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AN EXPLORATION OF BIOGAS FOR SUSTAINABLE ENERGY

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Abstract

Biogas is renewable energy source for emerging energy crisis. It can be exploited directly as a fuel or as a raw material for the production of gas. Methane (CH4) and carbon dioxide (CO2) are the main constituents of biogas and some small traces of undesirable compounds such as hydrogen sulfide (H2S), ammonia (NH3) and siloxanes are also present in biogas which can be separated for better usage of biogas.Due to resource depletion like fossil fuels and climate change, lipid-based algal biofuel has been pointed out as an interesting alternative because of the high productivity of algae. In this review study the technological advances in biogas synthesis and extraction, their methodology, results were focused to implement the same on upcoming energy crisis to fulfill the energy demands.

Keywords:Biogas, Anaerobic digestion, Methane, algal methane, oilcakes

I. INTRODUCTION

Biogas production through anaerobic digestion (AD) is an environmental friendly process utilizing the increasing amounts of organic waste produced worldwide. A wide range of waste streams, including industrial and municipal waste waters, agricultural, municipal, and food industrial wastes, as well as plant residues, can be treated with this technology [1].

In Anaerobic digestion process biodegradable organic matters are break down by microorganism in absence of oxygen, which leads to produce biogas. Organic matters are kitchen waste, manure from cattle,agriculture,sewage, poultry dropping etc. India is facing many problems on issue with energy. At present coal is the major energy production source inIndia. During the last couple decades, India has experienced manifold increase in energy use since demand is high with increasing population .According to International Energy Agency (2016), almost 82% people of India have electricity connection in. In India Almost 66% of the Indian population depends on traditional biomass for cooking purpose, whereas, the percentage of population

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depending on traditional fuel is as low as 4% in the middle eastern countries, 15%in Latin America and as a whole 49% across developing nations.

According to survey conducted by MOSPI (2013) almost 71.4%rural households use biomass, 24.4% use liquefied petroleum gas (LPG), 0.9 percent use kerosene and a very small segment of the population use biogas for cooking . The increased gas demand can results in the shortage of a gas in the country since the reserve of the natural gas is decreasing. In order to overcome these very sources has to be used. So for the alternative renewable energy sources such as solar, wind, tidal, biogas, and biodiesel etc. can reduces the supply of the nature gas. The continuous uses of fossil fuel lead to have concern into the search for new energy.

In a research article by S. Rasi, A. Veijanen, J. RintalaThe highest methane content (65%) was detected in the gas from the sewage digester and the lowest (47%) in the landfill gas. The methane content of the biogas from the sewage digester and the farm varied by less than4% and carbon dioxide, oxygen and nitrogen by less than2%.While in the landfill gas differences in methane and nitrogen content were from 10% to 15%. The amount of hydrogen sulphide in the landfill gas varied from 36 to115 ppm and in the farm biogas from 32 to 169 ppm, while hydrogen sulphide was not detected in the gas from the sewage digester. Other reduced sulphur compounds were found in all biogas samples.Low variation in methane and carbon dioxide content observedin sewage digester and farm biogases. Lower methane and higher nitrogen content in the landfill gas in the winter eitherdue to adjustments in gas recovery system ordifferences in landfill gas production. Higher amounts of aromatic compounds are found in landfill compared to sewage digester or farm biogases. Aromatic compounds are produced during anaerobic process viabreakdown of abundant lignin.

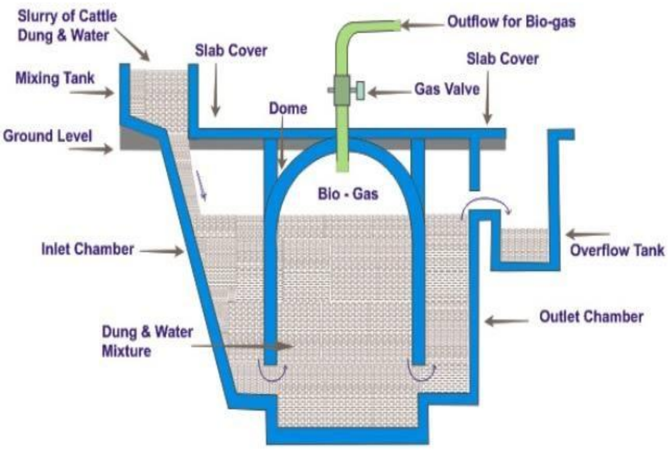

Fig. 1: Fixed dome type biogas plant(Source: Energy crisis-google images)

Figure 1 shows the fixed dome type biogas plant producing gas which is used for domestic applications, once the gas accumulated in the dome is taken through the control or gas flow valves as shown.

The amount of green house gases is rising, with the CO2 being the main contributor because of excessive use of fossil fuel. In addition, the global energy demand is increasing rapidly, with approximately 88% of the energy produced at the present time being based on fossil fuels. Biogas is a multilateral renewable from waste and residue can play a critical role in the futureenergy.Germany is the pioneer country in global biogas production. The United States, China, and India are also investing in alternative technologies for biogas production from cellulosic resources, and are likely future producers [5].

An alternative technique has been developed that is based on a high working pressure (up to 100 bar); with this technique, the production of biogas with more than 95% methane content is feasible. The aim of the technique is to integrate biogas production and in situ increased-pressure purification into a single process in order to produce clean biogas (99% methane) that can be fed directly into the natural gas networks.

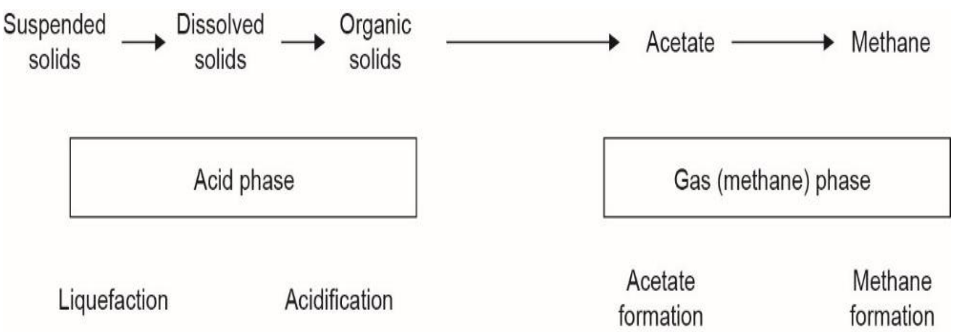

Fig. 2: Standard multiple-stage AD system

Figure 2 shows standard multiple stage AD Biogas system which shows suspended solids are first dissolved to organic matter then converted into methane gas from this acid phase through acidification and fermentation process.

II. COMPOUNDS IN BIOGAS

Biogas is produced duringanaerobic degradation of organic material. Methane is the main component of biogas. Biogas is considered acarbon dioxide-neutral biofuel and would emit lower amounts of nitrogen oxide, hydrocarbon andcarbon monoxide emissions compared to petrol and diesel engines. Upgrading of biogas for use as vehicle fuel is feasible inlarge-scale sewage and biowaste digesters.Biogas also contains hydrogen sulphide andsulphurcompounds alongside toxic volatile organic compounds (VOCs) which can haveenvironmental impacts like stratospheric ozone depletion, greenhouse effect andreduction in quality of local air due to high vapor pressure and low solubility.

By the study by Caroline M. Plugge As CO2 has a higher solubility than CH4, at higher pressures, it will fractionate more to the liquid phase, resulting in AHPD biogas with a high CH4 content (~90%–95% and 0.3– 9 MPa). Ideally, high-quality biogas can be directly used for electricity and heat generation, or injected in a local natural gas distribution.

III. RESULTS AND DISCUSSIONS

UkpabiChibuezeet *al.* produced biogas using cow dung and food waste in their study biogas production was done in batch system, where the digester was fed with 75 g of cow dung and 75 g of food wastes mixed with water at a ratio of 1:1 respectively. The digester was provided with suitable arrangements for feeding, gas collection and draining residues. The digester was connected to a calibrated measuring cylinder with paraffin oil displacement arrangement to measure the volume of biogas produced. The slurry was allowed to ferment anaerobically for 15days under mesophilic temperature of 26-35°C.This study have shown that production of biogas is partly dependent on pH and the volume of the slurry in the digester thus the combined waste slurry produces more gas (30.58ml) than cow dung slurry (19.20ml) as food wastes contain more nutrients than dung. The biogas can be used as a fuel, for cooking or other purposes and the solid residue can be used as organic compost.

An article byRecebli*et al.*carried out an experimentation in a farm, which includes 1400 chicken and 70 cattle, in summer season to provide optimum fermentation reaction conditions. According to the results of separate fermentation reaction experimentations of poultry and bovine manures in a 0.5 m3 fermentation tank orderly about 0.83 m3 and 6.33 m3 biogas was obtained. The end product of fermentation reaction was the fertilizer to dress the farm fields. About 47.5 kg and 145 kg fertilizer was formed at the end of the fermentation reaction.

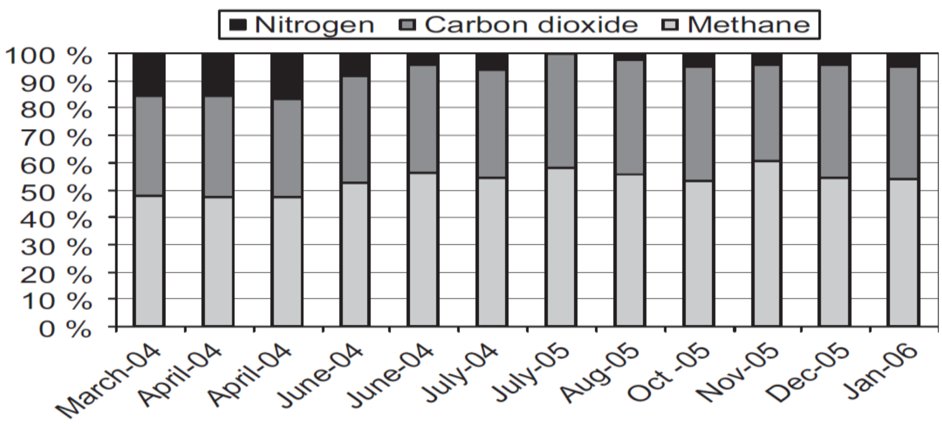

Fig. 3:Methane, carbon dioxide and nitrogen contents of landfill gas at different seasons [8].

Figure 3 shows content of methane, carbon dioxide, oxygen, nitrogen and hydrogen sulphide in the three biogases and the variation within them for different time periods. The highest methane content, 65%, was detected in the gas from the sewage digester and the lowest, 47%, in the landfill gas. The methane content of the biogas from the sewage digester and the farm varied by less than 4% and carbon dioxide, oxygen and nitrogen by less than 2%, while in the landfill gas differences in methane and nitrogen content were from 10% to 15%. The amount of hydrogen sulphide in the landfill gas varied from 36 to 115 ppm and in the farm biogas from 32 to 169 ppm, while hydrogen sulphide was not detected in the gas from the sewage digester [8].

Table 1: Composition of substances for biogas production [6]

Parameters (g/kg)	Corn Cobs	Plantain Peels	Cow Dung
Moisture	36.20 + 0.13	35.50 + 1.13	18.55 + 0.01
Ash	1.33 + 1.30	3.67 + 0.63	10.10 + 0.55
Crude fibre	0.67 +0.10	1.67 + 0.01	40.20 + 0.08
Crude protein	0.07 + 0.40	0.18 + 1.39	6.80 + 0.51
Crude fats	0.50 + 0.44	6.00 + 0.16	4.00 + 0.30
Carbohydrates	61.90 + 0.68	54.65 + 1.90	20.00 + 0.67

The composition of the food wastes and the animal dungwere presented in table 1. The result showed that the twofeedstock contained energy yielding nutrients but at varyingconcentrations. For instance, the carbohydrate values of thefood wastes (corn cobs 61.90 ± 0.68 g/kg and plantain peels54.65 ± 1.90 g/kg) were significantly ($p<0.05$) higher thanthe cow dung (20.10 ± 0.67g/kg).Experimentation have shown that production of biogas is partly dependent on pH and the volume of the slurry in the digester[6].

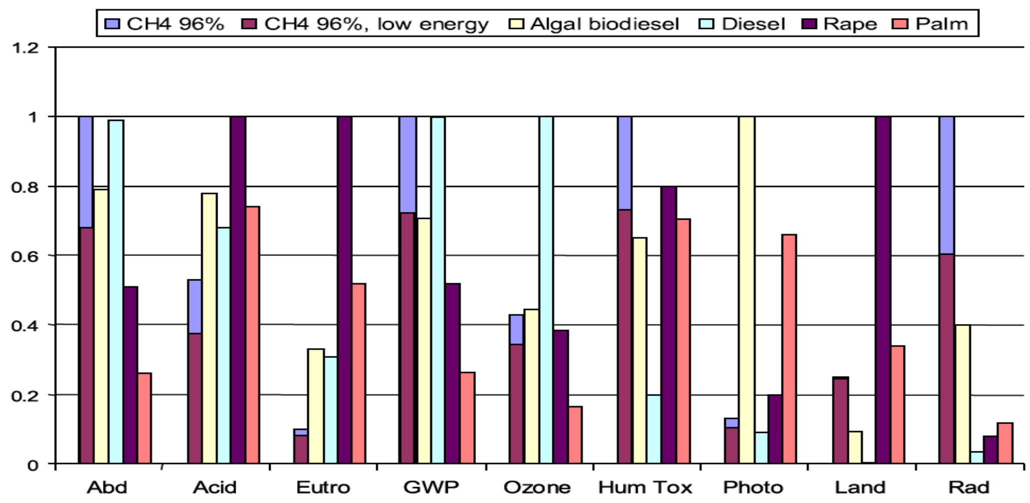

Fig. 4:Comparison of impacts generated by the combustion of 1 MJ of algal methane and others fuels (CH4 96%) [12].

Figure 4 shows Comparison of impacts generated by the combustion of 1 MJ of algal methane and others fuels. The impacts of algal-based methane (CH4 96%) and algal-basedmethane with low energy consumptions (CH4 96%, low energy) which are superimposed.Considerable part of the impacts has been allocated to oilcakes, these impacts are based on an energy allocation, which implicitly assumes that the total energy content of by-products can be extracted. On the other hand, in the anaerobic digestion scenario, the real extractability of energy is used and the remaining theoretical energy content of by-products (i.e. the soil conditioner) is not added to the balance. It results that the production of 1 MJ of methane-based biofuel requires apparently a higher land surface than the one of 1 MJ of algal oil. In the low nitrogen fertilizer input and wet extraction scenario chosen, 46% of the impacts are attributed to the oil. For instance in terms of land use, only 46% of the impacts generated by the pond construction are counted [12].

IV. CONCLUSION

The principal aim of this study is to review regarding updation in recent technology, processes, synthesis of bio gas production which is one of the renewable forms of energy. It highlights themain bottlenecks in this production, and compares them withthe advantages and the drawbacks of mature and other immaturetechnologies.Keeping various parameters within the desired range can improve the bio gas production but there is a practical difficulty which lies in maintaining and monitoring the system regularly. It is acrucial point which needs due consideration since aslight change in pH or temperature may resultin reduction of biogas production.

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