# An Energy Analysis of Lethal Biological Waste Through Anaerobic Digestion

[1]Parul Sharma, [2]C. Srisailam, [3]Sonali Suhane
[1,2,3] Ass. Prof. Department of Electrical and Electronics,
Gyan Ganga College of Technology, Jabalpur, INDIA

***Abstract - Biological waste disposal is one of major problems being faced by all nations across the world. Generation of wastes both in the solid and liquid forms is associated with the various activities of human beings. Due to improper waste management facilities and treatment, these wastes find their way into the environment. As a results quality of land water and air have drastically deteriorated causing various kinds of health problems.***

***Present study investigates the eco-friendly disposal, energy extraction, conversion of these lethal bio-medical waste [human anatomical waste, animal waste (animal body parts, carcasses, excreta, bleeding parts and wastes generated at veterinary hospitals), microbiology and biotechnology waste (waste from laboratory cultures, live or attenuated vaccines, human and animal cell culture used in research , waste from biological toxins), discarded medicines, soiled waste (cloth containing blood stains, blood coated cotton balls, soiled plasters, liquid waste (waste generated from laboratory housekeeping activities) etc] to worthy manure. Present methods of disposal through incineration and landfill are not environmental friendly and pollute with activated virus and bacteria. So, the investigation will also help to all municipal corporations, academician related to waste management system, energy and environmental issues in disposing such wastes to worthy resources.***

***Key words: Bio-medical waste, anaerobic digestion, C/N ratio, co-digestion***

## 1. INTRODUCTION

### *1.1 What is biological waste?*

The Medical Waste Tracking Act of 1988 defines medical waste as "any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biological matter." Biomedical waste, also known as infectious waste or medical waste is defined as solid waste generated during the diagnosis, testing, treatment, research or production of biological products for humans or animals. Biomedical waste includes syringes, live vaccines, laboratory samples, body parts, bodily fluids and waste, sharp needles, cultures and lancets. Biomedical waste, (BMW), consists of solids, liquids, sharps, and laboratory waste that are potentially infectious or dangerous and are considered bio waste.

### *1.2 Problem associated with present disposal of BMW*

The main problem associated with the BMW are the pathogenic agents which includes bacteria, viruses and other infectious agents that are responsible for various air borne diseases. So, the proper handling, treatment, disposal of bio-medical waste is very necessary.

Traditionally, land filling and incineration have been the most common treatment and disposal methods for Biological waste, however there are major drawbacks to both. Land is widely considered more valuable when used for housing, development, recreation and

agriculture. Medical waste incinerators emit toxic air pollutants and toxic ash residues that are the major source of dioxins in the environment.



## 2. MATERIAL AND METHODS

The substrate used in the experiment is fresh cow dung collected freshly from a cattle farm at the Panagar. The substrate was collected in a polyethylene bag and immediately prepared after collection by mixing with water in the ratio 1:1 (w/w) and then placed in the digesters for the experiments. Waste to water ratio is important parameter to optimize the gas production. The amount of water added depends upon the quality and quantity of the waste. The highly organic waste requires proper proportion of waste to water to degrade the complex compounds present in the waste. The experimental wastes which are Bio- medical waste were collected from hospital situated at Jabalpur. One-day-old poultry droppings were also collected from a poultry farm situated at the Barah. The waste samples were stored in black sealed polythene bags to conserve the moisture.

### *2.1 Designing of digester*

The digester used in the experiments is a simple (single stage) cylindrical batch feeding digester that has no moving parts. A set of 4 containers (each of capacity 15 kg) is used as digesters for this research, that is, one digester for each sample. Another set of 4 flasks is used each contained water and was connected to a particular digester by means of a connecting tube. On the other side connected to a measuring cylinder by means of a connecting tube. The gas collecting apparatus is used to run-off and measure water displaced by the collected gas. The gas is collected by water displacement method. This is carried out by measuring and recording the quantity of water displaced daily using a 100 ml measuring cylinder. For achieving the leach into groundwater. Medical waste has been identified by US Environmental Agency as the third largest known source of dioxin air emission.

planned target the whole digestion process is divided in to four stages named Experimental setup -1, Experimental setup-2,Experiment setup-3 and Experiment – setup-4.In each experiment, four digesters are used and each digester contains BMW, CD and PW in different proportions with a ratio of 1:1 with water.

## 3. BASIC EXPERIMENTAL SETUP

### *3.1 Seeding*

Bacterial growth is very essential for the bio gas production and it depends on seeding. For this experiment, cow dung was used for seeding because the bacteria required for the methane fermentation are present in the cow dung.

### *3.2 The digestion process*

The weighing balance is used to determine the mass of cow dung and Biological waste and poultry waste that made up the total solid. The digester is operated at ambient temperatures. A thermometer is used to determine the daily temperature. The average temperature was calculated and assumed to be the operating temperature. A digital pH meter is used to determine the pH of the digested slurry (sample) on the first day of the experiment.

For the purpose of this research, there were four x:y proportions aimed at investigating the efficiency of biological waste in biogas production with poultry waste. The experimental setups for our work are as follows:

### *3.3 Experimental setup 1*

All four digester filled with biological waste and poultry waste in different proportions in ratio with water and the whole waste then loaded to about 3/4 of the digester volume. Ratio of water and waste is 1:1. The four proportions are as follows: Sample A; 90:10, B; 80:20, C; 70:30, D; 60:40 BMW: Poultry waste on a weight percent basis (Table 1).

Table-1, Proportion of substrate in each sample

| Samples | % of X | % of Y |
|---|---|---|
| A | 90 | 10 |
| B | 80 | 20 |
| C | 70 | 30 |
| D | 60 | 40 |

X represents the BMW, Y represents Poultry waste

### *3.4 Experimental setup 2*

For the purpose of this research, there are four x: z proportions aimed at investigating the efficiency of biological waste in biogas production with cow dung. All four digester filled with biological waste and cow dung in different proportions in ratio with water and the whole waste then loaded to about 3/4 of the digester volume. Ratio of water and waste is 1:1. The four proportions were as follows: Sample A; 90:10, B; 80:20, C; 70:30, D; 60:40 BMW: cow dung on a weight percent basis (Table 2).

Table 2, Proportion of substrate in each sample

| Samples | % of X | % of Z |
|---|---|---|
| A | 90 | 80 |
| B | 80 | 20 |
| C | 70 | 30 |
| D | 60 | 40 |

X represents the BMW, Z represents cow dung

### *3.5 Experimental setup-3*

For the purpose of this research, there are three x: y: z proportions aimed at investigating the efficiency of biological waste in biogas production with cow dung and poultry waste. All three digester filled with biological waste, cow dung and poultry waste in different proportions in ratio with water and the whole waste then loaded to about 3/4 of the digester volume. Ratio of water and waste is 1:1. The four proportions were as follows: Sample A; 60:10:30, B; 70:10:20, C; 80:10:10, BMW: PW: CD on a weight percent basis. Here the percentage ofpoultry waste is fixed in each digester. (Table 3).

Table 3 Proportion of substrate in each sample

| Samples | % of X | % of Y | % of Z |
|---|---|---|---|
| A | 60 | 10 | 30 |
| B | 70 | 10 | 20 |
| C | 80 | 10 | 10 |

X; represents the BMW, Y; represents Poultry waste , Z; represents cow dung

### *3.6 Experimental setup -4*

For the purpose of this research, there are three x: y: z proportions aimed at investigating the efficiency of biological waste in biogas production with cow dung and poultry waste. All three digester filled with biological waste, cow dung and poultry waste in different proportions in ratio with water and the whole waste then loaded to about 3/4 of the digester volume. Ratio of water and waste is 1:1. The four proportions were as follows: Sample A; 60:10:30, B; 70:10:20, C; 80:10:10, BMW: PW: CD on a weight percent basis. Here the percentage of cow dung is fixed in each digester. (Table 4).

Table 4 Proportion of substrate in each sample

| Samples | % of X | % of Y | % of Z |
|---|---|---|---|
| A | 60 | 10 | 30 |
| B | 70 | 10 | 20 |
| C | 80 | 10 | 10 |

X; represents the BMW, Y; represents Poultry waste ,Z; represents cow dung.

ISSN: 2278-0181
Vol. 3 Issue 7, July - 2014

BIO - METHANATION UNIT


Fig. 1

## 4. RESULT AND DISCUSSION

*4.1 Co-digestion of Biological waste with poultry litter (Case-1)*

The trends of daily biogas production with time for all the digesters of case-1 are shown in figure 2. Referring to fig.2 biogas production commenced in all the digesters on 10th day after loading. The fig. also shows that the total biogas production from each of the digester and suggests that digester C produced the highest quantity of biogas (800 ml.) in 42 days. It can be seen biogas production starts on the 10th day, increased gradually on subsequent days then attained maximum value on 22nd day. After that because of the complete digestion of feed material in the digester the digestion process has stopped. The fig.2 also shows that the biogas production from digester A produced less biogas as compared to digester C. The fig. also shows that the biogas production from digester B and D starts on the 10th day, increased gradually on subsequent days then attained maximum value (80ml) on 22nd h day. After that because of the complete digestion of feed material in the digester the digestion process has stopped.

**CASE- I**

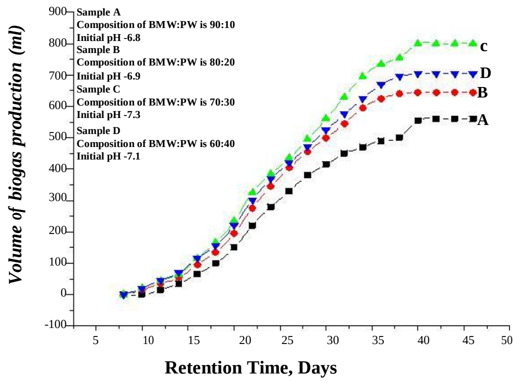


Figure – 2 Cumulative production of biogas in CASE-I

*4.2 Co-digestion of Biological waste with cow dung (Case-2)*

Trend of cumulative biogas production with time for all the digester of case-II are shown in fig.3 Referring to figure, maximum biogas produced by digester B and minimum biogas produced by digester A .This reduction in the biogas generation by the digester A may be because of the less pH- value. The pH-value of digester A is 6.9 which is very less as compared to digester C (pH-value is 7.3). Total biogas produced by digester B is 700 ml. which is maximum amongst other three digesters. Biogas produced by

digester B is 610 ml. Total biogas produced by digester D and A after 46 days from loading is 505,560 ml. respectively.

**CASE- II**

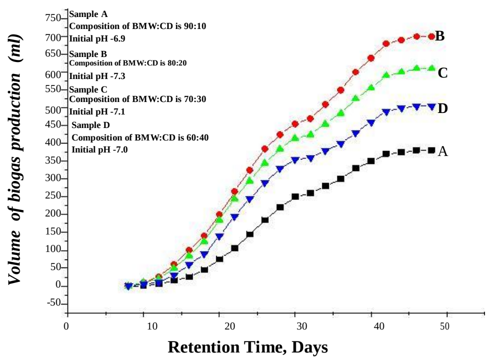


Figure –3 Cumulative Production of Biogas in CASE-II.

### *4.3. Co-digestion of biological waste with poultry waste and cow dung(Case-3)*

Trend of cumulative biogas production with time for all the digester of case-III are shown in fig.4 Referring to figure, maximum biogas produced by digester B and minimum biogas produced by digester C. This reduction in the biogas generation by the digester C may be because of the less pH- value. The pH-value of digester C is 6.9 which is very less as compared to digester B (pH-value is 7.2). Total biogas produced by digester B is 605ml. which is maximum amongst other two digesters. Biogas produced by digester A is 580ml. Total biogas produced by digester C after 42 days from loading is 490.0

CASE-III

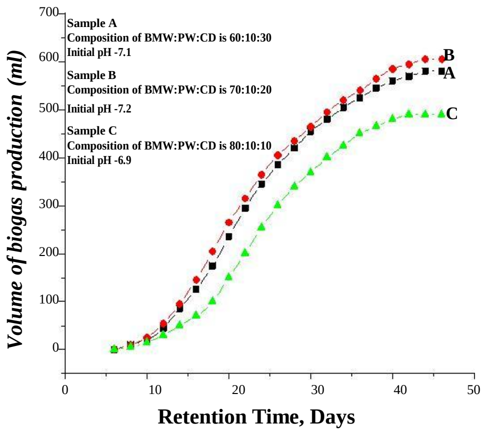


Figure –4 Cumulative Biogas production in CASE- III

### *4.4 Co-digestion of biological waste with poultry waste and cow dung (Case-4)*

Trend of cumulative biogas production with time for all the digester of case-IV are shown in fig.5 Referring to figure, maximum biogas produced by digester A and minimum biogas produced by digester C. This reduction in the biogas generation by the digester C may be because of the less pH- value. The pH-value of digester C is 7.0 which is less as compared to digester A (pH-value is 7.3). Total biogas produced by digester A is 650ml. which is maximum amongst other two digesters. Biogas produced by digester B is 550ml. Total biogas produced by digester C after 42 days from loading is 515.

**CASE- IV**

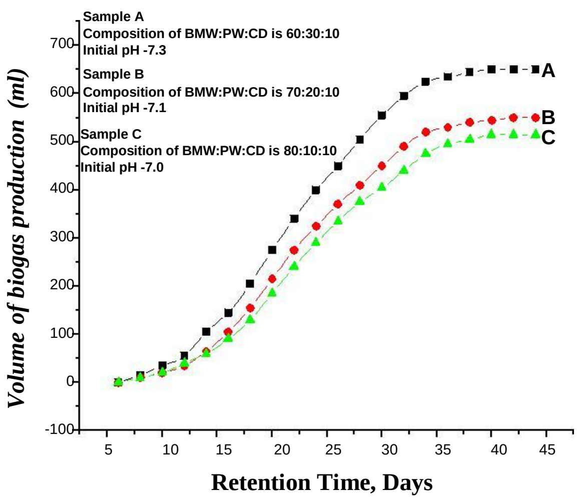


Figure –5 Cumulative Production of Biogas in CASE-IV

## 5. CONCLUSION

In the present investigation it has been found that biological waste is a lethal, highly polluting and cannot disposed through landfill or incineration until and unless a proper measure taken. However this waste can be anaerobically digested and that will not only eco-friendly but also it will generate biogas as high quality manure. For rapid digestion it has been found that BMW with PW in 70:30 leads high gas yield, less RT. whereas co-digestion with cow dung and PW in 70:20:10 ratio yield comparative less gas and taken more RT. The present study will fetch an opening to all accedimician, Municipal Corporation's, environmental related person in investigation, disposal and energy extraction from lethal BMW.

## 6. REFRENCES

1. Hartmann, H., Ahring, B.K "Anaerobic digestion of the organic fraction of municipal solid waste" influence of co-digestion with manure, 2005.
2. Colin D Rasmussen, Treatment of Biomedical Waste with Ozone, Ph.D., LL.B. – Rasmussen, Rasmussen & Charowsky, PLC, 2008.
3. Virendar Pal Singh, Gautam Biswas, Jag Jiv Sharma, Biomedical Waste Management - An Emerging Concern in Indian Hospitals, Vol. 1, No. 1 ,2007.
4. Gordon JG, Rein Hardt PA, Denys GA: Medical waste management:
Mayhall CG (ed). Hospital epidemiology and infection control, (3 rd) Lippincott Williams and Wilkins publication. Pages: 1773-85, 2004.
5. Hem Chandra, Hospital Waste: An Environmental Hazard and Its Management, ISEB, Vol. 5 No. 3, July 1999.
6. Sterling, M.C.Jr., Lacey, R.E., Engler,
C.R., Ricke, S.C. "Effects of ammonia nitrogen on H2 and CH4 production during anaerobic digestion of dairy cattle manure" 2001.
7. Ahring, M., Angelidaki, I. and Johansen, K., Anaerobic treatment of manur together with industrial waste, water science and technology vol. 25, pp. 311-318.bioreactors. Water Science and Technology, 52, (1), 13-20,1992..
8. Dela-Rubia, M.A., Perez, M., Romero,
L.I., Sales, D, "Anaerobic mesophilic and thermophilic municipal sludge digestion" 2002.
Gerardi, M.,The Microbiology of Anaerobic Digesters. Waste water Microbiology Series. John Wiley & Sons, Inc.United States of America 2003.
9. F. Cecchi, D. Bolzonella, P. Pavan, S. Macé, J. Mata-Alvarez, Anaerobic Digestion of the Organic Fraction of Municipal Solid Waste for Methane Production: Research and Industrial Application Comprehensive Biotechnology
( Second Edition), Volume 6, Pages, 463- 472, 2011
10. Hartmann, H., Ahring, B.K "Anaerobic digestion of the organic fraction of municipal solid waste" influence of co-digestion with manure. 2005.
11. Mata-Alvarez, Biomethanization of the Organic Fraction of Municipal Solid
Waste. IWA Publshing. ISBN: 1-900222-14-0, 2003.