International Journal of Engineering Research and Development
e-ISSN: 2278-067X, **p**-ISSN: 2278-800X, www.ijerd.com
Volume 6, Issue 10 (April 2013), PP. 15-22

Effect of Temperature on Biodegradable Solid Waste Digestion

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Abstract:- The study was carried out to find out the effect of temperature on biodegradable solid -waste digestion. Objectives of the research was 'Study thermophililic conditions for biodegradation' and to 'Study control conditions for biodegradation'. Present study shows that high temperature favored fast biodegradation. Complete degradation of the solid waste was observed when water at temperature 80C was passed through the tube. degradation was slow almost equal to the control (without and temperature control). The results are expressed in the form of graph and compared with the control. In the case of 80C the degradation rate has showed slight increase after 4 days of incubation. It may be due to acclimatization of the microorganisms during degradation. In the case of control after 17 days of incubation total degradation was about around 5.7 cm. and the total degradation in the case of no temperature was about 2.5 cm, for 17 days, and total degradation rate in 30 days control without addition of any external temperature was about 4.1 cm. This experiment clearly indicate that temperature controlled reaction was faster than that of without any additional temperature , this means high temperature favored the faster degradation.

Keywords: solid -waste, biodegradation, thermophililic, temperature.

INTRODUCTION

Waste is an unavoidable by-product of human activities. Economic development, urbanization and improved living standards in cities increase the quantity and complexity of generated solid waste. If accumulated, it leads to degradation of urban environment, stresses natural resources and leads to health problems (CPCB, 2000; NEERI, 1994; UN, 2000). Cities in the world are facing a high level of pollution; the situation in developing countries is more acute, this is partly caused by inadequate provision of basic services like water supply, sanitation facilities, transport infrastructure and waste collection (UNCHS Habitat, 2001). Municipal corporations of the developing countries are not able to handle the increasing quantity of waste, which leads to uncollected waste on roads and other public places.

The term solid waste includes all those solid and semi-solid materials that are discarded by a community. the solid waste generated through domestic and commercial activities is classified as municipal solid waste (MSW) and is also called refuse the solid waste generated by industries is known as industrial solid waste. Solid waste may also be generated agricultural activities. A large portion of which may also become a part of the municipal solid waste. the biomedical waste from hospitals and nursing homes. Similarly finds entry into the municipal solid waste. Through is supposed to dispose off separately as a hazardous biomedical waste. The animal excreta (gobar) and human excreta also does not stand included in the municipal solid waste though a portion of this type of semi solid waste may also find entry into the municipal solid waste .

A number of studies were carried out in the past to compare different methods of waste disposal and processing for different places. Maimone (1985) conducted a study for the Netherlands and concluded that composting was the best option of waste management. In another study done for the United Kingdom refused derived fuel was found to be the best option (Powell, 1996). There are a number of studies, namely Chung and Poon (1996), Poerbo (1991), Beukering (1997), suggesting different methods of waste management for different places. It can be inferred from the literature that no one method in isolation can solve the problem of waste management. There is a need to combine different methods and stakeholders in such a way so as to minimize environmental and social costs associated with waste management. Gerlagh et al. (1999) have developed a linear programming model to integrate different methods of waste management in Bangalore, India.

In this research, Effect of Temperature on Biodegradable Solid Waste Digestion were studied to determine heat effectiveness in accelerating the biodegradation of MSW.

MATERIALS AND METHODS

1.1 Module:

Simulated tank was made up of acrylic sheets with 37 cm X 43.5 cm X 18 cm dimensions. Waste material (6 kg) was chopped and 6 cm layer of waste was layered over 4 cm thick soil layers. Above the waste layer one more layer of soil of 4 cm was also added.

Once the layering was complete water was passed through the tube continuously. Temperature was maintained at 80ºC in different reactors. Degradation of solid waste was checked by measuring the height of the waste at regular intervals. Figure 2 shows the reactor set up. The reactor was run for 16 days. A control tank without temperature control was also kept. All the experiments were performed in duplicate and average of the values was taken during analysis. After the experiment was over, all the materials from the reactor was removed for physical observation.

1.2 Steps in which the whole process built up from:

1.2.1. Segregation:

At the very first stage of the process the organic solid waste collected from the municipal treatment plant and has been segregated to remove non degradable from biodegradable.

1.2.2. Pulverization:

Segregated material has been pulverized and amended to biological treatment by simulated landfill reactor.

1.2.3. Treatment in bioreactor:

Pulverized materials have been filled in simulated landfill reactor. Temperature of the reactor was regulated by passing hot water at different temperature through circular pipes inside the reactor. During the reaction degradation has been estimated by measuring the height of the material inside the reactor.

1.2.4.Monitoring and measurement:

Daily monitoring and measurement of how solid waste materials been degraded has been carried out to record any change in height of the solid waste in the simulator module, and finally the collected data have been organized in the form of tables.

Flow chart 1.1. Methodology.(Degradation with addition of temperature)

Flow chart 1.2. Methodology.(Degradation without addition of (temperature) Room temperature

1.3 Literature

A detailed study was carried out to collect baseline information related to various work done on the subject, methodology used and what were their observations. It includes review of books, journals, websites and magazines to understand the present status of work on Effect of Temperature on Biodegradable Solid Waste Digestion. This step provided a general framework and basic knowledge for further research into the topic and also helps in the identification of techniques and equipments appropriate for investigation.

1.4 Analysis:

Analysis of all above mentioned parameters done in BVIEER laboratory.

1.5 Data analysis and interpretation:

Collected data is statistically and graphically analyzed. This analysis was used for interpretation for drawing out conclusion.

1.6 Conclusions:

Analysis of data collected and information gathered helped to draw conclusion.

1.7 Suggestions:

Based on this study general conclusion drawn has reviewed with a view of drawing certain suggestions.

RESULT AND DISCUSSION

2.1 Summary

The study showed that we can implement this method of solid waste disposal to handle the municipal organic solid waste in a more hygienic way than open land fill along with the safe disposal . The municipal solid waste in can be converted in production of bad odors and without making the surrounding environment look bad, this way can be applied very easily without any initial investment, briefly we can summarized the applications of the study as followed.

1. Constructing the module as it has been used in a study in a larger scale nearby disposal sites as an alternative way to open landfills.
2. Farmers and agricultural department can construct this types of solid management field in the cultivatable lands which solid waste's product act as a natural fertilizer.
3. Food industries can have their own disposal sites which helps them to minimize the cost of waste food disposal and minimize the load which they are putting on municipality in collecting their waste.

2.2 The steps which study have been conducted:

In a small scale this study has gone through many steps to give a virtual look as much as possible, to have a realistic result to be used in a real world scenario, following are the stages and steps of the study conduction.

1. Constructing a module to represent the small land fill which latter filled up with elements of the study.
2. Passing a coiled cupper tube inside the module bellow the layers of soils and solid waste.
3. Adding one layer of soil with the height of four centimeters and placing the prepared solid waste with the height of six centimeters and covering the waste with four centimeters of soil on a top.
4. Appling heat daily by boiling water and adding it into the cupper coil which raise up the temperature of the soil layers along with solid waste which helps to degradation.

2.3 what makes this study different from the other:

As per the reference papers which have been used for the referencing of the study, this is a new way to dispose and disintegrate solid waste by heat, many other references are referring to decompose of the municipal solid waste by biological and chemical methods without referring to composition of this type of module.

The unique way in the study is one can use only heat to process the organic solid waste without addition of any chemical or any biological factors which makes us to say that this can be considered as a easier and cheaper way to disintegrate solid waste, in the other hand construction and side preparation of a module as such in a real case is much easier and safer as well as it will have less environmental compacts on the surrounding environment.

The ability of providing parcels of land for this types of project is available more than any other applied methods because inspite of easy management of the project the result of the landfill will be a fertile land which later on can be used as cultivation land ether for greeneries or for grain cultivation, another importance of this project is the landfill of the project can be reused many times after arranging and layering the solid wastes and the soil layers which depends on the depth and the size of the landfill.

2.4 Why this study:

Today one of the most greatest problem in managing municipal waste is it's huge amount as the result of existence of high population on our planet as common and specially in a country like India, there for scientists are in a continues struggle to find a way to deal with the waste in any type, this study is also one of the attempt to find a way which is more effective and much easier to deal with the solid waste. Another factor which has pushed us to seek for a new and more sufficient way in this field is to find a method of solid waste management to be easier to conduct without needs of huge initial investments and man power. According to the results out put the study shows that degradation of solid waste by heat is one of the most rapid and easy way to handle the giant amount of municipal solid waste.

Experiment 1. data with addition of temperature

Day	TS	TW	TSW
	At 80°C		
1	**8cm**	**6cm**	**14cm**
2	**8cm**	**5.8cm**	**13.8cm**
3	**8cm**	**5.4cm**	**13.4cm**
4	**8cm**	**4.8cm**	**12.8cm**
5	**8cm**	**4.2cm**	**12.2cm**
6	**8cm**	**3.6cm**	**11.6cm**
7	**8cm**	**3.3cm**	**11.3cm**
8	**8cm**	**3.1cm**	**11.1cm**
9	**8cm**	**2.8cm**	**10.8cm**
10	**8cm**	**2.6cm**	**10.6cm**
11	**8cm**	**2.3cm**	**10.3cm**
12	**8cm**	**2cm**	**10cm**
13	**8cm**	**1.6cm**	**9.6cm**
14	**8cm**	**1.3cm**	**9.3cm**
15	**8cm**	**0.9cm**	**8.9cm**
16	**8cm**	**0.4cm**	**8.4cm**
17	**8cm**	**0.3cm**	**8.3cm**

Table 2.1: data with addition of temperature (17 days)

TS: Total soil layer, TW; Total solid waste, TSW: Total soil and waste layer
The graph bellow is showing how both organic solid waste and total waste are declining with addition of temperature for 17 days.

Graph 2.1. Solid waste degradation in addition of 80C^0 for 17 days

According to the graph No.1both total waste and solid waste are declining daily by adding the temperature which shows that heat is acting as an auxiliary and helpful factor to reduce the height and the mass of the solid waste in the module, by this we can understand that increasing of temperature is causing decomposition of the municipal solid waste.
In this case both total solid waste and the added solid waste are declining in the same pattern in a direct proportion relation, at the first day of the experiment both of their lines are showing the highest values while by increasing the passing time their values are dropping down both together.

Experiment 2. data without addition of temperature

Day	TS	TW	TSW
	Control		
1	**8cm**	**6cm**	**14cm**
2	**8cm**	**6cm**	**14cm**
3	**8cm**	**6cm**	**14cm**
4	**8cm**	**5.9cm**	**13.9cm**
5	**8cm**	**5.7cm**	**13.7cm**
6	**8cm**	**5.5cm**	**13.5cm**
7	**8cm**	**5.5cm**	**13.5cm**
8	**8cm**	**5.4cm**	**13.4cm**
9	**8cm**	**5.2cm**	**13.2cm**
10	**8cm**	**4.7cm**	**12.7cm**
11	**8cm**	**4.5cm**	**12.5cm**
12	**8cm**	**4.2cm**	**12.2cm**
13	**8cm**	**3.9cm**	**11.9cm**
14	**8cm**	**3.8cm**	**11.8cm**
15	**8cm**	**3.6cm**	**11.6cm**
16	**8cm**	**3.5cm**	**11.5cm**
17	**8cm**	**3.5cm**	**11.5cm**

Table 2.2: data with addition of temperature (17 days)

TS: Total soil layer, TW; Total solid waste, TSW: Total soil and waste layer

Graph 2.2. Solid waste degradation in without addition of temperature for 17 days

Graph No.2.2 shows that declination of both solid waste and the total waste are little slow than the graph No.2.1, thus we can come to know that we can process and dispose municipal organic solid waste without any addition of temperature but the process of degradation will be much slower than with addition of heat.

In this case both total solid waste and the added solid waste are declining in the same pattern in a direct proportion relation as well same as experiment with addition of temperature , both of their lines are showing the highest values while by increasing the passing time their values are dropping down both together but the only difference is in this condition solid waste degradation process is slower than first experiment, there for we can conclude that degradation of municipal solid waste takes more time to happen in a normal room temperature.

Experiment 3.data without addition of temperature (30 days)

Day	TS	TW	TSW
	Control		
1	8cm	6cm	14cm
2	8cm	6cm	14cm
3	8cm	5.8cm	13.8cm
4	8cm	5.6cm	13.6cm
5	8cm	5.6cm	13.6cm
6	8cm	5.5cm	13.5cm
7	8cm	5.4cm	13.4cm
8	8cm	5.2cm	13.2cm
9	8cm	5.1cm	13.1cm
10	8cm	5cm	13cm
11	8cm	4.8cm	12.8cm
12	8cm	4.6cm	12.6cm
13	8cm	4.4cm	12.4cm
14	8cm	4.1cm	12.1cm
15	8cm	4cm	12cm
16	8cm	3.8cm	11.8cm
17	8cm	3.7cm	11.7cm
18	8cm	3.5cm	11.5cm
19	8cm	3.5cm	11.5cm
20	8cm	3.4cm	11.4cm
21	8cm	3.2cm	11.2cm
22	8cm	3cm	11cm
23	8cm	2.9cm	10.9cm
24	8cm	2.9cm	10.9cm
25	8cm	2.6cm	10.6cm
26	8cm	2.3cm	10.3cm
27	8cm	2.1cm	10.1cm
28	8cm	1.9cm	9.9cm
29	8cm	1.9cm	9.9cm
30	8cm	1.9cm	9.9cm

Experiment 4.data without addition of temperature (30 days)

TS: Total soil layer, TW; Total solid waste, TSW: Total soil and waste layer

Graph 2.3. Solid waste degradation with and without addition of temperature for 30 days

In this stage we can compare how the processes of degradation proceeding , by passing the days all three processes are declining both with and without addition of temperature, but the only difference is the declination with the temperature is higher than those without temperature. finally after 30 days the total remaining of solid waste is 1.9 cm, this shows that the process of degradation of solid waste can be happen in a normal room temperature but the process takes more period of time than that with an effect of heat.

Graph No.2.4: combination of degradation of total waste and solid waste with and without temperature for 30 days and 17 days.

Graph No.2.4 shows that the same solid waste which have been used in the degradation process with temperature is declining without adding any heat but it takes longer time to get totally decomposed. the orange pints movement showing how height of total solid waste is decreasing with increasing of days, while the green points are representing the degradation of total solid waste without addition of temperature, where the violet points are showing again the total solid waste with addition of temperature for experiment number 2.

CONCLUSIONS

The gained result of calculations show that in both cases either with addition or without addition of temperature the solid waste can be treated and digested in such kinds of landfill which have been shown as a module, but the process of minimization of the organic municipal solid waste is happening more rapidly when heat increase involved in the process, calculated weight of the total waste showed that only (0.5 %) of the total weight remained after storing the waste in the module for (17) days and heated frequently each (24 hrs) once, while (40.71 %) of the waste remained without addition of temperature, this shows that degradation of the solid municipal organic waste has more affinity toward decaying and digestion when the landfills temperature is higher than surrounding environment.

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