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Device Development for Generation of Biogas and Electricity from Food Waste for Domestic Applications

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***Abstract*: Organic waste can be generated to produce the Biogas. Biogas is produced by the anaerobic digestion or fermentation of biodegradable materials. Biogas can be used as fuel for heating purposes, it can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, much like natural gas, and used to power motor vehicles. A phenomenon called the Seebeck effect, Thermo Electric Heat Generator converts heat flux directly into electrical energy is made use for the generation of electricity.**

***Keywords*: Anaerobic digestion, Biogas, Digesters, Electricity, Food waste, Methane, Thermal heat generators.**

1. Introduction

Biogas is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen, usually consisting of certain quantities of methane and other constituents. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source. In India, it is also known as "Gobar Gas". Biogas is produced by anaerobic digestion with methanogen or anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials. This closed system is called an anaerobic digester, biodigester or a bioreactor. Biogas is primarily methane (CH) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulfide (H_2S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat.

2. Literature Survey

In [1] published by Edmund, the average methane (CH_4) gas composition operating period, both the mesophilic and thermophilic digesters produced their highest methane gas concentrations. proliferate, and more methanogens produce more methane. Gas from thermophilic digesters was often near, or even greater than 70% CH_4.

This suggests that allow more time for methanogens to These results show that anaerobically digested food waste can produce digester gas that has a higher energy value than gas produced from anaerobic digesters fed municipal wastewater solids (typically 50-60% CH_4).

In [2] by Banks, C. J. M. Chesshire, S. Heaven and R. Arnold, a mass balance accounted for over 90% of the material entering the plant leaving as gaseous or digestate products. A comprehensive energy balance for the same period showed that for each tonne of input material the potential recoverable energy was 405 kWh. Biogas production in the digester was stable at 642 m^3 tonne (-1) added with a methane content of around 62%. The nitrogen in the food waste input was on average 8.9 kg tonne (-1). This led to a high ammonia concentration in the digester which may have been responsible for the accumulation of volatile fatty acids that was also observed.

In [3] by G.M. Hall and J. Howe, studied that cleaner production, supply chain and life cycle assessment approaches all have a part to play as tools supporting a new vision for integrated energy and waste management. Our reliance on high-energy processing, such as canning and freezing/chill storage, might also need re-assessment together with processing based on hurdle technology. Finally, the concepts of energy and power management for a distributed energy generation system must be brought into the food processing industry. If the FPI is to get to grips with energy management it must embrace the widest definition of the subject and utilize the tools at its disposal to achieve these aims. The UK multi-agency Global Food Security Strategic Plan 2011-2016 has four research themes, of which, two are resource efficiency and sustainable food production and supply, with GHG, energy and waste reduction as major goals within these themes.

The strategic plan is a response to the national and global drivers which will impact and on food security and hence on the

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FPI and its supply chain

In [6] published by Capson-Tojo, Anaerobic processes are able to treat efficiently organic wastes, producing at the same time different value-added compounds. In addition, due to the lower costs and environmental impacts associated with these processes when compared to other options, they are among the most promising technologies for food waste treatment. The different processes that are assessed are anaerobic digestion for methane production, anaerobic fermentation for hydrogen and/or volatile fatty acids production and 2- stage systems.

3. Methodology

The aim is to generate electricity from biogas power plant that could generate methane gas and produce electricity as much as being produced by food wastes as the feedstock. This biogas power plant will indicate the amount of methane gas produced with the certain amount of feedstock used every day. This machine works based on biogas cylinder with total amount of feedstock ranging as per the capacity. These mini biogas power plants use anaerobic digestion (no present of oxygen) and the feedstock is mixed with the cow dung and water. The feedstock came from canteens and cafeterias waste for example leftover rice, vegetables waste, fish waste, fruits and any other food left overs. The Biogas is then burned and heated in a case and (Thermal Heat Generator) TEG device is placed to generate electricity from heat.

Organic waste, such as livestock manure, is incredibly rich in methane. This makes it the ideal ingredient in the process of creating biogas and recovering useful energy. While small-scale biogas plants are possible, the organic waste inputs required to make them a viable means of energy production are larger than a single home can provide. Communal biogas plants are conceivable, especially where there is a constant population of livestock producing large amounts of organic waste. All these can be added to the digester. Through an anaerobic process, the waste is broken down or digested in the digester. This process of energy recovery releases methane gas. In other words, potential energy stored in the organic waste is harnessed. The by-product of this process is an organic fertilizer that flows will flow through an outlet valve. Once the biogas is released from the organic waste, it is then channelled through a valve. Now, the gas is useful for cooking energy and gas heat, but it can also be converted to electricity by combusting it.

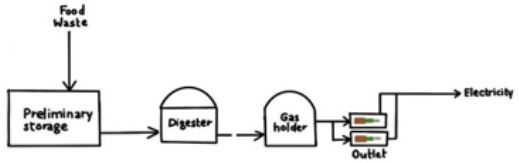

Fig. 1. Methodology

Finally, the combustion of the biogas heats in plate and electricity is generated using thermal heat generator. The generated electricity is then stored in a battery by adjusting the necessary voltage and current through it, the battery charger circuit safely charges the battery. The generated electricity is measured very sensitively using microcontroller.

The simulation file consists of two TEG circuit section each TEG module produces 4.8V so in- order to increase the current outcome it is connected parallel to the output from the TEG, which is connected to the battery and the supply from the battery is connected to the boost converter circuit in order to increase the output of the circuit is connected to load.

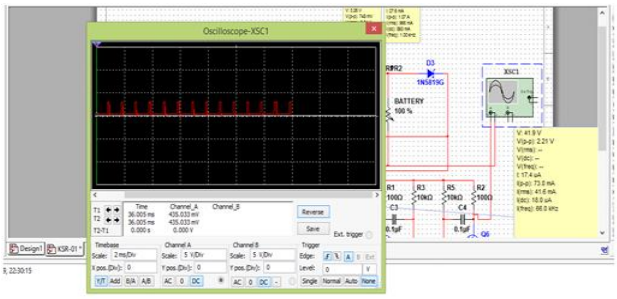

Fig. 2. Output

Two thermal Electricity generator circuit has been involved in order to produce maximum current from biogas here the circuit is connected in parallel and the generated power is connected to battery charging circuit. The battery charging circuit is nothing but it automatically controls the power which is sent to the battery if the battery gets fully charged it cuts off the circuit automatically if the battery is in empty state it allows the maximum generated power to pass through. Next to the battery charging circuit the connection from the battery is sent to the voltage booster circuit the voltage booster circuit automatically boosts the voltage of the output by consuming some amount of current this action is performed according to the load given.

4. Conclusion

The most suitable power plant system to be installed at remote area is mini organic power plant compared to solar energy system because of several reasons. First of all, this mini biogas power plant is easy to set-up because it is made in a modular system that could be installed or uninstalled and transferred easily everywhere and anywhere. When there is a human, there will be waste. It is not hard to collect the wastes to be used in generating the energy rather than waiting for the sunlight that is dependable on the weather. If it is raining season, they villagers will not suffer to stay in dark at night and feeling hot during the day. The generator will work 24 hours to generate electricity as long as there are wastes and the generator have enough fuels to work. If there is 1000kg waste per day, the mini biogas power plant can generate about 180 cubic meter methane gas and 600kW electricity per day. The waste produced should be enough to support this system. It is acceptable if the waste is lower than 1000kg per day, as long as it could support all the needs that the people demand at their place. The higher the amount of wastes could produce the higher the amount of electricity.

References

[1] Ebmud, 'Anaerobic digestion of food waste'. Final report prepared by East Bay Municipal Utility District for Funding Opportunity No. EPA-R9-WST-06-004, March 2008.

[2] Banks, C.J., M. Chesshire, S. Heaven,

[3] and R. Arnold, 'Anaerobic digestion of source- segregated domestic food waste': Performance assessment by mass and energy balance, Bioresource Technol. 102:612–20, 2011.

[4] G.M. Hall, J. Howe, 'Energy from waste and the food processing industry', Process Saf Environ, 90, pp. 203-212, 2012.

[5] Lin. N. B. D. Thi, B. Sen, C.C. Chen, G. Kumar, 'Food waste to bio energy via anaerobic processes Energy' Procedia, 61, pp. 307-312, 2014.

[6] G.M. Hall, J. Howe, 'Energy from waste and the food processing industry', Process Saf Environ, 90, pp. 203-212, published on 2012.

[7] Lin.N.B.D. Thi, B. Sen, C.C. Chen, G. Kum ar, 'Food waste to bio energy via anaerobic processes Energy' Procedia, 61, pp. 307-312, 2014.

[8] Lin N.B.D. Thi, G. Kumar, C.Y. Lin, 'An overview of food waste management in developing countries: current status and future perspective', 157, pp. 220-229, 2015.

[9] Capson-Tojo, G. et al, 'Food waste valorisation via anaerobic processes': A review. Rev. Environ. Sci. Bio/Technol. 15, 499–547, 2016.

[10] Mustafa, M. Y., Calay, R. K. & Román, E, 'Biogas from organic waste—a case study', Proced. Eng. 146, 310–317, 2016.

[11] Kayode Hassan Lasisi, Olanrewaju Adebayo Ojomo, 'Methane Generation from Cow Dung with the Aid of a Termitic Enzyme Using a Locally Fabricated Bio-Digester', 2017.

[12] Gong, J. et al., 'Direct conversion of wheat straw into electricity with a biomass flow fuel cell mediated by two redox ion pairs', Chemsuschem 10, 506–513, 2017.

[13] Chen, H., Osman, A. I., Mangwandi, C. & Rooney, D, 'Upcycling food waste digestate for energy and heavy metal remediation applications'. Resour. Conserv. Recycl. X 3, 100015, 2019.

[14] L.C. Ding, A. Akbarzadehl. L. Tan 'A review of power generation with thermoelectric system and its alternative with solar ponds', 2017.

[15] Hall O. and Scrase J. 'Will biomass be the environmentally friendly fuel of the future? Biomass and Bioenergy' 15: 357-67,1998

[16] Haripriye G, 'Estimation of biomass in India forests. Biomass and Bioenergy', 19: 245-58, 2000.