Influence of Igniter Component to The Burning of Bio Briquette Rice Husk Torrefaction

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Abstract
Rice husk as waste agricultural biomass has great potential to be used as an alternative fuel. Increased density of rice husk into bio briquettes will increase the calorific value, but the initial firing rate would be longer. One way to shorten the ignition time by adding an oxidant that supply oxygen for the oxidation reaction or adding liquid igniter to the fraction of briquette was called briquette igniter. Oxidizing agents that was used in this research were KMnO4, jatropha seeds and gondorukem. The purpose of this research were to observe the effect on bio briquettes igniter which could be shorten the ignition time and provided a homogeneous rate of combustion, briquetting pressure effects and the influence of composition on combustion characteristics briquettes. Oxidizers were mixed with rice husk that have been torrefied, coal and starch. Mixture then moulded and pressed to form a briquette. Proximate analysis, ultimate and calorific value were the quality parameter of these briquettes. Combustion characteristics were tested with test ignition time and hold time burning to find out the quality of briquettes combustion through the combustion temperature profile testing. Based on these results, the best torrefaction process at temperature 300º C and holding time 10 minutes. The best igniter was jatropha seeds with a short ignition time in the 19th minute and lasting burning time was 29 minutes long. Briquetting pressure of 100 kg/cm2 provided the shortest time that was burning in the 19th minute with a good briquette strength. Composition of rice husk and coal 70% and 30% provide the optimum combustion at ignition time in 19th minute, firing 29 minutes hold time, volatile metter 49.98%, fixed carbon 20.98% and calorific value 3885.7 kcal /kg.

Keywords: rice husk; torrefaction; briquetting; combustion

INTRODUCTION
Energy is the main need to mobilize human activity in achieving a life goal. Higher energy needs to be supplied from a wide variety of energy sources, including renewable energy. In connection with the depletion of fossil energy sources and the impact on the environment, the use of energy from renewable energy sources including biomass is increasing. The types of biomass that can be used include oil palm empty fruit bunches, palm shells, palm fruit fiber, rice husk and straw, corn cobs, sugarcane bagasse, etc. The potential of biomass that Indonesia has around 32000 MW and only about 1740 MW or 5.4% utilized [1]. Certainly the opportunities utilization of biomass as an energy source is still wide open. Currently, biomass utilization is still low, the amount of biomass accumulate and give rise to new problems such as decay and produce gases that affect the environment.

Biomass can be used as fuel by various processes that direct combustion, gasification or pyrolysis. So far, most utilization of biomass is done by direct combustion in the combustion
chamber to produce energy including generating steam. General conditions of biomass combustion were still done by direct combustion and the condition is less than optimal and inefficient combustion. Moreover, the impact of pollution from direct combustion of such high gas emissions that can lead to the effects of greenhouse gases and ash that is harmful to health [2]. Direct combustion of biomass are not optimal due to the quality of the biomass is not uniform so that the necessary homogenation quality biomass.

One method is the uniformity of quality biomass torrefaction. Torrefaction was the process of heating the biomass in the temperature range of 200 - 300°C in conditions of slow heating without oxygen. Torrefaction can be used as a method for improving the quality of the biomass prior to the stage of the process towards biomass. Torrefaction will produce a more homogenous biomass with higher energy content than ever before. Moreover, the nature of biomass products torrefaction becomes more difficult to absorb water so that the potential damage to the product due to water can be reduced. In general, torrefaction was done for the purpose of increasing the quality of current biomass used as fuel or raw materials. In general, torrefaction products will increase the energy density can reach up to 20% by mass loss of up to 45% in proportion to the increase in temperature [3].

In torrefaction at temperatures higher than 300°C will progressively eliminate the biomass so that the energy potential of biomass is also lost. In the pyrolysis temperature of 350°C, mass loss of biomass may reach 70% [4]. Thus, torrefaction as an initial method for quality improvement process prior to briquetting biomass can be an optimal point to get quality biomass. Several studies of the quality of the biomass briquettes by starting with torrefaction has been done to the wood. Energy density of wood briquettes torrefaction will be an increase of up to 20% of the initial energy 20.76 GJ / m3 to 24.79 GJ / m3 after torrefaction [5].

With a very large potential biomass for Indonesia, the production of biomass pellets Indonesia is still far from the europe countries that have the potential of biomass is much lower than Indonesia [6]. Energy utilization of biomass burning will be optimized by densified biomass in the form of briquettes or pellets. Densified biomass was done to optimize biomass combustion with the important factor is the density. Bio-briquette density is affected by the bonding mechanism between the solid biomass. The factors that affect the bond between solids is the pressure when pressing, the water content of the biomass, size of the biomass particles, the initial heating of process conditions, the type of binder, the mixing process of material bio-briquette [7]. Pressing pressure will affect the density of pores bio-briquette as diffusion of oxygen with carbon biomass for burning occurs. Besides burning biomass, briquettes have trouble at startup ignition. This condition was caused by the combustion of biomass is heterogeneous between solids combustion with oxygen so that it requires changing the phase of solids into gas to react with oxygen. As for the smaller particle size will increase density and efficiency of the combustion of biomass briquettes [8].

Several methods to speed up the ignition process of bio-briquette was mixing with the combustible components of biomass so that the ignition process will be easier. Some components of the igniter were examined using waste - waste generated from a process such as waste fuel, diesel engine oil waste and waste from industrial alcohol [9]. The study compared the quality of ignition and ignition time of some combustible material.

MATERIALS AND METHODS
Biomass used in this study was the rice husks to do the initial processing. As for the processing of rice husk was drying and decrease the size. Initially, rice husk is dried naturally using sunlight for 8 hours in hot conditions. Then the rice husk reduced in size using a rolling mill until the size reaches -10 + 14 mesh by screening. Subsequently, samples were taken for analysis by proximate and ultimate use TGA as well as the calorific value using a bomb calorimeter. The next stage is to do the initial processing of the rice husk using torrefaction at various temperatures 225, 250 and 300°C. The holding time of torrefaction at temperature 225 and 250°C for 20 minutes and the temperature of 300°C for 10 minutes. The changes of mass throughout torrefaction was recorded to demonstrate the kinetics of the torrefaction rice husk. It also conducted a proximate analysis, ultimate and the calorific value of the rice husk torrefaction product.
The next stage was to make bio-briquette and test the quality of bio-briquette combustion. Bio-briquette was made by mixing rice husk, coal powder, starch and compound igniter. The main components of bio-briquette were rice husk torrefaction and pulverized coal with a variation of 70:30, 80:20 and 90:10 wt %. The igniter compounds used are KMnO4, biji jarak and gondorukem. Bio-briquette mixture was then molded with pressure variations of 100, 150 and 200 kg/cm². Mould bio-briquettes were dried naturally to the sun for 3 days and analyzed for proximate, ultimate and calorific value. Then, bio-briquette burnt to determine the effect igniter compounds, compositions and pressures on the initial ignition timing, combustion temperatures and the holding time bio-briquette burning rice husk.

RESULTS AND DISCUSSION

Rice husk torrefaction resulted as the initial processing of rice husk was analyzed proximate to the variable fixed carbon and volatile matter (VM). The rise of torrefaction temperature will increase the fixed carbon content and lower volatile matter (Figure 3). This condition was caused by pores from rice husk increasingly open so volatile matter out through the pores. While the fixed carbon was a solid material with ash so that the temperature rise does not change but the weight percentage will be increased in accordance with the more lost volatile matter. In the temperature range of 250 to 300°C, the greater the loss of volatile matter due to the high temperature will further open the pores of the biomass and cause the greater the VM was lost (Figure 3).
A biomass pores filled with water and volatile matter. Both components will come out of biomass through a heating process. Water will first be lost and followed by volatile matter. Water does not have the energy content and need energy to pull out of the pores while the volatile matter consisting of components flammable and non flammable. Thus, the loss of the components of water and volatile matter content reduces little energy but the energy density will be increased because many components that do not contain the missing energy from biomass through torrefaction. The higher the temperature the more the components of water and volatile matter is lost from the biomass, the energy density will be increased (Figure 4).

Figure 3. Fixed carbon and volatile matter (%-weight) of raw rice husk and rice husk of product torrefaction at temperature 225, 250 and 300°C

Figure 4. Energy value (kcal/kg) of raw rice husk and rice husk of product torrefaction at temperature 225, 250 and 300°C

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Figure 5 showed that burning briquettes with an igniter gonderukem with rise in temperature was very slow and takes time startup 35 minutes to reach 500°C with holding time temperature for 20 minutes. The length of time for start-up was caused bio-briquette gonderukem igniters are unable to conduct the heat to bio-briquette other non igniter. When the first fire was
lit on bio-briquette gondorukem igniter, hot initial combustion was more widely used to deliver heat on all fronts bio-briquette igniter itself. When the hot briquette formed in the igniter bio-briquette then was transferred to non-igniter bio-briquette other and finally burning occurs in all bio-briquettes. The maximum temperature that can be achieved on the burning briquettes gondorukem igniter was 585 °C. Gondorukem has good adhesion so that the strength and hardness at the briquettes but when burning polluting black smoke, a pungent odor and residual unburned.

On the igniter bio-briquette KMnO4, when biobriket ignited spontaneously emit sparks. A spark caused by the oxidation of KMnO4 with fire and air, which are spontaneous and exothermic. However, the flame was formed only briefly and then immediately goes out back. The flames that briefly occur during repeated in the 5th minute to the 35th minute (Figure 5). In the 40th minute the temperature rise in the combustion starts to significantly due to the heat distribution on the briquette igniters has been uneven and visible from the formation on the entire surface coal briquettes. The heat of briquettes delivered to the other and in the 44th minute, the temperature reached 500°C. The maximum temperature 596°C can be achieved. KMnO4 serve as an internal oxygen supply in order to prevent oxidation briquette making it easier to ignite. The holding time at high temperatur with KMnO4 little longer than gondorukem that for 21 minutes. In the process of burning rice husk bio-briquette using biji jarak as igniter startup took a relatively shorter than the other igniter briquettes. In the 19th minute, the heat transfer has been evenly distributed to all lines of briquettes and combustion temperature 500°C has been reached. Bio-briquette had holding time above 500°C for 29 minutes with a maximum temperature of 672°C. The igniter bio-briquette with biji jarak had a long hold time. The holding time with biji jarak had longer than the igniter gondorukem and KMnO4. This condition was caused biji jarak contain oil which serves as fuel for heat supply.

By comparing three types of initial igniter can be concluded that the best igniter briquette is the biji jarak due to for rapid startup, longer holding temperature at high temperatur, highest maximum temperature and sourced from natural renewable. On the composition of the same rice husk energy content, bio-briquette of biji jarak has higher energy density at 3955.8 kcal/kg compared to ordinary briquettes was 3885.7 kcal/kg. Safety factor for igniter KMnO4, there was an explosion and the smoke arose because KMnO4 as a strong oxidizing agent was an exothermic when given pressure. KMnO4 can also damage the display devices briquettes due to rust. However, the weakness of the igniter biji jarak was cause less compact and hard so it will be a little difficult at the time of transport of heat supply.

![Figure 5. Influence of igniter types (Gondorukem, Biji Jarak and KmnO₄) of rice husk briquette to the combustion temperature](image_url)
CONCLUSIONS
Torrefaction of rice husk at the highest temperatures can produce the highest energy density with a fixed carbon content increases and decreases volatile matter. Igniter of biji jarak can provide the fastest time to time ignition combustion lasting longer than others igniter.

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REFERENCES