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Review Paper on Production of Biogas by Different Techniques & its Utilisation

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Abstract- **In recent time pressures on the global environment have led to calls for an increased use of renewable energy sources, in place of fossil fuels. The focus now is moving towards more and more the renewable sources of energy, which are obligatory, non-polluting. The major sources of renewable energy in India are biomass, biogas, solar, wind and hydro power etc. Biogas is a catchy source of energy for remote areas. It can be produced from cow dung and other animal waste, kitchen waste, municipal waste and from plant matter such as leaves and water hyacinth Biomass is one potential source of renewable energy and the conversion of plant material into a suitable form of energy, usually to produce electricity or run as a fuel for an internal combustion engine, can be cognizable using a number of different ways, each with specific profit and loss. A brief review of the main conversion processes and its utilization is presented, with specific regard to the production of a fuel suitable for spark ignition and compression ignition gas engines.**

Keywords: **Biogas, Anaerobic Digester, IC Engine, Dual fuel, Biogas utilization, Biomass.**

I. INTRODUCTION

These days, air pollution and global warming are the dominant anxiety grow in the environment of human. This issue could be attributed to the enormous evolution of greenhouse gases (GHG) like carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and other gases which have been produce from an extensive combustion of fossil fuels concurrently with increasing world population [1-3]. It is well known that GHG act as an important factor for global warming. In global warming the heat reflected from the earth surface to increases temperature of ambient temperature. These global warming major contribution of CO2 (60%) and less effect of CH4 (15%) [2,4-6]. Biogas is an environmentally friendly energy source which is mostly comprised of methane (CH4) (55-60%) and carbon dioxide CO2) (35- 40%). Moreover, biogas contains a low quantity of other gasses such as ammonia (NH3), hydrogen sulphide (H2S), hydrogen (H2), oxygen (O2), nitrogen (N2) and carbon monoxide (CO) [7-8]. Therefore, reducing emission of CH4 and CO2 from biogas is significant for stabilizing environment temperature and overcome climate problems. Meanwhile it should be noted that CH4 is also a neat fuel. For instance, the higher calorific value of a purified biogas (consist about 97% methane).

Biogas can be purified and it is used as a natural gas or vehicle fuel. Of course, it is prerequisite to upgrade the biogas through removing carbon dioxide to enhance the calorific values. Therefore, separation of CO2 from CH4 is very important to purifying biogas. Various ways to separate CO2 and obtain purified CH4 from biogas. These purification methods like water wash absorption, adsorption, cryogenic fractionation, and membrane separation. In developing countries, biogas is provided to a finite extend from small quantity in pastoral areas. This gas is used mainly for cooking and heating purpose. Regard less to this low utilization of biogas on rural areas, biogas production and use with modern technology could be a liberal of promises option to make use of kitchen waste and wet organic waste available everywhere at negligible costs. Regular operation is more difficult to achieve than its costly initial installation. The technical reasons are mainly from both their owners and the digesters themselves, such as less knowledge design standards of digester and cold fermentation technology. The farmer's poor knowledge to use digesters. In many cases, lacking of technical knowledge and non-technical reasons, including the loss of interest by users, are the main causes that lead to the failure of sustaining biogas digester running in rural areas, which is usually laborious and messy and offsets the convenience offered by biogas use. In fact, the nature of non-technical barriers is economic reasons. Farmers can only accept biogas digesters that have positive economic benefits to them.

Energy scenario in India

The demand for energy in India, in tandem with the economic growth and the resulting prosperity of the country has increased substantially in the recent years. In such a scenario,

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it is essential to meet the demand for all energy sources not only to meet the growth objectives but also to sustain the growth achieved till date. Primary energy consumed in the country has increased more than four times in the period from 1971 to 2009.

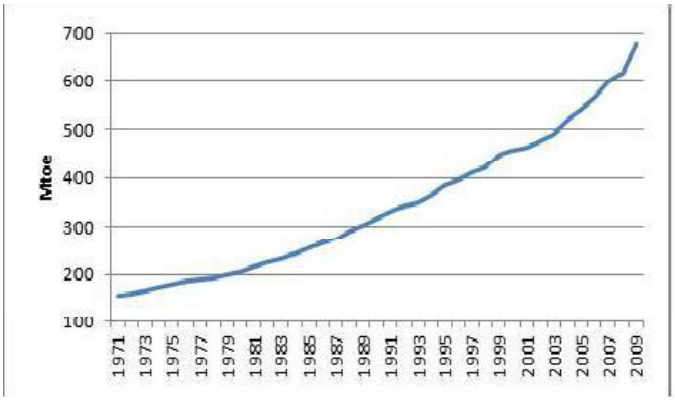

Figure 1: -Total primary energy supplies in India (in million tons of oil equivalent) [9]

This rising dependence on petroleum products and the growing share of imports in the domestic oil consumption. Despite the dependence on crude oil, domestic production has remained low and has, in fact, stagnated in the recent years. This has led to a rise in dependence on imports of crude oil to meet the domestic demand.

The transport sector is one of the major consumers of crude oil in the country and accounts for near about 40% of the country's total oil consumption.

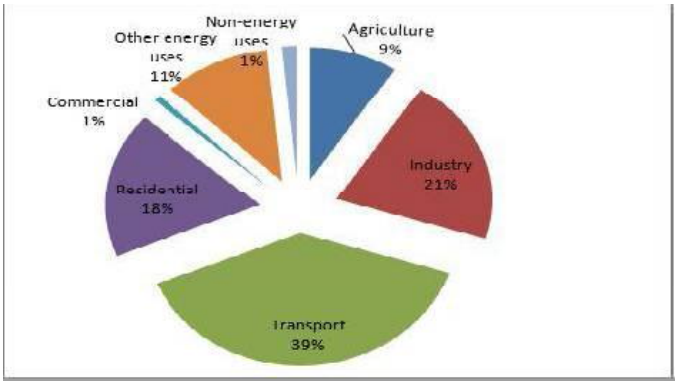

Figure 2:Sector-wise consumption of petroleum products in 2010-11 [10]

This relative lack of diversification in the fuel basket of the sector makes it particularly vulnerable to any shocks in the market. While diversification to other energy sources such as natural gas and electricity has been witnessed in recent times, the sector depends heavily on petroleum products (primarily diesel and petrol) to meet its continually rising demand. Renewable energy continued to grow in 2014 against the backdrop of increasing global energy consumption, particularly in developing countries, and a dramatic decline in oil prices during the second half of the year. Despite rising energy use, for the first time in four decades, global carbon emissions associated with energy consumption remained stable in 2014 while the global economy grew; this stabilisation has been attributed to increased penetration of renewable energy and to improvements in energy efficiency.[11]

Feed stock (raw material) of biogas Agricultural Feedstock

- Animal manure
- Energy crops
- Algal biomass
- Crop residues

Community-Based Feedstock

- MSW
- Sewage sludge
- Grass clippings/garden waste
- Food remains
- Institutional wastes etc.

Industrial Feedstock

- Food/beverage processing
- Dairy
- Starch industry
- Pharmaceutical industry
- Cosmetic industry
- Biochemical industry
- Wood waste

Biogas Applications

1. For cooking and heating.
2. As an illuminatant for domestic and street lighting.
3. For running tube well and water pump.
4. With minor modifications, conventional internal combustion engines, diesel and petrol engine both run on biogas.

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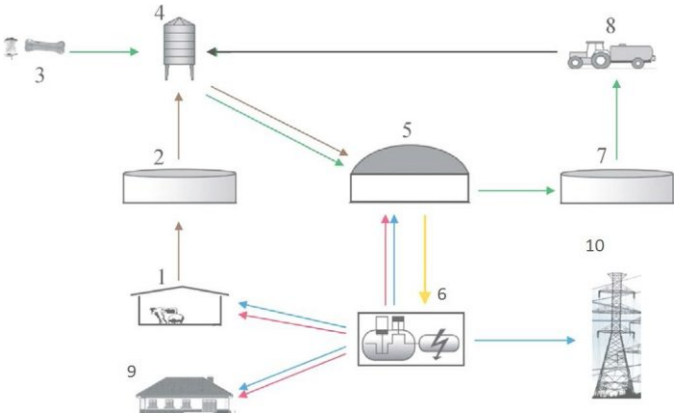

Figure 3: Picture of a biogas plant using livestock wastes: (1) Animal and poultry farm, (2) Preliminary tank,(3) Slaughterhouse waste,(4) Mixing tank,(5) Digester, (6) Power and heat cogeneration,(7) Post treatment tank,(8) Collection of fertilizer,(9) Offices and (10) Energy distribution grid. [12]

II. LITERATURE REVIEW

Method of production

Peyman Abdeshahian, JengShiunLim, WaiShinHo, HaslendaHashim, Chew TinLee **[13]** have studied the production of biogas to using the farm animals waste. The farm animals like cows, buffalo, chicken, sheep etc are produce to dairy products milk, poultry meat, beef and mutton. These animals also given animal manure, researchers is analysing to what amount of animal manure produce in different farms. The quantity of manure has been calculated for cattle 10-20 kg/day, for goat and sheep 2-3 kg/day, and for chicken 0.08-0.1 kg/day its mean quantity of manure is 5-6% of body weight/day for cattle, 4-5% of body weight/day for goat and sheep, and 3-4%of body weight/day for chicken. This farm animal manure is used to produce biogas in biogas disaster. Farm animal manure to feed in the biogas disaster, now this animal manure to perform chemical reaction is done by bacteria in anaerobic digester and produce biogas. In anaerobic digestion production of biogas is varies percentage of methane content it's depend on the feeding of animal manure. In anaerobic digestion cow manure gives 50-70% of methane, sheep manure gives 40-50% of methane and chicken manure gives 50-70% of methane contain in biogas. The total amount of biogas produced 4589.493 million m_3/ yr which used heating value of $8.46\times10_{10}$ M/yr and potential of electricity production of $8.26\times10_9$ KWh/yr. Biogas is used to produce electricity, which supplies and utilize in farm, office and society. This type of biogas is used in rural and urban areas.

RudiantoAmirta, Elisa Herawatib, WiwinSuwinartia, Takashi Watanabe**[14]** worked on the production of biomass to uses of wood waste for production of mushroom and biogas. In this experimental analysis firstly wood waste (saw dust) soaked in water for two- three days and then these saw dust was filtrated. After the filtration wood waste is dried at room temperature for a night. Fungal pre-treatments with production of edible mushroom were carried out. Fresh weight of mushroom yield per kilogram of air-dried woody waste biomass was considered as biological efficiency. In fermentation system taking 10-20 gems of untreated wood waste, pre-treated of mushroom waste 400-500 ml of slurry of cow manure. This fermentation container is purged with argon gas and kept temperature of 35_0C for 40-45 days. Biogas is produced and collects in cylinder. To enhancing the production of biogas by effective fungal pre-treatment is done. The quality of biogas is good because in burning of biogas blue flames is come out, without any smoke. Its means quantity percentage of methane (CH_4) is more than other one. Finally, fungal pre-treatment developed mushroom production to increase the production of biogas and shorea woody waste biomass. Two ways of utilized of mushroom for wood biomass and production of biogas, managing organic waste and disposal. Fungal pre-treatment of woody waste biomass was useful for food (mushroom) production and also for bio-pre-treatment of tropical hardwood for biogas fermentation. The bio-pre-treatment which is developed on a food-mushroom production was effective to enhanced biogas production 2-3 folds higher than the cow dung as common used. This result also showed that the tropical woody waste biomass, potential for development as an economical alternative material source for the sustainable food production (mushroom) and renewable energy, biogas.

Jing Wu, Zohaib Ur Rehman Afridi, Zhi Ping Cao, Zhong Liang Zhang, SouhilaPoncin ,HuaiZhi Li, Jian E. Zuo, Kai Jun Wang**[15]** studied the micro scale study on production of biogas. In this experiment take a transparent micro-reactor to use study of biogas production of granule. Micro-reactor is feed of carbon source as glucose. This synthetic feed pH value was 7.2. The reactor temperature was controlled by a heater with a digital controller at 37_0C.Granules were circulating in anaerobic reactor treating as waste water. The granules were respectively COD

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concentrations, to produce maximum biogas in average time period is 16 hrs. In the reactor porous structure is developed to allow the internal flow of granules. Granules consist of a mass transport to more important of reactor. Biogas production rate is depending on size of granules. In this experiment, the effect of granule size on biogas production was reported. The internal structural properties of the granules including the porosity pore diameter and channel length correlates to the biogas production. Biogas production rate could be proportional to the size of microbial granule used in the reactor. Among all granules, the large granules exhibited a well-developed internal pore structure that aided in the production of big biogas bubble. The large granules could be of more practical importance due to their good mass transfer conditions. The study would be helpful for the improvement of full scale reactors.

Arkadiusz Piwowar, MaciejDzikuć, JanuszAdamczyk[16] have done their research on the production of biogas using agricultural waste. Agricultural biogas plants feed substrates of plants kitchen waste and animal manure as raw material. Biogas production of different animal faeces, dung and liquid manure of cattle produce biogas 175-520 m_3 t s mo_{-1} taking its average 375 m_3 t s mo_{-1}, pigs dung and liquid manure produce biogas 220–637 m_3 t s mo_{-1} taking its average 428 m_3 t s mo_{-1} and poultry faeces produces biogas 327–722 m_3 t s mo_{-1} taking its average 524 m_3 t s mo_{-1}. 60 million m_3 of biogas is generated in 377,000 Mg of waste from vegetable and fruit processing and over 590,000Mg of waste from meat processing.Various types of plants are used to feeding in digester like maize is very useful cultivated plant to use biogas production. Sugar beet is also is very popular to use biogas production. In sugar beet different parts like roots, leaves etc or whole plants are used to making biogas. Maize silage is a high energy efficient while biogas produce is 170– 200 m_3 t s mo_{-1}. Agricultural biogas is also produce from agriculture food waste like beet, pulp, grains and molasses. In agriculture biogas plant feed raw material to making biogas, which digester to biochemical reaction take place under controlled conditions. This agricultural biogas plant is developed in uncultivated land. This type of bio-energy plant to development of agriculture, increases of agribusiness and also increases the source of income.

Cristina Rodriguez, A.Alaswad, K.Y.Benyounis, A.G.Olabi[17] worked on production of biogas from grass. The feed stock quality in influence by grass composition of the harvesting time, the chopping size is important factor. In anaerobic digestion the grass shall be suitable in order to micro-organisms and converted a large surface area before feeding the digester and thus increase the degradation process. The grass maturity increases the percentage of cell wall component (lignin and cellulose etc) and also increases the percentage of cell contents (sugar proteins etc). Pretreatment method of grass is increase degradation process and accelerated the biogas production. Many pre-treatment methods are following to pre-treating the grass like physical, mechanical, ultrasound, microwave, thermal, chemical, biological etc. In this pre-treatment process is to increase the surface area of the grass. Production of biogas is depending on the grass specie and its components. Anaerobic digestion process is different for grass specie and its type. To increase the production of methane, crop and grass substrates content low lignin. These components are high degradable and cell components. Most of the pre-treatment methods increase the biogas production from grass is around 50%. In mechanical pre-treatment method is increasing the biogas production around 60%.

Utilization of Biogas

Bhaskor J. Bora, Ujjwal K. Saha[18] worked on dual fuel diesel engines which fuel used liquid and gaseous (biogas) both. On starting of engine some liquid fuel supply to start the engine and then supply gaseous fuel that's biogas. This liquid fuel is called pilot fuel and gaseous fuel is called primary fuel. Different types of pilot fuel are used to start the engine like diesel, palm oil biodiesel, Jatropha oil, soybean oil biodiesel. To converted dual fuel diesel engine is using a gas mixer at inlet manifold of engine. This gas mixture is a venture gas mixer which works mixing of biogas and air to create pressure drop at throat and to control liquid fuel supply install control lever mechanism. Experiment is performed in single cylinder, variable compression ratio diesel engine. In this experiment emission of CO_2 is increases on increase the load of engine for both cases diesel and dual fuel mode. Emission of CO is varying in various conditions at low loads and higher loads CO emission is high but in medium load condition CO emission is low. In dual fuel mode emission is also reduce CO and HC emission, CO is reduced by 17.67% and HC is reducing by 17.18 %, but there increase NO_x and CO_2 emission in exhaust gases, NO_x is increased by 42.85% and CO_2 is increased by 14.43 % at different compression ratio from 17 to 18 dual fuel mode. The emission of HC increases on full load at 80% to 100% load because decreasing the availability of oxygen which results increasing emission of HC.

Jayesh, D.Vaghmashi, Mr.D.R.Shah, Mr.D.C.Gosai [19] showed utilization of biogas for transportation purpose in petrol engine. In petrol engine compressed natural gas (CNG)

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is used as a fuel. This experiment biogas is converted into a bio CNG. Purifying Biogas is to reduce CO_2, HS and water vapour content. To use of CNG technology biogas is converted bio CNG (enriched of methane). This bio methane is used in all application where CNG gas is used. This compressed biogas is easy to install in automotive engine without modification of CNG kit. Brake specific fuel consumption of compressed biogas is higher than petrol. Emission of HC and CO is decreases in use of compressed biogas.

III. CONCLUSIONS

This paper concludes the biogas production in various methods. To use of biogas, we have minimize use of crude oil or petroleum products like petrol and diesel etc. Biogas is easy to produced, Agriculture biogas plants are used generally in rural areas and full fill needs of daily energy requirement like heating, cooking etc. Production of biogas of using grass, pre-treatment method is preferred to increases rate of production of biogas up to 50%. Pre-treatment method is generally costly cannot be afforded poor villagers but its increases rate of production. The use of biogas-slurry manure reduces the adverse affect of injudicious application of pesticides on soils. Several private dairies possess large number of cattle heads and many-a-time face the problem of disposal or use of cattle dung in towns and cities. To overcome this problem, the biogas technology. Biogas is used in different places like electricity generation, runs an internal combustion engine. In India huge demand of energy, India spends a big amount of money to import petroleum and natural gas, to overcome of this demand using biogas and biomass.

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