INCREASING THE ADDED VALUE OF COCO PEAT WASTE INTO SOLID FUEL (BIO PELLET)

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Introduction

Globally, interest in using biomass for energy is increasing because of some benefits e.g. reduction of dependency on imported oil, employment creation where biomass fuels create up more employment than coal and oil, environmental benefits which relate to mitigation of greenhouse gas emissions, reduction of acid rain, and soil improvement. Biomass may include any fuel derived from organic matter, such as wood, oil crops, and agricultural and animal residues. Biomass can also be termed as biofuel, biodiesel, biogas, and bio pellet (solid fuel) that can be used for heat production, and electricity generation using a wide variety of conversion technologies. The selection and design of any biomass combustion or gasification system are determined mainly by the characteristics of the fuel to be used, existing environmental legislation, the costs and performance of the equipment available, as well as the energy and capacity needed.

One of the potential biomass that could be used as energy feedstock is coco peat. Coco peat is a biomass which is a by product of the processing of coconut fiber which has not fully utilized. The utilization of coco peat is still limited for media of plant growing, therefore mostly coco peat is disposed as a solid waste. Actually coco peat could be used as a raw material for renewable energy sources. The main problems in the use biomass like coco peat as a fuel materials are low density, high moisture content, low heating value per unit volume, non-uniform particle sizes, and susceptible to spoilage. The analysis of coco peat shows that it has 22.05 % fixed carbon, 6.14 % ash, 71.80 % volatile matter, 14-20 % moisture, and 1.14 % silica.

To maximize the utilization of coconut, some efforts should be conducted in developing coconut processing industries involving by-products and utilizing coco peat for heat generation. To make pellet as solid fuel, coco co peat should be have important characteristics namely high density pellets, low moisture content, uniform size, high energy content, easy to store and transport to long distances. Coco peat as feed stock can be processed into pellet shape and when they are burned using gasifiers, it will produce synthetic gas/syngas (H_2 and others) that can be used as energy or heat source for cooking in households and drying for agricultural products.

Pelletizing of coco peat is a densification process which improves its characteristics as a fuel, enhances its volumetric calorific value, reduce transport and storage costs, make less moisture content, and improves its handling characteristics such as higher density, friability and flowable and combustion efficiency (controllable feeding, more uniform and homogeneity fuel). Biomass pelletizing is a process of reducing the bulk volume of the material by mechanical means for easy handling, transportation and storage.
Biomass of plants in general have a high lignin content so because of the high lignin content will be helpful as the adhesive substance when used as pellet. Since lignin content of coco peat is relatively low, there should be added an adhesive such as starch when processed into coco peat pellets. Mostly biomass from plants is lignocellulosic biomass in its original form usually have a low bulk density of 30 kg/m3 and a moisture content ranging from 10% to 70% (wb). Pelleting increases the specific density (gravity) of biomass to more than 1000 kg/m3 Pelleted biomass is low and uniform in moisture content.

To change coco peat pellets into high energy fuel it needs a process means such as a gasifier. Inside the gasifier unit of coco peat pellets burned at a certain temperature to produce a gas with a high energy content. One type of gasifier that can be used to convert pellets of coco peat is kind of up-draft gasifier. Gasification can be explained as a staged combustion process and this can be done by burning coco peat pellet at a limited supply of oxygen. The gas which is produced from combustion still has potential to be burned. The objective of gasification is to break complex molecule bonds into simple gases i.e. hydrogen gas (H_2) and carbon monoxide (CO). H_2 gas as a main component of a syngas has very clean burning characteristics.

Production of Coco Peat Pellet

The process of manufacturing fuel pellets involves placing coco peat under high pressure and forcing it through a round opening called dies. When

exposed to the appropriate conditions, coco peat fuses together, forming a solid mass and this process is known as pelletizing. However, the creation of the pellets is only a small step in the overall process of manufacturing fuel pellets. Figure 1 shows the unit operations and the flow of coco peat pelletizing operation that consists of eight major unit operations namely sortation-sifting, drying (moisture control), size reduction (grinding), formulation, mixing, and densification (pelletizing), cooling, and packaging. Each step must be carried out with care if the final product is to be of acceptable quality.

Sortation or sifting of raw materials was required since coco peat must be uniform in size prior to making good quality of the pellet shape and structure, and improving the density of pellets produced. This is usually conducted using a sieve (60 mesh). In addition, this unit operation was used for separating foreign materials such as metal or stones from the feedstock. Size reduction was also conducted to get small size of biomass pellet in order to make uniform materials and to make solid form of pellets.

Moisture content of the feedstock was decreased by oven-drying at temperature of 50^{o}C. If the feedstock is too dry, moisture can be added by injecting steam or water into the feed stock. Coco peat typically has around 20% wet basis (wb) and must be dried prior to processing. Drying of raw materials was conducted to reach uniform drying level (10 - 14% wb) in order to have good pellet structure and to produce low emission pellet. When moisture content is higher than 14%, the pellet will release smoke and create environmental pollution. Maintaining an appropriate moisture level in coco peat is vital for overall quality of the final pellets.

One of the important process is formulation is since it will be quantified the amount of pellet materials that need to be put together to form a single uniform mixture of pellets. The formulation would dtermine all of energy release. Feed formulation is also a key operation in pellet production, ensuring that pellet ingredients are economically used for syngas production. The coco peat pellet can be composed of 85% coco peat, 5% tapioca starch, and 10% waste cooking oil. Tapioca starch

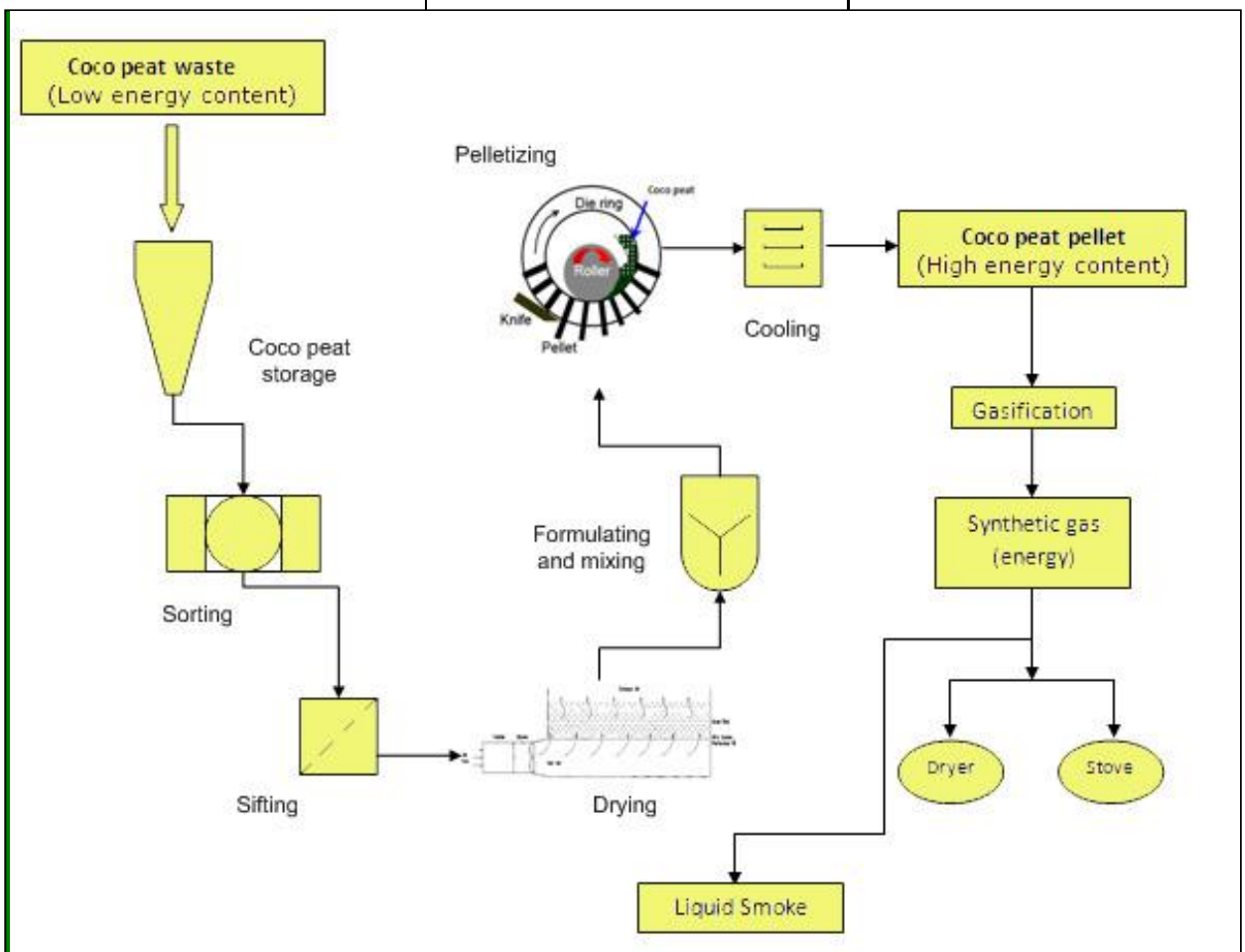

Figure 1. Flow process of coco peat pellet

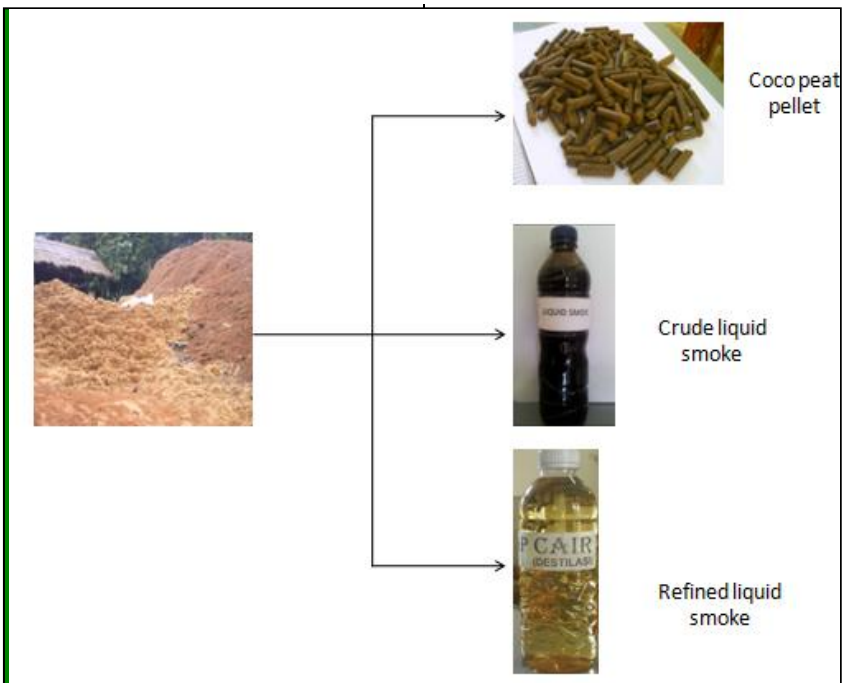

Figure 2. The Cocopeat pellet and liquid smoke or coco peat vinegar

was used as binding agent to improve the structure of pellet meanwhile waste cooking oil was applied to improve rheological properties of pellet materials when pelleting.

To homogenize all raw materials, mixing was done using a mixer. In mxing step, raw materials is homogenized in order to have uniform energy content of the pellets when gasification takes place. Pelletizing process was done by using a pelletizer unit with capacity of 100 – 150 kg/hour and a power of 10 HP. Pelletizing is intended to form biomass waste in pellet form with 3 cm in length and 8 mm in diameter. A roller is used to compress the biomass against a heated metal plate called die. The die includes several small holes drilled through it, which allow the coco peat to be squeezed through under high temperature and pressure conditions. If the conditions are right, the biomass particles will compress into a solid mass, thus turning into a pellet.

When leaving die, pellet was then cooled by blowing air from an axial fan. The pellet should be cooled soon since the pellets are covered by water which come from internal part of pellet when pressed. The pellets leaving the die are quite hot and fairly soft. Therefore, they must be cooled and dried before they are used. This is usually achieved by blowing air through the pellets as they sit in a metal bin. As pellets get cooled, they should be immediately packed, otherwise it could absorb moisture from the surrounding. Pellets were then packed in a plastic bag with a capacity of 20 kg.

Product and by product

The coco peat pellet and liquid smoke or coco peat vinegar as by product were presented in Figure 2. Liquid smoke was obtained when gasification of coco peat took placed. There is no specification or standard for coco peat pellet. For evaluating the quality of pellet, it can be referred to wood pellets specification. Wood pellet specification itself can vary greatly and should conform to one of the specifications e.g: 1) DIN 51731 Standard, 2) ENplus A1, and 3) European Norms (EN-B). The characteristics consist of size texture, surface condition, length, density, diameter, ash content, moisture content, and calorific value should be examined

According to standards from DIN 51731, ENplus A1, and EN-B, biomass pellet should have strong texture, shiny surface with minimum caloric value of 16,500 – 19,000 kJ/kg. The coco peat pellet calorific values resulted was 16,650 kJ/kg. They have met calorific value parameters required by all standards. The calorific value is the useful energy contained in a kilogram of fuel. This value is affected by the amount of non-combustible material (ash) and the moisture content of the pellet. Coco peat pellet showed solid and strong texture as well as darker color. These characteristics meet with the standard where biomass pellet should have strong texture, shiny surface.

Coco peat pellets produced have an ash content of 6.14 % which is much higher than all existing standards (3.0 %). This was due to the raw material (coco peat) which is more fragile when compared to the wood pellet or other biomass resources. The density of pellet based on the DIN 51731 standard for wood pellets is 1 – 1.4 kg/l. The density of coco peat pellet was 0.27 – 0.3 kg/l which was lower than the standard required. To improve this condition, it would be better if coco peat is mixed with other biomass materials which do not easily makes the pellets fragile. As recommended by pellet manufacturing industries, usual length is 15 - 40 mm and diameter is 8 mm. The length and diameter of the pellet produced were 12 mm and 6 mm, respectively and it means that all dimensions meet the standard required.

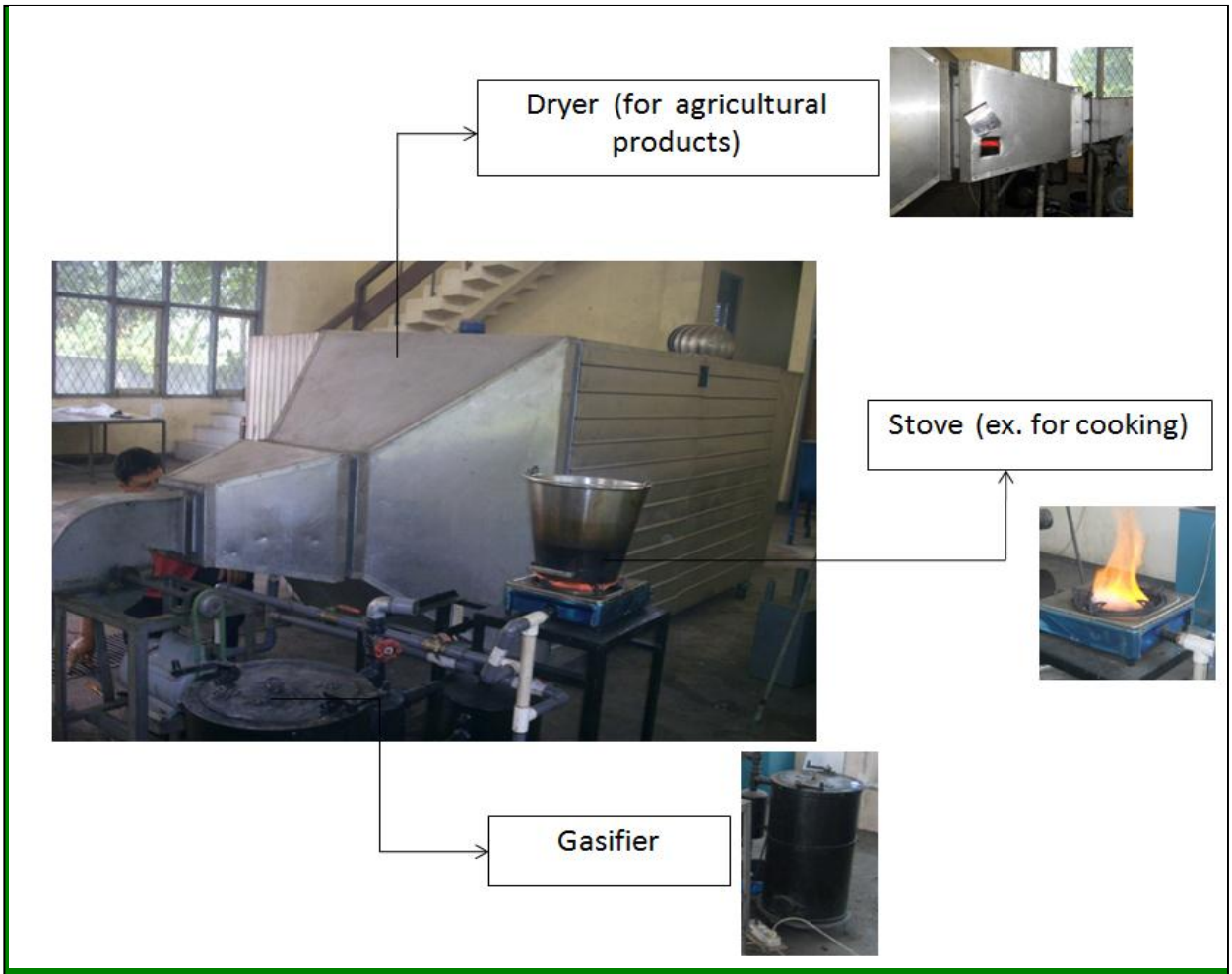

Figure 3. Gasification of coco peat pellet for drying and cooking

Moisture content is one of the important parameters that can influence the production of syngas. The lesser the moisture content, the better the quality of pellet becomes and the less smoke is produced when ignited at the first burning of coco peat pellet. The moisture content obtained was 14.2%. This value is slightly below the value of standard but the results of gasification still showed normal performance. Quality pellets characteristic should have moisture content below 12%.

Gassification

Gasification can be explained as a staged combustion process and this can be done by burning coco peat pellet at a limited supply of oxygen. The gas which is produced from combustion has potential to be burned. The objective of gasification is to break complex molecule bonds into simple gases i.e. hydrogen gas (H_2) and carbon monoxide (CO). H_2 gas as a main component of a syngas has very clean burning characteristics during gasification occurred. The experiments of gasification using coco peat pellets showed that 5 kg of pellets can be generated 3.5 hours burning and resulted 1350 ml of crude liquid smoke or coco peat vinegar.

During its operation, coco peat pellet was fed from the top of gasifier and burned in the gasification chamber, while fresh air was flowed using fan through fresh air inlet of the gasifier unit. On the gasifier, the air reacts with coco peat pellet producing synthetic gas (H_2 and CO). The synthetic gas produced was flowed through syngas outlet and it was controlled with syngas valve. The synthetic gas was split into two pipes and was ignited for drying agricultural products and for boiling water or cooking (Figure 3). The emission test results of pellet gasification showed that emission from gasification of coco peat pellet produced meet the requirement of Air Quality Standards.

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