International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

EFFECT OF DIFFERENT PARAMETERS ON BIO-GAS PRODUCTION

Maninder Kaur[1] , Sanchita Chauhan[2]

[1,2]Dr.SSBUICET, Panjab University,Chandigarh

ABSTRACT

The concern of energy security, threat to climate change and fear of depletion of fossil fuels have all stimulated investment in the development of alternative energy sources. Biogas is one of the means to obtain the energy security and thus an important step for sustainable development and helps in reducing poverty in developing countries such as India. As fossil fuel resources are limited and energy demand is high, this gap can be met with energy generation from alternate energy resources. Biomass is considered as valuable energy source to the fossil fuels world-wide because it can be converted into various available forms of energy, such as heat, biogas etc. Extensive research is going on world-wide to fully utilize the biomass potential. However, several factors influence the performance of biogas generation from biomass which are discussed here in this paper.

I. INTRODUCTION

India being one of the largest agriculture based country has an abundance of biomass resources. The agriculture waste produced here has not been properly used for bioenergy production because of undeveloped conversion technology. Instead ,they are burnt or dumped directly into fields causing serious environmental problems and degrades the soil conditions [1,2]. This concern has stimulated researchers to develop economically viable and environmental friendly alternatives to fully utilize the available biomass into useful forms of energy. It has been reported that biomass supplies 14% of the world's energy and research is still ongoing on to increase the role of biomass in overall energy system.

The process of biogas production through anaerobic digestion has received good attention from several scientist and farming communities. The anaerobic digestion is a natural biological process using naturally occurring micro-organism to breakdown organic matter into valuable fertilizer along with production of biogas. The anaerobic bacteria utilized in this process are commonly found in soil and deep water [3,4]. The three stages of biological anaerobic digestion process can be described as:

Hydrolysis – Hydrolysis is splitting of a compound with water. Carbohydrates, fats and proteins undergo hydrolysis to break up into smaller more soluble molecules. The liquefaction of complex compounds has great effect on the rate of digestion process.

Acetogensis – Acetogentic bacteria convert the hydrolysis product into fatty acids and produces acetate, CO_2 and H_2 .

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 01, January 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

Methanation – Methane is finally produced by methanogenic bacteria by breaking down the acetic acid and volatile fatty acids molecules. The metanogenic bacteria produces biogas comprising of methane, carbon dioxide and other traces of elements.

In order to complete all the above said stages , the anaerobic bacteria requires a suitable environment. Several techniques have been followed to promote methane production. It was observed that biogas production is greatly influenced by various factors such as: C/N ratio , temperature , pH value , hydraulic rentention time and pretreatment of the agro waste .

II. EFFECT OF CARBON/NITROGEN RATIO

Carbon to nitrogen ratio plays an important role in biogas production. The C:N ratio of the biomasses varies widely between 32 to 82:1, whereas the amount of cattle dung ranges from 21.8:1. It has been observed during various studies that during digestion process micro-organism utilizes carbon 25 to 30 times faster than nitrogen. Studies conducted on the characterization of biomasses shows that the mixing of lignocelluloses biomasses with cattle dung reduces the C:N between 25-30:1[5,6,7] indicating fairly good potential to generate biogas. So, the optimum ratio of C/N to produce maximum biogas has been observed to be between 25:1 to 30:1.

III. EFFECT OF TEMPERATURE

Temperature plays a critical role in the anaerobic digestion process, it has a strong influence not only on the quality but also on the quantity of biogas production. Figure 1 shows the three temperature ranges i.e cryophiles , mesophiles & thermophiles. Anaerobic digestion mainly takes place at either mesophilic temperature or at thermophilic temperature [7,8]. The microorganisms participating in the process of anaerobic digestion (especially methanogenicones) , are divided into three large categories:

• Cryophiles (Psychrophiles), operating at temperatures from 12 to 24°C,
• Mesophiles, operating at temperatures between 22-40°C
• Thermophiles, operating at temperatures between 50 – 60°C.

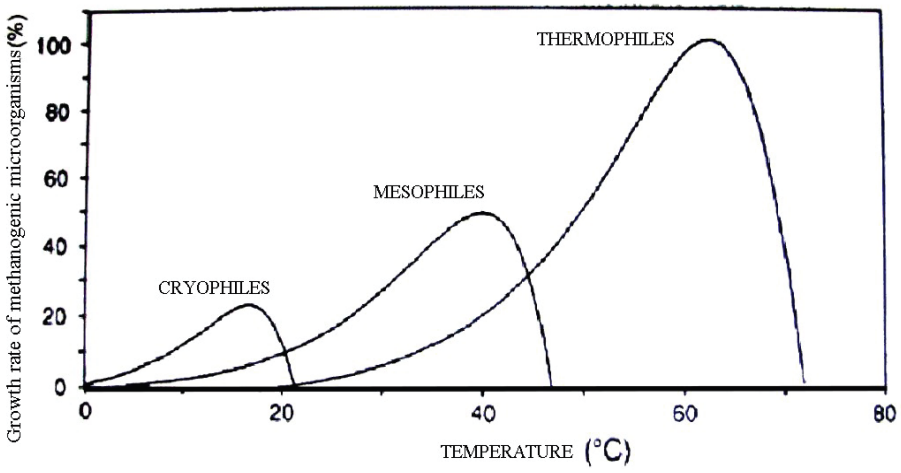

Fig.1 The growth rate of methanogenic bacteria for three different temperature ranges.

ISSN (O) 2454-9665
ISSN (P) 2454-0663

It has been observed that biogas production at thermophilic temperature was highest from fig.1. Thermophilic bacteria are most active in the range between 50-60^0 C [9,10]. Choice between the msophilic and thermophilic fermentations is governed by natural climatic conditions in which plant is located. Though it is possible to create the conditions for thermophlic fermentation by external heat, but as such this method has generally proved to be uneconomical.

IV. EFFECT OF PH VALUE

An optimum biogas production is observed when pH value of the mixture in digester varies between 6.25 to 7.50 [8,9]. During anaerobic digestion, microorganism requires a natural or mildly alkaline environment for efficient gas production. Methanogenic bacteria are very sensitive to pH value and do not thrive below a pH of 6.5. The pH value in a biogas digester is also a function of retention time. As the digestion process continues, the concentration of ammonia increases due to digestion of nitrogen which can increase the value of pH to above 8. During the period when ambient temperature ranges between 18 to 20^0 C i.e for cryophilic conditions, it takes approximately 14-18 days for pH value to attain a stable value.

V. EFFECT OF HYDRAULIC RETENTION TIME (HRT)

Hydraulic retention time is the average period that a given quantity of input materials remains in digester to be acted upon by methanogenes. HRT depends upon the temperature in digester, higher the temperature of the digester lower the retention time. HRT usually varies between 20 to 120 days, depending upon the design and operating temperature of the digester. In India, HRT is usually taken as 40-60 days and in colder countries digesters are designed for HRT of about 100 days. Figure 2 [10,11] it is seen that gas production increases from 2nd to 4th week after which rate decreases upto 6th week then increase till 7th week. This may be attributed to lowering of atmospheric temperature thereby decrease in gas production after 7th weeks, however, in confined environment keeping the temperature constant, the time to obtain gas may be prolonged.

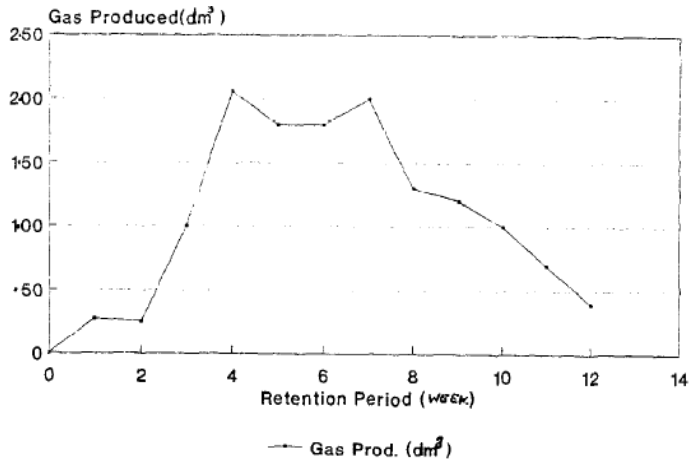

Fig. 2 Effect of HRT on biogas production

ISSN (O) 2454-9665
ISSN (P) 2454-0663

VI. EFFECT OF LOADING RATE

Loading rate is defined as the amount of raw materials fed per day per unit volume of digester capacity. If the plant is overfed, acids will accumulate and methane production will be inhibited since micro-bacteria cannot survive in acidic situation on the other hand if plant is underfed even then production will be low because of alkaline solution which is also not favourable condition for anaerobic digestion [5,12].A daily loading rate of 16 kg of volatile solids per m^3 of digester capacity produces 0.04-0.074 m^3 of gas per kg of raw dung fed[13] . Higher loading rates are recommended only in cases where mean ambient temperature is high.

VII. EFFECT OF DILUTION

According to the findings of TERI , fresh cattle waste consists of approximately 20% total solid (TS) and 80% of water. Total solids consists of 70% volatile solids and 30% of fixed solids. For optimum gas production through anaerobic digestion 8-10% of total solids in the feed are required [5]. This can be achieved by making slurry of fresh cattle dung in water in ratio 1:1. If the dung is too diluted then the solid particles will settle down in digester and if it is too thick, the particles impede the flow of gas formed at lower part of digester. In either case the gas production will be less than the optimum value.

VIII. CONCLUSION

India has huge potential of renewable energy sources from biomass which is burnt in the farms resulting in environment pollution due to lack of knowledge of the farmers. Whereas biogas technology has significant potential to mitigate several problems related to health, energy security and environment pollution. It is evident from the above discussion that the biomass can be efficiently converted into biogas through anaerobic digestion in which bacterial degradation of organic matter occurs in the absence of oxygen resulting in production of methane and carbon dioxide. Anaerobic digestion is a bacterial activity is influenced by several factors such as temperature, C:N ratio, HRT , pH value of slurry etc. and for optimum gas production these factors should be regulated properly. The fluctuation of temperature has very high impact on biogas production , as in north-eastern India there are drastic fluctuations in day and night temperature during winter season, so the temperature has to maintained at a constant value for efficient gas production.

REFERENCES

[1] Kumar A., Kumar N., Baredar P., Shukla A., A review on biomass energy resources, potential, conversion and policy in India, Renewable and Sustainable Energy Reviews ,45, 2015, 530–539.
[2] Ravindranath NH, Hall DO. Biomass energy and environment. Oxford: Oxford University Press; 1995.
[3] MNRE annual report 2012–13. NewDelhi: Ministryof New and Renewable Energy; 2012–13.
[4] Qasim, S.R., Warren, K. and Udomsinrot, K., Methane Gas Production from Anaerobic Digestion of Cattle Manure, Energy sources : An Interdiciplinary International Journal of Science and Technology,

ISSN (O) 2454-9665
ISSN (P) 2454-0663

7(4), 1985, 319-341.

[5] Mahanta P., Saha U.K., Dewan A., Kalita P., Buragohain B., Biogas Digester: A Discussion on Factors Affecting Biogas Production and Field Investigation of a Novel Duplex Digester, Journal of the Solar Energy Society of India, 15(2), 2005, 1-12.

[6] Ghatak M., Mahanta P., Kinetic Assessment of Biogas Production from Lignocellulosic Biomasses, International Journal of Advanced Technology, 3(5), 2014, 244-249.

[7] Tanimu I., Ghazi I., Harun M., Idris A., Effect of Carbon to Nitrogen Ratio of Food Waste on Biogas Methane Production in a Batch Mesophilic Anaerobic Digester, International Journal of Innovation, Management and Technology, 5(2), 2014, 116-119.

[8] Sambo A.S., Garba B., Danshehu B. G., Effect of some Operating parameters on Biogas Production Rate, Renewable Energy, 6(3), 1995, 343-344.

[9] Mahanta P., Saha U.K., Dewan A., Kalita P., The Influence of temperature and total solid concentration on the gas production rate of biogas digester, Journal of Energy in Southern Africa,15, 2004, 112-117.

[10] Dorbe P., Nicolae F., Matei F., Main factors affecting biogas production – an overview, Romanian Biotechnological Letters, 19(3), 2014, 9283-9296.

[11] Garba B., Effect of temperature and retention period on biogas production from lignocellulosic material, Renewable Energy, 9(1-4), 1996, 938-940.

[12] Srivastava, V.J. and Chynoweth, D.P., Kinetic Analysis of Biogasification of Biomass, Waste Blend and Its Engineering, Significant Energy from Biomass and Wastes, 1987, 1021-1034.

[13] Moharao, G.J., Scientific Aspects of Cow Dung Digestion, Khadi Gramodyog, 20 (7), 1974, 340-347.