Review: Generation of Biogas from Kitchen Waste, Bagasse and Garden Waste

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***Abstract-* In India, Large amount of kitchen waste, vegetable waste, bagasse, garden waste are obtained which is given in municipal solid waste which adds to management of waste. If it can be utilized for better purposes it can reduce load to municipal solid waste management. This waste being organic in nature can be used for biogas production. This paper reviews the utilization of organic waste available for anaerobic digestion of waste and thus utilization of waste to energy. Any matter which can be decomposable by the action of microorganisms in a short period of time is called biodegradable. Mostly food waste; vegetable waste, bagasse, Garden waste are biodegradable. These wastes are generally dumped in dumping sites which when degraded release carbon dioxide, methane, ammonia and hydrogen sulphide into the environment thereby contributes to air pollution and odors pollution. In this paper review of experiment work by different researchers for generation and utilization of biogas by organic wastes. This paper even opens new avenue of waste to energy method of disposal of municipal waste. These waste if treated in proper method can be utilize for integrated solid waste management. Efficiency of production of biogas increases by mixing cow dung to any of these wastes. Cow dung is also easily available in rural part of India and even at urban India. This paper leads to finding out most effective waste for biogas production and finding its percentage with cow dung.**

***Keywords-* Bagasse, Biogas, garden waste, kitchen waste, renewable source, vegetable waste.**

I. INTRODUCTION

Fuel requirement is increasing due to population growth, changing lifestyle, urbanization etc. this gives a quantum jump to requirement of fuel. Fossil fuel are major source of fuel in world around which is in reduction stage now. Thus universe has moved toward renewable source of fuel and energy. Fossil fuel on burning emits out green gases and other air dispersible pollutants. Different wildly used sources of renewable energyare Solar energy, wind energy, different thermal and hydro sources of energy, biogas etc. An anaerobic digestion process(Biogas generation) is an alternative renewable energy which is utilize because of its characteristics of using, controlling and collecting organic wastes and at the same time producing fertilizer and water for use in agricultural irrigation. Biogas does not have any geographical limitations. Biogas is very simple to use and apply. Biogas is produced from organic wastes by concerned action of various groups of anaerobic bacteria through decomposition. [1]

Anaerobic digestion is a four step process involving different microbial population for each step. The first step starts with hydrolysis. In hydrolysis, the complex organic waste converts into simpler component and formation of organic waste takes place. The second and third step is acid phase involving acitogenesis and acidogenesis. The fourth step is called methanogenosis. The detention time depends on biodegradability of waste. If waste is more biodegradable then reduce retention time. [2]

Biogas refers to a gas made from anaerobic digestion of different organic waste such as kitchen waste, vegetable waste, bagasse, garden waste.[3]

II. REVIEW OF GENERATION OF BIOGAS FROM DIFFERENT WASTE

A. KITCHEN WASTE AND VEGETABLE WASTE

Kitchen waste (KW) is organic matter which discarded from restaurants, hotels and house. Generally KW is not segregated from other solid waste from the source. KW is disposed along with Municipal Solid Waste (MSW) which is generally dumped. Dumping of such waste can cause fire hazard in landfill site due to generation of methane and other inflammable gases. KW along with other MSW causes public health hazard and other issues like flies, air pollution etc. Kitchen waste can be best utilized for waste to energy process as it is having high calorific volume. Many researchers have worked in different types of kitchen waste from residence, vegetable market etc. [4],[5], 6] .

The vegetable waste is also organic matter which leftover from vegetable markets, restaurant, house, hotel. Vegetables are source of proteins, vitamins, minerals, dietary fibers, micronutrients, antioxidants, carbohydrates. The vegetable waste is a very serious issue. The vegetable waste disposal methods include dumping in municipal landfills, spreading on land and by feeding to animals. These methods results in many issue like dieses (cholera, malaria, and typhoid), insect, hazards, water pollution, air pollution and land pollution. [7, 8].

GUJALWAR et.al. (2014) has studied generation of biogas in combination of kitchen waste and cow dung. They have used 20 liters air tight anaerobic digester for digestion of kitchen waste. The digester was installed in Environmental Engineering laboratory of Civil Engineering, Department, at Jagadambha College of Engineering and Technology, Yavatmal, India. Potato chips used as kitchen waste and cow dung used as an inoculums. They concluded that mixing of extra bacterial seed improves digestion of kitchen waste and production of bio gas, generation of biogas increased by stirring of the mixure for homogeneous mixing of substrate with bacteria present in anaerobic bacteria. They concluded that biogas produced for 500 ml food slurry has increased by about 70 ml for successive twelve days, biogas has increased with maximum use of cow dung in food slurry with use of lab stirrer than without use of lab stirrer. [9]

Reddy et.al. (2017) has studied Bio Gas Generation from Biodegradable Kitchen Waste**.** Kitchen waste likevegetable peelings, fruit peelings, and Food waste collected from Siddartha Nagar, Kandivili East at Radha Residence CHS of 300 families with a population about more than 1200 people livingin Mumbai city**.** From the house hold Survey and from the society office registers it has beeninvestigated that on an average 400 kg of organicWaste is collected from house to house.The fresh kitchen waste is mixed with cow dung and waterto prepare slurry. The ratios are 40% kitchen waste plus10% cow dung and 50% water. They concluded that 75:25 Ratio of foodwaste and cow dung will provide more efficient gas. Fulfill the demand and supply for energy sources canbe reduced by converting Bio degradable kitchen waste intoa biogas. [10]

Tanimu et.al. (2014) completed a study on effect of carbon to nitrogen ratio of food waste on biogas methane production in a anaerobic digester. Food wastes were collected from Taman Sri Serdang, Selangor, Malaysia. Food waste (raw chicken meat/ beef (5%), kitchen wastes such as rice and noodles (77%), leafy vegetables/ salad (7%), soup (6%) cooked meat/fish (5%)),vegetable waste (baby corn (5%), lettuce (24%), carrot (5%), broccoli (18%) and green leafy vegetables (48%)), fruit waste (papaya (27%), orange (19%), pineapple (39%), watermelon (11%) and berries (4%)) was collected for produce biogas. They concluded that methane composition of biogas increased with increasing C/N ratio with the highest methane composition of 85% obtained during the digestion of feedstock 3 with C/N ratio of 31. Similarly, the treatment efficiency of food waste during the digestion also increased from 69% to 74%, for C/N ratio of 17 to 26, respectively and to the highest value of 85% at C/N ratio of 30. It can be resulted that increase in C/N ratio of food waste resulted to better pH stability and enhanced methanogenic activities. [11]

OjikutuAbimbola O, OsokoyaOlumide O (2014) has studied Biogas production from kitchen waste. Food waste includes yam peels, plantain peels, orange rind and fish waste was collected for bio gas production. Mixture of these waste were carried out in batch type digester for 70 days digestion period. They resulted that the food waste type had significant ($P \leq 0.05$) effect on substrate temperature and pH but had no significant ($P>0.05$) effect on biogas production. The mean value of biogas production was in the range of 1090 ml/day and 8016.67 ml/day. The study concluded that anaerobic digestion of the mixture of the FW enhanced biogas production although not significantly ($P>0.05$*). [6]*

Dhanalakshmi Sridevi V and Ramanujam R.A. (2012) has studied Biogas Generation in a Vegetable Waste Anaerobic Digester**.** Nine reactor of 500 ml capacity lab scale batch reactors are used for generation of biogas at koyembedu, Chennai, india. Carrot, beans and brinjal having pH 5.4, 5.8 and 5.7 and moisture content 89.8%, 90.29% and 89.4% respectively were chosen for the study of generation of bio gas. Daily generation of biogas was measured by water displacement method. It can be concluded that vegetable waste contain high carbohydrates are responsible to anaerobic digestion process and maximum gas production occurred during 5 to 10 days of digestion. Carbohydrates have been broken down much faster than protein and fats present in the vegetable waste and produced gas. [7]

Patil V.S, Deshmukh H.V.(2015) has studied Anaerobic digestion of Vegetable waste for Biogas generation. They concluded that VW have high carbohydrate and high moisture content. It is a good substrate for the production of biogas through biomethanation**.** Biogas yield reported is in the range of0.360 L/g of VS to 0.9 L/g VS added. The biogas yield is affected by temperature, pH, organic loading rates and design of reactor. Biomethanation process reduces the load of organic pollutants in reduction of total solids, volatile solids, bio chemical oxygen demand and chemical oxygen demand. [8]

Muhammad Rashed Al Mamun, Shuichi Torii (2015) has studied Production of Biomethane from Cafeteria, Vegetable and Fruit Wastes by Anaerobic Co-Digestion Process. The study was conducted to determine the optimal mixing ratio of cafeteria, vegetable waste and fruit waste in generation of biogas and methane yield using batch type anaerobic digester at mesophilic temperature. The mixing ratio used were cafeteria waste: vegetable waste: fruit waste (0.5: 1:1.5, 1: 1.5: 0.5, 1.5:0.5:1, 1:1:1) .200 L digester was used for biogas production. At four mixing ratio tested, after 35 days of digestion, the biogas yield was determined to be Cafeteria waste: Vegetable Waste: Food Waste (0.5:1.0:1.5, 1.0:1.5:0.5, 1.5:0.5:1.0 and 1.0:1.0:1.0) were 13.38, 15.85, 17.03 and 19.43 L/day, respectively. The biogas yields obtained in the study for the cafeteria (CW), vegetable (VW) and fruit wastes (FW) mixture were in the order of (1.0:1.0:1.0 > 1.5:0.5:1.0 > 1.0:1.5:0.5 >0.5:1.0:1.5).). The higher methane contents and yields were obtained from the Cafeteria waste: Vegetable Waste: Food Waste (1.0:1.0:1.0) mixture ratio than those from the Cafeteria waste: Vegetable Waste: Food Waste (1.5:0.5:1.0, 1.0:1.5:0.5, and 0.5:1.0:1.5). it can be Concluded that maximum yield within 35 days hydraulic detention time without inoculums added.[12]

B. BAGASSE WASTE

Bagasse is the fibrous matters that remain after sugarcane crushed to make juice. It is a dry pulpy residue left after the extraction of juice from sugarcane. Bagasse are lignocellulose in nature. Hence digestion of bagasse takes more time to generation of biogas and increase detention time. Bagasse is used as a bio-fuel and raw material for pulp and paper production, boards, animal feed, product based on fermentation. Bagasse is burnt by sugar industry as fuel for boiler. Mechanical pre-treatment, alkaline pre-treatment and acid pre-treatment are used for enhancement of biogas production. [2] [13] (Eshore et al. 2017, Talha et al. 2016**)**

Md. Abdur Rashid Mia, Md. Rasel Molla, TanzinaSayed, Md. Moksadul Amin, TanzimaYeasmin, Md. Belal Uddin (2016) has studied Enhancement of Biogas Production by Cellulitis Bacteria from Bagasse**.** The main objective of researcher study wasenhancement of biogas production by cellulitis bacteria from bagasse using methanogens.five set of five liter capacity of digester were used. Bagasse,inoculum (cow dung), cellulitis and methanogenic bacteria are used as a raw material. Bagasse was collected from Rajshahi sugar mills, Bangladesh.Cellulitis bacteria were collected from MicrobiologyLaboratory Department of Biochemistry and MolecularBiology, university of Rajshahi, Bangladesh. Thesystem was consisted of three digesters (A, B andC) and three gas collecting bottles (X, Y and Z). Digesterbottle (A) for control was connected with gas collectingbottle (X) by a rubber pipe. Digester bottle (B) for S1 strainof cellulitis bacteria was connected with gas collectingbottle (Y) by a rubber pipe. Another digester bottle (C) for S3strain of cellulitis bacteria was connected with gascollecting bottle (Z) by a rubber pipe. 5 lit capacity of digester was used. The methane of biogas obtained from bagasse was 80%. The S1 strain (Monococcus sp.) and S3 strain (Streptococcus sp.) of cellulitis bacteria produced 3.45×10^{-3} (m3/day/kg feedstock) biogas and 3.85×10^{-3} (m3/day/kg feedstock) biogas at 22th day respectively whereas control produced 2.85×10^{-3}(m3/day/kg feedstock) biogas at 34th day by using bagasse as feedstock material. They concluded that the rate of biogas production was increased by S1 strain and S3 strain of cellulitis bacteria. The mean biogas was found 54.20×10^{-3}m3, 66.21×10-3m3 and 61.59×10-3m3 for control, S1 strain and S3 strain of cellulitis bacteria, respectively. They concluded that the present work can be used to design biogas reactor in the field conditions to operate batch and semi-continuous mode for disposal management of sugar mills and thereby contribute a lot of in our fuel and fertilizer sectors. [14]

Eshore et.al (2017) has studied Production of Biogas from Treated Sugarcane Bagasse. Sugarcane bagasse was choose for this study to enhancement of biogas production and minimization of detention time. Biogas generation of Sugarcane bagasse treated with mechanically was maximum in production rate and ultimate yield of biogas. Alkaline and acid treatment also used in generation of biogas but their corrosive effect is a reason for being less effective in enhancement of biogas yield as compared to mechanical treatment. The maximum ultimate biogas yield was308.7 ml/gVS. Pretreatment method like acid, alkaline, mechanical pretreatment was used for biogas production from sugarcane bagasse. Mechanical pretreatment is most economic. [2]

C. GARDEN WASTE

Green waste is organic waste includes foliage, plant residues, fallen flowers, garden refuse, leaf litter, cut grass, residues of pruning, weeds and other organic matter discarded from gardens and greeneries. These green wastes disposal method include dumping in municipal landfills, or will be burned, if not collected and processed contributing to the pollution of land, air, water. [15]

Gupta et.al (2012) has studied biogas production by anaerobic digestion of garden-waste. Garden waste, cow-dung, paddy field soil, mine water and termites were used in this work. Microbes present in paddy field soil when enriched on garden-waste gave best results out of four natural sources. Green waste was collected from the botanical garden of CIMFR, Dhanbad, India. They concluded that Paddy-field soil proved to be superior to cow-dung, mine water, or termite guts as a source of microbial inoculums to initiate reactors for the conversion of GW to methane, paddy-field soil to GW ratio is 1:100, addition of culturing is needed to achieve the maximum biogas production, addition of paddy-field soil is needed during the startup of the reactor. [15]

Dan Brown, Yebo Li (2012) has studied anaerobic co-digestion of yard waste and food waste for biogas production. Co-digestion of yard waste and food waste was carried out at F/E ratios of 1, 2, and 3. The result show that increase methane yields as the percentage of FW was increased to 10 and 20 percent of the substrate at f/e ratio of 2 and 1. This research show that co digestion of food waste with yard waste at specific ratio can improve digester operating characteristics and end performance metric over SS-AD of yard waste alone. Yard waste was collected from the OARDC Wooster campus and contained leaves and tree branches. [16]

III. CONCLUSION

Kitchen waste, vegetable waste, bagasse, and garden waste is very essential for biogas production. Additions of bacterial growth are very essential for enhancement biogas production and digestion of kitchen waste, vegetable waste, bagasse, garden waste. Pretreatment methods like acid, alkaline, mechanical pretreatment are very good for enhancement of biogas production from sugarcane bagasse. Digestion of kitchen waste and production of bio gas. This technique if used for management of municipal solid waste management will reduce the load in MSWM.

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