

Bio Methanation of Organic Domestic Waste through Anaerobic Digestion

R.Boopathiraja ¹, K.Kayalvizhi ²Assistant Professor, Department of Civil Engineering, The Kavary College of Engineering, Salem, Tamilnadu, India^{1,2}

ABSTRACT: Developed countries seek to reduce municipal solid waste disposal by management technique that concentrate on waste minimization a recycling. In MSW 83% of waste sent to landfill site, 8% sent to incineration and 9% of waste is recycled by composting and anaerobic digestion. Energy deficiency is another major problem in developing countries. It has been estimated that, in 2013 energy consumption is greater that production. Anaerobic digestion gives solution for the above problems. A well-designed anaerobic digestion fosters sustainable development since it recovers energy by reducing fossil fuel use and it reduces the green house gas emission. Anaerobic digestion was adopted for recycling process of organic waste. Organic fractions of waste with inoculums were characterized and daily biogas production a methane concentration was evaluated for 40 days. This project aims at production of biogas by using cow dung, vegetable waste, fruit waste and kitchen waste and will provide alternate and renewable energy production from the waste. At the same time, to implement a biogas plant to every street and apartments and hence it reduce land pollution caused by the disposal of organic waste.

KEYWORDS: Anaerobic digestion, bio methanation, bio gas production, food waste, reactor.

I. INTRODUCTION

The pollutant free environment is the most and essential for the human being as well as other living beings. The pollutant free air will provide a good eco-system and green environment. The population of urban India is 285 million as per 2001 census. The municipal agency spend 5% to 25% of their budget on solid waste management is Rs.75 to Rs.250 per capita per year. Waste generation varies between 0.2 to 0.4 kg per capita per day. Now the urban population reaches to 341 million in 2010. The waste production quantity estimated to increase from 46 million tonnes in 2001 to 65 million tonnes in 2010. This show, due to rapid growth of population waste production also attains growth. present status of waste management are Storage of waste at source is lacking, domestic waste thrown on streets, Bio-medical waste disposed in municipal waste stream, Rag pickers collect recyclables from municipal bins / dumpsites and litter the waste causing insanitary conditions, Primary collection of waste not done at place of generation design & location of municipal waste storage depots inappropriate, resulting in littering of garbage, Waste processing partially practiced in 35 ulbs only, Final disposal done through crude dumping. Methods of disposal of waste.

- Sanitary landfill - Expensive, no resources recovery and polluting.
- Incineration - Expensive, highly polluting, no biomass recycling.
- Biogas technology - Non-polluting traditional and inexpensive, resource.
- Recycling - Non-polluting and resource recovery.
- Composting - Controlled process and expensive.

The main objective of the paper is as follows.

To obtain the optimal conditions for biogas production in the reactor through biomethanation process, the production of alternate renewable energy (biogas) by using cow dung, kitchen waste, vegetable and fruit waste in the ratio of 2:1:1. At the same time we suggest to implement a biogas plant to every street and apartments and hence it will prevent environmental degradation and it reduce the land pollution caused by the disposal of organic waste and also the vegetable and food waste should also be managed and it gives the aesthetic look to the environment.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

II. WASTE GENERATION

Table (1) Population Growths and Impact on Overall Urban Waste Generation & Future Predictions Until 2041.

Year	Population (Millions)	Per Capita	Total Waste generation Thousand Tons/year
2001	197.3	0.439	31.63
2011	260.1	0.498	47.30
2021	342.8	0.569	71.15
2031	451.8	0.649	107.01
2036	518.6	0.693	131.24
2041	595.4	0.741	160.96

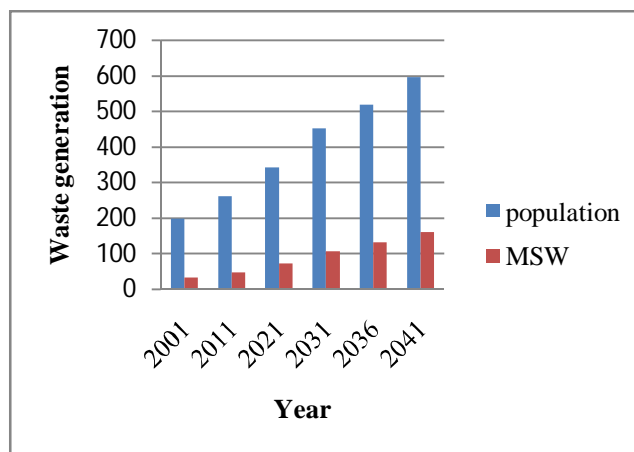


Fig. (1) Year Vs Population And Waste Generation Rate

Factors Influencing Biogas Production from Solid Waste

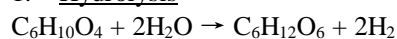
1. Digester Temperature
2. Retention Time
3. Alkalinity and Ph
4. Total Solids
5. Volatile Solids
6. Fixed Solids

III. ANAEROBIC DIGESTION

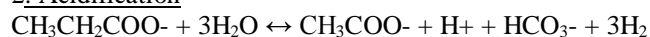
It occurs in three stages, which are listed below

1. Hydrolysis
2. Acidification
3. Acetogenesis
4. Methanogenesis

1. Hydrolysis



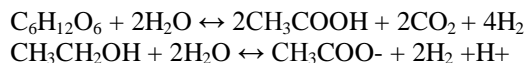
2. Acidification



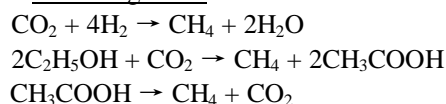
International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016



3. Methanogenesis



IV. MATERIALS AND METHODS

The materials used for the study is food waste, vegetable waste, fruit waste and cow dung (inoculums) was collecting from the kitchen and Dairy farm. The waste is mixed with water in 1:1 ratio. The sample was analyzed for the total solids, volatile solids, total dissolved solids, carbon content, nitrogen content, carbon nitrogen ratio. As biodegradable COD was a measured using standard method. The pH of the wastes was measuring using digital pH meter. The characterization of the different waste a given in table 2.

Table (2) Characteristics Of Different Waste (Vegetable, Food, And Fruit & Cow Dung).

Characteristics of waste	Vegetable+fruit Innoculums (g/l)	Food+Innoculums(g/l)	Cow dung (g/l)
Ph	7.9	5.6	9.8
TS	17.64	14.2	5.03
VS	53.91	37.78	67.7
COD	30	28	23
BOD	12	14	13
Carbon	43.4	38.7	28.4
Nitrogen	2.24	1.45	2.86
C:N	19:1	27:1	20:1

V. REACTOR SET UP

Bottles of capacity 1L closed by the rubber stoppers equipped with tubes for gas collection. The gas measurement is done by the water displacement method. The biogas production was determined as follows a known volume of the heads space gas (V1) production in a bottle was syringed and injected in the rubber stopper and another tube is connected to the bottle will collect the displaced water due to gas production. The amount of water displaced due to the pressure by gas production will gives the value of gas production by the sample.



Fig. (2) Analysis Of Gas Production By Water Displacement Method.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

Table (3) Analysis Measurement of Gas Production by Water Displacement Method

S.No	No. of days (ml)	Vegetable+Fruit +Innoculum (ml)	Food+Innoculum (ml)	Cow dung (ml)
1	5	75	48	82
2	10	56	35	62
3	15	48	20	50
4	20	30	18	30

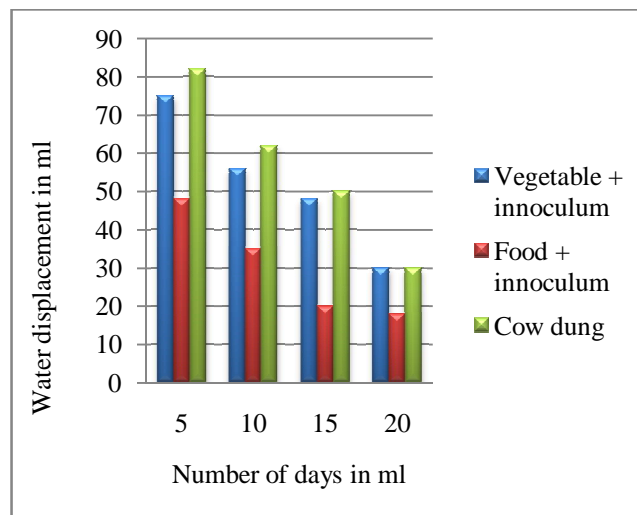


Fig. (3) Water Displacements in ml Vs Number Of Days

Collection of Waste and Combined Degradation of Wastes (Vegetable +Food+Fruit+Cow Dung + Water):

The waste that is fruit, vegetable, food, and cow dung is collected and grinded to a mixture then it is added in the proportion of 2:1:1 and equal proportion of water is added.

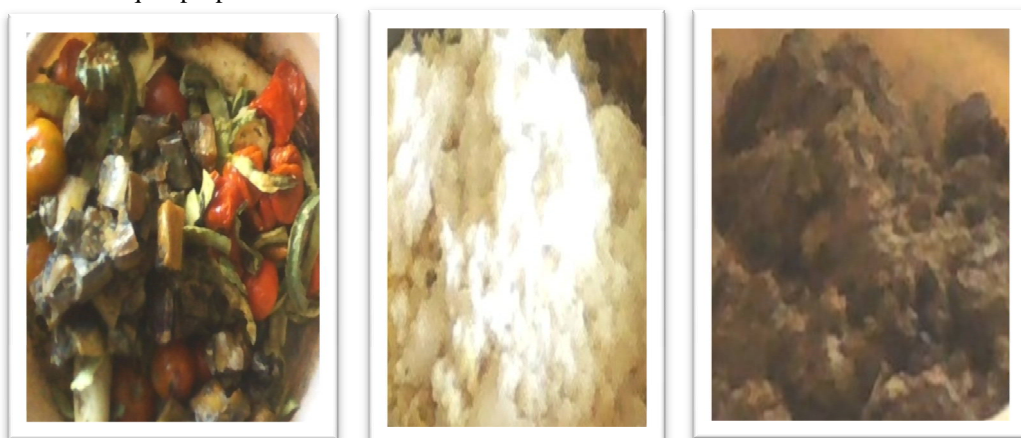


Fig. (4) Collection of waste (Vegetable and fruit waste, food waste, cow dung).

All the wastes (Vegetable and fruit waste, food waste, cow dung) are mixed in a mixer without adding of water and put it in to the container.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

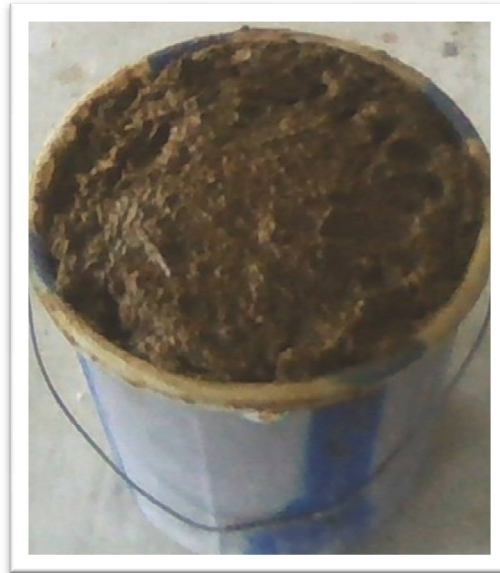


Fig. (5) Grinding and mixing of waste.

Table (3) Quantity of waste taken for degradation

S.No	Waste	Quantity(kg)
1	Vegetable + fruit	2
2	food	2
3	Cow dung	4

The grained wastes are placed in the sunlight to improve the production of bacteria. For degradation propose the sample is placed in the container for 20 days.



Fig. (6) Waste kept for degradation in the sealed reactor.



Fig. (7) Degraded wastes inside the reactor after degradation.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

Reactor Set Up For Combined Waste:

The 25L capacity container is taken as reactor. After the waste grinds and mixed in equal proportion with water the waste is filled about 3/4th of the container. The container is sealed and kept for degradation for 20days. After 20days the gas analysis started. The gas measured is done by connecting the reactor to the graduated jar by using the tube which is placed in the small water tank and then tube is sealed with container and graduated jar. On the result of gas production due to the pressure exerted by the bio gas the water level in the graduated jar varies from the initial level. From that we can find out the gas production range. And every day the variation of water level in the graduated jar is measured. And gas production range is measured using the depth of the water level.



Fig. (8) Reactor Set up for analysing the gas production.

Table (4) Characterization of combined wastes (vegetable & fruit + food + cow dung)

S.No	Parameter	Value
1	Ph	6.7
2	Carbon	44
3	Nitrogen	1.37
4	TS%	17.63
5	VS%	13.65
6	VS/TS%	77.42
7	C:N	32:12

Table (5) Analysis of biogas production by combined waste

S.NO	DAYS	GAS PRODUCTION
1	18.05.2016	-
2	19.05.2016	0.2
3	20.05.2016	0.4
4	21.05.2016	0.6
5	22.05.2016	0.8
6	24.05.2016	1.1
7	25.05.2016	1.3
8	26.05.2016	1.5
9	27.05.2016	1.6
10	28.05.2016	1.8
11	03.06.2016	2.1
12	04.06.2016	2.3
13	05.06.2016	2.5

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

14	06.06.2016	2.7
15	07.06.2016	3.0
16	08.06.2016	3.2
17	10.06.2016	3.3
18	11.06.2016	3.5
19	12.06.2016	3.8
20	13.06.2016	4.1

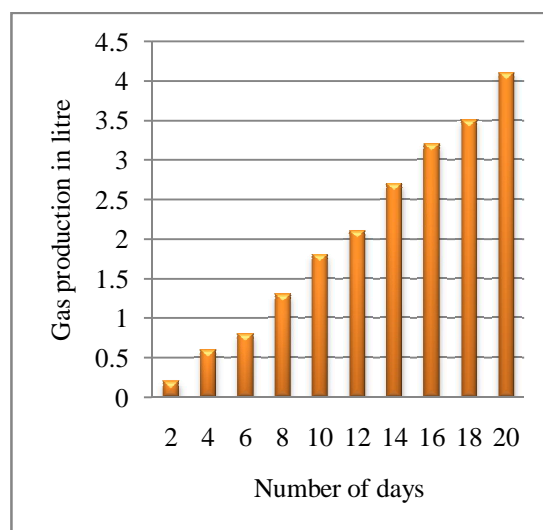


Fig. (9) Gas productions in litre Vs number of days

VI. CONCLUSION

The production of biogas by using cow dung, vegetable and food waste in the ratio of 2:1:1 is done successfully in this paper. Production of biogas is a high – grade soil conditioner. The economical benefits are Reduction in the use of artificial mineral fertilizers and reduction in the land filling through the increased recycling of waste. Modular construction of plant and closed treatment needs less and area. Reduction energy cost through biogas to heat and electricity. At the same time, if biogas plant is implement **to every street and apartments** and hence it reduce land pollution caused by the disposal of organic waste and gives more economic benefits.

REFERENCES

- [1] J Mata-Alvarez, S Mace, P Llabres, “Anaerobic digestion of organic solid wastes. An overview of research achievements and perspectives Bioresource technology, 2000 – Elsevier, Volume 74, Issue 1, August 2000, Pages 3–16.
- [2] M Sharholly, K Ahmad, G Mahmood, RC Trivedi, “Municipal solid waste management in Indian cities–A review.” Waste management, 2008 – Elsevier, Volume 28, Issue 2, 2008, Pages 459–467.
- [3] A Karagiannidis, G Perkoulidis, “A multi-criteria ranking of different technologies for the anaerobic digestion for energy recovery of the organic fraction of municipal solid wastes”, Bioresource technology, 2009 – Elsevier, Volume 100, Issue 8, April 2009, Pages 2355–2360.
- [4] J Mata-Alvarez, P Llabres, F Cecchi, P Pavan, “Anaerobic digestion of the Barcelona central food market organic wastes: experimental study, Bioresource Technology, 1992 – Elsevier, Volume 39, Issue 1, 1992, Pages 39–48.
- [5] A Khalid, M Arshad, M Anjum, T Mahmood “The anaerobic digestion of solid organic waste”, Waste Management, 2011, Volume 31, Issue 8, August 2011, Pages 1737–1744.
- [6] N Bardiya, D Somayaji, S Khanna “Biomethanation of banana peel and pineapple waste”, Bioresource technology, 1996 – Elsevier, Volume 58, Issue 1, October 1996, Pages 73-76.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

- [7] JH Thiele, JG Zeikus "The anion exchange substrate shuttle process: A new approach to two stage biomethanation of organic and toxic wastes", *Biotechnology and bioengineering*, 1988 - Wiley Online Library, Volume 31, Issue 6 20 April 1988 Pages 521–535.
- [8] FJ Callaghan, DAJ Wase, K Thayanithy "Co-digestion of waste organic solids: batch studies, *Bioresource technology*", 1999 – Elsevier, Volume 67, Issue 2, February 1999, Pages 117-122.
- [9] H Bouallagui, Y Touhami, RB Cheikh, M Hamdi "Bioreactor performance in anaerobic digestion of fruit and vegetable wastes:, *Process biochemistry*, 2005 – Elsevier, Volume 40, Issues 3–4, March 2005, Pages 989–995.
- [10] IG Lalov, II Guerginov, MA Krysteva, K Fartsov "Treatment of waste water from distilleries with chitosan" *Water Research*, 2000 – Elsevier, Volume 34, Issue 5, April 2000, Pages 1503–1506.
- [11] J De Vrieze, T Hennebel, N Boon, W Verstraete, "Methanosarcina: the rediscovered methanogen for heavy duty biomethanation" *Bioresource technology*, 2012 – Elsevier, Volume 112, May 2012, Pages 1–9.
- [12] DR Kashyap, KS Dadhich, SK Sharma, "Biomethanation under psychrophilic conditions: a review" *Bioresource technology*, 2003 – Elsevier, Volume 87, Issue 2, April 2003, Pages 147–153.