THE EFFECTIVENESS OF GENERATING ELECTRICITY FROM BIOGAS CREATED FROM FOOD WASTES WITH THE USE OF PELTIER DIODE AS A NEW SOURCE OF RENEWABLE ENERGY

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Abstract - Biogas is produced by the breakdown of organic matter including food wastes. It has a high percentage of methane that makes biogas an excellent source of renewable energy to replace the need for natural gas and other fossil fuels. In that case, biogas can help in reducing greenhouse gases. The purpose of this research is to lessen the food waste that causes greenhouse gases and to provide an alternative source of renewable energy.After the researchers gathered all the necessary data, the team proceed to work on materials needed in the study, especially the food wastes and Peltier diodes. The biogas created from food wastes will be converted into heat energy with the help of Peltier diodes. The four (4) Peltier diodes, that convert heat energy into electricity, produced six (6) volts and was able to charge an android phone. On the other hand, the researchers noticed that the amount of biogas used in testing lasted only for two (2) minutes. The study has a big potential to contribute to the world of renewable sources, it proves that it could produce enough amount of electricity that can be a new source of green energy. The four (4) digester successfully produced methane but despite that, it took almost two (2) months to obtain the amount of biogas needed in the experiment.

Keywords - Biogas. Peltier diode. Renewable energy. Organic matter. Greenhouse gases. Methane. Food wastes.

I. INTRODUCTION

Biogas is also called as deep green energy because it provides clean renewable source of energy ("Biofuel in the Loop," 2017). Biogas is made from waste materials from municipal and industrial waste water treatment plants, food production such as food waste, brewery waste, fish and dairy processing, and also from residual waste from livestock such as uneaten food, manure and dung. Biogas is a renewable source of energy. It can only be depleted when the world stops producing waste. In addition, production of biofuel helps to eliminate the problem of landfill and dump sites or garbage, which is anticipated to provide a positive impact on the demand for biogas. Biogas is already being used in rural areas as well as in urban areas. Based on the industry needs, the creation of biogas is creating many job opportunities (Jiang et al., 2011). The systems that are used to create bio-energy can greatly contribute to reducing greenhouse gases as they have the possibility of reducing the need to use fossil fuels. By providing a non-polluting energy source which is also renewable, the earth is being kept clean of harmful emissions. Cleaner energy sources have been one increasing research topic in electricity generation. In that regard, waste of production processes can be object of anaerobic digestion, generating biogas; it can environmentally benefit by means of waste treatment and electricity production. Biogas is also the ideal way to have electricity in almost all places. As a fairly cheap source of electricity, biogas is a fuel source that has the power to provide decent energy to the world(Salvador,2018). Biogas can be considered as one of the great source of electricity that has renewable source of energy which is suitable and more convenient than other sources. Biogas is produced by anaerobic digestion, a biological process in which microorganisms break down biodegradable materials in the absence of oxygen ("What is Anaerobic Digestion?", 2018). Its advantage to other source is that it can save environment; wastage management and can also be a source of an improved organic fertilizer. Last June 5, 2018, under United Nations auspices, World Environment Day 2013 was observed with the theme, "Think, Eat, Save." Sadly, very little was said about this in the national media. Searching beneath the theme, however, discloses interesting data on global food production, distribution, and consumption and the tremendous amount of food that lost and wasted yearly (Ocampo, 2013). All these affect the degrees of global mass hunger, poverty, and ecological destruction, on which much begs to be done in terms of adopting appropriate national policies and programs and forging relevant enforceable international accords. Food waste also contributes directly to climate change. Most wasted food ends up in landfills, where the zero (0) oxygen environment turns organic matter from bread to banana peels into methane, a gas that traps about thirty(30) times more heat than carbon dioxide over the course of a century. Between the emissions associated with its production and its decay in landfills, food waste represents 4.4 billion tons of annual greenhouse gas emissions (Pearson, 2018). An electricity shortfall looms as a serious problem for the Philippines, where growth in generating capacity is not keeping pace with demand. Rolling blackouts may be implemented on the largest island of Luzon this year. The Philippine economy has been

expanding at a more than five percent (5%) annual clip. Demand for power is expected to reach thirty (30) million kilowatts in 2030, but current capacity is just seventeen (17) million kilowatts. The use of biogas as replacement for a single resident's electricity source, biogas technology has successfully been used on municipal, agricultural and domestic scale throughout the world. The use of biogas as a source of electricity on rural areas will be effective and will lead a huge role in producing enough electricity to support other areas (Satake, 2015).

The study aims to lessen the amount of food waste that causes greenhouse gasses. If food wastes were a country, it would come in third after the United States and China in terms of impact on global warming (Frischmann,2018). Hence, the team concluded that food wastes should be converted into energy with the use of green technology. The study also aims to provide an alternative source of renewable energy. With the use of the biogas created from food wastes, it will be converted into heat energy and with the use of Peltier diodes, it will be converted into electricity.

II. METHODOLOGY

2.1 Construction of Biogas Digester

The researchers prepared all the needed materials in product making. The team made sure that the water gallons are free from dirt and well dried. The researchers cut four (4) twelve (12) inches gas hoses and twelve (12) six (6) inches gas hoses. The team made a hole in the water gallons' cap equal to the circumference of the hose and attached the twelve (12) inches hose to the cap. The team secured the cap and the hose to avoid sudden discharge of air. The researchers put some Vulcaseal around the hose and applied super glue on it. It is needed in anaerobic digestion. The end of the hose was linked into the T-valve and the other two (2) hoses are linked into the same T-valve. The ball pin was attached to the end of the six (6) inches hose. Gas valve was attached into the end of the six (6) inches hose and another six (6) inches hose was attached. The researchers made a hole in the lower part of the plastic storage box and put the hose inside the hole and ensured it stands. Another ball pin was attached at the end of the hose inside the plastic box. On the other six (6) inches hose, the team attached a rubber ball and attached it to the storage box. The researchers ensured that there are no openings and the device is airtight. All hoses are secured with cable ties. The researchers repeated the process on the other gallons. The team made a slurry with a mixture of 3.5 kilograms of food wastes and one (1) liter of water. The ratio of food wastes should be more than water. It will help in fastening the production of biogas (Kalia& Singh). The mixture was poured inside the gallon and cap. The team painted the digester with black paint so that sunlight will not pass through the digester and algae will not form.

2.2 Construction of the Thermoelectric Generator

A Ball pin was put inside the plastic storage box inside the metal container. Aluminum was placed above the metal container. This will act as a heat conductor. Peltier diode was placed above the aluminum sheet. Wires were connected with other Peltier diodes and formed a series circuit. The researchers connected the wires to a USB port. Above the Peltier diode, the team put a plastic container with ice inside of it. The Peltier diode generates electricity from both heat and cold. (Vispute, 2017).

2.3Data Gathering

Data will be gathered as all the biogas digester produce enough methane to perform the whole experiment. Researchers prepare all the instrument in gathering data and made it sure that Peltier and the cooling system are all in the right place.

III. RESULTS AND DISCUSSION

The data was gathered when the four (4) Peltier diodes were heated up with the fire produced by biogas. The experiment involves 10 trials which were checked every 10 seconds. Time was measured through the use of a stopwatch which was stopped after each trial. A thermometer was used to measure the heat of an aluminum plate which was placed above the fire produced by the gas. Voltage was measured through the use of digital voltmeter that is connected in the Peltier diodes which convert heat energy of the fire into electricity. The researchers used these instruments to efficiently gather the data in testing. The testing was executed after 71 days of decomposition of organic materials which was sealed and undergone anaerobic respiration. The researchers prepared all the instruments needed and made sure that all devices were working properly for the testing.

Table 1. Data gathered during the experimental phase.

Time	Temperature (°C) Hot/Cold		Voltage per Peltier diode
10s	52°C	5°C	1.38V
20s	77°C	5°C	1.42V
30s	97°C	5°C	1.75V
40s	106°C	5°C	2.20V
50s	132°C	5°C	2.51V
60s	143°C	5°C	2.78V
70s	149°C	5°C	2.88V
80s	155°C	5°C	2.92V
90s	161°C	5°C	2.93V
100s	160°C	5°C	2.89V

Table 1 shows the voltage produced by the Peltier diode and the temperature affecting it with the increasing time. Celsius is the unit used in the measurement of temperature.

The data gathered by the researchers shows the direct relation of the temperature that comes from the biogas, the cooling system, and the voltage that is

being produced. The conversion of heat energy of the four (4) Peltier diodes, working simultaneously, converted almost six (6) volts and is able to charge an Android phone. However, the amount of biogas that the researchers used in the testing only lasted for about two (2) minutes and started to fade in the succeeding minutes, the biogas, as well as the voltage, slowly decreased.

According to a research paper entitled Thermoelectric Power Generation from Waste Heat of Natural Gas Water Heater (Ding et al., 2017), the researchers used Seebeck effect, theproponents analyzed a thermoelectric generator to generate electricity from the excess heat in the surroundings. The researchers presented the different possible applications of Peltier tile.

CONCLUSION

The four (4) digester that successfully produced methane through the use of anaerobic digestion and the use of Peltier diode as a device in converting heat into electricity was successfully obtained by the team. However, It took almost two (2) months after the researchers obtain the amount of biogas that was presented in the experiment. After gathering the data, it proves that it could produce enough amount of electricity that could charge an android phone in a limited time, thus researchers still conclude that the product is indeed effective and has a big potential in the world of renewable resources. It may not be easy to use like other renewable resources but still, it is definitely cheaper and environmentally friendly.

RECOMMENDATION

To maximize the use of the Peltier diodes, proper control of air circulation is needed. The temperature of the air on both sides can affect the amount of electricity produced. There are three ways to optimize the Peltier effect, namely, reducing the temperature difference(dT) between two sides, minimizing power losses, and optimizing the coefficient of performance(COP). To reduce the dT, the heatsink and fan must be placed strategically, depending on the setup. Proper air insulation for the cooling side must be exercised to prevent the air in the cooling side to escape ("Peltier Element Efficiency," 2018)

The setup used by the researchers is only for experimental purposes. By using a larger setup, the amount of electricity will change drastically. The researchers also recommend switching to the Seebeck effect instead of using the Peltier effect. The Seebeck effect is used with larger setups compared to the Peltier's.

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