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# A Review of Biomethanation Technology as a Promising Waste to Energy Option

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**Abstract—***Waste to Energy is perceived as a means to dispose municipal solid waste, produce energy, recover materials, and free up scarce land that would otherwise have been used for landfill. The Ministry of New and Renewable Energy (MNRE) lists number of technologies for energy recovery from urban and industrial waste that not only reduce the quantity of waste to meet the required pollution control standards, besides generating a substantial amount of energy.Biomethanation is one such technology where there is anaerobic digestion of waste leading to generation of biogas. This is a promising method for treatment of kitchen waste, vegetable and fruit market waste. The gas is useful as fuel to substitute firewood, cow-dung, petrol and diesel. These digester systems also provide a residue organic waste after its anaerobic digestion that has superior nutrient qualities over normal organic matter. This paper reviews various aspects about biomethanation technology, various factors affecting the biogas generation, physical and chemical characteristics of biogas and various researches adopted in the past.*

## 1. WASTE TO ENERGY POTENTIAL OF INDIA

According to Ministry of New and Renewable Energy (MNRE), there is a potential of about 1700 MW from urban waste (1500 from MSW and 225 MW from sewage) and about 1300 MW from industrial waste. There has been subsidies and incentives for waste to Energy projects from the ministry. According to Indian Renewable Energy Development Agency (IREDA), India has so far realized only about 2 % of its waste to energy potential.

Due to the characteristics of vegetable market wastes, biomethanation is a lucrative process for bio energy production and manure production. It is a well-established technology for stabilization of sewage sludge, farmyard manures, animal slurries, and industrial sludge and for disinfections, deodorization. It leads to bio-gas/power generation in addition to production of compost (residual sludge).

This method is suitable for kitchen wastes and, other putrescible wastes, which may be too wet and lacking in structure for aerobic composting. It is a net energy-producing process (100–150 kWh per tonne of waste input). A totally enclosed system enables all the gas produced to be collected for use. A modular construction of plant and closed treatment needs less land area. This plant is free from bad odour, rodent and fly menace, visible pollution, and social resistance. It has potential for co-disposal with other organic waste streams from agro-based industry. The plant can be scaled up depending on the availability of the waste.

Apart from cow dung as a raw material for the biomethanationplant, there is also a huge potential for biomethanation from other sourcessuch as poultry wastes: ~3000 million cu.m biogas/yr, MSW: 3670 MW, sewage: 390 MW, distillery effluents: 503 MW, milk processing: 70 MW, food processing, leather processing, rubber processing, slaughterhouse wastes, Pulp and paper industry wastes, vegetable markets, kitchen and canteen wastes (Kishore and Pant).

Anaerobic digestion is controlled biological degradation process which allows efficient capturing & utilization of biogas (approx. 60% methane and 40% carbon dioxide) for energy generation. Anaerobic digestion of food waste is achievable but different types, composition of food waste results in varying degrees of methane yields, and thus the effects of mixing various types of food waste and their proportions should be determined on case by case basis.

Anaerobic digestion (AD) is a promising method to treat the kitchen wastes. There are many factors affecting the design and performance of anaerobic digestion. Some are related to feedstock characteristics, design of reactors and operation conditions in real time. Physical and chemical characteristics of the organic wastes are significant for designing and operating digesters, because they affect the biogas production and process stability during anaerobic digestion. They include, moisture content, volatile solids, nutrient contents, particle size, & biodegradability. The biodegradability of a feed is indicated by biogas production or methane yield and percentage of solids (total solids or total volatile solids) that are destroyed in the anaerobic digestion. The biogas or methane yield is measured by the amount of biogas or methane that can be produced per unit of volatile solids contained in the feedstock after subjecting it to anaerobic digestion for a sufficient amount of time under a given temperature.

In recent times, varied technological modifications and improvements have been introduced to diminish the costs for the production of biogas. Different Methods have been developed to increase speed of fermentation for the bacteria gas producers, reduction of the size of the reactors, the use of starchy, sugary materials for their production, the modification of the feeding materials for fermentation and the exit of the effluent for their better employment, as well as compaction of the equipments to produce gas in small places like back-yard, among others. The biogas technology developed at BARC in India and commercialized asNisarguna Biogas Plant is an improvement on this technology (Asnani )

## 2. BIOGAS PRODUCTION AND COMPOSITION

Biogas is produced by bacteria through the bio-degradation of organic material under anaerobic conditions. Natural generation of biogas is an important part of bio-geochemical carbon cycle. It can be used both in rural and urban areas. The composition of a gas issued from a digester depends on the substrate, of its organic matter load, and the feeding rate of the digester.

**Composition of Biogas**

| Component | Concentration (by volume) |
|---|---|
| Methane (CH4) | 55-60 % |
| Carbon dioxide ($CO_2$) | 35-40 % |
| Water ($H_2O$) | 2-7 % |
| Hydrogen Sulphide ($H_2S$) | 2 % |
| Ammonia ($NH_3$) | 0-0.5 % |
| Nitrogen (N) | 0-2 % |
| Oxygen ($O_2$) | 0-2% |
| Hydrogen (H) | 0-1 % |

Composition of biogas depends upon feed material also. Biogas is about 20% lighter than air has an ignition temperature in range of 650 to 750 0C.An odorless& colourless gas that burns with blue flame similar to LPG gas. Its caloric value is 20 Mega Joules (MJ) /$m^3$ and it usually burns with 60 % efficiency in a conventional biogas stove.

The factors affecting the fermentation process of organic substances under anaerobic condition are,

- Quantity and nature of organic matter
- Temperature
- Acidity and alkanity (pH value) of substrate
- Flow and dilution of material

## 3. LITERATURE REVIEW

Many researchers in India and abroad have carried out studies for the production of biogas from kitchen and vegetable wastes, sewage sludge and municipal solid wastes (MSW) etc.

kameswari*et al* (2007) have developed a demonstration plant of capacity 30 t/d for the biomethanation fromvegetable market waste at Koyambedu, Chennai with financial contributions from Ministry of New Renewable Energy Sources (MNRE) Govt. of India, New Delhi and Chennai Metropolitan Development Authority (CMDA), Chennai with Technical support from Central Leather Research Institute (CLRI), Chennai. The Biomethanation plant was designed for 30 tonnes per day, organic loading rate of 2.5 kg of VS/day/$m^3$ with biogas generation of 2500 $m^3$ of biogas per day and is in operation since September 2005.

Biomethanation technology on a small scale is also functioning at Vijayawada and at other places in the country for the treatment of selected organic waste collected from canteens, vegetable markets, etc.

Mondal and Biswas(2012)have done a comparative study on production of bio gas from green vegetables wastes and dried vegetable wastes at different temperatures and concentrations by using two identical anaerobic bio digesters.

HilkiahIgoni (2008) studied the effect of total solids concentration of Municipal SolidWaste (MSW) on the Biogas Produced in an Anaerobic Continuous Digester. The total solids (TS) concentration of the waste influences the pH, temperature and effectiveness of the microorganisms in the decomposition process. The results show that when the percentage total solids (PTS) of municipal sold waste in an anaerobic continuous digestion process increases, there is a corresponding geometric increase for biogasproduced. They also performed a statistical analysis of the relationship between the volume of biogas produced and the percentage total solids concentration established that the former is a power function of thelatter, indicating that at some point in the increase of the TS, no further rise in the volume of thebiogas would be obtained.

## 4. CONCLUSION

Due to high population growth, municipal solid waste generation is also increasing. There is a need to have alternative option for the management of voluminous amount of solid waste as Present landfills are not adequate for waste disposal. Apart from issue of CO2 emissions is also there from the aerobic digestion of waste. In such scenario, proposal of biomethanation technology for the digestion of waste is a viable and profitable option.

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