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Design of Rice Husks Gasification Stove

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ABSTRACTS

The human population increases every year, reported from the official website of the United Nation, in 2011 the world population reached 7 billion people. Then in 2016 reached 7.4 billion people and the world population in 2020 reached 7.7 billion people. It is estimated that by 2030 it will grow to 8.5 billion people and by 2050 to reach 9.7 billion inhabitants. which makes energy needs also increase. With these facts, we design gasification stove biomass energy that aims to reduce the use of non-renewable fuels. The study aims to design a rice husks gasification stove to minimize agricultural waste. In this study, there is an innovation in tar reduction using dolomite as a catalyst. This research uses qualitative research methods that are presented descriptively. The gasification stove design is inspired by the oil stove with the addition of an iron pipe that serves as an oxygen supplier. The design of gasification stoves using rice husk as fuel was successfully carried out. This stove is proven to be one of the tools to maximize the potential of using rice husks as fuel. Finally, we hope that this research can continue to be refined in further studies to maximize the utilization of rice husk waste as renewable alternative energy.

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1. INTRODUCTION

The human population increases, every year, which makes energy needs also increase. With the increasing need for energy, people began to look for other sources of energy, which are easy to be and can be an alternative for every daily life. However, this is not balanced with the availability of fossil energy sources (Hopfenberg & Pimentel, 2001). In 2011 the world oil price (Brent oil and Indonesian Crude Oil Price or ICP) was at a level above the psychological limit of USD 100 per barrel. The price hike reached an average of around USD 111 per barrel or an increase of about 40% compared to the average oil price in 2010 which reached USD 79 per barrel. The increase in world oil prices every year and reached its peak in July 2008, which reached the US $ 147.27 per barrel, caused the government to sell non-subsidized kerosene to the people and launch a policy program for the conversion of kerosene to LPG. The aim of the kerosene to LPG conversion program is to reduce the burden on the state budget for kerosene subsidies by Rp. 23.12 trillion / year but this conversion program is not running well due to the government's unpreparedness in providing infrastructure and infrastructure for the kerosene to LPG conversion program. As a result, people experience difficulties in getting LPG so that their welfare decreases (Griffin & Teece, 2016; Departemen ESDM Ditjen MIGAS, 2008; Media Indonesia, 2008; Kementerian Energi dan Sumber Daya Mineral (ESDM), 2012).

Seeing this problem, the solution to the energy crisis is by utilizing rice husks as an alternative fuel and applying it to a stove made from used cans. Rice husks have abundant availability in Indonesia, reaching 20-30% of the total dry grain weight, and are still neglected as agricultural waste so that it can be optimized as a more affordable and environmentally friendly energy source. The potential for rice husks based on the Agency National Statistics Center of unhulled rice production in 2017 is estimated to have reached 57.05 million tons of milled dry unhulled rice. With this 5% production growth, in 2018 the national rice production target will reach 59.9 million tons. This figure was achieved with an increase in production of 2.85 million tonnes of dry unhulled rice (Pujotmo, 2017; Simatupang and Timmer, 2008).

Besides, the husk has a high calorific value, which is between 3,100-3,300 kcal/kg. Used cans that have been pollutants for the environment are used as material in the manufacture of husk stoves which are used as a means to produce burning fires from waste from rice husks. Apart from being able to reduce the production cost of making husk stoves because the raw materials used are made of used cans that are not used, this step is expected to reduce pollution and environmental disturbances caused by used cans (Maiti *et al.*, 2006).

The use of rice husks as fuel for cooking can save costs of ± 50 - 60% when compared to the use of LPG gas cylinders (assuming the same duration of use) which is a gas natural product of petroleum processing. The resulting emissions are very much different considering that biomass is carbon neutral or does not have a carbon footprint as a result of its combustion. With Indonesia's abundant resources, especially rice, the gasification stove biomass energy was designed to reduce the use of non-renewable fuels. The study aims to be alternative energy using rice husks, can also minimize agricultural waste and create new product ideas that can trigger new jobs for the local community (Pradhan *et al.*, 2013).

2. METHODS

In this study, we used an experimental research study method. Experimental research is a study that strictly adheres to a scientific research design. It includes a hypothesis, a variable that can be manipulated by the researcher, and variables that can be measured, calculated, and compared. Most importantly, experimental research is completed in a controlled environment **Figure 1**.

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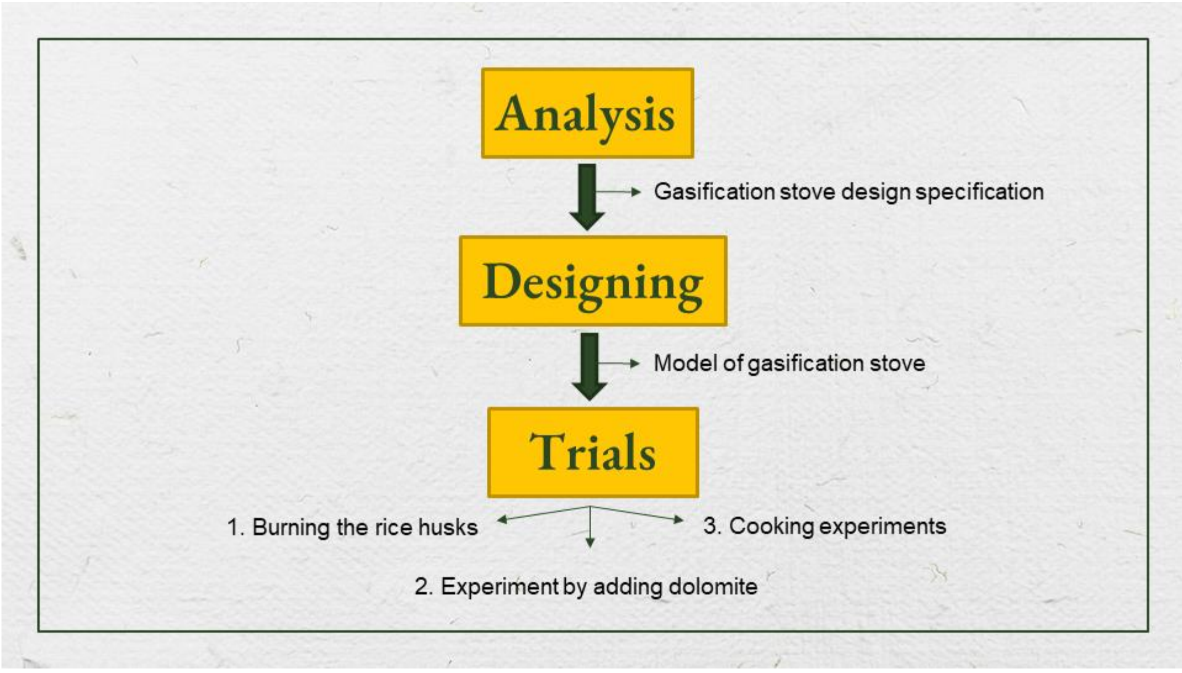

Figure 1. Steps of the research

Based on the experimental data, we collected and analyzed data, and results will either support or reject the hypothesis. This method of research is referred to a hypothesis testing or a deductive research method.

2.1 Analysis

At this point, an analysis of the main components needed in the manufacture of the stove is carried out. This is so that the stove is made to function properly.

2.2 Model design

At this point, a gasification stove model is designed. The design is made by considering the parts needed in the gasification process then combining them with the main components in a stove in general. The sizes of the sections are determined based on literature studies from various journals by considering their effects on the gasification process.

2.3 Trials

At the last point, several experiments were carried out on the stove that had been made. Among them are rice husk burning experiments, experiments to add dolomite, and cooking experiments.

3. RESULTS AND DISCUSSION

3.1. Analysis main components of stove

Based on observations of stove models in the community, there are several components needed to design rice husk gasification stoves. These components are the body, stand, burner, air vent, and fire furnace. The stove body is needed to unite the other components. Stove stands are needed to support the stove body and keep it in a fixed position. The stand should be flat at the bottom so that the stove doesn't shake easily when you hit it. The burner is used as a meeting place for gas and oxygen to produce a flame on a stove unit. The air vent on the

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stove serves to drain air containing oxygen from outside into the combustion chamber or burner. Based on the principle of the fire triangle, this oxygen is needed for the fire to ignite. the fire furnace is a cooking stand that makes the cooking container more stable. It is used as a place to place the cooking container (Varunkumar *et al.*, 2012). Here are some of the functions of each part in the gasification stove model design in **Figure 2**.

3.2. Model design

The following is a gasification stove design that has been made by incorporating all the main components of the stove into it and modifying it so that it can be used in the gasification process. The gasification stove design is inspired by the oil stove with the addition of an iron pipe that serves as an oxygen supplier.

3.2.1. Outward appearances

On the outside of the stove, there are several parts, including the stove body and a support made of a freon tube. The stand is made of the top of the freon tube while the rest is used to make the stove body. Apart from functioning as a unifier for all components, the stove body also functions as a burner. This stove is made of plate iron which is formed in a circle with a diameter of 1 cm larger than the stove body for easy installation. On the stove are combined 4 iron window trellis to support the cooking container while cooking. This air distribution pipe is made of iron pipe whose outer end is the place for the pump, while the inner end is connected to the air spreader chamber. This pipe is used to drain the air generated by the pump to the combustion chamber. This air pump is made of iron rods which are connected by rubber at the inner end. an air pump is needed when starting a fire or when the coal starts to go out.

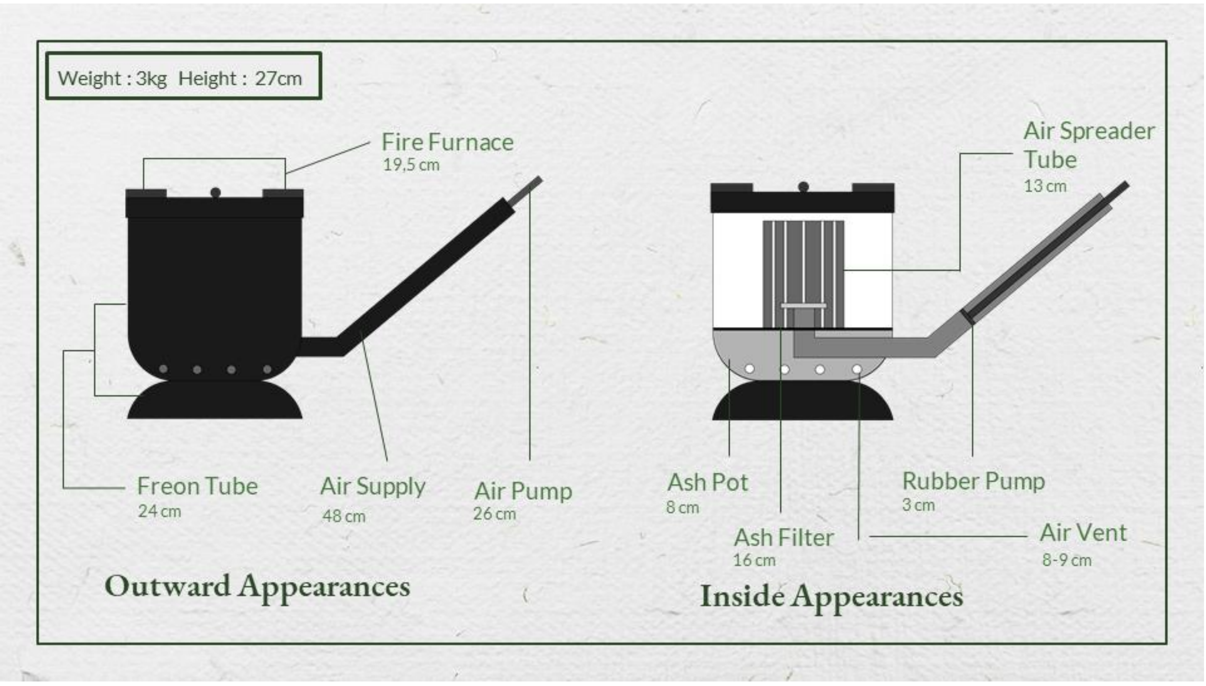

Figure 2. Model design of gasification stove

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3.2.2. Inside appearances

On the inside there are several parts including the air spreader made of used cans that are perforated vertically along with the height with a distance between the holes of about 2 cm. it is used to spread the air supplied by the air supply pipe throughout the fuel. The ash filter is made of iron plates that are randomly perforated to separate and filter the ash from the combustion. The filtered ash will go into the ash pot just below it. Ash pot is used to store the ashes from combustion that have been filtered in the ash filter. The ash pot is part of the freon tube which is separated (without being cut) by an ash filter. And the air vent is a small hole in the stove body (freon tube) which is parallel with a diameter of 9-10 mm. The air vent serves to drain natural air from outside during the combustion process.

3.3. Trials result

The stages carried out in the trial process were burning the rice husks and experimenting by adding dolomite and cooking experiments.

3.3.1. Burning the rice husk

The first trial was with burning the rice husks on the stove that we had designed. The research purpose is to test whether the gasification stove can run properly marked with a blue flame. Burning rice husks will light up quickly if aided by the wind directed at the stove, as shown in **Figure 3**. This is because the gasification process requires air to convert biomass into gas products. The air is needed in the oxidation process where there is a reaction between the rice husks and the results of the previous gasification process with oxygen (Pujotmo, 2017; Febriansyah *et al.*, 2013). The reaction is exothermic so that the heat generated by the gasification stove with rice husk as fuel can be used as a substitute for LPG. Therefore, the gasification stove design is not yet suitable for use, it still needs more improvements in the future.

Figure 3. Coal from combustion

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3.3.2 Experiment by adding dolomite

The addition of dolomite when burning rice husks has been shown to reduce smoke-containing tar (Myrén *et al.*, 2002). In this test, the dolomite we use is the same mass as the rice husk as fuel, which is twenty grams. In the burning of rice husks without dolomite, the resulting smoke looks a lot to fill the roof. Whereas in burning rice husks with dolomite, the smoke produced is less than the burning experiment without dolomite. Since it is known that the smoke produced from this gasification process contains tar, it can be concluded that the addition of the dolomite catalyst is effective in reducing the tar content of the burning of rice husks.

From this experiment, we can see that rice husks have greater energy potential than another biomass. Rice husks have abundant availability in Indonesia, reaching twenty to thirty percent of the total dry grain weight, and are still neglected as agricultural waste so that they can be optimized as a more affordable and environmentally friendly energy source (Pujotmo, 2017; Quispe *et al.*, 2017). Besides, the use of rice husks, which is one of the agricultural wastes, can overcome the problem of handling waste so that rice husks are not only an environmental pollutant but can be used as a substitute for diesel fuel.

The quality of the combustion of rice husks will be better if more ventilation is made on the stove so that more air can enter. This affects the duration of the flame and its quality. Besides, on the inside of the tube used as a stove, it would be better if it could be coated with clay. In addition to reducing heat so that it is not channeled into the outer tube, clay can also increase the temperature of the rice husk coals during the combustion process, so that the coals will heat faster (Imaduddin, 2013; Chen *et al.*, 2018).

The reddish-yellow flame color indicates that the combustion of hydrogen, methane, and carbon monoxide gases is in a low oxygen burner with an excess composition of carbon monoxide (Julieta, 2019; Scholte and Vaags, 1959).

3.3.3 Cooking experiments

The cooking experiment was carried out when the embers had formed and ignited. In this experiment, a chicken egg was used to check how long it took to burn it until the eggs were cooked. Once observed, the eggs are cooked within 5-6 minutes after the oil has heated up. The texture of the eggs is no different from when cooked using a normal gas stove. During cooking, the air is re-pumped twice to keep the coals burning.

Figure 4. Experimental cooking with rice husk as fuel

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The advantage of this gasification stove is it can minimize the use of non-renewable fuels, save the cost of expenditure 50-60% when compared to the use of LPG gas, reduce agricultural waste, the resulting emissions are of biomass is carbon neutral or does not have a carbon footprint, this is reinforced by the use of dolomite that can reduce the tar content in combustion results. The drawback is that the fire is red due to a lack of oxygen which can cause the pan to blacken quickly, the combustion time takes longer, and takes more effort than the use of the stove in general because they have to supply air manually every time the fuel goes out. The potential of stoves can be produced on a large scale for people in the village who generally have jobs as farmers.

4. CONCLUSION

The design of gasification stoves using rice husk as fuel was successfully carried out. This stove is proven to be one of the tools to maximize the potential of using rice husks as fuel. Finally, we hope that this research can continue to be refined in further studies to maximize the utilization of rice husk waste as renewable alternative energy.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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