The Increasing of Air and Biogas Mixer Instrument for Generating Friendly Environmental Electricity Power

Ni Ketut Lasmi¹, a), AlamtaSingarimbun¹, and Wahyu Srigutomo¹

¹Institut Teknologi Bandung

a)Email: k.lasmi@yahoo.com

Abstract. The abolition of BBM Subsidize by the government causes increasing of its price, so a solution is necessary to find an alternative energy that is relatively cheap, environmentally friendly and affordable by all layers of society. Biogas is one of the renewable energy resources that are potential to be developed, especially in a farming area, because up until now, animal’s excrement is not yet optimally used and it causes problem to environment. In response to this, one innovation to do is to make an instrument which is able to mix biogas and air by venture pipe using the basic theory of fluid mechanic, in order to raise the use of biogas as electricity source. Biogas conversion is done by changing fuel in benzene 5 kilowatt genset to biogas so it becomes a biogas genset. The biogas pressure is controlled when it enters the mixer instrument so that the velocity of biogas when it enters and it comes out the mixer is the same, and it will gain different pressure between biogas and air. By the pressure difference between biogas in the mixer instrument, biogas goes to the burning room so that the conversion of mechanical energy biogas to electricity will happen, and it will be applied as light and society’s needs.

Keyword: Instrument, biogas, conversion, environmentally friendly

1. Introduction

It is a fact that in these past few years energy has become a crucial issue in Indonesia especially about electricity. A higher demand of electricity is caused of the rapid increasing of population [1]. Electricity grows into an inseparable part of population daily needs because of the growth in industry, information and transformation. But in the reality, the supply of energy by PLN, as the official institution chosen by the government to manage Indonesian electricity, is not yet sufficient to cover all the needs of the population as a whole [2, 3].

According to Ramani (1922) in[1], Indonesia’s geographic condition which is consisted of thousands of islands and archipelagos, the spread out and uneven electricity sources, the low demand of electricity in several areas, the high of marginal cost in electricity supply system development and the limited financial ability are the hindrances to electricity supply in national scale. The decreasing of fossil energy source which has been the main component of electricity source in Indonesia causes the search of alternative energy that can decrease the dependency on fossil energy so it will provide electricity in local regional scale. The use of local source of energy will not harm environment. The system that is able to do that is the energy convert system that uses renewable energy source such as solar, wind, water and biomass (Djojonegoro, 1922 in[1]).

In these last few years, the use of alternative energy is much developed in Indonesia, and one of them is the development of biogas becomes bioelectric. Bioelectric is an electricity obtained by biogas from cow’s excrement and liquid and solid waste by anaerobic digestion process [4]. Biogas is one of the energy technology solutions to solve the problem in society because of the increasing of BBM price. This technology can be applied to society in order to fulfill the national need of energy. In line with this, one of the innovations is to develop a mixer instrument of biogas and air to obtain electricity that is environmentally friendly by using the basic theory of fluid mechanic.
2. Theory and Method

Biogas has an excellence compared to BBM from fossil. Its character of environmentally friendly and the ability to be renewed are the excellences of biogas. To produce biogas, it is needed to have a biogas reactor, an installation which is not containing air so the decomposition of cow’s excrement can be optimum, and the emission of methane gas can be decreased. The main gas produced by biogas is methane (75%), Carbon Dioxide and Carbon Monoxide [5]. From this reactor biogas is flowed to a biogas genset through a venture pipe. Because of the difference in the pressure between biogas and air, biogas will flow until the combustion room which is the energy source that moves this generator so it will produce electricity that can fulfill the needs of the society. The most useful part of biogas is the amount of calorie in $\text{CH}_4$ because methane is the most valuable component of biogas as fuel. Energy that is contained in biogas depends on methane concentration. The higher the methane is, the bigger the energy in biogas is.

Venture Meter Design

To measure the pressure difference of biogas and air, used the Bernoulli equation and continuity equation.

$$Q_{\text{ideal}} = A_1 v_1 = A_2 v_2$$

$$Q = C_v Q_{\text{ideal}} = C_v A_2 \sqrt{\frac{2(p_1 - p_2)}{\beta(1-\beta)}}$$

1. **Venturi Pipe** for penetrate the biogas
2. **Pipe** for air flow
3. **Pipe** for mixture air and biogas
4. **Valve** for controlling biogas
5. **Pipe** for entrance the gas

**FIGURE 1.** Mixer Instrument

Efficiency of biogas genset is:

$$\eta_g = \frac{E}{Q m}$$

In which:

- $m = Q t \rho = \text{biogas fuel mass (kg)}$
- $Q = \text{volume velocity (liter/minute)}$
- $t = \text{time (minute)}$
- $\rho = \text{density (kg/m}^3\text{)}$
- $E = \text{machine power (kJ/kg)}$
3. Result and Discussion

When biogas enters the mixer instrument, the biogas debit is measured by flow meter, the pressure by pressure gauge. When biogas comes out from the mixer instrument to the combustion room in the genset, the debit is also measured.

This analyzed result to gain the velocity and the pressure difference of biogas is

**TABLE 1.** The result of Biogas Debit Measurement and Pressure without Load (156 liter/hour)

| Time (minute) | Starting velocity (Liter/hour) | Ending velocity (Liter/hour) | Starting pressure (k.Pa) |
|---------------|-------------------------------|-----------------------------|-------------------------|
| 5             | 700.2                         | 713.2                       | 10                      |
| 10            | 713.2                         | 726.4                       | 10                      |
| 15            | 726.4                         | 740.2                       | 10                      |
| 20            | 740.2                         | 753.4                       | 10                      |
| 25            | 753.4                         | 767.0                       | 10                      |
| 30            | 767.0                         | 780.4                       | 10                      |

**TABLE 2.** Result of Biogas Debit and Pressure Measurement with Lamp Load 15 watt (210 liters/hour)

| Time (minute) | Starting velocity (Liter/hour) | Ending velocity (Liter/hour) | Starting pressure (k.Pa) |
|---------------|-------------------------------|-----------------------------|-------------------------|
| 3             | 746.0                         | 756.5                       | 2.5                     |
| 6             | 756.5                         | 767.0                       | 2.5                     |
| 9             | 767.0                         | 777.8                       | 2.5                     |
| 12            | 777.8                         | 788.3                       | 2.5                     |
| 15            | 788.3                         | 798.9                       | 2.5                     |
| 18            | 798.9                         | 809.3                       | 2.5                     |

**FIGURE 2.** Graphic Between Starting Velocity and Pressure Difference with No Burden
FIGURE 3. Graphic Between Ending Velocity and Pressure Difference with No Burden

FIGURE 4. Graphic Between Starting Velocity and Pressure Difference with Burden

FIGURE 5. Graphic Between Ending Velocity and Pressure Difference with Burden
From the first and second table, it is showed that during the operation of the machine there is no pressure change. From the data resulted from this experiment, the velocity of biogas when it enters ($v_1$) and when it comes out ($v_2$) from the mixer can be measured. Also the pressure difference of this mixer can be measured. The pressure difference in the mixer causes the biogas to flow to the combustion room, so conversion from biogas to electricity will happen.

The result by using 210 liter/hour of biogas and 2.5k Pa of pressure will be a 600 watt electricity power. Air biogas mixer with 16 m$^3$ capacity can be used to obtain 900 watt electricity for 12 hours. It is very prospective to be the alternative energy. The electricity power resulted by biogas conversion is now used a lot in Indonesia especially in farming areas, but the biogas conversion to electricity by biogas and air mixture using venture pipe is not yet commonly done in society.

4. Summary
1. Biogas and air mixer is an application of fluid mechanic concept.
2. The principle of the biogas mixer instrument is the continuity equation and Bernoulli equation, so the biogas pressure difference when it goes to the combustion room can be measured.
3. The biogas pressure difference in the mixer causes biogas flow to combustion room and energy conversion from biogas mechanic and electricity will happen, and it can be applied as light.

References

[1] N. A. Pambudi, *Pemanfaatan Biogas Sebagai Energi Alternatif*. Visiting Researcher in Biomass energy, gasification and process integration, Laboratory of Energy Engineering and Environmental Protection Sahkoniehentie 4, Otaniemi, Espoo 02150.

[2] T. W. Widodo, A. Asari, N. Ana, dan R. Elita, 2006. *Rekayasa dan Pengujian Reaktor Biogas Skala Kelompok Tani Ternak*, "Jurnal Enjiniring Pertanian, Vol. IV, No 1, pp. 41-52, April 2006.

[3] T.W. Widodo, A. Asari, A. Nuhasanah, dan E. Rahmarestia, 2006. *Biogas Technology Development for small Scale Cattle Farm Level in Indonesia*. International Seminar on Development in Biofuel Production and Biomass Technology. Jakarta, February 21-22, 2006 (Non-Presentation Paper)

[4] C.G. Gunnerson, and D.C. Stuckey,. 1986. *Anaerobic Digestion : Principles and Practises for Biogas System*. The World bank Washington, D.C. USA

[5] D. Deublein, and A. Steinhauser,. 2008. *Biogas from Waste and Renewable Resources*, Wiley- VCH Verlag GmbH & Co. KgaA, Germany.

[6] E. Porpatham, A. Ramesh, and B. Nagalingam. 2007. *Investigation on the effect of concentration of methane in biogas when used as a fuel for a spark ignition engine*. Internal Combustion Engines Laboratory, Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai – 600 036, India.

[7] T.C. Herberg, M. Enskat, and D. Abmann, 2014. *Conference Issue Paper. Renewables 2004 – International Conference for Renewable Energies*. 1–4 June 2004, Bonn, Germany.