7th National Conference on
"Role of Engineers in Nation Building" organized by VIVA Institute of Technology, Mumbai
(1st and 2nd March 2019)
International Journal of Engineering Research & Science (IJOER)
ISBN: [978-93-5321-411-1] ISSN: [2395-6992] [Vol-5, Issue-3, March- 2019]

Design, Analysis & Fabrication of Rocket Stove -Concept

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Abstract— *Rocket stove is a portable combustion device that provides a cleaner combustion, reduced emission of harmful gases, and provides a more efficient overall combustion through the use of a fan that directs a predetermined volume of air over the combustible fuel-wood pellets. The combustion device consists of inner combustion cylinder, outer cylinder, grate, burner, main outer framework and electronics unit. Electronics unit consists of thermoelectric generator (TEG), DC fan and a DC-DC step up converter. TEG generates an electrical output based on a difference in temperature on its opposing sides which further increases the combustion efficiency significantly over time.*

Keywords— Burner, DC-DC step up converter, Fan, Inner and outer cylinder, Main frame, Rocket stove, TEG, Wood-pellets.

I. INTRODUCTION

Solid fuels used for cooking food, boiling water, and heating are wood, charcoal, coal, etc. The WHO (World Health Organization) estimates that millions of people prematurely die or suffer with difficulty in breathing, stinging eyes, and chronic respiratory diseases each year due to exposure to the smoke and other air pollutants from burning fuels. Women and children are affected, because they tend to spend more time close to cook stoves .Previously built cook stoves based on kerosene, wood, coal, etc. which are designed to improve efficiency instead of improving the effects on environment. Since this renewable resources are limited we need an alternative fuel source for various uses. Non usable trees, Agricultural waste, Organic waste from industries, etc. are processed to form wood pellets. Wood pellets are of different type based on the origin its calorific values changes accordingly.

Cook stoves based on biomass has been an active field for many previous years and has resulted in much progress towards cleaner and more efficient cook stoves. It has been a challenge to develop high efficient, eco-friendly cook stove product that also satisfy user preferences and are affordable. Purpose of creating an alternate fuel based stove is to decrease air pollution and to initiate environment friendly cooking techniques.

II.PROBLEM DEFINITION

2.1. Problem statement

Burning of fuels (i.e. Kerosene, Wood, etc.) releases indoor air pollutants and high amount of hazardous smoke containing CO, NOx, SO, and particulate matter (PM) which have been proven detrimental to human health; these harmful emissions are responsible for three million deaths globally.

2.2. Objectives

a. Reduces significant soot, smoke and toxic combustion byproducts.
b. Increase in overall efficiency by utilizing heat lost in convection.
c. Use of alternative fuel for cooking.
d. Reduces fuel consumption.
e. Less costly option for cooking than costly LPG gas.
f. Capable of generating electrical output that can be used for forced draft in rural areas.

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III. METHOD

3.1 Step I- Combustion

The fuel i.e. wood pellets is feed by opening the burner placed above combustion assembly. After the pellets are feed up to a point then it is burned using naphthalene balls or camphor and the burner is closed. It will take 2-3 min to burn the upper layer of the pellets. Initially air in the combustion chamber flows naturally.

Fig A. Rocket stove.

3.2 Step II- Natural and forced draft

The air in the beginning of the combustion is sucked into combustion chamber naturally due to the burning of fuel and air present in the combustion chamber which is called as natural draft. Once the air and fuel is burned than the hot fumes is released through burner which creates a low pressure region inside the cylinder. Now to overcome the deficiency of air inside the combustion chamber air is forced inside with the help of a fan, the air entering from the fan is said to be forced draft. After combustion there is a temperature gradient between the two surfaces of TEG which allows it to create an electrical output which is used to drive the same fan used for forced draft technique and cooling of one of the surface of TEG.

3.3 Step III- Maintaining air flow

When a stabilised temperature is reached inside the combustion chamber with one of the surface in contact with heat sink connected to the TEG will tend to increase the temperature of TEG from one side, similarly cooling achieved on one of the surface by ambient air due to natural draft will create a temperature gradient in TEG. This phenomena in TEG will create an electrical output which will drive the fan and force the external ambient air into the combustion chamber. After sometime the system will stabilise with a constant TEG output and a fan running with a constant output and providing a stable mass flow rate.

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Fig B. Block diagram of the process.

IV. RESULT AND DISCUSSION

The comparison of Wood-pellet based cook stove with non-renewable energy based stoves on the basis of pollution, availability, cost of each in kg is mentioned in the Table A. below.

1. It can be observed that the cost of the wood-pellets in per kg compared to other fuels are almost 80% cheaper.
2. Better Overall efficiency as compared to cost.

Table.4.1

Sr.No	Fuel	Calorific value (MJ/kg)	Overall efficiency (%)	Cost per kg in Rs.
1	Wood-Pellet	16.73	40-50	10-15
2	LPG	45.5	57.4	45-60
3	Kerosene	43.1	49.5	55-70

V. CONCLUSION

Modifications focused at redesigning the inner cylinder in such a way that it will minimize heat loss by conduction, convection and radiation ensure maximum heat transfer to the base of the vessel. It can also be seen that the modification made in the stove by using TEG to convert heat rejected during combustion into electricity which is used to drive DC fan has served to increase the overall efficiency of system by incorporation of forced draft technique to increase air flow rate. There has also been a drastic reduction in smoke, soot, CO, NOx, emission making the stove more user-friendly in health, comfort and convenience.

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