A Study of Treatability of Kitchen Wet Waste And Biogas Production

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ABSTRACT

The present paper contributes to solve 'the waste disposal' problem to some extent. The percentage of Kitchen waste in total Municipal solid waste is quite high, so the treatability of Kitchen waste should be start at personal level i.e. from homes. The contribution in treating the waste by using organic wet waste in anaerobic digestion i.e. decomposition of large complex chain into smaller chain of molecules without the presence of oxygen. Anaerobic digestion process is placed in Biogas plant. So for a middle class family the plan should be economical. Deenbandhu biogas plant is Economical plant, because the Payback period of this plant is 2 and half year only. The initial investment cost is only Rs27000/-. Place for such kind of plant at homes is 424sq. ft, which is easily available at backyard of home. The contribution describes the several month laboratory research of the utilization of domestic waste as the organic source of biogas production .The results from Deenbandhu biogas plant produces up to 6m³of Biogas per day, which is available for cooking 8-12hours for 10- 14 family members. Production of Biogas depends upon various factors which are also to be taken into account. So the optimum pH, TS% and temperature which is recorded time to time are i.e. 7, 12%and 37˚C respectively.

KEYWORDS : *Waste disposal, Treatability, Kitchen waste, Anaerobic digestion, Economics, Deenbandhu biogas plant.*

I. INTRODUCTION

Waste disposal is one of the major problems being faced by all nations across the world. The daily per capita per person solid waste generated in our country ranges from about 300 g to 500g. If we carefully analyse this waste we will realize that majority of it is biodegradable. Waste like glass, metals and paper would be recyclable. There is large amount of waste being produced in every household. Toxic Links at New Delhi conducted a survey in May 2002 and prepared a fact file on waste in India. (Manmeet Kaur et al, 2012). It stated that about 0.1 million tone of MSW is generated in India every day. So, annual production reaches approximately 36.5 million tonnes. Per capita waste generation in major Indian cities ranges from 0.2 Kg to 0.6 Kg. Difference in per capita waste generation between lower and higher income groups range from 180 to 800 gram per day. The urban local bodies spend approximately Rs.500 to Rs.1500 per tone on solid waste for collection, transportation, treatment and disposal. About 60-70% of this amount is spent on collection, 20-30% on transportation and less than 5% on final disposal. (Hilkiah Igoni, M. F. N. Abowei, M. J. Ayotamuno And C. L. Eze (2008)'Waste are of different types such as Food waste, plastic waste, paper waste, solid waste et al. Kitchen waste is a form of food waste i.e. Wet wast. Food waste is an unwanted raw or cooked food discarded during or after food preparation that is no longer fit for consumption or desirable (Nathalie Jean et al., 2009). The two main sources from where a large amount of kitchen waste can be collected are Household and Residential areas. Larger households waste more avoidable food than smaller households; certain types of households (e.g. households with children) appear to waste more food but that is mainly because they contain more people .Single person households waste the most food on a per capita basis. On contrary to accepted wisdom, older people waste as much avoidable food as younger people (1.2kg per person per week); retired households appear to waste less but that is because they tend to be smaller (Lorrayne Ventour, 2008).

Biogas Plant: Anaerobic digestion (AD) is a promising method to treat the kitchen wastes. Anaerobic digestion is controlled biological degradation process which allows efficient capturing & utilization of biogas (approx. 60% methane and 40% carbon dioxide) for energy generation.. (Wastesum et al 2006). Biogas plants are installed at individual family level by Using Deenbandhu model biogas .

The biogas from this type of biogas plants are used by the individual family. The size of these plants is recommended up to 6 m3 per day. (Dr. Sarbjit Singh Sooch et al (2012) Biogas is produced by bacteria through the bio-degradation of organic material under anaerobic conditions. Natural generation of biogas is an important part of bio –geochemical carbon cycle. It can be used both in rural and urban areas. The dumping of food in places and making the places unhygienic can be taken good care of. It adds to the value of such Biogas plants. Using the natural processes like microorganism's kitchen waste & biodegradable waste viz paper, pulp can be utilized. Composition of biogas depends upon feed material also.

II. MATERIALS AND METHODS

Materials Used: 20 litre container, PVC pipe 0.5'' (length ~ 1 m), Solid tape M – seal, Plastic cape (to seal container), Funnel (for feed input), Cape 0.5" (to seal effluent pipe), Pipe (for gas output, I was used level pipe) (3-5 m), 2 Buckets (15 to 20 litre) for collection of gas , Gas burner with nozzle , pH meter. (Suyog Vij & Prof. Krishan Parmanik et al.(2011)

Kitchen Waste used: Tea bags, Turnip, Rotten tomato, Potato Waste Spinach, Onion ,Pea peels , Bread ,Pumpkin, Cheese, Butter, Rotten Apples ,Eggs, banana peels, Paper, Mushrooms ,Cooked meat , Rice. (Dhanalakshmi Sridevi V.1 And Ramanujam R.A Et Al. (2012)

Sample Collection : Collect the waste from kitchen dustbin then put all the collected waste in grinder mixture with water to make slurry of it also add Fresh cow dung then pour the mixture in 20 lit. Digester. (Ranjeet Singh ,S.K.Mandal ,V.K.Jain (2008))
Propotion of the Sample + Water + Cow Dung used in the experiment as follows, (pH – 4.39) ,Waste Material – 6kg ,Water – 7lit. ,Cow dung – 1kg(app.)

Anaerobic digestion ; This biogas plant consists of mainly two parts:

- A digester or fermentation tank with an inlet and outlet chambers for the entry of fermentable mixture (cow dung and water in 1:1 ratio) in the form of slurry into the digester and exit of digested slurry. The outlet would also control to constant volume of slurry in the digester. (Dr. Sarbjit Singh Sooch et al. (2012)
- A gas holder to collect biogas, so formed by fermentation in the digester. It would also help to maintain anaerobic condition in the digester in the digester in which kitchen waste was put gas is formed:
- The outlet of anaerobic digester is the inlet of water bottle.
- When gas is formed pressure will be generated in the mentioned water bottle.
- Now when the pressure is exerted due to gas, the water comes out and is collected in the jar.
- Now we measure the water which we collected by graduated cylinder

III. RESULTS

Economics of Deenbandhu Model Biogas Plant :The economics of all the models of biogas plants (i.e. saving money by using biogas for cooking instead of using other conventional fuels like LPG etc.) during the year 2013 is explained as below : Size of biogas plant taken = 6 m3. (Gurvinder Singh Brar Dr. R. K Khitoliya & Er. Sarbjit Singh Sooch (2005)

$$\text{Payback period of the plant} = \frac{\text{Initial investment}}{\text{Annual profit}} = 2.37 \text{ years}$$

At optimum pH, temperature & TS%, the biogas production goes on increasing that is shown in Table 1 & 2. The variability in gas evolution is based upon hydrolysis & acidogenesis stage , which produce bacterial for methanogenesis.It has been seen that the production of biogas goes on decreasing at first week because hydrolysis and acidogenesis reaction in very fast as bacteria utilize the waste more readily.

Table 1 : Biogas production(m^3/kg) v/s days

Biogas production v/s days	*Biogas production in m3*	
1st day	0.51	*AVERAGE BIOGAS PRODUCTION FROM 20LIT. DIGESTER WITH APPROX. 7KG KITCHEN WASTE: 0.535 m3*
5th day	0.21	
10th day	0.57	
15th day	0.63	
20th day	0.65	

As it is a continuous fed digester we put kitchen waste again through the funnel, and fermentation starts within 24hrs , the gas production goes on increasing.

Table 2 : pH and total solid concentration of setup.

Day	pH	TS %
1st day	6.9	12
5th day	5.83	10
10th day	7.18	12.34
15th day	7.52	12.97
20th day	7.3	12.97
AVERAGE	6.93	12.35

IV. DISCUSSION

Graph Analysis – it can be seen from the graph that gas production decreasing first upto 6days but then it starts increasing as acid concentration increasing in the digester and pH decreasing below 6.8, after 6days slurry of kitchen waste added to dilute which increases the pH, gas production starts increasing.

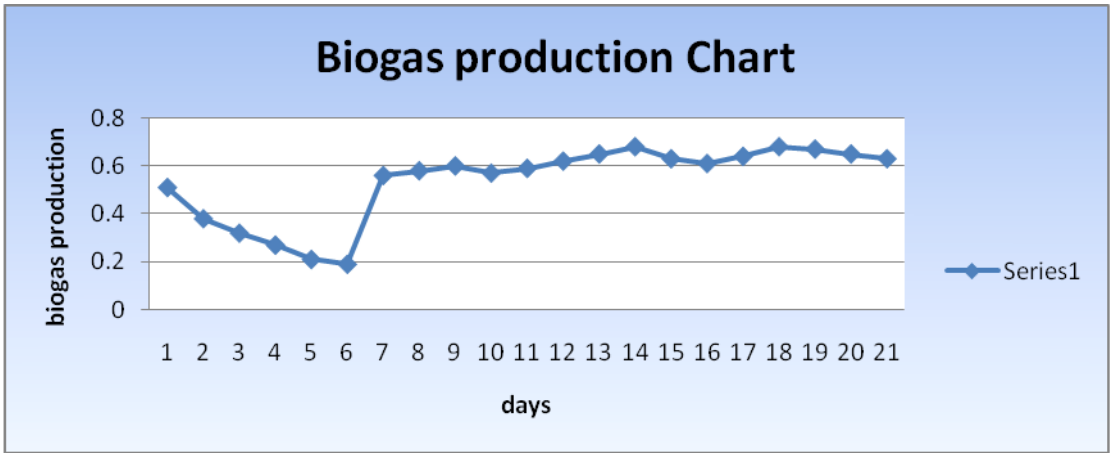

Fig. 1: Gas production m^3/kg V/s days

pH

Graph Analysis - Acid concentration greatly affects the biogas production. Hydrolysis and Acidogenesis reaction is very fast as bacteria utilize the waste more readily so gas production decreasing.

Simplification of process is as follows:

Acidogenesis reaction – Fast

pH – Decreases

Gas production – Decrease

(And vice-verse all the above increases the gas production)

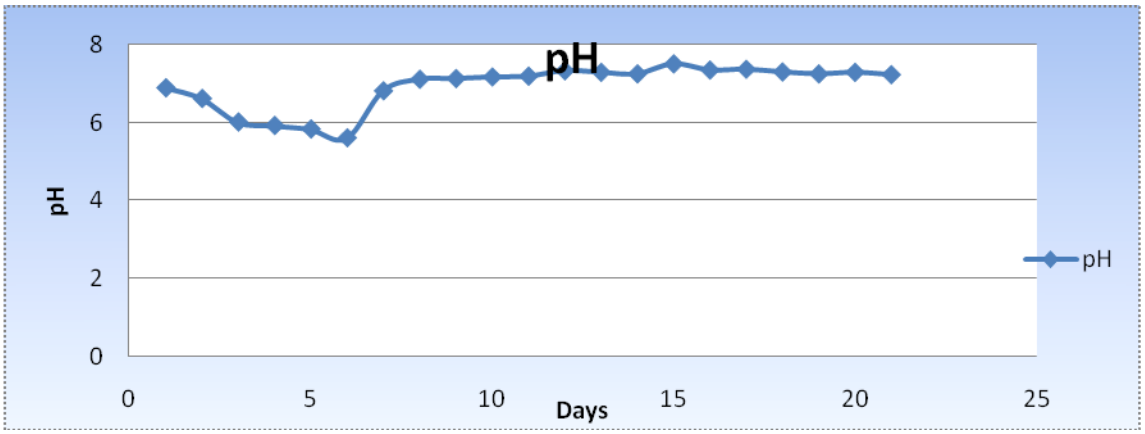

Fig 2 : variation in pH V/s days

TS%

Graph Analysis - Acid concentration greatly affects the biogas production. Methanogens reaction is very fast as bacteria utilize the waste more readily so gas production decreasing. Simplification of process is as follows: Methanogens reaction – Fast TS% – Decreases
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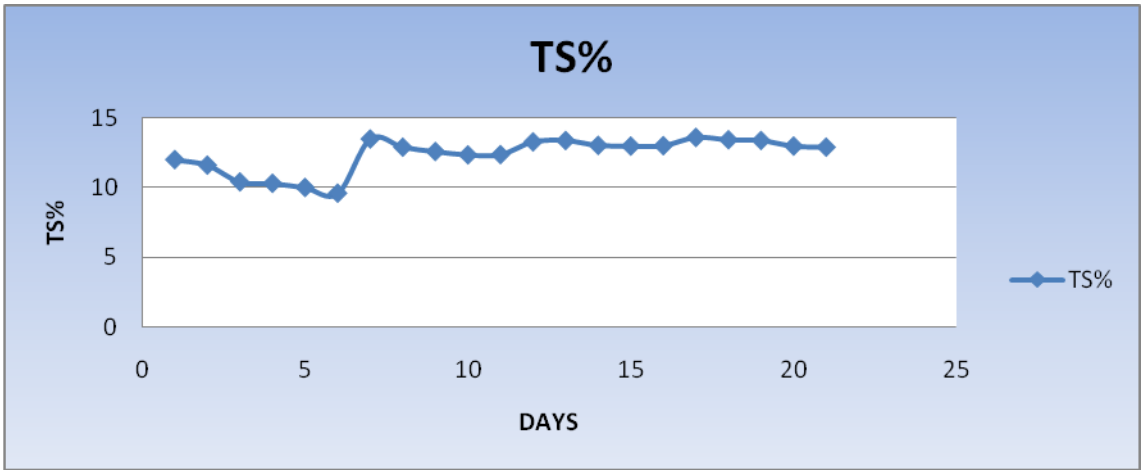

Fig 3: variation in TS%

Temperature: Methane microorganisms are very sensitive to temperature changes; a sudden change exceeding 3°C will affect production, therefore, one must ensure relative stability of temperature. Optimum temperature for biogas production is 35°-45°C. It is the temperature, prevailing inside the digester.

V. CONCLUSION

The study has shown that Kitchen Wet Waste is useful and can be utilized for energy generation. The study has also shown The Treatability of Waste through Anaerobic Digestion & Economics of the Biogas plant for a middle class family. The efficient disposal of kitchen waste can be ecofriendly as well as cost effective. Deenbandhu biogas plant is Economical plant, Payback period of this plant is 2 and half year only. The initial investment cost is only Rs27000/-. Place for such kind of plant at homes is 424sq. ft, which is easily available at backyard of home. 12kg of kitchen waste was produced 1m³(app.) of gas per day if there is ambient environment like optimum temperature conditions, pH , TS% i.e. 37˚C , 6.8 & 12%.

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REFERENCES

[1] A. Singh and K. Hayashi. Microbial cellulase, protein architecture, molecular properties and biosynthesis. Adv. Appli. Microbiol. 40:1-44 (1995)
[2] Manmeet Kaur & Dr. S Arora Isolation and Screening of Cellulose Degrading Bacteria in Kitchen Waste and Detecting Their Degrading Potential Journal of Mechanical and Civil Engineering 33-35(2012).
[3] Nathalie Jean-Baptiste,2009,People & Food waste-The practice of everyday life;
[4] Wastesum (2006). Management and Valorisation of Solid Domestic Waste for the Small Urban Communities in Morocco, LIFE-3rd Countries, 2007-2009.
[5] Dr. Sarbjit Singh Sooch (2012) Hand Book-Ready–Recknor Of Biogas Technology, School Of Energy Studies For Agriculture Punjab Agriculture University Ludhiana.
[6] Suyog Vij & Prof. Krishan Parmanik(2011) Biogas Production From Kitchen Waste ,Bachelor Of Technology Seminar Report For Nit Rourkela.
[7] Gurvinder singh brar Dr. R. K Khitoliya & Er. Sarbjit Singh Sooch (2005) ,to study the economics and performance of biogas plants using different feed materils. M.E Student Thesis Report ,PEC University Chandigarh.
[8] Dhanalakshmi Sridevi V.1 And Ramanujam R.A Et Al. (2012) Biogas Generation In A Vegetable Waste Anaerobic Digester : Analytical Approach ,Research Journal Of Recent Science 41-47
[9] Establishment of Waste Network for sustainable solid waste management planning and promotion of integrated decision tools in the Balkan Region (BALKWASTE) LIFE07/ENV/RO/686
[10] Fruit And Vegetable Waste Utilization, Science Tech ntrepreneur January (2007).
[11] Handbook On Biogas Utilization, 2nd Edition Muscle Shoals.
[12] Hilkiah Igoni, M. F. N. Abowei, M. J. Ayotamuno And C. L. Eze (2008), Effect Of Total Solids Concentration Of Municipal Solid Waste On The Biogas Produced In An Anaerobic Continuous Digester.
[13] Ranjeet Singh ,S.K.Mandal ,V.K.Jain (2008) development of mixed inoculum for methane enriched biogas production..