The Performance of a Night Soil Based Biogas Plant

Fear is commonly expressed about the inefficient performance of a biogas plant exclusively run on human excreta on account of uncontrolled quantity of water used for ablution purposes and consequent enormous dilution of the organic matter entering the biogas plant. At the same time it becomes difficult aesthetically to limit the use of water for ablution. Studies were therefore undertaken over a period of one year to examine the performance of the 'Krishna Model' biogas plant connected to latrines and urinals on the campus of Shivsadan Sahakari Society, Sangli. The following is the account of the said investigation.

The Krishna Model biogas plant (fixed-dome type) with 6000 L digester capacity was installed on the factory premises and connected to three latrines and two urinals. The latrines and urinals were provided each with a water tap connected to an overhead water reservoir. Instructions were given to the workers to record the use of latrines and urinals and care was taken to ensure that the said record was maintained meticulously for the initial period of three months. No restrictions were enforced on the use of water for ablution. The total daily consumption of water was recorded during this period from the quantity of water used from the over-head reservoir. The biogas plant exclusively received the discharges from the latrines and also the urinals and on the basis of the average daily water consumption the hydraulic retention time (HRT) of the plant was found to be about 8 days. The effluent of the plant was spread on the nearby open land.

The biogas produced daily was measured with the help of a dry gas flow meter "Osnabruck" make. The pH of the influent, BOD of the effluent and the methane content of the biogas produced were estimated intermittenly. The methane content of the biogas was determined by Gas Chromatography (Netel Chromatographs, Thane). Since it was not possible to collect the representative sample of the influent, the BOD of the ingoing material was calculated on the basis of quantity of night soil and urine contributed and recorded for a representative user, namely 0.4 kg of faecal matter and 0.2 L urine per head per sitting (Report 1988). The dry matter content of faeces was 23 %.

The data on the daily average biogas production every month and its methane content together with the details of pH and BOD (5 - days) values of influent and effluent are given in Table I.

Tab. 1: Monthly Average Values of Biogas Production and its Methane Content

Sr. No.	Month	Biogas L/Day	%Methane Content
1.	May 1989	873	64.2
2.	June 1989	869	65.7
3.	July 1989	734	-
4.	August 1989	674	-
5.	September 1989	600	-
6.	October 1989	669	-
7.	November 1989	654	-
8.	December 1989	848	-
9.	January 1990	716	67.2
10.	February 1990	518	-
11.	March 1990	745	66.9
12	April 1990	828	-
	Average	727	66.0
		Influent	Effluent
	pH	6.02	7.47
	BOD 5 day mg/L	1113	442.5

The data on the daily water consumption, number of urinal and latrine users for the initial period of three months are given in Table II. It can be seen from the Table I that the average daily production of biogas ranged between 518 and 873 L with an average of 727 L. The data show that the gas production was more or less uniform throughout the year with due influence of the ambient temperature on it as is evidenced by the fact that the gas production was maximum in May during summer and was minimum in February during winter. The daily average gas production for the three months from May to July was 825 L. Based on the average number of latrine users viz 21 (Table II), the biogas production per kg of night soil (dry matter 23 %) comes to 427 L ingnoring the contribution of the urine. This value is comparable with the 380-420 L/kg reported by Bohra (1984) and 314-420 L/kg reported by Satyanarayan (1987). The relatively high value of biogas production obtained in the present investigation could be attributed to the addition of urine in the fermenting matter of the biogas plant. The methane content of the biogas was 66 % as against 55 % commonly observed for cattle dung based biogas plant, possibly due to the rich nutrient contents in the human excreta. The BOD values of the influent and effluent show about 61 % mineralization of the organic matter through the anaerobic digestion during the retention period of 8 days. The pH of the effluent was 7.47 as against 6.02 of the influent thus indicating development of a good buffering system in the fermenting matter.

Since the number of users of the sanitory block depended upon the shifts of the workers, the data of the first three months was further analysed on daily basis viz, Sunday, Monday, Tuesday etc. The details are given in Table - III. It can be seen from the table that the

Tab. 2: Average Water Consumption, Number of Latrine and Urinal Users

Sr. No.	Month	Water Utilization L/Day	Latrine Users	Urinal Users
1.	May	693.23	19	16
2.	June	716.16	27	34
3.	July	749.00	18	27
	Average	773.13	21	32

Tab. 3: Relation Between Daily Number of Latrine and Urinal Users, Consumption of Water and Generation of Biogas

Sr. No.	Days of Week	Water Utilization L/Day	Latrine Users No/Day	Urinal Users No/Day	Biogas Production L/Day
1.	Monday	595	23	45	868.5
2.	Tuesday*	-	-	-	887.5
3.	Wednesday	901	35	61	866.5
4.	Thursday	618	22	60	1191.5
5.	Friday	765	29	47	930.0
6.	Saturday	727	26	46	921.0
7.	Sunday	810	25	41	859.5

*Weekly holiday for the factory workers.

production of biogas gets correlated with the number of users. Thus, for example the number of users were the maximum on Wednesdays and Thursdays of the week and consequently the production of biogas was comparatively more on Thursdays and on Fridays.

Assuming the maximum quantity of 1 L of water utilization by the urinal user per sitting, the per capita water utilization by latrine user averages to 35 litres, (Table II). However, this unrestricted used of water by sanitory block users does not adversely affect in any manner the performance of night-soil based biogas system. Thus a night-soil based biogas plant would become a very useful facility, particularly for Small-Scale Industries. The biogas generated from it could be profitably used for labour welfare activities like running a canteen kitchen etc.

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*L.N. Danawade and V.R. Joglekar**
*corresponding Author
Shivsadan Renewable Energy Research Institute
192/3, Industrial Estate, Sangli
Maharashtra, India 416 416

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summary

The Performance of a Night Soil based Biogas Plant

A fixed-dome plant (Krishna Model) with 6 m³ VD was connected to three toilets and two urinals. Users were given no special instructions at all which means the results achived correspond to the reality. The hydraulic retention time was about 8 days. Gas production in relation to 1 kg of faecal matter amounted to 427 l. The latrines were visited on six days per week,21 times per day and the urinals 32 times. Gas production in relation to 7 days/ week was around 727 l/day.

sommaire

Rendement d'une installation de biogaz pour matières fécales humaines

Une installation à dôme fixe (modèle Krishna-Modell), d'un volume de digesteur de 6 m³ a été rattachée à trois cabinets de toilette et à deux urinoirs. Les utilisateurs n'étaient soumis à aucune prescriptions d'utilisation, de sorte que les valeurs mesurées correspondent à la réalité. La période de séjour hydraulique s'élevait à environ 8 jours. La production de gaz par rapport à un Kg de matières fécales s'élevait à 427 l. Les latrines ont été utilisées 21 fois par jour, les urinoirs 32 fois par jour à raison de 6 jours par semaine. La production de gaz par rapport à une semaine / 7 jours s'élevait à 727l par jour.

resumen

Capasidad de rendimiento de una instalación de Biogas con excrementos humanos.

Una instalación de cúpula fija (Modelo Krishna) con 6 m³ VD fué conectada a tres excusados y dos orinales. Al utilisador no se le dio ningún tipo de instrucciones de utilización,así que los valores medidos corresponden a la realidad. El tiempo de permanencia hidraulica alcanzó aproximadamente 8 días. La producción de gas alcanzó 427 l con respecto a 1 kg de excrementos. En seis días en la semana se utilizaron las letrinals 21 veces por dia y las orinales 32 veces por día. La producción de gas con respecto a 7 días o una semana,alcanzó 727 l/día.

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