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# Review on Development and Performance Evaluation of Rice Husk Cook-Stove

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*Abstract:* **In many rural contexts of the developing world, agriculture residues and the organic fraction of waste are often burned in open-air to clear or just to dispose them. This is a common practice which generates uncontrolled emissions, while wasting a potential energy resource. In such context household energy supply is a further critical issue. Modern liquid fuel use is limited and traditional solid fuels (mainly wood) are used for daily cooking in rudimentary devices like 3-stone fires, resulting in low efficiency fuel use, huge health impacts, increasing exploitation stress for the local natural resources. Rice husk may be an alternative fuel to wood for household energy supply. In order to recover such a biomass. In an attempt to provide solution to the environmental pollution resulting from in discriminate dumping of by-product of rice mill. The machine can be employed to reduce environmental pollution by enhancing the process of burning of rice husk.**

*Keywords:* **Biomass, Rice husk, Cook stove, gasifier.**

## 1. INTRODUCTION

The list of waste biomass usable for energy purposes is nearly endless and depends on what is readily available in a certain location. A number of processes has been studied and implemented not only in industrialized countries but also in low income countries to reuse the organic fraction of waste in cost effective ways, such as through anaerobic digestion at micro-scale and other energy recovery processed. Actually often the most common practice is the open burning, in particular for agri-wastes, which are generated in large volumes seasonally. Besides the loss of potential recovery of a local resource, that results also in a huge impact on the environment generating uncontrolled emissions. A number of studies assessed the environmental impact in terms of Green House Gas (GHG) emissions, in particular $CH_4$ and $NO_2$ , related to the common practice of open burning of rice husk heaps or field. Therefore, ceasing open burning and replacing fossil-fuel or non-renewable biomass using these residues as alternative domestic fuel has a large GHG mitigation potential, while increasing energy access for low-income populations.

In the developing world, most agricultural residues that are burnt as fuel are used In their natural state with some pre-treatment like drying and cutting. Compared to wood fuels, crop residues typically have a high content of volatile matter and ash, lower density and lower energy values. Conventional ‘stoves’ are mostly designed to burn firewood or charcoal. The direct use of unprocessed solid biomass waste for cooking in wood-fuel stove.

The use of clean energy to all of India's households through the development of “the next-generation of household cook-stoves, biomass-processing technologies, and deployments. Providing an affordable and reliable clean cooking energy option for the poorest households now relying on traditional biomass technologies is expected to yield enormous gains in health and welfare for the weakest and most vulnerable sections of society. At the same time, cleaner household combustion is expected to reduce the several products of incomplete combustion that are important outdoor and climate-active pollutants, thus helping combat regional environmental impacts and global climate change.

In contrast to any other large-scale improved biomass stove program in the world, past or present, the new Indian National Cook-stove. Initiative has set itself a lofty goal for all Indian households.

**Cook-Stove:**

The task of burning rice husk for cooking purposes is not so simple with the constraints of this context. Heat generation from rice husk cannot be achieved efficiently with a simple 'direct' combustion. Proper gasification, with the aid of forced air, would be the best technical way, but this work has focused on an intermediate solution, where rice husk in part burns 'directly' and in part is gasified. No available or reliable electricity prevents the possibility to use fans or blowers, while some draft is fundamental for operation. Hence, natural draft is provided by the pressure gradient given by the height of the chimney if the pot is sealed in its proper position. In the meantime the chimney withdraws the smoke from the cooking position. This is a benefit for the user's health, but the chimney must be installed properly, to prevent accidents, and users must be trained for a proper cleaning and maintenance, which often is not already embedded in local knowledge and habits. The choice of using unprocessed rice husk derives mainly from the difficulties encountered trying to briquette it, but assessing a technique to use unprocessed rice husk can bring along a great practical advantage.

The choice of using crude-earth bricks, besides for their local availability, provides different heat losses in comparison to a metal structure, much more heat is accumulated in the structure, but it is radiated much more slowly. This choice highly limits the portability of the stove.

A set of prototypes was developed and various geometries and dimensions have been tested before defining the actual layout. The rice husk is put in a metal-net basket that is placed in the center of the combustion chamber. This geometry forces air to flow through the rice husk, allowing the production of combustible gases that can burn just below the pot, where secondary air enters the combustion chamber through the central duct in metal-net. A small starting fire (using a little amount of wood or charcoal) is placed in the central duct and this allows the process to start. After the ignition, the starting fire runs out and the central duct is free for the secondary air flow.

## 2. LITERATURE REVIEW

### 2.1 Experimental Analysis:

**Francesco Vitali, [1]:**

In this paper are authors are testing a proper stove with an original design. Its layout featuring a metal net basket to contain the fuel and a chimney to force a natural air draft allows a mix of combustion of the biomass occurring in a completely burning fire, appropriate for cooking tasks. According to results obtained with rigorous test protocols different lay-outs have been designed to improve the performance of the stove. Technical and economic issues have been addressed in the development of such a model,building materials have been chosen in order to guarantee a cost as low as possible, using locally available items. The feasibility of the introduction of the stove in the studied context was assessed through an economic model that keeps into account not only the technology and fuel costs, but also the energy performance.

A significance first improvement was achieved introducing some modifications are:

1. Primary air inlet was changed switching from a horizontal duct linked with the central vertical duct, to a metal-net on the bottom of the combustion chamber. That allowed air to flow also through the fuel, supplying the required air according to a more uniform distribution.

2. The top metal-plate was substituted with an upper cover realized using the bottom of a drum and filled with the same material used to manufacture the crude-earth bricks. That reduced the heat losses through the metal layer and the escape of smoke. From the spaces created by its thermal deformation.

3. Square base was substituted by a round base to allow a more uniform distribution of temperature inside the combustion chamber.

**Manisha Joshi and R.K.Srivastava [2]:**

In this study, an improved three pot cook stove was designed, fabricated and tested to evaluate its performance. The thermal performance of the improved three pot stove was compared with that of traditional mud stove. The results obtained showed a better performance of the improved three pot cook stove than that of the traditional mud stove. The results also showed that the improved three pot stove with wood burning rate of 0.17 kghr–1 can handle fuel more efficiently and economically than traditional mud stove, which has wood burning rate of 0.28 kghr–1. The thermal efficiency of improved three pot cook stove was found to be 28.4%, whilst that of traditional mud stoves was 10.7%.

The mean power output rate obtained for the traditional mud stove and improved pot cook stove. This result shows that the traditional mud stove had a less power output rate than improved three pot improved cook stove. The average power output rate of improved three pot cook stove was 2.8 kW and power output rate of traditional mud stove was observed 1.0kW. Similar study conducted by Joshi *et al*. (1989) on emission from burning biomass in cook stove and their results revealed that average power output of conventional stove and improved stove i.e. „Priyangi" stove was 3.93 kW and 4.64kW and the average thermal efficiency of these stove was 15.0% and 26.0% respectively.

**GbaboAgidi, J.T.Liberty,andJ.C.Eluwa [3]:**

In this work which focused on the design, construction and performance evaluation of a motorized rice husk gasifier is cheap, affordable, easy to maintain and less laborious to use. This gasifier will go a long way to make rice processing attractive to rural processors, reduce deforestation and environmental pollution. It will save cost of firewood, gas and electricity that are other alternative source heat source for rice parboiling. All components parts of the gasifier were fabricated from mild steel. The fan was powered by diesel engine which makes the machine easy for rural farmers to operate. However, it is recommended that more spaces be created around the burner for better oxygenation to aid faster burning of the rice husk.

In this paper can be result in the quantity of heat generated was determined with thermometer at different time interval as shown below:

| Time (minute) | Temperature(C) |
|---|---|
| 5 | 160 |
| 10 | 200 |
| 15 | 270 |
| 20 | 390 |
| 25 | 500 |

**Alexis T. B., and Emmanuel, V. [4]:**

In this paper based on the study, the rice husk gas stove performs accordingly with design. It can satisfactorily provide combustible gases for continuous operation of more than one hour domestic cooking. It can be energized either by direct connection into an AC-DC calculator adoptor in areas where grid is available or by the use of a 12-volt battery with 12-volt 5-watt solar panel in off-grid situation. With proper operation, smoke is almost completely eliminated and clean combustible gases for cooking is achieved. The stove can be fabricated even in a backyard shop using metal sheets and bars employing the local people. The price of the stove is affordable to many and households can generate substantial savings from the use of biomass fuel over the use of conventional fuel. Investment can be recovered within a short period of less than a year.

Advantage features of the stove are:

Uses rice husks as fuel; (2) Produces combustible gases for cooking; (3) Continues operation until all cooking preparations are finished; (4) Fast ignition of fuel and almost no smoke during operation; (5) Operates on AC line or on DC using a battery; (6) Low $CO_2$ and black carbon emissions; (7) Simple design and fabrication making the technology affordable; (8) Safe to operate; and (9) Burned rice husks can be used as soil conditioner.

**Alexis Belonio and Edward Ligisan [5]:**

In this paper can performance evaluation of the stove shown in table above revealed that in one load, it consumes 0.4 kg of rice husks within 18 to 20 minutes, depending on the input voltage of the fan that controls the flow of air through the fuel bed. Start-up time is almost 1 minute using burning pieces of paper. Two liters of water can be boiled in the stove within 12 minutes. A 200-g rice can be cooked within 15 minutes while 3 pieces of tilapia can be fried within 18 minutes. Moreover, the computed specific gasification rate of the stove is 114 kg/hr-m2 with a power output of 0.91 kWt. The stove has the following advantages: (a) easy to operate; (b) controllable flame intensity by simply adjusting the input voltage of the fan with the use of a switch located at the adoptor; (c) with light-blue colored flame indicating the gas burned is clean; (d) no smoke during operation; (e) safe to operate since it operates in DC power and at almost ambient pressure; (f) very minimal electrical Consumption in running the fan; and (g) very affordable. In cases where grid is not available, the stove can still be used with a 12-volt battery or a 5-watt solar panel to energize the fan.

**C. Venkataraman, A.D. Sagar , G. Habib , N. Lam , K.R. Smith [6]:**

In this paper, we focus on what is known about the health, environment, energy security, and climate impacts of the current pattern of biomass use in the country for cooking in relation to cleaner cooking options such as LPG. We draw on this knowledge base to assess the potential full benefits of meeting this Initiative's goal, i.e., bringing all India's citizens the level of cooking energy service now already available to about a quarter of Indian households and, worldwide, nearly half of humanity. In a companion paper, we discuss current thinking on the technologies, dissemination modes, financing, potential rates of implementation, and other aspects of the new national program that will lead toward this goal.

Now research paper can be benefit are :

1. We now understand that the international price of LPG, being a petroleum product, likely will continue to increase faster than rural in comes, thus making the transition to modern household fuels difficult and, if subsidized by government, increasingly expensive. This adds to the attraction of deploying advanced biomass stoves that provide high performance using local renewable resources and relieve the government of the cost of fuel subsidies.

2. It is now recognized that climate change is a major threat and household biomass fuel combustion is a contributor with significant greenhouse impacts per unit energy delivered (from emissions of nitrous oxide, methane and other important greenhouse pollutants)compared to nearly all other human uses of energy, although not a large contribution in total compared to other sectors. In addition, biomass fuel combustion emits other shorter-lived pollutants (like black carbon) that contribute to reduction of crop yields and may contribute to accelerated melting of glaciers and disruption of the monsoon.

It is now understood that rural outdoor air pollution is a significant problem in India, with average levels of pollution in the Ganga River Basin, for example, being substantially above Indian and WHO health-based norms. Biomass combustion plays an important role in creating this pollution.

**Mr. Shailesh R. Kantharia, Prof. S. R. Gajjar, Prof. V. P. Rathod [7]:**

In this research paper deals with respect to global issues of sustainable energy and reduction in greenhouse gases, biomass energy as one of the key sources of renewable energy is getting increased attention as a potential source of energy in India. In this work has been carried out to develop, design and fabricate an applicable for the production of producer gas using locally available biomass fuel rice husk. Gasifier design based on rice husk as a biomass. Factors effects design of gasifier are fuel feed rate, air flow rate, time for cooking, item used for cooking. Gasifier reactor having an internal diameters of 15cm was designed and fabricated, operating period of 25-30 min, and amount of biomass fuel consumed 1kg. Traces of producer gases, were found and flame was found to be blue.

Biomass gasification offers one of the most promising renewable energy systems for developing countries.

## 3. CONCLUSION

Based on the results of the study, the rice husk gas stove performs accordingly with design. It can satisfactorily provide combustible gases for continuous operation of more than one hour domestic cooking. It can be energized either by direct connection into an AC-DC calculator adoptor in areas where grid is available or by the use of a 12-volt battery with 12-volt 5-watt solar panel in off-grid situation. With proper operation, smoke is almost completely eliminated and clean combustible gases for cooking is achieved. The stove can be fabricated even in a backyard shop using metal sheets and bars employing the local people. The price of the stove is affordable to many and households can generate substantial savings from the use of biomass fuel over the use of conventional fuel. Investment can be recovered within a short period of less than a year.

i. Biomass gasification offers one of the most promising renewable energy systems for developing countries.

ii. Rice husk is more prefer biomass because it have low moisture contain and give good calorific value at low ash produce therefore it is better for small scale application for rural area.

iii. 1 kg of rice husk gasify continuous for about 22-30 min. and give producer gas continuous with blue flame.

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