The Production of Biogas by using Kitchen Waste-A Review

Rakesh Chaturpale[1], Pragati Kawadkar[2], Ravi Rawani[3], Rajat Anerao[4], V.P. Katekar[5]

[1,2,3,4]Student, Deptt of Mechanical Engg, SBJITMR, Nagpur, India

[5]Assistant Professor, Deptt of Mechanical Engg, SBJITMR, Nagpur, India

Email.- rakeshchaturpale28@gmail.com, pragatikawadkar@gmail.com, ravisrawani@gmail.com, rajatanerao@gmail.com, vpkatekar@gmail.com

Abstract: This paper reviews the biogas production from anaerobic digestion of various kitchen wastes. Biogas technology seems promising to attain sustainable energy yields without damaging the environment. Waste management, manure creation, health care and employment foundation are the benefits of biogas system. Use of biogas assures renewable energy supply and balance of green house gases. India is traditionally using biogas since long time but there is need to improve the technology, applications and deployment strategies. Bioenergy centralization in urban and decentralization in rural can help government to minimize both the import of fuel derivatives and solid waste processing cost. The aim is to highlight potential of the technology to bring social and economical sustainability to India. In this review, demand of energy sources, drivers for bioenergy use, economical, social and environmental benefits of biogas regularization in India are described with emphasizing biogas as an ideal sustainable energy source with its potential applications. This papers reviews the various recent methods of biogas generation.

Key Words: Energy, environment, bioenergy, biogas, sustainable.

INTRODUCTION:

Worldwide energy consumption and demand are growing up since past 50 years. Most of the resources used like petroleum, natural gas, coal are not sustainable sources of energy. Numbers of countries in the world including India are currently passing through the critical phase of population explosion and the growing population demands more energy inputs. In India there is deficiency of energy in required form to meet national developmental needs. Raw vegetables wastes are used to produce biogas by anaerobic digestion process from a long time because in principle, it has high energy potential and enormous quantity of vegetable wastes are dumped daily in municipal and urban areas which needs to be processed to minimize environmental pollution.

Even though anaerobic digestion is an old and proven technology, process design for efficient energy production is not fully understood and research and development work is going on to improve efficiency, reliability and applicability using various biomass. Literature shows that many works have been carried out in India and abroad for production of biogas using farm wastes, sewage sludge, and municipal solid wastes (MSW) etc. It is clear from review that there are no common governing factors that indicate the suitability of any particular reactor design for a specific effluent. By suitable modifications in the reactor designs and also by altering the influent physio-chemical characteristics, high rate digesters can be accomplished for the treatment of organic solid wastes.

Ezekoye, V. A, Onah, D. U, Offor, P. O. & B. A. Ezekoye[1]:

Ezekoye[1] did the experiment Rice husks and algae plan substrates where successfully used to produce biogas. A metal fixed-dome biodigester (bioreactor) was used for the characterization of the biogas generated from these plants wastes.As in the figure 1, A total of 35 kg of slurry (sludge) made from 5 kg of rice husks and 30 kg of algae were mixed in water in the ratio of 1:6 and fed into the biodigester (bioreactor). The digestion of slurry was undertaken in batch-type anaerobic digestion and mesophilic temperatures range at 29.00oC – 33.45oC. For over period of 75 days, the cumulative biogas produced from the wastes was 156.25 litres. The percentage of the methane component of produced biogas was 52.3% .The biogas from the seeded rice husk was combustible on the 45th day. This result that many of the microorganisms associated with the fermentation of rice husk and algae from sewage pond originated from the inoculum and substrate used.Also since the population of the microbes in the digester was increased by addition of the inoculum, there was fierce competition for the limited substrate, and the intensity of this competition depends on the net population of the microbes in the digester. This is the determinant factor for the retention time of the substrate as well as the quantity of the biogas produced. The addition of inoculum to rice husk was found to enhance gas production. It was also found to be influential especially in specific gas production, cumulative gas production and percentage degradation of solid particles. An inoculum of between two to three weeks of age could be used as a seeding agent for starting up biogas digesters.

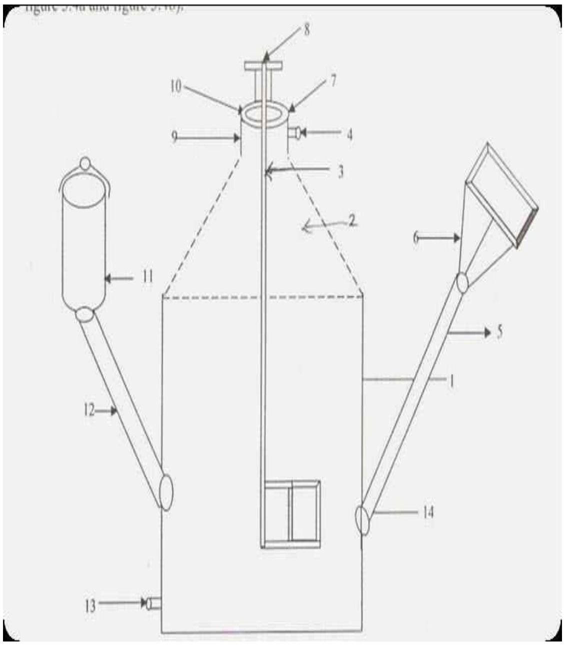

Figure 1

C. Marimuthu and V. Kirubakaran [2]:

In this paper, C.Marimuthu and V. Kirubakaran[2] did the anaerobic digestion method is used to find the potential of energy recovery from the liquid and solid waste in the form of biogas. Thus the production of biogas from industrial and domestic waste is working successfully in small and large scale private projects in India. The potential of energy recovery has been estimated based on the available data. Also the carbon emission from the natural gas production plant is found and compared with the conventional coal based power production method. The carbon intensity of coal based power plant and biogas power plant has been compared with each other based on the potential of power production. The effective utilization of biogas from the various wastes can be reduced the carbon emission nearly 4520 tons per day. With increasing demand for energy to maintain a standard of living, many countries now move forward to renewable energy sources. Renewable energy sources are the best alternative however the diversified form leads to a lot of inconvenience in usage. This paper revolves the energy extraction from the waste which is an inventible source of the processing industries. If all the industries adopt these technology, every industry will become self sustain in energy production. As a whole the industries will change from energy intensive to energy generation system which will solve the future energy crisis. The effective utilization of the waste to energy power can reduce significantly the power shortage in India. Also reduce the carbon emission nearly 4520 tons per day.

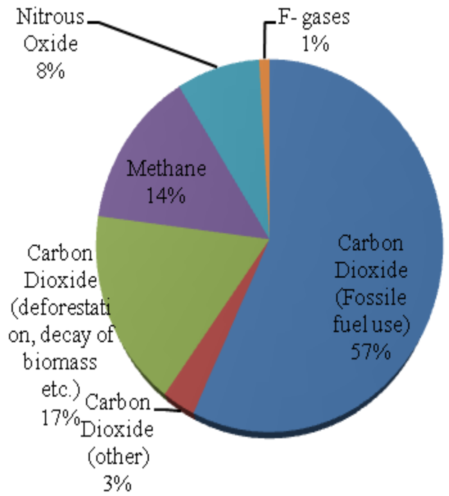

Figure 2

Gauri P. Minde Sandip S. Magdum and V. Kalyanraman[3]:

Biogas has been produced since the second half of the 19th century. India was one of the pioneering countries which were generating biogas from manure and kitchen waste for household purposes. Biogas is the gas generated from anaerobic digestion (AD) of organic matter which includes animal-human excreta, kitchen-agricultural residues, municipal wastes and algal-plant biomass etc. with balanced carbon cycle. Biogas is being generated form cattle dung and kitchen waste since long but for highest yield the reactors are being optimized not only in size and types but also the substrates are studied. In this review paper gauri minde and her team discribes demand of energy sources, drivers for bioenergy use, economical, social and environmental benefits of biogas regularization in India are described with emphasizing biogas as an ideal sustainable energy source with its potential applications. There are many advantages of biogas system such as waste to energy conversion, NPK rich manure, ease in operation for urban as well as for rural people. Biogas is supportive to agriculture hence can improve the status of farmers.

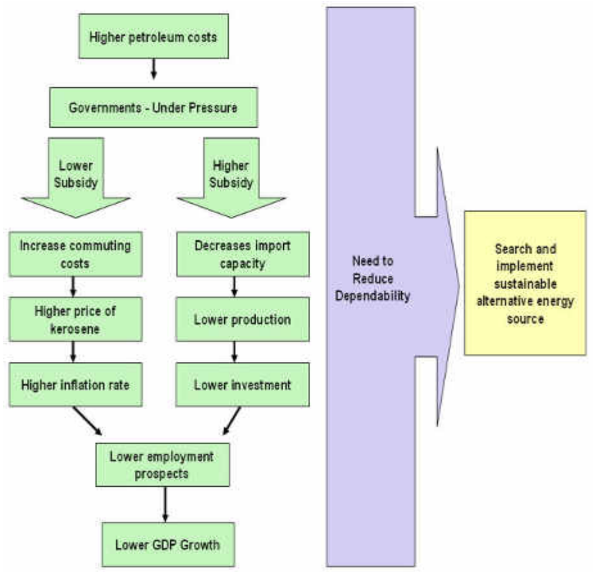

Figure 3

Jayesh D. Vaghmashi, Mr.D.R.Shah and Mr.D.C.Gosai[4]:

Biogas typically defines a gas resulting from the anaerobic(i.e. absence of O2) decomposition or fermentation of organic material like: Municipal waste or leftovers landfill gas, Sewerage waste, sewage gas, Liquid manure or dung. Energy crops (corn, wheat, grass) etc.Man in his lifetime, uses energy in one form or the other. In fact whatever happens in nature, results, out of the conversion of energy in one form or the other? The blowing of the wind, the formation of the clouds and the flow of water are a few examples that stand testimony to this fact. Of late, erratic and perfunctory usage of energy has resulted in an energy crisis, and there is a need to develop methods of optimal utilization, which will not only ease the crisis but also preserve the environment. This attempts to show how man has been utilizing energy and to explore prospects of optimizing the same. Researches show that the world has already had its enough shares of its energy resources. After removal of CO2 and H2S by use of scrubbing, biogas is enriched in methane (CH4) and becomes equivalent to natural gas but limitation is production rate is very low. Presence of up to 30% carbon dioxide in biogas improved the engine performance as compared to the same running with natural gas. After studying of research paper, we can say that biogas is a most important renewable source of energy. Biogas is a cheaply available in India.

Alemayehu Gashaw[5]:

Biogas, which is principally composed of methane and carbon dioxide, can be obtained by anaerobic fermentation of biomass like: manure, sewage sludge, municipal solid waste. Biogas production represents a very promising way to overcome the problem of waste treatment. Further more, the solid residuals of fermentation might be reused as fertilizers. This review clearly indicates that co-digestion of organic waste is one of the most effective biological processes to treat a wide variety of solid organic waste products and sludge as well as biogas production. The prime advantages of this technology include (i) organic wastes with a low nutrient content can be degraded by co-digesting with different substrates in the anaerobic bioreactors, and (ii) the process simultaneously leads to low cost production of biogas, which could be vital for meeting future energy-needs. In this review,Biogas can be produced from the co-digestion of municipal biodegradable solid waste with human excrement. This technology has tremendous application in the future for sustainability of both environment (treatment of wastes) and agriculture, with the production of energy as an extra benefit. Biogas production depends on various parameters that affect the yields of the gas from different substrates.

Rama Dhanariya, Sarita Sharma, Ashok K Sharma and Sanjay Verma[6]:

Currently, much of our biodegradable wastes such as kitchen wastes, agricultural wastes & animal wastes are used to produce Biogas, a powerful greenhouse gas. Anaerobic digestion (AD) is a treatment that composts these wastes in the absence of oxygen, producing a biogas that can be used to generate Heat & Power. Producing renewable energy from our biodegradable wastes helps to tackle the energy crisis. It is effectively a controlled and enclosed version of the anaerobic breakdown of organic wastes which releases methane. AD produces a biogas made up of around 60 per cent methane and 40 per cent carbon dioxide (CO_2). It is important to know the composition of the kitchen waste in order to be able to predict both the bio-methanization potential and most efficient AD facility design. The biomethanization potential of the waste depends on the concentration of four main components: proteins, lipids, carbohydrates, and cellulose. This is due to different bio-chemical. characteristics of these components. The highest methane yields have systems with excess of lipids but with longest retention time.

The methanization of the reactors with excess of cellulose and carbohydrates respectively. Anaerobic digestion is a proven technology for processing source-separated organic wastes and has experienced significant growth. This technology is superior to the land filing and also the aerobic composting. The most successful AD processes at this time are thermophilic processes. Even though AD is effective, there are problems associated with the application of this technology in diverting organics from the landfills and composting facilities. Additional difficulties in the operationfinding is of special importance because this lowers the operating costs, decreases the capital and operating costs of the anaerobic digestion of source-separated kitchen waste, and reduces the greenhouse gas emissions of both processes.

Rebecca Sebola, Habtom Tesfagiorgis, and Edison Muzenda[7]:

Anaerobic digestion is proposed to produce biogas and enhance the methane production by identifying the best substrate. This paper reviews the biogas production from anaerobic digestion of various wastes. Feedstock composition is one of the major factors that affect the production of biogas. High yields of methane depend mainly on the substrates used as feeding material. However, the difference in total methane yield varies based on the type of interactions between different wastes that interfere with digestibility of wastes in the system. The rate of digestion of organic wastes depends mainly on the relative proportion of the component, the amount of the mixture and other physical variables such as temperature and pressure. There is limited information on the optimum conditions that can enhance methane yields and treatment of residues. It is, therefore, recommended that optimum conditions for anaerobic co-digestion must be investigated as well as treatment of sludge to manage the landfill crisis.Conversion of waste into energy is a technology that has the potential in producing cleaner energy and greener alternative fuel. Anaerobic digestion technology is considered to be a practical method to reduce waste.

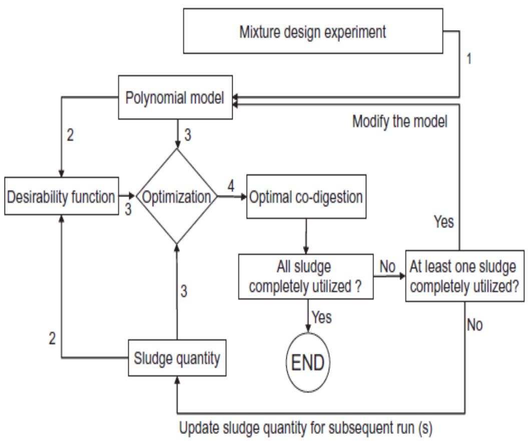

Figure 4

Noxolo Sibiya, and Edison Muzenda[8]:

Anaerobic digestion (AD) of organic materials offers an alternative source of renewable energy, as bio-methane has a potential to replace fossil fuels for energy production for heat and power, vehicular fuel and as well as valuable material recovery. In addition AD can address pollution problems by minimizing and utilizing biodegradable waste. This a well-researched and technologically advanced technique with various successful small to large scale plants in the developed world. For developing countries, not much success has been reported due to operational and maintenance challenges, low biogas production and public perceptions among other several contributing factors. This paper reviews AD process optimization focusing on parameters such as temperature, pH, loading rate, hydraulic retention time and agitation. Several studies have shown optimum biogas production from grass in mesophilic, alkaline or neutral conditions at retention times of about 30 days. This review is the background and basis of our current work on optimizing biogas production from selected South African grass species. the optimal process parameters that may improve biogas production from grass silage. Information for bio-degradation of grass is limited. Various studies of anaerobic digestion of grass are focused on evaluating physical parameters. Most grass AD plants are operated at mesophilic temperatures at pH ranges of 6.5 to 7.2 with retention times of 30 days. Grass has been reported to have high methane content compared to energy crops. Overloading results in reduced biogas production due to the formation of volatile fatty acids. On the other hand underfeeding may also reduce gas production due inadequate food for bacteria. Gentle mixing in an anaerobic digester is recommended to avoid the formation of impermeable crust.

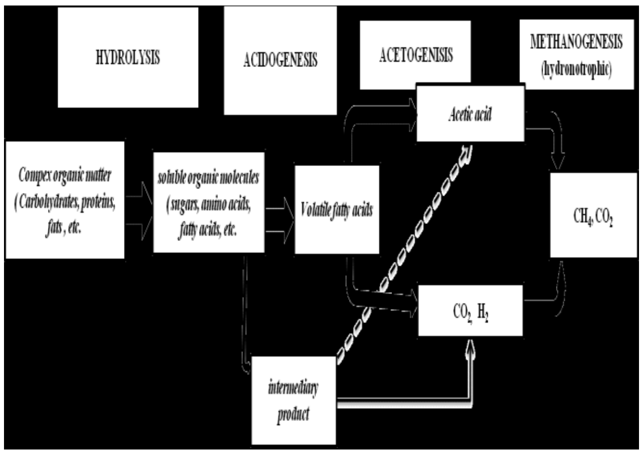

Figure 5

DR. Chanchal Mondal, Prof. G.K.Biswas[9]:

A comparative study on production of bio gas from green vegetables wastes and dried vegetable wastes at different temperatures and concentrations by using two identical anaerobic bio digesters. The productions of biogas yield and ultimate methane yield have been compared for both the cases and optimizations of concentrations have been presented. Raw vegetables wastes are used to produce biogas by anaerobic digestion process from a long time because in principle, it has high energy potential and enormous quantity of vegetable wastes are dumped daily in municipal and urban areas which needs to be processed to minimize environmental pollution. Anaerobic digestion is a biochemical process in which organic matter in absence of air (oxygen) is converted to a mixture of methane and carbon dioxide called biogas. In the technical point of view anaerobic digestion is a four step (1) process namely hydrolysis, acetogenesis, hydrogenesis and methanogenesis in which complex organic materials are converted to the end products of methane and carbon dioxide. In general two groups of micro-organisms are responsible for this conversion. The first group of organism is collectively termed as acid formers which convert large organic molecules such as proteins, starches, cellulose etc. into organic acids (step one and Step two). In step three the conversion of acids to acetate and finally, in step four, acetate is converted to methane and carbon dioxide by the help of a group of micro-organisms collectively termed methanogens.Solid retention time in anaerobic batch digestion is high (2). Time required for first two steps is very high with respect to other steps because hydrolysis and acid formations are taking places in these stages which consumes most of the time.These studies are aimed to produce biogas using dried vegetable wastes other than raw vegetable wastes with short retention time and compression of both. Optimum solid concentration and ultimate yields of biogas using dried and raw vegetable wastes have been presented. . Study shows production of biogas as well as methane yield per day per kilogram of solid is much higher when dried grinded vegetable is used as feed rather than raw vegetable wastes for the production of biogas using anaerobic batch digester. This study will be helpful to produce biogas within very short period time.

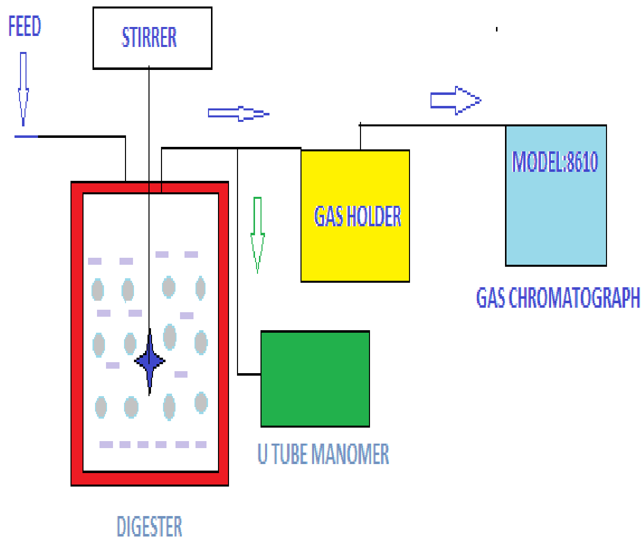

Figure 6

Rajesh Ghosh & Sounak Bhattacherjee[10]:

In India we provide the fuel for industry, household mainly from fossil fuel in the form of Petrol, Diesel, LPG, Natural gas, Coal. Since the source for the fossil fuel is fast depleting and at the same time, creating some actual problem related to availability, high cost and atmospheric pollution, so research are extended to search an alternative source of non-conventional energy named as Biogas. Biogas is produced by anaerobic digestion of the organic waste material, which typically consists of methane, with a significant proportion of carbon dioxide, and smaller quantities of other gases such as nitrogen and hydrogen. The calorific value of biogas varies from 4800-6900 Kcal/m3. Different types of feed material are 1. Manure (Cow Dung) 2. Sugar Cane Baggase 3. Cotton dust 4. Weed 5. Night soil 6. Poultry Bird 7. Cowdung and Cotton stalk 8. Cow dung and weeds. Biogas is used for cooking, lighting, motive power and industrial uses. The biological anaerobic degradation of green house residues, which can be divided into four steps 1. Hydrolysis 2. Acedogenesis 3. Acetotgenesis 4. Methanogenesis.the factors influencing the biogas production are 1. Nutrients 2. Solid concentration 4. Temperature 5. Retention time 5. pH 6. Mixing 7. Effect of Hydrogen Sulphides 8. Effect of carbon-di-oxide concentration 9. Scum formation 10. Thickness of insulation. Types of reactor are 1. Plug flow digester, 2. Complete mix digester, 3. Covered lagoon digester, 4. Fixed film digester. Design of plug flow digester: Digester volume= 15.277 m3 Biogas produced= 4.0075m3/day Complete mix digesters, are unsuitable for high efficiency and rapid rate conversion of solid or semi solid substrates. Plug flow digester are suitable for the digestion of solid and concentrated semisolid feeds which are by far the largest biomass and waste resources available for simultaneous stabilization and energy production. Biogas is one of the future fuel, but it difficult to obtain when compared to the other most efficient fossil fuel today. But if we apply the ideas and modern technology to produce biogas from waste, we can increase the methane yield and hence the efficiency. It is proven that one ton of municipal waste can produce up to 250kg's of biogas. If we utilize the waste produced in the urban cities to produce biogas it is possible to eliminate the energy crisis which we are facing today. For example if we use the waste produced in the Bangalore alone, which is about 2000 tons per day, we can produce up to 5lakh kg of biogas daily, from which we can light up about 1000 houses.

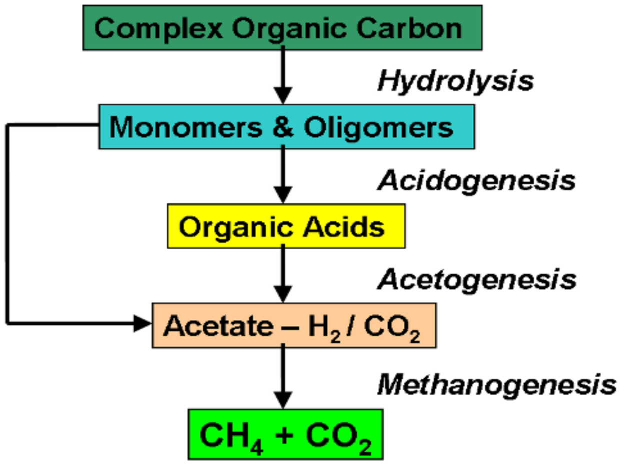

Figure 7

CONCLUSION:

The study carried out in this review has shown that the anaerobic digestion of kitchen waste is a feasible alternative to biogas generation. This finding is of special importance because this lowers the operating costs, decreases the capital and operating costs of the anaerobic digestion of source-separated kitchen waste,and reduces the greenhouse gas emissions of both processes. Further research is necessary to collect additional data on the use of the Anaerobic Digester using kitchen wastes.There is need to utilize biogas technology renewable energy sources in combinations for Indian as well as global bright energy future. Even though anaerobic digestion is an old and proven technology, process design for efficient energy production is not fully understood and research and development work is going on to improve efficiency, reliability and applicability using various biomass. Literature shows that many works have been carried out in India and abroad for production of biogas using farm wastes, sewage sludge, and municipal solid wastes (MSW) etc. It is clear from review that there are no common governing factors that indicate the suitability of any particular reactor design for a specific effluent. By suitable modifications in the reactor designs and also by altering the influent physio-chemical characteristics, high rate digesters can be accomplished for the treatment of organic solid wastes.

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