International Journal of Engineering Research
Volume No.5, Issue No.12, pp :939-942

ISSN:2319-6890 (online),2347-5013(print)
1 December 2016

An Analytical Report on Renewable Energy Production from Municipal Wastes in Bangladesh

Goutam Das[1*], **Nurul Anwar**[2], **Shovan Chowdhury**[3], **Partha Pratim Chakraborty**[4]

[1-4]Department of Mechanical Engineering, Chittagong University of Engineering and Technology, Chittagong-4349, Bangladesh

[1,*]Goutam_das@outlook.com, [2]im_ayn@outlook.com, [3]shovan.c91@gmail.com, [4]dip.partha@gmail.com

Abstract: ***Daily wastes could be a great source of renewable energy. In a densely populated country like Bangladesh, tones of wastes are produced daily, a considerable portion of which is organic in nature, and also biodegradable. Due to absence of adequate waste treatment plants in Bangladesh, the accumulation of these wastes represent a serious environmental hazard, especially when untreated wastes are dumped directly into water bodies. But if these wastes can be processed systematically, it is possible to generate renewable energy from those. Bangladesh is already going through a dire shortage of electricity and power and with most of its gas fields nearing exhaustion, the situation is likely to worsen in near future. Hence, a way of extracting power from municipal waste essentially provides Bangladesh with alternative fuel option as well as reduces its waste disposal problem. This paper represents the procedures of getting renewable energy from daily municipal wastes in a regulatory way: how the wastes are to be first sorted according to biodegradable/non-biodegradable nature, subsequent power extraction from the first and recycling of the latter portion. The paper also includes the likely hurdles that have to be overcome, possible outcomes and benefits too.***

Keywords**: Renewable Energy, Bangladesh, biodegradable, Electricity and municipal waste.**

I. INTRODUCTION

Considerable efforts are being put all around the world for finding possible renewable energy sources after realizing the fact that fossil fuels would not run for eternity in the world. While rich countries can afford to look for expensive ones too, for a developing country like Bangladesh with a low GDP, the options are quite limited and it can only interest in the sources which are cheap to extract. The declining gas reserve of Bangladesh recently alarmed the government to look for possible renewable energy sources. Some of the prospective ones are wind energy, solar energy, biogas, geothermal energy etc. However, every source of energy comes at a price such as solar energy requires direct sunlight to get accountable output, wind power plants are mostly practical at seashores, Geothermal energy are not available everywhere, hydropower may be the best of all but it requires to control the river which is not environment friendly, tidal energy is hard to get as it requires huge infrastructure which is not cost effective. Municipal wastes are hardly believed as a potential solution rather a major problem but it seems like some windows are opening through it, as it can be our permanent solution of energy scarcity. Biogas production can really enjoy a boost as the raw materials are available in plenty, for Bangladesh being an agricultural country. If municipal wastes too can be used as a raw material for Biogas production, it will be a boon in Biogas production and reduce Bangladesh's dependency on natural gas for energy production. Currently there is around 14 thousand ton municipal waste production per day across the country. With increasing population, this figure is only expected to rise in future, never decrease. Hence, the use of municipal waste essentially means an unending source of energy for Bangladesh. On the plus side, it also reduces the waste disposal problem of Bangladesh and helps the developing country attain a better and cleaner environment in future.

II. MUNICIPAL WASTE CHARACTERISTICS IN BANGLADESH

Municipal solid wastes are items that are discarded by the public and thrown away. The composition of municipal waste varies greatly from country to country and changes significantly with time. It depends on factors like food habit, cultural tradition, socio-economic and climatic condition. In urban Bangladesh, solid wastes are originated from residential houses, street sweeping, commercial, industrial and other sources.

Fig.1: Composition of Municipal Wastes in Bangladesh [ix]

These includes dust, ash, vegetable and animal bones, putrescible matter, paper and packing of all kinds, rags and

ISSN:2319-6890 (online),2347-5013(print)
1 December 2016

other torn fabrics, garment materials (wastes) glass and many other non-combustible trash. These wastes are often thrown into and / or dumped and piled roadside or corner dustbins, vacant spaces near markets, road intersections and other such areas.

As is seen from the pie chart, there is very high percentage of food, vegetable and garden waste in Bangladesh. All of which is bio-degradable and hence municipal waste in Bangladesh will be a potential source for Bio gas production

III. AMOUNT AND COLLECTION OF WASTE

In majority of urban areas, community bin system of waste collection is being practiced in Bangladesh. Recently, in some areas NGOs have introduced door to door collection of solid waste. But the coverage of neither communal dustbin system nor house to house waste collection system is sufficient yet. Moreover, no specific rule or criterion is followed while placing dustbins. The practice of widely spaced communal bins is usually a failure because the demand placed on the household goes beyond willingness of the residents to co-operate. This creates a messy situation and an unpleasant site almost in majority of areas. Table below shows the waste generation and waste collection rate:

Table 1: Waste Generation and Collection in Bangladesh [viii]

City/Town	TWG* (Ton/day)	Waste Collection Rate, %
Dhaka	4634.52	37.00
Chittagong	1548.09	70.00
Rajshahi	172.83	56.67
Khulna	321.26	47.70
Barisal	134.38	44.30
Sylhet	142.76	76.47
Pourashava	4678.40	54.42
Other Urban enter	1700.65	52
Total	13332.89	Avg.55

*TWG=Total Waste Generation

Several thousands of urban dwellers in Bangladesh, make their living upon wastes in many small industries using plastics, in cans, bottles, bones, hair, leather, glass, metal etc. recovered from MSW. All metals, unsoiled paper, plastics, glass, cardboard etc. are readily marketable and hence recycled by householders themselves or Rag-pickers. By the time waste reaches the community bins, it contains very little in the way of recyclable and consists mainly of vegetable/fruit peelings, scraps of soiled paper and plastic, used toiletries etc. [i]. Thus it shows that very little sorting is indeed necessary for feeding the biogas plant, and a majority of the portion can be fed in its entirety with little work needed. Still, we propose the following collection and sorting method for increasing efficiency.

1. The collection of waste could be handed over to the very firm which would run the Gas generation plant. This way they themselves will make sure the best possible collection rate, as more raw materials for their plant means more profit for them. Government can make a deal with them, giving them the ownership of wastes of particular geographic location. Fines could be imposed if waste collection is not satisfactory or unorganized.

2. The sorting is best done at source. A massive awareness program has to be launched with the help of government to encourage sorting of waste at the very source, means the residents and market places. Two separate bins are to be maintained in every establishment, one for the organic bio-degradable material and one for the rest.

IV. BIOGAS

Biogas, which is mainly composed of methane and carbon dioxide, is produced during the decomposition of organic matter in anaerobic conditions. The organic matter is decomposed in a number of steps in collaboration between several different types of microorganisms. The efficiency of biogas production depends on how suitable the conditions are for the microorganisms. To initiate a biogas process, sludge containing the bacteria is inoculated from existing biogas plant. The natural generation of biogas is an important part of the biogeochemical carbon cycle. Biogas is produced by anaerobic digestion with anaerobic bacteria or fermentation of biodegradable materials such as manure, sewage, municipal waste, green wastes (wastes originated from tress and herbs) and crops.

Biogas is a mixture of gases that is composed of methane(CH_4): 40-70 vol.%, carbon dioxide (CO_2): 30-60 vol.%, other gases: 1-5 vol. %, hydrogen (H_2): 0-1 vol.% ,hydrogen sulfide(H_2S): 0-3 vol.%[ii]. The calorific value of biogas is about 6 kWh/m3 this corresponds to about half a liter of diesel oil. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat.

There are three distinctive procedures in biogas production. They are:-

- The fermentative bacteria converts organic material into fatty acid, alcohol, carbon dioxide, sulfur and ammonia.
- The acetogenic bacteria consumes the primary products and produce hydrogen, carbon dioxide and acetic acid.
- In this stage two types of bacteria work.

The first reduces carbon dioxide to methane, and the second decarboxylates acetic acid to methane and carbon dioxide.

ISSN:2319-6890 (online),2347-5013(print)
1 December 2016

Bangladesh has a wonderful climate for biogas production. The ideal temperature for biogas is around 35°C. The temperature in Bangladesh usually varies from 6°C to 40°C. But the inside temperature of a biogas digester remains at 22°C-30°C, which is very near to the optimum requirement. In Bangladesh animal dung, poultry waste, and agricultural residues have long been used to produce biogas in the plant. The high production rate of animal dung has given it more attraction to be used as the chief biomass element. But in urban areas due to the unavailability of space animal farm is not available. So there were concerns for alternative sources of biogas. The municipal wastes could be a potential source of biogas production across Bangladesh.

To be viable, digesters require a regular supply of slurry with greater than 6% total solids (TS) content, which should produce a biogas yield of about 16-20 m3 biogas per ton of slurry[5]. Therefore, dilution of slurry should be avoided. On many farms the removal of dilution water from slurry would involve extensive civil work. At the other extreme, a high TS content of slurry (>12%) makes poor flow characteristics and difficult for pumping.

Digester heating is normally carried out by circulating hot water through a heat exchanger located inside or outside the digester. Hot water can be produced by utilizing some of the biogas produced through a biogas boiler (75-90% efficient), or through a combined heat and power unit. Alternatively heat can be provided by electrical heating, by an oil boiler or from some other source of energy. Insulation of the digester is important to minimize heat loss.

V. OVERVIEW OF THE PROCESS

The following summarizes the different steps to be followed in extracting energy from municipal waste:

- Collection: The collection of wastes is to be handled by the existing city corporations. However, steps need to be taken to increase the efficiency of collection. Private firms could be included to do so.
- Primary storage: Wastes collected by City Corporation will be stored in this storage tank.
- Sorting: Wastes will be sorted according to putrescent/non-putrescent nature.
- Organic putrescent portion to be used for Biogas production.
- Inorganic portion: To recycling plants.
- Secondary storage: This tank contains the raw materials that will be fed directly to the digester.
- Digester: In this tank, with light and oxygen excluded the biomass is digested by anaerobic micro-organisms. This digestion process produces methane and carbon dioxide-the biogas.
- Gas storage: The resulting gas is stored in the top hood of the fermenter directly above the fermenting biogas.
- To Power plants: For maximum efficiency, CHP (Combined heat and power) system is best method available up to date.
- Excess: If there is excess after supplying the power plants, the excess could be treated by a gas treatment plant. The methane content and quality of the biogas are increased to make it like conventional natural gas. After treatment, the gas could be fed directly into existing natural gas network.
- Digestion Residue: After fermentation in the digester, the digestion residue is first placed in the digestion residue storage facility from where it can be removed later and used as high-quality fertilizer.

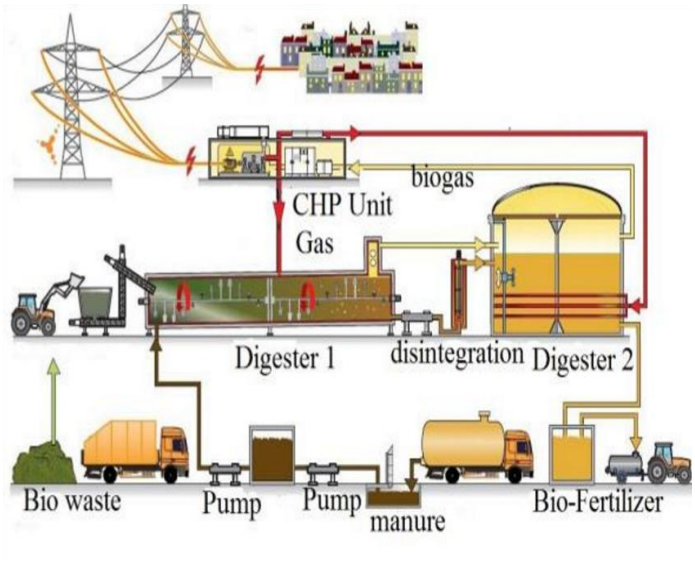

Fig 2: Overview of the process[x]

VI. PROSPECTIVE OUTCOME

A typical normal cubic meter of methane has a calorific value of around 10kWh, while carbon dioxide has zero. The energy content of biogas is therefore directly related to methane concentration. In other words, assuming a biogas composition with 60% methane concentration, then, the energy content would in this case be around 6.0 KWh per normal cubic meter [iii] [iv].

The calorific value of biogas is thus variable (depending on methane content) at 20-26 MJ/m^3 [v]. Biogas is thus an excellent source of renewable energy.

Total waste available: 14000 ton per day [1].

Usable Organic fraction: 80 %(approximate.)[1].

Usable portion for Biogas production:

0.8*14000 ton = 11200 ton.

Efficiency: (85-159) m^3 [vi] per ton of waste. Average: 120 m3 per ton of waste.

Biogas Production: 11200 * 120 = 1344000 m3.

ISSN:2319-6890 (online),2347-5013(print)
1 December 2016

Calorific value: 23 MJ/ m3 [v].

Total energy: 23 * 1344000 = 30912000MJ per day.

Overall efficiency of CHP system = 75% [vii]

Energy output= 23184000 MJ per day= 6440000 kWh per day.

Efficiency of electrical output= 31% [vii]

Electricity output = 9582720 MJ per day = 2661866 kWh per day.

VII. CONCLUSION: TOWARDS A GREENER FUTURE

The calculation shows that a considerable amount of energy could be extracted from the municipal waste of Bangladesh. For a country in dire electricity crisis, there is no scope of avoiding its potential. As more fossil fuel is being harvested in the world, finding new sources becomes more difficult and more expensive, and exploiting them becomes more challenging and sometimes dangerous as well. Marginal reserves, such as oil sands, require the burning of huge amounts of natural gas to refine them into usable oil. Drilling under the ocean floor can lead to catastrophic accidents, such as the British Petroleum oil spill of 2010. Renewable energy, by contrast is the greenest form of energy and also, raw material for our biogas project comes very cheap. On the plus side, it solves Bangladesh's Waste Disposal problem too. Pilot project should therefore be undertaken by the government to implement this process to boost our energy sector and also to help keep our environment clean. We can follow developed countries who have successfully adapted technologies in biogas production. Private sectors should be given incentives to invest in electricity from municipal waste. To raise awareness among the mass people, the media should be used effectively.

VIII. REFERENCES

i. *Salequzzaman et al, 1998.*

ii. *Bangladesh Power Development Board. Annual Report of 2006-2007. Dhaka, Bangladesh: BPDB, 2008. Availabe: www.bpdb.gov.bd/download/Annual%20Report-10.pdf*

iii. *Energinet.dk, www.energinet.dk,*

iv. *Preem, www.preem.se*

v. *Interim Technical Report, Peter Frost and Stephen Gilkinson, August2010. Available: http://www.afbini.gov.uk/afbi_ad_18_months-web .pdf*

vi. *Kelleher, 2007. BioCycle V. 48, No. 8, p.51.*

vii. *United States Environmental Protection Agency. Available at: http://www.epa.gov/chp/basic/efficiency.html*

viii. *Urban Solid Waste Management Scenario of Bangladesh. Iftekhar Enayetullah, A.H. Md. Maqsood Sinha, Syeda Shaila Akhter Khan.*

ix. *Carncross and Feachem, 1993, *IFRID and BCSIR, 1998, **Field survey*

x. *https://www.pinterest.com/pin/396950154627057358/*