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Article

Methane Gas Cooker: Potential of Biodegradable Kitchen Waste in Production of Methane Gas and Its Detection

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Abstract: Biodegradable kitchen waste has huge potential in the production of methane gas. In this study, kitchen waste such as vegetable peels and fruit pulps were collected and composted for methane gas production. Comparison was made between kitchen and agricultural waste by measuring the amount of gas produced. Arduino methane gas sensor that was embedded in a bin composter enabled measurement of methane gas production in this experiment and the absolute gas volume produced were determined using display LCD panel located on the bin composter. The outcome shows that Methane gas produced in this study can be harvested directly form bin composter and it has a huge potential as a substitute of LPG Gas.

Keywords: Arduino, Biodegradable, Methane Gas, Waste compost

1. Introduction

Bio-composting is the biological process of breaking up organic waste such as food waste, manure, leaves, grass trimmings, paper worms and general household waste into an extremely useful humus-like substance by various micro-organism including bacteria, fungi and antinomycetes in the presence of oxygen at suitable pH.

Bio-composting is a natural way of recycling organic farming wastes. At the simplest level, the process of composting simply require making a heap of wetted organic matter (leaves, food waste) and waiting for the materials to breakdown into humus by undergoing biological decomposition after a period of weeks or months. These wastes are generated out of human activity and the sources would also from residential areas.

There are two ways bio-composition may occur; fundamental types of

composting which is aerobic composting and anaerobic composting. For Aerobic composting, the process involve the decomposition of organic waste in the presence of oxygen (air); the process which also requires Carbon dioxide (CO_2); Ammonia (NH_3), water and heat. Bio-composition may occur 1 in any organic waste but, effective composting requires the right combination of ingredients and conditions such as moisture contents (around 60-70%) and Carbon to Nitrogen (C/N) ratios of 30:1. However if there exist any significant variation in these conditions, it may inhibits the degradation process. In general, wood and paper is an important source of carbon for the decomposing microbes, while sewage sludge and food waste provides nitrogen to ensure an adequate supply of oxygen at all times. Ventilation of waste, either forced or passively essential.

Meanwhile, anaerobic composting is the decomposition of organic wastes in the absence of O_2, the products being methane (CH_4), CO_2, NH_3, trace amounts of other gases and organic acids. Anaerobic bio-composition was traditionally used to compost animal manure and human sewage sludge, but recently it has become more common for some municipal solid waste and green waste to be treated in this way.

The parameters which may influent the yield of bio-gas are water content, nutrients, pH, oxygen demand temperature and time. Other than that, composting also consists of several methods like static pile, In-vessel, bin composter, windrow and vermicomposting. In this study, the efficiency of the Methane Gas Cooker were evaluated based on two parameters; material and type of organic wastes used for composition.

According to Nallamilli and Satyanarayana (2017) biogas refers to a gas made from anaerobic digestion of kitchen waste. Methane is a clean gas which generates energy and mainly used as cooking gas. Thus, it may serve as an alternative resource leading to cheaper and greener technology. Most of the biodegradable food waste from residential are generally waste food, vegetable peeling, fruit peeling etc. These are organic wastes and can be decomposed quickly by the action of biodegradable bacteria in soil. During decomposition process, these waste materials will tend to release carbon dioxide, methane, ammonia and hydrogen sulphide into the environment thereby contribute to air pollution and odour pollution. The gases like methane that are released on the other hand can be captured and collected for the economic utility whereby making them as cooking gas. This will also prevent air pollution while safeguarding cleaner environment.

According to Gonawala and Jardosh (2018), organic waste can be either agriculture waste or kitchen waste. Though these wastes can be easily decomposed by biodegradable bacteria, the by-product generated depending on the quality of the compost; moisture content, heavy metal, 2 stability, nutrient content, particle size distribution, pathogen levels and product consistency over time will determine yield and productivity of Methane gas.

2. Methodology

2.1 Materials

Gas sensor (MQ-4, China), Temperature sensor (DHT22, China), LCD display (IIC 12C LCD 1602, China), Arduino UNO (R3 compatible with CH340G), Jumper wires (Breadboard Dupont, 40p - 10cm), Compost Bin (Waste Converter, SKU889754), Plastic Tank (Kang Zhi Yuan, 1ADE), PVC pipe (No brand, 20mm 3/4" Made), Water Tap (No brand, B00015) and Ball Valve (WaterFila, Adverse ½").

2.2 Method

The Methane Gas Cooker is an Arduino project based programmed to measure the reading of methane gas level. This programme uses a gas sensor and a temperature sensor to ensure the quality of the compost. Anaerobic microorganism in this experiment able to breakdown kitchen or agriculture waste in the absence of oxygen. The digester can be a hard plastic tank or using portable compost bin. In this project, production of Methane biogas was collected and measured with Arduino

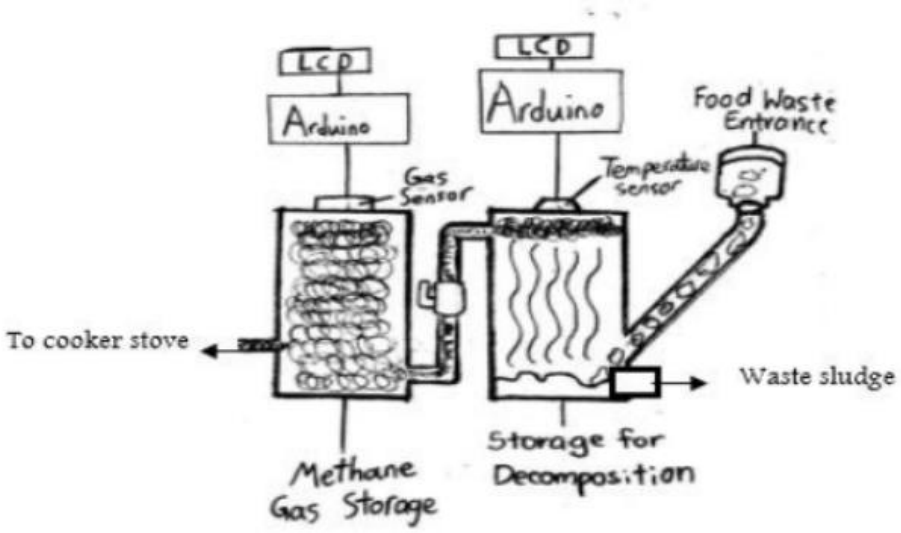

Figure 1: Methane Gas Cooker Project/ Anaerobic Digester Experiment. Anaerobic bacteria were used to decompose the waste. These conventional composting was influenced by 3 temperature, oxygen supply and humidity content. Cow dung was used as a catalyst in this process. Two sample; sample A and B was used in this experiment.

based project.

2.3 Experimental procedure

Sample A: Kitchen waste +10% cow dung.
Sample B: Agricultural waste +10% cow dung.

Sample A consisting of fruit pulp, vegetable peeling and food waste is mixed together with cow dung and water to prepare slurry. The ratios are 40% kitchen waste plus 10% cow dung and 50% water. Sample B on the other hand consisting dry leaves, green leaves small branches and twigs mixed together with cow dung and water to prepare slurry. The ratios are 40% agricultural waste plus 10% cow dung and 50% water. The slurry sample was pumped into an anaerobic digester tank. The tank was thermally insulated, under mesosphilic conditions at 38 °C and retained nearly for 96 hours. After 96 hours different gases such as Methane, Ammonia, Carbon dioxide and Sulphur dioxide were generated. The volume of methane gas was measured using sensors that was collected in separate gas collection tank. The waste sludge from anaerobic digester was collected and used as bio-fertiliser.

3. Result and Discussion

The volume of methane gas obtain was measured using Arduino Methane Gas sensor and the results had indicated that the Sample A which contain kitchen waste and cow dung obtained higher volume of methane gas.

Sample A design with high caloric content and anaerobic microbes. Livestock manure such as cow dung has been established as major source of microbes while food waste have high calorific and nutritive values for growth and sustainability of microbes. Higher methane gas production because of the 3 stages of three stages (hydrolysis, acidification and methanogenesis) of biochemical processes with release of energy rich biogas. The organic matter is catabolized externally by extra cellular enzymes, in the first stage. The acid producing bacteria converts the 4 intermediate to low molecular weight compounds thereby creating anaerobic condition which is essential for the methane producing microorganisms Methane producing bacteria which are involved in the third stage decompose compounds having low molecular

Table 1: Production of Methane Gas by Sample A and Sample B

Sample	Volume of Methane Gas / cm^3		
	Day 4	**Day 6**	**Day 8**
Sample A	85	93	130
Sample B	30	45	75

weight to form CH_4 and CO_2. These gases can be measured by counting anaerobic microbes and/or the amount of CH_4 that are produced by the volume shown by Methane gas Sensor.

Meanwhile Sample B, the agricultural waste has low production of methane gas because having a lower amount of anaerobic microbes for decompositions. Our invention 'The Methane Gas' cooker will help to determine the waste composition by showing the reading of methane gas that have been produce in a same period of time, and parameters by using bin composter.

4. Conclusion

From the result of this study, the methane gas cooker equipped with sensor able to measure production of methane gas produced during the bio-composition of kitchen waste. The advantage that we have compared to other Methane Gas Cooker was the sensor that able to measure the amount of methane gas being generated. Hence the invention 'The Methane Gas Cooker' objectives is to produce a renewable bio energy, to reduce air pollution, to find ecofriendly disposal methods, to generate revenue from the waste that is generation of wealth from waste and furthermore to reduce global warming.

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