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BIOGAS FROM ANAEROBIC DIGESTION OF FISH WASTE

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ABSTRACT

Biogas is a by-product of the biological breakdown of organic wastes under oxygen free condition. Research work was conducted to investigate the production ability of biogas from anaerobic digestion of fish waste. This paper presents results of research work conducted in laboratory scale to produce bio gas from fish waste and cow dung. Five laboratory scale digesters were made to co-digest fish waste (FW) and cow dung (CD) in various proportions. The digesters were made of plastic container of four liter capacity each. Fish wastes were used 200 gm and 250 gm, and cow dung were used 0 - 300 gm to make fish waste to cow dung ratios in the range (wt.) of 1:0 to 1:1.5. The digester were fed on batch basis and operated at ambient temperatures for 15 days. Total solid contents of 8% were used for all the experiments. The highest gas yield was obtained about 2 L/kg waste from a fish waste and cow dung ratio of 1:1.2. It was observed that when only fish waste was used, gas yield obtained was 150 ml/kg waste and it took 10 days to start bio gas generation. Whereas when cow dung was mixed with fish waste, gas production starting time reduced to 7 days.

Keywords: Biogas, Anaerobic, Fish Waste.

1. INTRODUCTION

Anaerobic digestion (AD) is a complex biological process in which anaerobic bacteria decompose organic matter in environments with little or no oxygen. The products of anaerobic digestion are biogas and digested substrate, commonly named digestate, and used as fertilizer in agriculture. The biogas generally composes of 55-65% methane, 35-45% carbon dioxide, 0-3% nitrogen, 0-1% hydrogen, and 0-1% hydrogen sulfide [1]. By AD process the significant methane emission resulting from the uncontrolled anaerobic decomposition of organic waste into atmosphere would be stopped, where methane has 21 times more global warming potential than carbon dioxide [2]. Moreover, production of biogas will reduce the use of fossil fuels, thereby reducing the carbon dioxide emission. This is thus in accord with Kyoto Summit agreement [3].

Production of biogas from organic fraction of municipal solid wastes, different animal manures, fish waste, agricultural waste etc. were reported by different researchers. Not much works of fish waste digestion were reported. Lanari and Franci [4] produced biogas from rainbow trout biomass (faecal sludge) using up-flow anaerobic recirculating digester made from fiber-glass cylindrical tank of 1.5 m height and 0.6 m diameter, which was randomly packed with cubes in reticulated polyurethane. McDermott et al. [5] reported biogas production during investigating the effect of ultrasonication as pre-treatment of the aquaculture waste for anaerobic digestion. Marchaim et al. [6] to treat the solid waste from the Yona Tuna and Sardines fish processing factory by a combined method of digestion by thermophilic anaerobic bacteria and by flesh flies, produced biogas. Gebaur [7] reported anaerobic treatment be the preferred method of stabilization and hygienization of sludge from saline fish farm effluents because of its energy (biogas) production. Gebaur carried out mesophilic treatment of sludge of total solids (TS) 8.2-10.2 (wt.%) in 15 L continuous stirred tank reactors at 35^{o}C. Batchwise digestion of fish waste and sisul pulp was studied by Mshandete et al. [8] both with the wastes separately and with mixtures in various proportions in 1000 mL bioreactors constructed by using conical glass flasks. Gebaur and Eikebrokk [9] investigated the treatment of concentrated sludge (10–12 wt.% TS) collected from Atlantic Salmon smolt hatchery with biogas production in order to reduce the high energy demands of smolt hatcheries.

The scope of this present work was to conduct research work in laboratory scale to produce biogas from mesophilic anaerobic digestion of fish waste and co-digestion of fish waste and cow dung.

2. MATERIALS AND METHODS

2.1 Waste Sources

The fish waste in this experiment was collected from the Pahartali Bazar, Choumuhoni, in Chittagong, consisted of offals and gills. The cow dung was collected from local area around CUET. The total solids of fish waste and cow dung were considered to be 32.2 wt.% [8] and 18 wt.% [10] respectively.

Figure 1 shows the fish waste used.

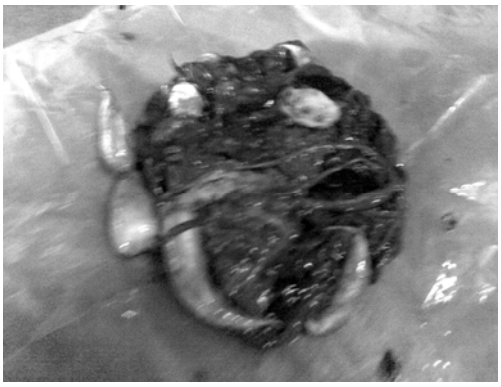

Fig 1. Fish waste used for anaerobic digestion

2.2 Experimental Set-up and Procedure

The anaerobic digestion of fish waste and co-digestion of fish waste and cow dung were tested in 4 L plastic digesters with different working volumes below around 2 L. Five laboratory scale digesters were made to digest fish waste, and co-digest fish waste and cow dung mixture in various proportions. Fish wastes were used 200 gm and 250 gm, and cow dung were used 0 - 300 gm to make fish waste to cow dung ratios (wt.) in the range of 1:0 to 1:1.5. The schematic diagram of the set-up is shown in figure 2. The digesters were set-up with other equipments such as displacement tank/gas collector and

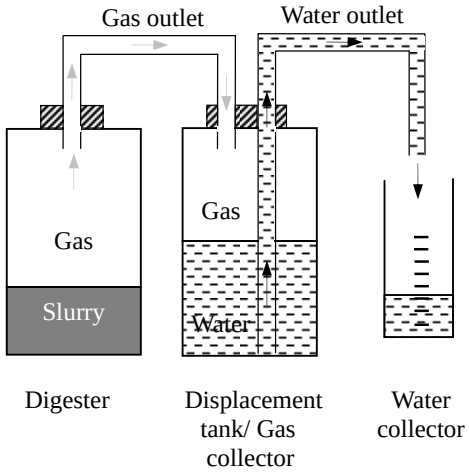

Fig 2. Schematic diagram of the experimental set-up for anaerobic digestion

water collector. Plastic pipe was used to connect digester and displacement tank. The pipe allowed the gas produced in the digester to pass to displacement tank and was fitted air tight in both the tanks and inserted at top positions. The gas was collected by water displacement method [5, 7]. The digesters were operated in batch mode at room temperature for 15 days and fed manually. Total solid contents of 8%(wt.) [10, 11] were used for all the experiments. To make the slurry of total solid content 8%(wt.), required amount of water was added. Table 1 shows the amounts of water and waste/s for different mixture. In water displacement method, initially the displacement tank/gas collector was kept full of water. When the gas started coming to the gas collector it displaced the water out of the collector to make its space inside. Another plastic pipe was used to take the displaced water from the displacement tank to the water collector which was fitted air tight in the displacement tank and inserted up to bottom part of it. The gaseous yield was measured by measuring the displaced water volume.

3. RESULTS AND DISCUSSION

Figure 3 shows the total gas yields for different fish waste to cow dung ratios. For all the co-digestion processes the gas generation started on the 7th day. For anaerobic digestion of fish waste gas generation started on the 10th day and generation continued only for 2 days.

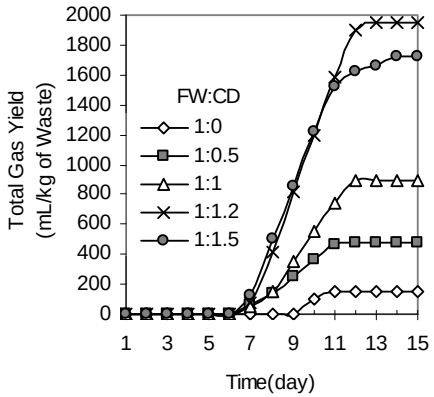

Fig 3. Total gas yield from anaerobic digestion

Figure 4 shows the daily gas production for each ratios and it is clear that highest gas production rates lie between the 8th and 10th days for all the co-digestion

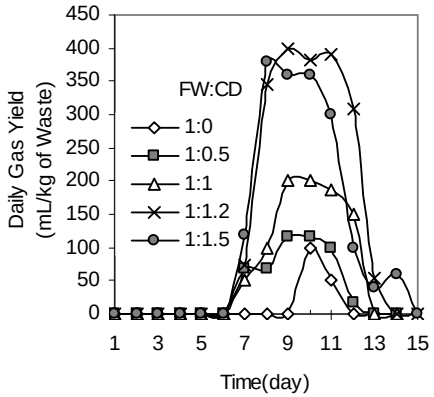

Fig 4. Daily gas yield from anaerobic digestion

processes. The maximum daily gas yield was observed from 1:1.2 (FW:CD) ratio (wt.) and on the 9th day maximum gas yield was found to be 400 ml/kg waste. For 1:1.5 (FW:CD) ratio (wt.) the maximum gas yield was observed on the 8th day of 380 ml/kg waste and higher than 1:1.2 ratio. At ratios of 1:1, 1:0.5 and 1:0 the

maximum daily gas yields were 200, 117, and 100 ml/kg waste respectively.

Figure 5 shows the ultimate gas yield and total retention time for different ratios. It is observed that with the increase of cow dung fraction the retention time was increased. For fish waste digestion retention time was 11 days. Whereas for co-digestion of fish waste and cow dung with 1:1.5 (FW:CD) ratio (wt.) the retention time was 14 days. The maximum ultimate gas yield was obtained from 1:1.2 (FW:CD) ratio(wt.) and amounted to 1955 ml/kg waste.

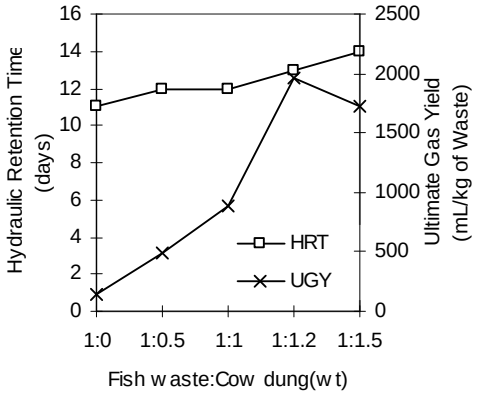

Fig 5. Ultimate gas yield and hydraulic retention time for anaerobic digestion

4. CONCLUSION

Biogas was produced from anaerobic digestion of fish waste and also from anaerobic co-digestion of fish waste and cow dung. The results indicated anaerobic co-digestion of fish waste and cow dung with 1:1.2 (FW:CD) ratio (wt.) gave the highest gas yield of about 2 L/kg waste. The total gas yield from anaerobic digestion of fish was 150 ml/kg waste. More work should be done with proper slurry volume to digester volume ratio for the purpose of producing more gas.

5. REFERENCES

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Table 1: Relative wastes and water amounts in the slurry

FW:CD(wt. ratio)	1: 0	1:0.5	1:1	1:1.2	1:1.5
Fish waste (gm)	200	200	200	250	200
Cow dung (gm)	0	100	200	300	300
Water (gm)	605	720	835	1101	950