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Innovative Practices: Biogas Plant Operation and Maintenance with Efficiency in Mendha-Lekha Village of Gadchiroli District (M.S.)

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Abstract

Innovation in any sector plays a key role in development and prosperity. Bio gas plant operation with innovation is necessary in developing countries like India. Biogas is the promising renewable source of energy in rural India. Gobar gas (biogas) is produced in a Mendha - Lekha village by utilizing locally available cow dung, obtained from livestock, especially, cows and buffaloes with innovative methods of collection of cow dung. Connection of household toilets with gobar gas plant is a unique feature and perhaps innovative thinking in the Mendha - Lekha village. Barefoot operation and maintenance of gobar gas plant can be compared to the scientific operation of biogas plant. The research paper is an attempt to highlight innovation in the collection of cow dung, operation and maintenance of gobar gas plant with efficiency in methane gas production. The result showed better operation and maintenance, efficiency in reduction of solids and volatile solids.

Keywords: Gobar gas, bio gas, solids, Volatile solids, Mendha-Lekha, Methane

1. Introduction

Mendha (Lekha) village (200 11’55” to 200 14’48” N latitude and 800 15” 55” to 800 19’ 26”E longitude) is situated in the Dhanora Taluk of Gadchiroli district, Maharashtra State in Central India which is situated at the tail end of the Satpura Range of hills [1]. The people are Adivasies with dependence on forest for livelihood. The village has its own forest got under Nistar (ownership rights to forest resources). Tribal people are utilizing wood for firewood and cooking purpose. Mendha-Lekha villagers adopted Deenbandhu Biogas Model as gobar gas generating unit because of its advantages over other biogas plants. Efficiency of biogas plant w.r.t. Physicochemical analysis of cow dung slurry and digester content is not performed due to lack of laboratory facilities. Method of cow dung slurry preparation, operation of biogas plant in winter is some of the parameters on which the efficiency of biogas plant is evaluated. Parameters like pH, temperature, alkalinity and total solids and reduction in volatile acid would indicate the performance of the biogas plant as superior or inferior.

2. Methodology

A survey programme followed by discussion among bio gas user was organized to assimilate information about working of biogas plants. Biogas plants were identified and selected randomly for sampling. Sample family having a bio gas plant with an insufficient cattle population had chosen for efficiency. Information regarding the inspiration behind the installation of bio gas plant, connection of toilet to bio gas plant, collection of cow dung in spite of insufficient cattle, operation and maintenance of plants had collected from the people. Cow dung slurry and digester

content sample were collected in summer, rainy and winter season. For volatile acid analysis separate pot having one litre capacity was used. The initial temperature of biogas content was recorded at the site by using thermometer – pH of the inlet and biogas plant content was analysed by using a pocket pH meter. Handling of biogas plant samples, sample transportation and processing, preservation of sample, sample pretreatment for the analysis of Kjeldahl's Nitrogen were performed by adopting the procedure mentioned in standard methods for the examination of water and wastewater (APHA) [2].

3 .Result and Discussion

3.1Innovative Practices

Gram Sabha, the highest decision making body in Mendha-Lekha village decided to allow people without cattle to collect cow dung from Aakhar (open place where cattle sit) and open place during movement of cattle for grazing. People think that milk obtained from cow belong to calves. Cows and buffaloes are used for agriculture purpose and carrying wood from the forest. Most of the family members are trained for construction and maintenance of Deenbandhu biogas plant (training is provided by Centre of Science for Villages, Wardha (M.S.). The person having sufficient knowledge further educate and train next family to construct the bio gas plant. People have connected the toilet to the biogas plant as they learnt the quality of gas obtained by doing so. Waste slurry after drying is used in agriculture getting double benefits. Proportion of cow dung and water and feeding timing is fixed.

3.2 Efficiency of biogas plant

The efficiency of Biogas plant was evaluated in terms of anaerobic conversion of the organic matter into energy yielding biogas. The result of physical and chemical analysis of biogas plants is given in table no. 1

Table 1: Physicochemical parameter analysis of biogas plant

Sr. No.	Physicochemical parameters	Concentration of Inlet parameters (Cowdung slurry)			Concentration of outlet parameters (Digester content)		
		S 1	R 1	W1	S2	R 2	W2
1	PH	7.72	7.28	7.45	7.68	7.15	7.34
2	Temperature degree C	32	29	26	30	28	24
3	Total Alkalinity mg/lit.	3600	3200	3070	3465	2825	2520
4	Volatile Acid mg/lit.	1648	1340	1430	118	480	1056
5	Total solids %	19.5	19	18.5	11	10.5	10
6	N %	1.6	1.8	2.0	1.0	1.2	1.4
7	P %	0.94	1.0	1.2	0.50	0.75	0.80

8	K %	0.65	0.75	0.83	0.3	0.4	0.6
9	Iron mg/ l , ug/l	0.10 mg/l	0.15 mg/l	0.18 mg/l	40 ug/l	50 ug/l	70 ug/l
10	Nickel ug/l	10	20	40	05	12	20

S=Summer Season, R=Rainy Season, W=Winter Season

pH

The ideal pH values for digestion are in the range 7 to 7.5 but, value around 8.2 in most anaerobic digestion is optimum for digestion of wastes [3]. The lowest pH value (7.15, Table 1) was recorded during rainy season due to rain water which is slightly acidic in nature. In spite of that, Present study doesn't show low pH, i.e. below 6 or higher pH content, i.e. above 9 in inlet as well as digested content. Efficiency of biogas plants in Mendha Lekha village was well within optimum pH range.

Temperature

It is evident from temperature reading that the maximum and minimum temperature of cow dung slurry and digested content was 24°C and 32°C in winter and summer (Table 1). Mesophilic and themophilic microorganisms works optimally within 30°C to 40°C and 50°C to 65°C. Methonegens (Methane gas former) are active at a temperature of 35°C - 38 °C. The gas production starts falling at temperature below 20°C. Such situation is possible in Mendha-Lekha village in winter, quantity of gas is reduced not the quality [3].

Total alkalinity

Drastic change in hydrogen ion concentration is corrected by buffering capacity of alkalinity in biogas plant. Alkalinity is an important factor in determining the capability of cow dung slurry to biological treatment. Alkalinity is generally present in adequate amount in cow dung slurry. Alkalinity of digester is comparatively less (2520 mg/l) than cow dung slurry (3600 mg/l) indicating active acetogenesis (Acid formation step) followed by methogenesis (Methane formation step) in the digester (Table1). In the present investigation total alkalinity values show better buffering capacity of gobar gas plant.

Volatile acid

Acid forming microorganisms, such as, formicogen (producing HCOOH), Acetogen (producing CH3COOH) and propionigen (producing CH3CH2COOH) works efficiently at Mesophilic and thermophilic range [4]. If a gobar gas plant is loaded with too much cow dung slurry at a time, acid will accumulate in digestion chamber and fermentation will stop. Temperature of digester greatly affects utilization of volatile acids (118 mg/l at 30°C in summer and 1056 mg/l at 24°C in winter (Table1). People come to know the problem only when gas production decreases day by day or stop completely. Volatile acid utilization in biogas plant is better, except in winter.

Total solids

The major advantage of total solids determination in the cow dung sample and the digester content sample is to obtain a measure of the amount of organic matter present [3]. The cow dung is mixed usually in the proportion of

1:1 (by weight in order to prevent shock loading. The adjustment of total solid content helps in biodigesting the material at a faster rate. Total solids % removal of digester shows better efficiency irrespective of season (Table 1). In Mendha village, people are well trained for mixing cow dung with water in 1:1 proportion. The values obtained in the present investigation satisfy the control feeding of cow dung in gobar gas plant.

Nitrogen

Acetogens (acid former) and methonogens (methane former) require nitrogen and phosphorus for degradation of organic waste in biogas plant. Microorganisms in biogas plant require nitrogen for the formation of proteins, cell wall and nucleic acids [5]. Carbon and nitrogen as protein are the principal food of anaerobic bacteria. Carbon is used by microorganisms in the digester for obtaining energy and nitrogen to build the cell structure. Present investigation shows the highest N (2%) in cow dung feed which is a normal value generally found in cow dung slurry. Connectivity of toilet to biogas plant has advantages than cow dung operated biogas plant.

Phosphorus

Phosphorus is an important constituent in the growth and maintenance of bacterial cells and plays a key role in an energy yielding system of bacterial populations [6]. In most of the instances, nutrients such as N2 and P are always in short supply. Present investigation shows the highest phosphorous (1.2%) in the cow dung feed. Night soil is enriched with phosphorus and helpful to obtain maximum production of gas.

Potassium

Potassium also serves as a beneficial macro nutrient. Bacteria have a requirement for potassium for growth [6]. Present investigation indicates the highest value of potassium (0.83%) in the cow dung feed which is required for microbial growth.

Iron

Iron is essential for almost all living organisms as it is involved in a wide variety of important metabolic processes. Iron is known to catalyze a wide range of biochemical reactions essential for most living organisms [6]. The maximum concentration of iron mg/lit.in cow dung slurry and digester 0.18mg/lit. and 70 ug/l indicate fairly good amount of iron for bacterial growth.

Nickel

Nickel is required micronutrient as it is involved in a most of cellular processes. Its deficiency may affect anaerobic digestion of cow dung slurry [7]. Source of nickel in cow dung slurry may be geogenic in nature. Concentration of nickel ug/lit in cow dung slurry and digested sample is merely an indication of presence of nickel in feed and digester (Table1).

4. Conclusion

Innovative practices of cow dung collection for the biogas plant operation, training and skill development with the further communication of knowledge have changed the overall biogas operation in the Mendha – Lekha village. Except in winter season, biogas operating parameters indicate the optimum efficiency of the bio gas plant.

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