Measurement of Level Content of Methane in Household Waste Based on Arduino and Gas Sensor

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Abstract. Household waste is an alternative energy source that is potential to be developed considering the continuously of production. Nevertheless, it is necessary to measure gas levels of waste as the effort to manage the waste effectively and efficiently. The design and manufacture of methane concentration gauges is the first step for this purpose. The tool is designed using Arduino and gas sensors as the main components. The measurement results are displayed on the LCD screen and picoscope measuring instrument. The sample used as a measuring object are decomposition of vegetables, liquid waste, and mixed waste. The measurement results show that the three types of waste show an increased concentration of methane gas, but the highest concentration of gas in vegetable waste.

Keywords: household waste, alternative energy source, Arduino, gas sensors, methane gas

1. Introduction
Waste management is one of the severe problems faced by almost all major cities in Indonesia. Especially in Makassar City, waste management is still conventional such as waste is transported from sources (houses, restaurants, traditional markets, modern markets, hotels, and offices) in mixed conditions and then transported to landfills. The end of this process only produces waste that is increasingly mounting and spreading bad odors without added value. The government realizes that urban waste which is mostly household waste is a potential renewable energy source so that it is used as a national priority in the field of new and renewable energy. However, the utilization of waste into energy is still very low, only around 1600 MW or around 3.25% of the available potential [1].

According to the city park and sanitation service in Makassar, where this research was conducted, the amount of waste produced in 2016 averaged 700-800 tons/day, and could even reach 1,200-1,500 tons/day on certain days. Whereas in Indonesia the volume of waste ranges from 64 million tons per year. Until 2020, the volume of urban waste in Indonesia is expected to increase five-fold. More than 40% of food becomes waste starting from the process of planting, production, shipping to final consumption [2]. The volume of waste is a big problem and should be handled and the other side, household waste has a considerable energy potential. The potential of household waste to be used as methane gas is high compared to some other types of organic material.

On the other hand, the need for energy is getting higher, so it is very urgent to look for new and renewable energy sources. Therefore, the Minister of Energy and Mineral Resources of the Republic of
Indonesia (ESDM) issued Ministry Regulation No. 12 of 2017 concerning Utilization of Renewable Energy Sources for Electric Power Supply. This policy emphasizes renewable energy sources. One potential energy source and can be used as an alternative energy source is biogas. As for potential household waste in urban areas, comprehensive research is still rarely carried out. For cities, the acquisition of alternative energy sources is possible from household waste because these sources are abundant compared to other sources. Besides that, processing waste into alternative energy (waste to energy) has other positive impacts, namely reducing environmental pollution and also can reduce methane (CH\textsubscript{4}) emissions into the air [3].

2. Literature Study

2.1. Biogas
Biogas is a gas produced by fermentation from organic materials such as human or animal waste, domestic waste, other biodegradable waste. The composition of biogas varies according to the source of the biogas material. But generally it contains 50-70% CH\textsubscript{4} (methane), 25-50% CO\textsubscript{2} (carbon dioxide), 1-5% H\textsubscript{2}, 0.3-3 N\textsubscript{2}, and H\textsubscript{2}S [4]. Biogas is a potential energy source, especially in waste-producing areas, such as oil palm plantations, urban areas and so on [5].

2.2. Methane gas content measurement tool
Measurement of biogas concentration, especially methane gas must be carried out continuously to maintain the sustainability of the supply of energy sources [6]. At present, the methane gas concentration data is still difficult to obtain because the equipment for gas measurement is still very limited. The effort to overcome this problem is to design a biogas measuring instrument that is reliable, accurate and thorough. One of the most commonly used sensors is the MQ-4 or TGS-2611 sensor combined with the Microcontroller or Arduino Uno. The design of the methane concentration measuring instrument can be seen in Figure 1 and 2.

![Figure 1. Layout methane concentration measurement instrument](image1)

![Figure 2. Methane concentration measurement tool](image2)

The methane content detection device is designed using several electronic circuit blocks, including the MQ-135 sensor, a series of power supply to provide voltage, a series of Arduino Uno single-board microcontroller, a series of push buttons for data input, and also a series LCD to display the output, buttons, minimum systems and drivers. The order structure in Arduino generally consists of 2 (two) parts, namely void setup, and void loop. The void setup contains commands that will be executed only once since the Arduino is turned on. While the void loop contains commands that will be executed repeatedly as long as Arduino is turned on.
The command is processed by the micro and becomes part of the gas detection control system. The button circuit is connected to port C Atmega32. From the process above the data from the sensor and the button will be processed by the microcontroller then displayed to the LCD pin on the LCD connected to port B Atmega32 with 2x16 character display, the display can help us to find out the methane concentration. When the detector on the system bridge also sends a PWM signal to the driver circuit, the speed of the detector is also displayed on the picoscope according to the PWM signal being sent.

3. Research Methods
The design of the tool begins with the design of the tool by the needs and characteristics to be achieved. Furthermore, the selection of precision electronic components is carried out and by the need to measure the gas content of the household waste. Furthermore, the measuring instrument will be tested for accuracy and accuracy in the electronic laboratory by using methane gas or the like as objects, and using household waste to see the success rate of the instrument. As a result of this stage, a reliable, thorough, accurate measurement tool is obtained. This instrument is one of the main tools as a biogas detector that will be used continuously in future research.

4. Results and Discussion
To test the success rate of methane gas detection devices that have been designed used methane gas in packaging as an object. The measurement output is done using picoscope. The visible changes in PWM values before and after methane gas measurement. Then the measurement is continued with the actual household waste object. The measurement results are seen on the LCD which is a series of detection devices.

The design of this tool uses a length of 18 cm wide by 10 cm and a height of 8 cm. There are four parts of the electrical circuit in this device consisting of a minimum system, Arduino UNO, as the center of control on this tool and the MQ-135. Gas Sensor is useful for detecting ammonia content which converted into digital values. The LCD is used for display the digital value characters read by sensors. Push Button has a function to manage data on the minimum system. Apart from the electrical circuit, there is a box as a gas reservoir that is isolated from outside air, so that data collection is more accurate.

![Figure 3. Gas packaging used as an object](image1)

![Figure 4. Output monitoring](image2)
In the initial measurement using gas in the package obtained the change in PWM voltage. This change indicates that there is an increase in the concentration of methane gas in the container. Before giving the gas as an object of measurement, the width of the pulse voltage is around 0.2 ms, while after giving the gas the pulse voltage width becomes 1.0 ms. The results of this initial test indicate that the detection device that has been designed works appropriately. The higher the level of gas concentration is measured, the more full the pulse rate.

In the second trial, where various types of household waste were used as objects, the concentration of methane gas content was different for each type of waste (Table 1). Vegetable waste in the form of vegetables has the highest concentration of methane gas, and mixed waste has the lowest methane gas content. The measurement result can be seen on the LCD. However, the measurement of methane gas content for various types of household waste will be carried out in further research.

Design the program on this tool using the Arduino IDE application. Where in making the program use the Liquid Crystal library to activate the LCD so that it can receive data to display the reading value from the Mq-135 sensor. In the management of sensor data using the ADC (Analog to Digital Converter) feature so that the analog data read by the sensor Mq-135 can be converted into digital values so that the reading range can be easily observed on the LCD.

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5. Conclusion

Testing of the methane gas measurement program with Arduino Uno and gas sensors is carried out in two stages: measuring the accuracy of the gas measuring instrument and the second step is the use of Arduino and Gas sensors reliable measuring methane content on household waste. The reading of the output on display is straightforward and clear. The results of this initial test indicate that the detection device has been designed works appropriately. The full rate of the concentration is measured, the full the pulse rate. The second test is the measurement of the three types of waste and produces variations in reading methane content.

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