

THE EFFECT OF F/M RATIO TO THE ANAEROBIC DECOMPOSITION OF BIOGAS PRODUCTION FROM FISH OFFAL WASTE

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Abstract - Biogas is a gas produced from the anaerobic decomposition of organic compounds. In the production of biogas from anaerobic digestion, value of F/M ratio shows a ratio between the mass of food available in the waste substrate with a mass of microorganisms that act as decomposers. F/M ratio is too small causing microbes could not metabolize perfectly and vice versa on the value of the ratio F / M overload resulting metabolic imbalance. The purpose of this study was to assess the effect of F/M ratio to optimal production of biogas from fish offal waste. The process of anaerobic digestion is conducted in the biodigester with four-liter volume and batch system operated at ambient temperature for 38 days. As a raw material, fish offal and microbial sludge obtained from the curing of fish and river mud discharges in the region of Bandarharjo, Semarang, Central Java. F/M ratio is set at 0.2, 0.4, and 0.6 are derived from sewage sludge VSS weight ratio of fish offal with sludge containing microbes. The addition of micronutrients supplied with a concentration of 0.4 mg/liter. Yield maximum methane gas obtained was 164,7 l/kg CODMn when the ratio F/M was 0.2. Based on the results of the study, found that the ratio F/M affect the amount of biogas produced. Meanwhile, the retention time (HRT) is only influenced by the ratio F/M.

Keywords: fish offal; biogas; F/M ratio; CODMn

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INTRODUCTION

Fishery is the result of residual waste or discarded unused substances from the processing of fish, the fish auction, canning industry, industrial pemiletan, restaurants, and so on. Waste fishery is divided into solid waste (solid waste) in the form of pieces of fish meat, scales, gills, or parts of fish body unused and liquid waste (liquid waste) originating from mucus, blood, washing water fish, liquids resulting fish industry, etc. According to the Gebauer (2004), fisheries waste contains a high COD is approximately 60.3 to 74.1 g / liter which can cause environmental health problems if not managed properly. In addition, the volume of waste fisheries in Indonesia, which reached 5.4 million tons per year, about 20% to 30% of that amount is wasted as waste. If not handled properly, two million

tons of waste with high COD content is a potential threat to the preservation of the ecosystem environment, especially water.

Biogas is gas produced from the decomposition of anaerobic (without air) or fermentation of organic material into methane (CH₄) and CO₂ as its main component (Goodrich et al., 1979; Amaru, 2004). The economic potential of biogas is very large considering that 1 m³ of biogas is equivalent to 0.62 liters of kerosene (Dit. Processing of Agricultural Products, DG PPHP-MOA). Therefore, biogas is suitable for use as an alternative fuel is an environmentally friendly substitute for kerosene, LPG, butane, coal, and other materials derived from fossils.

Anaerobic decomposition is a complex biological process which is a decomposition process of organic

matter by anaerobic bacteria into the environment without oxygen. The products of this process contain residual biogas and substrate decomposition commonly called digestate, and used as fertilizer in agriculture. Biogas produced generally contain 55-65% methane, 35-45% carbon dioxide, 0-3% nitrogen, hydrogen 0-1%, and 0-1% hydrogen sulfide gas (Milono P. et al., 1981). Anaerobic decomposition processes consist of the step of hydrolysis, acidogenesis, acetogenesis, and methanogenesis.

In the production of biogas in anaerobic, the value of F/M shows a comparison between the amount of food available in the waste and the number of microorganisms that used. In describe the waste, microbe using organic materials (COD) as a substrate food used in the metabolic or chemical reactions in the body microbes to produce compounds that are simpler and gas metabolism (Wagiman, 2001). In a ratio F / M is too small, microbial metabolism can not do it perfectly because the supply needs for the metabolism is lack. Reversely, at a ratio F/M excessive, organic substrates exceed the requirements needed microbe and lead to metabolic imbalance (Wagiman, 2001). According Wagiman, about the influence of F / M to the allowance for biological nutrient from natural rubber processing waste shows that the best COD removal occurred on the F / M ratio between 0.1 to 0.5 mgCOD / mgVSS.hari ie 98-99%, and decreased the F/M > 1 mgCOD/mgVSS.days. In addition, the processing of freshwater fish limbah maximum biogas yield (2 liters / kg waste) generated on the value of F / M 1: 1.2 and the decline in F/M 1: 1.5 (B. Salam et al., 2009).

MATERIALS AND METHODS

The materials used in this study were waste of fisheries in the form of offal, filth, and gills are derived from fish fumigation in the region Bandarharjo, Semarang, Central Java. While, microbes that used to come from mud taken around the place fumigation same. Other support materials are NaOH, H₂SO₄, KMnO₄, H₂C₂O₄, NiCl₂.6H₂O salt, and Co (NO₃)₂.6H₂O. NaOH solution used for pH regulation at start-up and absorption of CO₂ in the process of measuring the volume of methane gas. H₂SO₄ solution, KMnO₄, and H₂C₂O₄ used in the analysis process CODMn using permanganometry. Meanwhile, NiCl₂.6H₂O salt, and Co

(NO₃)₂. 6H₂O is used as a micronutrient for anaerobic metabolic processes.



Figure 1. Offal Fish Waste

The processing of fishery waste anaerobic digester done in lab scale in the form of a plastic container specially designed with a volume of 4 liters and operates at ambient temperature. Figure 2 shows suite of tools used in this study. The tool set consists of a digester that are connected by a small pipe as the gas outlet to the measuring scale gas pipeline catcher charged water. Pipe catcher contain this gas pipeline is connected with a measuring scale CO₂ absorption is filled by a solution NaOH. Gas formed on digester issued through gas outlet pipe toward catcher gas. Then, total volume of gas measured at the gas pipeline. Furthermore, back flowed into the pipe and the CO₂ absorption is measured as volume methane. On this study assumed that all CO₂ absorbed in NaOH solution in the absorber pipes.

F/M ratio defined in this study was 0.2, 0.4, and 0.6 were obtained from the comparison VSS VSS sewage sludge and fisheries. VSS test is conducted by heating the sludge and fish waste and measured the weight lost as VSS respectively. Meanwhile, the addition of micronutrients added variation were 0.2, 0.4, and 0.6 mg/l with a ratio NiCl₂.6H₂O, and Co (NO₃)₂. 6H₂O 1: 1. The combination of F / M and the addition of micronutrients to produce nine variations gas percobaan. The measurement is done every day for 38 days. At the moment, in order to determine the yield of methane gas in each of the various experiments, measurements CODMn with permanganometry method performed every two days for 38 days.

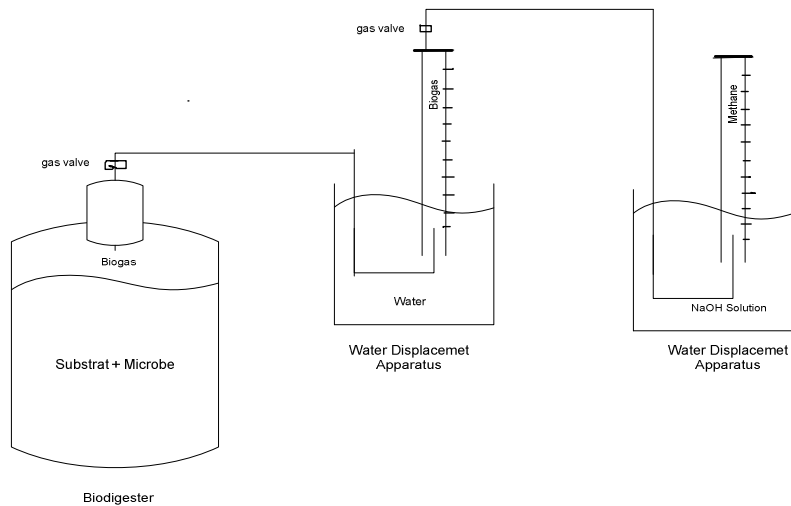
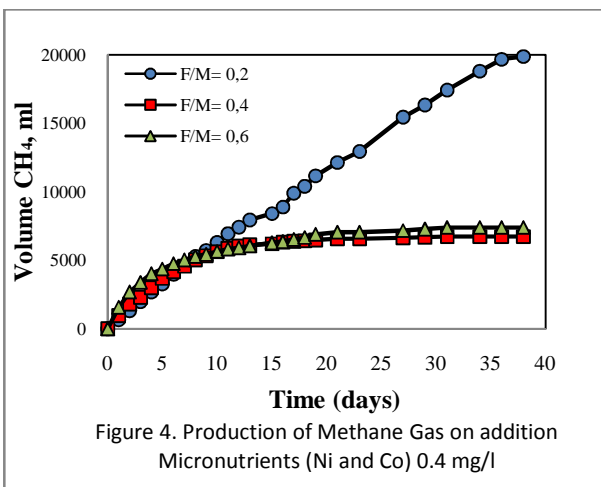
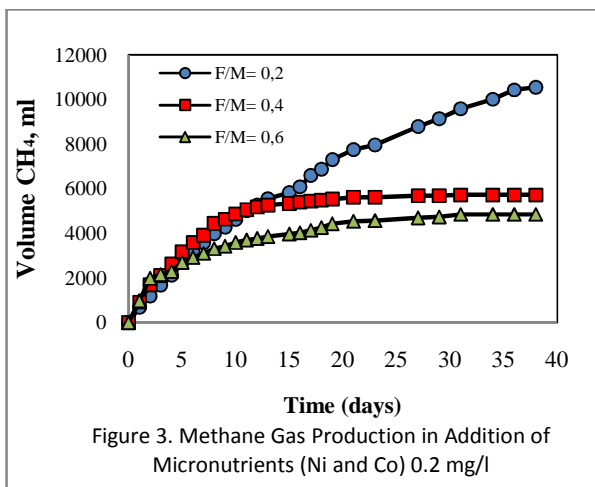


Figure 2. Apparatus set for biogas production and measurement

RESULTS AND DISCUSSION

Figure 3, 4, and 5 show the total volume of methane gas obtained in the F / M ratio is different with the addition of micronutrients Ni and Co at the same concentration. In the process of this fishery waste decomposition, gas formation occurred after fermentation run for one day. The addition of Ni and Co of 0.4 mg / l, F / M ratio of 0.2 giving a total volume of gas at most that 19 890 ml and a decline in F / M ratio of 0.6. A similar thing happens when the micronutrient addition of Ni and Co respectively 0.2 and 0.6 mg / l, F / M ratio of 0.2 giving a total volume of biogas most anyway and the decline occurred in the F/M 0.6. The decline in the volume of methane gas that occurs in the ratio F/M 0.4 and 0.6 caused by the F/M is too large. In the F / M ratio is excessive, substrates that exceed the needs of microbes will lead to metabolic imbalance. This imbalance occurs because when the number of microbes

less, the possibility of contact with the substrate will be smaller. Additionally, substrate concentrations can result in excessive diffusion cell (cell rupture) which causes the microbes to die so that the number of microbes in the system increasing. Figure 3, 4, and 5 show a tendency that the production of biogas from waste fish, the smaller the value of F/M the volume of methane gas obtained will be greater (Wagiman, 2001). As for the addition of micronutrients to 0.4 mg / l occur deviations indicate that the F/M 0.4 produces less gas than the F/M 0.6. This occurs due to the mixing process is done manually so that the homogeneity of the system is less than perfect. The stirring process associated with the likelihood of contact between the microbe and the substrate. Stirring is not perfect caused a buildup substrate on one side of the system so that contact with microbes substrate not uniform.



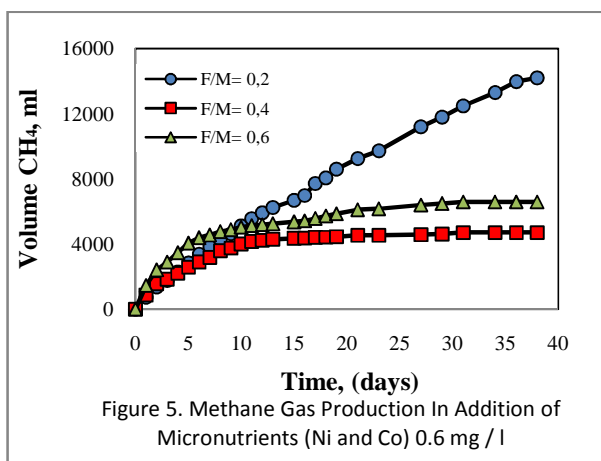


Figure 5. Methane Gas Production In Addition of Micronutrients (Ni and Co) 0.6 mg / l

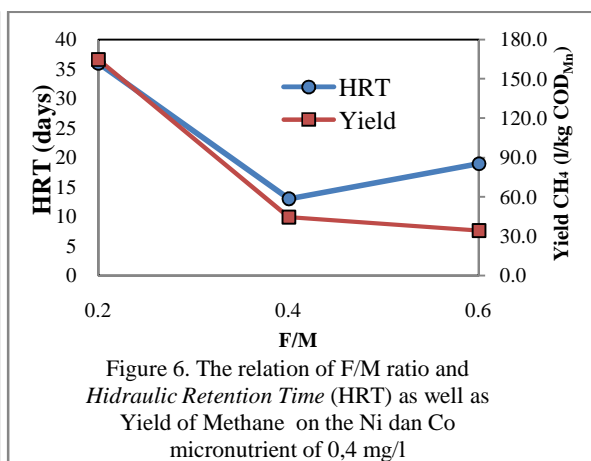


Figure 6. The relation of F/M ratio and Hydraulic Retention Time (HRT) as well as Yield of Methane on the Ni dan Co micronutrient of 0,4 mg/l

Figure 6 shows value and total yield of methane gas retention time (HRT) on the value of F/M different. Based on these images can be observed that the increase in the value of F / M can increase biogas production and decline in F/M particular. Methane yield maximum value obtained in the F / M 0.2, which amounted to 164.7 l/kg CODMn. In addition, the F/M ratio considerable influence on the retention time. Retention times obtained for the F/M ratio of 0.2, 0.4, and 0.6 respectively are 36 days, 13 days and 19 days.

CONCLUSIONS

F/M ratio has a considerable influence in the production of biogas. The production of biogas which are obtained at a ratio of F / M 0.2 with a total maximum methane yield 164.7 l/kg CODMn. In addition, ratio of F/M provides a significant influence on retention time (HRT). Retention time obtained in F/M ratio of 0.2, 0.4, and 0.6 respectively 36, 13 and 19 days. The addition of nickel and cobalt micronutrients affect the amount of biogas produced. The production of biogas which are obtained on the addition of nickel and cobalt respectively 0.4 mg/l with a maximum total methane yield 164.7 l kg CODMn and decreased on the addition of 0.6 mg/l.

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