Biogas as a Sustainable Energy Source in India

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ABSTRACT

In Indian scenario, Biogas can be a substitute for dung and firewood, it can meet the rural energy demand and also become a clean source of energy. It is a renewable energy source and can become a replacement for natural gas and Liquid petroleum gas. Different tests that can help in accessing biogas as a contender for new generation energy source are controlled cooking test, kitchen performance test, boiling test etc. 1.0 m^3 of biogas is equal in energy content to 1.7 L of bio ethanol, 0.97m^3 of natural gas and 1.1 L of gasoline. This paper throws light upon the progress of biogas technology in India, suggesting how this valuable potent resource can be used for future sustainability. This study can be helpful in implementing biogas technology in many rural areas across India thereby establishing social and economic stability.

Keywords: Biogas, Energy, Environment, Indian Scenario, Sustainable Fuel.

1. INTRODUCTION

India is the fastest growing economy and is seventh largest in the world by nominal GDP. India had 17% of the world's population by 2011, March and was ranked first for a high population density of 371 people per Km2 [11]. Still there are a large number of villages devoid of electricity due reasons like remote lands, rugged terrains and various other geographical reasons. The environment is also at stake as greenhouse gases, pollutants and other by-products critically impair the nature's wealth causing climate changes. Also due to population rise there is an increased demand for energy resources for national development needs. Ershad Ullah et.al, stated that biomass is still being depended upon as a solid fuel for cooking (thermal efficiency 5-15%) by about 30% of total Indian population [9].The strategy must target on the principal seven goals to fulfill the energy demand of the population in India which are minimization of cost, maximization of efficiency, employment generation, reliability of the system, minimization of petroleum product, maximize the usage of local resource and minimization of emissions [3]. Biogas has been found to be an eco-friendly fuel which can cater all the requirements of the present scenario in India. From being an easily producible fuel to an eco-friendly one, it can be used for cooking, heating, lighting and running small I.C engines.

This is eligible in fulfilling the basic needs of an Indian household to managing waste from society. Biogas is a gaseous fuel which is obtained from biomass by means of fermentation of wet organic matters. Biogas is clean as it does not release additional carbon into the atmosphere on burning and reduces greenhouse effect. Therefore it is eco-friendly and less polluting. All these factors effectively convey how biogas can become a sustainable source of energy in India.

2. LITERATURE REVIEW

Biogas is produced from anaerobic digestion of biodegradable organic matter, or "biomass." Bacteria present in, or added to, the biomass ferments it anaerobically (without oxygen), through biochemical reactions. The constituents of biogas include methane (60% to 80%), carbon dioxide (20% to 40%), and trace amounts of hydrogen sulfide, nitrogen, and other impurities. Cleaning to remove impurities and moisture is necessary before biogas can be used as an energy source for certain alternatives, such as compressed natural gas. This purification is known as "upgrading" the biogas. Rendering biogas to be at least 98% methane produces a product known as "biomethane." Biomethane performs identically to conventional fossil fuel natural gas, with all the same benefits and uses, and is one of the cleanest and most efficient alternative energy sources.

Major sources of biogas include municipal wastewater treatment plants, industrial waste treatment facilities, landfills, and agricultural sources such as manure and energy crops. In the past, such facilities used anaerobic digestion for stabilization, pathogen reduction, and volume reduction of wastes prior to disposal or land application. In many cases, biogas was simply flared. Biogas now is developing into a significant alternative energy source. Using biogas to produce electricity satisfies several regulatory concerns at once. Greenhouse gas emissions are reduced, because the release of methane is prevented; green and renewable energy is produced; volumes of waste requiring storage and disposal are reduced. At a time when the viability and safety of energy alternatives is being debated, it is pertinent to look at one of the oldest renewable energy alternatives, Biogas.

Biogas is primarily Methane and Carbon dioxide. It may have small amounts of hydrogen sulphide moisture and siloxanes. The gases methane, hydrogen and carbon monoxide 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. A family type biogas plant generates biogas from organic substances such as cattle–dung, and other bio-degradable materials such as biomass from farms, gardens, kitchens and night soil wastes etc. The process of biogas generation is called anaerobic digestion (AD). The following are the benefits of the Biogas technology

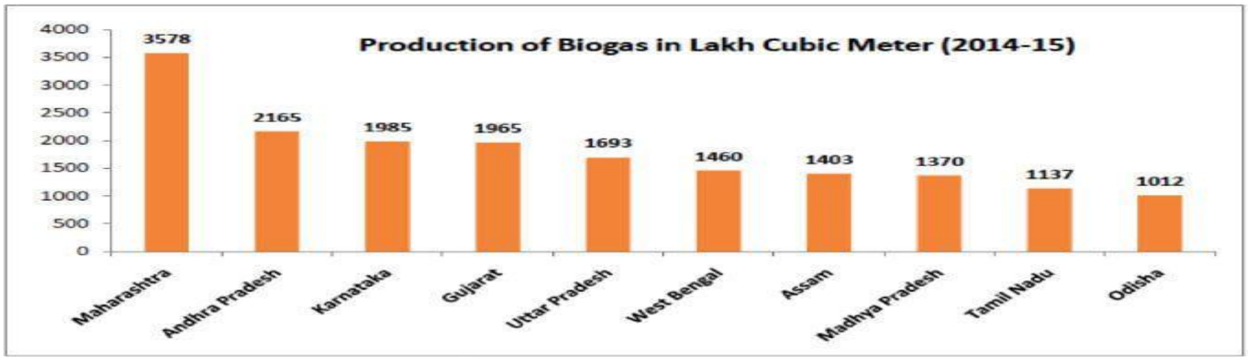
- It provides clean gaseous fuel for cooking and lighting.
- Chemical fertilizers can be done away with since the digested slurry obtained from the biogas plants can be used as enriched bio-manure.
- It is good for the climate and for sanitation problems since toilets can be linked directly with biogas plants.

3. Biogas Production in India

The biogas can be used to meet on-farm heating needs via combustion in boiler, heater, or engine. It can also be used to meet electrical demands with the excess electricity having the potential to be sold to a local utility company. Unfortunately, in most instances of full-scale anaerobic digestion, the energy savings and potential revenue (i.e. current selling price of electricity) are not enough to provide a positive cash-flow. Thus, producers often explore the use of cost-share, grant monies, or other subsidiary support to off-set a portion of the capital and installation costs [5, 13]. The digestate can be sent to a solid– liquid separator with the liquid portion being utilized as a fertilizer. The separated solids can be composted to both stabilize them and convert them into a more useful product (Fig. 2). There are many types of biogas plants in Europe, categorized according to the type of digested substrates, according to the technology applied or according to their size. The biogas plants digesting manure are categorized as agricultural biogas plants, and they usually co-digest manure and other suitable organic residues, many of them of agricultural origin, as well. A common classification of the agricultural biogas plants is: (1) the large scale, joint co-digestion plants and (2) the farm scale plants. There is not a sharp delimitation between these two categories as elements of technology from one category are also common to the other.

In India, the estimate for the production of biogas is about 20,757 lakh cubic meters in 2014-15. This is ***equivalent to 6.6 crore domestic LPG cylinders***. This is equivalent to 5% of the total LPG consumption in the country today.

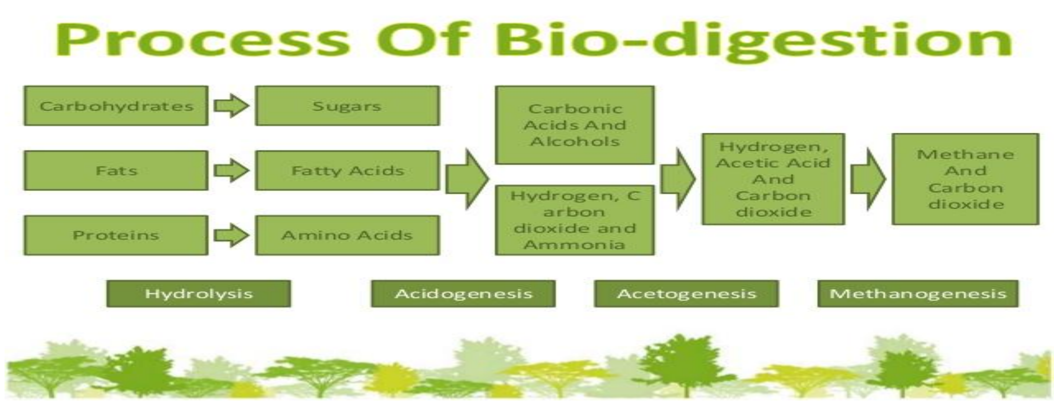
Within states, Maharashtra tops the production with 3578 lakh cubic meters while Andhra Pradesh comes next with 2165 lakh cubic meters.



4. BIOGAS TECHNOLOGY IN INDIA

The fermenter is the core of each biogas plant. It can degrade bacteria and decompose organic matter introduced.This releases the desired biogas. Without treatment in biogas plants these persistent substances can degrade and be converted to smell, ammonia, and reduce the proportion of oxygen in the soil. The process of obtaining biogas as to provide a double environmental benefit: in addition to power generation, which does not burden the atmosphere with additional greenhouse gas emissions, the starting material for the substrate is processed so that there are also less other emissions and are more environmentally acceptable. This requires a well-functioning fermenter which must be designed as follows:

- Access of air and light must be prevented .
- Containers must be watertight and gas-tight.
- It must be warmed to the desired process temperature and its preservation and precise regulation (thermo static regulation) ensured.
- Frequent and abundant mixing should prevent the formation of layers and zones.
- We need to ensure a reliable input and output, as well as the movement of the substrate.
- Adequate time of keeping the substrate in fermenter must be anticipated .
- The inlet cold-larger quantities of the substrate at a time must be avoided .
- Excessive amounts of inlet disinfectant substances must be avoided.



Biogas system consists of several components - in summary, the cave collecting substrate (manure, slurry, biowaste). Dip cutter first weighs, grinds and mixes. The mass of the system is transferred (pumping station), then proceeds to the fermenter, which is heat-insulated, gas-tight and equipped with wall heating. Charging of the fermenter is generally performed twice daily. This fermentation process is different and depends on the composition of the substrate. Fresh slurry and then the added weight are pushed from the first to the second fermentor and from it through another pump shaft are pumped in the final slurry tank. Slurry after fermentation does not contain nitrates, it is a valuable bio-fertilizer, which does not cause scorching of green leaves and is almost odorless. Second fermenter is usually of the same size as the fermenter, gas-tight and equipped with a mixing device. As a general rule it is necessarily not warmed and is sun heat insulated. Here desulphurization process with controlled air flows underway to prepare the biogas. Biogas from the second fermenter is stored in the gasometer which is designed to hold it, since production and use of biogas is not run simultaneously. The spectrum of substrates, the possibility of production and energy use of biogas are also expanding rapidly. The investors also set new challenges and risks faced by the Administration and various eco-sanitary and veterinary regulations and electrical permits.

5. BIOGAS AS A SUSTAINABLE ENERGY SOURCE

Utilization of Biogas

- **Cooking:** A biogas plant of 2 cubic meters is sufficient for providing cooking fuel needs of a family of about five persons.

- **Lighting:** Biogas is used in silk mantle lamps for lighting purposes. The requirement of gas for powering a 100 candle lamp (60 W) is 0.13 cubic meter per hour.

- **Power Generation:** Biogas can be used to operate a dual fuel engine to replace up to 80 % of diesel-oil. Diesel engines have been modified to run 100 per cent on biogas. Petrol and CNG engines can also be modified easily to use biogas.

- **Transport Fuel:** After removal of CO2, H2S and water vapor, biogas can be converted to natural gas quality for use in vehicles.

Benefits Of Biogas

- Availability of power at affordable rates
- Reduces pollution
- Reduces time wastage while collecting firewood
- Reduces reliance on fossil fuels
- Saves on the environment (Reduces deforestation)
- Improves living standards in rural areas
- Reduces global warming
- Produces good quality enriched manure to improve soil fertility.
- Effective and convenient way for sanitary disposal of organinc wastes, improving the hygienic conditions.
- As a smokeless domestic fuel it reduces the incidence of eye and lung diseases.

Biogas Production Potential From Different Wastes

	Raw Material	Biogas Production Liters/Kg	Methane Content in biogas %
1	Cattle Dung	40	60.0
2	Green leaves and twigs	100	65.0
3	Food Waste	160	62.0
4	Bamboo Dust	53	71.5
5	Fruit waste	91	49.2
6	Bagasse	330	56.9
7	Dry Leaves	118	59.2
8	Non edible Oil Seed Cakes	242	67.5

6. Biomethanation of manure

Anaerobic digestion is one of the technologies used to produce energy as well as to stabilize the waste. Energy production has remained an important factor, even with dropping energy prices. The atmospheric greenhouse effect, sustainable development and the ozone layer depletion have all contributed to the value of anaerobic digestion as a renewable energy source [19] .

The utilization of animal manure as a feedstock for biogas production will save plant nutrients and improve health conditions and quality of life in the villages [8]. Biogas is a CO neutral fuel and the increase of biogas utilization will achieve CO and methane emission decrease. However this reduction will depend on careful handling of fresh and digested manure to avoid significant methane losses to the atmosphere.

Many researches have studied the Biomethanation of cow manure in detail. Many studied the mesophilic and psychophilic digestion. Others studied thermophilic digestion [28]. Thermophilic digestion has many advantages over the mesophilic, such as higher metabolic rates, pathogen removal and improved physical-chemical properties.

7. Conclusion

There is a considerable potential of biogas production from anaerobic digestion of animal manure and slurries in Europe, as well as in many other parts of the world. Anaerobic digestion of animal manure offers several environmental, agricultural and socio-economic benefits through improved fertilizer quality of manure, considerable reduction of odours and inactivation of pathogens and last but not least production of biogas, as clean, renewable fuel, for multiple utilizations.

The last decade brought about huge steps forward, in terms of maturation of biogas technologies and economic sustainability for both small and large scale biogas plants. One of the driving forces for integrating biogas production into the national energy systems will continue to be the opportunities offered by biogas from anaerobic co-digestion of animal manure and suitable organic wastes, which solves some major environmental and veterinary problems of the animal production and organic waste management sectors. Rewarding manure processing for biogas production and for the environmental benefits provided by this would ensure the future development of the manure based biogas systems.

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