The effect of variation number of holes on burner cap of TLUD gasification stove

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Abstract—The objective of this research was to investigate the influences of number of holes on the burner cap to performance of TLUD (top lit up draft) gasification. Number of holes on the burner cap usually used to distribute methane gas that comes out from gasifier and then to be flamed become fire. Variation of number of holes on the burner cap was intended to get flame effective and the best temperature at TLUD gasification stove. This TLUD gasification stove use rice husks biomass as source of fuel with a mass of 1.5 kg and mesh 10. The method was by varying number of hole of the burner cap of 20, 30, 40 and 50 holes with a diameter of every hole was 5 mm. Water boiling test was used to prove which hole produced the fastest time to boil 2 liter of water. The results show that the burner cap with number of holes as much as 50 produce a longer time flame and stabilize the combustion temperature produced by TLUD gasification stove.

1. Introduction
Waste of biomass can be used as source of energy to substitute the fossil based fuel. Fuels such as kerosene, LPG, gasoline and others that come from the fossil fuel are very limited and tend to be exhausted. The population also rapidly growing, and increasing the use of fossil fuel consumption. Recently, fossil fuel crisis has drawn attention to develop viable and sustainable alternatives to substitution of kerosene and LPG. In the developed country, some attempt was done to reduce fuel consumption by using alternative energy. They exploit natural resources that are unlimited in numbers such as wind, solar, and ocean waves become source of energy. In some developing countries, waste biomass such as rice husk, sawdust, rice straw and others can take a position as substitution of fossil fuel.

Gasification is conversion process of solid fuel become gas fuel with high temperature. Gasification produces environmentally friendly gas product such as hydrogen and carbon monoxide. Moreover, gasification is easier to control than another biomass direct combustion because it is gasiform. Gasifier is the technology for Gasification (for example TLUD gasifier stove/wood gas stove). Gasification is a process that converts organic or fossil-based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam [1].
In most developing countries, the type of fuel that is used depends on household income. To cook, usually using kerosene or LPG. Utilization of biomass waste as a fuel source can reduce costs to be incurred by each household. One of the alternative energy sources that can be developed as a replacement for fossil fuels is rice husk. In an agricultural country such as Indonesia, Philippine, India and in some developing countries is increasing the production of rice husk. The abundance of rice husks continuously can be used as a source of raw materials for TLUD gasification stove.

Examples of research about alternative energies to substitute fossil fuel can be found in the works by [2, 3], and briquette using biomass by [4, 5]. Biomass such as chopped wood, rice husks, straws of rice is not only directly used to fuel material, but also to improve efficiency and calor. It can be made briquette or burned by gasification method. Therefore, this study was made to improve combustion efficiency by using gasification. Rice husk can produce the largest methane gas that can be used as a substitution for LPG gas. To improve the performance of the gasification furnace of TLUD, be attached of reflectors on the burner with a variety of shapes and angles.

Research for the best insulators on the gasification furnace are use clay insulation materials fire-resistant (refractory clay) [6]. Rice husk biomass waste with a capacity of 1.5 kg can produce effective flame for 47 minutes. Air flow rate at the gasification furnace influences the combustion temperature [7].

Study about the influence burner on combustion system worked by [8, 9] and showed that burner give the influences to the maximum temperature. Optimal ratio between height of gasifier and burner and air flow distribution on the TLUD gasification stove of biomass has done by [10], and showed that air flow distribution on burner is very important to get ratio of burner. Optimal ratio is around 1:3 to produces stabilize of flame and blue fire.

2. Methodology
This section explains the methodology used in this research.

2.1. Material
Rice husk used as main material with a water content of ±10%. Rice husk is grinding by a machine, and then be sifted by size of mesh 10. Then 1.5 kg of the shifted rice husk was put into the gasifier tube.

2.2. Equipment
The main equipment use type gasifier updraft (TLUD) with an outer diameter of 200 mm and an inner diameter of 160 mm (see figure 1). Refractory clay gasifier is used as an insulator, and placed between an inner and an outer diameter of the gasifier tube. Height of the reactor tube is 600 mm.

The variation of burner and burner cap with variation number of hole is shown in figure 2. Number of holes on the burner cap using variation 20, 30, 40 and 50 holes as shown in figure 3(a)-(d) respectively. Every holes having 5 mm of diameter.

Figure 4 shows the installation of the research. Firstly, the gasifier tube (6) was filled with 1.5 kg rice husk. Secondly, the process of gasification was started with burning the surface of rice husk on the gasifier using the lighter. Following this process, the blower (3) was turned on at a speed of 10 m/s. After gasification process began, the temperature at the burner was measured using thermocouple (9) while the time process was noted using a stopwatch. The steps were done repeatedly with time span of 30 seconds until the fire stops.
Figure 1. Gasifier tube.

Figure 2. Burner and burner cap with variation number of holes.

Figure 3. Number of holes (a) 20 holes (b) 30 holes (c) 40 holes and (d) 50 holes.
3. Results and discussion

As can be seen on figure 5, which represent result of gasification process with variation of number of holes on burner cap, obviously, that the most stable temperature occurs when using burner cap with number of hole are 50. It reaches average temperature 746°C and length of flame is around 46 minutes. On the other hand, burner with number of holes 20 give the shortest length of flame, and average temperature is not quite high as well. Increasing number of hole on burner cap indicate that average temperature are better than small number or holes. Furthermore, more number of holes produces length of flame better than small number of holes.

Figure 6 represents time to boil of 2 liter of water using water boiling test. Number of holes on burner cap 50 can be boiled water on 7 minutes. That is the fastest time to boil water compare to the other burner with number of hole 20, 30 and 40. This study show that increasing number of hole on the burner cap give influence to the time flame effective and time to boil of water.

![Figure 5. Comparison result of gasification with variation of number of holes on burner cap.](image-url)
Figure 6. Comparison result of water boiling test with variation of number of holes on burner cap
(a) original comparison graph (b) zoomed version of (a).

4. Conclusions
The result shows gasification processes using variation of number of hole on burner cap give effects to the effective time flame, combustion temperature and time to boil of water. Burner with number of holes 50 produces the best average temperature, the longest time flame and the shortest time to boil of water. The average temperature is 746°C, length of flame is around 46 minutes and approximately 7 minutes to boil of water.

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