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BIOGAS AS A GREEN SUSTAINABLE SOLUTION FOR CHENNAI SMART CITY

[1]M.Aravind, [2]M.M.Vijayalakshmi, [3]E.Natarajan
[1] KCG College of Technology, Chennai
[2]Department of Civil Engineering, School of Building and Environment, Satyabhama Institute of science and Technology, Chennai
[3]Institute for Energy Studies, Department of Mechanical Engineering, Anna University, Chennai

Abstract - Rapid urbanization leads to more waste generation which can be used for bio – gas generation. Throughout the evolution of the human kind, energy has always been a driving force towards betterment. Considering the actual state of global needs for all forms of energy, assessing the potential of organic wastes that could be processed to obtain biogas, is one of the main tasks for a region's successful socio-economical development. The availability and assessment of natural resources, renewable or non-renewable, is a complex issue and the assessment of biomass for energy production is no exception. Studies have been carried out in order to evaluate the biomass potential for energy use. The waste generation estimated by the Chennai Corporation is 601 MT/day, out of which 91% solid waste is collected each day, which can be a source for biogas production to meet the energy requirement with clean environment

Keyword: Solid waste, Municipal waste, Bio-gas, Green Technology, smart city.

I. Introduction

Solid waste Management is one among the major challenges faced by the state Governments in urban areas. The problem of waste management is much more acute in metropolitan cities like Chennai. The Project has been conceptualized as an Integrated Municipal Solid Waste Management Construction, Operation & Maintenance of MSW, *Mamallapuram biogas plant*, Hand in hand India Ltd. Mamallapuram has set-up a 100 cu.m bio-methanation plant with a capacity of handling 500 to 800kgs of food waste every day was installed and the food waste was converted in to methane. The plant was commissioned in January, 2008. Shriram Energy Systems Ltd., Hyderabad have set-up a 6 MW power generation project at Vijayawada. About 150 tonnes per day (tpd) of Refuse Derived Fuel is being produced by processing 600 tpd of MSW. The plant was commissioned in December, 2003 and has so far generated over 47 million units of electricity, which meets the energy demand in a effective manner.

II. Biogas as a Better Alternative Source

Cow dung is probably the single material which has been used for the production of biogas. But now a day's food wastes are also widely used for the production of biogas. Cellulosic organic materials like agricultural wastes are also useful source of materials for methane production through anaerobic fermentation. The promising waste materials for the production and utilization of biogas are municipal solid waste or domestic waste which has a greater perspective of producing biogas for the purpose of cooking and to a greater extent of electrifying the home.

Under this circumstance S, the situation warrants a study in-depth, so that the benefits of biogas production from such waste materials reach the larger section of the urban society. This will result not only in the economic benefit of the people in our nation, but provide energy sustainable opportunities.

Commonly Used Organic Matters

- Cattle dung
- Kitchen and dining hall waste
- Vegetable market waste
- Poultry dropping
- Crop residue
- Pig and horse excreta
- Aquatic weeds such as water hyacinth
- Agro industrial waste
- Sewage Sludge

Composition of Bio-Gas

- Methane 50-70%
- Carbon dioxide 30-45%
- Hydrogen 0-1%
- Nitrogen 0-1%
- Water 0-1%
- Hydrogen Sulphide 0-1%
- Oxygen 0-1%

[1]Corresponding Author

Such attractive domestic aspects will provide effective compensating factors to the economic attraction in the crowded urban areas.

III. Need for the Study

Rapid growth in urban population leads in generation of waste from different sources. It exerts considerable pressure to the agency handling collection and safe disposal of waste. Manpower available is very limited to handle waste collection that leaves many neighborhoods having bad environmental and unhygienic condition that needs immediate solution. This problem can be solved through scientific manner. Hence this work attempts to identify such neighborhood that needs attention and utilize generation of household waste for production of Bio-Gas. The investigation carried over in this study will help the urban centers, Townships for adopting and further implementation of the project.

IV. Study Area

To demonstrate best practice construction of bio-gas Plant in the cluster near OMR and ECR. This may tends to reduce the energy demand in the future.

The city has 185797 units of residential and non - residential properties, as shown in Table 1 and 2.

Table 1 Number of Households, shops & establishments

Type of building	Numbers
Residential	155201
Shops	30596

Table 2 Number of Hotels, Marriage halls and Noon meal centers

Type of building	Number
Hotels	137
Marriage/community halls	46
Noon meal centers	32
Total	215

The quantity of waste generation estimated by the corporation is 601 MT/day, out of which 91% solid waste is collected each day (Table 3 to 5).

Table 3 Quantity of waste generated

Waste generators	Estimated quantity of waste generated MT
Household	328.00
Markets, Hotels, Marriage Halls	181.90

Table 4 Types of waste generators

Types of waste generator	Quantity of waste generated per day in MT
31105 commercial units	36.81
1008units of hotels, markets, marriage halls	181.90

Table 5 Carbon - Nitrogen ratio (C/N ratio)

Food waste	Carbon for Nitrogen ratio
Market - vegetables	26:1
Household	20:1
Hotel	40:1
Fruit	22:1

Specifications

- Daily dumping waste, 500kg - 800kg /day.
- Digester: 60 cubic meter.
- Gas holder: 40 cubic meter.
- Gas output: 45 kg/ day.

V. Methodology

1) **Mixing Platform:** It is used to mix the waste material uniformly (Fig.

Fig. 1 Mixing Platform

i) The collected food waste was separated.

ii) Then food waste was mixed with 20% of water, so that the waste would be converted in to semi-solid form.

iii) This semi-solid waste was sent to the crusher.

2) <u>Crusher</u>

Fig. 2 Crusher

i) The semi-solid waste sent from the Mixer was crushed.

ii) The crushing process is done to convert the semi-solid waste in to a thick liquid form.

iii) This is done because the chemical reactions in the digester can be made faster**.**

iv) Then this liquid waste was sent in to digester for anaerobic process.

3) <u>Digester</u>

Fig. 3 Digester

i) Waste from the crusher was sent in to the digester.

ii) Rotor present in the digester makes the waste to move inside continuously.

iii) Heating coil heats the waste, so the waste is broken down by bacteria in the absence of oxygen, and methane gas is produced.

iv) Methane gas moves in to the steel gas holder.

v) The gas holder starts to move in upward direction.

vi) When the area of 40cu.m is field with gas, then it has moved to the gas storage tank.

4) Gas Storage Tank

Fig. 4 Gas Storage Tank

i) The gas from the gas holder was transferred to the gas storage tank.

ii) The gas stored here and was sent in to generator, which converts methane to electricity.

iii) This methane gas can directly sent to the household for cooking purposes.

iv) Methane can also be used as a means of fuel.

5) Slurry Collection Tank

Fig. 5 Slurry Collection Tank

i) The waste remaining after 30 days of anaerobic process is called slurry.

ii) This slurry can be used as fertilizer.

iii) It was collected in the slurry collection tank.

iv) Then the slurry was vermiculated and used as fertilizer.

v) It serves as one of the best fertilizer for soil and crops.

VI. Fertilizer

Vermicomposting Method

Vermicompost is the product or process of composting utilizing various species of worms, usually red wigglers, white worms, and earthworms to create a heterogeneous mixture of decomposing vegetable or food waste, bedding materials, and vermicast. Vermicast, similarly known as worm castings, worm humus or worm manure, is the end-product of the breakdown of organic matter by a species of earthworm.

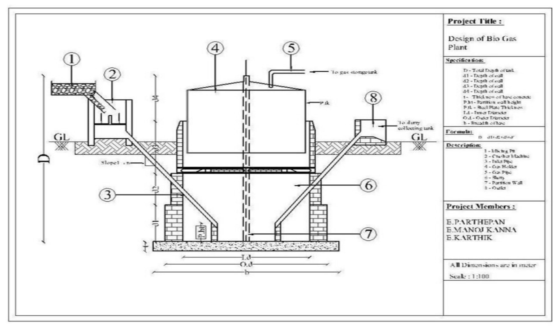
There are two main methods of large-scale vermiculture. Some systems use a windrow, which consists of bedding materials for the earthworms to live in and acts as a large bin; organic material is added to it. Although the windrow has no physical barriers to prevent worms from escaping, in theory they should not due to an abundance of organic matter for them to feed on. Often windrows are used on a concrete surface to prevent predators from gaining access to the worm population.

The second type of large-scale vermicomposting system is the raised bed or flow-through system. Here the worms are fed an inch of "worm chow" across the top of the bed, and an inch of castings are harvested from below by pulling a breaker bar across the large mesh screen which forms the base of the bed.

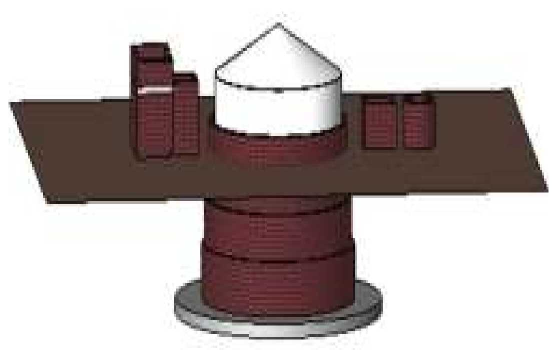
Because red worms are surface dwellers constantly moving towards the new food source, the flow-through system eliminates the need to separate worms from the castings before packaging. Flow-through systems are well suited to indoor facilities, making them the preferred choice for operations in colder climates.

Fig. 6 Vermicomposte

Plan of a Bio-Gas Plant



3D Rendered View (Section)



VII. Conclusion

- This project costs around Rs. **17,45,680/-** for a 100 cubic meter plant.
- Institutional biogas plants in sizes ranging from 25 to 250 cubic meter gas per day are installed.
- Biogas plants for treating the market, hotel and other institutional waste, waste of Silk warms, Jiggery cocking waste, Poultry litter etc.
- Electric power generation through bio gas.
- 400 liters of gas collection, 350 can be used effectively which is available for about 1 hour continuously.
- The gas is clean and odorless.
- The obtained slurry is an excellent fertilizer.
- The gas production is high in summers while the efficiency is reduced in winters.
- Much useful for a family for the conservation of Energy

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