STUDY ON PRODUCTION OF BIOGAS FROM FISH PROCESSING WASTEWATER

Lwin Ko Latt[1], Khin Thet Ni[2], Khin Hla Mon[3]

Abstract

In this work, the physico-chemical characteristics of wastewater effluent from Makro Co, Ltd, fish processing industry, Tharketa Township, were systematically analyzed. The effluent from draining steps of Platu Fish processing unit was collected. It was observed that the characteristics of effluent highly depend on the type of processing undertaken. One of the main task of anaerobic digestion is the conversion of organic matter to biogas. Therefore, bench scale anaerobic filter reactor was fabricated to treat fish processing wastewater for production of biogas. Biogas consisted of CH_4 (50 %-75 %), CO_2 (25 %-45 %) and few by-products such as H_2S (<1%) analyzed by the experiments were conducted at various the Hydraulic Retention Time (HRT) (6 hr,12 hr, 24 hr, 36hr and 48 hr) , pH (6,7,8)and different influent COD concentration (COD = 6000 ± 200 mg/L ,10000± 200mg/L,16000 ± 200mg/L and 20000 ± 200mg/L). The maximum gas-production from a given amount of raw material depends on the type of substrate and other parameters such as changes in ambient temperature. The methane content also depends on the influent COD concentration. The maximum amount of biogas has been yielded for the reactor with influent COD concentration of 20000 ± 200 mg/L operating for 48 hr in the neutral pH.

Keywords: influent, biogas, methane

Introduction

There is a growing interest in alternative energy sources as a result of increase demand for energy coupled with a rise in the cost of available fuels. Rapid Industrialization has resulted in the generation of a large quantity of effluents with high organic matter contents. It is treated suitably a perpetual source of energy can be trapped. In spite of the fact that there is a negative environmental impact associated with industrialization, the effect can be minimized and energy can be tapped by means of anaerobic digestion of wastewater.

In recent years, considerable attentions have been paid towards the development of reactors of anaerobic treatment of wastes leading to the conversion of organic molecules into biogas (Lettinga, 1995).Additional benefits of anaerobic digestion are the conservation of fertilized value of the feed material, pathogen reduction, odor reduction, resource recovery, and mitigation of greenhouse gases of environmental concern. The way in which the digestion is carried out depends mainly on the type of feed. It can be carried out as a batch process, a continuous process or a multi-stage process (Harris, 1999).

Biogas originates from bacteria in the process of biodegradation of organic material under anaerobic (absence of air) conditions. The natural generation of biogas is an important part of the biogeochemical carbon cycle. Raw material for a biogas plant may be obtained from a variety of sources; animal waste such as human excreta, cow dung, pig dung, chicken drops; agricultural waste such as rice straw, cane-trash, corn stubble and bagasse; plant waste such as aquatic weeds, fallen leaves, water hyacinth and filamentous algae, such as brewery waste, cannery waste, dairy

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waste and distillery waste, industrial food waste and municipal solid waste; residential commercial and institutional waste. Organic waste can be divided into two groups; carbon-rich such as plant waste, agricultural waste and municipal solid waste and nitrogen-rich such as animal waste and kitchen waste. The carbon-rich wastes contain a lot of carbon cellulose, which promotes biogas production and the nitrogen-rich wastes provide nutrients which promote the growth and reproduction of anaerobic bacteria (Environmental Protection Agency, 1996).

The maximum gas-production from a given amount of raw material depends on the type of substrate and other parameters such as changes in ambient temperature that can have a negative effect on bacterial activity (Bastien, Y, 2003).

Materials and Methodology

Materials

Fish processing wastewaters were collected from Marko Co. Ltd., Tharketa Industrial Zone,Yangon Region. The wastewater samples were maintained at 4°C in a refrigerator before analysis, treatment and production of biogas.

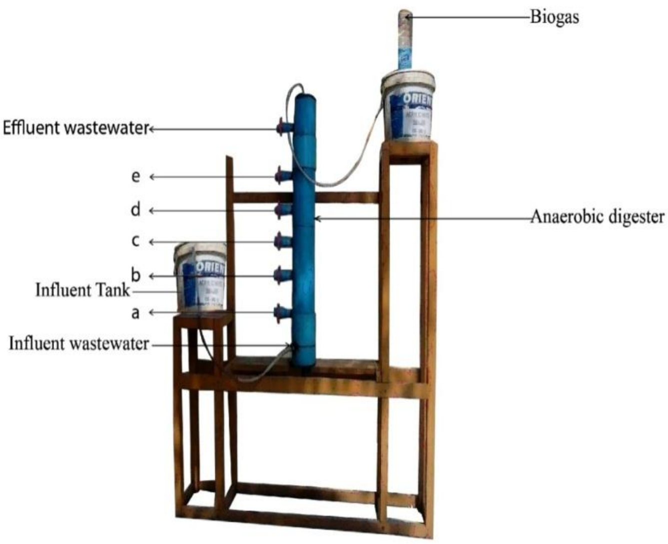
Methodology

Analysis of COD of Fish Processing Wastewater

Sample 500 mL was homogenized using the prepared sample (2.5 mL) was mixed with potassium dichromate solution (1.5 mL) and sulfuric acid (3.5 mL), and digested in COD digester (DRB200) at 150°C for 2 hours.The COD concentration of digested samples was read using Digit Logging Colorimeter (DR/890, HACH). (Closed Reflux Colorimeter method)

Composition of Starter-sludge

The composition of Starter-sludge used in upflow anaerobic filter reactor was 100 g of straw, 500 g of cow manure, 15 L of water and 50 mL of effective microorganisms (EM) (Singh, 1960).



1 = Influent Tank, 2 = Submersible Pump, 3 = Packing Media, 4= Sludge Outlet, 5= Different Levels (a,b,c,d,e) , 6= Effluent Wastewater,

Figure 1 Upflow Anaerobic Filter Reactor

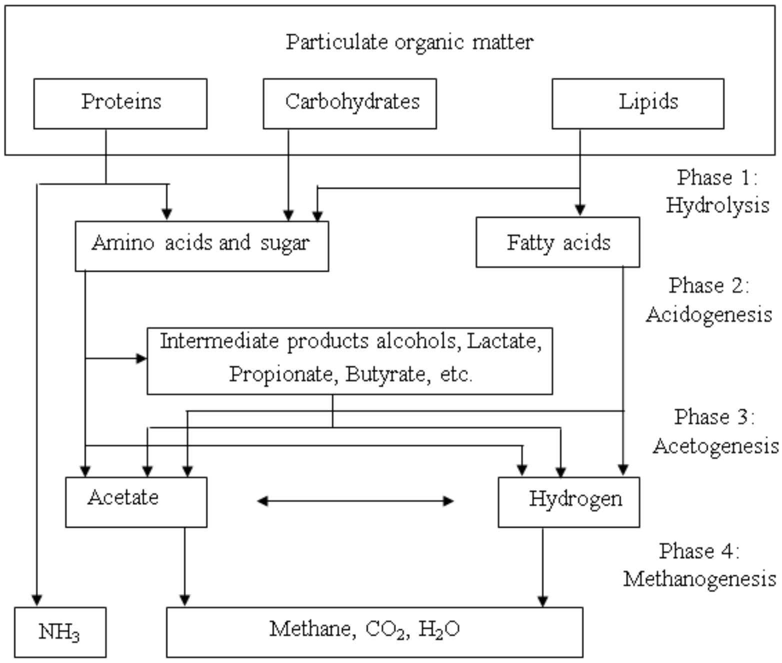


Figure 2 Process Flow Sheet for Biogas Production

Table 1 Operational Parameters for Upflow Anaerobic Filter Reactor Based on the Upflow Anaerobic Filter Reactor Obtained from Internet

Sr. No.	Parameters	Value
1	Reactor working volume (L)	5.5
2	Cross-sectional area (m^2)	8.11×10^{-3}
3	Upflow velocity (m/h)	0.113,0.056,0.028,0.019,0.014
4	Hydraulic retention time (hr)	6, 12, 24, 36 and 48
5	Flow rate (m^3/d)	0.022,0.011, 5.5×10^{-3}, 3.67×10^{-3} , 2.75×10^{-3}
6	Influent COD concentration (mg/L)	6000, 10000, 16000, 20000
7	pH	6, 7, 8

Production of Biogas from Fish Processing Wastewater by Varying Operational Parameters

pH of diluted fish processing wastewater with different COD concentration (COD = 6000 ± 200 mg/L ,10000± 200mg/L,16000 ± 200mg/L, 20000 ± 200mg/L) and its pH was adjusted to (pH : 6,7,8 ± 0.1). Then this prepared wastewater was pumped continuously down the bottom of the reactor and the flow rate(0.022m^3/d,0.011m^3/d, $5.5 \times 10^{-3} m^3$/d, $3.67 \times 10^{-3} m^3$/d,$2.75 \times 10^{-3} m^3$/d) was controlled to obtain the various hydraulic retention times (6 hr,12 hr, 24 hr, 36 hr and 48 hr). It flowed upward through the filter medium (PVDF) and came out from the effluent point near the top of the reactor. The effluent pipe was connected to a water-sealed arrangement to prevent the escape of the gas through the effluent. A periodic cleaning of the submersible pump was also carried out. The height of the influent wastewater tank and the biogas collector were kept constant throughout the entire experiment. Biogas was collected by water displacement method. The operating temperature of the reactor was in the mesophilic range (29-35°C).

Table 2 Total Amount of Biogas Evolved for (influent COD = 6000±200 mg/L) at Different pH

Sr. No.	Hydraulic Retention Time (hr)	Total amount of Biogas (L)		
		pH 6	pH 7	pH 8
1	6	14.5	15.5	15
2	12	15	16.3	15.4
3	24	15.3	17.5	16
4	36	15.5	17.7	16
5	48	16	18.3	17

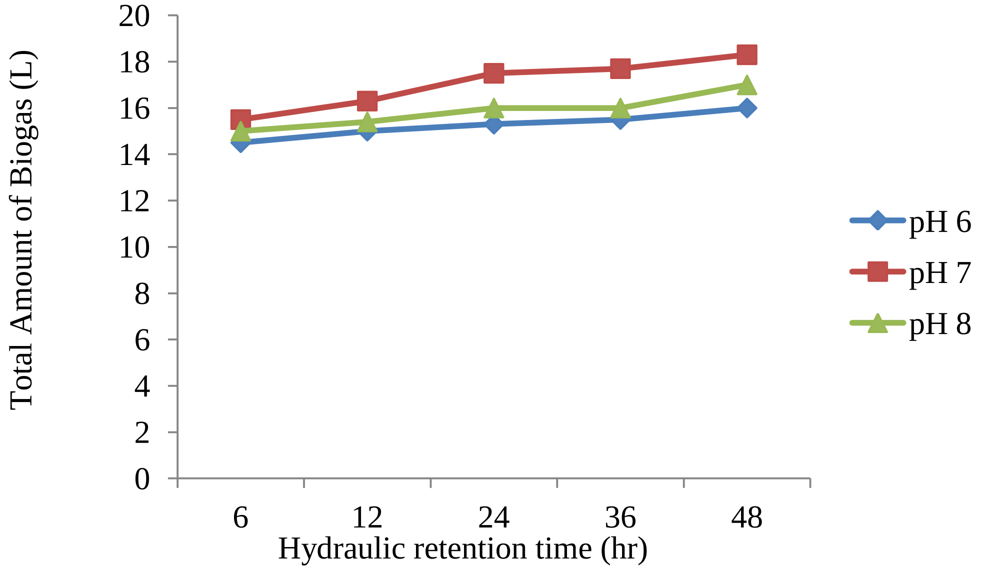


Figure 3 Total Amount of Biogas Evolved for (influent COD = 6000±200 mg/L) at Different pH

Table 3 Total Amount of Biogas Evolved for (influent COD =10000 ±200 mg/L) at Different pH

Sr. No.	Hydraulic Retention Time (hr)	Total amount of Biogas (L)		
		pH 6	pH 7	pH 8
1	6	18.6	21.5	20
2	12	19.2	27.7	20
3	24	20	24	21.8
4	36	23	25.5	23.5
5	48	23.2	27.3	25.7

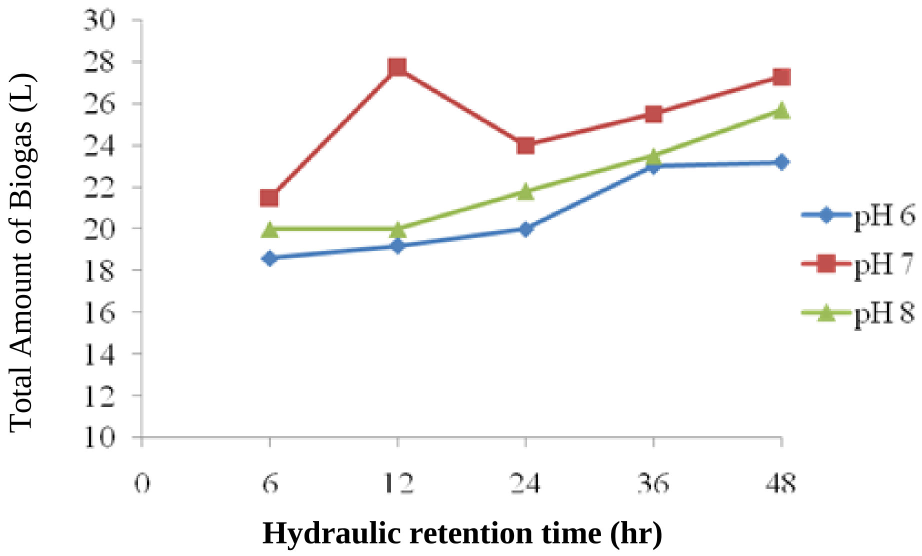


Figure 4 Total Amount of Biogas Evolved for(influent COD = 10000±200mg/L) at Different pH

Table 4 Total Amount of Biogas Evolved for(influent COD =16000±200 mg/L)at Different pH

Sr. No.	Hydraulic Retention Time (hr)	Total amount of Biogas (L)		
		pH 6	**pH 7**	**pH 8**
1	6	25.4	29	27
2	12	27	32	30
3	24	28	36	32.8
4	36	29.2	37	33
5	48	30	38.5	34

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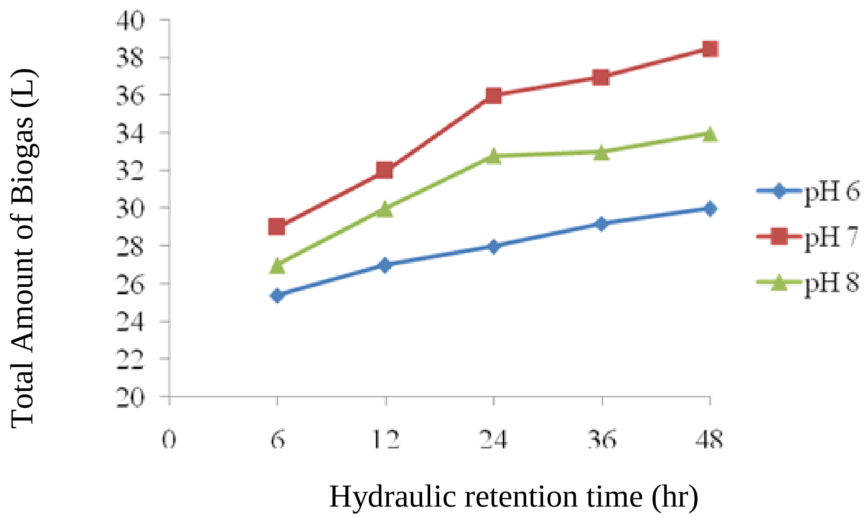

Figure 5 Total Amount of Biogas Evolved for(influent COD = 16000±200mg/L) at Different pH

Table 5 Total Amount of Biogas Evolved for (influent COD =20000± 200mg/L at Different pH

Sr. No.	Hydraulic Retention Time (hr)	Total amount of Biogas (L)		
		pH 6	pH 7	pH 8
1	6	21	31	30
2	12	27.5	32.5	32
3	24	32	35	33
4	36	32.5	36	35
5	48	35	38	37.2

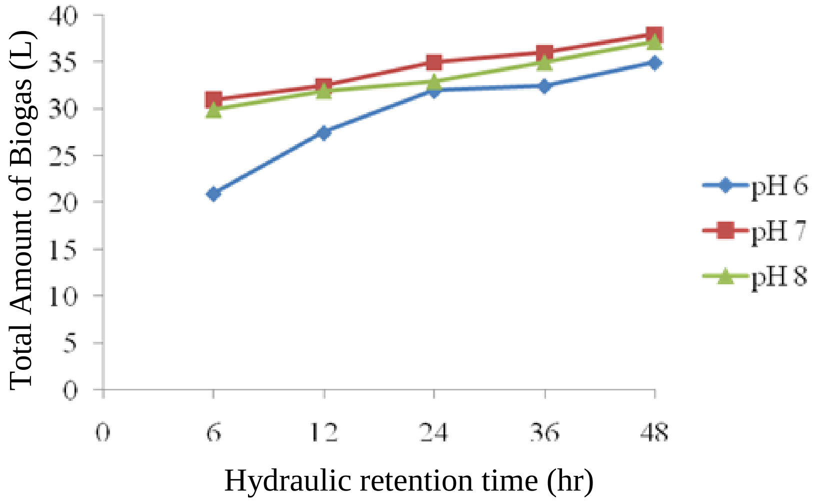

Figure 6 Total Amount of Biogas Evolved for (influent COD = 20000±200 mg/L) at Different pH

Results and Discussion

Production of Biogas from fish processing wastewater was conducted with various COD concentration at different pH. The results of the total amount of Biogas evolved for various influent COD concentrations are shown in Tables (2) - (5) and figures (3) - (6).According to the results, the higher the hydraulic retention time, the higher the amount of biogas evolved. If the COD concentration was the most increased, the amount of biogas was increased than it. Fish processing wastewater was diluted with tap water to obtain the desired COD concentration and pH was adjusted by using NaOH, and HCl. It was shown in Tables (2) to (5).while other operating parameters (Hydraulic Retention Time and influent COD concentration) were kept constant. The removal efficiencies were better in neutral (i.e. pH 7) than slightly acidic (pH 6) and slightly alkaline (pH 8) conditions, while other operating parameters (Hydraulic Retention Time and influent COD concentration) were kept constant. By varying the influent COD concentration, it was clearly observed that the removal efficiencies decreased with increase in influent COD concentration, while other operating conditions were kept constant. In general, COD of a waste is higher than BOD because more compounds can be chemically oxidized than can be biologically oxidized. For many types of wastes, it is required to correlate BOD with COD to obtain the estimate BOD value without determination. This can be very useful because the COD can be determined in three hours, compared with five days for the BOD.

According to the COD and BOD data obtained from the treatment process, the amount of BOD and COD was highly correlated. Therefore the Up flow Anaerobic Filter Reactor has good performance in chemical and biological degradation.

In this study, wastewaters from fish processing industry were collected and characterized. According to the results, it was found that the characteristics of wastewater were highly depended upon the type of fish being processed and the type of processing undertaken. In general, the wastewater contained relatively higher amount of organic pollutants and it should not be disposed of without treatment.

According to the results obtained, In case of biogas; higher influent COD concentration produced more biogas. The methane content also depends on the influent COD concentration. The maximum amount of biogas was obtained when the reactor was fed with wastewater of influent COD concentration of 20000 ± 200 mg/L operating at 48 hr in neutral pH. pH influent and pH effluent was always within the optimal ranges; however, pH effluent was always higher than the pH influent. pH in the reactor varied between 6.69 and 7.68, so the reactor was always optimally self-buffered.

Conclusion

In general, at the longer Hydraulic Retention Time and the lower influent COD concentration, better removal efficiencies were obtained. The removal performance of the anaerobic reactor in terms of COD depends on HRT, organic loading rat. In case of biogas, higher influent COD concentration produced more biogas.

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