Production of Biofuel from Food Waste

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Abstract — **The current work focuses on the generating bio-gas from food waste produced by BELLARY INSTITUTE OF TECHNOLOGY AND MANAGEMENT College Canteen using anaerobic digestion process. Attempts have been made to optimize various parameters in order to determine the most favorable recipe for maximum biogas production from the digested food waste. The biogas yields have been determined using batch anaerobic thermophilic digestion tests for a period of 45 days. Characteristic oscillation was observed in the rate of methane production, which may be due to the presence of methylotroph population in the activated sludge, which uses methane as a carbon source for their growth. The total biogas generated in the system over the experimental period was the sum of methane and carbon dioxide. Biogas produced from the decomposition of food waste was a mixture of 76% methane and 24% carbon dioxide.**

Keywords- Biogas, Food waste and Cow dung

I. INTRODUCTION

Due to scarcity of petroleum and coal it threatens supply of fuel throughout the world also problem of their combustion led to research in different corners to get access the new sources of energy, like renewable energy resources. Solar energy, wind energy, different thermal and hydro sources of energy, biogas are all renewable energy resources. But biogas is distinct from other renewable energies because of its characteristics of using, controlling and collecting organic wastes and at the same time producing fertilizer and water for use in agricultural irrigation. Biogas does not have any geographical limitations nor does it require advanced technology for producing energy, also it is very simple to use and apply. Deforestation is a very big problem in developing countries like India, most of the part depends on charcoal and fuel-wood for fuel supply which requires cutting of forest. Also, due to deforestation It leads to decrease the fertility of land by soil erosion. Use of dung, firewood as energy is also harmful for the health of the masses due to the smoke arising from them causing air pollution. We need an ecofriendly substitute for energy. Kitchen waste is organic material having the high calorific value and nutritive value to microbes, that's why efficiency of methane production can be increased by several orders of magnitude as said earlier. It means higher efficiency and size of reactor and cost of biogas production is reduced. Also, in most of cities and places, kitchen waste is disposed in landfill or discarded which causes the public health hazards and diseases like malaria, cholera, typhoid. Inadequate management of wastes like uncontrolled dumping bears several adverse consequences: It not only leads to polluting surface and groundwater through leachate and further promotes the breeding of flies, mosquitoes, rats and other disease bearing vectors. Also, it emits unpleasant odor & methane which is a major greenhouse gas contributing to global warming. Biogas refers to a gas made from anaerobic digestion of kitchen waste. Methane is a clean energy one of the constituents of biogas which has a great potential to be an alternative fuel. Abundant biomass from various institutions could be a source for Methane production where combination of waste treatment and energy production would be an advantage. In state of Karnataka around of 256 educational institutions are there, from those institutions a large amount of waste is produced but those waste are not utilized. Objective of this study is to utilize the kitchen waste in a bio digester to produce biogas which will be the alternative fuel for their kitchen energy need. This work was carried out to produce biogas in a Compact Water Plastic Tank with a fixed type, using different kitchen waste from the kitchen, hostel, and canteen in B.I.T.M Engineering College.

II. OBJECTIVES OF THE PRESENT STUDY

Biogas production is clearly suitable for India's tropical climate. The reduced cost brought about by lower power consumption are generally enough among all the waste treatment methods even if any returns of gas utilization are neglected. Objective of this study is to utilize the kitchen waste in a bio digester to produce biogas which will be the alternative fuel for their kitchen energy need.

III. SCOPE OF PRESENT STUDY

Solid and liquid waste of food is collected from kitchen and their characteristic has been studied. Before discharging waste water to water bodies it has to be treated to reduce the Chemical Oxygen Demand, Sulphate content. As a result of this treatment Biogas liberated can be used for domestic purpose. To define the current development situation of the biofuel's enterprises with regards to biofuel production using wastage of food.

a) Increase rural income and ensure women empowerment.
b) Generate rural employment.
c) Promote Renewable Energy through harnessing of Biofuel energy.
d) Reduce the import bill of oil for the country/State Promote availability of organic manure.
e) Reduce toxic emission during combustion of Biofuel, which is practically free of sulphurous compound.
f) Reduce greenhouse gas emissions through substitution of fossil fuels with plant oils-based fuel.

IV. MATERIALS AND METHODS

A. Sources and generation of food waste

Food waste which is collected from Ballary institute of technology and management Engineering College canteen situated in Allipura includes vegetables, fruits and other items. The treatment process of food waste products gives hazardous waste. The usage of chemicals is one of the main reasons for this. The manufacturing of food items is a process that must be accomplished by adhering to strict controls of both the local and Federal food regulatory agencies. The items of food that are manufactured are as varied as the people they serve. Common staples, exotic delicacies, snack foods and ethnic specialties are all food items that go through a controlled and precise manufacturing process with safety always at the forefront.

B. Sample collection

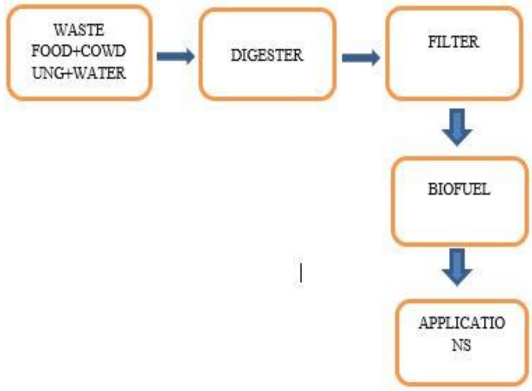
Samples for treatment of food waste, both solid and liquid were collected from BITM Engineering College canteen. About 150 kg of waste items collected are categorized as vegetables, fruits, rice, other food items and waste water which mixing together, forms semi solid state.

a. Materials

The semi-solid waste used in this study is collected from college canteen. The fresh Cow Dung Slurry was added to the above food waste to supplement the reaction process. It is used as a seeding material for the reaction process in the container.

Fig.4: Food waste

C. METHADOLGY



Procedure

a) The various forms of food waste is collected from the kitchens, collage hostels, hotels, etc. and mixed with a 2:1 quantity of water in the mixing tank. This forms the slurry.
b) The slurry fed into the digester through the inlet chamber.
c) When the digester (container) is partially filled with the slurry, the introduction of slurry is stopped and the plant is left unused for about 30 to 40 days.
d) During these 30 to 40 days, an anaerobic bacterium present in the slurry decomposes or ferments the food waste in the presence of water.
e) As a result of anaerobic fermentation, biogas is formed, which starts collecting in the dome of the digester.
f) As more and more biogas will start collecting, the pressure exerted by the biogas forces the spent slurry into the outlet chamber.
g) From the outlet chamber, the spent slurry overflows into the overflow tank.
h) The spent slurry is manually removed from the overflow tank and used as manure for plants.
i) The gas valve connected to a system of pipelines is opened when a supply of biogas is required.

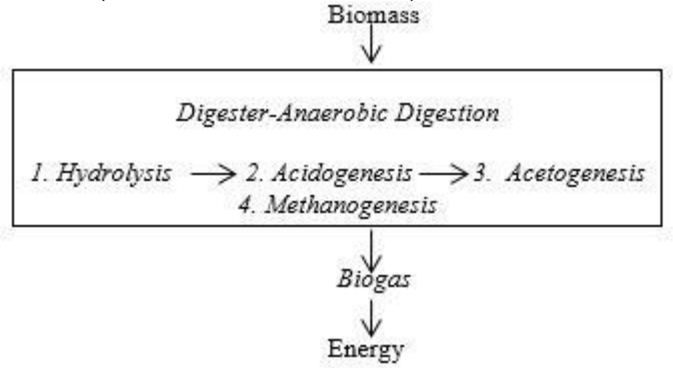
j) To obtain a continuous supply of biogas, a functioning plant can be fed continuously with the prepared slurry.

D. DIAGRAM AND WORKING PRINCIPLE

Figure. 6 Biogas digester

Experimental studies were carried out in batch reactors of 300lit capacity and made up compact water plastic material. The effective volume of the reactors was maintained at 178lit the reactor was providing with suitable arrangements for feeding, gas collection, and draining residues. Experiments were carried out in the ambient temperature. Each reactor was added with 15lit sludge and diluted to 300lit of working volume.

E. REACTION INVOLVED IN BIOGAS PLANT (ANAEROBIC DIGESTION)



Anaerobic digestion is a multistep biological and chemical process that is beneficial in not only waste management but also energy creation. There are four fundamental steps of anaerobic digestion that include Hydrolysis, Acidogenesis, Acetogenesis, and Methanogenesis. Throughout this entire process, large organic polymers that make up Biomass are broken down into smaller molecules by chemicals and microorganisms. Upon completion of the anaerobic digestion process, the Biomass is converted into Biogas, namely carbon dioxide and methane, as well as digestate and wastewater.

F. FUNDAMENTAL STEPS

Hydrolysis: - In general, hydrolysis is a chemical reaction in which the breakdown of water occurs to form H+ cations and OH- anions. Hydrolysis is often used to break down larger polymers, often in the presence of an acidic catalyst. Through hydrolysis, these large polymers, namely proteins, fats and carbohydrates, are broken down into smaller molecules such as amino acids R-CH (NH_2)-COOH, fatty acids (CH_3)-COOH, and simple sugars. While some of the products of hydrolysis, including hydrogen and acetate, may be used by methanogens later in the anaerobic digestion process, the majority of the molecules, which are still relatively large, must be further broken down in the process of Acidogenesis so that they may be used to create methane

1. **Acidogenesis: -** Acidogenesis is the next step of anaerobic digestion in which acidogenic microorganisms further break down the Biomass products after hydrolysis. These fermentative bacteria produce an acidic environment in the digestive tank while creating ammonia (NH_3), H_2, CO_2, H_2S, shorter volatile fatty acids (VFAs), carbonic acids, alcohols, as well as trace amounts of other byproducts. While acidogenic bacteria further breaks down the organic matter, it is still too large and unusable for the ultimate goal of methane production, so the biomass must next undergo the process of acetogenesis.

2. **Acetogenesis:** - In general, acetogenesis is the creation of acetate, a derivative of acetic acid, from carbon and energy sources by acetogens. These microorganisms catabolize many of the products created in acidogenesis into acetic acid (CH_3COOH), CO_2 and H_2. Acetogens break down the Biomass to a point to which Methanogens can utilize much of the remaining material to create Methane as a Biofuel.

3. **Methanogenesis:** - Methanogenesis constitutes the final stage of anaerobic digestion in which methanogens create methane from the final products of acetogenesis as well as from some of the intermediate products from hydrolysis and acidogenesis. There are two general pathways involving the use of acetic acid (CH_3COOH) and carbon dioxide (CO_2), the two main products of the first three steps of anaerobic digestion, to create methane in methanogenesis:

1) Chemolithotropic methanogens chemical reaction

$$CO_2+4H_2 \rightarrow CH_4+2H_2O$$

2) Methyl tropic methanogens chemical reaction

$$CH_3COOH \rightarrow CH_4 + CO_2$$

While CO_2 can be converted into methane and water through the reaction, the main mechanism to create methane in methanogenesis is the path involving acetic acid. This path creates methane and CO_2, the two main products of anaerobic digestion.

V. CONCLUSION

To overcome fossil fuel crisis problem, environmental pollution and meet the energy demand one of the best ways is to replace non-renewable resource with renewable resource. Various researches have been performed to identify the best alternative way of reusing renewable resources, most importantly waste product for biofuel production. Waste products like sewage sludge, industrial waste, waste cooking oil etc., are zero cost raw materials that can be used for biofuel production which will help to minimize waste generation, handling and disposal problem. In this study an innovative approach to utilize kitchen food waste for biodiesel production has been initiated. Concentration of free fatty acid methyl ester. Physical and chemical properties of biodiesel were performed and found satisfied by comparing with different standards.

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