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The Use of Natural Rubber Leaves, Seeds, Vegetable Clippings and Animal Droppings as Materials for Biogas Production

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Abstract:
The importance of green chemistry cannot be overemphasized, hence the world over, the use of renewable materials and energy is now the norm and is in vogue. In this paper a study of the production of biogas from vegetative sources, in this case rubber leaves and other plant and animal waste or remains, is carried out with a view to encouraging the use of Nigerian's vast agricultural resources as a raw materials for the production of green environmental friendly and ecologically friendly biodiesel. It will also help to reduce cost of fuel and pollution and green house effects.
A 3600 litres capacity biogas plant turns about 9kg 12.5kg of vegetable waste (NR Leaves and seeds and chippings into cooking fuel daily. The decomposition of the vegetable waste yields methane and carbon dioxide, which inflates a number bladder to creative the pressure necessary to supply a gas burner. The can be used for cooking, lighting and heating and be used for biodiesel in some diesel engines and in cooling systems and other appliances, thus biogas can effectively replace fossil – based natural gas. An 800litres capacity biogas plant can provide about 1hour - 2hours daily stovetop cooking for a family.

Keywords: *Biogas, fruits and vegetable remains, generator, renewable energy sources, waste to fuel, digester, anaerobic.*

1. Introduction

The generation of renewable energy by bio conversion of vegetable and animal wastes is gaining importance as it has proved to be a proficient means of utilizing perishable vegetable and animal residues. Many researchers and industries are now fully engaged in projects involving the science and technology of waste to fuel. Bioenergy is a promising, inexhaustible, sustainable source to combat the rising environmental, economic and technological issues relating to depleting fossil fuels. The most aspect for the sustainable production and supply of bioenergy is the availability of feedstock. Among various substrates production from wastes has received a special acceptance for maintaining environmental integrity. Wastes are generated in many form and various stages, ranging from domestic, farm settlements agro-allid industries to other industrial levels and their improper disposal has detrimental effects on the environment. In rubber plantations (in general many farm settlements) all over the world, millions and millions of tonnes of leaves, grass chippings, food waste and animal wastes are produced. These are all a veritable feed stock for biogas or natural gas or methane or cooking gas production for the individual too, one can also transform leaves, chippings, food waste, animal and human waste (manure or compost) into renewable energy via a homemade biogas generator (1,2,3). Much if not all of all the household organic waste materials can be used to produce natural gas for cooking, lighting and for space and water heating. This gas is known as biogas (because it is got from biological materials). Biogas can also replace fossil-based natural gas to fuel, an engine or an absorption cooling system, such as a gas refrigerator or chiller. Some gasoline engines are designed for or can be modified for use with natural gas, propane or biogas diesel engines can accept up to 80% biogas. Biogas is a mixture of primarily flammable gases mostly methane – along with carbon dioxide that forms anywhere

organic material decomposes anaerobically (without oxygen), such as in water, deep in a sanitary landfills or in the guts of animals, including man. A more preferable name for the system is the term 'generator', because it conveys the intention of producing something. By constructing a home or industrial biogas generator or digester, enough fuel can be produced to provide cooking energy at the least. A family with a modest daily cooking need will at a minimum require the output of a warm, well-fed, 800 litres (27 – cubic – foot) generator. This much biogas will allow for about one hour of daily stovetop cooking. One can start small to develop an understanding of biogas by making a small generator from a single 220 litres barrel (3,4)

2. Materials and Methods

Materials for biogas includes leaves, grass clippings, water, livestock manure and human wastes, containers i.e., drums, plastics buckets or containers bricks etc. (6,7,8)

3. Methods

A 2,400 litres biogas generator can turn 6kg of vegetable waste into cooking fuel daily. As vegetable and human waste decompose, methane and carbon dioxide are created, airlifting the rubber bladder to create the pressure necessary to supply a gas burner. This biogas generator was design to produce enough gas to supply a burner. A very common biogas, generator or digester is the floating drum. Floating drum digesters are operated by feed the vegetable and animal wastes mixed with water into a digester inlet pipe. Theslungflows down the inlet pipe and enter the bottom of the digester. The bucket is mounted on the containers with water jacket located outside the digester, and as the pressure of biogas increases in the drum, the drum rises accordingly. Therefore, we must but the heavier rock or brick on the bucket so that the bucket would not fall off easily as the bucket rises. To reduce the building cost, the floatinggas drum can be replaced by a balloon above the digester (7). The digestion can be carried out at a temperature of 25^{o}C to 35^{o}C at an uncontrolled pH for 1 to 5 weeks (7, 1, 6, 8, 4, 5).

4. Result and Discussion

A well-managed methane digester can produce approximately its own volume of biogas each day (1, 2, 3). Anyway, from 10 to 60% of the solids will convert into biogasduring anaerobic digestion, so we can expect to produce 90 litres to 540 litres of available biogas energy for each kilogramme of vegetable or animal waste. The exact make-up of biogas depends on what is fed into the digester. The main ingredient of biogas is methane (CH_4). Methane is the primary component of conversional natural gas commonly used for cooking and heating, although biogas is not as energy-dense; the methane content of biogas will probably range from 50 to 80%, compared with about 70 to 90% in utility-supplied natural gas. Natural gas contains up to 20% other combustible gases, such as propane, butane and ethane, while biogas does not. Biogas' primary non-combustible components are carbon dioxide, water vapour, nitrogen and some traces of hydrogen sulphide (1, 2, 3).

5. Feeding the Feedstock into the Plant or Generator

A good material for producing biogas in terms of both production availability is freshly natural rubber NR leaves and freshly cut grass clippings, which can produce about 60 litres to 90 litres of biogas per kilogramme. At this rate, about 10kg of NR leaves/ clippings will generate one hour of cooking fuel. Grass silage and food and animal waste can yield slightly higher amounts of biogas per kilogramme than leaves or grass. Fresh manure from livestock is well-suited for on-farm methane production, in spite of every its relatively low yield per day kilogramme. One cow can produce about 75kg (72 litres) of manure each day which could generate an average of 2500 litres of biogas or about 3 hours to 4 hours of daily cooking fuel. It is however difficult to collect the manure produced during hours the animals are on pasture (1, 2, 3, 4).

Any materials meant for compositing, can be digested. The ideal biogas ingredients are those material of which one is sure of enough convenient and constant supply so as to able to make a steady and useful quantity of biogas. Combinations of NR leaves, other vegetables, food scrapes, grass clippings/trimmings, animal manure, human waste (faces), meat, slaughter house waste and fats will suffice as long as the recipe contains the right proportion of carbon and nitrogen. Linin from too much wood, cells should be avoided because its resistant to microbial breakdown and can clog the digestion reaction progression. The feedstock much first mixed with water, that is about 90% of material inside the generator (digester plant) can be water. It's more efficient to cut the solid material in small pieces, this will provide more surface area for microbes, and hence theacceleration of digestion or breakdown the organic material sometime some plant material will digest readily if allowed to age for some days by makingfungi and bacterial to start digestion of fibre before feeding into the plant (1, 2, 3, 4).

6. Generator Reaction Conditions Control

On loading the plant / generator with the feedstock, enough water should be added to make a slurry, and then add a starter culture of the methane-producing organisms. These microbes, known as 'methanogens' usually exist naturally in most animal dung or manure. When animal dung is used, there's no need of methanogens. However, if it is one vegetable and food waste, one has to inoculate the mix to get the biochemical processes started, usually once. A temperature of 25°C to 35°C should be maintained with the plant, this is close to the body temperature, an uncontrolled pH in less than two – three weeks, biogas will be generated. The generated can be exposed to direct sunshine, to increase microbial activity or wrapped with thin flexible foam insulation, or unit uv-resistant black plastic sheets, all to reduce external heat (1,2,3,4,6). As the biogas is produced, it should be piped into a simple holding container such as a small jar or jerry can, inverted into a

larger jerry can, filled with water (2,3,4,5). A storage container that is airtight and expandable as gas flows in and out should be used. An external weight should be applied to the storage container to achieve the correct pressure required for a gas appliance (3,4,5). The retention time which is the length of time the plant needs to convert solids to biogas, can be determined by practice and study. While the plant is loaded and working, the rate of gas production should be monitored by watching the expansion of the collection apparatus (jerry can) when the expansion slows the production rate has reduced and it is time to feed. Feeding the generator might be daily or weekly. Feeding rates usually depend on the material mix and the reaction conditions in the plant.

7. Recipe

A recipe is blend or gathering of different vegetable and animal materials suitable for biogas generation. It is usually most recommendable to feed according to a recipe (1,2,3). The production of most recommendable to feed according to a recipe (1, 2, 3). The production of effluents is usually associated with biogas production. Effluent is a low-odour blend of compostable solids and nutrient-rich liquid from the generator, it can be applied to garden soil for soil remediation or as a compost material (4, 6)

7.1. Precautions and Safety Measures

One of the most critical details is thebiogas plant/generator temperature control. Most times the feedstock in a well-maintained methane generator operating at a temperature range of 20 – 36^0C will be easily digested in about 3 – 5 weeks, feeding should be continuous as material digests (4, 6, 7, 8). Conditions should be similar to those in the gut or stomach of a ruminant (cow).

Biochemical activity within the generator will produce some heat, how depending on weather and climate conditions, additional heat might be required. The inside temperature of the plant must not rise above 35 – 37^0C at the most. Never make biogas inside the house or in poorly ventilated areas. Methane is a flammable gas and will burn when in contact with air or exposed to a flame. A biogasplant can explode if the pressure drops and the flame is allowed to toll back through the pippin. The risks are similar with handling and storing conventional natural as (1, 3, 5, 7).

8. Biogasenergy from Sanitary Landfill Methane

Solid waste landfills from village, cities, municipalities make up a large source of methane emissions (about 30 – 35%) in some countries e.g. (3, 4, 6, 7). However, instead of allowing this methane to be released into the atmosphere to cause a lot of harm to the ozone layer, it can be captured and used for electricity production. According to U.S. environmentalProtection Agency, about 600 U.S landfills capture methane to use in a variety of ways including firingglass-blowing and pottery kilns, heatinggreenhouses and even powering an ice rink, methanol as fuel for vehicles etc. (4, 5, 6, 7).

9. Conclusion

The production of biogas (or methane) for cooking, lighting, space and water heating is a very good step in filling the yarning or ever increasing gap in our energy needs. It will reduce the cost of refuse disposal, provide cheap and clean energy or bioenergy sources, reduce the amount deforestation, reduce the cost of cookinggas, reduce the cost of kerosene and in general reduce the cost of living. While improving the standard of life of the average Nigerian and reduce over-dependence on the National Power Provider. The most beautiful aspect of biogas production is that it is a renewable source of fuel; it is green and helps to generate carbon credit. Other by-products are biodiesel for diesel engines, bioethanol and biobutanol as alternatives to petroleum based transportation fuels and biohydrogen.

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