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Biogas Scenarios

Soham M. Trivedi
Biotechnology Engineering Department, V.V.P. Engineering College, Rajkot, India

ABSTRACT

The demand of energy has been increased over the years due to increasing world population and expansion of global industries especially for food and feed. Most of the energy is consumed in transportation, industries & factories, power generation, and community sectors. Moreover, in order to fulfill our demand we are mostly dependent on energy, taken from fossil oil, gas and coal. In developing countries like India, more than 80% of the population lives in the rural areas where more than 90% of the energy being consumed comes from non-commercial sources, the major one being fuel wood. The increasing cost of conventional fuel in urban areas necessitates the exploration of other energy sources. Biogas technology provides an alternate source of energy in rural India as a substitute for fossil fuels. The generation of biogas from food waste/refuse or peelings, agricultural and animal waste produces energy. In Gujarat the fossil resources are limited, and they impose a high burden on the environment therefore looking at the ecological and economical perspectives, biogas is an important source of energy for the state. In addition to biogas generation, another important aspect of biogas compression is the scrubbing of the biogas in order to remove impurities that are generated during the digestion process such as carbon dioxide and hydrogen sulfide. Thus as effective biogas production is strategic the review highlights the various biogas scenarios that can facilitate the vision of a more cleaner environment and to effectively deal with the energy crises problems.

Keywords: **- Biogas, Biomass, Energy crisis, biogas scrubbing**

I. BIOGAS AND GUJARAT

The range of application of biogas technology in Gujarat is currently being limited to applications in the developing world such as India, Africa, and the Philippines for uses such as cooking fuel and heating homes [1, 2]. After independence it was realized that the country was facing severe power shortage. Therefore there was a crying need to overcome this shortage by rendering services and making the availability of Renewable Energy Sources in the most rural parts of the country. Therefore from a primitive stage long term R&D goals were set to enhance the idea of renewable energy in Gujarat state with a ultimate aim to enlighten each and every house in remote villages, facing power problems. Furthermore R&D aimed to effectively utilize eternal resources of energy like the Sun, biomass and wind to provide sophisticated services with generation of employment. Thus, biogas developments in Gujarat can facilitate the vision of a energy-independent state and ultimately can add to the country's economy.

Looking at Gujarat's ecological and economical perspectives, biogas is an important source of energy. The fossil resources are limited, and they impose a high burden on the environment. A resource-conserving alternative made from biomass poses a different scenario. The raw material is renewable, and conversion only releases as much CO_2 as was previously contained by the source material. With the technological progress made in recent years, high energy efficiency and low-maintenance operation have made investment into biogas facilities more and more attractive. Accordingly, an attractive business opportunity has been created, one that is setting new standards in matters of sustainability and efficiency. Development of Biogas technologies in the state can thus enhance the provision of electricity at guaranteed rates, a lasting heat source at constant costs. It can serve as a constant energy source for the agricultural business and has a potential to increase fertilizing efficiency of fermented liquid manure significantly reduced odor emissions of fermented liquid manure. The ease in storability of biogas allows it to be used for the lucrative peak load coverage.

Biogas is defined as the mixture of methane and carbon dioxide produced by the bacterial decomposition of sewage, manure, garbage, or plant crops [3]. In Gujarat most research in this area is currently being done to explore biogas generation through anaerobic digestion in an effort to develop inexpensive and effective methods for promoting digestion of animal and human waste. Anaerobic digestion is the breaking down of organic matter by microorganisms in an oxygen poor environment, and results in biogas [4]. There are two different types of digesters Mesophilic and Thermophilic, which refers to the temperature at which they operate and the corresponding bacteria which thrive in that environment [5]. Mesophilic digesters operate near 30°C (86°F), and in warmer climates often require no additional heating. Thermophilic digesters operate around 60°C (140°F), and thus require additional heating and are often only practical for large industrial uses.

Biogas is considered renewable because it mainly depends on the supply of grass which grows back but natural gas comes from the fossilized remains of plants and animals from thousands of years ago so it is not considered "renewable". Methane is a well known type of biomass energy. Some examples of biomass energy are wood, straw and manure. Certain seminal experiments in the state were based on the bacterial strains that are present in the intestines of many animals. When these bacterium breaks down cellulose (the main ingredient in plant fibers) it produces biogas. For this reason methane is found in many other places as well, such as bogs, swamps and landfills. It can be used as an alternative opposed to natural gas for heating and cooking.

In Gujarat, for the production of biogas generally organic material, such as animal and plant waste is placed along with water into an oxygen free tank, or in some cases plastic membrane for digestion. In a common mechanism for gas collection in a continuous digester, there is the variable volume design of a Gasometer in order to accommodate the increasing methane. In this case, the gas outlet is located at the bottom of the tank, as it is easier to install in the case of a solid walled digester and does not require elasticity in design. The organic matter is fed into the vessel and the resulting gas is outlet through a pipe that inlets above the waste liquid levels in the tank. Similar mechanisms are achieved using plastic membranes, which are contained in secure enclosures in the ground [6]. Another area of research includes attempting to simulate and model methane generation from different types of waste in different environments in order to better understand the process [7, 8].

II. SCRUBBING THE BIOGAS

In addition to biogas generation, another important aspect of biogas compression is the scrubbing of the biogas in order to remove impurities that are generated during the digestion process such as CO_2 (Carbon Dioxide) and H_2S (Hydrogen Sulfide). There are many different methods of Biogas Scrubbing, each with varying degrees of effectiveness. Many methods of Scrubbing the Biogas of single or multiple impurities are discussed in Kapdi's work [9], although few methods seem economically feasible for small scale developing world operation. The Scrubbing is viewed as very important as Hydrogen Sulfide is highly corrosive to the cooking and heating systems that would utilize the biogas, and the presence of Carbon Dioxide makes the gas more difficult to compress and store, although it does not increase the volatility [9]. A simple method for Hydrogen Sulfide utilizing steel wool in a glass bottle is modeled, and seems to be the most viable option for low cost, easy implementation Hydrogen Sulfide removal [4]. In this method of Sulfide removal, the gas reacts with the steel wool, creating black Iron Sulfide. The Iron Sulfide generation begins at the bottom of the container, and once the steel wool is 75% black (i.e. 75% of it has been turned into Iron Sulfide); the wool should be removed and replaced. The used wool can be reused after exposure to air. This oxidizes the wool to rust, which can be reused in the system, as it will react with the Hydrogen Sulfide [4].

For Carbon Dioxide removal, as well as additional Hydrogen Sulfide removal a method of water spray cross-flow can be used [4, 9]. In this method the Biogas enters one end of a tube and experiences water streams flowing in the opposite direction, effectively removing a good deal of Carbon Dioxide from the gas. This design can be varied and the wastewater can be re-used in the process [9].

Scrubbing has also been a strong area of technical development and patenting. USPN 7160456, Method and equipment for processing of organic material, outlines the use of a second chamber and ammonia in order to remove CO_2 from biogas. Complementally, USPN 6709592, Removal of Sulfur compounds from wastewater, outlines a dual chamber digester method for Sulfide removal. USPN 6221652 Process for biological removal of Sulfide outlines a method in which and aqueous washing liquid is treated with Sulfide oxidizing bacteria. There is also a patent for a method of Wet Scrubbing for the removal of CO_2, which outlines the process and design by which this would take place. USPN 7033822, Self-contained and streamlined Methane and/or high purity Hydrogen generation system, outlines a method for hydrogen specific generation using anaerobic digestion as well as mixed gas to power a gas driven generator in order to further compress the gas for Hydrogen removal. Although this patent heavily refers to mixed gas compressors and their use, it does not discuss the method for compression in any sort of detail.

Although much work has been done in research and development of methods to produce as well as scrub Biogas, and compression is often mentioned, less work is done regarding the actual method of compression of the gas. In industrial uses, classic industrial air compression techniques are often used, however in this small scale, off the grid usage, different methods of compression and driving compression need to be determined.

III. INDIA AND ENERGY

The role of energy in India's economy has become globally relevant in recent years due to the country's high economic growth and rising concerns about the environmental impacts of energy use. Primary energy demand grew at the rate of 6 per cent a year between 1981 and 2001 (Planning Commission, 2002), and India now ranks fifth in the world in terms of primary energy consumption. It accounted for about 3.5 per cent of the world's commercial energy demand in 2003. Although there has been a gradually increasing dependency on commercial fuels, a sizeable amount of the national energy requirement, especially in the rural household sector, continues to be met by noncommercial energy sources. These include fuel wood, crop residue, and animal waste, as well as human and draught animal power. Future economic growth will lead to a rapid increase in demand for commercial energy higher levels of urbanization, and adoption of modern lifestyles.

The Renewable Energy Plan 2012 calls for achieving a 10 percent share for renewable energy in incremental power capacity by adding about 10,000 MW of new renewable energy (RE) based generation. In addition to the grid-connected RE goal, other major RE initiatives include- installment of 1 million household solar water heating systems; electrification by renewable mini-grids for 24,000 villages without electricity; deployment of 5 million solar lanterns and 2 million solar home lighting systems; (4) and establishment of an additional 3 million small biogas plants. The Electricity Act of 2003 has provided a major thrust to RE technologies via its mandate: "To promote cogeneration and generation of electricity through renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any persons, and also specifying, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee." The National Electricity Policy of 2005 gives each State regulator authority to create a Renewable Energy Portfolio Standard for the transmission and distribution companies serving their jurisdictions.

The Ministry of New and Renewable Energy (MNRE) is involved in the development, demonstration and utilization of various renewable energy-based technologies, including Solar Thermal, Solar Photovoltaics, Wind power, Biomass combustion/co-generation, Small Hydro power, Biogas, Geothermal, Waste-to-energy, and tidal power. Major MNRE activities include: (i) Project development and financing of RE-based grid power; (ii) Urban solar hot water heaters; (iii) rural biogas projects; and (iv) resource mapping.

India has the most developed and diversified renewable energy market. The annual turnover of the RE industry in India is approximately US$500 million, with total RE investment of around US$3 billion. Furthermore, the 3,500 MW of RE generation capacity installed so far is just a fraction of the estimated total economic potential of 100,000 MW. The Government of India has set a goal of electrifying 18,000 remote villages and meeting 10 percent of the country's power supply through RE by 2012. These targets are in addition to those fixed for other RE devices or programs, including establishing 1 million biogas plants; 1 million solar PV systems for lighting; 8,000 solar PV pumps for irrigation; 10,000 solar PV generators, stand-alone solar PV power plants, solar water heating systems, solar air heating systems, and solar cookers, including large steam cooking systems; 360 energy demonstration parks, and; more solar retail outlets and solar passive buildings.

IV. GLOBAL SCENARIO

There are currently multiple US patents for Biogas digestion technology, many dealing with Biodiesel generation, although some are Biogas specific regarding construction of digesters. USPN 7,186,339B1, Anaerobic Digester System for Animal Waste Stabilization and Biogas Recovery, addresses the design of a flexible bladder digester, as well as transmission of the Biogas from the bladder to a storage container, but it does not address any methods of compression. USPN 7,005,068, Method and Apparatus for treating animal and wastewater, addresses uses of Biogas as well as details regarding digestion methods and suggests that the Biogas can be compressed for storage, but does not specifically outline compression methods to be used. One notable patent in the area of Bio-diesel usage that should be mentioned is USPN 5501185, Biogas driven generator set, which outlines a method to use Biogas in a Bio-diesel engine, and includes a pumping process to boost the pressure of the Biogas for pumping into engine regulator.

V. CONCLUSION

Although renewable energy power generation is a genuine clean development success story, there are some problems that need to be addressed to make the industry sustainable and self-supporting. There is currently some retrenchment going on with respect to RE policy amongst the State regulators. States with strong RE policies include Andhra Pradesh, Tamil Nadu, Maharashtra, and Gujarat. A strong RE policy consists of: (i) Preferential treatment; (ii) Portfolio standards; and (iii) Standardized PPA. However, care must be taken towards over-subsidizing renewable energy development relative to other energy sources at the expense of rate payers and taxpayers. The disaggregate nature of implementing the Electricity Act's renewable energy portfolio standards has created considerable disparities and lack of analytic basis for the relative pricing of various forms of RE within and between different States (e.g., Hydro gets a lower price than Wind or Biomass in one state, or the price is very different between two adjacent states). Because the price made available to RE project developers does not seem to be firmly grounded, transmission and distribution licensees are going to court to avoid entering into power tariffs for purchases of renewable energy. There is a need for standard methods of valuation of the relative environmental benefits accruing to different forms of RE, which could then be reflected in PPA price differentials RE resources should also play a bigger role in providing decentralized power to remote areas, in line with the goal of providing modern energy access to all by 2012. Decentralized power generation, especially in remote locations where the grid cannot be extended, should necessarily be based on RE forms to provide these regions with access to clean and reliable energy. [12]

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