Feasibility Study for Decomposition of OFMSW with Anaerobic Digestion for Composting Manipulations.

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ABSTRACT-

With today's energy consumption, the world is running out of non-renewable energy sources. The most commonly used energy source is natural gas that mainly consists of a compound known as methane. It was discovered that methane could be recovered by anaerobic digestion of organic matter such as food waste, sludge and etc. Similarly, one should note that wastemanagement of excessive amount of solid organic waste has been a great concern for ourenvironment.
In this research paper, we discussed the process & need ofanaerobic decomposition.

Decomposition is a complex and continuous process where multiple type of biological material reduced to its mineral form. These can be characterised by many physical, chemical and biological processes.

Anaerobic decomposition is a process by which a complex mixture of symbiotic microorganism transforms the organic material under oxygen free conditions, and it's a process by which a complex mixture of symbiotic microorganism transform the organic material under oxygen free conditions. In anaerobic decomposition which mainly consist of Hydrolysis /liquefaction, acidification (Acid phase)and Acetogenesis,Methanogenesis(methane phase).

Anaerobic digestion is the biological process in which the biodegradationand stabilization of complex organic matter in the absence of oxygen in association with microorganismlead to the formation of energy-rich biogas. It is used to replace fossil fuel. The residues ofanaerobic digestion process are nutrient-rich, used as soil amendment and where asleachateused as plant nutrients.

Keywords: Anaerobic, digestion, organicwaste, decomposition, microorganism, stabilization.

1. INTRODUCTION

Rapid urbanization, improved living standards, population growth, aggregation of human settlements and changing habits for utilization of food by the people of India have increased the amount of municipal solid waste (MSW) production.

As per PCMC Environment department record, @ 900 - 1000MT/day of domestic waste is generated & out of which 600MT/day is the part of wet waste. In view of growth rate in the solid waste generation,the existing centralised solid waste management may inadequate in future,so PCMC aiming for Zero Garbage i.e. no waste should go to the landfills from the wards by adopting decentralisedsolid waste management.In this regards, PCMC asked to co-op societies to manage their own organic waste anyhowThe options available are-

1. Degrade the organic waste by any natural methods with material recovery.

2. By decomposition of waste with energy recovery.
3. Supply the organic waste to piggery farms.
4. MSW solidification and incineration.

In current scenario, decomposition is the most easy&suitable method as mentioned above. We are aiming to develop the system of anaerobic digestion of wet waste and to stop the valuable biomass being just dumped in landfilling with huge transporting cost with creation of dumping yards. Anaerobic decomposition is a space friendly compact solution without consumption of electrical/fuel energy in minimum installation /maintenance/operational cost with earning the benefits of a manure for soil enrichments, plant nutrients and economical sustenance.

Some of the following points will elaborate the background of need of thesis.

1. Reduction in the collection and transportation chainof MSWManagement and costs thereof.
2. Reduction in Green House Gas emissions
3. Reduction pathogenic diseases
4.Waste and unpleasant odour management.
5. Production of natural fertiliser
6. Reduction in healthy issues of people working in these unhealthy conditions.

2.0 MATERIAL AND METHODOLOGY

2.1 Objectives of the process-

A. To stabilize the organic matter (OFMSW) through anaerobicdecomposition processby generation of energy recovery, material recovery as natural fertiliser & plant nutrients.

B. Quantifying the biochemical parameters of the product.

C. Deciding and quantifying the stability of the product.

D. Techno commercial aspect assessment of the process.

2.2Biological methods of waste utilization

All biological waste utilization methods involve the decompositionof biodegradable wastes by living microbes (bacteria andfungi), which use biodegradable organic matter as a food source forgrowth and reproduction. As the microbes grow and reproduce a significant proportionof these nutrients is converted into heat, carbon gases andwater. This results in a large loss in weight during the process.Sometimes slightly larger organisms are also used such asinvertebrates.

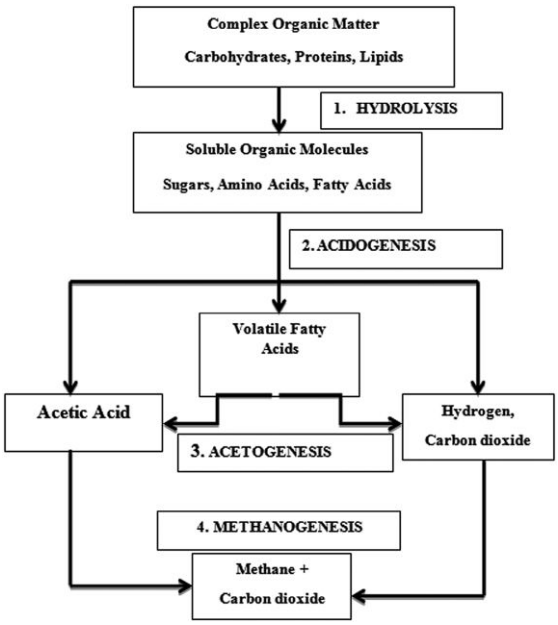
Therefore, there are two main types of biological processesused to treat biodegradable waste: aerobic - in the presenceof oxygen and anaerobic - in the absence of oxygen.

Anaerobic digestion

The biological method of waste utilization is anaerobicdigestion, also called methane fermentation. Anaerobic digestioncan be described by the schematic equation
:
Organic waste
+ heat Microorganisms->

heat +Energy+ Leachate +Compost

The microorganisms convert biodegradable material into biogasin a series of biological processes without oxygen.The most popular feedstock for anaerobic digestion are differenttypes of organic waste like municipal solid waste[1,2]. The anaerobic digestion is completed after four successivephases: hydrolysis, acidogenesis, acetogenesis and methanogenesis.In hydrolysis, monomers are produced from complexpolymers by enzymes, which are further transformed into volatilefatty acids (acetic, propionic and butyric acids) and hydrogen duringthe second stage of the process - acidogenesis. In acetogensis,acetate, carbon dioxide and H2 are generated from volatile fattyacids and finally they are converted into methane in the methanogensisprocess [3].



There are three types of most commonly used household anaerobic digesters : fixed dome, floating dome & plug flow digester

The fixed dome digesters and floating drum models are difficultto move after installation, thus portable units were developed suchas plug flow digesters (see Fig. 1). It is a sealed tubular structure
usually made of soft plastic that may vary in size and thickness withan average length to width ratio of 5:1. The input and output of thetank are located at opposite sides and the device is inclined to theground. The inclined position provides separation of acidogenesisand methanogenesis zones. Important advantages of this design arelow cost and ease of transportation and maintenance. However, thedigesters are relatively easy to damage [4,5]. Plug flow digestershave a constant volume, but produce biogas at a variable (relatively
low) pressure. Yimer et al. [8] reported, that gas production washigher for a single layered and above ground geomembrane plasticdigester than the fixed-dome.

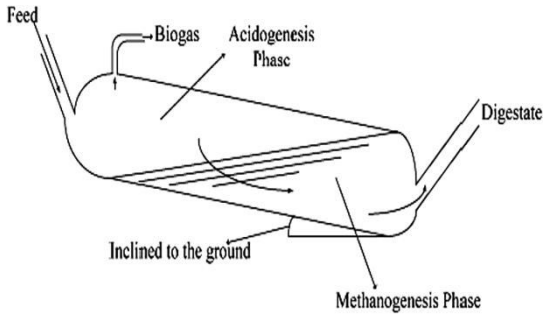


Fig. 1. Schematic of Continuous plug flow digester unit [6].

3.0 Literature survey –

To work on Objectives, we did the literature survey and from survey, we found following important references to relate the objectives.

Anaerobic composting of solid waste in batch load in digesters.

Waste generated in a community can be a valuable energy and material resource, current waste disposal practices consumes energy and have led this resource to become a serious environmental burden as many areas landfill sites are on verge to close and difficult to get new sites. Anaerobic composting for recycling the biodegradable MSWOF is good option for waste disposal. Its decompositions that occurs using microorganism that do not requires oxygen. There is thin line in anaerobic & aerobic composting in contrast to wastewater treatment.

The objective of this study was to study the anaerobic composting process for the MSWOF and this study investigated the potential of anaerobic composting as safe disposal method for it.

For two waste combinations on the four samples, the rate of composting was compared with analysis of physical, chemical, and biological characteristics at start and end of process to evaluate the suitability of product – compost as a soil conditioner based on the bacterial die off and changes in other characteristics.

An experimental set up of eight brick digesters for two combination x 4 periods with proper cover and water seal and Gas outlet in the cover provided. All eight digesters were used for first run, then group of two digesters were opened in succession of 20, 40, 60, and 90days. At this time, each group refilled with respective waste combination to initiate run II, III & IV. Run I were carried out at 20, 40, and 60 days' milestones, however rest three runs parameter analysed only at beginning and end of the run only.

Conclusive readings and noting –

Temperature was low around 27*c high at initial grown to 54*c within first 28 hours of composting then stabilized to 31*c.

1. pH increased in process and reached at ends about 6-8.
2. Moisture content reduced 68 % to 47 % at end.
3. % C reduced to 22% from 41%.
4. % N – was in span from 1.34 to 1.73 ended with 1.45
5. C/N ratio reduced 31 to 16.
6. % P – increased from .13 to .21.
7. Total Coliform declined negligible at the end of 90 days.

The decreasing rate of Carbon content and C/N ratio indication seems. Composting process progressed, the C/N ratio during the first run varied,

The C/N ratio was 30.35 at the beginning and decreased to 29.19, 27.16, 22.37, and 18.54 after the intervals of 20, 40, 60, and 90 days, respectively.

Anaerobic composting for recycling the biodegradable organic fraction of solid wastes are one good option for waste disposal. Although, anaerobic digestion of organic waste is also catching attention due to the high-energy recovery, anaerobic composting may score higher due to the several factors. One of them is that the effluents from anaerobic digestion are not generally suitable for putting directly onto land. Post-treatment after anaerobic digestion is needed to obtain high quality, finished product. Thus, compared to anaerobic composting, anaerobic digestion is a complex process that requires larger investment, On the other hand, the end

Product of anaerobic composing of organic waste is directly applicable on land. Based on the results of this study, it could be concluded that anaerobic composting of the organic fractions of municipal solid waste could not only be a safe disposal method but also would provide a useful end product-compost. Further study needed to evaluate the suitability of anaerobic composting for other organic waste compositions under a range of climates.

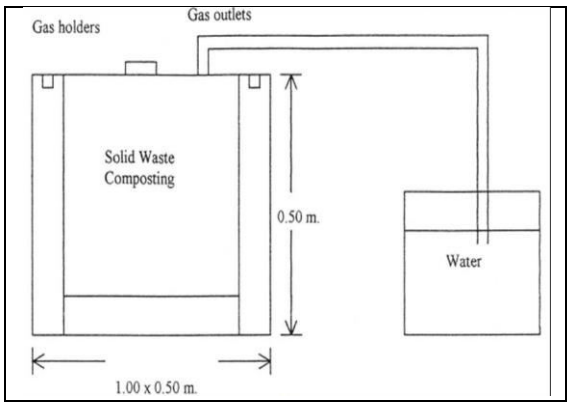


Figure 2: Schematic setup for anaerobic composting.

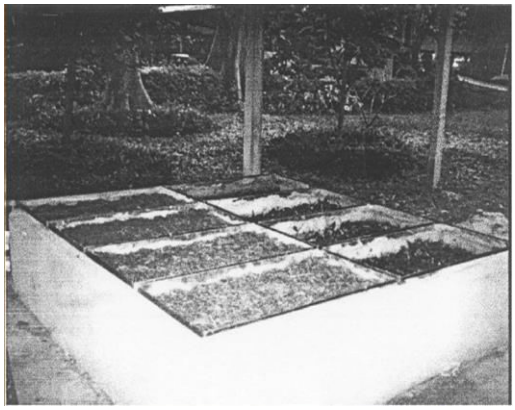


Figure 3: Actual photograph of setup.

From - www.less is more.org (Non Experimental process using two-bin system)
In this reference, they suggested to use two anaerobic composting bins should be used to

allow for continuous composting. While one is finishing composting, the other can be filled. If you plan to construct a homemade composting bin, be sure to choose a bottomless barrel with a lid that seals tightly and has a capacity of 35 gallons or more (see Section 5). An anaerobic composting bin should be located in a spot with good drainage. Accessibility, aesthetics, and convenience should also influence where your bin is placed. If located under or next to fruit trees, they will benefit from the added moisture and nutrients. To prevent the contamination of water, avoid a bin location near waterways or drainage courses. To prepare the site, dig a hole 6 to 12 inches deep, set the bin into the hole, and pack the ground firmly around the bin. Lining the bottom of your bin with. -inch poultry wire will fortify it from scavengers but still allow earthworms to enter.

Figure 4: Schematic sketch for two-bin system.

Investigation of Biological process aimed at improving the quality of compost from bio waste.

MSW generated, if properly processed it can be an important means for contributing to the restoration of carbon sink in soil and for substituting mineral fertilizers. Anaerobic Digestion (AD) can be used as diffused technique for recovering material (e.g. nutrient and organic carbon) and energy from bio-waste. Biological treatment aimed at material recovery from the bio waste should generate compost with a high, but also a stable organic matter content.

As there is lack of information on how anaerobic pre -treatment can perform in production of compost, the pilot run experimental setup helps in ref investigations.

In ref experiment 1) SADB (solid anaerobic digester batch) for 30 days + Post composting treatment test 60days total -90 days.

2) SADB 30 Days + Inoculum 60days + Post composting total -90dyas and 3) only composting -90 Days.

Total six runs performed, three were for pure composting and SADB + PC and three were for pure composting and SADB +Inoculum + Post composting.

The results indicated that the quality of the amendment in term of TOC, HA& FA (Homicide and felvic acid) content was higher for the integrated SADB treatment W.R.T. both SADBPC-I, and composting.

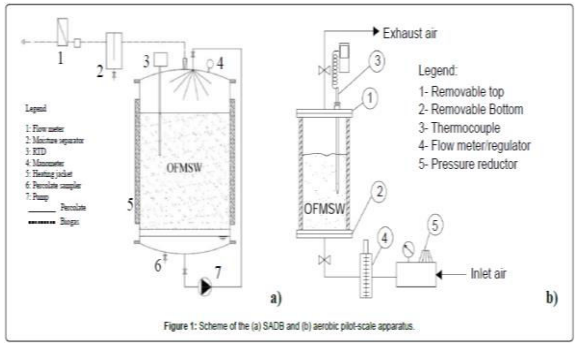


Figure 5: Details of process set up for aerobic pre-treatment and process flow diagram.

The present study showed how non-intensive anaerobic digestion pre-treatment results in digested bio waste with balanced concentration of less and rapidly biodegradable organic

compounds able to increase the quality of compost after a post composting –phase.

During the test methane gas content rapidly increased after 5days, indicating developing of balanced methane fermentation. During these stage acids were converted to methane and Co2, another important observations is that these runs were very stable by virtue of the removal of inhibitory volatile fatty acids formed during start up.

4. METHODOLOGY TO BE OPTED-

I. Initial survey of raw source of OFMSW

II. Literature survey for finalising the type, method of process to be adopted for treatment.

III. Collection & sorting of OFMSW from raw source.

IV. Selection of site for installing Continuous plug flow reactors for treatment process.

V. Anaerobic loading treatment.

VI. Testing of samples

5.0Design Consideration

While designing any treatment plant for treatment of organic fraction MSW, factors like characteristics of waste, environmental and economic conditions are considered such as : Nature of digester, Temperature, Hydrogen Ion concentration or pH value, composition of food waste, Organic loading rate, Retention time, Mixing, Waste particle size, C/N ratio, cost, Moisture content, etc.

6. RESULTS AND TABLES

Based on literature survey we noted following important point in reference of –

Anaerobic decomposition

1. Anaerobic decompositionis to obtain a high quality, finished product.
2. Anaerobic decompositiontechniques requires larger investment and monitoring.
3. Various emissions of volatile compounds during anaerobic composting to be monitored and utilised for electricity.
4. Digestion mostly get used for energy recovery and less for fertiliser production.

7. CONCLUSION

Conclusion – The various factors involved in the process of design of anaerobic decomposition for the generation of bio gas, plant nutrient & good natural fertilizer from OFMSW have been reviewed. The anaerobic digestion is proven superior to landfilling and aerobic digestion of wasteThe design considerations like nature of digester, hydrogen ion concentration,temperature, composition of waste, organic loading rate, retention time, mixing, waste particle size,C/N ratio, cost, and moisture content were discussed and analyzed to achieve optimal, cost-effectiveand environment-friendly designed digesters. According to this review, further advanced research isnecessary for data collection, performing the experiments, and designing environmentally feasibledigester for food waste. Many types of reactors like conventional batch, single, two-stage, and plug floe reactors were employed for various substrates. The plug flow reactor systemshowed good ability and efficiencyfor the biodegradation of food waste. Thus, more attention should be directed toward thedevelopment of such systems for food waste.

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