Potential to Produce Biomass Briquettes from Tea Waste

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Abstract

Tea wastes are generated on a daily basis in tea estates and these pose an environmental threat due to greenhouse gases emissions yet these presents an opportunity of generation of biomass briquettes. In this study, tea wastes were converted to bio char at 300°C and ground to a particle size of less than 8mm. The bio char was compacted to form briquettes with a calorific value of 22-24 MJ/kg and moisture content of less than 10%. The tea waste briquettes can be integrated back into the tea manufacturing system as a co firing agent with coal or as an independent energy generator.

Keywords: Biomass briquettes, calorific value, renewable energy, tea wastes

1. Introduction

The charcoal briquetting industry offers an opportunity for waste to energy technologies at the same time providing an eco friendly and alternative source of energy (Grover and Mishra, 1996; Quartey). The sub Sahara Africa has huge amounts of biomass generated from agro waste and can be converted to charcoal briquettes (Atanassov, 2013). The use of biomass briquettes as an alternative source of energy help to curb problems such as deforestation as well as climate change effects .Several agro based biomass such as paddy, wheat, sorghum, oil seed crops, cotton husks, coffee waste and corn stover have been used for the production of biomass based briquettes (Sugumaran and Seshari., 2010; Luengo *et al*., 2003). Biomass briquettes can be used for cooking and heating purposes as well as co firing of boilers. Various types of briquettes are shown in Figure 1.

Figure 1. Biomass briquettes (Singh, 2013; Sharma et al., 2015)

Biomass briquettes are manufactured using different technologies including pyrolysis (carbonization), torrefaction and hydrothermal carbonization. Figure 2 shows the various steps involved in biomass briquettes production.

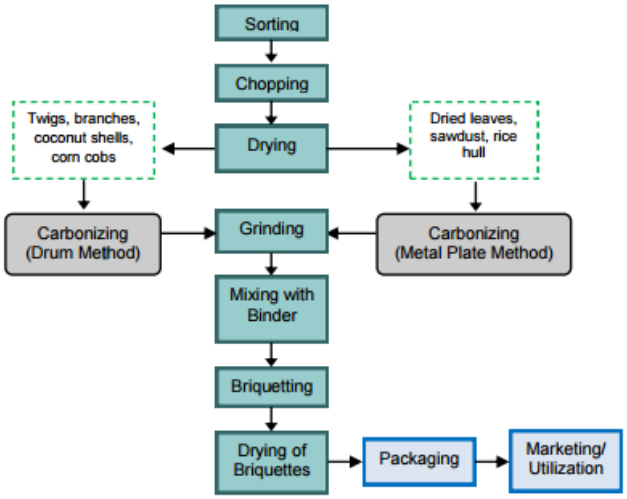

Figure 2. Biomass briquettes from agro waste manufacturing processes (Macabebe et al., 2016)

In this study, the potential to produce biomass briquettes from tea waste was investigated. Tea is farmed in abundance in the region 1 in Zimbabwe and tea wastes are generated during the harvesting and processing stages.

2. Materials and Methods

2.1 Materials

The tea waste was obtained from a tea estate located in Chipinge, Manicaland, Zimbabwe. Moisture content, fixed carbon and ash content in the tea waste and the briquettes was analyzed using an AND moisture analyser. An ASTM D240 bomb calorimeter was used for calorific value measurements and sieve analysis in accordance to WSDOTFOP standards was used for bio char particle size measurement.

2.2 Methods

The production of tea waste briquettes involved several unit operations including: shredding, carbonizing, briquetting and drying. The tea waste was carbonized at 300 °C in a carbonizing reactor in the absence of oxygen. Biochar yield of 65% was recovered from the tea waste.

The moisture content, ash content, fixed carbon and calorific value measured were measured in accordance to Sambo *et al*. (2014).

The particle size of the bio char was measured through sieve analysis. The biomass was compressed at high pressure to allow the interlocking of the particles and densification of the briquette for use as bio energy. Briquetting was done a man made briquetting machine made from scrap metal.

3. Results and Discussion

3.1 Tea waste characteristics and tea waste briquette characteristics

The characteristics of the tea waste and the biomass briquettes produced are shown in Table 1. The biomass briquettes had calorific values ranging between 22-26 MJ/kg and these compared well to the calorific value of coal that is available in Zimbabwe. Due to the high heating value of the tea waste briquettes, they can be integrated back in the process as a co-firing agent together with coal. The biomass briquettes also had a moisture content that was 50% less as compared to the raw tea waste. In addition, the ash content for the biomass briquettes was also about 70% lower in comparison to the raw tea waste. The density of the biomass briquettes was 60% higher in comparison to the tea waste and this is attributed to the high pressure compaction that was attributed to the bio char during densification to produce the briquettes. In addition, the fixed carbon increased from 18.9% to 42.6% (Table 1) and this was attributed to the increased carbon content during the carbonization process.

Table 1. Tea waste and the biomass briquettes characteristics

Parameter	Tea waste	Biomass Briquette
Moisture	12.9%	6.4%
Ash content	3.7%	1.6%
Calorific value	14-16 KJ/kg	22-26 KJ/kg
Fixed carbon	18.9%	42.6%
Density	0.7 g/cm^3	1.2 g/cm^3

3.2 Effect of process parameters

3.2.1 Effect of particle size

The accepted particle size for the bio char for biomass briquetting is less than 8mm (Grover and Mishra, 1996). Increase in the bio char particle resulted in decreased ignition rate for the biomass briquettes. This is because it will take time for the bio char particles to lighten up. Biomass briquettes with particle size of less than 1mm burnt for a longer time of around 20 minutes as compacted to those with particle size of around 8mm. Smaller particles of the bio char promote increased densification of the bio char making the briquette to last longer during burning.

3.2.2 Effect of moisture content

Increased moisture content in the tea waste briquettes resulted in increased ignition times, lowering the burning rate of the briquettes. Ideal moisture content for optimal briquettes performance must be less than 10% (Maninder *et al*., 2012).

4. Conclusion

Tea waste has potential to be converted to biomass briquettes for use as an alternative energy for larger domestic and industrial use. The biomass briquettes can provide an alternative source of energy to fire the boiler or be used as a co-firing media with coal.

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