 10.95, 14. 60, 21.90, 43.80.
Influent average COD, mg/L	:	1559.17, 2605.64, 3557.76, 4116.40 and 4599.68
Organic loading rate, Kg COD/m^2.day	:	0.013, 0.022, 0.031, 0.035, 0.040

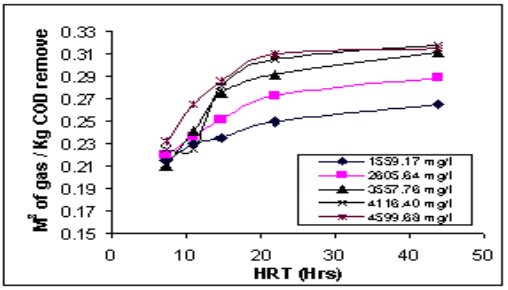

Fig. 5 HRT Vs m^3 gas/kg COD removed

facilities.

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