Asian Journal of Chemistry Vol. 19, No. 5 (2007), 3435-3439

Biogas from Organic Waste Diluted with Sugar Mill Waste Water

ANJALI GOEL*, MANU and SAVITA GUPTA
Department of Chemistry, Kanya Gurukul Mahavidyalaya
Gurukul Kangri University, Hardwar-249 407, India

The biogas production depends on various factors, such as charactersitcs of feed components, ratio of blending of feed components, type of water used, pH and temperature, *etc*. In the present studies, rice straw and cow dung are used as feed components. The gas production was recorded weekly. It has been observed that with the increase of rice straw blending, the rate of gas production increases. In the next series of experiments, the gas production blended with cow dung, rice straw and distilled water/sugar mill eflluent has been carried out. It is observed that digesters blended with distilled water show minimum gas production as compared to others with Deoband, Khatauli or Uttam sugar mill effluent. The characteristics like total solids, volatile solids, carbon, nitrogen, C/N ratio and protein contents of feed component have been studied initially and after 4 weeks. The results show a decrease in the values of all the characteristics. The effect of pH has also been studied in the pH ranges of 5 to 9. The results indicate that for biogas production pH-7 is most suitable. The amount of CO_2 produced in biogas was estimated volumetrically.

Key Words: Biogas, Sugar mill effluent, Blending, Cow dung, Rice straw.

INTRODUCTION

Recently, there has been an increasing interest in using anaerobic fermentation to produce biogas as an alternative energy source[1,2]. To utilize animal and other low moisture content organic wastes as feed stocks for biogas production, a slurry containing an appropriate solid concentration (5-10 %) should be normally prepared. This is usually done by mixing the waste with water. Depending on waste type considerable amounts of water is needed for slurry preparation. In some regions the fresh water sources are either scanty or costly. While plenty of industrial effluent are available having large amount of organic wastes. Gamel-el-Din[3] has showed an increase in biogas production rate by diluting with sea water below an inhibitory level. In the present studies, rice straw and cow dung diluted

with sugar mill effluent for feeding biogas digester was used in zero to hundered per cent ratio. The effluent of three sugar mills namely-Deoband, Khatauli and Uttam sugar mill was used for this purpose.

EXPERIMENTAL

The required quantities of cow dung and 1 mm sieved rice straw were mixed with sufficient amount of distilled water or effluents to give 10 % solid concentration in slurry. The pH of the digester content was adjusted to 7. The digester were anaerobically incubated at room temperature for 28 d. The volume of the gas produced was noted weekly by water displacement method[4]. The gas was assayed for CO_2 % after the completion of the experiments[5]. CO_2 was determined volumetrically by injecting the biogas in concentrated solution of sodium hydroxide. The unused hydroxide was titrated with standard hydrochloric acid solution. The feed components and feeding mixture were analyzed for their characteristics like total solids, volatile solids, carbon-nitrogen, C/N ratio and protein content[6].

RESULTS AND DISCUSSION

The biogas production depends on various factors, such as characteristics of feed components, ratio of blending of feed components, type of water used, pH and temperature, *etc*. To study the effect of feed components 5 digesters were set up having the blending of rice straw with cow dung 00% in D_1 digester, 25 % in D_2, 50 % in D_3, 95 % in D_4 and 100 % in D_5 digester. Same type of digesters were set up with all the 3 sugar mills effluents. The characteristics like total solids, carbon, nitrogen, C/N ratio and protein contents of feed components have been studied initially and after 4 weeks. The results show a decrease in the values of all the characteristics. C/N ratio initially is equal to or higher than the prescribed value[7] of 30, but after 4 weeks it decreases and some times it becomes less than 30. It is also supported by low biogas generation in the 4th week (Table-1).

The effect of composition of substrate on biogas production is also studied using effluent of each sugar mill. The data are presented in Table-2. The results show that the gas production in D_4 and D_5 digester are much higher than D_1 and D_2. In digester D_1 and D_2, the highest gas production is in 2nd week while in D_3 to D_5, it is in the 1st week. Thus as the percentage belnding with rice husk increases. The rate and amount of gas production also increase (Figs. 1 and 2).

In the next series of experiments the gas production blended with cow dung, rice straw and distilled water/sugar mill effluent has been carried out. It is observed that digester with distilled water show minimum gas production as compared to others with Deoband, Khatauli or Uttam sugar mill effluents (Table-3).

TABLE-1
CHANGES IN CHARACTERISTICS OF SUBSTRATE OF D_4 DIGESTER AFTER ANAEROBIC DIGESTION OF 4 WEEKS WITH DIFFERENT SUGAR MILL EFFLUENT

Parameters	Deoband sugar mill effluents		Khatauli sugar mill effluents		Uttam sugar mill effluents	
	Initial	Final	Initial	Final	Initial	Final
Solid concentration	88.60	47.30	87.70	60.20	89.60	37.24
Volatile solids	80.30	37.5	84.10	57.40	80.60	35.50
C%	44.61	20.83	46.72	31.88	45.50	19.72
N%	0.88	0.93	0.96	1.09	0.90	0.93
C/N	50.74	22.40	48.50	29.19	50.78	24.06
Protein	5.61	5.95	6.15	6.97	5.72	6.68

TABLE-2
TOTAL GAS PRODUCTION IN D_1 TO D_5 DIGESTERS BELNDED WITH COW DUNG, RICE STRAW AND EFFLUENTS

Digester No.	Blending (%)	Total biogas production (L/kgm of TS)		
		Deoband sugar mill	Khatauli sugar mill	Uttam sugar mill
D_1	0	169	102	162
D_2	25	174	202	195
D_3	50	240	253	238
D_4	75	255	266	253
D_5	100	275	301	277

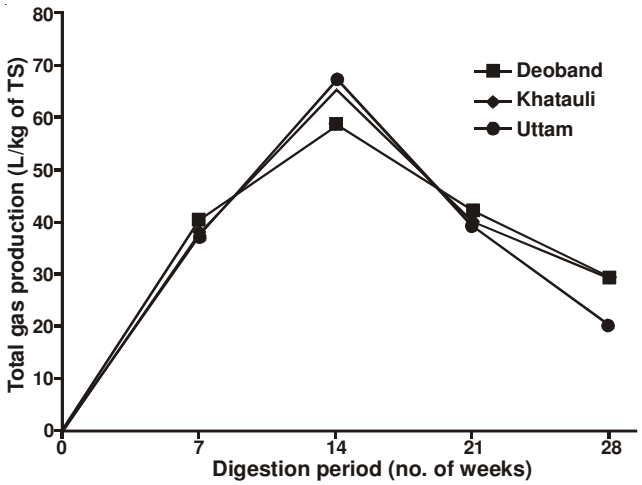

Fig. 1. Weekly gas production by D_1 digester blended with 100 % cow dung, 00 % rice straw and sugar mill effluent at pH 7

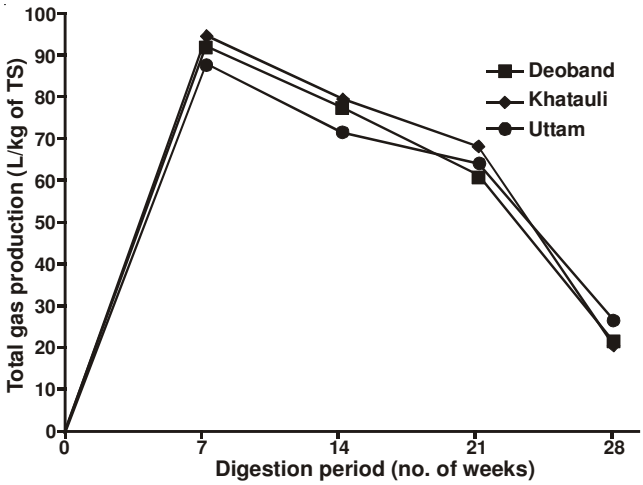

Fig. 2. Weekly gas production by D4 digester blended with 25 % cow dung, 75 % rice straw and sugar mill effluent at pH 7

TABLE-3
COMPARISON OF WEEKLY GAS PRODUCTION BETWEEN DISTILLED WATER AND EFFLUENT WITH COW DUNG

Digester No.	Blending (%)	Weekly gas production (L/kg of TS)				
		No. of weeks when gas production is recorded				
		Ist	IInd	IIIrd	IVth	Total gas production
C_1 (Distilled water)	0	18	47	23	12	100
D_1 (Deoband)	0	40	58	42	29	169
D_1 (Khatauli)	0	38	65	40	29	162
D_1 (Uttam)	0	37	67	39	20	162

TABLE-4
VARIATION IN WEEKLY GAS PRODUCTION WITH pH IN D_4 DIGESTER BLENDED WITH COW DUNG, RICE STRAW AND EFFLUENTS

Sugar mill effluents	pH	Weekly gas production (L/kg of TS)				
		No. of weeks when gas production is recorded				
		1st	2nd	3rd	4th	Total gas production
Deoband	5	34	69	30	25	190
	7	92	78	60	23	225
	9	22	57	18	13	110
Khatauli	5	30	58	28	18	119
	7	95	80	69	22	266
	9	25	47	20	18	110
Uttam	5	32	50	28	12	122
	7	88	72	65	28	253
	9	24	38	20	14	96

The effect of pH has also been studied in the pH ranges of 5-9. The result in Table-4 indicated that for gas production pH value 7 is most suitable. The amount of CO_2 produced in biogas ranges from 26.72 to 35.62 % in case of all the 3 sugar mills. These values are comparable with the reported values of about 30 %[8]. Thus the above study shows that it is better to use sugar mill waste water for slurry preparation in biogas generation.

REFERENCES

1. V. Singhal and J.P. Rai, *Biores. Technol.*, **86**, 221 (2003).
2. N. Chakraborty, G.M. Sarka and S.C. Lahiri, *J. Indian Chem. Soc.*, **79**, 522 (2002).
3. H. El-Din Gamel, Biogas Technology, Transfer and Diffusion, pp. 417-422 (2002).
4. S.K. Sharma, Investigation of Characteristics of Biogas Generation using Biomass Waste, Chemical Eng. Department, Ph.D. Thesis, Roorkee IIT (1986).
5. H. El-Din Gamel, Biogas Technology, Transfer and Diffusion, pp. 437-445 (2002).
6. P.K. Gupta, Soil, Plant, Water and Fertilizer Analysis, Agro. Bot., edn. 1, p. 269 (1999-2000).
7. R.C. Dubey and D.K. Maheshwari, Practical Microbiology, S. Chand & Co., New Delhi, edn. 1, pp. 192-193 (2002).
8. D.W. Williams, D. Schleef and A. Schuler, Anaerobic Digestion of Brewery Wastewater for Pollution Control and Energy, Biomass: A Growth Opportunity in Green Energy and Value Added Products, 4th Biomass Conference of the Americas, Oakland, CA, Elsevier Science, Vol. 4, pp. 759-761 (1999).

(*Received*: 6 February 2006; *Accepted*: 19 February 2007) AJC-5426