ENVIRONMENTAL ANALAR

Env. Anal. 10 (2004) pp 1231-1239

BIOCONVERSION OF MUNICIPAL ORGANIC WASTE FOR EFFECTIVE WASTE MANAGEMENT STRATEGY IN NIGERIA

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Accepted 10th November, 2004

ABSTRACT

The cost of the present waste management in Nigeria is so expensive and ineffective. A search for is a simple engineering technology has evolved a less complex biotechnology aiming at transforming the so-called waste into useful resources. The adoption of biogas technology for the bioconversion of municipal organic waste will gear-up demand for municipal waste and transformed waste into resources. The simplicity, economic reliability and low cost of maintenance, make biogas technology a need now in the country. The adoption of biogas technology would make waste management venture lucrative for both government and private entrepreneurs.

INTRODUCTION

In recent years, many factors such as decreasing availability of land near population centres for land fills, rising cost of sewage disposal methods, escalation of the costs of convenient energy like fuel, gas and electricity, concern for conservation of exhaustible natural resources and the need for environmental protection have ushered in the philosophy of regarding waste as a natural resources.

The use of biogas technology in India so far, has been for generation of biogas (methane) and spent slurry (manure). In Nepal, China, and India animal and agricultural waste are fed into the digester. In urban areas where these materials are not easily and uniformly available, organic waste can be used. Biogas technology can be selectively adopted base on the source and availability of resources.

Markets in Nigeria, generate daily a lot of organic waste, which makes the areas unhealthy and whose disposal is a major problem. Ever since biogas technology came into existence, no effort has been made to employ this simple technology for effective use in the area of waste disposal/management in Nigeria. Lack of proper planning is the major problems of organic waste management in Nigeria, thus the adoption of biogas technology will create demand for organic waste. In countries like Nepal Ethiopia, Kenya, China, Brazil, China, Morocco, Sweden, Norway, Australia, Korea, United States, United Kingdom and Malaysia biogas technology is beginning to enjoy considerable support.

There is a wide range of degradable organic waste littering every available space in Nigeria. The availability of raw materials for biogas plant is not the problem but how to see waste as raw materials for economic drive. The simplicity, economic reliability and low cost of maintenance made biogas technology a needed technology for self-reliance economy. The present urban waste management problems, cost of living, unpredictable source of energy supply, high cost of waste management, daily increasing cost and quality of fertilizer and unemployment should change our concept to transform all problems to challenges.

In this paper the wider adoption of biogas technology as a source of bioconversion of biodegradable organic waste into fertilizer and methane gas for self-reliance economy is advocated. The methodology of doing this is one of the issues discussed in this paper and the economic viability is highlighted

Biogas technology

Anaerobic digestion is the controlled production of biogas (mainly methane) through the action of various bacteria in the absence of oxygen. One of the world's first large- scale anaerobic digesters was constructed in a Birmingham sewage works in 1911, but digesters have been designed to cope not only with sewage and animal slurry, but also with dilute dissolved or high – solids crop wastes. The anaerobic production of methane from waste material proceeds in three stages (Stafford et al 1980).

(1) In the first insoluble organic compounds are converted (via hydrolyzing bacteria) to more soluble products such as proteins, lipids, carbohydrates, and alcohol's.
(2) The second stage converts these soluble organic to organic acids (via acidogenic bacteria) as such as propionic acid acetic acid.
(3) The third stage (methane forming phase) the fatty acids and alcohols are converted to methane and carbon dioxide (via methanogenic bacteria).

REQUIREMENT FOR THE BIOGAS PLANT

Biodegradable organic waste: The biodegradable organic waste consists of cellulosic materials obtained from vegetables, fruits, cotton materials and paper. This waste must be carefully separated from the non-degradable materials and must be free from contaminants that may inhibit the growth of methanogenic bacteria.

Digester: Usually the anaerobic digestion is conducted in a closed vessel called digester. The digester can be built into the ground using burnt bricks. The installation of the digester should be in a close vicinity to the source of raw materials. Digester retention time for mesophilic process is about 40 days while that of the thermophilic process is about 20 days. Most digester requires neutral to alkaline pH (6.5-7.4).

Water: There must be a regular supply of water by the provision of borehole water some distance from the location of the digester.

THE WORKING OF BIOGAS PLANT

Pretreatment Process: This process prepares municipal solid waste for easier anaerobic digestion. It is designed to remove contaminants, metals, glass, and other non-biodegradable waste. It assures the quality of substrate in the biogas plant. The process may involve chemical, physical, thermal and mechanical methods. Though, the pretreatment process requires additional cost or energy input, but necessary for faster operation of the system.

Anaerobic Digestion and Bioconversion process: Anaerobic digestion of cellulosic waste material is a biotechnological process with methane-rich gas (biogas) and a spent slurry (organic fertilizer) as end products. During the hydrolysis phase, enzymatic breakdown of complex organic material into simpler molecules taken place. The acid forming phase involves the conversion of the organic material into fatty acids like propionic acids by bacterial action. In the methane-forming phase, the fatty acids and alcohols are converted into methane by methanogenic (methane forming) bacteria.

The anaerobic biodegradation process is affected by many factors. These are the carbon: nitrogen (C:N) ratio, temperature, pH, digester design, type and operation and toxicity. Generally, a C:N ratio of 45:1 or more appropriately 30:1 will favour gas production; a pH in the range of 7.0 to 7.2 is considered appropriate for the biodegradation process (Tchobanoglous et al, 1993), although a range of 6.1 to 7.6 is allowed. The higher the nitrogen content, the greater the ammonia concentration and its attendant inhibition: If the nitrogen content is too small, the bacterial will be unable to produce the enzymes, which are needed to utilize the carbon. A shortfall in the carbon may be corrected by the additional of organic waste to the feedstock. The process can be undertaken at (below 20°C) mesophilic (around 35°C) and thermophilic (around 54°C).

Methane gas can be produced at mesophilic and thermophilic temperatures. The mesophilic temperature range tallies with the average ambient temperature range in Nigeria. Consequently, biogas can be produced here without the need for heating. Biogas production at thermophilic temperature requires heating and thus increases the cost of production. However, gas production at the thermophilic temperature is faster.

Optimal temperature depends upon the type of bacteria used. Most experience is available with mesophilic bacteria (20 – 50°C) but thermophilic (50 – 65°C) or psycrophilic (<20°C) types can also be used. Psycrophilic digestion appears to be slowed by low temperatures. Obviously the mesophilic process can be conducted in ambient while the thermophilic process requires heating of the digester, which is paid off to some extent by enhancing rate of gas yield. This is a biological engineering structure in which anaerobic condition is ensured.

Energy conversion efficiencies in excess of 60% have been reported using animal slurry, even in systems, designed for simplicity (Parikh and Parikh, 1977, NAS, 1977). Solid waste digest with much greater difficulty, but efficiencies in the range 40-60% may be achieved (Anderson, 1972). Biogas from anaerobic digestion contains 60-90% methane, which can be used as fuel, and spent slurry (fertilizer) Fig. 1:

Precautions: Toxicity in the form of ammonia-nitrogen concentration in excess of 3,000m/l and the presence of heavy metals such as calcium, sodium, etc. is countered productive. The presence of antibiotics in the organic waste similarly affects the quantity and rate of biogas production. Methane forming bacteria are very sensitive to substrate composition pH and temperature. The concentration of dry matter should not exceed 10% by weight the rest being water and C:N ratio should be about 30:1. Lawson and Callaghan (1983) suggested adequate nutrients for bacterial growth (nitrogen phosphorus, sulphur and trace elements) must be maintained and about 8 parts of nitrogen and 1 part of phosphorus should match each 150 parts of carbon. (C:N:P ratio 150:8:1).

MUNICIPAL WASTE ARE NOT WASTE

Urban waste disposal was probably mankind's first environment problems; its management is an indicator of efficient urbanization. All solid waste management system has two aspects collection and viz. storage at or near the point of generation, gathering and disposal of waste.

In Nigeria, a huge lots of degradable organic waste are generated daily from the township markets and homes, polluting the air with obnoxious odour, harbouring and becoming a breeding spot for diseases, blocking water channels, inviting flies and vultures, making a mess of a beautifully set-up community. Of recent, most of the municipal wastes are contracted out to private individuals with little or no knowledge of waste management system. As a result, huge amount is invested in the programme but hardly any effective result is achieved. Not until trained private individual is admitted into this business, the problems of refuse disposal cannot be overcome.

Municipal wastes are of two types the degradable organic waste and non-degradable waste. The degradable organic waste comprise of toilet and urinary waste, cellulose waste (paper, vegetable, fruits) and animal waste. The non-degradable waste includes broken glasses, metals, and rubber materials. Looking at the nature of waste generated in a community effort should be geared toward designing appropriate waste management programme.

In Germany the Federal Government's Waste Management Programme instituted in the 1965 had three objectives.

(1) Reduction in quantities and avoidance of waste products.
(2) Increased utilization of waste and
(3) Environmentally sound disposal of waste products.

In Germany about 1.4 million tonnes scrapped cars are used as scrap metals. More than 70% tyres are also recycled. In United States of America re-utilization of tyres is done by the cryogenic method. The amount of recycled glass was more than double since 1975, when the figure was 200,000 tonnes to 490,000 tones in 1980.

The degradable waste is one of the most valuable natural resources, and produced in large quantity within the homes and market in Nigeria. It gulps more than five billion naira annually, to clear these organic wastes from the capital cities. Despite the huge amount expended on waste disposal the impact is not felt.

The introduction of biogas technology will not only purifies and c[illegible]se the surrounding but also provide job opportunity for able youths

and great demand for organic waste. Not until a demand was created for crude oil, no oil exploitation. Likewise, not until a demand is created for municipal waste there cannot be a proper waste management system. The only economic option for now is through biogas technology.

The Economic Prospect of Biogas Technology

There is a great economic prospect for the use of biogas technology in tropical Africa, because the raw material is very much available and cheap. Presently, most of the fertilizer company in the country are not functional i.e. unable to meet the agricultural demand of the nation. The inorganic fertilizer is also fast becoming unsafe for several reasons. In the United State of America, more than 75% of the Agricultural products are of organic fertilizer. To empower the million of youth in the country roaming about the street, involving themselves in anti-social and criminal offences, this simple biological engineering could be the only way to tap both the human potentials and economic resources of the youths. By so doing, a big demand is created for municipal waste and ecologically safe, biological and soil friendly fertilizer will be injected on the field and the entire ecosystem. The future leaders (youth) can through this process earn their living and contributes to the economy of the country. The cost of setting-up many of this biogas plant will not come closer to building a fertilizer company. The biogas plants can be fabricated locally and will not involve importing any part from outside the country. Biogas technology is non-polluting and could eliminate or reduce the occupational risk with careful monitoring of the system It is unlikely that the accident will be greater than in the coal and Uranium mining industries (EL-Hinnari 1981). The raw materials that could pose problems are abundantly available. The spare parts for the equipment and the machines will not be a hindrance to the maintenance of the equipment. It is possible the company run into problem where excess of methane gas is produced by the digester plant in the storage tank. The individual may give out excess gas to independent Renewable Energy Generation (IREG) who can lay gas pipeline on demand to the market or nearby residential houses.

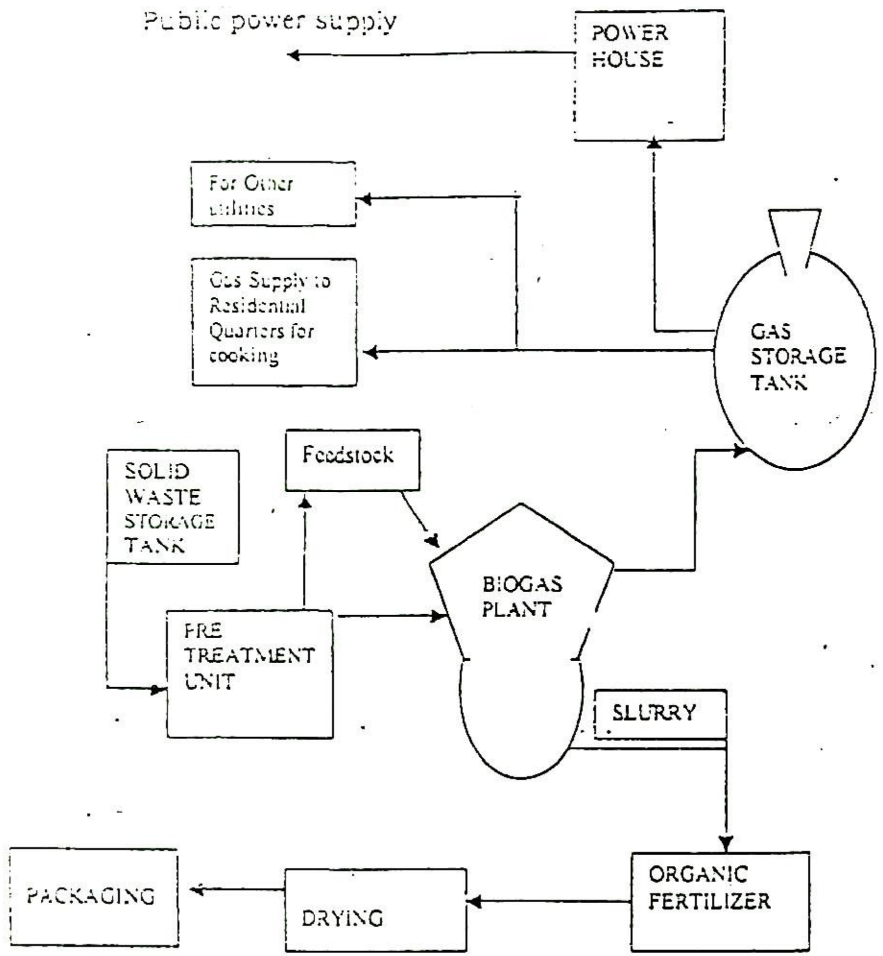

Fig. 1. Flow chart for the proposed strategic municipal waste management biogas plant

CONCLUSION

Biogas technology is awaiting its full exploitation in tropical African communities in the area of waste management and energy generation. The simplicity, economic reliability and low cost of maintenance make biogas technology a need now in the country. The adoption of biogas technology would make waste management venture lucrative for both government and private entrepreneurs.

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