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# The Effect of Modification of Addition of Variation in Cylinder Diameter on Biomass Briquette Stove Performance

Sallolo Suluh[1*], Rita Tanduk[2], Ferayanti Boas Gallaran[3]

Mechanical Engineering Departement, Indonesia Christian University Toraja, Tana Toraja, Indonesia[1*]
Indonesian Languange Education Departemement, Indonesia Christian University Toraja, Tana Toraja, Indonesia[2]
Informatics Engineering Departement, Indonesia Christian University Toraja, Tana Toraja, Indonesia[3]

Corresponing Author: 1*

**ABSTRACT**— The utilization of biomass briquettes used as an alternative fuel can replace fuel oil, especially kerosene and gas, which has not been very effective in its journey because several factors influence it. Therefore, it is important to improve the stove, which functions to transfer heat from biomass briquettes to make the cooking quality more effective. So this study aims to utilize coconut shell waste briquettes as fuel on a stove whose combustion chamber is modified by varying the diameter of the aluminum cylinder. The results showed that the variation of the cylinder diameter 180mm was the most superior in terms of fire temperature, water boiling ability, and thermal efficiency of 514°C, 30 liters, and 37.74%.

**KEYWORDS:** Coconut shell briquettes, stove modification, cylinder diameter, fire temperature, ability to boil water, thermal efficiency.

## 1. INTRODUCTION

Energy needs are increasing along with population growth and advancing technological developments. Meanwhile, the amount of available energy supply is limited due to continuous use. This is due to the scarcity of energy and soaring world oil prices due to its non-renewable nature. This must be immediately balanced with the provision of alternative energy sources that are renewable, abundant, and affordable for the wider community. One of the abundant alternative energy sources comes from biomass energyseasons. Biomass is an organic waste material that comes from green plants. Biomass originates in agriculture, plantations. One of the wastes that are used comes from the plantation sector, namely coconut shell waste. Coconut shell charcoal goes through a carbonization process which is easily compressed and shaped and has a high calorific value. The effectiveness of coconut shell waste is used in research because there are several previous studies, namely [1] researching coconut shell charcoal with variations of sand additives resulting in a calorific value of 5893.33 calories/gram and thermal efficiency of 64.15%. [2] Conducting research on coconut shell briquettes for fuel obtained a calorie value of 4949 calories/gram. [3] conducted a mixture of coconut belt and coconut shell with a ratio of 20%: 60% yielding a heating value and thermal efficiency of 5675 cal/gram and 43.82%, respectively. [4] Conducted research on a mixture of rice husks and coconut shells with a ratio of 50:50 to produce a calorific value of 4966 kcal/kg. And finally, [5] conducted a study on rice husks and coconut shells with paper powder adhesives resulting in a calorific value of 4214.86 kcal/kg. In certain conditions encountered, the problem that often arises is not the use of briquette fuel, but more specifically the biomass briquette stove as a less optimal heat conductor. Reminding there are several studies before modifying the stove combustion chamber, namely [6] conducting research on a biomass stove with an addition of a 180mm cylinder to produce a thermal efficiency of 52.87%, [7] making modifications to the stove resulting in a thermal efficiency of 68%, [2] modified the combustion chamber of the biomass stove with an aluminum cylinder resulting in a thermal efficiency of 70.73%, [8] modified the combustion chamber of a coal stove

with an aluminum cylinder with one row of holes above, resulting in a thermal efficiency of 71.03%. [9] Modified 3 stoves with the addition of aluminum cylinders and Up, Down Grate resulted in a thermal efficiency of 65.06%, and [10] modified the stove with the addition of an insulin cylinder resulting in a thermal efficiency of 57.4%. Therefore, in this study, a modification of the stove combustion chamber was carried out by adding variations in the diameter of aluminum cylinders using coconut shells. Given the absence of similar research using stoves and insulators made from the same, namely aluminum.

## 2. MATERIALS AND METHODS

The biomass stove used is made of aluminum with dimensions of 300mm high, 220mm outside diameter, and 210mm inside diameter.

**Figure 1.** Aluminium Stove

he type of biomass used in this research is coconut shell waste, with the form of briquettes used in the form f a wasp nest. The research method used is an experimental method by utilizing coconut shell briquettes as uel on an aluminum stove with a modification of the addition of variations in the diameter of the cylinder aterial as many as 5 pieces with a diameter of 180 mm, 170 mm, 160 mm, 150 mm and 140 mm.

## RESULTS AND DISCUSSION

he research was carried out as follows: making briquettes, drying briquettes, testing the approximation and lorific value, and testing combustion on stoves with modified variations of cylinder diameter. The rameters in this study are the temperature of the fire, the diameter of the sleeve, the ability to boil water, the ss of briquettes used, the fuel consumption, and the thermal efficiency. The results can be seen in the table low:

**Table 1.** Recapitulation of stove performance efficiency results on coconut shell briquettes

| Coconut Shell Briquettes | | | | | |
|---|---|---|---|---|---|
| **Code sample** | Cylinder Variations (mm) | | | | |
| | 180 | 170 | 160 | 150 | 140 |
| $m_{water}$(Kg) | 5 | 5 | 5 | 5 | 5 |
| $Cp_{air}$ (kj/kg°C) | 4,1769 | 4,1769 | 4,1769 | 4,1769 | 4,1769 |
| $m_{panci}$ (Kg) | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 |
| $Cp_{panci}$ (kj/kg°C) | 0,9 | 0,9 | 0,9 | 0,9 | 0,9 |
| $m_{bt}$ (Kg) | 0.76 | 0,75 | 0,85 | 0,89 | 0,88 |
| FCR (Kg/s) | 0,0001 | 0,0001 | 0,0001 | 0,0001 | 0,0001 |

| | | | | | |
|---|---|---|---|---|---|
| **LHV (kj/kg)** | 1209,7 | 1209,7 | 1209,7 | 21209,7 | 1209,7 |
| **$P_{out}$ (kW)** | 1,1265 | 0,9759 | 0,7844 | 0,7601 | 0,6871 |
| **$P_{in}$ (kW)** | 2,9850 | 2,7137 | 3,3385 | 3,7453 | 5,1575 |
| **$P_{losses}$ (kW)** | 1,8549 | 1,7377 | 2,5541 | 2,9851 | 4,4704 |
| **ηth (%)** | 37,7405 | 35,9646 | 23,4965 | 20,2966 | 13,3229 |

Table 1 shows that the maximum thermal efficiency is achieved by using a 180mm diameter shell of 37.74%, the distance of the shell is the farthest variation between the combustion chamber and the stove wall in this study. Therefore, we can see the capability process shown in the graph below:

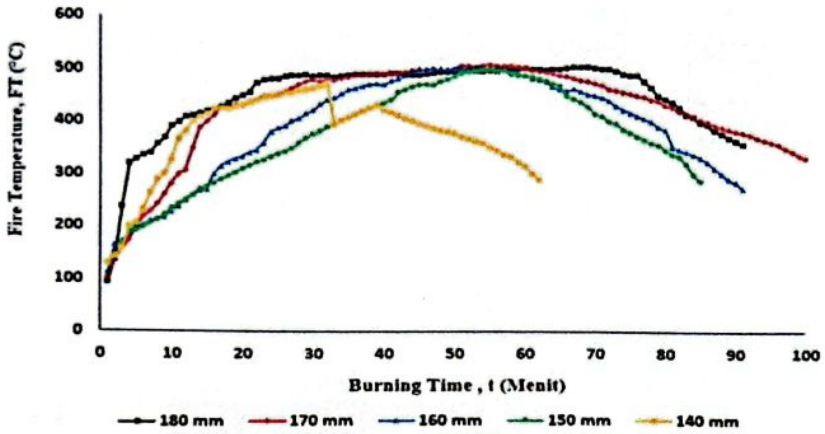


**Figure 2.** The temperature history of the fire

In Figure 2 above, it can be seen that the phenomenon of the highest fire temperature point with variations in the diameter of the aluminum cylinder is obtained at 514°C to 42 minutes at a cylinder diameter of 180mm. It can be seen that the fire temperature increases along with the wider diameter of the aluminum cylinder used. This happens because the more air that helps the briquette combustion process, the faster the rate of the combustion process, resulting in a high fire temperature.

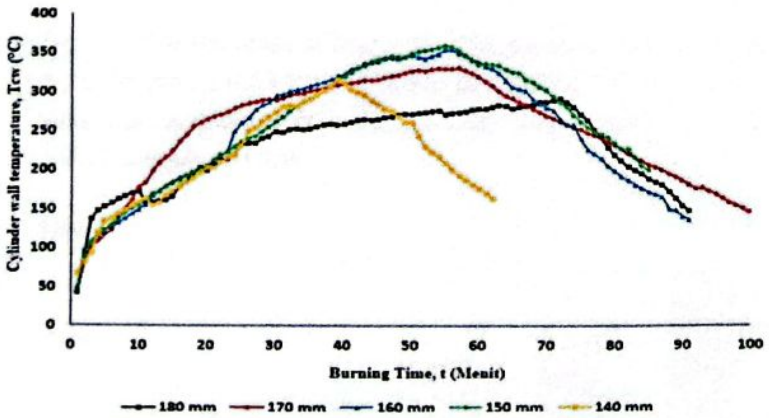


**Figure 3.** History of cylinder wall temperature

n Figure 3 above, the maximum temperature of the cylinder wall by using a cylinder diameter variation is enerated at 398°C in the 24th minute. It can be seen that the increase and decrease in cylinder wall mperature tend to be stable. This occurs as the temperature of the sleeve wall almost approaches 100°C.

In Figure 4 below, it can be seen that the ability to boil the most water by using variations in cylinder diameter is produced at a cylinder diameter of 180mm and 170 mm, respectively 15 liters. This happens because the wider the diameter of the aluminum cylinder used, the more air supply that will enter to help the combustion process. So that the ignition process is getting longer along with the increasing capacity of the water being cooked.

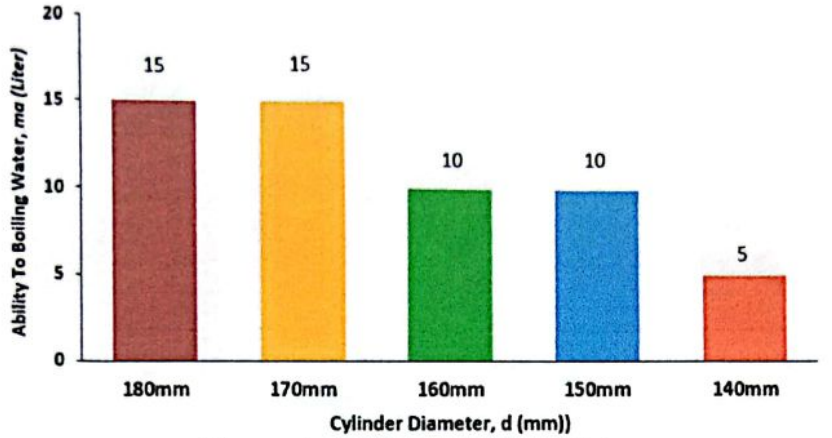


**Figure 4.** Ability To Boiling Water

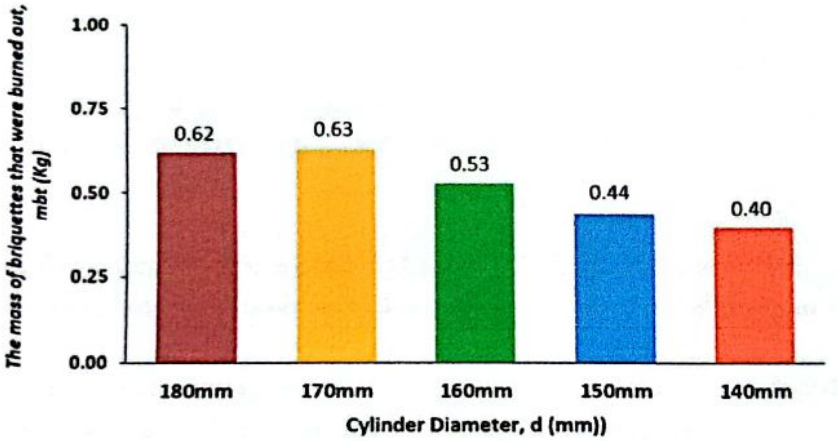


**Figure 5.** The Massa Of Briquette That Were Burned Out

In Figure 5 above, it can be seen that the mass of briquettes that are most used up in the combustion process using variations in cylinder diameter is 0.63 kg at 170mm in diameter. This happens along with the large supply of fuel-air which helps the combustion process, the longer the briquette ignition process will take. So that the remaining mass of fuel is produced less

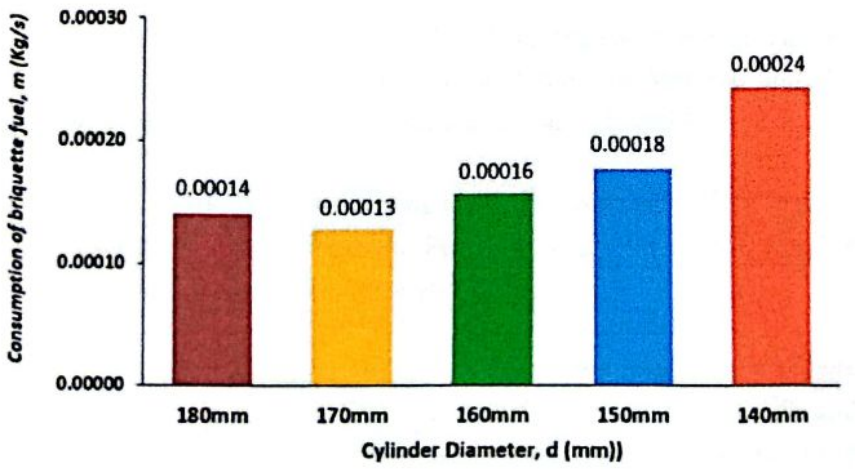

**Figure 6.** Consumption of Briquette Fuel

Figure 6 above, it can be seen that the least fuel consumption by using a variation of the diameter of the aluminum cylinder is produced only 0.00013 kg / s at a diameter of 170mm. This happens as the wider the diameter of the cylinder used, the longer it maintains the flame. Resulting in smaller fuel consumption.

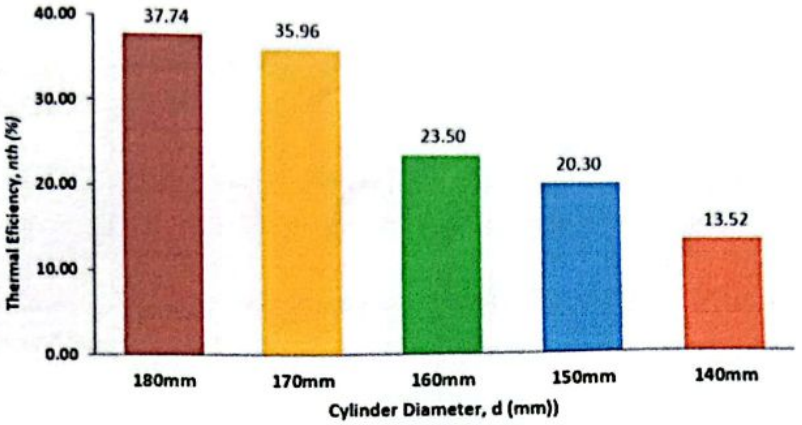


**Figure 7.** Thermal Efficiency

Figure 7 above shows, the highest thermal efficiency is produced at 37.74% in variations of the aluminum cylinder diameter 180mm. and the lowest thermal efficiency is only 13, 52%. This occurs because of the high temperature of the resulting flame at this diameter. So that it is able to maintain the heat quality of the briquettes to help the quality of the maximum thermal efficiency of the stove

## 4. CONCLUSION

1. The maximum flame temperature is produced at 396°C with a diameter variation of 180mm
2. The highest ability to boil water is obtained at a cylinder diameter of 180mm and 170mm, respectively 15 liters.
3. The mass of briquettes that burns out and the best fuel consumption is produced in variations of the 170mm aluminum cylinder diameter of 0.63 kg and 0.0013 kg / s, respectively.
4. The maximum thermal efficiency is 37.74% in the variation of the cylinder diameter of 180mm

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