International Journal of Latest Trends in Engineering and Technology
Vol.(17)Issue(3), pp.001-006
DOI: http://dx.doi.org/10.21172/1.173.01
e-ISSN:2278-621X

BIO GAS GENERATION FOR ENERGY CONSERVATION

Insha Zahoor[1], Danish Ahmed[2]

Abstract- Energy conservation is the need of the hour. We have to save as much conventional energy as we can for the future generations. Such an effort has been made at NIT Campus Srinagar. The Campus houses a large number of students, besides faculty members. The amount of bio waste is very large and needs periodic removal. Bio Gas digesters are designed at various locations to cater for the fuel needs. A large amount of vegetable peels, left over food and fruit peels are generated, which are proposed to be used for Bio Gas generation, thus saving the fuel costs

Key Words :- Bio Gas, Energy Conservation, Green Campus, Kitchen Waste

I. INTRODUCTION

On a global scale, urbanization and rapid population growth has led to a rampant increase of solid waste generation per unit area. Dumping waste on open ground may lead to environmental pollution problems such as soil contamination, groundwater contamination, health problems, etc. When solid wastes are incinerated, the waste turns into ash and potentially hazardous gases are released into the air causing public health risks. When these wastes are disposed by dumping into landfills, there is huge contribution of methane emissions to the atmosphere. Methane gas has a global warming potential of 20 times that of Co_2. The 21st century faces the problem of increasing energy consumption and reducing supplies of fossil fuels. This has encouraged researchers to develop new technological processes of energy production using renewable sources. One of the possible options is the biological conversion of solid wastes that contain higher percentages of organic matter and moisture content (about 45 -50%) to produce biogas. .

II. METHODOLOGY AND APPROACH:

(a) The initial survey for characterization and quantification of organic waste produced at the Jhelum and girls hostel mess: A site survey was carried out to identify the composition of kitchen waste and quantify organic waste (vegetable and fruit waste and leftover food) produced at the hostel messes. The mess schedule for lunch and dinner was monitored to determine the exact variety and quantity of vegetables being cooked and fruits being served to the hosteliers, to determine the quantity of leftover food and organic green waste in the mess.
(b) Waste sampling: To cater to the compositional variability of organic waste over a week, daily sampling was performed for seven days. Waste samples of 500g were taken from mixed waste and analyzed.
(c) Chemical analysis: Samples were analyzed for pH, total solids and Organic content according to the standard method. Food waste samples were tested for chemical parameters at the laboratory using standard analysis methods according to the following:

[1] Department of Civil Engineering, SSM College of Engineering, J&K India
[2]Department of Civil Engineering, National institute of Technology, Hazratbal, Srinagar, J&K India

III. RESULTS AND ANALYSIS

Survey results for Jhelum hostel (500 inmates):

Leftover food after consumption

Table 4.1.1: Daily food wastage for a week in Jhelum hostel(in Kgs)

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Breakfast	10	12	13	9	10	7	8
Lunch	42	45	47	38	52	32	36
Dinner	35	48	42	44	55	38	41

Approximate weekly wastage = 664 kg Therefore, Approximate monthly = 2656 kg

Fruit and vegetable waste

Table 4.1.2 Monthly FVW in Jhelum hostel

Fruit/vegetable	Consumption per day in Kgs	No. of times consumed per month	Monthly wastage (in Kgs)
Cauliflower	8	20	160
Cabbage	4	16	64
Potato	6	20	10
Peas	5	12	60
Spinach	8	12	96
Tomato	2	10	20
Banana	35	15	500
Beans	2	10	20
Cucumber	2	10	20
			Total = 1060

Survey results for Girls hostel (230 inmates)

Daily food wastage for a week in girl's hostel (in Kgs)

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Breakfast	5	5.8	6.2	4.5	6	5.5	4
Lunch	20	21.5	47	18	24	15	17
Dinner	17	23	42	21	26	17	19

Fruit and vegetable waste

Monthly FVW in Girl's hostel

Fruit/vegetable	Consumption per day in Kgs	No. of times consumed per month	Monthly wastage (in Kgs)
Cauliflower	5	14	70
Cabbage	5	5	25
Potato	5	10	50
Peas	3	8	25
Spinach	4	10	40
Tomato	10	10	100
Banana	20	10	200
Beans	1	8	8
Cucumber	1	8	8
			Total = 436

pH value of FVW and LFW and mixed waste

	Leftover Food Waste	Fruit & Vegetable Waste	Mixed waste
Sample 1	6.1	6.7	6.5
Sample 2	6.03	7.2	6.8
Sample 3	6.13	6.13	6.7
Sample 4	6.12	7.1	6.8
Sample 5	6.2	7.13	6.8
Sample 6	6.1	6.7	6.5
Sample 7	6.03	7.2	6.8

The average pH value for FVW is 6.67 and 6.08 for LFW and 6.66 for the mixed waste of both FVW and LFW. The methane-producing bacteria thrive best under neutral to alkaline conditions. As per research finding the food waste is observed to be slightly acidic for the growth of the methanogenic bacteria

Total solid % of LFW and FVW

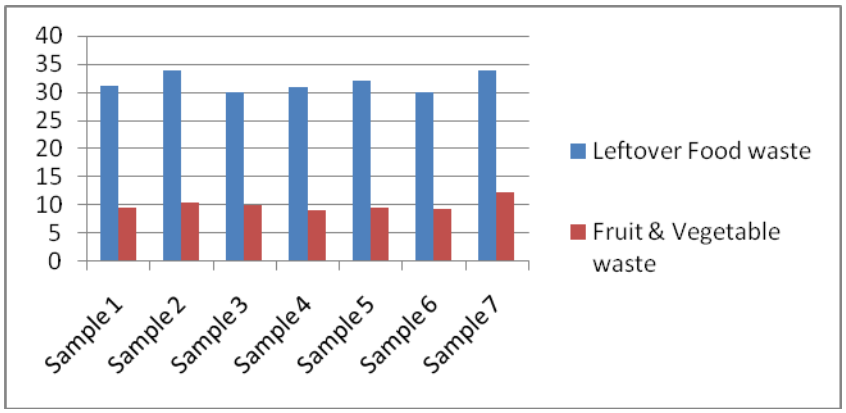
	Leftover Food Waste	Fruit & Vegetable Waste	Mixed waste
Sample 1	38.8	11	30.8
Sample 2	41.9	12	28.3
Sample 3	34.2	11.5	29.9
Sample 4	35	11.2	29
Sample 5	36	11	30
Sample 6	38	11	30
Sample 7	41	12	28

The average percentage of Total solids of FVW accounts for 11.5 and 38.3 for LFW. The total solid percentage for mixed waste is 29.66. It is observed that FVW has a low amount of total solids due to high moisture content, compared to FVW, LFW is having higher total solids content.

[1] Department of Civil Engineering, SSM College of Engineering, J&K India
[2]Department of Civil Engineering, National institute of Technology, Hazratbal, Srinagar, J&K India

Organic content in Fruit and Vegetable waste, leftover food waste

	Leftover Food waste (%)	Fruit & Vegetable waste (%)
Sample 1	31.2	9.58
Sample 2	33.93	10.52
Sample 3	30.09	9.98
Sample 4	31	9
Sample 5	32	9.52
Sample 6	30	9.33
Sample 7	33.96	12.21



The average percentage of Organic content % of FVW accounts for 10.02 and 31.74 for LFW. It is observed that FVW has a low amount of organic content compared to LFW. High organic content is beneficial for anaerobic digestion

Biogas potential of feedstock material from BMP test values:

Jhelum Hostel

Organic content in leftover food = 31.74/100 x 2656 = 843Kg

- Amount of biogas production from leftover food per month = 472.08m^3
- Organic content in fruit and vegetable waste = 106.31 Kg
- Amount of biogas production FVW = 0.30 m^3 /kg of organic content= 31.893 m^3
- Total Monthly biogas production = 503.97 m^3
- Therefore, Total daily biogas production = 16.80 m^3
- Biogas from kitchen waste contains 60 – 65 % methane with calorific value of 55MJ/kg (density = 0.668Kg / m^3)

Calorific value = 36.47 MJ/m^3
Considering 60% methane in biogas
Calorific value = 22.044 MJ/m^3
Therefore total energy from biogas (monthly) = 503.97 x 22.044 = 11109.51MJ
Calorific value of LPG = 46.1MJ/Kg
Number of cylinders used monthly in Jhelum hostel = 90
Therefore Total energy from cylinders (monthly) = 78831MJ

Thus energy potential from kitchen waste = [11109.51 / 78831 x 100] % of energy used
= 14.09 % of monthly consumption

(Equivalent to approximately 13 cylinders)

Similarly, daily biogas production potential for girls hostel = 7.986 m^3.

For Indus, Chenab and Jhelum – Extensions hostels = 16.80m^3

And for Tawi hostel = 5.04m^3

Design calculations of continuous flow digester

Jhelum and Jhelum Extension Hostels

Since Jhelum and Jhelum extension hostels are in proximity to each other, a biogas plant common to both hostels was proposed

Combined daily biogas production for both hostels = 33.60m^3

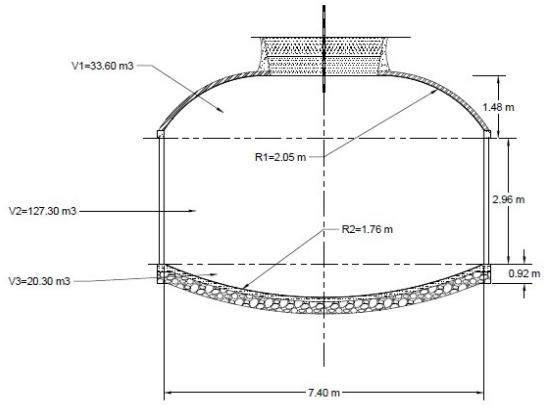
Total volume of the digester is V = 181.22m^3

Wall height = 2.96m

Dome height = 1.48m

Base depth = 0.925m

Total height of digester, H = 5.365m



Indus Chenab & Tawi hostels:

Since Indus Chenab & Tawi hostel's messes are in proximity to each other, a biogas plant common to these hostels is proposed.

Combined daily biogas production for the three hostels = 38.64m^3

Total volume of the digester is V = 208.295m^3

Wall height = 3.1m

Dome height = 1.55m

Base depth = 0.968m

Therefore, total height of digester = 5.618m

Girl's hostel:

Daily biogas production for the hostel = 7.986m^3

Total volume of the digester is V = 43.096m^3

Wall height = 1.832m

Dome height = 0.916m

Base depth = 0.572m

Therefore, total height of digester = 3.320m

[1] Department of Civil Engineering, SSM College of Engineering, J&K India

[2]Department of Civil Engineering, National institute of Technology, Hazratbal, Srinagar, J&K India

III. CONCLUSION

From the work carried out, a large amount of LPG cylinders have been eliminated. The work has reduced the solid waste load of the NIT campus, saved a lot of energy and money and accelerated the concept of an efficient usage of non conventional energy source. A cost estimate of the money saved is given in the table below.

Potential savings in monetary terms (rates as on February 2019)

Hostel	Monthly equivalent cylinders saving potential	Money saved
Indus	13 cylinders	₹17264
Chenab	13 cylinders	₹17264
Jhelum – Extensions	13 cylinders	₹17264
Jhelum	13 cylinders	₹17264
Tawi	3 cylinders	₹3984
Girls	6 cylinders	₹7968

REFERENCES

[1] CPHEEO manual on Sewage and sewerage treatment.
[2] Dr.Ayoup M. Ghrair; Grey water filtration systems: For a sustainable water culture
[3] Dr. Nitin W Ingole; Development and Design of Biogas Plant for Treatment of Kitchen Waste International Journal of Research in Engineering, Science and Technologies Vol.:1 No.:5 Aug 2015
[4] Environmental engineering Vol II by Santosh Kumar Garg
[5] IS 1172: 1993
[6] IS 12933 (Part 1 - 5): 2003
[7] K. M. Akkoli, B M Dodamani, Jagadeesh A Ravi C; Design and Construction of Food Waste Biogas Plant for Hostel Mess, IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 03, 2015 | ISSN (online): 2321-0613
[8] Leta Deressa, Solomon Libsu, R.B.Chavan, Daniel Manaye, Anbessa Dabassa; Production of Biogas from Fruit and Vegetable Wastes Mixed with Different Wastes, Environment and Ecology Research 3(3): 65 – 71, 2015
[9] Nasir Ul Rasheed Rather, Anju Singh, Asghar Samoon; Solar Resource Assessment in Jammu and Kashmir State, International Journal of Advanced Engineering Research and Science (IJAERS) [Vol-5, Issue-1, Jan- 2018 ISSN: 2349-6495(P) | 2456-1908(O)