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Research Paper

Management

Technological Intervention in Institutions through Biogas Plants

KEYWORDS : Fossil fuels, Energy crisis, Waste disposal, Biomethanation, Biogas, Organic waste, Slurry, Organic Fertilizer.

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ABSTRACT

Energy is the prime factor of economic growth and development with increasing industrial and agricultural activities. It is the vital input for economic and social development. This growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal, oil, and gas. Thus 21st century has been witnessing serious threat to progress of human civilization due to dearth of energy. India is on the brink of a massive waste disposal crisis and is likely to face a massive crisis situation in the coming years. The enormous increase in the quantum of waste materials led to an increasing awareness world-wide about an urgent need to adopt efficient, scientific and safe method for the treatment, processing and disposal of wastes. Among the various technologies available for conversion of organic waste, bio-methanation appears to be the most desirable as it results in the production of methane rich gas (biogas), an alternative of conventional fuel and digested slurry, which can be used as an organic fertilizer.

INTRODUCTION

The energy consumption is bound to increase over the years with the development of the country. Over the past 30 years, the energy consumption rate has grown much faster; as a result "Global Energy Crisis" has been raised to an alarming level[1]. Excessive consumption of energy has caused the fast depletion of fossil fuels, large scale deforestation, hike in the prices of petroleum and also global environment problems-global warming[2]. Therefore, the challenge is to increase energy generation through judicious utilization of abundant renewable energy resources. Alternative use of energy has gained greater importance, of which organic waste plays a vital role as it is most abundantly available in our country[3]. The mushroom growth of educational institutions and industries consumes enormous quantity of fossil fuels and generates enormous quantity of waste such as night soil, garbage and left over foods. These wastes should be channelized in an appropriate way to generate fuel, fertilizer and promote a clean environment[4]. For facilitating better use of organic waste in large scale establishments, Institutional Biogas Plant is a convenient and operationally viable device.

METHODS AND MATERIALS

Survey of Institutional Biogas Plants

The social, environmental and ecological benefits accrued from institutional biogas plant in large scale establishments such as educational institutions, industries and hospitals need to be explored. Therefore, a survey at micro level was felt necessary.

Locale of the Area

Tamil Nadu and Kerala states located in the Southern part of India have been chosen for the study. Realizing the importance of energy crisis and the need for disposing night soil and garbage in a most scientific way several voluntary agencies have been involved in converting waste to energy particularly in large scale establishments through Institutional Biogas Plants. The Nirmal Biogen Technology, a well-known voluntary organization had done commendable work by installing around 124 Institutional Biogas Plants in Tamil Nadu and Kerala.

Selection of Institutions

In Tamil Nadu 40 institutions and in Kerala 10 institutions were selected based on purposive sampling method.

Selection of Research methods and Tools of Enquiry

Interview cum observation method was adopted for collection of data as this technique is considered as a two way method which permits exchange of ideas and information.

Formulation of Tool

To enable the investigator to collect relevant data pertaining to the study in a coherent manner, an interview schedule was prepared. The schedule has been structured to contain both closed and open ended questions. The schedule thus prepared covers:

- Prerequisites considered for installing the Institutional Biogas Plant
- Design of the plant
- Details of construction and labourers involved
- Details of operation
- Quantum of fuel saved after installation of biogas.
- Problems occurred in the use of gas plant.
- Prospects gained in using Institutional Biogas Plants.
- Suggestion for future owners.

Collection of Data

The person in-charge of the Institutional Biogas Plant answered the queries put forth by the investigator. Necessary evidences in the form of photographs were also collected. The investigator observed the site of the biogas plant, the mixing tank, generation of organic wastes, the use of biogas in the kitchen and the spent slurry for enriching the garden.

Comprehensive Study of an Institutional Biogas Plant

comprehensive study has been planned to review an Institutional Biogas Plant located in an educational complex to assess the various parameters of the unit. It comprises of the following steps:

1. Selection of Institution (Maharaja Co-Education Arts and Science College, Perundurai)
2. Gathering information regarding Institutional Biogas Plant.

Assessing the Resource Recovery in terms of Fuel Energy, Cost, Manurial value and Environmental Benefits

The resource recovery through the installation of Institutional Biogas Plants is discussed under the following headings:

Recovery of fuel energy

The educational institution has a clean and hygienic hostel which offers boarding facility for nearly 1200 students. In the hostel breakfast, lunch, evening snacks and dinner were prepared according to the strength of the inmates. In order to quantify with empirical evidence a scientific study has been planned and carried out. A Gas flow meter, known as Rota meter was used to quantify the biogas required to prepare a day's menu. This experiment was conducted for a period of one month to quantify the flow of gas.

Recovery of organic manure (Farm yard manure)

The slurry which comes out the biogas plant constitutes good quality manure, free from weed seeds, foul smell and pathogens. It contains a full range of plant nutrients (i.e. N_2, P_2O_5, K_2O). It has been observed that the use of digested slurry as a manure improves soil fertility and increases crop field by 10-20 per cent. In order to assess manurial value of slurry obtained from the Institutional Biogas Plant, the sample was collected and tested in the Environmental Science laboratory of Tamil Nadu Agricultural University, Coimbatore to find out the Nitrogen,

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Phosphorus and Potassium content.

Table 1 presents the nutrient content of Biogas Spent Slurry and other Organic Manures.

Table 1: Nutrient Content of Biogas Spent Slurry and other Organic Manures

Manure	Nitrogen (N_2O)	Phosphorus (P_2O_5)	Potassium (K_2O)
Farmyard manure*	0.4 – 1.5	0.3 – 0.9	0.3 – 0.9
Compost*	0.5 – 1.5	0.3 – 0.9	0.8 – 1.2
Biogas spent slurry**	0.18	0.58	0.85

*** Source from Khandelvel and Rajamani (2010);**
**** Test result from TNAU-Environmental Science Laboratory**

From the above table, it is inferred that the percentage of manure obtained from farm yard manure and compost is more or less same as the manure obtained from Biogas Spent Slurry. The Educational Institution has 3.5 acres of vacant land where coconut and mango trees are planted and nurtured. Before the installation of the IBP the authorities purchased a large quantity of organic manure by spending a lot of money to raise the trees. Realising the nutrient content they used only Biogas Spent Slurry as manure after installation of IBP.

Environmental benefits

Environmental benefits accrued by installation of this plant were calculated by assessing the BOD and COD level.

Results and Discussion

Concept of installing IBP

The most pressing problems such as energy crisis and waste disposal made the administrators to install Institutional Biogas Plant in their campus. Table 2 outlines the concept behind for their installation of IBP.

Table 2: Concept of Installing IBP

Concept	Institutions*	
	N:50	Percentage
Achieving National millennium goal	50	100
Safe disposal of night soil	50	100
High cost and sudden hike in price of LPG	50	100
Recovery of energy from waste	48	96
Energy efficient technology	47	94
Relevant utilization of garbage and leftover foods	46	92
Appropriate technology	45	90
Restoring hygienic environment	42	84
Transport of waste material	39	78
High demand of LPG	38	76
Collection and storage of firewood	8	16

***Multiple responses**

Achieving National millennium goal in energy efficiency made all of them to venture into this project. All of them unanimously expressed the safe disposal of night soil; high cost and sudden hike in price of LPG are the major issues in deciding the installation.

Resource recovery in terms of fuel and money

The main aim of installing IBP in the institutions is to recover fuel energy. The institutions are spending huge amount in using Liquefied Petroleum Gas as fuel for quantity cookery. The introduction of IBP paves way for them to minimize the usage of cylinders to a certain extent.

Table 3: Mean Cost Benefit through the Installation of Institutional Biogas Plant per Month

Capacity (cu.m)	LPG cylinders/month			Amount spent for LPG `		Net savings `
	Before	After	Savings	Before	After	
10	50	38	12	86,750	65,930	20,820
15	65	52	13	1,12,775	90,220	22,555
20	76	58	18	1,31,860	1,00,630	31,230
25	84	68	16	1,45,740	1,17,980	27,760
30	90	72	18	1,56,150	1,24,920	31,230
35	96	80	16	1,66,560	1,38,800	27,720
40	98	84	14	1,70,030	1,45,740	24,290
45	104	88	16	1,80,440	1,52,680	27,760
60	110	86	24	1,90,850	1,44,210	41,640
80	115	96	19	1,99,525	1,66,560	32,965
85	120	98	22	2,08,200	1,70,030	38,170
90	124	99	25	2,15,140	1,71,765	43,375

As per the statistics given by the authorities (Table 3) a considerable number of commercial LPG cylinders are saved through the installation of IBP. The saving of LPG cylinders is directly proportional to the capacity of the plant in that as higher the capacity, the more number of cylinders are saved.

Description of an Institutional Biogas Plant

a. Digester: The Institutional Biogas Plant comprises of a digester of volume 453.6cu.m with dome shaped structure to ferment night soil, garbage and left over foods in an efficient manner. It is cylindrical with arched top and bottom reinforced concrete structure made of kiln-burnt brinks and cement masonry work constructed underground. The fixed dome is preferred due to the reasons such as less formation of sludge, temperature tends to remain constant as this type is constructed below the ground and are often considerably higher than ambient temperature in winter.

b. Inlet tank: Inlet tank is constructed of 2.25cu.m length, breadth and depth adjacent to the left side of the digester. In this tank, the feed stock materials are fed in to the plant by adding sufficient quantity of water. A metal screen is placed to prevent non bio-degradable materials getting into the digester.

c. Outlet tank: It is constructed of 57.6cu.m larger than inlet tank and placed in the right side of the digester of the gas plant. It is designed as such the digested slurry flows out of the plant after production of biogas.

d. Accessories: The gas outlet pipe is attached at the top of the digester and connected to the kitchen. The gas distribution pipeline includes the gas vent pipe, gate valve, hose pipe, moisture trap, pipes, bends, joints and stop cock. Special care is taken when laying the pipeline because biogas contains water vapours which condense in the pipeline. A provision is made for removal of water from the pipeline by means of providing a correct slope to the pipe, especially the pipe nearest the gas plant. As the gas pressure goes up to 900mm water column in this type of gas plant good quality pipes are used to avoid leakages.

Recovery of Fuel, Money and Organic Manure Resources

Fuel energy

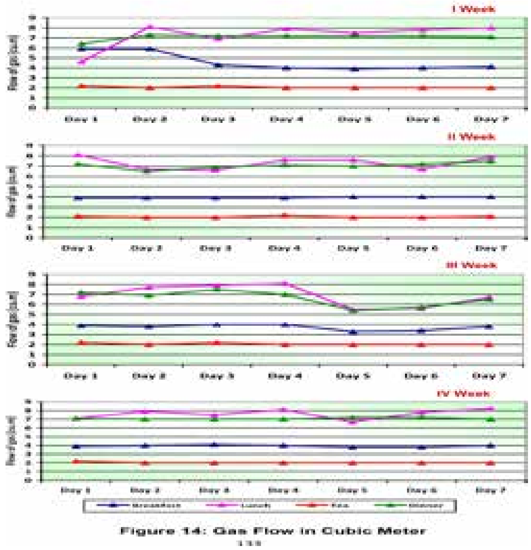
Table 4 projects month wise average gas production from organic wastes per day.

Table 4: Month Wise Average Gas Production from Organic wastes

Month	Night soil Generation kg	Gas Production* Cu.m	Garbage / Left over foods Generation kg	Gas Production** Cu.m	Total gas Production Cu.m
July	394.50	7.89	125.87	12.59	20.48
August	407.47	8.15	134.63	13.46	21.61
September	428.27	8.57	131.77	13.18	21.75
October	413.94	8.28	119.35	11.94	20.22
November	353.84	7.08	112.34	11.23	18.31
December	355.07	7.10	109.00	10.90	18.00
January	420.37	8.41	113.20	11.32	19.73
February	403.24	8.06	102.03	10.20	18.26
March	419.55	8.39	138.90	13.89	22.28
April	358.52	7.17	105.21	10.52	17.69

*** 1 kg human excreta=0.02cu.m/day; ** 1kg garbage = 0.1cu.m/day**

The average generation of organic wastes is calculated based on the number of inmates and garbage/leftover food generated in the hostel. It can be inferred that production of gas per day increases with the generation of night soil and garbage/leftover food per day.



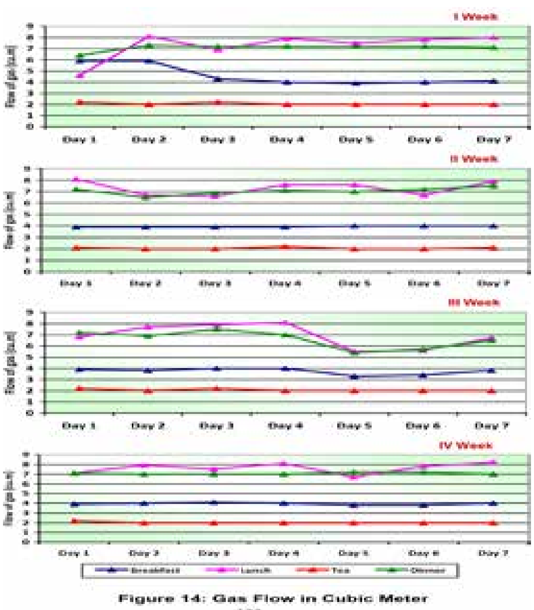


Figure 1 Gas Flow in Cubic Meter

The analysis by using the Gas flow meter indicated that flow of biogas per day is minimum of 19.3cu.m and maximum of 21.1cu.m. The biogas consumption is more for preparing lunch and dinner and less for preparing tea.

Environmental Benefits

Through the installation of biogas plant, environmental benefits are also gained by the institution. The analysis of effluent water clearly shows it. Table 5 brings forth the chemical parameters of untreated and treated effluent water.

Table 5: Analysis of Untreated and Treated Effluent Water

Parameters	Untreated	Treated
Biochemical Oxygen Demand (BOD)	13 ppm	11 ppm
Chemical Oxygen Demand (COD)	220 ppm	110 ppm
pH	6.89	7.53
Total Dissolved Solids	1220 ppm	1030ppm
Electrical conductivity	2.72 ms	2.37ms

The analysis of effluent water shows the reduction of toxic substances if it is anaerobically digested. The BOD and COD of the effluent gradually decrease when it is treated in the biogas plant. As the toxic content of the effluent water decreased it can be readily used as manure for trees. This shows that installation of biogas plants offers multidimensional benefits to the institution including healthy environment.

Conclusion

We, in India are bestowed with vast natural resources as well as rich biological heritage. The day when fossil fuels get exhausted one needs to turn onto the perennial sources of energy - the radiating sun, the blowing wind, the surging tide and other sources of biomass, especially the misplaced resource 'Waste' is not far off. Continuous, conscientise and co-operative efforts on a large scale by Governments, Universities and Voluntary agencies will pave way towards achieving self-sufficiency in energy.

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