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Production of Gasifier Stove for use in Nigeria
An Alternative Energy Awareness

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Abstract

This write up presents the report of the research on alternative technology for cooking vis-à-vis energy. Equally the fabrication of one of the adopted ones around the world is reported. Biomass constitutes the biggest source of energy in rural Nigeria. However, its utilization in the domestic sector is mostly inefficient and polluting, resulting in resource wastage. Traditional cook stoves, predominantly used in the households for domestic cooking, have been a major contributor to these ill effects. Improved cook stove programmes implemented in the developing countries of the world, like China, India, Kenya, etc. attempt to address these problems. Biomass gasification appears to have a significant potential in Nigeria for domestic cooking applications. A number of gasification-based cooking systems, which are more efficient than traditional stoves and are almost smoke-free, have been developed and demonstrated recently to highlight the potential benefits of introducing them in developing countries like Nigeria.

Index Terms—**Gasifier Stove, Biomass, Energy, Smoke free.**

I. Introduction

Domestic cooking accounts for the major share of the total biomass use for energy in Nigeria. However, use of biomass fuels in traditional stoves is characterized by low efficiency and emission of pollutants. In an effort to address these problems, many of the Asian countries have initiated national programmes to promote improved cook stoves. Although significant achievements have been reported in some of these countries, the potential for further efficiency improvements is still very large. A study by Bhattacharya et al (1999) estimated that the biomass saving potential in seven Asian countries (China, India, Pakistan, Nepal, Philippines, Sri Lanka and Vietnam) as 152 million tons of fuel wood and 101 million tons of agricultural residues, in the domestic cooking sector alone in early nineties. The amount of biomass that can be saved through efficiency improvement can serve as a source of additional energy and can potentially substitute for fossil fuels to reduce net GHG emission. The residue left over after the cooking could be biochar.

Biochar is a fine-grained, highly porous charcoal that helps soils retain nutrients and water. Biochar is found in soils around the world as a result of vegetation fires and historic soil management practices. Intensive study of biochar-rich dark earths in the Amazon (terra preta), has led to a wider appreciation of biochar's unique properties as a soil conditioner *(International Biochar Initiative 2008).* Fig 1 shows a sample biochar

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Figure 1: Sample Biochar
Source: *www.biochar.info.com*

II. Justification

The costs of fossil fuels and gas as a preferred cooking fuel, is on the increase. The use of biofuel gasification technology will cut down the demand on fossil fuels for cooking. Biomass **gasifiers** are attracting renewed interest. The possibilities for biomass gasification technology for cooking applications are leading to a number of initiatives to demonstrate the potential benefits of introducing them in developing countries, like **Nigeria**.

III. Objective

To produce a gasifier stove that runs on solid fuel without release of Green House Gases (GHG) into the atmosphere.

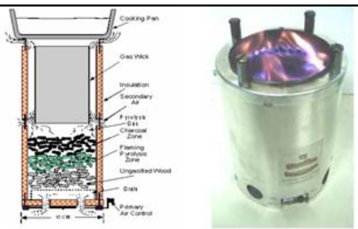
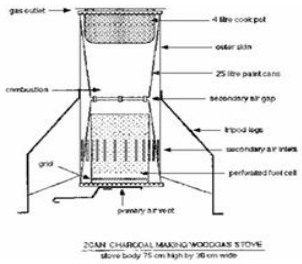
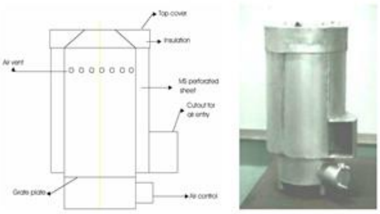
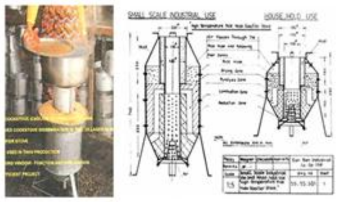
IV. Literature

Gasifier stoves, which are basically compact gasifier-gas burner devices, have been tried since mid-nineties for cooking applications. Several hundred biomass gasifier cook stoves are already in operation in countries such as China and India. In many countries, policy measures (such as governmental support in the form of subsidies on investments) are in place to stimulate biomass gasification (IEA, 2003).

Apart from being fuel efficient, gasifier stoves are also emission efficient in comparison to traditional cook stoves. The traditional cook stoves, because of their very low efficiency, emit more than 10% of their carbon as products of incomplete combustion (PIC) comprising varying amount of tars. In addition, about 100-180 g of carbon monoxide and 7.7 g of particulate matter are also emitted per kg of wood. Gases such as methane, total non-methane organic compounds (TNMOC) and N_2O are added to this. These PIC emissions are even higher in the case of loose biomass or cow dung used as fuel in these stoves (Grover. P.D., 2003).

Some of the natural draft stoves (based on combustion of gas produced from biomass) developed so far are listed in Table 1. The capacity of these stoves ranges from 3kW th to 20kW th , making them suitable for domestic as well as community cooking applications. Compared to the 5-15% efficiency of traditional cook stoves in the Asian region [1], the efficiency of these gasifier stoves is in the range of 25-35%. The design of the inverted downdraft type stoves are illustrated in Figures 1-5.

Table 1: *Natural draft gasifier stoves developed worldwide for cooking applications*

S/N	***Name of Stove***	***Product and developed by***
1.	Wood-Gas Cook Stove	 *Thomas Reed and Ron Larson*
2.	Charcoal Making Wood Gas Cooking Stove	 *Elsen Karstad*
3.	Natural draft cross flow stove models IGS2, DGS2 and CGS3	 *Asian Institute of Technology, Thailand*
4.	Briquette gasifying stove	 *Richard Stanley (Legacy Foundation, USA) and Kobus Venter (Venter Forestry Services, South Africa)*
5.	IISc Gasifier Stove	 *Indian Institute of Science*
6.	San San Rice Husk Gasifier Stove.	 *U Tin Win (under guidance from P.D. Grover and G.R. Quick)*

V. Theoretical Analysis

- **Design Brief**

The gasifier is a stove with two compartments intended to use any solid fuel. It has three major parts:

- The Top Lid
- The Inner Tin
- The Outer Tin

This fabrication is based on specifications given in "Everything Nice Stove Instruction" sourced from *www.biocharinfo.com*

- **Preliminary Specification**

The stove will satisfy the following conditions:

- Its capacity will be 355,314.13 mm^3
- It will not release Green House Gases (GHG)
- It will give blue flame
- It will not get cooking utensils dirty

- **Material Selection**

The material used is mild steel. It has stability to heat below its lower critical temperature (^0C). It is easily worked and it is of good weld ability. It is readily available will be convenient for the finance available for the fabrication.

- **Parts Description**

Top Lid

Its cross section is of two concentric circles. It has a hole central to the body where the flame produced appears.

Inner Tin

It is cylinder with holes of 4mm made round its base.

Outer Tin

It is a cylinder with larger holes near its base.

- **Specification**

S/N Parts Dimension (mm)

1. Top Lid 303
2. Inner Tin 290 x 390
3. Outer Tin 300 x 400

VI. METHODOLOGY

- **The Marking out process**

The first stage of this fabrication is the marking out of the required dimensions of the 2.5mm thickness of the sheet metal and the angle iron.

- **The Cutting Process**

The second stage after the required dimensions were marked out was the cutting out of the length required from the material. This was done with the aid of hack saw and cutting machine.

- **The Grinding Process**

After the cutting out process, I dulled the sharp edges of the plate that was cut.

- **The Drilling process**

The next process was drilling the holes that allow the inflow and out flow of air (vent) the way they are being marked out.

- **The Folding process**

To fold the plate, I have to make a circular model using wood. This helped me in folding the two plates.

- **The Welding process**

Electric arc welding is used to ensure stability of joint, and hence durability. This joining method will also ensure stability against thermal stress and strain.

VII. DIAGRAMATIC REPRESENTATION OF THE GASIFIER STOVE

Fig 2: The Isometric View of the Gasifier Stove

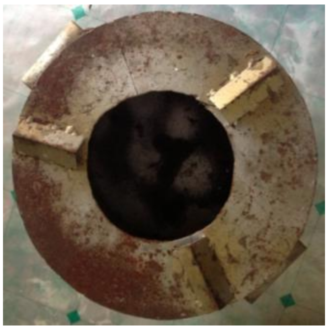


Fig 3: The Top View of the Gasifier Stove

Fig 4: The Inside View of the Gasifier Stove

Fig 5: The Side View of the Gasifier Stove

VIII. TESTING AND RESULT

The fabricated gasifier stove was tested to evaluate its performance.

First and foremost, 10kg bag of cow dung (burning fuel) was collected and dried under the sun. After which we made sure that it was mashed into fine grains before it was packed into the stove. During packing of the cow dung into the stove, we created an opening were the flame will be coming out from. Now the machine is now set for the test.

Afterwards, we lighted the cow dung which was our preferred fuel and it started burning smoothly. As the heat increased, the most interesting part of the testing was the stove produced just the blue flame showing that the amount of inflow of air (oxygen) is equal to that of the outflow.

A ten liter water filled pot boiled within the space of 10 minutes. This is to say that the performance of the stove was on the higher side.

IX. CONCLUSION

Biomass is a major source of energy for cooking applications in Asia. Large quantities of surplus biomass residues are available in the Asian region, but are mostly under-utilized. Recent developments in gasifier technology for cooking applications offer an ideal opportunity by utilizing this surplus biomass cleanly and efficiently. Several biomass gasifier-based cook stoves have been developed since 1995, both for household cooking and community cooking. Centrally installed gasifiers supplying cooking gas for whole villages or communities have also been successfully demonstrated. For wider adoption, the technology requires further refinement since there are some technical as well as social aspects which are still to be addressed. Cost is another barrier, which can be tackled to some extent by the economy of scale. Standards are needed for acceptance tests, guarantee and certification. Involvement of private entrepreneurs in commercializing gasification based cooking systems would be vital for large-scale promotion of biomass gasification-based cooking systems. It is expected that the convenience, efficiency and safety advantages offered by gasifier stoves over other improved cook stoves will help their rapid adoption in rural households across the country in the near future.

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