

USING AN AEROBIC BIO-FILM REACTOR EFFECT OF ORGANIC LOADING RATE ON DAIRY WASTEWATER

M.S. SIVAKUMAR * AND B. ASHA

* Department of Civil Engineering, Annamalai University, Annamalai Nagar 608 002, T.N., India.

Key words : Organic Loading Rate, Hydraulic Retention Time, Chemically Oxidation Demand, Biogas, Bio film

(Received 10 May, 2021; accepted 26 May, 2021)

ABSTRACT

A short term solution for the treatment of dairy wastewater is discussed with an average COD values of 3620, 4060, 4300, 4570 and 5200mg/L with varying OLR of 0.1502, 0.1706, 0.1798, 0.1912, 0.2166 and kg COD/m³/day. The performance of model was evaluated in terms of % COD removal and biogas conversion.

INTRODUCTION

India is a large producer of milk and dairy product in the world with annual milk production crossing 85 million tones in the year 2002 and growing at the rate of 2.8% per annum (Ramasamy *et al.*, 2004). The dairy wastewater consists of high organic matters, mainly Lactose, fat and protein. The enriched nutrients in cheese whey have created a suitable environment for *Lactobacillus* species to convert organic sources into methane via anaerobic process. Anaerobic treatment process is an ideal technique for the bioconversion of dairy wastewater into biogas. In this study, anaerobic bio film reactor, which is a time-tested proven technology to remove COD up to 84% for dairy wastewater is evaluated with an experimental model for the performance and detailed experiment study was conducted.

In this anaerobic treatment process no require-

ments for aeration, low amount of excess sludge production and low area demand are the additional advantages of anaerobic treatment process (Deminel *et al.*, 2005). Dairy Industries produce wastewater with a high Organic Loading Rate fluctuation resulting by seasonal products and products variations such as Yogurt, Ice cream, milk, cheese whey and other relevant products (Healy *et al.*, 2007; Broustton *et al.*, 2007).

The methods of handling, treating and disposing of the farm wastes may adversely affect air, water and soil condition, and may be a nuisance to those who dwell nearby (Coker *et al.*, 2001). Large scale dairy production system generates great quantities of wastewater.

MATERIALS AND METHODS

The experimental setup consist of an anaerobic bio-film reactor having effective volume of 13 liters. The

physical features and process parameters are present in Table 1. The schematic of the experimental set up is shown in the Figure 1.

Table 1. Physical features and process parameters experimental models:

Reactor volume, liters	: 13
Reactor height, cm	: 125
Reactor diameter, cm	: 12
Height of the bio mass support media fill, cm	: 50
Diameter of the influent and effluent pipes, cm	: 0.6
Sample ports from the bottom of the reactor, cm	
S1	: 20
S2	: 45
Influent average COD, mg/L	: 3620, 4060, 4300, 4570, 5200,
Hydraulic Retention Time, hrs.	: 72, 36, 24, 18, 14.4
Peristaltic Pump (Miclin's make)	: PP 10 model

The experiment was commissioned using domes-

tic wastewater collected from the sewage treatment facility of our university. The reactor was acclimatized and attained a steady state condition after 90 days with an average COD removal of 66% to 84%. The samples were collected from M/S. Aavin chilling plant Ltd., Villupuram, Tamil Nadu and analyzed for critical parameters. The characteristics of the parameters and their values are presented in

Table 2.

Table 2. Characteristics of Dairy wastewater

Parameters	Concentration
pH	6.69
Total Suspended Solids, mg/L	660.00
Total Dissolved Solids, mg/L	2380.0
Total Volatile Solids, mg/L	650.00
Total Fixed Solids, mg/L	1700.00
Total Solids, mg/L	3050.00
BOD5 @ 20°C, mg/L	2100.00
COD, mg/L	4100.00
Nitrogen (as N), mg/L	16.80
Phosphorous (as p), mg/L	15.15

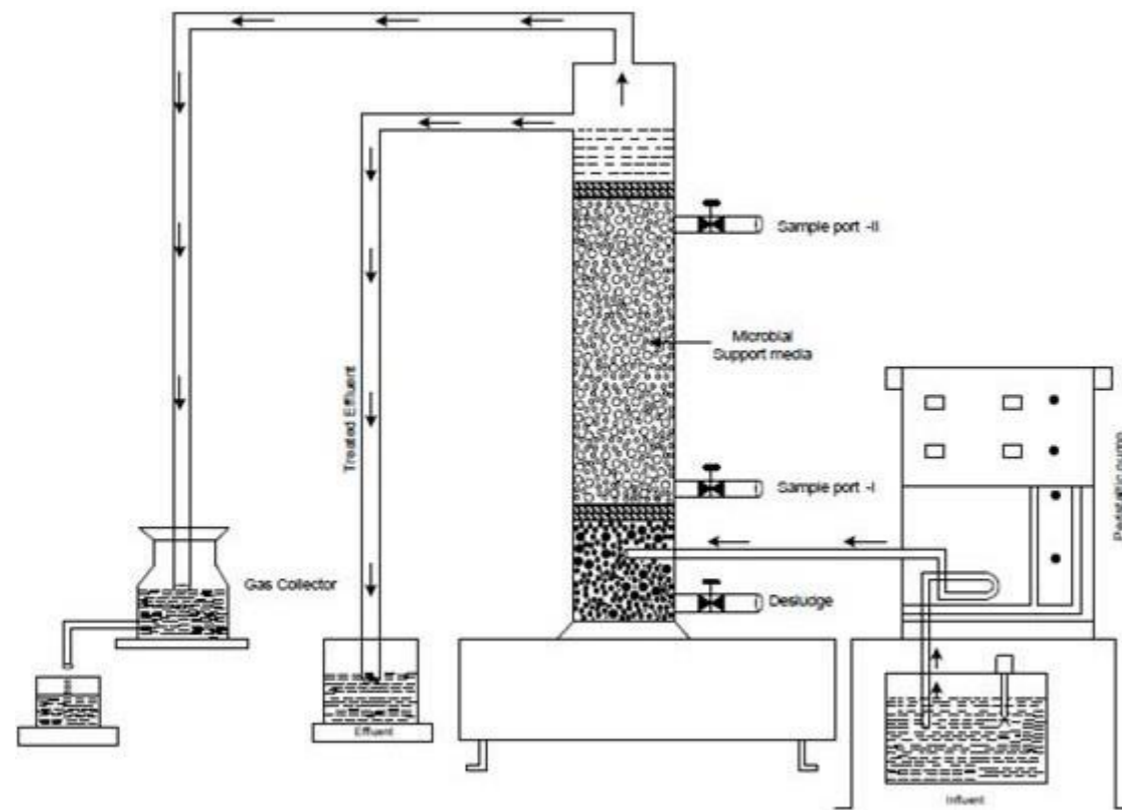


Fig. 1 Experimental setup for an anaerobic bio film reactor

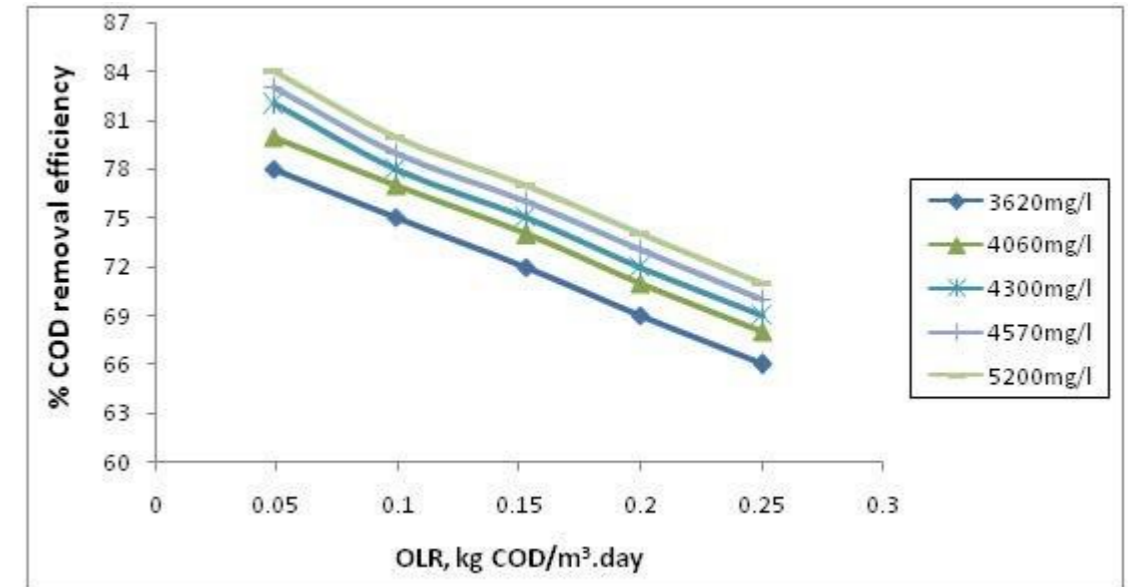


Fig. 1 OLR Vs % COD removal efficiency

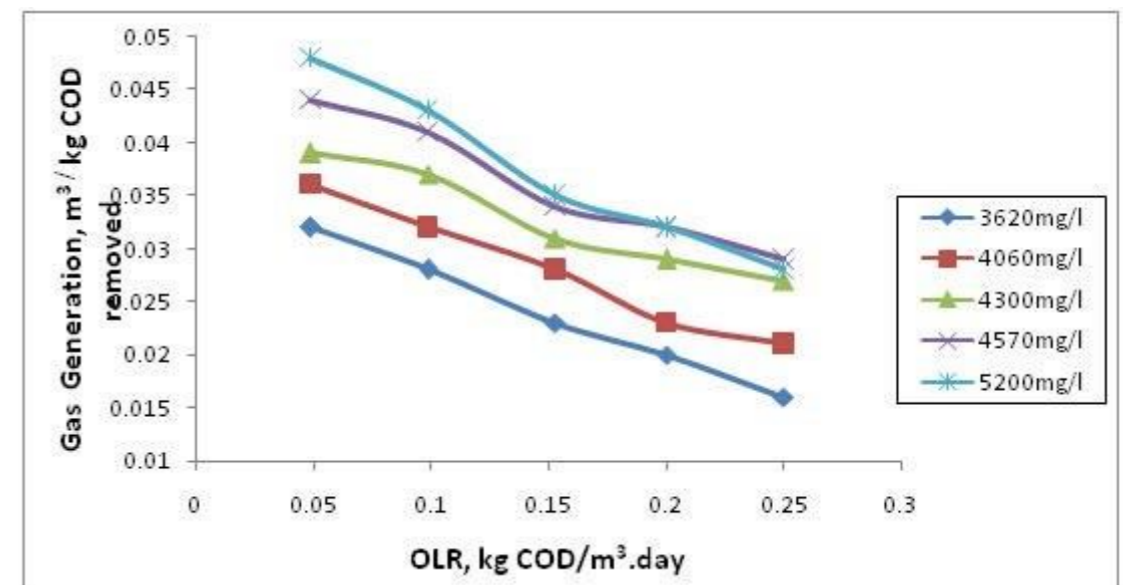


Fig. 2 OLR Vs Gas Generation

The wastewater was introduced initially in the reactor with an overall average OLR of 0.1816 KgCOD/m³/d and in stages mixed with domestic wastewater in proportion of 20%, 40%, 60% and 100%. The process stabilization and acclimatization was attained with an average COD reduction of 76% after 30 days. After attained the steady state condition the experiment was run continuously for different combinations of influent COD of 3620, 4060, 4300, 4570 and 5200 (mg/L). The operating conditions are

interpreted for the parameters of Organic Loading Rates (OLR), 0.1502, 0.1706, 0.1798, 0.1912, 0.2166, kg COD/m³/d and Hydraulic Retention Times (HRT) of 72, 36, 24, 18, 14.4 hrs.

RESULT AND DISCUSSION

Figure 1 shows five different concentration of dairy wastewater was investigated. The maximum removal of COD attain at 84% for 0.0726, kg COD/m³/d OLR.

Figure 2 shows the biogas collection from the reactor was found in the range from 0.016 to 0.048 of gas / kg COD removed.

CONCLUSION

The present investigation reveals that the biogas production and % of COD removal efficiency of dairy wastewater using an anaerobic bio-film reactor as a novel film anaerobic bio reactor with high performance for handling the high organic load was successfully achieved. The reactor was very efficient in the treatment of diluted high strength dairy wastewater at a maximum COD removal efficiency of 84% with an OLR of 0.0726 kg COD m³/d.

The maximum yield of biogas production was achieved at influent COD 4500mg/L with OLR of 0.0623kg COD/m³/d.

ACKNOWLEDGEMENT

The authors are thankful to the authorities of Annamalai University for having provided the Laboratory facilities.

REFERENCES

- APHA, AWWA, WEF, 1992. *Standard Methods for the Examination of Water and Wastewater*, 18th Ed., Washington DC, USA.
- Broughton, A., Pratt, S. and Shilton, A. 2008. Enhanced biological phosphorus removal for high-strength wastewater with a low rbCOD; P ratio. *Bioresource Technology*. 99 (5) : 1236-1241.
- Coker, A.O., Olugasa B.O. and Adeyemi, A.O. 2001. Abattoir wastewater quality in south Western Nigeria. *Proc, 27th Water, Engineering and Development Centre (WEDC) Conference, Lusaka, Zambia, 20-24 August 2001*, pp.329-331. Loughborough University, Leicestershire, UK.
- Demirel, B. Yenigun, O. and Onay, T.T. 2005. Anaerobic treatment of dairy wastewaters: a review. *Process Biochemistry*. 40 : 2583-2595.
- Healy, M.G., Rodgers, M. and Mulqueen, J. 2007. Treatment of dairy wastewater using constructed wetlands and intermittent sand filters. *Bioresource Technology*. 98 (12) : 2268-2281.
- Ramasamy, E.V., Gajalakshmi, S., Sanjeevi, R., Jithesh, M.N. and Abbsi, S.A. 2004. Feasibility studies on the treatment of dairy wastewaters with upflow anaerobic sludge blanket reactors. *Bioresour Technol*. 93 : 209-212.

