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Geographical Study of Electricity Generation from Biogas Cogeneration Plant at Jambhali in Shirol Tahsil of Kolhapur District

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Abstract:

Energy is a key determinant of socio-economic development of any country. Biogas as a renewable source of energy is an important assets to prevent energy crisis especially in rural areas. It is very important domestic energy for cooking and treated as an environmentally clean technology. Biogas can be produced from agricultural residues, animal wastes, municipal and industrial wastes etc. However in country like India, due to the extreme socio-religious sensibilities people have shown their opinion against using biogas from animal wastes and sewage for cooking. In this respect, biogas can be used for lighting purpose. However producing electricity from biogas is still relatively rare in most developing countries. In Germany and other industrialized countries, power generation is the main purpose of biogas plants. Conversion of biogas to electricity has become a standard technology. The present research paper will discuss the necessary frame work condition for the utilization of biogas for electricity generation, its potentials, advantages and disadvantages in rural areas of India. The research work is based on primary as well as secondary source of data. Primary data has been collected by visiting Motake-Patils biogas cogeneration plant located at Jambhali. Secondary data has been collected from books, news papers, internet etc. the study reveals that electricity generation from biogas could be the better solution of energy problems in the rural areas of India. The technology is easily adaptable and can be applied at household and community level in rural areas of the country. It has several advantages like generation of renewable green electricity, low operating cost, reduces green house gases, increases family income etc. However the technology is a bit too expensive for ordinary rural people and more profitable at larger level, so it is more applicable at community level rather than household level or small farmer. Government should work as promoter of this technology.

Key Words: Biogas, Renewable Green Electricity, Green House Gases, Environmentally Clean Technology

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INTRODUCTION

It is hard to imagine life without energy of some sort. Energy is treated as an important resource of planet earth. It plays vital role in shaping the all kinds of development in any region of the world (Murthy 2005). Energy is a key determinant of socio-economic development of any country. The industrial revolution and urbanization have caused the energy crisis because the said processes have quickly digested the traditional source of energy. The rate of energy consumption is increasing as well as the traditional sources of energy are continuously diminishing. This is the reason why the attentions of planners have been oriented toward the use of non-renewable source on a sustainable basis. Scientist thinking is that most renewable source of energy are environmentally rather sound and could specially help to most decentralized rural energy requirements (Prasad and Kislaya 2007).

Biogas is an important asset to present energy crisis especially in rural areas. It is very important domestic energy for cooking and treated as an environmentally clean technology. According to DNES (1984-85) 150 thousand biogas plants shall result in saving of 600 thousand tones of wood equivalent per year and a return of Rs.500 million per year. Biogas can be produced from animal wastes, agricultural residues, municipal and industrial wastes etc. however in country like India, due to extreme socio-religious sensibilities people have shown their opinion against using biogas from animal waste and sewage for cooking. In this respect, biogas can be used for lighting purpose also. However, producing electricity from biogas is still relatively rare in most developing countries. In Germany and other industrialized countries, power generation is the main purpose of biogas plants. Today, conversion of biogas to electricity has become a standard technology. The present research paper attempts to find out the potentials, advantages, disadvantages and necessary frame work condition for the utilization of biogas for electricity generation in rural areas of India.

SCOPE OF THE PROBLEM

The present research work deals with potentials, advantages, disadvantages and necessary frame work condition for the utilization of biogas on livestock farms for electricity generation in rural areas of India. The research work has been carried out by conducting intensive case study at Motake-Patils Cattle and Dairy Farm, and Biogas Cogeneration Plant located at Jambhali in Shirol tahsil.

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OBJECTIVE

These are the objectives that guided this research work.

1. To comprehend the necessary frame work condition for the utilization of biogas for electricity generation.
2. To examine the advantages and disadvantages of electricity generation from biogas on livestock farms.
3. To assess the potentials in biogas cogeneration plant especially in rural areas of India.

DATABASE AND METHODOLOGY

The data compiled in the study is collected from both primary as well as secondary source of information. The primary data is collected with the help of interview schedule and discussion with Hon. Annasaheb Patil- proprietor of Motake-Patils Cattle and Dairy Farm, and Biogas Cogeneration Plant. Secondary data is collected from the books, reports, newspaper, internet etc.

BIOGAS COMPOSITION

Biogas is by-product of the biological breakdown under oxygen free condition of organic wastes such as animal waste, agricultural residues, municipal and industrial sewage etc. it is also known as swamp gas, marsh gas, gobar gas etc. Actually it is a mixture of methane, carbon dioxide, water and hydrogen sulphide produced during the anaerobic (without air) decomposition of organic matter. It is produced by bacteria in the bio-degradation process of organic materials under anaerobic conditions (Jamil 2014).

Biogas consists mostly of methane (CH_4, around 65-70 %), carbon dioxide (CO_2, around 25-30 %) and varying quantities of water (H_2O), and hydrogen sulphide (H_2S) and some trace amount of the compounds. Methane is the valuable component under the aspects of using biogas fuel. The calorific value of biogas is about 6kWh/m^3, which corresponds to about half a liter of diesel oil and can be utilized directly as a heat source or to produce electricity (www.sswm.info/.../biogas electricity).

BIOGAS PLANT TECHNICAL CONSIDERATIONS

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Typically, a biogas plant consists of two components- a digester, or fermentation tank and gas holder. A digester is cube-shaped or cylindrical water proof container in which the digestion process occurs. The fermentable raw materials are introduced with water in digester in the form of liquid slurry. The gas holder is normally an airproof steel container that cuts off air to the digester and collects generated gas. The discharged materials are called effluents or sludge which could be used as fertilizers.

A typically biogas plant has the following components-

- A digester in which the slurry (dung mixed with water) is fermented.
- An inlet tank used to mix the feed and let it into the digester.
- A gas holder / dome in which the generated gas is collected.
- An outlet tank to remove the spent slurry.
- Distribution pipelines to take the gas into the kitchen.
- A manure pit, where the spent slurry stored.

There are some crucial factors – those have to be observed carefully, such as the temperature and retention time, solid concentration, location of the plant etc. Temperature is an important factor that can manipulate digester efficiency directly. Especially in winter, amount of gas production is reduced up to 5 to 10 %. The moisture of slurry should be in the range of 5 to 12 % of the total solid. The slurry should be diluted to such a consistency, that it makes a thick cream. A rule of thumb for diluting cattle waste is 2.5 parts water for every one part of relatively dry waste or one part of water for every one part of fresh manure (Mattocks, 1984). The digester should be located near the supply place, it could minimize the labor and other cost.

CONVERTING TECNOLOGY FOR ELECTRICITY GENERATION FROM BIOGAS

Various technologies to generate electricity from biogas on household or community level are available. Theoretically, biogas can be converted directly into electricity using fuel cell. However, very clean gas and an expensive fuel cell is necessary for this process. This is therefore still a matter for research and is currently not a practical option (http://energypedia.info/.../electricity_gen...).

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In principal, the chemical energy of the combustible gases is converted to mechanical energy in a controlled combustion system by heat engine. The mechanical energy then activates a generator to produce electrical power. Appropriate electric generators are available in virtually all countries and in all sizes. The technology is well known and maintenance is simple.

In theory, biogas can be used as fuel in nearly all types of combustion engines, such as gas engines (Otto motor), diesel engines, gas turbines; sterling motor etc. gas turbines are occasionally used in developing countries as they are expensive. Sterling motors are also relatively expensive and characterized by low efficiency. So there use is limited to number of specific application. In most commercially run biogas power plant today, internal combustion motors have become the standard technology.

In general, diesel engines operate on biogas only in dual fuel mode. To facilitate the ignition of the biogas, a small amount of ignition gas- often diesel fuel is injected together with the biogas. The advantage of these motors running in dual fuel mode is that they can also use gas of low heating value. However, in such case, they consume a considerable amount of diesel. Up to engine size of around 200 kW, diesel engines seem to have an advantage over gas motors due to their slightly higher efficiency (3-4 %) and lower investment costs. By contrast, gas motors with spark ignition (Otto system) can operate solely on biogas. In practice a small amount of petrol (gasoline) is often used to start the engine. This technology is used for very small generator sets (0.5-10 kW) as well as for large power plants (http://energypedia.info/…/electricity).

Today, experience of the use of combustion motors to produce electricity from biogas is extensive; this can be regarded as proven standard technology. However, it has taken lengthy and determined effort to make this technology as durable as it is today. Internal combustion motors have high requirements in terms of fuel quality. Harmful components especially hydrogen sulphide (H_2S) in the gas can shorten the lifetime of motor considerably and cause serious damage.

Appropriate gas quality:

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For use in gas or diesel engines, the gas must fulfill certain requirements.

1. The methane content should be as high as possible as this is the main combustible part of the gas.
2. The water vapor and carbon dioxide content should be as low as possible, mainly because they lead to a low calorific value of the gas.
3. The sulphar content in particular, mainly in the form of H_2S, must be low as it is converted to corrosion causing acids by condensation of combustion.

The following simple methods have generally established themselves as standard.

- An optimized steady fermentation process with continuous availability of appropriate feedstock is important to produce a gas of homogeneous quality.
- The injection of a small amount of oxygen (air) into the headspace of the storage fermenter leads, to oxidation of H_2S by microorganism and hence the elimination of a considerable part of the sulphar from gaseous phase. This is the most frequent used method for desulphurization. It is cheap and can eliminate up to 95 % of the sulphar content in the biogas. Another option is external chemical treatment in a filter. The filter can be regenerated by adding oxygen absorption material may be iron-rich soils, waste material from steel or aluminum production.
- Activated carbon- certain companies provide activated carbon filters as a standard component in the gassets.

A CASE STUDY ANALYSIS

This case study contains information obtained directly by conducting interview schedule and discussion with Hon. Annasaheb Patil- proprietor of Motake-Patil cattle and dairy farm and biogas cogeneration plant. The details of the biogas cogeneration plant are as below.

- Plants name - Motake-Patil cattle and dairy farm and biogas cogeneration plant
- Location – At.-Jambhali, Tal – Shirol, Dist- Kolhapur
- Year of commencement – 2012
- Total cost- 20,00,000

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- Government grant received- 5,00,000
- Total number of cattle- 250
- Collected cattle dung -3000kg per day
- Required cattle dung – 2000kg per day
- Required process water- 2000-2500 per day
- Plants yields capacity – 100m3/per day
- Biogas plant type- Modified Dinbandhu
- Capacity of biogas generator- 15 KVA/12 kW
- Plant yields- biogas-110m3/day

  Electricity-150 unit/day

  Water slurry-3000 lit. Per day used as varmi wash

  Organic manure-1200 kg. Per day
- Future plan- since enough amount of gas remain unused, gas filling centre will be set up.

  Packed organic manure and slurry water plant will be started.

POTENTIALS OF ELECTRICITY GENERATION FROM BIOGAS PLANT

- merits of the electricity generation from biogas plant-

1) Plant saves 25 liter diesel per day and around 9000 liter annually which in turn saves nearly 4,50,000 rupees annually. Milk machine, 10 hp agricultural well pump, chop cutters etc. are run on the electricity produced by biogas cogeneration plant.
2) It also provides cooking gas to 10-15 labor quarters which also saves nearly 65,000 rupees annually and is also available for 24 hours.
3) It also makes available nearly 300 tones of good organic manure yearly which cost about 6, 00,000.
4) It provides 3000 liter water slurry which is used as varmi wash and directly provided to field by pumps. Hence it saves labor charges.
5) It requires low operating and maintenance cost and has long life span.
6) It generates renewable green electricity and reduces green house gases. It is an environmental friendly way of energy production and has a positive impact on climate change. In fact, the contribution of methane molecule (CH4) to the green house effect is

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21 times greater than that of carbon dioxide molecule (SUSANA 2009). Therefore, burning methane, even though producing CO2, reduces its impact on environment.

- Demerits of the electricity generation from biogas plants-

1) The installation of present plant requires high capital cost. So, it is bit too expensive for ordinary rural farmer.
2) Bigger plant are more cost efficient. Small plants are economically not profitable. This project is only applicable where minimum 70-100 cattle are available.
3) Expert design, skilled construction and expert maintenance are must. Technical knowledge is essential as basic requirement, otherwise dealing with digester inputs, temperature, water content etc. could be a problem. However in rural areas sometimes these things remain absent.
4) Biogas production below 15oc is no longer economically. Seasonal variations in atmosphere also have impact on biogas plant. Especially in winter season, production of gas reduces up to 10 %.

CONCLUSION

With the ample grazing land, availability of grass, abundant water and healthy atmosphere Kolhapur residents have traditionally reared large number of cattle, with the district counting for 5.25 lakh cattle. The dung, which would otherwise be dumped or burnt, has been used over the last few years to generate biogas. However, large amount of biogas is only used for cooking purpose but now due to technological advancement it is possible to use it for the electricity generation also. Though this technology requires high capital cost and it is mostly applicable to big farmers, it can be applicable at community level. Small farmers should come together and installed an electricity generation plant on biogas. It is also possible to earn some carbon credits and it will be an additional source of income for farmers. The Kolhapur Zilla Parishad, with its one lakh biogas plants, might become the first local civic body in Maharashtra to earn carbon credit. It generates renewable green electricity and reduces green house gases. It is an environmental friendly way of energy production and has a positive impact on climate change. In fact, the contribution of methane molecule (CH4) to the green house effect is 21 times greater than that of carbon dioxide molecule (SUSANA 2009). Therefore, burning methane, even though producing CO2, reduces its impact on environment. Government should work as promoter of this technology. Government support is important. They can provide small

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credits and finance to farmers to set up plants. They should pass information and technical education among rural people. More research is needed on community based biogas digester and electricity generation plant so that electricity from biogas plant would become regular source of energy in rural areas of India.

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