Asian J. Exp. Sci., Vol. 23, No. 1, 2009; 95-98

Biogas production from Sludge of Sewage Treatment Plant at Haridwar (Uttarakhand)

D. S. Malik and Umesh Bharti
Department of Zoology and Environmental Science,
Gurukula Kangri University,
Hardwar-249404 (U.P.); India.

Abstract : Biogas, a source of non-conventional energy is produced by fermentation of sludges. The sewage have collected through sewage pumping stations and treated in the primary and secondary treatment steps in sewage treatment plant at Jagjitpur, Hardwar. The Sewage Treatment Plant receives approximately 40 mld sewage from different pumping stations and 18 mld sewage is used for treatment at sewage treatment plant. Raw sewage consists of organic and inorganic solids in dissolved and suspended form with 90-99.9% of water. After treatment, huge amount of solid waste remains as sludge left with the treated water. Around $96X10^5$ liters liquid sludge is being collected per day. In this process, the organic fraction of the waste is segregated and fed into a closed container, called biogas digester. Segregated waste undergoes biodegradation in the presence of methanogenic bacteria produce methane-rich biogas known as Biomethanation. Sludge from the anaerobic digestion can be used as a soil conditioner or composting. The present study was focused on biogas production from 1kg of sludge received 0.6 m^3 volume on calculating value. The maximum biogas production was observed in volume 84952.34 m^3 during summer and minimum volume of gas production was observed during winter as 76252.81 m^3 in 2008.The biogas is used as energy source for running the all devices of treatment plant and others as lighting, laboratory works etc.

Key words : Biomethanation, Biocomposting, Biogas, Sewage, Sludge

Introduction

The pressure has been increased on the conventional source of energy due to continue requirement of energy that increased the importance of renewable & non-conventional source of energy. On the other hand due to burning of fossil fuel chances of Global warming is also increased by which most of the countries attract towards the importance of non-conventional source of energy. Bio-energy production based on decomposition of sludge material definitely is helpful in solving the problem of energy crisis in the house hold of staff/ laboratory at site and to remove some pressure from the conventional sources of energy (Mukharje, 2007). The sewage treatment plant at Hardwar, received 18 mld sewage from thirteen pumping station through out the Hardwar district. In this treatment plant sewage is being treated and remaining residue (sludge) being used as slurry, which have high volume of TS and VS. The sludge is being thickened in thickener and pumped to digester tank. In the anaerobic digester tank, microbial activity takes place and produces 55-65% methane with the other gases, (CO_2, H_2S). This is called as Biomethanation process. Biogas is an environmental friendly, clean & cheap fuel. It is produced by the fermentation process in the dome type digester tank. The equipment (container) in which produced gas is being stored, called as Gas Holder. In converting biogas to electrical energy using gas-engine generators, the appraisal was based on the

*** Corresponding author :** D. S. Malik, Department of Zoology and Environmental Science, Gurukula Kangri University, Hardwar-249404 (U.P.); India; E-mail : *dr.d.s. malik@gmail.com*

biogas consumption of 0.50 m^3 (kWh)-1. On the other hand, 1 kWh of electricity would be generated by 0.34 L diesel (Salam, 1985).

Materials and Methods

The Sewage Treatment Plant has capacity to treat 18 mld sewage from main pumping station. After primary and secondary treatment, sludge is remain left that is being collected in thickener and around $96X10^5$ liters sludge is being drained from thickener to digester tank at each 12 hrs. The sludge was taken from thickener and digester tank and Temperature, pH, Total solids %, Volatile solids %, and Alkalinity parameters were analyzed with the help of the procedure described by APHA (1998). Nutrients, as NPK were also analyzed by Trivedy and Goel, (1988).

Results and Discussion

The biogas is an environmental friendly source of energy. It is a by-product of anaerobic decomposition of organic matter, consists mainly of methane, carbon dioxide and trace amounts of ammonia, hydrogen sulfide and other gases. The present study was done in the months of winter and summer and the sampling were done seasonally from the sewage treatment plant. Raw sewage consists of organic and inorganic solids in dissolved and suspended form with 90-99.9% of water. Physical characteristics of digester sludge were recorded at sewage treatment plant, as pH was observed highest 7.06 during summer and lowest 6.89 during winter, total solids % was observed highest in summer 3.42% and lowest in winter 3.04%, Volatile solids% was observed highest 1.46% during summer and lowest 1.26% during winter, Alkalinity was highest 1600 mg/l during summer and lowest 1500 mg/l during winter. Methanogenic bacteria are obligate anaerobes whose growth rate is generally slower than the bacteria. The methanogenic bacteria use acetic acid, methanol, or carbon dioxide and hydrogen gas to produce methane. ***Methanobacterium, Methanoccus and Methanosarcino barkeri*** were methane-producing bacteria, which decomposed the sludge and formed biogas (Prescott and Klein, 2007). The gas production was observed in volume 84952.34 m^3 during summer under thermophilic condition and during winter volume of gas production was observed under mesophilic condition as 76252.81 m^3. In this study the concentration of NPK (Ammonical nitrogen 1.08X5 micro gm/gm, Potassium 51.8X10 micro gm/gm and Phosphorous 1.12X10 micro gm/gm) were recorded as nutrient values of dry sludge (Table-1).

Table 1: Nutrient Concentration in Dry Sludge (composting) at sewage treatment plant.

Ammonical nitrogen	1.08 x 5 µg g^{-1} or ppm.
Potassium	51.8 x 10 µg g^{-1} or ppm.
Phosphorous	1.12 x 10 µg g^{-1} or ppm.

Table 2: Seasonally Biogas production (m^3)

Production of biogas seasonally	Amount of biogas production (m^3)	Quantity of sludge	Temperature range (°C)
Winter	76252.81 m^3	96 x 10^5 liters	25-35 °C
Summer	84952.34 m^3	96 x 10^5 liters	25-45 °C

Table 3: Chemical characteristics of Digester sludge at sewage treatment plant.

	Parameters	Winter					Summer			
1	Temperature (°C)	16.5 - 18.7					20.5 - 22.4			
2	pH	6.98	6.97	6.98	6.89	7	6.98	7	7.06	7.02
3	Total solids (%)	3.04	3.08	3.02	2.84	3.08	3.02	3.42	3.06	3.06
4	Volatile solids (%)	1.26	1.32	1.38	1.3	1.42	1.36	1.62	1.4	1.46
5	Alkalinity (mg/l)	1500	1560	1600	1600	1560	1500	1400	1600	1560

According to Lee *et al.*, (1970) also made a study on farm scale Biogas plants which have been designed to process pig slurry of 10 $m^3 day^{-1}$ under mesophilic conditions. In this system, the biogas generation rate was 138-$m^3 day^{-1}$, with 230 kg of volatile solids addition. To produce the electricity, the amount of biogas consumed was 1.8 m^3 per kwh at 5-9 kw power loads. This result showed that renewable energy production with 2000 pig was 216000 kwh yr^{-1}- enough to meet the electricity demands of 100 rural households in Korea. Chanakya *et al.* (1992) utilized major part of SW for biogas production. The digester employed in present study constitutes solid phase acidogenic digester and up flow bed methanogenic digester packed with acid washed granite chips, with the capacity of 2L and 0.5L respectively. Feed rates adopted for this study was 1g TS, increased up to 2g TS / week for 63 days and 102 days respectively. The total 19g TS of urban garbage samples gave rose to 6.37gVFA and 1.73L gas production, showing the utilization efficiency of 33.5%. The revenue to be derived from byproduct utilization in the anaerobic treatment system is associated with energy recovery from the biogas methane generated and nutrient recovery from the digester effluent. Biogas containing 65% methane has a heating value of 22.4 MJm^{-3} reported by Metcalf and Eddy (1991), while the calorific value of diesel or fuel oil is 34.5 MJL-1.

Hamzawi et al. (1998) evaluated the technical feasibility of the anaerobic co-digestion of sewage sludge with the organic fraction municipal solid waste. Using biological activity tests, an optimal mixture was identified with 25% organic fraction of municipal solid waste and 75% sewage sludge based on biogas production.

The municipal garbage is a high potential bioenergy source and it can be effectively utilized for biomethanation process. Results showed that biogas yield of 0.661m^3/kg VS, indicating the high biodegradability of the feed. This yield was found to be 2.5 times the yield obtained from the cattle dung, indicating that anaerobic conversion of municipal garbage to biogas is a suitable option for commercial energy production reported by Rao *et al.*, (2000). In contrast to the biological stability the use of biodegradable organic waste is advantageous in terms of the biogas yield. A comparison of biogas yields per ton of feedstock material between cow manure and kitchen waste revealed that municipal sewage waste potentially generates several times more biogas than cow manure. So finally biogas can be produced by adding other materials to get the energy and used for various applications, such as for cooking, lighting, electricity production etc, if the proper maintenance of the plant is regularly be done and keeping the view in mind to develop the non-conventional sources of energy.

References

APHA (1998): Standard methods for teh examination of water and wastewater. 20th ed. American

Public HealthAssociation, 1015, fifteen street, New Washington, **15**, 1-1134.

Chanakya H.N., Borgaonkar S., Rajan M.G.C. and Wahi M. (1992): Two-Phase anaerobic digestion of water hyacinth or urban garbage. *Bioresource Technology*, 123-131.

Hamzawi N., Kennedy K.J. and Mclean D.D. (1998): Anaerobic digestion of commingled municipal solid waste and sewage sludge. *Water Science and Technology*, **38**, 127-132.

Lee Jong-Sik, Woo-Kyun P., Dong-gyu lm and Mun-hwan kho (1970): Biogas production from Pig Slurry in Korea, NIAST, republic of Korea pp 251-260

Metcalf and Eddy (1991): *Wastewater Engineering: Treatment, Disposal and Reuse*, Tchobanoglous, G.; and Burton, F.L. (Eds.) New York: McGraw-Hill. pp 826.

Mukharje P.K. (2007): Biogas an energy source for future. In: Aavishkar magazine, July pp 20-24.

Prescott, Harley and Klein's (2007): Waste water treatment process, Applied and industrial Microbiology, pp.1055-61.

Rao M.S., Singh S.P., Singh A.k. and Sodha M.S., (2000): Bioenergy conservation studies of the organic fraction of MSW: assessment of ultimate bioenergy production potential of municipal garbage. *Applied Energy*., **66**, 75-87.

Salam B.A. (1985): The contribution of the oil palm by-products towards the national energy policy – an economist point of view. In: *Proceedings of the National Symposium on Oil Palm By-Products for Agro-based Industries*, Kualalumpur, Malaysia. Bangi: Palm Oil Research Institute of Malaysia. pp 133-145.

Trivedy R.K.and Goel P.K. (1988): In: chemical and biological methods for water pollution studies. Environmental Publication, Karad (India) pp 251.