Development of Portable Digester with IoT (Genbiot) 2.0 Technology in Biogas Production Welcoming the Industrial Era 4.0

Rais, Arfan Haqiqi Sulasmoro\*

Department of Computer Engineering, Politeknik Harapan Bersama Tegal \*Corresponding author: rais@poltektegal.ac.id

**Abstract.** At the village level, there is still a lot of organic waste, namely in the form of cow dung, food waste and garden waste, as well as land for managing waste is also still wide. Morover, kitchen waste and organic waste can be changed into biogas which can be converted into electricity or for kitchen needs. Regulation of Minister of Energy and Mineral Resources Number 27 in 2014 supports biogas development and will purchase electricity from biogas conversion. The potential of biogas from organic waste per 1000 people is 7619.8 litres of biogas, meaning that the energy contained is very abundant and its production can still be increased if it is processed with a modern digester system. Currently, there are many types of buried biogas design in the community, namely biogas that is buried in the ground. This design makes it difficult to maintain and check for leaks in the digester system. This research produces a tool in the form of a portable digester or another name is GenBIoT 2.0 (IoT-based Biogas Generator) which can be used by the public to produce biogas that can be used by home industries or factories in general. By using a research method that is almost similar to the System Development Life Cycle (SDLC), this tool is built with several stages starting from planning analysis, design, testing and implementation. This tool can be used as an alternative as a cheap and easy source of energy. The use of a water ratio of only 10% makes the fermentation time too long. Although the biogas content is high in this ratio, it is not effective in terms of energy utilization time. Organic waste will pile up later if you keep using such a comparison. This year we will use the ratio 3:2:5 and 4:1:5. By mixing organic waste, cow dung and water, GenBIoT can produce VGM (Methane Gas Volume up to 120 Biogas (L) with a composition of 16 Kg Cow dung, 4 Kg Organic Waste and 20 litres of water means that 120 L is enough to meet the needs community by utilizing existing waste in addition to waste pollution will decreasen.

1. Introduction

Geothermal, bioenergy, mini and microhydro, solar, water, wind, sea are various types of new and renewable energy (EBT). It is undeniable that the Indonesian nation has abundant wealth of green energy. The potential of EBT in Indonesia released by the MINISTRY of ENERGY with a total potential of 441.7 giga watts should be seen and developed for the realization of green energy Indonesia. But if you look at the installed capacity column, it turns out that only less than 3% of power plants are already installed and operating as of 2018. This means that there are still about 430 giga watts of unprocessed green energy[1].

In 2020 alone Indonesia needs a fossil energy contribution of 60,485 MW equivalent to 85% of the total national electricity needs. This means that dependence on energy is still dominated by fossil fuel energy (oil, gas, and coal) which in fact has sucked up an average budget of Rp. 120 trillion or about 11%-12% of the State Revenue and Expenditure Budget (APBN) for energy subsidies. As can be seen from figure 2, the trend of each line of primary energy tends to increase as well as fossil fuels. While EBT itself the most widely needed trend is from the type of Bioenergy (renewable energy obtained from biological sources including wood, biofuel and biogas)..

In the midst of the many renewable energy supplies in Indonesia, it turns out that it even causes a new problem that is still lack of interest in developing EBT due to expensive development costs and consuming a lot of research time. While PLN has now changed the 2018-2027 AGM will lower the total plan for the construction of a new power plant from 78,000 megawatts to 56,024 megawatts. As a result, EBT generating capacity will also be cut from 21,500 megawatts to 14,912 megawatts. This condition is actually quite worrying for the development of EBT in Indonesia. But if you look back at the potential of green energy specifically in the bioenergy sector and also kitchen waste, EBT development becomes crucial. Seen in Figure 3, where the largest organic waste is followed by plastic and paper. Looking further, even though organic waste has more positive sides, namely the existence of energy that can still be harvested in the form of biogas [2].

At the village level itself there is still a lot of abundant organic waste in the form of cow dung or kitchen waste or garden waste, as well as land to manage waste is also still wide. Considering further, the number of families in village A was 1000 people. If we calculate based on data from waste management, waste, and hazardous toxic materials (PSLB3) klhk, on average everyone disposes of waste of 0.7 kg / day then there is about 700 kg of waste, of which 50% is organic waste (kitchen and foliage). So there are 350 kg or 1,652 liters of organic waste in the village, precisely this is a fresh breeze because there is a renewable energy source every day for the village. If we calculate based on data from waste management, waste, and hazardous toxic materials (PSLB3) klhk, on average everyone disposes of waste of 0.7 kg / day then there is about 700 kg of waste, of which 50% is organic waste (kitchen and foliage). . So there are 350 kg or 1,652 liters of organic waste in the village, precisely this is a breath of fresh air because there is a renewable energy source every day for thevillage. Organic waste can be converted into biogas so that later it can be used to turn on stoves or electrical energy. So the future prospects for biogas production are very convincing with organic waste from abundant food. Organic waste can be converted into biogas so that later it can be used to turn on the stove or electrical energy. On average every 1 liter of household waste produces 4.61 liters of biogas, so there are 7619.8 liters of biogas available at the end of the biodigester fermentation period. The government encourages the development of biomass and biogas with the issuance of Esdm Ministerial Regulation No. 27 of 2014 on the Purchase of Electricity from Biomass Power Plants and Biogas Power Plants by PT Perusahaan Listrik Negara (Persero). If each village is able to build a power plant independently to be used or sold to PLN then there will be a surplus of electricity every year. This is where the idea of this research proposal was made [5].

Until now many are found in the biogas design community pendam, namely biogas that is buried in the ground. This design makes it difficult to maintain and check for digester system leaks. In addition, the cost of making and designing a 4 m3 pendam digester is about 10-12 million rupiah and does not include training costs and handyman fees. In this proposal, we propose a portable digester design that allows the digester to be carried and easily installed which we further named GenBIoT (IoT-Based Biogas Generator). Thus, portable biogas designs can be made in factories to be shipped and applied in the field. In addition, our design digester has been combined with IoT technology that will facilitate government operators in monitoring biogas and also map the distribution of portable digesters in an area. Thus, the government will be able to see the potential in a more transparent manner and can strive to increase biogas production to further build micro-power plants in the area

1. Methods

### Materials

The research materials used in this study consist of:

1. Household organic waste
2. Cow sling dung Air
3. Water

### Tools

1. Reactor tube with a capacity of 500 Liters
2. Screw
3. Motor Gear
4. Press Tube
5. Vacuum Pump
6. Hose capacity 0.4 Inches
7. Buffer
8. Microcontroller
9. DHT Sensor

### Program Flow

Start

Portable digester design

Design IoT Devices, Web and Servers

Functional Test

Data Analisis

Results Reporting

End

1. Results and Discussion

## Trial 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Experiment To** | **Composition** | | | **Total** |
| **Cow Dung** | **Organic Waste** | **Water** |
| 1 | 30% | 20% | 50% | 100% |
| 2 | 40% | 10% | 50% | 100% |
| 3 | 50% | 40% | 10% | 100% |

|  |  |
| --- | --- |
| Dung production per 6 cows (kg) | 18.20 |
| Production of Kitchen Waste per house 4 people (kg) | 3.20 |
| Kitchen Waste Production per 5 Families (kg) | 16.00 |
| Total Production | 37.40 |
| **It's set around.** | 40 kg |

Using experiment tables and average production assumptions, we calculated the composition of each experiment as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Digester 1** | | | | |
| **Experiment To** | **Composition** | | | **Total (Kg)** |
| **Cow Dung (kg)** | **Organic Waste (kg)** | **Water (kg)** |
| 1 | 12 | 8 | 20 | 40 |
| 2 | 16 | 4 | 20 | 40 |
| 3 | 20 | 16 | 4 | 40 |

**Calculation of the Potential of Each Experiment:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trial 1** | |  | | |
| **Percentage of Total Solid (TS) and Volatile Solid (VS) Cow Dung** | |  | | |
| %TS = 21% x Cow dung Production (kg/day) | | 2.52 | | |
| %VS = 78% x TS(kg/day) | | 1.97 | | |
|  | |  | | |
| **Percentage of Total Solid (TS) and Volatile Solid (VS) Kitchen Waste** | |  | | |
| %TS = 10% x Kitchen Waste Production (kg/day) | | 0.80 | | |
| %VS = 79% x TS(kg/day) | | 0.63 | | |
|  | |  | | |
| **Potential Volume of Biogas (PVB) m3/day** | |  | | |
| PVB = 0.04 \* %TS Cow Dung | | 0.10 | | |
| PVB = 0.04 \* %TS Kitchen Waste | | 0.03 | | |
| Potential Volume of Biogas Per Day | | 0.13 | | |
| Potential Volume of Biogas Per Hour | | 0.01 | | |
|  | |  | | |
| **Time required Gas Collector capacity 48 L Full (Hours)** | |  | | |
| 0.048 m3 / Total PVB m3/day \* 24 Hours/day | | 8.67 | | |
|  | |  | | |
| **Average Gas Production per m3 per day (K) in Percent (%** | |  | | |
| K= Potential Volume of Biogas (PVB) of Cow dung / VS \*100% | | 5.13 | | |
| K= Potential Volume of Biogas (PVB) Kitchen Waste / VS \*100% | | 5.06 | | |
|  | |  | | |
| **Volume Gas Metana (VGM) Biogas** | |  | | |
| VGM = 65.7% x PVB Cow Dung m3/day | | 0.07 | | |
| VGM = 65.7% x PVB Kitchen Waste m3/day | | 0.02 | | |
| **Total VGM** | | **0.09 m3/day** | | |
| Trial 2 |  | | |
| Percentage of Total Solid (TS) and Volatile Solid (VS) Cow Dung |  | | |
| %TS = 21% x Cow dung Production (kg/day) | 3.36 | | |
| %VS = 78% x TS(kg/day) | 2.62 | | |
|  |  | | |
| **Percentage of Total Solid (TS) and Volatile Solid (VS) Kitchen Waste** |  | | |
| %TS = 10% x Kitchen Waste Production (kg/day) | 1.20 | | |
| %VS = 79% x TS(kg/day) | 0.95 | | |
|  |  | | |
| **Potential Volume of Biogas (PVB) m3/day** |  | | |
| PVB = 0.04 \* %TS Cow Dung | 0.13 | | |
| PVB = 0.04 \* %TS Kitchen Waste | 0.05 | | |
| Potential Volume of Biogas Per Day | 0.18 | | |
| Potential Volume of Biogas Per Hour | 0.01 | | |
|  |  | | |
| **Time required Gas Collector capacity 48 L Full (Hours)** |  | | |
| 0.048 m3 / Total PVB m3/day \* 24 Hours/day | 6.32 | | |
|  |  | | |
| **Average Gas Production per m3 per day (K) in Percent (%)** |  | | |
| K= Potential Volume of Biogas (PVB) of Cow dung / VS \*100% | 5.13 | | |
| K= Potential Volume of Biogas (PVB) Kitchen Waste / VS \*100% | 5.06 | | |
|  |  | | |
| **Volume of Methane Gas (VGM) Biogas** |  | | |
| VGM = 65.7% x PVB Cow Dung m3/day | 0.09 | | |
| VGM = 65.7% x PVB Kitchen Waste m3/day | 0.03 | | |
| **Total VGM** | **0.12 m3/day** | | |
| Trial 3 | | |  | | |
| **Percentage of Total Solid (TS) and Volatile Solid (VS) Cow Dung** | | |  | | |
| %TS = 21% x Cow dung Production (kg/day) | | | 4.20 | | |
| %VS = 78% x TS(kg/day) | | | 3.28 | | |
|  | | |  | | |
| **Percentage of Total Solid (TS) and Volatile Solid (VS) Kitchen Waste** | | |  | | |
| %TS = 10% x Kitchen Waste Production (kg/day) | | | 1.60 | | |
| %VS = 79% x TS(kg/day) | | | 1.26 | | |
|  | | |  | | |
| **Potential Volume of Biogas (PVB) m3/day** | | |  | | |
| PVB = 0.04 \* %TS Cow Dung | | | 0.17 | | |
| PVB = 0.04 \* %TS Kitchen Waste | | | 0.06 | | |
| Potential Volume of Biogas Per Day | | | 0.23 | | |
| Potential Volume of Biogas Per Hour | | | 0.01 | | |
|  | | |  | | |
| **Time required Gas Collector capacity 48 L Full (Hours)** | | |  | | |
| 0.048 m3 / Total PVB m3/day \* 24 Hours/day | | | 4.97 | | |
|  | | |  | | |
| **Average Gas Production per m3 per day (K) in Percent (%)** | | |  | | |
| K= Potential Volume of Biogas (PVB) of Cow dung / VS \*100% | | | 5.13 | | |
| K= Potential Volume of Biogas (PVB) Kitchen Waste / VS \*100% | | | 5.06 | | |
|  | | |  | | |
| **Volume of Methane Gas (VGM) Biogas** | | |  | | |
| VGM = 65.7% x PVB Cow Dung m3/day | | | 0.11 | | |
| VGM = 65.7% x PVB Kitchen Waste m3/day | | | 0.04 | | |
| **Total VGM** | | | **0.15 m3/day** | | |

**Conclusion**

The provisional conclusions reached until this progress report is made are:

1. GenBIoT has a positive impact on the community in addition to organic waste cow dung can also be used to produce bio gas so that pollution will be reduced

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Biogas Potential Per-day** | | | | |
| **Experiment to** | **Composition (Kg)** | | | **Volume of Methane Gas (VGM) Biogas (L)** |
| **Cow Dung** | **Organic Waste** | **Water** |
| 1 | 12 | 8 | 20 | 90 |
| 2 | 16 | 4 | 20 | 120 |
| 3 | 20 | 16 | 4 | 150 |

1. From some of the results of the experiment below

The use of a water ratio of only 10%, makes the fermentation time too long. Although the biogas content is high at the comparison, it is not effective in time energy utilization. Organic waste will be mountainous later if you still use such comparisons. This year we will use the ratios of 3:2:5 and 4:1:5

**References**

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