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Experimental Analysis of Briquetted Agro Waste for Gasification

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***Abstract*—The increase in energy consumption is attributed due to technological advancements and population growth. Due to the high energy demand, various research is been carried out to for bringing alternate sources of energy with promoting sustainable development. Bioenergy provides a viable option for overcoming the energy demand by utilizing the biomass sources available. The biomass gasification process involves conversion of solid biomass into producer gas, the efficiency of the process depends on the type and composition of biomass feed been used. Briquetting of the agro waste materials facilitates ease of transport and storage and provides better combustion properties than agro waste in its original form. In this paper the agro waste such as coir pith and sawdust are briquetted and been processed for gasification process. The characteristics of briquetted agro waste material and suitability for gasification is investigated.**

Keywords—Briquetting, Agro-waste, Gasification

I. Introduction

The need for alternative and environmentally friendly energy sources are increasing with population growth and environmental sustainability goals. The meet the targets of sustainable development, the developed and developing countries are focussing on developing infrastructure based on renewable energy sources. [1] Energy from organic biomass is one of the alternate sources of energy been popular in rural areas for energy supply. The energy extracted from biomass feedstocks are been utilized for electricity generation, heat recovery, liquid fuel extraction etc. and possess an ideal alternative for different sectors. [2]. Studies carried out in previous research implies, due to barriers in economical, technological and infra related the municipal solid wastages (MSW) are not been managed in efficient manner and still lies for scope for improvement.[3] According to data provided by international energy agency, the MSW production in India and China shows incremental levels. The estimated MSW production for year 2023 also indicates sharp increase in the MSW production. [4]. The increasing MSW has to be properly managed and can be utilized as source for energy generation. The utilization of the biomass energy plays a significant role in achieving sustainable development goals as it facilitates economic development. The problems associated with the utilization of fossil-based fuels such as coal, oil results in carbon di oxide emission which can be lowered with the biomass energy [5].

With agriculture been predominant area in most parts of world, as it directly related to food supply, the agro based wastages also form large volume requires proper management for energy requirement. Agricultural wastages include the end and by product such as straw, bagasse, shells, husk etc. These agricultural wastages in most conditions been left unmanaged. The potential of utilizing these wastages for energy generation can be achieved by utilizing various techniques such pyrolysis gasification in case dry biomass and anaerobic fermentation for wet type of biomasses. Moreover, the agricultural wastages are also been utilized as biosorbents for waste water treatment around the world. [6] From the report of Indian Ministry of New and Renewable Energy, India accounts one of the higher amounts of agricultural residual. [7]. Moreover, the opening burning of crop residues results in release of carbon di oxide to the environment contributing towards global warming. Open burning of residual crops in rural areas. These mass burning leads to lower waste generation in rural areas comparing to urban areas in India. With proper management of these agricultural residual wastages, a great potential of alternative energy source can be formulized. [8]. Biomass as alternative energy source has shown promising results by considering the positive impacts they bring towards sustainable environment with lesser emission. Co-gasification of biomass particles, including waste biomass through thermo chemical energy conversion technique requires sophisticated infrastructure, can be optimized to avoid issues related to co-gasification.[9] Biomass to energy through gasification results in production of syngas which can be utilized for varying applications including power generation through gas turbine, operating engines, boilers etc. With different gasifier design, the optimized performance and efficiency can be achieved for varying feedstock materials. [10] Briquetting is one of the methods utilized for making loose biomass particles into solid biomass product. The density of the loose particles was densified by applying external pressure [11]. Briquette binder utilized during the production of briquette is one of the responsible factors the quality of output. With different material are been briquetted, an appropriate organic or inorganic binder need to be selected and used. The selection of the binder is important as it tend towards the ash content, stability and strength. With availability of both organic and non-organic binder available, proper binder should be selected based on considering cost, ease of availability, properties they provide etc. [12] In Recent research, the concept of binderless briquettes is also been examined and had shown promising development. [13] One of the important parameters contributing towards efficiency of briquetting is raw material particle size. In most cases the materials are been chopped as it is directly improving the product quality. Study carried out implies the mixed materials better properties than comparing to normal uniform sized materials. The mixed materials results in better product density with lower energy consumption. [14] Moisture content also have significant importance in determining the efficiency of the process. The optimized moisture content for ideal briquette is 10-18 %. Incise of non-optimized values, the resulting briquette is with poor in bonding and breakdown into pieces. [15] The objective of the work is to experimentally analyse the suitability of briquetted biomass for gasification process.

II. Methods and Materials

The Agro-waste materials Saw dust, Coir pith and mixture of saw dust and coir pith in ratio of 1:1 are briquetted and investigated for gasification process suitability. The briquetting process involves removing the moisture content by drying them in the open atmosphere. Then the dried material is feed into the hopper of briquetting machine. The feed material enters the cold chamber through the screw. With continuous input of feed material, pressure builds in the die section and loose feedstock is formed into shape of die. The shaped briquette is heated at 3500C to 400 0C for retaining the briquette shape. The Process of briquetting shown in Figure 1.

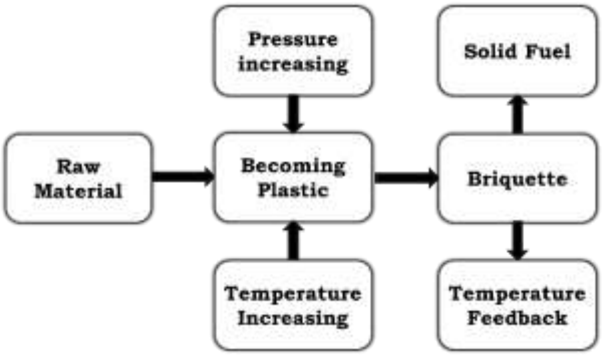

Fig. 1. Briquetting Process

Fig. 2. Briquetting Machine

The briquetting machine is equipped with 50 hp induction motor capable of rotating at 1400 rpm. Screw material is made from E.N.32 with length of 395 mm, outer diameter of 52 mm. The length of die is 78 mm with external diameter of 85 mm and internal diameter of 62mm. Pulley and V belts are employed for power transmission and the hourly consumption of electricity is 0.15 kW. The briquetting machine used for conducting the experiment is shown in Figure 2.

III. Result and Discussion

The ASTM standards D3172- 75 modified procedures recommended for volatiles (sparking fuels) is used for the proximate analysis. The three feed material samples were prepared to get the most representative samples in accordance with ASTM D 2013-86 by making use of power tools. A muffle furnace was employed for carrying out the proximate analysis. An analysis is carried out on these materials and suitability for gasification process is evaluated.

A. Moisture Content

The moisture content in the briquette sample is measure by utilizing a drying oven, as the samples were taken in crucible and measured for its weight compared to sample been subjected to temperature of 110 + 5oC for one hour. The percentage of moisture in the samples can be determined using the following equation.

$$\text{Moistute content} = \frac{\text{Intial Weight of sample} - \text{Final weight of sample}}{\text{Intial Weight of sample}} * 100$$

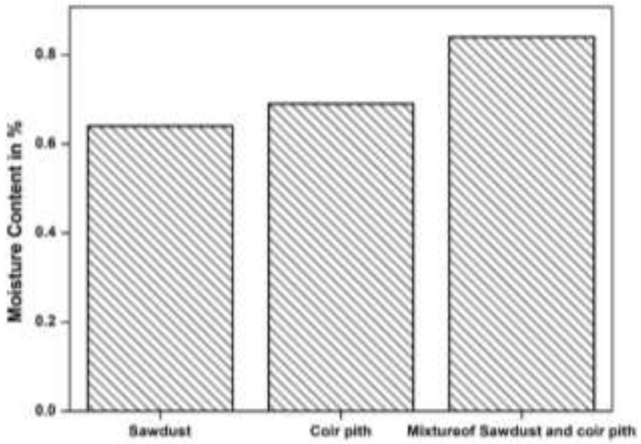

Fig. 3. Moisture Content

The moisture content of the saw dust 0.64 % coir pith is 0.69 % and mixture of these two are 0.84 % shown in figure 3. With 0.84 % of moisture content the briquetted material possesses good bonding and integration.

B. Ash Content

The ratio of the weight of ash and weight of original sample is measured to calculated the ash content. Material usually with lower ash content are preferred for gasification. For measurement of ash content, the dried samples resulted from moisture content analysis were subjected to 750oC in furnace for two hours. The sample subjected to high temperature for a prolonged time resulted in ash as carbon and volatile matters gets oxidized. The ash is calculated by using the formula.

$$Ash\ Content = \frac{weight\ of\ Residue\ sample}{Weight\ of\ Dried\ Sample} * 100$$

The ash content of coir pith, saw dust are higher comparing to mixture of coir pith and saw dust shown in figure 4. With lower ash content, the mixture provides a suitable feedstock for gasification.

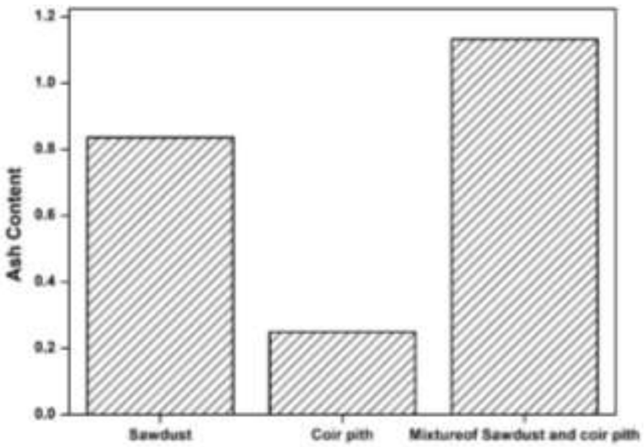

Fig. 4. Ash Content

C. Fixed Carbon

Fixed carbon refers to remaining solid residue after expelling of volatile matter on heating. The fixed carbon content is calculated by using the following formula.

$$Fixed\ Carbon = 100 - [Moisture\ content\ \% + Ash\ content\ \% + Volatile\ matter\ \%]$$

The fixed carbon % of saw dust is 97.36 % , coir pith is 98.48 % and mixture is 96.92 % shown in figure 5.

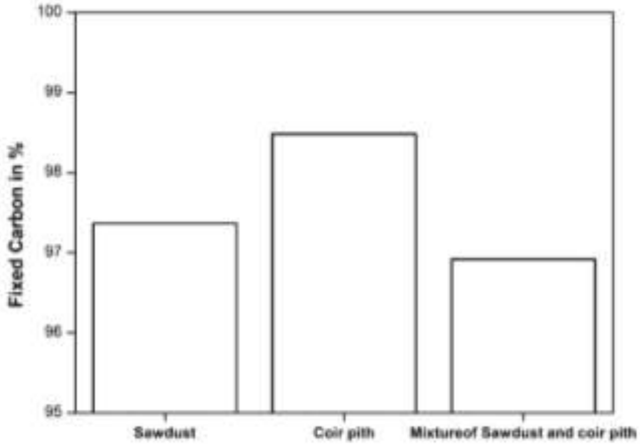

Fig. 5. Fixed Carbon %

D. Volatile Content

Feedstock with higher volatile content is preferred for gasification process. For determining the volatile content, the dried samples in closed crucible were subjected to 950 o C for 7 minutes and allowed to cool. The weight of dried sample is compared to sample after been heated. The volatile content is given by formula.

$$Volatile\ Content = \frac{Intial\ Weight\ of\ sample}{Final\ weight\ of\ sample}$$

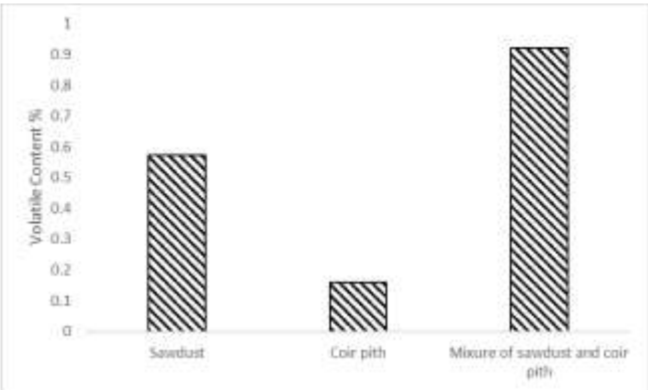

Fig. 6. Volatile content

The figure 6 shows the agro waste material such as sawdust, coir, mixed ratio briquettes, the volatile content of the coir is 0.571%, sawdust0.16% and mixture briquettes with ratio of 50:50 is 0.92% the mixed ratio briquettes are having more volatile content when compared to another briquette.

E. Cost

The cost associated with power consumption, labor associated charges, maintenance cos and raw materials are considered. Based on the analysis the cost of raw material saw dust is on higher side and mixture of saw dust and coir pith are found be optimized. The maintenance cost is independent of the feed material.

IV. CONCLUSIONS

The efficient management of the agro-residues and wastages can be by done by utilizing them for energy generation by various techniques. Based on the proximate analysis, the coir pith has higher heating value of 36.307 MJ/Nm3 and fixed carbon content of 98.4 %. The sample with mixture of both saw dust and coir pith in equal ratio has moreover the same heating value of 36.104 MJ/Nm3 which is in par with coir pith and saw dust value. Moreover, the fixed carbon is 96 .9 %. The economic aspects of the utilizing the mixture also proven to be cost effective comparing to utilizing the feed materials in their own forms. The mixture of saw dust and coir pith in 1:1 ratio can be suggested for gasification process for power generation.

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