Gh_{24} Bio Generator Power Generating Device

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***Abstract:** From time to time researcher developed different types of electricity generating device s. Because electricity and home lighting are considered essential for a country's economic and social developments. GH_{24} bio generator is a device that converts the chemical energy of waste organic compound into electricity (light) using naturally occurring microorganisms found within the waste. 40 cm height, 20 cm width, 60 cm length, and 3.5 Kg mass prototype was developed. The prototype was composed of four reactor chambers, sample inlet pipe, bridge, gas outlet pipe waste disposal pipe and upper and bottom protective layer. The greenness, simple operation and effective design are characteristic of the devices. Prototype testing was performed using a liquid dough as a sample. A maximum of 3.403 V was generated when the GH_{24} bio generator prototype operated with 3.5 L of waste liquid dough sample. This renewable energy is given light for 10-12 hr. using one light bulb. The device could be used as an important source of light for people living in off-grid access to electricity area. Other benefits of the device is used to minimizing the health and environmental impact of fuel-based lamps by replaced it.*

***Keywords:** Bio generator; Electricity; Rural electrification; Kerosene lamps.*

I. INTRODUCTION

Electricity is a widely used forms of energy by human beings throughout the world. Before the modern civilizations, cities and towns were constructed close to the waterfalls that turned water wheels to perform their daily need. Over 100 before the electricity generation began, oil lamps were used for lighting purposes and rooms were warmed by burning wood or coal in the chimney. Most of the people in developed countries are not worried or ever think about their lifestyle with the absence of electricity due to the presence of the electricity, for lighting, maintaining room temperature, and powering televisions and computers etc., throughout the year using various modern technologies [1].

International literature on payment system regulatory (PSR) in developing countries covers rural electrification (RE) in a very limited fashion. Most of the rural communities most commonly in periurban areas were categorized as low population density and a huge ratio of poor households. They usually in demand for electricity which is limited for their residential and agricultural irrigation purposes and even many households consume less than 30 kWh of electricity per month [2].

Lack of appropriate incentives, the weak implementation capacity of adequate design and effective implementation of a rural electrification program requires technical and managerial skills that are not always available and electricity generation shortage is an obstacle to supply power in rural area in many countries with low access rates due to the insufficient capacity of generating from the main electricity system [3].

The participation of local investors in RE is even scarcer. In developing countries such as Ethiopia, RE is still a key objective of national development program [4].

Ethiopia has one of the lowest rates of access to modern energy services, and its energy supply is primarily based on biomass. With a share of 92.4% (88% according to scaling up renewable energy program (SREP) investment plan) of Ethiopia's energy supply, waste and biomass are the country's primary energy sources, followed by oil (6.7%) and hydropower (0.9%). Whereas, the households, industries and service enterprises use biomass as a source of energy as 99%, 70% and 94% respectively. The installed electricity generating capacity in Ethiopia is about 2060 MW from the source of 88% hydro, 11% diesel and 1% thermal and production covers only about 10% of national energy demands [5]. Almost 85% of the Ethiopian people live in rural areas, and there is a significant bias between the power supply of urban and rural populations: only 2% of the rural but 86% of the urban residents have access to electricity [6].

Most of the Ethiopian people living off the grid access to electricity use Candles and kerosene lamp lighting to do a different activity. Fumes produced from traditional lighting methods are toxic and lead to chronic lung problems, especially when children are exposed using these dimmer sources of light [7]. Hence, the aim of the present research work is to generate electricity using GH_{24} bio generator power generating device for people living in off-grid access to electricity area.

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II. MATERIALS AND METHODS

A. Material Used

The material used in the present work are light bulb, single-conductor (solid core) copper wire, thin-wall conduit cheap coloured PVC pipe (hard tube), 1/2 inch diameter black furniture grade schedule 40 PVC pipe, 45º malleable iron elbows, cements, songhui (Model:S R-7369) divider, clear plastic straight-sided jars with yellow screw top cap (as reactor champer), AISI 304 Stainless Steel Wire, conical-shaped plastics, high-quality board PP hollow sheet plastic (Corrugated Sheet), stick graphite and liquid waste product of dough.

B. Specification of GH_{24} Bio Generator Bio Generator

The overall height, width, length, weight, and shape of the GH_{24} bio generator are 40 cm, 20 cm, 60 cm,3.5 kg and rectangular respectively.

C. Selected Material Design

The selection and specification of plastic materials are based upon its non-corrosion property and its local availability. The detailed specification of the materials used in the present work is given in Table-I.

Table -I: Specification of the Materials

Name of Material	Weight (Kg)	Length (Cm)	Volume (Cm^3)
1/2 inch diameter black furniture grade schedule 40 PVC Pipe (Feed-in late pipe)	–––	50	–––
Corrugated Sheet top part	–––	48	–––
Corrugated Sheet bottom parts	–––	50	–––
Thin wall conduit cheap coloured PVC (gas out the lite pipe)	–––	70	–––
Thin wall conduit cheap coloured PVC pipe(waste disposal)	–––	15	–––
Reactor chambers	–––	–––	1000
Cement	0.5	–––	–––
Waste dough products	–––	–––	875
Stick graphite	6.5	–––	–––
Copper (solid core) wire	–––	150	–––
AISI 304 Stainless Steel Wire		24	

D. Process Flow Diagram

Wastes were inserted through a waste inlet cylinder then transported and distributed into the whole reactor chamber through 1/2 inch diameter black furniture grade schedule 40 PVC pipe and plastic bridge tubes, respectively Fig. 1.

The chamber contained anode and cathode electrodes. Organic wastes inserted in the reactor chamber are digested by the microorganism and the emitted electron during the digestion process.

The electrons produced in the reactor chamber are extracted through the electrodes and rotate in the external circuit with a spiral-shaped solid core (Copper) weir that connected with Songhui (Model: SR-7369) divider.

The Light Bulb was connected to Songhui (Model: SR-7369) divider given bright light. The dead waste was removed through the (thin wall conduit cheap coloured PVC pipe) waste disposal part of the device.

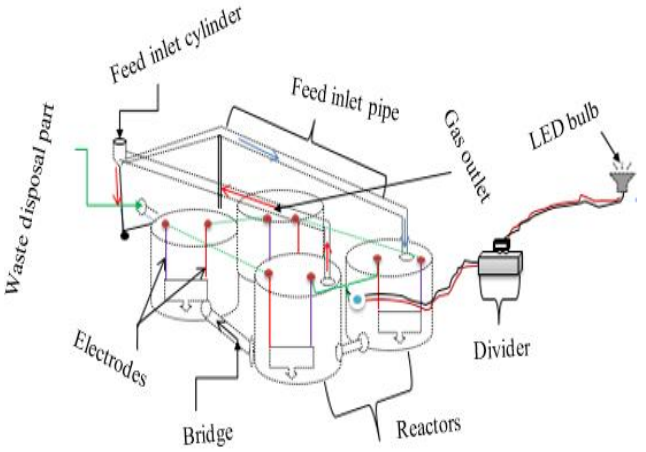

Figure. 1: Process flow diagram of GH_{24} bio generator

E. Anode and Cathode materials

In a GH_{24} bio generator, the anode, the receptor of electrons, is where electricity-produced. Therefore, an ideal anode material should be highly conductive, non-corrosive, possessing a high specific surface area, non-fouling, inexpensive and easily made. A graphite material was used as an anode.

Because graphite is the simplest materials for anode electrodes construction as they are relatively inexpensive and easily available. Moreover, a stainless-steel material was used as a cathode. Because reduction has been observed for steel cathodes which will rapidly reduce the oxygen and as per the design the cathode electrode is placed on the top parts of anode electron as showing in Fig. 2

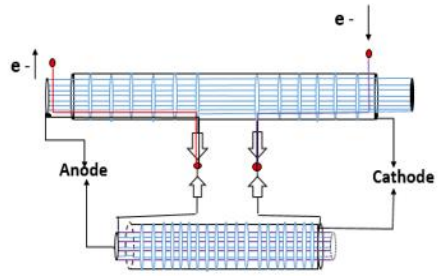

Figure. 2: Anode and cathode electrodes arrangement in the GH_{24} bio generator.

F. Prototype Development

GH_{24} bio generator was constructed with batch operation as shown in Fig.3. Based on the above information, the prototype of the device was finalized. Initially arranged the feed-in late cylinder and attached with one of the 10oz clear plastic straight sided jars with yellow screw top cap (as reactor) using both 1/2 inch diameter black furniture grade schedule 40 PVC pipe and thin wall conduit cheap colored PVC (hard tube) on the top sides.

Four chambers (10oz clear plastic straight sided jars with yellow screw top cap (as reactor)) in the GH_{24} bio generator were joined by 1/2 inch diameter black furniture grade schedule 40 PVC pipe.

The joints were covered by cement to prevent water losses. Each reactor cylinder contends anode and cathode electrodes. The stick of graphite electrodes was used as anode and steel metal as a cathode. The anode is located at the inner parts of a cathode and the cathode is located at the top part of the anode separated by an insulator material. Anodes in GH_{24} bio generator are components oxidation of organic compounds takes place, whereas cathodes in GH_{24} bio generator are components oxygen reduction takes place.

The main function of the insulator material is to avoid electrical short circuits. Anode and cathode electrodes are connected by an external circuit. The difference in voltage between the anode and cathode, along with the electron flow in the circuit, generates electrical power.

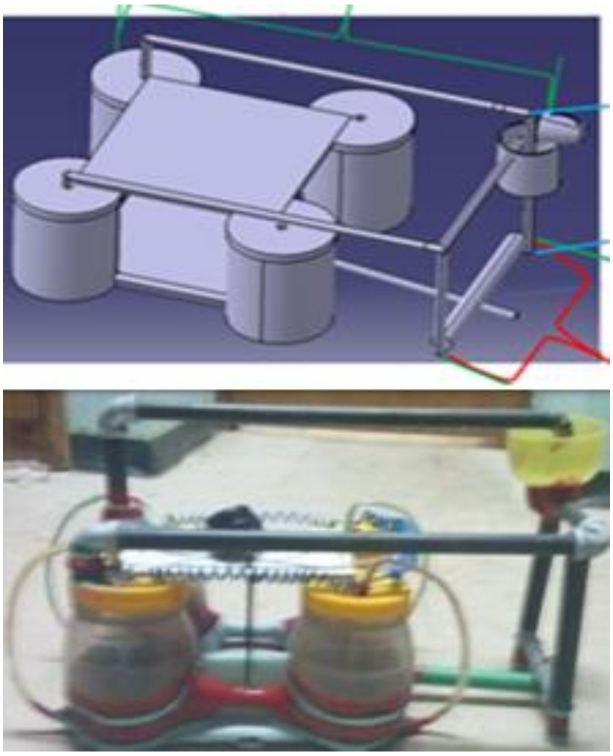

Figure 3: Prototype of GH_{24} bio generator

G. Experiment Process

After developing the prototype, different experiments were conducted to check the efficiency of the model. The input raw material waste liquid dough was collected around the Mekelle city, Ethiopia. Calibrate digital multimeter to measure the resistance of the prototype.

They measured and recorded internal resistance of the GH_{24} bio generator before inserted the sample. 3.5- 4.5 L waste liquid dough was prepared. 3.5 L waste liquid dough was added to the prototype which has 4L capacity.

Measured the voltage output of the prototype using a digital multimeter within 1hr intervals. The experiment was conducted two times. They calculated the average current using equation (1).

$$I = \frac{V_{av}}{R} \quad (1)$$

$$V_{av} = \frac{V_{11}+V_{12}}{2} \quad (2)$$

Where

V_{av} =Average voltage (V)

R= Resistance (Ω)

I = Current (A) [12]

III. RESULT AND DISCUSSION

The need for new and alternative sources of energy is increasing day by day. In the upcoming days, alternative sources of energy will be applied everywhere. A Microbial fuel cell (MFC) is a technology that uses microorganisms to convert the energy stored in chemical bonds of organic compounds to electrical energy through reactions naturally occurring within the natural microbial metabolism [8].

The microorganisms can produce electrochemically active substances that may be either metabolic intermediaries or final products of anaerobic respiration utilizing consuming sugar as a substrate to produce carbon dioxide, protons and electrons [9]-[10]-[11].

The measured and recorded internal resistance of the GH_{24} bio generator before inserted the sample as shown in Table -II. The prepared waste liquid dough was inserted in the GH_{24} bio generator and measured the voltage output of the prototype using a digital multimeter within 1hr intervals as shown in Table-II

Table -II. Digital multimeter reading result of voltage and internal resistance for E1 and E2

T (hr.)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Experment1 (E_1) Volt (V)	0	2.301	2.732	2.941	3.403	3.201	-	-	-	-	-	1.304	1.005	0.821	0.492
Experment2 (E_2) volt (V)	0	2.271	2.761	2.901	3.381	3.201	-	-	-	-	-	1.321	1.102	0.867	0.359

No of try	Try 1	Try 2	Try 3	Try 4	Try 5
Resistance(R)	0.805	0.804	0.808	0.806	0.798
R	= 0.8042 Ω				

The maximum average voltage produced was 3.392V shown in Table -III. Fig.5 shows the occurrence of maximum Current peaks after 4 hrs during microbial reaction takes place in the chamber. All average voltage was calculated using equation (2) and results are showing in Table -III.

Table –III. The average value of voltage, and current, obtained for an experiment using waste dough.

Time(hr)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Voltage(V)	0	2.286	2.747	2.921	3.392	3.206	_	_	_	_	_	1.313	0.941	0.849	0.423
Current (A)	0	2.843	3.415	3.632	4.218	3.987	_	_	_	_	_	1.632	1.196	1.055	0.528

The amount of voltage produced in GH_{24} bio generator using waste liquid dough increase up to 4 hrs and steadies out at 4hr and finally decrease as time increase as shown in Fig.4. This is due to the biological activity of the microbes and the environmental condition of the device. As the time increases up to 4hr the microbe adapted the reactor chamber environment.

As the time increase beyond 4 hrs, the organic content of the waste decreases. Thus, the rate of reaction, electron formation, and voltage production decrease. The plot for current follows a similar trend with the plot for voltage as showing in Fig.4. This is because current is directly proportional to voltage.

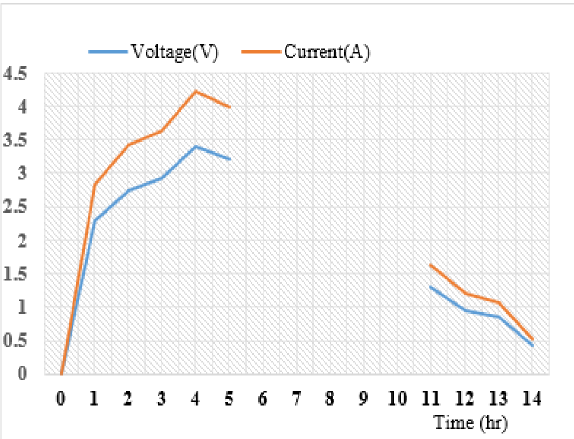

Figure 5: Graphical representation of the average value of Voltage, and Current, obtained from the experiment using waste dough as raw material.

IV. CONCLUSION

A Prototype (GH_{24} bio generator) of the devices was developed to produce electricity form food waste. The experiment conducted using the GH_{24} bio generator demonstrated that electricity could be generated using waste liquid dough. The microorganism needed to be were already naturally present in the waste.

It was observed that the current increase with time but after a certain period it becomes constant then starts decreasing. The basic reason for an increase in current is that in initial phase microorganism which was responsible for electricity generation were less active but when they stayed for 14hrs time in the reactor they activating themselves started degrading organic matters present in the waste at anode electrodes.

Further studies should be carried out to increase the performance of the device and developed devices for manufacturing in large scale production. It will make a significant impact on the country's economic development

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