A Study of Biogas Production from Different Kitchen Waste

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Abstract

The proper management of solid waste is the need of the time. The solid waste consists of various components, some of them are biodegradable where as other are non biodegradable. The waste from various biodegradable sources could be utilized as a feed material for the gas production. The objective of this study is food waste management through biogas production. Various parameters were studied during biogas production like total solid, pH, suspended solid, biological oxygen demand, and chemical oxygen demand. The present study is helpful to set up small scale biogas plant with locally available waste material.

Keywords: anaerobic digestion, biogas, kitchen waste, renewable energy, solid waste management.

Introduction

Waste minimization and energy generation is the recent emerging concepts. The conventional energy resources are declining now a days, hence a suitable substitute for conventional resources are being explored. Girls hostel of Govt. Engineering College Ujjain typically produce solid waste 0.4-0.5Kg /person /day. Solid wastes can be used for production of biogas. Biogas comprises of 68% methane, 31% carbon di oxide, 1% nitrogen, It also forms a combustible mixture in range of 6% to 15% concentration in air.Anaerobic digestion is a known process to treat organic wastes. Resource recycling and energy saving systems for processing organic solid waste in urban areas need to be established. The advantages of such processes over conventional aerobic processes are low energy requirement for operation, a low initial investment cost and a low sludge production.

Food waste (falls into a broader category of biodegradable waste) means all sorts of food wastes coming from restaurants, catering facilities and as well as home kitchens. Kitchen waste makes up a significant part of biodegradable waste and thus it should be further processed.The present study is concerned with the alternative energy production from solid waste especially food waste. The objectives of present work are to investigate the potential of food waste in terms of biogas production and organic matter degradation. The alternative energy resource is the need of time but as the management of solid waste is a big problem.

Objectives

i) To generate energy from waste .

ii) To study the different physical and chemical parameters of food waste.

iii) Comparison of biogas from conventional resources.

Material 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) , 1 Buckets (15 to 20 litre) for collection of feed material ,1 water filled container(for gas collection) Gas burner with nozzle , pH indicator.

Kitchen Waste used: Rotten tomato, Potato Waste Spinach, Onion ,Pea peels , Bread ,Pumpkin, Butter, Rotten Apples, banana peels, Paper ,cooked Rice, and other vegitables and fruits are used.

Sample Collection: the waste from kitchen dustbin of girls hostel are collected then puted 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.

Proportion of the Sample + Water + Cow Dung used in the experiment as follows, (pH – 6.8)

Waste Material – 6kg ,Water – 7lit. ,Cow dung – 1kg(app.)

Experimental set up : A laboratory scale plant was set up for the study purpose .Experiment were carried out in 20L digester constructed using a plastic container with two opening .The opening is drilled and fixed with valve . First opening is used for inlet input material and second for output digested material .The other opening was drilled to enable the biogas to flow from the digester .The opening was connected with a 0.5 inch diameter .Rubber piping to a water container where biogas push the water and by displacement of water we can observe level of gas produced .

The digester was operated at room temperature varying from 25^0c to 36^0c and pH ranged to 5.5 to 8.5 throughout experiment with constant feed 7Kg kitchen waste.

Analytical Method: The substrates were analyzed at the specific intervals for the biogas production. Prior to anaerobic digestion process, the food waste sample was analyzed for pH , BOD, TS, TSS, COD, Temp . Table 1 reports the initial loading conditions for the substrate . pH , BOD, COD, were determined.

Table 1: Initial characteristics of various parameters of all the substrates

Parameter	Food waste substrate
pH	6.8
Temperature	28^0c
Total Solid (gm/lit)	85.142
COD (mg/lit)	3000
Bod (mg/lit)	130
Alkalinity (mg/lit)	500

Table 2: volume of gas generation, Temperature, pH concentration of substrate

Parameter	Days	Substrate
pH	1	6.8
	5	5.83
	10	7.18
	15	7.52
	20	7.3
	25	7.16
Temperature	1	28^{o}c
	5	25^{o}c
	10	28^{o}c
	15	29^{0}C
	20	31^{0}C
	25	32^{0}C
Vol. of biogas produce in ml	1	-
	5	400
	10	8500
	15	8600
	20	10650
	25	10900

Result and Discussion:

At optimum pH, temperature & TS%, the biogas production goes on increasing that is shown in Table 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 is very fast as bacteria utilize the waste more readily.

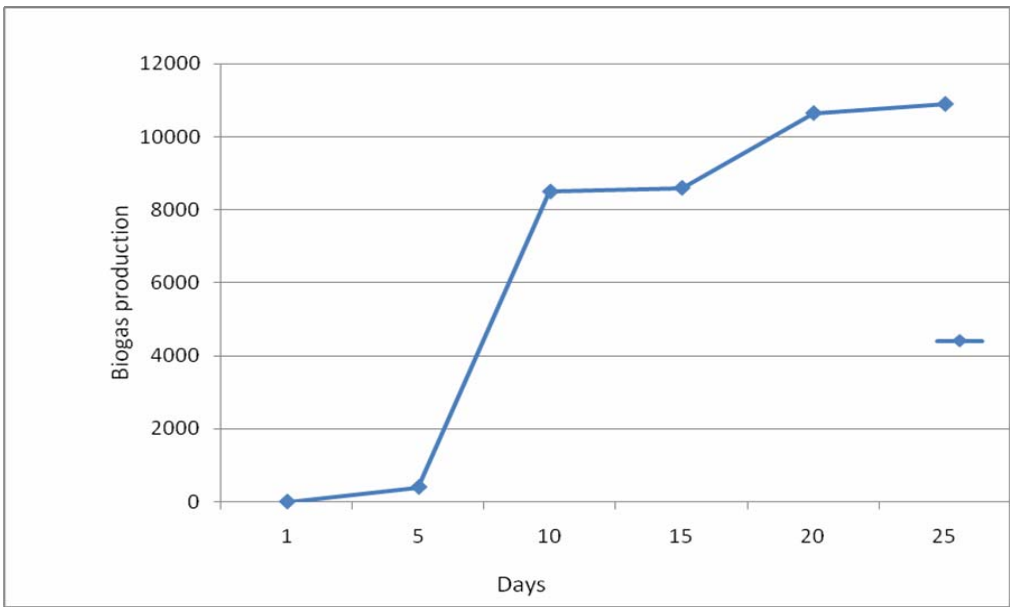

Fig. 1: Gas production ml V/s days

Graph Analysis

It can be seen from the graph that gas production is less 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.

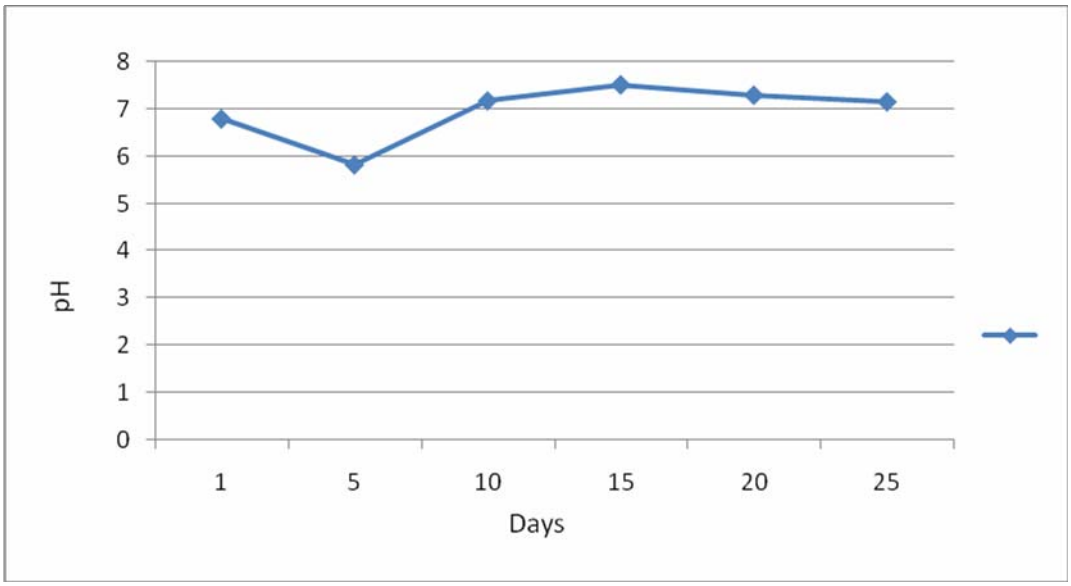

Fig-2 variation in pH v/s days

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).

Conclusion:

Study revealed that the gas generation directly depends on the initial characteristics of the substrates. The results indicate that the food waste is the best source of methane generation due to its biodegradable capacity Biogas production from different food wastes could be enhanced by adopting biotechnological applications. And further study could be carried by various pre treatments of above substrates to gain maximum methane gas production.

References:

[1] Kumar S., Technology options for municipal solid waste to energy project, TERI Information Monitor on Environ. Sc., 5(1), 10-13, (2000).

[2] ENVIS [Urban Municipal Waste Management Newsletter] National Solid Waste Association of India, 12th Issue, (2008)

[3] Park Y.J., Hong F., Cheon J.H., Hidaka T. and Tsuno H., Comparison of Thermophilic anaerobic digestion characteristics between single –phase and Two phase systems for kitchen garbage treatment, J. Biosc. and Bioeng., 105(1), 48-54, (2008).

[4] Kim J.K., Oh B.R., Chun Y.N. and Kim S.W., Effects of Temperature and Hydraulic Retention Time on Anaerobic Digestion of Food Waste, J. Biosc. and Bioeng., 102(4), 328-332, (2006).

[5] Bouallagui H., Ben C.R., Marouani L. and Hamdi M., Mesophilic biogas production from fruit and vegetable waste in a tubular digester, Bioresource Techn., 86, 85-89, (2003).

[6] Uemura S. and Harada H., Treatment of sewage by a UASB reactor under moderate to low temperature conditions. Bioresource Techn., 72, 275-282, (2000).

[7] Gosavi P. G., Mirashi A.S., Waghmare A. S. and Singh R., Biogas and marine boaed using waste green leaves, J. Environ. Res. Develop., 4(3), 695-704, (2010).

[8] Milan Z., Sanchez E., Weiland P., Borja R., Martin A. and Ilangovan K., Influence of different natural zeolite concentrations on the anaerobic digestion of piggery waste, Bioresource Tech., 80, 37-43, (2001).

[9] Beno Z., Boran J., Houdkova L., Dalabaja T. and Sopnar J.. Confermentation of kitchen waste with sewage sludge, Chem. Eng. Trans., 18, 677-682, (2009).

[10] APHA, AWWAWPFC, Standard methods for the examination of water and wastewater, Seventeenth Edition, Washington, DC (1989).

[11] Buekens A., Energy recovery from residual waste by means on anaerobic digestion technologies, proceedings from The future of residual waste manag. Europe, (2005).

[12] Park Y.J., Tsuno H., Hidaka T. and Cheon J.H., Evaluation of operational parameters in thermophilic acid fermentation of kitchen waste, J. Mater Cycles Waste Manag., 10, 46-52, (2008).