CSE499A Project Report (GROUP-5)

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Real Time Monitoring and Control Process of Bio-fuel Production Using Biodegradable Waste

ABSTRACT

Necessity of Waste management has become an important issue in Bangladesh. The proper management of solid waste is the need of the time. The objective of our study is to utilize biodegradable waste where kitchen waste, food waste are included. The waste from various biodegradable source such as kitchen waste could be utilized as a feed material for the gas production. There are many parameters to be considered to turn the kitchen waste into gas, such as pH level, oxygen demand, total solid waste count, temperature etc. In this Project we are going to study the parameters to produce biogas from kitchen waste in a small-scale biogas plant, analyze it and monitor the dataset by building a monitoring system.

INTRODUCTION

Bangladesh Is One of The Most Heavily Occupied countries In the World. Over Population And Enormous Consumption Lead To Large Quantities Of Waste. Waste Management Is One of the Most Instant and Serious Problems of Bangladesh. Another Problem to be concerned about is that, the conventional energy resources are declining now a days. Mainly Scarcity of gas is one of the major problems now in our country. Already the sources are at risk that about to finish. It is time we should think about a suitable substitute for conventional resources and the alternatives rather than depending on the natural resources of gas. So if we merge the two problems to get a single solution we can utilize the wastes to generate renewable energy. Every day we throw a lot of waste products, mostly kitchen wastes which are not well managed. If we consider a five storied building on average in Dhaka city, the average kitchen wastes come from that building is minimum 25kgs per day. If not utilized, these wastes can be burden for a city. So we can come up with an idea which will picture producing biogas using Kitchen waste and utilizing the produced gas as cooking gas to fulfill the need of that building, Building up a monitoring system to manage fuel production, monitor various important parameter like gas level, humidity and PH level.

There are several kinds of biodegradable source from where biogas can be produce for both large and small scale. They are- animal waste, agricultural waste, industrial waste, food waste, kitchen

waste, municipal waste. But in this Project only kitchen waste from a single building will be used to produce biogas

Literature Review

1.Biogas:

Biogas is produced by anaerobic digestion which involves the natural breakdown of organic matter in the absence of oxygen into a methane rich gas (biogas) via the complex and successive interactions of various kinds of microorganisms [1]. It is the only process which can generate energy from waste material and provide a large part of energy. Biogas is produced under strict anaerobic conditions by acting on biodegradable materials such as animal excreta, kitchen waste, sewage sludge, municipal solid waste, spice residues, market wastes, and organic residues from food industry. It is an odorless and colorless gas that burns with clear blue flame similar to that of LPG gas [2] which comprises of 68% methane, 31% carbon di oxide, 1% nitrogen [3].

2.Biogas Plant:

Biogas plant is a complete system for producing biogas from natural materials which includes a waste supplier bin connected to a anaerobic digester chamber linked to a gas chamber [4].

3.Biogas Production from kitchen waste

Though kitchen waste is one of the source of biodegradable material for producing biogas, but there are differences in parameters between biogas production from kitchen waste and from manure.

Laxman Lama et al., (2012) carried out study at Kathmandu University and focuses on production of biogas as an alternative energy by using biodegradable kitchen wastes of Kathmandu University Premises. The research was conducted on modified ARTI model compact biogas plant of 1 m^3 digester and 0.75 m gasholder in focusing the management of daily produced biodegradable wastes from households. The maximum methane gas was recorded as 65% and average maximum carbon dioxide was recorded as 58%. The daily temperature inside the digester was found in the range of **(25-34^o C)** and pH value of the slurry was found in between **(6.7-5.48)**. The average gas production was found to be **173 L/day**. The maximum burning period of the gas was approximately **62 min/day** and average [5]. So we have to find an optimum calculation for wastes so that the range of different parameters reach to an optimum point for getting perfect amount of gas without loss.

Figure 1: Different model of biogas plant for both small scale and large scale from the papers we have studied

Methodology

Process of the work:

There are three parts of this project which we are going to follow step by step.

1) Research Work

2) Designing

3) Implementation

To build a proper complete project we have studied from different sources and we have come up with the idea to design the model of the project, so that we can analyze the data properly and proof the concept of our idea. There are two ways the idea can be represented-

- Design of real product, that would be built for real using purpose
- Design of prototype, which will be designed to proof the concept of what we have proposed.

Model

The real model and prototype of proposed project has several parts to become a whole system-

- Biogas Plant
- Integrated monitoring system
- Links to the house
- Devices to monitor the real data

The real model will be built on a single house or on rooftop of a single building. The real biogas plant is consisted of a garbage supplier, an anaerobic digester which has a slurry collector, a gas chamber linked with pipes through the house.

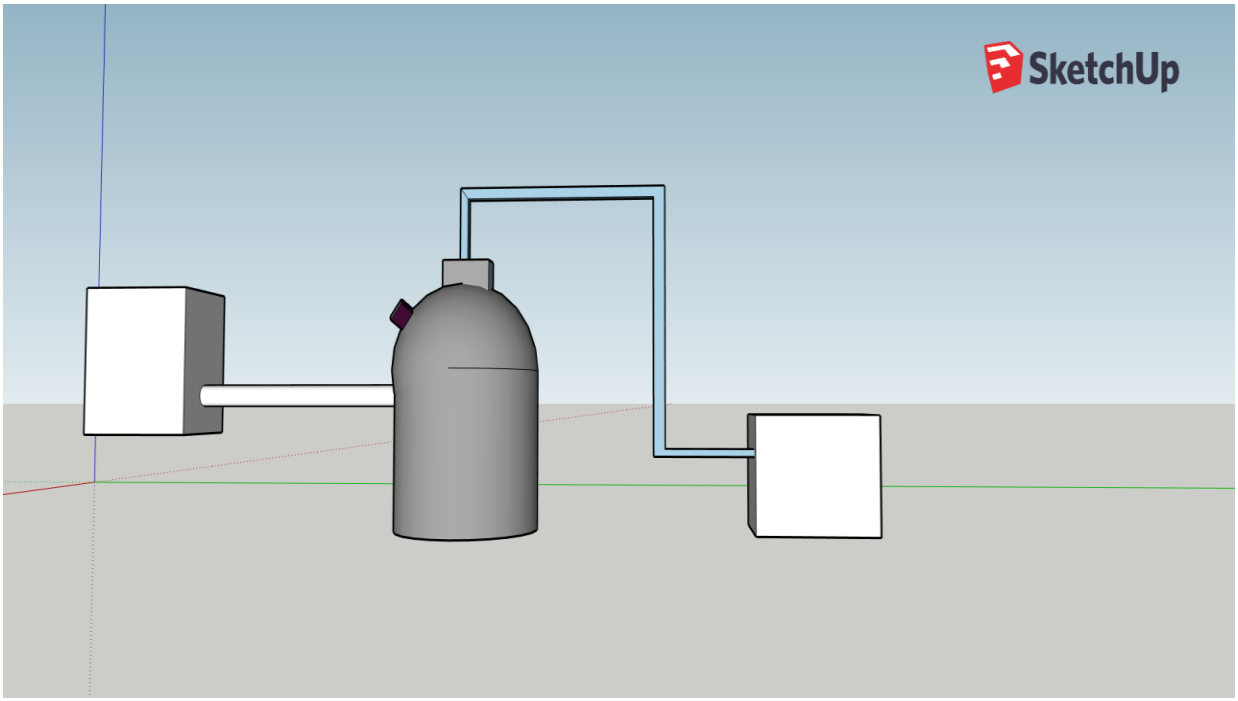

Figure 2: The main four part of the system. Garbage supplier, digester, gas chamber and an integrated device for monitoring data.

Figure 2 is not the model of the whole system; it shows the main four parts of the system and just a outer look of the real product. To understand the process which is going in the plant or how the whole system will work we have to look into figure 3. Figure 3 describes the complete process from garbage

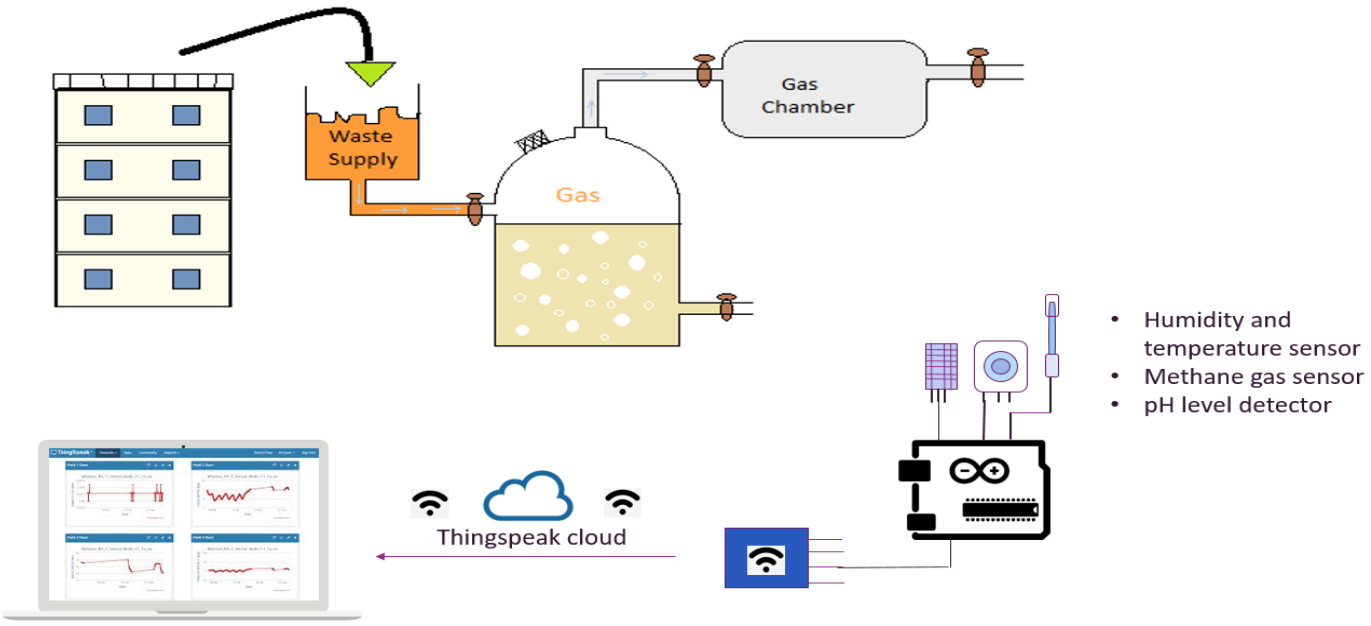

Figure 3: the design of the whole process of the system

collection to receiving data. In figure 3 we can see that, garbage or waste is collected from the building and delivered into the digester. In anaerobic digester micro-organisms starts to decompose the mixed waste and after several days gas starts to be produced. The produced gas is stored in the gas chamber from which the gas is supplied in the building as cooking gas. As this is an untouched process, the production of gas should be monitored and the real data should be analyzed for better production of gas. For this we have to integrate a monitoring system with it, which includes microprocessor, some sensors, devices and softwares-

- Arduino
- DHT-11 Humidity and temperature sensor
- MQ-5 methane gas sensor
- pH level detector
- Wifi module
- IOT cloud
- Laptop/mobile

The sensors will receive the data and the data will go to a IOT cloud through Wi-Fi module. Then the data will be received by the user's device. The monitoring device will be integrate for management and process control purpose.

Data Calculation and Parameter analyzing

To make sure that the gas is being produced properly we have to concentrate on the ratio of the garbage or waste first. We cannot just put everything in the digester. It will not be efficient and feasible. If we wanted to use manure for gas production it would be easier to determine the ratio of manure and water. But as we are using kitchen waste there will be different kinds of wastes like starch, vegetable, dairy products etc. In the paper ***Mini Biogas Plant Using Kitchen Wastes*** they have shown a ratio of different kind of wastes we get from kitchen in table no 1 [6].

Kitchen waste	ratio
Uncooked fruits & vegetables	(51%)
Cooked meat	(16%)
Uncooked meat	(15%)
Bread	(2%)
Tea waste	(5%)
Eggs	(6%)
Cheese	(3%)
Paper	(2%)

The data and ratio in the table 1 is not the final and optimum ratio for our project. But we have to start with the ratio first and after implementation we need to improve the ratio on the basis of the analyzing and output. There is another important factor we have to maintain which is, environment inside the digester. There many parameters and their optimum range we have to maintain. Such as-

a) Temperature is the most critical process parameter. Anaerobic bacteria survive from freezing to 70°C, but thrive best in either a mesophilic **(25-40°C, preferably 35 °C)** or a thermophilic range **(50-65°C, preferably < 55 °C)** [7].
b) The pH of the anaerobic digestion process is another parameter that has a significant effect on the digestion process. The optimum pH range in an anaerobic digester is **6.8 to 7.2**. However, the process can tolerate a range of **6.5 up to 8.0** [8].
c) The produced methane gas from the wastes should be **55%-65%.**
d) The produced carbon di-oxide should be **30%-40%.**

Completed work

1.Research work

We have studied a lot on biogas plant and how it can be built in as a real plant and a prototype through websites, papers, pictures and videos .After gathering all of our resources we have found out some factors that we will have to focus on. Like-The environment inside the plant, temperature, pH level etc.

2.Architectural design

After dealing with the research work the research we have done with our designing both real model and prototype .Though we have done both but we are only going to implement the prototype model only because some of our obstruction. To design the model we have used Sketch Up model designer and raw paint application.

3.Preparation and Cost finalization

Then our last part is implementation that we are going to do next. We have bought some of our equipment for monitoring the systems already .We are very concerned about the cost of the project. So that, we have finalized the total cost of the project to build in and it is around 3000bdt.

Works to be done

1. Implementation of biogas plant as prototype
2. Building up the integrated monitoring system with sensors. We are going to build up both the biogas plant and monitoring system with sensor. These sensors will monitor the important parameters.
3. Analyzing the data and comparing

Future Work

As the whole system produces renewable energy which is very important to build a green environment, the idea is very potential to be applied on various field. Biogas can be used as domestic cooking, industrial heating, combined heat and power (CHP) generation as well as a vehicle fuel [9]. We can produce electricity from gas by building a small generator. Currently we are trying to make gas from kitchen which can be used for fuel in our daily life but producing electricity from gases by building up a small generator is possible too in future. As it deals with gases, there can be possibilities of dangerous situation. We can control the process by adding an alarm system to avoid any hazardous incident. Obviously it can be implemented on large scale for some big restaurants from where the food waste are thrown daily. Also emergency supply system of raw materials can be added with the system.

As we are using wastes from kitchen for producing biogas and they are biodegradable so there is a high possibility for producing toxic gases. So if we want to keep record about toxic gases besides other gases we can add a sensor which can detect toxic gases in near future. The toxic gases are Carbon monoxide (CO), hydrogen sulfide(H_2S) etc [10].

Reference:

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[9] The Application of Biogas – A List of the 7 Top Uses https://anaerobic-digestion.com/application-of-biogas/

[10] Bioenergy Consult-Powering clean energy future Tag Archives: Major Factors in Biogas Plant https://www.bioenergyconsult.com/tag/major-factors-in-biogas-plant/

Further Reading:

- how to make Free Gas from KITCHEN WASTE | mini bio gas plant | 100% free energy. https://youtu.be/89-WE0eFbak
- Biogas plant (anaerobic digester) Gobar Gas plant Construction https://youtu.be/fDw2IoPxY9k
- Arduino + Delphi Interface Biogas Monitoring (MQ4, MQ8, MG811) https://youtu.be/XKptYB11Wqw
- https://youtu.be/8nKKC0y8jEY
- https://youtu.be/XKptYB11Wqw
- https://www.instructables.com/id/Biogas-at-home-Cheap-and-Easy/
- https://paksc.org/pk/diy-projects/764-biogas-plant-experiment/