CONCEPT PAPER: FABRICATING A DIGESTER FOR BIOGAS FROM FOOD WASTE DISCARDED BY SEKOLAH RAJA TUN AZLAN SHAH (SERATAS) DINING HALL

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ABSTRACT

This is a concept paper extracted as part of the fabrication of a biogas power generation facility project at Sekolah Raja Tun Azlan Shah (SERATAS) Taiping, Perak. In this paper, the needs and method of fabricating a digester used in the proposed biogas plant is discussed. For a start, the size of the digester is based on the food waste discarded at the school's canteen at lunch hour by 612 students for the study year 2016. Fabrication of the digester concentrates on the need to separate methane from other biogas produced and also the process of trapping methane so as to avoid leakages to the environment. The amount of gas is measured and later included in the plan to be converted to electrical energy. The electrical energy will be used to power the lights along the corridor of the dining hall.

Keywords: biogas methane, digester, renewable energy.

1. Introduction

The government of Perak Darul Ridzuan and the Federal Government of Malaysia is actively promoting sustainable development and it is with this in mind that SERATAS took the stand to inculcate in its education the need for its students to be part of a resilient society by being inclusive and able to contribute towards a sustainable future.

Subsequently, the government of Perak Darul Ridzuan has identified energy sustainability measurements as one of the sustainability indicators. Energy as it is being defined, is the power derived from the exploitation of physical or chemical resources, in particular for light, heat or merely to work machines. At the rate of its consumption; study has shown that those energy resources will deplete unless conservatory and sustainable action is being planned. These studies referred to are with regards to the Malaysia's population and the indicators are; Inadequate energy supply Management, High rates of Energy Wastage, High rates of Non-Revenue Energy (NRE), Legislation and Enforcement, Institutional issues, Privatization of the energy sector and Low Energy Tariffs (Aikanathan, 2014).

SERATAS decided to look into waste management as an effort to be inclusive in the sustainable action. Thus this study will revolve around efforts directed towards utilizing renewable and cost–wise green energy alternatives to lessen the dependence on fossil fuels as suggested by Abdeshahian *et.al*. (2016).

One of the many alternatives being studied is the use of biogas. Despite their potential beneficial effect on the environment, the use of biogas was not particularly common. Biogas is an environmentally advantageous energy source, which is mostly comprised of methane (60%) and carbon dioxide (35–40%) (Aishah *et.al*., 2013). Biogas also contains a low quantity of other gasses such as ammonia (NH_3), hydrogen sulfide (H_2S), hydrogen (H_2), oxygen (O_2), nitrogen (N_2) and carbon monoxide (CO). The production

of biogas evolved from a process known as anaerobic digestion. Anaerobic digestion has been found as a biological process to recycle waste materials to energy sources through the treatment of various organic waste such as municipal solid waste, food waste, industrial waste, sewage sludge, animal manure and agricultural residues (Bao *et.al*., 2015).

2. Method

2.1. Participants and procedure

SERATAS is a boarding school with 612 students, all living and studying in the same compound at Sekolah Raja Tun Azlan Shah, Taman Tasik Taiping, 34000 Taiping, Perak, Malaysia. On a normal school day, the school's dining hall will churn out 20kg to 25kg of food waste. Food waste (FW) is defined as the food that is good quality and fit for human consumption but that does not get consumed most due to the process discarding it occurred either before or after it spoils. FW typically, occurs at the selling and utilization stages. It is the result of negligence or a conscious decision to throw food away. The FW from SERATAS dining hall are usually thrown directly to the bin and collected by the Taiping Municipal Council. 90% of these foods are inedible; therefore they can't be recycled by donating to the needy.

In this project, the dining hall's FW will be collected as sample and transported to a workshop within the school's compound. At the workshop, the FW will be manually removed from any impurities. This will later become the project sample. The sample will be stored in plastic bottles at 20 ± 2 °C until further used. The sample will later be thawed overnight under ambient conditions, and ground up using a kitchen blender before usage.

Studies showed that FW biomass generates more methane than animal manure and municipal sewage sludge. The biogas is produced mainly from liquid manure (56.67% of all substrates), followed by maize silage (23.2%), distillery stock (6.5%). other organic waste used to produce biogas includes manure, fruit and vegetable wastes, potato pulp and cereals (13.6%) (Bo *et al.*, 2015).

2.2. Instruments

Ideally, the effect of feeding of the FW should be studied in a 60-liter plastic drum digester by cycling each waste every fifth day in order to operate the digesters as and when there was supply of feed. However, due to budget constraints, the team of student researchers suggested to use the 1.5-liter and 5-liter plastic container, which are readily available. This digester will be designed with an inlet and an outlet for feeding and effluent discharge along with a gas outlet. The digesters, with working volume of 1.1 ± 0.05-liter and 3.7 ± 0.05-liter, will operate under the semi-continuous mode of feeding at a temperature of 30 ± 2 °C. (Carlsson *et.al.*, 2015)

3. Results

The expected biogas generated will be collected in a 1.5-liter and 5-liter plastic container. The presence of methane in the biogas can be tested using the burning of gas. The volume of biogas collected in a plastic container can be measured with a water displacement method. Studies suggested the composition of biogas to be analyzed using a GC (Agilent 7890A, USA) equipped with a Thermal Conductivity Detector (Chen *et.al.*, 2016) however this equipment is very costly.

3.1. Measurement Model

Methane is a colourless and odourless gas. In this experiment as FW is gestated in a 1.5-liter and 5-liter tightly sealed plastic container, the aerobic decomposition will occurs first and CO_2 is produced while oxygen is consumed. Once the oxygen has been used up the methanogenic bacteria is expected to start growing and consume the CO_2 to produce methane. Therefore, it an initial increase in CO_2 production is expected and this will be followed by a decrease in CO_2 and a steady increase in methane production. The biogas obtained at the end of the reaction will be a mixture of CO_2 and CH_4 . The CO_2 can be monitored using a CO_2 detection probe. The methane can be identified by burning it. The

expected biogas generated will be collected in a 1.5-liter and 5-liter plastic container and burned under the hood.

4. Discussion

This study found that there are a few important questions that the reseacher can only come across while at the project. These findings will lead to solutions that will affect the outcome of this project. The identified questions are:

What are the limiting factors in the production of CH4?
How could methane production be increase?
How to trap methane so as to avoid leakages to the environment?, and
How can pH influence methane production?

5. Conclusion

Designing and fabricating a biogas digester make it an ideal project for SERATAS student researchers to be inclusive and contribute towards energy sustainability measurements. The findings of this project will also enable them to ask what the economical and ecological implications of biogas production.are. With the knowledge from this project, it will encourage student researchers to be more responsive and responsibe towards being an agent in the for sustainable living.

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