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Design and Benefit Analysis of Biogas Plant for Rural Development in Bangladesh

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Abstract— Energy is one of the major concerns for the developing future of any nation and electricity is the most useful form of energy. Around 65% people are getting electricity. As Bangladesh is blessed with suitable geographical location for solar energy and perfect weather condition for Biomass energy, we can think only solar and Biogas energy to supply them electricity. Although solar home system (SHS) is getting popular in the non grid areas of Bangladesh, however per unit cost of such electricity is extremely high (nearly 50 cents). Poor households cannot afford to buy such an expensive system. Sort term loan is being offered to the rural people to popularize the SHS; however response of the rural masses to adopt such system is a bit sluggish. This paper focuses on potential of biomass resources and its proper utilization can help to give an easy realistic solution on the way of sustainable energy security of Bangladesh.

Index Terms—**Biomass Energy, Bangladesh, Cattle Dung, Sustainable Energy, Potential of Biomass in Bangladesh.**

I. INTRODUCTION

Global energy requirement is increasing at every moment and to cope up with this daily need, the role of renewable energy is becoming more and more important in the developed as well as the developing countries to meet partially the need of global energy. Also Bangladesh as a developing country is facing serious energy crisis due to depleting gas reserves and lack of proper utilization of the available resources for energy. With the acute shortage of gas, Bangladesh government is inclined to install coal fired power stations to generate electricity which can be supplied to the grid areas. Nearly 65% of the people live in non grid areas and have no access to the grid electricity. As Bangladesh is blessed with suitable geographical location for solar energy and perfect weather condition for Biomass energy, we can think only solar and Biogas energy to supply them electricity. Although solar home system (SHS) is getting popular in the non grid areas of Bangladesh, however per unit cost of such electricity is extremely high (nearly 50 cents). Poor households cannot afford to buy such an expensive system. Sort term loan is being offered to the rural people to popularize the SHS; however response of the rural masses to adopt such system is a bit sluggish. Bangladesh is an agricultural country. About 85% of total population lives in villages. Village households mainly depend on wood and cow dung and other bio mass sources to meet their energy requirements. The negative impacts on the dependence of such sources as fuel pose a great threat to the environment.
Due to deforestation, wood is becoming scarce and its price is increasing at a fast rate. Use of other biomass sources for heating in a primitive way pose a great threat to the environment as well as on the general health of the rural people. Majority of the rural masses do not adopt scientific and efficient methods to harness energy from these bio mass sources. From this motivation, I am writing this report how biogas plants can play a vital role on the development of rural socio-economic condition.

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II. LITERATURE REVIEW

Bangladesh is a sovereign state located in South Asia. It is bordered by India and Biogas, a renewable energy source, is mainly composed of methane and others. Biogas originates from bacteria in the process of bio-degradation of organic material under anaerobic (without air) conditions. Methanogens (methane producing bacteria) are the last link in a chain of micro-organisms which degrade organic material and return the decomposition products of the environments and Methane is odourless gas and burns with a clear blue flame without smoke. It can be used as fuel for cooking, lighting, electricity generators etc [1]. Using generators we can generate electricity from it. Like other third world countries Bangladesh is an agro based country and almost 85% of her population directly or indirectly depends on agriculture. So converting the waste material into energy is economically beneficial. Bangladesh has a wonderful climate for biogas production. The ideal temperature for biogas is around 35°. The temperature in Bangladesh usually varies from 9.6°C to 33.9°C .But the inside temperature of a biogas digester remains at 22°C-30°C, which is very near to the optimum requirement. So, from environmental perspective Bangladesh is more efficient to produce Biogas [2].
The average composition [3] of biogas is shown in Table 1 in percentage. As the amount of methane in percentage 55-75%, biogas is well substitute of natural gas.

Table 1: Average Composition of Biogas

Matter	%
Methene	55-75
Carbon Dioxide	25-45
Carbon Monoxide	0-0.3
Nitrogen	1-5
Hydrogen	0-3
Hydrogen Sulphide	0.1-0.5
Oxygen	0.1-0.8

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Hydraulic Retention Time (HRT) : The retention time is the theoretical time that a particle or volume of liquid added to a digester would remain in the digester. It is calculated as the volume of the digester divided by the volume of slurry added per day and it is expressed as days. The solids retention time (SRT) represents the average time that the solids remain in the system. The solids retention time can be determined by dividing the weight of volatile solids in the system by the weight per unit time of volatile solids leaving the system. The hydraulic retention time (HRT) is equal to the solids retention time in completely mixed non-recycled digester systems [3].

Total Solid (TS): The amount of solid material without considering the liquid part is termed as Total Solid (TS) . Total solid is the material unit that indicates the production rate of Biogas. The favourable total solid value for smooth fermentation is 8% [3].

Fresh Discharge: Fresh discharge is the total amount of manure including moisture content directly obtained from the cow, chicken, human etc [3].

Liquid Part: Liquid part is the amount of water to be added with fresh discharge to make the TS value is 8%. The Solid and Liquid Content of Common Fermentation Materials (Human, Cow and chicken) are shown in Table-2 [3].

Table 2: The Solid and Liquid Content of Common Fermentation Materials

Materials	Dry Matter Content (%)	Water Content (%)
Human	20	80
Cow	16	84
Chicken	20	80

Selection of Site: First choose the site which is nearest to the place of raw materials as well as appliances to be used for the following reasons and these are extra labour requires feed the digester if it is too far from the source of raw materials, longer length of gas distribution pipe line will reduce the design pressure in a considerable amount, construction cost will be higher, condensate could be trapped if any sag in long gas pipe line which may block the gas pipe line [3].

Relationship between Temperature and HRT (for constant value of 8%): The relationship between Temperature and HRT is given below:

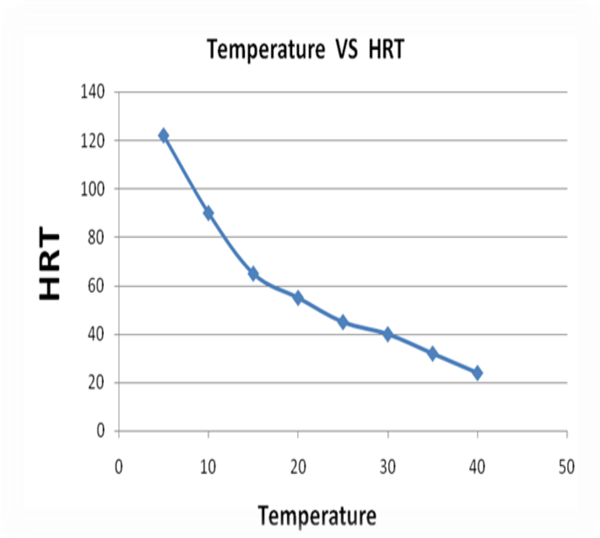

Fig.1: Relationship between Temperature and HRT

The table showing discharge per day, TS value of fresh discharge and water to be added to make favourable TS condition.

Table 3: Table showing Discharge per day, TS Value of fresh Discharge and Water to be added to make favourable TS Condition Some Common Fermentation Materials.

Kinds	Body weight (kg)	Discharge per day (kg)	TS value of fresh discharge (% by wt.)	Water to be added with fresh discharge to make the TS value 8% (kg)
Human	50	0.5	20	0.75
Cow	200	10	16	10
Chicken	1.5	0.1	20	0.15

C/N Ratio: It is the carbon nitrogen ratio. Favourable range is from 20:1 to 30:1. Carbon – Nitrogen Ratio's of some common Fermentation Materials are shown in Table – 4 [3].

Table 4: Carbon – Nitrogen Ratio's of some common Fermentation Materials

Material	Carbon Content of Materials (%)	Nitrogen Content of Materials (%)	Carbon - Nitrogen ratio (C/N)
Fresh Cattle dung	46	0.53	87:1
Fresh Human Waste	2.5	0.85	29:1
Dry Rice Straw	42	0.53	67:1
Fallen Leaves	41	1	41:1

Components for Biogas Plant: The required components for generation of gas [4] and electricity are:

Receiving Tank/ Inlet: The waste is 1st taken to the receiver and mix-up with water to make the favourable total solid (TS) value of the waste. The waste wait in the receiver tank for 4-5 days and then it is send to the digester.

Digester : Digester is the main part of a biogas plant. The process of gas generation called fermentation process occurs in the digester. The design of the digester should be such that no air can enter in to the digester. The generated gas in the digester gather in the upper part of the digester called gas collected chamber.

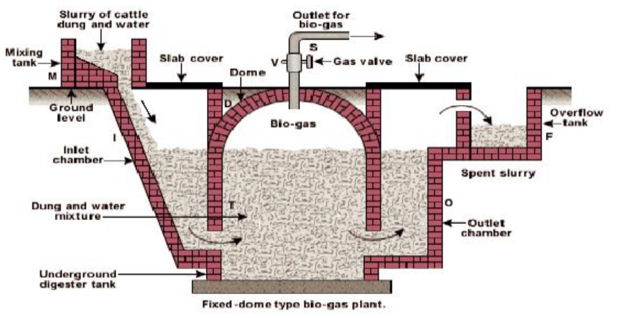

Fig. 2: Fixed Dome type Biogas Plant

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(Most commonly used Biogas plant in Bangladesh)

Outlet: Due to the pressure of gas in the gas collection chamber, some of waste goes out from the digester every day. They exit through the outlet.

Gas Purification Unit: Bio-gas contains about 55-75 % methane. It also contains moisture, hydrogen sulphide and some other impurities. The main purpose of the gas purification unit is to remove these impurities.

Gas Generators: Gas generators are internal combustion (IC) gas engines. They internally burn the biogas and convert the prospective energy of the biogas to mechanical rotation which next convert into electrical energy. The electrical energy is used to operate the electrical loads.

III. BIOGAS PROSPECT OF A TYPICAL RURAL VILLAGE IN BANGLADESH

In Bangladesh a small community/ village consist of around 100 – 500 households and about 70-80 % of those households have one or more than one cattle and at least five chickens per household. In Bangladesh, Typically each and every village have either poultry farm or dairy farm. Based on these, we can assume total number of cattle becomes 150-500 and chicken becomes around 30000 to 40000. In addition, every household has agricultural by products like paddy straw, rice husk. On the other hand it can be seen very often in the rural area that there are some small ponds full of water hyacinth. These are good biomass sources to produce biogas production can be increased.

Assume mentioned scenario of rural area of Bangladesh, Potential of biogas and generated electricity can calculate as:

A. *Cattle Dung*

1) Total cattle population of a village/ rural area = 140
2) Dung available = 1400 kg/day
3) Gas that may be obtained = 51.8 m^3/day
4) Electricity that may be generate from obtained Gas = 103.6 kWh

(Each cow yields = 10 kg dung/day, 1 kg of dung yields = 0.037 m^3 gas, each cubic (m^3) of biogas contains the equivalent of 6 kWh of calorific energy. However, when we convert biogas to electricity, in a biogas powered electric generator, we get about 2 kWh of useable electricity, and the rest turns into heat which can also be used for heating applications.)[5]

B. *Poultry Litter*

1) Total poultry population of a village/ rural area = 35000
2) Total poultry litter that may be obtained = 3500 kg/day.
3) Gas that may be obtained = 259 m^3/day.
4) Electricity that may be generate from obtained Gas = 518 kWh.

(Each bird yields = 0.1 kg litter/day, 1 kg litter yields = 0.074 m^3 gas, each cubic meter (m^3) of biogas contains the equivalent of 6 kWh of calorific energy. However, when we convert biogas to electricity, in a biogas powered electric generator, we get about 2 kWh of useable electricity, and the rest turns into heat which can also be used for heating applications.) [5]

If I assume 140 Cows and 350000 chickens then Total Biogas volume will (51.8 m^3/day + 259 m^3/day = 310.8 m^3/day).And if this biogas convert to electricity through gas generator then amount of produce Electricity is 621.6 kWh.

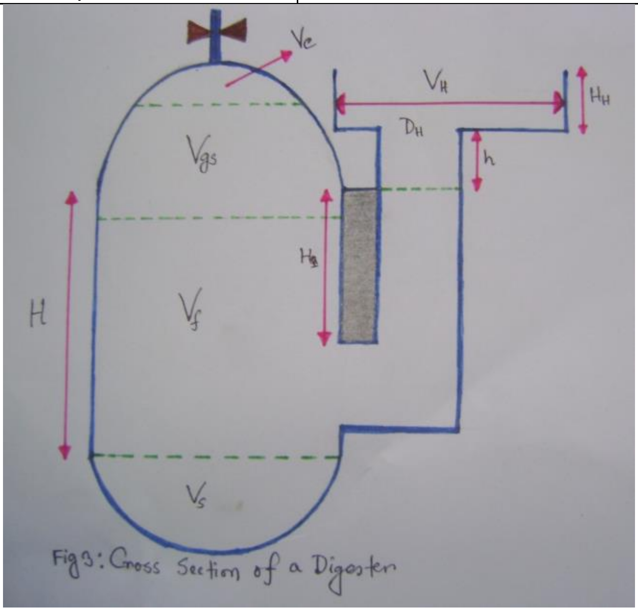
IV. DESIGN OF BIOGAS PLANT

Based of Cattle and Poultry population, more than one biogas plant can design rather than one in order to make more efficient.(Maintenance, shortage of raw materials).

Now I plan to design Two Digesters for chicken with (15000 chickens + 20000 chickens) and another Two digester with equal capacity 70 cows. A typical Digester which is used in Bangladesh as shown in Fig- 3 and Geometrical Assumption For Digester Design as shown in Table – 5.

Table 5: Geometrical Assumption for Digest

For Volume	For Geometrical Dimensions
$V_C \le 5\% V$	$D = 1.3078 \times V^{(1/3)}$
$V_s \le 15\% V$	$V_1 = .0827 \times D^3$
$V_{gs} + V_f = 80\% V$	$V_2 = .05011 \times D^3$
V_{gs} = VH	$V_3 = .3142 \times D^3$
$V_{gs} = 0.5 \times (V_{gs} + V_f + V_s) \times K$ Where K = gas production rate per cubic meter volume per day. For Bangladesh K = 0.4 m^3/day.	$f_1 = D/5$
	$f_2 = D/8$
	$R_1 = 0.725 \times D$
	$R_2 = 1.0625 \times D$
	$S_1 = 0.911 \times D^2$
	$S_2 = 0.8345 \times D^2$



Where V_c, V_{gs}, V_f, V_s, V_H are the volumes of gas collecting chamber, gas storage chamber, fermentation chamber, sludge layer and hydraulic chamber respectively. Total volume of digester $V = V_c + V_{gs} + V_f + V_s$.

A. *Design of Digester for 15000 chickens:*

Volume Calculation of Digester Chamber:

Let, HRT= 40 day (for temperature 30° C).

We know, from every chicken 0.1 Kg waste is obtained per day.

Total discharge = (15000×0.1) Kg = 1500 Kg.

TS of fresh discharge = (1500 × 0.2) = 300 Kg.

To make the TS value of 8% for favourable condition we have to mix some additional water with fresh discharge. The required water to be added can be calculated by the following way.

8 Kg solid equivalent of influent; 300 Kg solid equivalent = (100* 300)/8 Kg = 3750 Kg .

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So, Total influent required Q = 3750 Kg.
Required water to be added to make TS value 8% = (3750-1500) Kg = 2250 Kg
Working volume of digester = V_{gs} + V_f. V_{gs} + V_f = Q × HRT
=3750 Kg per day × 40 days
=150000 kg = 150 m^3.
From geometrical assumption : V_{gs} + V_f = 80 % of V
or,   150 m^3 = 0.8 × V
or,   V = 187.5 m^3 == 190 m^3
Since, V = 190 m^3 ,
In Bangladesh Fixed dome cylindrical Digester is used,
D= 1.3078 × $V^{(1/3)}$ = 7.518 m == 7.52m.
V_1 = .0827 × D^3 = 35.2 m^3
V_2 = .05011 × D^3 = 21.3 m^3
V_3 = .3142 × D^3 = 133.61 m^3
f_1= D/5m = 1.504 m
f_2 = D/8 = 0.94 m
R_1 = 0.725 × D m = 5.452 m
R_2 = 1.0625 × D m = 7.99 m
Since V_3 = 133.62 m^3,
V_3 = (3.14×D^2×H)/4
Or, 133.62 m^3 = [3.14 × $(7.52)^2$×H] /4
Or, H = 3 m
From assumptions,
V_c = 5% × V m^3 = 9.5 m^3
V_s = 16% × V m^3 = 30.4 m^3
Now the volume of gas storage chamber should be 50 % of the gas produced in a day .
So, V_{gs} = Amount of daily gas yield = TS × gas production rate per Kg TS = 105 m^3
Now the discharge of outlet should be the same of inlet recharge.
So, outlet discharge $V_{discharge}$ = 3750 /1000 = 3.75 m^3 == 4 m^3.
Total volume of the gas staying chamber = V_c + V_1+ $V_{discharge}$ = 52 m^3.

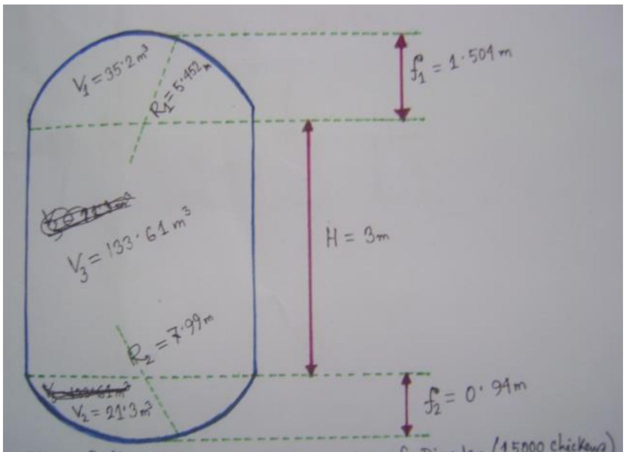

Fig 4 : Different measurement parameter of Digester (15000 chickens)

Design of Digester for 20000 chickens:

Volume Calculation of Digester Chamber:

Let, HRT= 40 day (for temperature 30° C).
We know, from every chicken 0.1 Kg waste is obtained per day.
Total discharge = (20000×0.1) Kg = 2000 Kg.
TS of fresh discharge = (2000 × 0.2) = 400 Kg.
To make the TS value of 8% for favourable condition we have to mix some additional water with fresh discharge. The required water to be added can be calculated by the following way.
8 Kg solid equivalent of influent ; 400 Kg solid equivalent = (100* 400)/8 Kg = 5000 Kg .
So, Total influent required Q = 5000 Kg.
Required water to be added to make TS value 8% = (5000-2000) Kg = 3000 Kg
Working volume of digester = V_{gs} + V_f. V_{gs} + V_f = Q × HRT
=5000 Kg per day × 40 days
=200000 kg = 200 m^3.
From geometrical assumption : V_{gs} + V_f = 80 % of V
or,   150 m^3 = 0.8 × V
or,   V = 250 m^3
Since, V = 250 m^3 ,
In Bangladesh Fixed dome cylindrical Digester is used,
D= 1.3078 × $V^{(1/3)}$ = 8.23 m

V1 = .0827 × D^3 = 46.10 m^3
V2 = .05011 × D^3 = 27.94 m^3
V3 = .3142 × D^3 = 175.15 m^3
f1= D/5 m = 1.646 m
f2 = D/8 = 1.0287 m
R_1 = 0.725 × D m = 5.97 m
R_2 = 1.0625 × D m = 8.75 m

Since V_3 = 175.15 m^3,
V_3 = (π ×D^2×H)/4
Or, 175.15 m^3 = [3.14 × $(8.23)^2$×H] /4
Or, H = 3.3 m
From assumptions ,
V_c = 5% × V m^3 = 12.5 m^3
V_s = 15% × V m^3 = 37.5 m^3
Now the volume of gas storage chamber should be 50 % of the gas produced in a day .
So, V_{gs} = Amount of daily gas yield = TS × gas production rate per Kg TS = 140 m^3
Now the discharge of outlet should be the same of inlet recharge.
So, outlet discharge $V_{discharge}$ = 5000 /1000 = 5 m^3
Total volume of the gas staying chamber = V_c + V_1+ $V_{discharge}$ = 65 m^3.

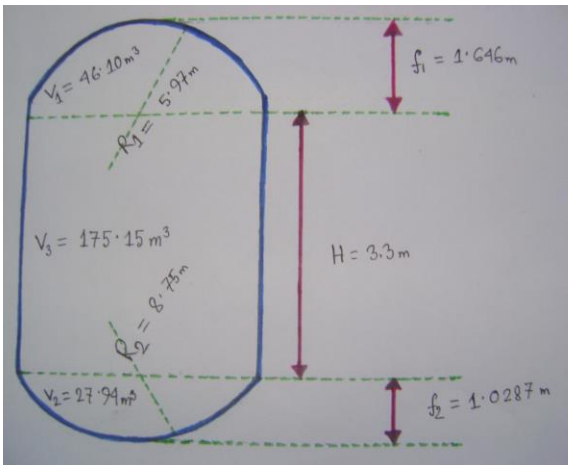

Fig – 5 : Different Measurement Parameters of Digester (20000 chickens)

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B. *Design of Digester for 70 Cows:*

Volume Calculation of Digester Chamber:

Let, HRT= 40 day (for temperature 30° C).

We know, from every chicken 10 Kg waste is obtained per day.

Total discharge = (70 × 10) Kg = 700 Kg.

TS of fresh discharge = (700 × 0.16) = 112 Kg.

To make the TS value of 8% for favourable condition we have to mix some additional water with fresh discharge. The required water to be added can be calculated by the following way.

8 Kg solid equivalent of influent; 112 Kg solid equivalent = (100* 112)/8 Kg = 1400 Kg .

So, Total influent required Q = 1400 Kg.

Required water to be added to make TS value 8% = (1400 - 700) Kg = 700 Kg

Working volume of digester = $V_{gs} + V_f$. $V_{gs} + V_f$ = Q × HRT

= 1400 Kg per day × 40 days

= 56000 kg = 56 m^3.

From geometrical assumption : $V_{gs} + V_f$ = 80 % of V

or, 56 m^3 = 0.8 × V

or, V = 70 m^3

Since, V = 70 m^3 ,

In Bangladesh Fixed dome cylindrical Digester is used,

D= 1.3078 × $V^{(1/3)}$ = 5.4 m

V1 = .0827 × D^3 = 13.03 m^3

V2 = .05011 × D^3 = 7.89 m^3

V3 = .3142 × D^3 = 49.48 m^3

f1= D/5 m = 1.08 m

f2 = D/8 = 0.675 m

R_1 = 0.725 × D m = 3.915 m

R_2 = 1.0625 × D m = 5.7375 m

Since V_3 = 49.48 m^3,

V_3 = (π ×D^2×H)/4

Or, 49.48 m^3 = [3.14 × $(5.4)^2$×H] /4

Or, H = 2.16 m

From assumptions ,

V_c = 5% × V m^3 = 3.5 m^3

V_s = 15% × V m^3 = 10.5 m^3

Now the volume of gas storage chamber should be 50 % of the gas produced in a day .

So, V_{gs} = Amount of daily gas yield = TS × gas production rate per Kg TS = 43 m^3

Now the discharge of outlet should be the same of inlet recharge.

So, outlet discharge $V_{discharge}$ = 1400 /1000 = 1.4 m^3

Total volume of the gas staying chamber = V_c + V_1+ $V_{discharge}$ = 18 m^3.

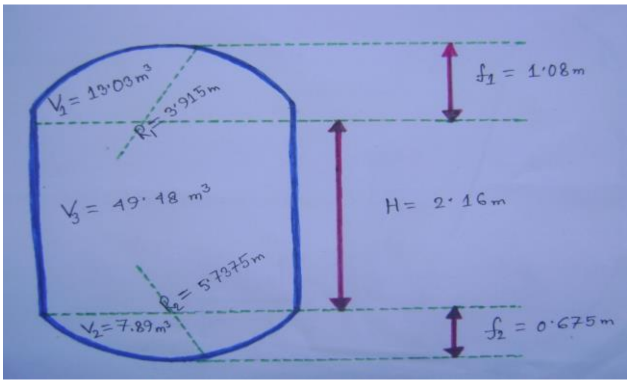

Fig – 6 : Different Measurement Parameters of Digester (70 Cows)

V. BENEFIT OF BIOGAS

Energy Benefit: Biogas contains mainly CH_4 (60% - 70%), which is the same energy carrier as in natural gas. So, biogas and natural gas can be used for same application. Methane can be burnt for cooking or lighting the house. It can also be used to power combustion engines to drive a mechanical motor or generate electricity.

Economic Benefit: Biogas has two types of economic benefits one is it saves the energy cost to be purchased and on the other hand extra money can be earned by selling biogas to the neighbours.

Carbon credit: Methane captured from anaerobic digestion of livestock manure may be qualified to receive carbon credit if it is collected and prevented from discharging in to the atmosphere. According to the Second Assessment Report (1996) of the Intergovernmental panel on Climate change (IPCC), the Global warming potential of CH4 is equivalent to 21 times that of CO2 . This means that in terms of global-warming potential, reducing one metric ton of CH4 gas emissions has the same impact as reducing 21 metric tons of CO2 emissions.

Agricultural Benefit: In a biogas plant cow dung and other organic waste are converted to liquid slurry. The liquid slurry can be easily brought to places that need organic fertilizers. The most important benefit is that the slurry is a very effective fertilizer that can improve the growth of the crops. Nitrogen is one of the major nutrients required for plant growth. In cow dung most of the nitrogen is not immediately available for the plants. Before plant can use the nitrogen in organic fertilizer, the nitrogen is not immediately available for the plants. Before plant can use the nitrogen in organic fertilizer, the nitrogen need to be extracted from large organic molecules and transformed into smaller inorganic water soluble compounds before plants can use it. This transformation process is called mineralization. In the conversation process, that takes place in a biogas plant, the organic nitrogen in the cow dung are mineralized to ammonium and nitrate. The nitrogen is thus available for the plants and the short term fertilizer value is doubled. The slurry from a biogas plant can be used to fertilize crops; the slurry from a biogas plant can be used to fertilize crops; the slurry can raise the crop growth considerably. In the area the slurry is mainly used for fertilizing vegetables and bananas growing in the areas close to the house. The farmers have experienced that the fertilizer here gives best results and also that the work of bringing out the slurry in to these area are less labor intensive. The surplus slurry can be used to fertilize other crops on the fields. As the slurry contains substantial of liquid, the slurry will in dry period also supply the plants with some water for the plant growth. The slurry brought out will form a cover on the soil and hereby reduce the evaporation from the soil. We have seen examples of that household having biogas plant in dry periods have been able to grow vegetables, when other households have been unable to grow anything . Health Benefit: During the conversion process a lot of micro organisms, that represents a health risk, are killed. By this the hygienic standard in the household have been improved. The following germs are killed in biogas digester. (paratyphoid , Cholera and dysentery bacteria (in one or two weeks),

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Hookworm and bilharzias (in three weeks), Tapeworm and roundworm die completely when the fermented slurry is dried in the sun.

Furthermore, this conversion in a biogas plant has several benefits for the household. The availability of biogas can have effects on nutritional patterns too. With easy access to energy, the number of warm meals may increase. Whole grain and beans may be cooked longer, increasing their digestibility, especially for children. Water may be boiled more regularly, thus reducing waterborne diseases.

Environmental Benefit: Producing biogas from livestock manure can reduce odour because the slurry does not produce severe smell and does not attract flies. Furthermore, it helps reducing water contamination risk when it comes in touch with cow dung, Pathogen reduction, Methane destruction/capture through digester. In a conscious way, we can say that Large scale biogas Plant development in Bangladesh could bring significant environmental benefits. These are :

A. Reduce higher level of deforestation.
B. Reduce net greenhouse gas emission.
C. Improve air quality and reduce acid erosion.
D. Improve soil quality and reduce erosion.
E. Reduce land filling by adding value to residues.
F. Reduce agricultural chemical runoff.
G. Improve sanitation condition.
H. Improve habitat for native wildlife and improve biodiversity.
I. Outlining sustainable land use and improved air quality.
J. Improved habitat for wildlife and reduced use of fertilizers and insecticides compared with lands used for row crops, protection of riparian areas and erosion protection for sensitive land areas.
K. Reduction of green house from biomass power takes place because the carbon dioxide released during combustion is absorbed by the plants as they grow.

VI. SOCIO ECONOMIC IMPACT OF THE PLANT

By implementing these types of big scale biogas plant (community/ village based) , there have several benefits; some are described below :

Encourages farming: Once the people of community/village are benefited by the project then they will be inspired for farming and rising of bovine animals.

Economically independent: When the citizens start to get the benefit of biogas slurry rather than chemical fertilizer then they will reduce dependence on chemical fertilizer. So, this can make the people benefited economically.

Reduce deforestation: In rural areas, the most popular energy source is wood to cook food or generate heat. This causes deforestation in a country. By implementing such project, people will have gas to generate heat for cooking which will eventually reduce deforestation.

Saves eco system: Unbalancing the eco system is the main cause of natural disasters. This project can play a powerful role to keep the balance of eco system as it will encourage farming and reduce deforestation.

Enhances nutrition system of rural mass by producing milk, meat and organic fertilized crops: As this project will run on animal manure. So, people will be motivated to produce more cropes and enhanced farming will fulfill the lack of meat protein and milk. Crops will be more reliable and healthy to eat as chemical fertilizer will not be used for farming.

Improves agricultural productivity: It is proven that biogas slurry is a good quality organic fertilizer. So, farmers will start to use this fertilizer in place of conventional chemical fertilizer which not only reduce the quality of crops but also reduce the productivity of soil.

Develop lifestyle: In rural area women are often use wood to produce heat for cooking in a conventional oven. On the other hand using readily available biogas women will be able to save significant time spent for collecting wood. They can invest their time thus saved to more productive purpose. The air pollution will decrease and respiratory diseases and infections in eye will be reduced significantly. So, it is clear that better lifestyle can be attained by implementing such project.

VII. CONCLUSION

Lack of public awareness and proper motivation some biogas project have become unsuccessful in Bangladesh. So, it is necessary to develop awareness amongst the rural population about the benefit of biogas plants. Bangladesh has abundant bio mass resource, it can be optimally used to generate biogas for its energy needs. Making small co-operatives and setting up biogas plants under these co-operatives may change the overall energy scenario of Bangladesh and government may save substantial amount of foreign exchange by reducing the import of hydro carbons. Though building up a biomass conversion plant involves high cost of investment, but considering the global warming and its effect on the eco-system and above all the risk of health hazards from the conventional stoves proposed biogas plant will be cost effective. The main challenge to implement such a biogas plant is to enhance public awareness in rural areas. If once the public awareness gets momentum then the project will run efficiently and economically.

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