Experimental Investigation On Biogas Production By Using Natural Wastes

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Abstract- *The increased use of fossil fuels for energy consumption has causes environmental problems both locally and globally. The study investigates the anaerobic digestion in the production of biogas a renewable energy from the digestion and co-digestion of three different types of biodegradable wastes (cow dung, fruit waste and food waste) as an alternative for fossil fuels for energy consumption. This was carried out using a 25 Litres capacity plastic keg prototype biogas plant, constructed to investigate the anaerobic digestion in generating biogas. The experiment was batch operated and daily gas yield from the plant was monitored for 30 days. The slurry temperature and pH were also monitored and presented. The digester was charged with these wastes in the ratio of 3:1:1, of waste to water respectively. The mesophilic temperatures range attained within the testing period were 25 - 28.4 and a slurry temperature range of 24.4 -28.4 . The result obtained from the biogas production showed that the co-digestion of cow dung and food waste produced the highest biogas of 164.8%, followed by the codigestion of the three waste (cow dung, fruit waste and food waste) which has a percentage of 91.0%, co-digestion of cow dung and fruit waste (83.9%), cow dung of 79.8%, food waste of 77.4% and fruit waste of 76.4% within this retention period.*

Keywords- Fossil Fuels; Anareobic Digestion ;Microbial Growth; Samp Gas; Digestion Period;Natural Wastes .

I. INTRODUCTION

Stability of biogas production is highly dependent on the microbialcommunity composition of the bioreactors. This composition is basically determined by the nature of biomass substrate and the physical–chemical parameters of the anaerobic digestion. Operational temperature is a major factor in the determination of the anaerobic degradation process. Next-generation sequencing (NGS)-based metagenomic approach was used to monitor the organization and operation of the microbial community throughout an experiment where mesophilic reactors (37 °C) were gradually switched to thermophilic (55 °C) operation. Temperature adaptation resulted in a clearly thermophilic community having a generally decreased complexity compared to the mesophilic system. A temporary destabilization of the system was observed, indicating a lag phase in the community development in response to temperature stress. Increased role of hydrogenotrophic methanogens under thermophilic conditions was shown, as well as considerably elevated levels of Fe-hydrogenases and hydrogen producer bacteria were observed in the thermophilic system.

Donald L, Wise(1990) biogas produced of waste give the information about potential of biomass. Biogas digester design. Use of the upflow anaerobic sludge, blanket process in waste water temperature. Methane from crop-grown biomess. Methane production from agriculture residues digestion in batch and continuous culture. An integrated approach to the anaerobic digestion process.

Mr. Rai's (2011) **Biogas Production** OF BIOMASS text attempt has been made to present the subject matter in a simple lucid and precise manner. Sufficient solved examples are given to illustrate the use of equations developed in the text. Biomass under two type one is biogas generation and second biomass gasification.

Mr. Khan(2020) **Biomass Conversion Techonology** give a brief review of both Conventional and Non- Conventional energy source highlighting the importance of Non-Conventional energy source. The contents are covered in fourteen chapters. Again required knowledge of organic Chemistry and biology is also included in this chapter. Biomass resources, Biomass conversion Technology, Biomass gasification, Biogas production, Energy farming also studied Govt. of India‘s report(2002) on **―Evaluation Study On National Project on Biogas Development**, presents a preliminary study of two highly successful rural biogas models wherein biogas is produced and utilized as a cooking fuel by the villagers. The two models studied were the Community Biogas plant established by SUMUL Dairy at Bhintbudrak, Gujrat and the Individual Biogas plants established by Bhagirath Pratisthan (an NGO) in south Konkan region of Maharashtra. Various aspects including design, operation, economics and benefits to the stakeholders had been described. The report ends with a comparison of the two models studied on the basis of their design, vision, performance, economics and benefits.

Reinhard Madlenera, et al.(2006) compares multi-criteria decision aiding (MCDA) and data envelopment analysis (DEA) approaches for assessing renewable energy plants, in order to determine their performance in terms ofeconomic, environmental, and social criteria and indicators. The case is for a dataset of 41 agricultural biogas plants in Austrlia using anaerobic digestion. The results indicate that MCDA constitutes an insightful approach, to be used alternatively or in a complementary way to DEA, namely in situations requiring a meaningful expression of managerial preferences regarding the relative importance of evaluation aspects to be considered in performance assessment.

II. THE SOURCES OF MATERIALS

2.1. Methane (CH4)

Is a gas produced by a group of colonic anaerobes, absorbed from the colon and excreted in expired air. As a result, breath CH4 excretion can be used as an indicator of the in situ activity of the methanogenic flora. All CH4 produced in human beings is a metabolic product of intestinal bacteria, and about 50% of CH4 produced in the gut is absorbed and excreted in expired air. Because there appears to be no catabolism of this gas by other colonic organisms or host cells, breath CH4 measurements provide a rapid, simple means of semi quantitatively assessing the ongoing in situ metabolism of the methanogenic flora. It could seem likely that the intracolonic activity of a variety of bacteria similarly might be assessed quantitatively via analysis of expired air. However, the application of this methodology has been confounded by the rapid catabolism of many volatile bacterial products by other bacteria or human tissue. A striking aspect of the studies of breath CH4 measurements is the enormous individual variations in the excretion of this gas.

2.2 Carbon dioxide

(CO2), a colourless gas having a faint, sharp odour and a sour taste; it is a minor component of Earth's atmosphere (about 3 volumes in 10,000), formed in combustion of carbon-containing materials, in fermentation, and in respirationof animals and employed by plants in the photosynthesis of carbohydrates.

2.3 Hydrogen

Is the first chemical element in the periodic table. It has the atomic symbol H, atomic number 1, and atomic weight [1.00784; 1.00811]. It exists, under normal conditions, as a colorless, odorless, tasteless, diatomic gas. Hydrogen ions are PROTONS. Besides the common H1 isotope, hydrogen exists as the stable isotope DEUTERIUM and the unstable, radioactive isotope TRITIUM. Hydrogen is a colorless, odorless, nonmetallic, tasteless, highly flammable diatomic gas with the molecular formula H2. With an atomic weight of 1. 00794, hydrogen is the lightest element. Besides the common H1 isotope, hydrogen exists as the stable isotope Deuterium and the unstable, radioactive isotope Tritium. Hydrogen is the most abundant of the chemical elements, constituting roughly 75% of the universe's elemental mass.

2.4 Hydrogen Sulfide

Is a flammable, poisonous gas with a characteristic odor of rotten eggs. It is used in the manufacture of chemicals, in metallurgy, and as an analytical reagent. (From Merck Index,) Hydrogen sulfide is a highly toxic and flammable gas. Because it is heavier than air it tends to accumulate at the bottom of poorly ventilated spaces. Although very pungent at first, it quickly deadens the sense of smell, so potential victims may be unaware of its presence until it is too late. H2S arises from virtually anywhere where elemental sulfurcomes into contact with organic material, especially at high temperatures.

III. COLLECTION OF SAMLPES

3.1 COW DUNG

When antibiotics first became available, farmers used them indiscriminately dribbling streptomycin into chicken feed to boost growth and doling out low doses to fatten pigs. Now scientists know that the overuse of antibiotics in livestock can foster drug-resistant bacteria that are dangerous to human health. Amid debates over what kinds of restrictions should be put in place, figuring out how antibiotic-resistant bacteria evolve and make their way to humans remains an area of intense interest. Jo Handelsman is tracing one such pathway that, as she puts it, travels from "barn to table."

Raw Material	Days	Methane Content %
COW DUNG	5	0.25
	10	0.56
	15	1.26
	20	2.82
	25	3.4

3.2 FOOD WASTE

Is made up of materials intended for human consumption that are subsequently discharged, lost, degraded or contaminated. The problem of food waste is currently on an increase, involving all sectors management from collection to disposal; the identifying of sustainable solutions extends to all contributors to the food supply chains, agricultural and industrial sectors, as well as retailers and final consumers. A series of solutions may be implemented in the appropriate management of food waste,and prioritised in a similar way to waste management hierarchy. The most sought-after solutions are represented by avoidance and donation of edible fractions to social services.

3.3 FRUIT WASTE

Recent rapid growth of the world's population has increased food demands. This phenomenon poses a great challenge for food manufacturers in maximizing the existing food or plant resources. Nowadays, the recovery of health benefit bioactive compounds from fruit wastes is a research trend not only to help minimize the waste burden, but also to meet the intensive demand from the public for phenolic compounds which are believed to have protective effects against chronic diseases. This review is focused on polyphenolic compounds recovery from tropical fruit wastes and its current trend of utilization. The tropical fruit wastes include in discussion are durian (Durio zibethinus), mangosteen (Garcinia mangostana L.), rambutan (Nephelium lappaceum), mango (Mangifera indica L.), jackfruit (Artocarpus heterophyllus), papaya (Carica papaya), passion fruit (Passiflora edulis), dragon fruit (Hylocereus spp), and pineapple (Ananas comosus).

Raw Material	Days	Methane Content %
FRUIT WASTE	5	0.092
	10	0.125
	15	0.168
	20	0.209
	25	0.359

3.4 NAIPER GRASS

(Pennisetum purpureum) and maize (Zea mays) bran were tested as low- cost inputs to earthern ponds and concrete tanks. In Experiment 1, fresh napier grass was given at 50 kg dry matter (DM) ha−1 day−1 alone and in combination with maize bran at 3% fish body weightday−1 and/or agricultural limestone (L) applied at 100 kg ha−1 per 2 weeks. Treatments were applied over 181 days to a mixed-sex 1:1 polyculture of Tilapia rendalli and Oreochromis shiranus stocked at 2 m−2 in 200 m^2ponds. In Experiment 2, fresh napier grass (NG) was given whole (WG), chopped (CG) or ground (GG) at 50 kg (DM) ha−1 day−1 or in combination with maize bran (MB) at 3% fish body weightday−1 for 108 days to a mixed-sex polyculture of six T. rendalli and six Oreochromis karongae stocked at 2.4 m^2 in 5 m^3 tanks.

Raw Material	Days	Methane Content %
GREEN LEAVES	5	0.023
	10	0.028
	15	0.092
	20	0.019

3.5 INDUSTRIAL WASTE

The proper disposal of the several types of wastes produced in industrial activities increases production costs. As a consequence, it is common to develop strategies to reuse these wastes in the same process and in different processes or to transform them for use in other processes.

This work combines the needs for new synthesis methods of nanomaterials and the reduction of production cost using wastes from citrine juice (orange, lime, lemon and mandarin) to produce a new added value product, green zero-valent iron nanoparticles that can be used in several applications, including environmental remediation.

3.6 PLANT WASTE

If developed sensibly, nuclear power could be truly sustainable and essentially inexhaustible and could operate without contributing to climate change. In particular, a relatively new form of nuclear technology could overcome the principal drawbacks of current methods—namely, worries about reactor accidents, the potential for diversion of nuclear fuel into highly destructive weapons, the management of dangerous, long-lived radioactive waste, and the depletion of global reserves of economically available uranium. This nuclear fuel cycle would combine two innovations: pyrometallurgical processing (a high-temperature method of recycling reactor waste into fuel) and advanced fast-neutron reactors capable of burning that fuel.

IV. A MIXTURE

The type of manure used is also of great importance. Especially manure that has a large amount of “volatile solids” (VS) (material that is digestible to the bacteria and which becomes available for gas production have been gathered), in relation to the amount of total manure, (VS) will yield biogas.

Cow manure is very high in volatile solids, horse, pig, human and chicken manure is far rich in volatile solids.

4.1 METHANE

Household kitchen waste has the potential of producing enough biogas to cook three meals a day for a family of four and still have enough left over to heat some water for washing up. Biogas is produced by means of a process known as anaerobic digestion, where organic matter is broken down by microbiological activity and, as the name suggests, it is a process which takes place in the absence of air. It is a phenomenon that occurs naturally at the bottom of ponds and marshes and gives rise to marsh gas or methane, which is a combustible gas.

4.2 BIOGAS FOR STREET LIGHTNING

Biogas generated from decaying garbage in a landfill in the northern Mexican city of Monterrey is being turned into electricity that is illuminating city lights and making a significant dent in the methane (CH4) emissions that are contributing to global warming.

4.3 TURNING INTO LIGHT

The Monterrey landfill receives 4,500 tons of garbage daily. Natural degradation of the organic materials included in this waste stream produce methane, a pollutant and greenhouse gas with a Global Warming Potential 72- times that of carbon dioxide. That's changed, thanks to deployment of a landfill biogas system carried out by SEISA, which manages the gas collection and treatment, alongside the public landfill operator Sinaproc, and with support from 33 the World Bank.

4.3 BIOGAS STREET

Biogas consists mostly of methane (CH4, around 65-70%) carbon dioxide (CO2, around 25-30%) and varying quantities of water (H2O) and hydrogen sulphide (H2S) and some trace amounts of other compounds, which can be found, especially in waste dump biogas (e.g. ammonia, NH3, hydrogen H2, nitrogen N2, and carbon monoxide, CO). The amount of each gas in the mixture depends on many factors such as the type of digester and the kind of organic matter. Diverse sludge composition requires diverse/specialised reactor designs to achieve a high conversion. Methane is the valuable component under the aspect of using biogas fuel. The calorific value of biogas is about 6 kWh/m3, which corresponds to about half a liter of diesel oil and can be utilised directly as a heat source or to produce 34 electricity. In all cases, the biogas must be dehumidified and purified before combustion; otherwise it can damage the gas engine.

4.3 CONVERTING TECHNOLOGIES

For small-size heat engines, combustion engines are popular as they are more efficient and less expensive than small gas turbines. However, gas turbines may be more efficient when operating in a cogeneration cycle producing heat and electricity. Cogeneration or combined heat and power (CHP) describe the simultaneous generation of both electricity and useful heat. Heat engines (also thermal power plants) in general do not convert all of their thermal energy into electricity. In most cases, a bit more than half is lost as excess heat. By capturing the excess heat, CHP use heat that would be wasted in a conventional power plant, potentially reaching an efficiency of up to 89%, compared with 55% for the best conventional plants (WRAPAI 2009). This means that less fuel needs to be consumed to produce the same amount of useful energy. By-product heat at moderate temperatures (100-180°C) can also be used in absorption chillers for 35 cooling (WRAPAI 2009). A plant producing electricity, heat and cold is sometimes called trigeneration or more generally a polygeneration plant.

4.4 A MIXTURE OF METHANE AND CARON DI OXIDE

Ng, H.-J., Robinson, D.B. and Leu, A.-D., 1985. Critical phenomena in a mixture of methane, carbon dioxide and hydrogen sulfide. Fluid Phase Equilibria, 19:273-286. The two- and three-phase boundaries for a mixture containing nominally 0.50 mole fraction methane, 0.10 mole fraction carbon dioxide and 0.40 mole fraction hydrogen sulfide were determined experimentally for a range of temperatures from c. 29 to – 83°C at pressures up to c. 13 MPa. The two-phase boundary curve commences with a conventional hydrogen-sulfide-rich liquid dew point locus which passes through an upper retrograde region and terminates at a vapor-hydrogen-sulfide-rich liquid critical point at − 16.9°C and 11.03 MPa. The phase boundary then follows a bubble point locus which terminates at a hydrogen- sulfide-rich liquid-methane-rich liquuid critical point at −45.6°C and 8.79 MPa. After this the boundary turns sharply upwards to higher pressures at lower temperatures. This separates the single phase from a second retrograde-like two- liquid region.

4.4.1 AEROBIC DECOMPOSTION

When the decomposition occurs in the presence of air which has oxygen, the bi-products are carbon-di –oxide (CO2), water (H2O) and energy in form of heat. It is exactly how food people consume is broken down in the body. The gastric juices, enzymes and friendly germs in our gut break down the carbohydrates proteins and fats into smaller units called glucose, amino acids and fatty acids. Our body either uses these molecules to form new units or degrade them in simple waste products thereby releasing energy. This process is called metabolism. You can also observe the degradation process in household 40 composting or garden composting. The compost heap is turned every few days to aerate it. A compost heap gets get hot during the degradation process. Temperatures can reach to 60 degree centigrade. The degraded simple waste products in this case are water, carbon dioxide and energy or heat. However the above mentioned processes occur mostly in the presence of air. These are aerobic processes. In the absence of air, the end products are different which why swamp gas is formed.

4.4.1 ANAEROBIC DECOMPOSTION

Within any ecosystem death plays an important part. However dead and decaying plants and animals in the swamps slowly get buried in the supersaturated soil. There they keep degrading in absence of air. The anaerobic bacteria, present in abundance in swamps, breakdown the dead plants and animals. The gases formed as a result are Methane(CH_4), carbon di oxide(CO_2) , nitrogen(N) and traces of Hydrogen(H),carbon mono oxide(CO), propane(C_3H_8), hydrogen sulphide (H_2S), phosphines(PH_3) other hydrocarbons. Famous scientist Alessandro Volta (1745-1847) isolated methane from swamp gas in 1783, prior to his work on electricity. Possible explanation of self ignition of the ‘swamp gas’given by science .

V. HANSEN METHOD

Source-sorted municipal organic waste collected from different dwelling types in five Danish cities and pre-treated at three different plants was sampled and characterized several times during one year to investigate the origin of any differences in composition of the pre-treated waste introduced by city, pre- treatment technology, dwelling type or annual season.

5.1 INCUBATION TECHNOLOGY

The effects of fumigation on organic C extractable by 0.5 M K_2SO_4 were examined in a contrasting range of soils. EC (the difference between organic C extracted by 0.5 MK_2SO_4 from fumigated and non-fumigated soil) was about 70% of FC (the flush of CO_2-C caused by fumigation during a 10 day incubation), meaned for ten soils. There was a close relationship between microbial biomass C, measured by fumigation-incubation (from the relationship Biomass C = FC/0.45) and EC given by the equation: Biomass C = (2.64 ± 0.060) EC that accounted for 99.2% of the variance in the data. This relationship held over a wide range of soil pH (3.9–8.0). ATP and microbial biomass N concentrations were measured in four of the soils. The (ATP)(EC) ratios were very similar in the four soils, suggesting that both ATP and the organic C rendered decomposable by $CHCl_3$ came from the soil microbial biomass. The C:N ratio of the biomass in a strongly acid (pH 4.2) soil was greater (9.4) than in the three less-acid soils (mean C:N ratio 5.1). We propose that the organic C rendered extractable to 0.5 M K_2SO_4 after a 24 h $CHCl_3$-fumigation (EC) comes from the cells of the microbial biomass and can be used to estimate soil microbial biomass C in both neutral and acid soils.

5.2 REACTOR NITROGEN

An intermittently aerated and decanted single-reactor process was proposed and some key control parameters investigated for nitrogen removal from wastewater by simultaneous nitrification and denitrification (SND) via nitrite. Two types of synthetic wastewater with acetate as the main carbon source, and chemical 61 oxygen demand (COD):nitrogen (N) ratios of approximately 5:1 and 10:1 were used. For both types of wastewater the average COD removal efficiency reached above 95%, and under optimal conditions nitrogen removal efficiency also reached above 90%. This process consisted of 72 min aeration, 48 min settling and 24 min effluent decanting. Influent wastewater was fed from the bottom of the reactor, and did not require a separate mixing phase.

5.3 ANERAOBIC CONDITIONS

Inoculum population appeared to have no influence on the eventual population. The influence of environmental parameters on the diversity of methanogenic communities in 15 full-scale biogas plants operating under different conditions with either manure or sludge as feedstock was studied. Fluorescence in situ hybridization was used to identify dominant methanogenic members of the Archaea in the reactor samples; enriched and pure cultures were 62 used to support the in situ identification. Dominance could be identified by a positive response by more than 90% of the total members of the Archaea to a specific group- or order-level probe.

5.4 ANEROBIC CO-DIGESTIONS OF MESOPHILIC

Crude glycerol derived from biodiesel production is characterized by its high concentration of organic carbon and its solubility in water; properties that make it a suitable co-substrate to improve the efficiency of a manure digester. An increase of about 400% in biogas production was obtained under mesophilic conditions when pig manure was co-digested with 4% of glycerol, on a wet-basis, compared to mono-digestion. The increase in biogas production was mainly a consequence of the increase in organic loading rate. However, the differences could also be related to the synergy between both substrates and the carbon-tonitrogen ratio.

5.5 EVALUTIONS OF ANEROBIC TWO STAGE

The marine algae are considered an important biomass source; however, their utilization as energy source is still low around the world. The technical feasibility of marine algae utilization as a source of renewable energy was studied to laboratory scale. The anaerobic digestion of Macrocystis pyrifera, Durvillea antarctica and their blend 1:1 (w/w) was evaluated in a two-phase anaerobic digestion system, which consisted of an anaerobic sequencing batch reactor (ASBR) and an upflow anaerobic filter (UAF). The results show that 70% of the total biogas produced in the system was generated in the UAF, and both algae species have similar biogas productions of 180.4(±1.5) mL g^{-1} dry algae d^{-1} , with a methane concentration around 65%.

VI. CONCLUSION

In this experiment the amount of Natural Waste gathered by the village and its use compared to use of Biogas. There is sufficient cow dung present to use biogas on a larger scale. The anaerobic degradation of organic material requires a well function microbial growth. This waste can be utilized for energy generation instead of burring them up or having them littered around and invariably constituting a nuisance to the environment. The cow dung with Natural waste has produced 63% of Biogas throughout the digestion period for 30 days for poor producing wastes.

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