

# Design, Development and Testing on Rice Husk Gasifier

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**Abstract**---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. 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 25-30min, and amount of biomass fuel consumed of 1kg. Traces of producer gases were found and flame was found to be blue.

**Keywords:** Design, Gasifier, Rice husk.

## I. INTRODUCTION

Biomass is the oldest source of energy and currently accounts for approximately 10% of total primary energy consumption. Many of the developing countries has growing their interest in biofuel development and providing greater access to clean liquid fuels while helping to address the issues such as increase in fuel price, energy security and global warming concerns associated with petroleum fuels. Abundant biomass is available throughout the world which can be converted into useful energy. Biomass is considered as a better source of energy because it offers energy security, rural employability and reduced emission. Biomass is traditionally available in the form of solid. Solid biomass include crops residues, forest waste, animal waste, municipal waste, food waste, plant waste and vegetable seeds. This biomass can be converted into heat and power by adopting appropriate method.

Modern agriculture is an extremely energy intensive process. However, high agricultural productivities and subsequently the growth of green revolution have been made possible only by large amount of energy inputs, especially those from fossil fuels. With recent price rise and scarcity of these fuels there has been a trend towards use of alternative energy sources like solar, wind, and geothermal etc. However, these energy resources have not been able to provide an economically viable solution for agricultural applications.

**A. Rice Husk:** Rice husk gasification is the process of converting rice husks fuel into combustible carbon monoxide by thermo-chemical reaction of the oxygen in the air and the carbon available in this material husk during combustion. In complete combustion of fuel, the process takes place with excess air. In gasification process, on the other hand, it is accomplished with excess carbon. In order to gasify rice husks, about 30 to 40% of the stoichiometric air (4.1587kg of air per kg of rice husk) [4] is needed.

Gasification of rice husks is accomplished in an air sealed chamber, known as the reactor. Limited amount of air is introduced by a fan into the fuel column to convert rice husks into carbon-rich char so that by thermo-chemical reaction it would carbon monoxide, hydrogen, and methane gases, which are combustible when ignited.

**B. Factors that Influence Gasification:** Studies have shown that there are several factors influencing gasification of rice husks. These include the following:

**1. Energy Content of Fuel:** Fuel with high energy content provides better combustion. This is most especially obtained when using rice husks that are freshly obtained from the rice mill. Deteriorated rice husks, such as those dumped on roadsides and along river banks for several months, were observed to be more difficult to gasify than the fresh ones.

**2. Fuel Moisture Content:** The moisture content of rice husks also affects gasification. Rice husks with low moisture content can be properly gasified than that with high moisture. Freshly produced rice husks are preferred to use for they usually contains only 10 to 12% moisture. Rice husks with high moisture content should be dried first before they are used as fuel for the gasifier.

**3. Size and Form of Fuel:** Rice husks obtained from steel huller type rice mill or "kiskisan" are difficult to gasify. Over milling of rice produces powdery-form rice husks which require high-pressure fan in order to be gasified. Husks produced from rubber roll-type rice mill are more suitable for gasifier operation.

**4. Size Distribution of the Fuel:** Rice husks mixed with other solid fuels are not suitable for gasifier operation. Not uniform fuel size distribution will result to difficulty in getting well-carbonized rice husks, which affects fuel gasification.

**5. Temperature of the Reactor:** Temperature of the reactor during gasification also affects the production of flammable gas. There is a need to properly insulate the reactor so that during gasification, flammable gas can be produced. Rice husk ash and refractory materials are good examples of materials effective in maintaining high temperature in the reactor for better gasification. Providing an annular space in a double core reactor is also an effective way in maintaining high temperature in the reactor.

## II. DESIGN OF RICE HUSK GASIFIER

There are several factors to consider in designing a biomass gasifier. The major issue in designing this gasifier was that the holes for air inlet to be sufficient to supply adequate amount of air for the gasification process inside the reactor and then the producer gas could be pass towards the gasifier freely. The ash remover made for convenient performance & easy removing of ash.

The gasifier consists of a cylinder shaped combustion chamber, where fuel is gasified and the gasified fuel is burned by forced convection mode. During gasification, air passes through the layer of fuel and escapes at the other end of the chamber through a producer gas outlet. Flow of air and of gases in the stove is facilitated by the draft created in the combustion chamber. Ash is discharged from the ash pit door of the gasifier.

A. *Design Procedure:* Determine the energy needed, based on the energy requirement to cook food for a specific time period, and is important in determining the energy demand for cooking. Normally a household requires about 0.8 to 1.2 kW heat energy for cooking and for institutional is 5.5 kW and for commercial activities 11.5 kW heat energy is required.

- The power output of the stove is highly dependent on the diameter of the reactor. The bigger the diameter of the reactor, the more energy that can be released by the gasifier. This also means more fuel is expected to be burned per unit time since gas production is a function of the gasification rate in kg of fuel burned per unit time & area of the reactor.
- The total operating time to produce gas is affected by the height of the reactor. The higher the reactor, the longer is the operating time. Identify all components that need to be quantified starting from the most important one to the least. This may include the fuel hopper, combustion chamber, and air in late.
- The design considerations for the air in late should be based on the pressure required to overcome the resistance to be released by the char instead of that by the biomass. In a continuous operation, the resistance available in the reactor gradually increases as the combustion zone reaches the bottom end of the reactor. During gasification, the biomass's lower resistance to airflow is gradually converted into a high resistance material i.e. Char.
- The size of the air in late is dependent on the size of the reactor. The bigger the diameter of the reactor, the more airflow is needed. The higher the reactor, the more pressure is needed in order to overcome the resistance exerted by the fuel.
- Openings or any possible leakage of air in the gasifier fuel or char doors should be eliminated. Sometimes it is difficult to diagnose the problem in the operation of the gasifier when there is air leaking in the system. Air leakages basically lower the pressure needed in the reactor, which also reduces the performance of the reactor in gasifying biomass.
- Materials for the reactor should be carefully chosen. The inner cylinder, which is directly in contact with the burning fuel, should be made of a heat resistant material, Stainless steel; mild steel material is used for the inner cylindrical core of the reactor.
- The size and especially the thickness of the materials need also to be considered in the design. The cost and the life span of the gasifier unit are basically affected by the size of the material.

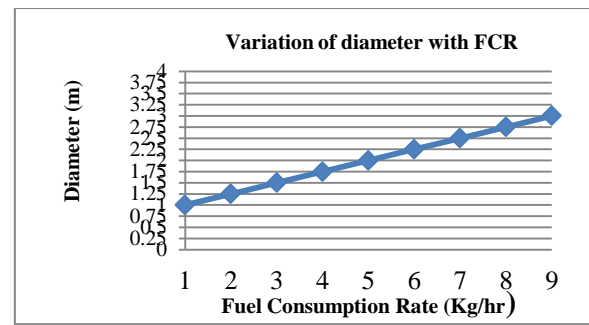


Fig. 1: FCR Vs Diameter

In fig.1 FCR vs Diameter, we get the linearly increase in diameter with respect to increase in fuel consumption rate keep SGR constant. I get the value of diameter 0.1468m with calculated FCR with acceptance of cooking for 2-3 kinds of people.

In fig.2 Time vs Height, we get linearly increase in height with respect to increase in consumption time keep SGR constant. I get the value of height 0.5m with assume 40 min total consumption time of feed stock.

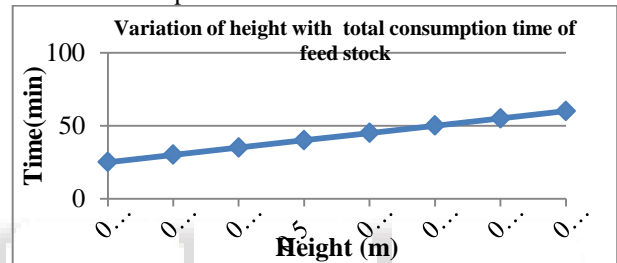


Fig. 2: Height Vs Time

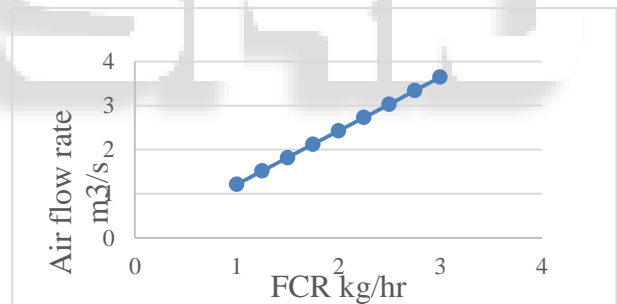


Fig. 3: FCR Vs AFR

In fig .3 FCR Vs AFR, we get AFR linearly increase with respect to increase in FCR with keep constant equivalence ratio. I take calculated FCR 1.272 kg/hr get 1.542 kg/m<sup>3</sup> air flow rate.

B. *Model Drawing:* In this fig.4 show a 2-D diagram of rice husk gasifier front and top view. All the dimension are shown in fig and are in mm.

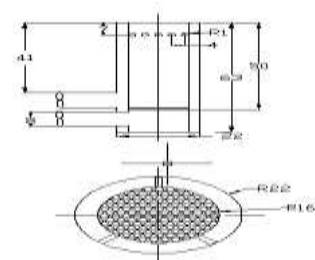


Fig. 4: Model drawing

C. *Methodology*: The gasifier consists of reactor, char chamber, fan assembly and grate as illustrated in Figure 5. The reactor where rice husks are placed and burned with limited amount of air. Rice husk was used as fuel in the experiments conducted to measure the gasifier efficiency. Rice husk is located into the fuel chamber that burned inside the reactor in a batch mode. The fuel is ignited from the top of the reactor by introducing burning pieces of paper. The burning layer of rice husks moves down the reactor depending on the amount of air supplied by the fan. The more air is introduced to the rice husks, the faster is the downward movement of the burning fuel.



Fig. 5: Rice husk gasifier

As the combustion zone moves downward, burned rice husks are left inside the reactor in the form of char or carbon. The combustible gases that are coming out of the reactor are directed to the burner holes which secondary air is naturally injected to the combustible gases through the secondary air holes. After each operation, char is discharged from the reactor by tilting the char grate with its lever.

### III. TESTING

The starting time from ignition of rice husk by pieces of paper with spraying of small amount of kerosene to burn produced gases in the burner is only about 1.275 minutes that shorter period compared to traditional stove. The average operating time of this model is 30 minutes that generally enough for cooking 2 to 3 kinds of food, but the operating time can be designed to the requirement of user. Furthermore, the luminous blue flame was observed which almost similar to that of the LPG stove as shown in



Fig. 6: Blue flame during gasification

### IV. CONCLUSION

- Biomass gasification offers one of the most promising renewable energy systems for developing countries.
- 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.
- From ultimate analysis and proximate analysis by calculation i got calorific value of rice husk feed stock is 2639.03 Kcal/kg.
- 1 kg of rice husk gasify continuous for about 25-30 min and give producer gas continuous with blue flame.
- Compare with open flame the pot flame is stable and continuous.

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