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Constuction of A Two Pot Forced Air Charcoal Stovepowered by 6V Battery

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***Abstract*— The two-pot forced air charcoal stove was constructed as a better replacement to the traditional firewood stoves and many others. The smoke from the burning firewood contains toxic that are detrimental to our health causing eye, lung and heart ailments and increasing the risk of strokes. However, the two-pot forced air stove was constructed, tested and found to ensure almost complete combustion of charcoal producing large quantity of heat energy that we use to cook our meals, and carbon iv oxide which is used by green plant in the process of photosynthesis. In this way, the family members are shielded from the negative consequences of smoke and their meals cooked efficiently, saving time. The stove components include the metal rod unit, the cylinder unit, the mod unit, the blade unit, the blade enclosure unit, the battery unit and the resistance box. The result from the device shows that 300g of beans were well cooked in 24 minutes with only 150g of charcoal other achievements were also observed and recorded.**

***Index Terms*— Renewable energy, non-renewable energy, charcoal, stove, biomass, forced air stoves.**

I. INTRODUCTION

Physics is a branch of science which deals with the study of matter in relation to energy. It always tries to pave the easiest path for man to obtain the desired energy for domestic and industrial utilization. It seeks to identify the sources of energy and offer the physical principle that will guide man to obtain energy in form of chemical, heat and mechanical energy and ensure effective inter-convertibility between them to solve his everyday problems. This everyday efforts in the scientific and technological world led man to several achievements in the field of energy physics. Such innumerable successes include electric bulbs, pressing irons, fuels and atomic energy from radionuclide such as uranium and thorium. Over the pass decades innumerable organizations and projects have developed models of firewood saving stoves because most household in west Africa have been in a crying need of improved cook stoves better and more efficient to cook their meals. (Liana, 2014).

Technological innovation geared toward moving away from traditional stove to a more modern and efficient stove is one of the best technological innovations today. A report of the Global Alliance for clean cook stoves shows that two million deaths are recorded yearly from exposure to smoke from conventional cooking stoves and the open fires they cause (Anderson, 2011). They also cause undesirable health effects, early childhood pneumonia, emphysema, lung cancer, e t c. (WHO, 2011). The world Health organization (WHO) has pointed out that smokes from traditional stoves is very harmful and among the five dangers to public health in poor countries (Liana, 2014). Taking Nigeria as a reference point, it has been reported that 100,000 persons die annually as a result of traditional cooking stoves in their respective homes. (WHO, 2011). Experts describe this situation as among Nigerians number one cause of death after malaria and AIDs (Liana, 2014). The most worrisome is that millions of Nigerians do not know that wood smoke from traditional stoves emits toxics that cause eye, lung and heart ailments, as well as amplify the risk of strokes (Liberty, 2009).

II. EXPERIMENTAL SETUP

The various materials required for the construction of a two pot forced air stoves are: 6v battery, Rectangular metal sheet, Circular metal sheet, Peak in cover, Rectangular metal pipe, Cylindrical metal pipe, Light circular metal sheet, Cylindrical metal rod, Copper wire, Resistance box, Crocodile clips, Connecting wires, Hammer, Nails, Metal, Water, Chisel, Insulating material, Metal scissors and HB pencil / eraser.

The design of the various units of the stoves is considered based on the availability of the components. The units include metal rods unit, the cylinder units, the mud unit, the blade unit and the blade enclosure unit, these various units that formed the complete circuit of the forced air are illustrated in the form of block diagram as shown:

Power Supply Unit

The power unit constitutes a 6VLechandelle battery. Lithium is the lightest of all metals, has the greatest electrochemical potential and provides the largest specific energy per weight. This madeLithium-ion(Li-ion) more preferable to other types such as Nickel Cadmium(Ni-Cd), Nickel-Metal Hydride(Ni-MH) and Lead-Acid.

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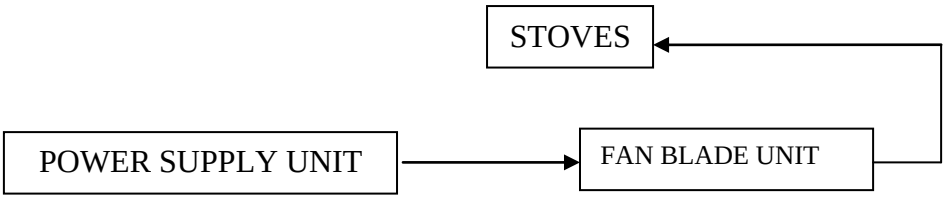


The Blade Unit

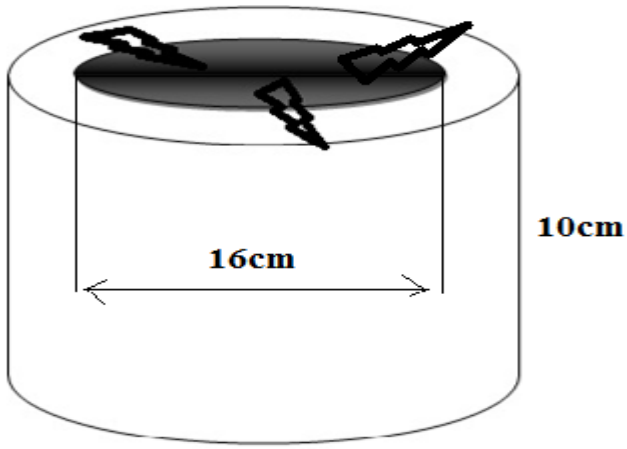
With the aid of a pencil, the blade was designed on the circular metal sheet of diameter 10cm. It was then cut with a metal scissors to have the blade. Another circular metal sheet diameter 16cm greater than the diameter of the blade was perforated at the middle and used as the base enclosure unit where the blade, motor, insulating material and switch were fitted by means of a copper wire.With a rectangular metal sheet folded and welded, circular holes of diameter 7cm each were made at both sides of the rectangular metal with the aid of a chisel.

Two pipes of length 14cm and internal diameter of 5cm each were then welded to the holes and a perforated peak tin covers with openings were used to cover the blades enclosure.

The Mud Unit

The metal sheet of about 55cm in length and 30cm in width was folded in the circular form to make two circular holes. The circular holes were with diameter 16cm and the depth of 10cm. Inside the circular holes made, nails were used to perforate the region below in such a way that small charcoalwill be prevented from falling down as shown below.

Fig.1 The mud unit



Power Utilization

The battery stores chemicals energy. When the terminals of the battery are connected to the external circuit, current flows through the circuit and power is generated. The magnitude of the rate of energy extended per unit time is given by:

Power,

$$P = IV$$

…… (i)

Where I = current; $V = p.d.$ across the battery terminals

From ohms law

$$V = IR \quad \text{……(ii)}$$

Where R = resistance

Power

$$P = IV = I^2R = \frac{V^2}{R}$$

…… (iii)

Equation (iii) shows that the rate at which the chemical energy contained in the battery is converted to electrical energy and ultimately mechanical energy to rotate the blades is directly proportional to the square of the battery voltage V and inversely proportional to the external resistance R. Kinetic energy of the rotating blades is given by

Kinetic energy

$$K.E = \frac{1}{2}I\omega^2 \quad \text{……...(iv)}$$

Where I = average moment of inertia of the blade, ω = angular velocity of the blades.

Assuming that the energy lost in the process as heat is negligible, we have that

$$\frac{V^2}{R}t = \frac{1}{2}I\omega^2$$

Where t = time

Or

$$R = \frac{2V^2}{I\omega^2}t = \frac{2V^2}{4\pi^2 f^2 I}$$

……(v)

Where f = frequency

Equation (v) shows that for a given battery of emf$V$, the external resistance R is inversely proportional to the square of the angular velocity w and the square of the frequency of the blade's rotation F. This means that when the resistance R is kinetic energy of the blades can be varied by simply varying the resistance R.

How the Forced Air Stove Works

From the connection, current, **I**flow from the positive terminal of the battery ofemf 6v to the resistance box were resistance is varied. The higher the resistance R the lower is the angular velocity of the rotating blade and vice versa. The number of air particles directed into the stove is proportional to the speed and frequency of rotation of the blades. If the frequency rotation is high, access air containing access energy are directed into the stoves. Carbon atoms from the heated charcoal combine exothermically with oxygen from the access air to produce carbon (IV) oxide, accompanied with the evolution of large amount of head which is used to look meals.

On the contrary, if resistance is high, the blades speed and frequency of rotation is low and only limited air is directed into the stoves. In this process, little heat energy is produced as the rate of combustion of the fuel (charcoal) is limited. Hence the efficiency of the stoves is varied simply by varying

the resistance R from the resistance box.

Fig.2.The constructed two-pot forced air charcoal stove

III. RESULTS

This project work aimed at achieving a better and efficient cooking stove that will save our people from the detrimental effects of smoke from firewood stoves, and reduce our reliance on firewood as fuel which is the main cause of deforestation and erosion. The results obtained from the constructed charcoal stove were very encouraging and are shown in table 4.1.

Table 4.1: Results of device testing

S/N	Name of Item	Mass of item used	Volume of item used	Cooking time
1.	Water	1500g	$1500cm^3$	5.00minutes
2.	Beans	300g		24minutes
3.	Yam	150g	Half tuber	15minutes

It was found that 1.5 litres of water boiled after 5.00 minutes.Half a yam tuber got well-cooked after just 15 minutes, all with only 150g of charcoal. In the same vein, 300g of beans were cooked in 24 minutes.

After cooking, the outside bottom of the pot in contact with the flame was found to be white, (i.e no black carbon was deposited on it). This means that the forced air contained sufficient oxygen to ensure complete combustion of the charcoal, yielding carbon (IV) oxide and large quantity of head energy.

IV. DISCUSION

The stove was found to better suit outdoor cooking. Sufficient connecting wires must be used to keep the battery away from the cooking stove, especially being close to the flame, to avoid explosion and children reach.

Since the stove/forced air pipes are connected in parallel to the battery with large EMF of the battery and the current, 6V and5.5A respectively, more than three stoves could be used at a time and will all be powered efficiently by the battery. This is because the P.d across the forced air pipe is the same and equals the emf of the battery. Suppose that 4 stoves are used. The current I passing through each of the pipes is 1.09A and the amount of chemical energy converted to electrical and finally mechanical energy per second is $6.55Js^{-1}$.This is about twice the energy delivered per second when rechargeable batteries are used instead of the 6V Leclanche cells.

The following points should be noted for proper functioning of the stoves.

i. It should be far from water
ii. The units should be handled with care so that it will last for long
iii. The battery should be kept out of reach of children and far from sunlightand the stove to prevent explosion.

V. RECOMMENDATIONS

In the forced air charcoal stove, a lot of head energy is not utilized and is released to the surrounding. Further research may be undertaking to improve the situation so that such head energy will be maximally utilized. Because of the iron and the stoves weights approximately 20kg, further investigation will lead us to find a better replacement to make the stoves less heavy and more portable.

VI. CONCLUSION

We can draw conclusion from the result of this research work that the forced air charcoal stove:

i. Ensure effective utilization of the available charcoal in our environment
ii. Cooks meals effectively, saving time
iii. Ensure complete combustion of charcoal to release CO_2 gas

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