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An alternative design for anaerobic digestion of food waste: Biogas production

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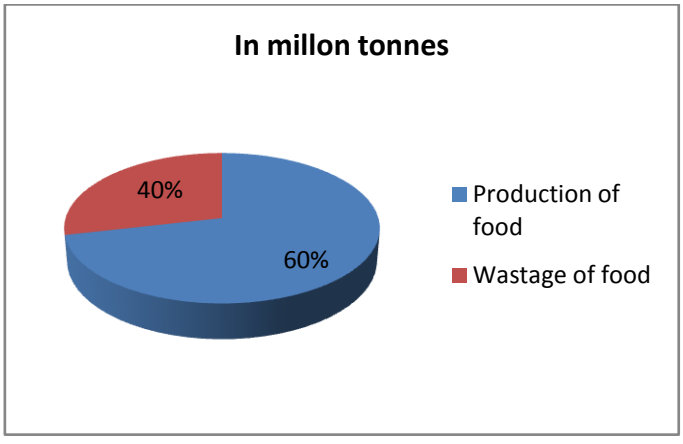
Abstract

India's 89% population is dependent on (LPG) supplied in portable cylinders for their daily needs. Hence India is in need of a green, efficient, carbon- neutral energy source to replace fossil fuels. About 40% of food produced in India is waste which is estimated around 50,000 crores rupees per year. Therefore using Biogas which is obtained from food waste as the raw material can solve the problem of LPG usage and at the same time, allow the safe decomposition of food waste which can be used as fertilizer. With help of anaerobic digestion food waste is converted into biogas which is a renewable source of natural gas. Aim of this paper is to carry survey of food waste and exploring its capability to be used for production of biogas.

Keyword: Renewable source, food waste, anaerobic digestion.

Introduction:

Due to exponential growth of population there is increase in need of natural fuel to meet our daily basic needs which leads to scarcity fuels.Therefore there is need for renewable and efficient fuel know as bio gas which can be prepared from food waste. Food waste management has become any important aspect as about 111 million tonnes of food is wasted annually in India which results into loss of 50,000 crore rupees per year.



According to Bombay Municipal Corporation there is generation of 9,400 metric tonnes of solid waste daily out of which 6,862 metric tonnes contains food. This is then dumped in open landfill, this garbage dump are about six storey high buildings.

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1.1 purpose of food waste treatment

For disposal of this food waste most commonly used method is landfills. Ground water contamination occurs due to release of several toxins knows as leachate, which comes out of the food waste left in open landfills. Methane is developed due these open landfills which consequently absorb suns heat which warms up environment and contributes to global warming. Hence we can use this food waste as raw material to make biogas by aerobic digestion which releases Methane (CH_4) of high calorific value. This biogas can be substitute for the LPG in kitchen. Due to anaerobic digestion, organic matter of food waste contain nutrients will be mineralized and conserved and hence can be used as good bio fertilizer. By using residue in agricultural lands crops will benefit as it provides nutrients.

1.2. Aim of the present study

Complete disposal of food waste hence creating a productive outcome in form of biogas which can be a good substitute for LPG and residue of this digestion can be used as Fertilizer.

1.3 scope of present study

1. Can be used at college canteens, hotels, kitchens, etc.

2. Considerable reduction of Landfill.

3. Biogas can be used for domestic purposes.

4. Residue remain can be use manure

Literature Review

Dr.AnandKarve (ARTI) [1][2] developed a compact biogas system that uses starchy or sugary feedstock (waste grain flour, spoilt grain, overripe or misshapen fruit, nonedible seeds, fruits and rhizomes, green leaves, leftover food, etc). Shalinisingh et al.[3] (2000) studied the increased biogas production using microbial stimulants. They studied the effect of microbial stimulant aquasan and teresan on biogas yield from cattle dung and combined residue of cattle dung and kitchen waste respectively.

Biogas being a renewable fuel is on tremendous demand around the world. Various universities, villages, hotels, industries are using biogas plant for cutting down their expenses on fuel cost.
There are various biogas start-up's happening in India on the which have 30 biogas generating plants across 11 states and they covert 20 tonnes of food waste to 1400kg biogas.
Many colleges are installing biogas plants as it is really tedious work to dispose the food waste generated everyday by canteen and mess.

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Hence installing biogas plant in the college will help them in successfully disposal of foodwaste and the same time they will be benefitted cutting down the fuel expenses by use of the biogas evolved from the anaerobic digestion of this food waste.

Conventional Biogas Plant

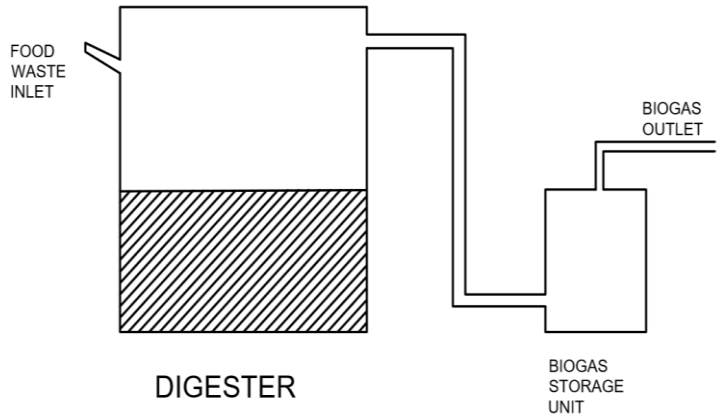

Fig. 1:Conventional Biogas plant

The conventional biogas systems, using sewerage, cattle dung, etc. use about 40 kg feedstock to produce the same quantity of methane, and require about 40 days to complete the reaction.

The significance we will be adding to biogas plant is giving approximately zero percent wastage outcome after aerobic digestion. From the research we have done, we concluded that the biogas plants gives out a water which is not being treated till now. Hence we have provided solution for it by treating the residual water in water purifier therefore will be giving out water which will be reused.

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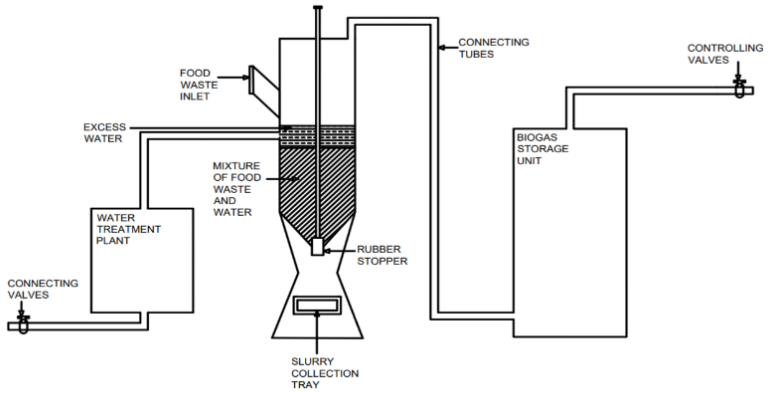

Fig.2 Alternative design for biogas plant

The design we have made has a unique mechanism which allows us to flush out the undigested residual of anaerobic, which again helps us reduces the manual.
This will result into a completely efficient biogas plant which will help us to create biogas and at the same time will help us to manage food waste giving out approximately zero percentage of waste.

Methodology:
Following steps are involved in biogas production:-

Step I: Collection and segregation of food wastes
i) Separate container for egg shells, coconut shells, peels and chicken mutton bones. These will be crushed separately by mixer grinders.
ii) Different containers for wet waste, stale cooked food, waste milk products. The vegetables refuse like peels, rotten potatoes coriander leaves collected in bags.

Step II: Hydrolysis:-
It is the first step reaction which takes place in digester where organic matter is enzymolysed externally by extracellular enzymes, cellulose, amylase, protease &lipase, of microorganisms and bacteria decompose of long chains of complex carbohydrates, proteins, & lipids takes place which are converted into small chains. For example, Polysaccharides are converted into monosaccharide. Proteins are split into peptides and amino acids.

Step III: Acidification:
Now in next step of this process, the acid-producing bacteria are involved which helps to convert the intermediates of fermenting bacteria into acetic acid, hydrogen and carbon dioxide. These process taken by the bacteria are anaerobic and they can grow under acidic conditions. But to produce acetic acid, bacteria requires oxygen and carbon for this process so they use dissolved O2 or bounded-oxygen. Thus the acid-producing bacteria creates anaerobic condition for themselves which is essential for the methane producing microorganisms. Also, they help in reducing the compounds which have low molecular weights into alcohols, organic acids, amino acids, carbon dioxide and some traces amount of methane is also produce. This process is also partially endergonic (i.e. only possible with energy input), since bacteria alone are not capable of sustaining that type of reaction.

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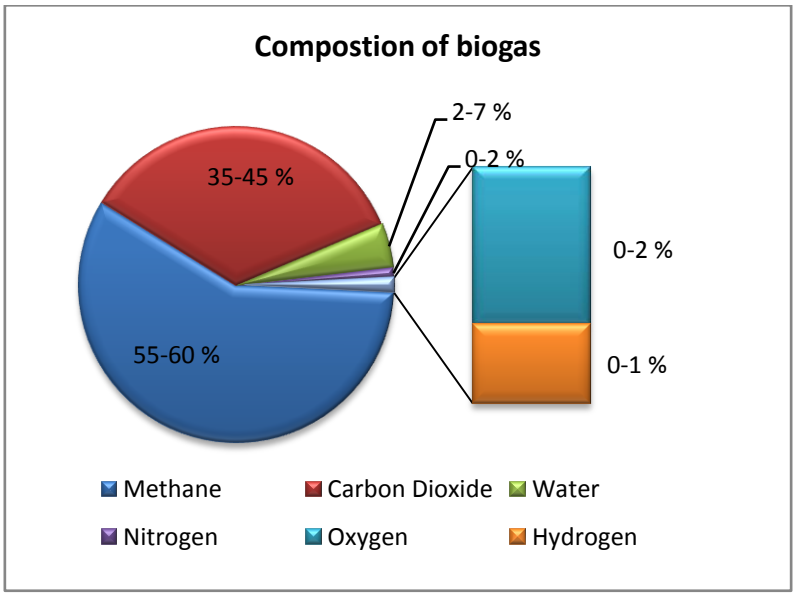
Step IV: Methanogenesis:
It is third and final process in anaerobic digestercalled Methanogenesis (Methane formation) which involves Methane-producing bacteria. In this process, it decompose compounds having low molecular weight. They utilize hydrogen, carbon dioxide and acetic acid and convert them into methane and carbon dioxide.

Step V: Symbiosis of bacteria:
In this process there is symbiotic relation between Methane and acid-producing bacteria. These acid producing bacteria create an atmosphere with is essential for the methane producing bacteria(anaerobic conditions, Compounds with a low molecular weight). But also, methane-producing bacteria use the intermediates of the product of the acid producing bacteria and without consuming the product or else the toxic conditions for the acid-producing microorganisms would develop. In the fermentation processes the metabolic actions of various bacteria acts and no single bacteria is able to produce fermentation products alone as it requires others too.

Step VI: Recycling of waste water generated
Water which is coming through outlet is then send to sand water filter so that water free from solid impurities can be use for gardening.
Step VII: Residue left use as fertilizer

Biogas is process done by bio-degradation of organic material under anaerobic conditions thorough presence of different bacteria. Biogas is 20% lighter than air, odourless and colourless gas that burns with blue flame similar to LPG gas. Biogas is a renewable form of energy. Biogas is mixture of different gas. The approximate volume percentage of different components concentration present in the biogas are.



Methane (CH_4) 55-60 %, Carbon dioxide (CO_2) 35-40 %, Water (H_2O) 2-7 %, Nitrogen (N_2) 0-2 %, Oxygen (O_2) 0-2 % and Hydrogen (H_2) 0-1 %.Biogas plant the unwanted residue organic waste, after its anaerobic digestion that has superior nutrient qualities and can be use over normal organic fertilizer, as in the form of manure. Biogas technology

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is mostly valuable process in agricultural residual treatment of animal excreta and kitchen residuals. This plant is very useful in both urban and rural areas.

A biogas process consists of the following components such as Manure, Anaerobic digester, Effluent storage, Gas handling and Gas use. In nature as microorganisms breaks the complex carbon into smaller substances through digestion similar bacteria present in digesters break complex food waste substance into simpler which involves biochemical decomposition of complex material and release energy rich gas which can be used as biofuel and produce neutrinos effluents.

In digester the waste food is store which gets digested through a process which occurs without (absence) oxygen and it is known as anaerobic digestion which generates mixtures of gases. The main gas produced through this process is methane which can burned at normal room temperature and in the presences of a viable environment and use as eco-friendly energy source to replace fossil fuels (non-renewable).

Anaerobic process is a controllable biological degradation process which allows to capture efficient utilization of biogas and produce approximately 60% methane and 40% carbon dioxide for energy generation. Anaerobic digestion (AD) is a promising method to treat the kitchen wastes. They include, moisture content, volatile solids, nutrient contents, particle size, & biodegradability.

Considering all above components of biogas the other parameters which can affect the production of biogas is found as following:-

Parameters	**Value Unit**
PH	7.2 - 7.5 mg/l
COD	137 -141 mg/l
BOD	868 – 880 mg/l
SO_4	445 - 460 mg/l
NO_3	934 -939 mg/l

This material represent the approach to utilize the production of biogas. Now the result and discussion section elaborates reveals the important gap that the current study fills and provides the necessary support to justify the investment of energy and resources into biogas project plant. The conclusion section presents concluding remarks on the study of the biogas plant.

Result and discussion:

From the above discussion about the biogas project via anaerobic digestion we can say that:

• The project will result in reduction in Green House Gas emissions significantly.

• The project will make use of methane rich biogas which can also use for the production of electricity.

• The project will act as a clean technology which could be used in a model in dairy farms, home, labs and for many other purpose.

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Conclusion:

As we know that world's population growth and pressure on resources is continuously increasing, this we all have the responsibility to over the reuse of resources and waste. To overcome such problem we have proposed a model which is successful in decomposing the food waste and hence benefits us by giving out methane which is a good substitute for LPG. This results into cutting the fuel expense. The residual left are the aerobic digestion of the food waste can be used as biofertilizer. Significance added by us to the normal biogas plant is that the water which comesout after anaerobic digestion will be purified hence giving out approximately zero present wastage. Ergo we conclude that installing biogas plants will lead us to healthy and efficient future.

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