Physical Characteristics of Agro Solid Fuel From Sorghum Stem – Straw Using Wheat Starch

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Abstract: - The use of agricultural wastes is a practical and appealing solution for reducing pollution and reversing the overexploitation of fossil resources. The use of fossil fuels has expanded dramatically in recent years, resulting in a pair of critical issues: depletion of a finite supply of fossil fuels and rising pollution, both of which have substantial repercussions. Biomass densification can help with dealing, shipping, and storage issues, as well as automating the loading and unloading of road transportation and storage solutions. The purpose of the research is to identify the physical characteristics of agro solid fuel from Sorghum stem – Straw with wheat starch. The binding agent was 10% (w/w) wheat starch, and the briquettes were made utilising a compressed hydraulic system with a 90-second dwell time at low compaction pressure (250kN). The mix ratios of Straw and sorghum stem solid fuels were 0:100, 20:80, 40:60, 50:50, 60:40, 80:20 and 100:0. The physical characteristics includes shattered index, colour, diameter, mass, height, density, volume, relaxed density, density ratio, texture and relaxation ratio were determined using ASTM standards. The physical qualities of these wastes showed that they might be used to make briquettes for use as fuel in a variety of purposes, primarily storage and transportation.

Key-Words: - Biomass Briquitte, Sorghum stem – straw, Wheat starch and Physical characteristics, Waste to wealth

1 Introduction

A briquette is a flammable material that serves as a heat source and starter. Briquettes are then created from various elements such as ash, garbage, and so on. Briquettes created from agricultural wastes will be a low-cost, no-cost, self-made product that lowers pollution in the environment. It has a high calorific value and is employed in the country's domestic fields. Low bulk density briquettes aid in efficient burning, save storage costs, and can withstand lengthy transit distances. We can refine carbon emission, density, and calorific value using equations from various analyse [1]. There are two types of energy sources in the world: renewable and non-renewable. Non-renewable energy sources, such as kerosene, diesel, and other types of fuels, can be substituted with a good by-product briquette [2]. Recycling Africa's rich agricultural wastes into solid fuel will not only save the environment from a variety of health conditions, but it will also improve the energy mix of these countries. Biomass briquettes can help mitigate the detrimental effects of climate change and greenhouse gases on the environment. [3]. Biomass fuels, such as wood, have gradually replaced coal for normal household stoves in many countries, to also reduce carbon emissions and because they are usually a more sensible solution. The widespread use of wood-derived fuels, on the other side, has put a huge strain on forest resources, as biomass accounted for about 10% of energy use in Europe in 2017. Biomass fuel is used in many countries [4]. Energy demand in India for domestic and industrial uses is influenced by the country's population; if the people is more, the demand will be larger; if the population is less, the demand will be lesser. People will keep living with their things. But, India has a growing population and is the world's second largest country, with rapidly increasing demand in urban areas of the industry [5]. When comparing the energy demands of China and India, it is clear that both countries will face future issues as a result of such changes. In China and India, single linear and hybrid linear approaches are employed to increase energy demand consumption [19]. The acceleration of globalization leads to decline in energy demand in India. Economic growth and urbanization are the key factor leading for increasing energy demand in India [20]. Briquette is a fire hazard that functions as a heating element and starter. Briquettes then are made from various materials such as ash, waste, and etc. Lump charcoal created from agricultural wastes will be a high, no-cost, self-made product that lowers pollutants. It has a high calorific value and is employed in the country's domestic fields. The unit weight of the material [6]. Briquette characteristics, after the briquettes are produced, they are placed under the characteristics for briquette usage. Density, moisture content, ash content, volatile matter, fixed carbon, and heating value are the aspects to consider. Then it can be used as a combustible material and kindling fuel to start a fire. Biomass briquetting is controlled by feed parameters that influence the extrusion process. These feed parameters, such as particle size, moisture content, density, and compressive strength temperature, differ between briquetteing machines. Briquette hardness, and hence briquette quality, can be evaluated through a water test, where a quality briquette should rapidly sink to the bottom due to its higher specific density than water. [7]. The physical properties which are involved in density, density ratio, relax density, relaxtion ratio and shattered index. Briquettes have the advantage of becoming inexpensive and easy to store and transport. It is a self-made product that is the best replaceable product and a sustainable energy source compared to other fossil fuels. It emits less carbon dioxide than coal and other fossil fuels and has a high calorific value. It generates no smoke and helps reduce waste. It helps to prevent deforestation. There are several corps reeds in China, and that they have detailed cost rates for rural and resource purposes, and also different cost rates in bar graphs [9]. The use of fossil energy is hampered by price increases, decreasing oil reserves, and greenhouse gases. The use of renewable resources that can be used to produce energy again and again, such as solar energy, renewable power, biomass energy, geothermal energy, agriculture waste, and so on, has prompted the expected crises of increasing energy demand and environmental issues [8]. These briquettes, which are produced from agricultural waste, can be used in a variety of heating and electricity production applications. Boiler units, Industries, Pharmaceutical industry, Brick kilns, Oil mill, Cooking, Dyeing industry, Power plant, and Paper mill are all examples of replacements for firewood.

2 Methods and materials

- Straw
- Sorghum stem
- Wheat starch

2.1 Straw

Straw waste is material which is seems more in India. We collected from Namakkal district, and the latitude and longitude are 11.3263, 78.2431. Mostly straw are used in agricultural side. There are so many straw like rice straw, wheat straw and paddy straw etc.

Fig 1, Straw waste

Straw sizes were found to affect the methylmercury (MeHg) accumulation in rice grains induced by straw incorporation. The mechanism behind, however, still remains unclear. Here, we incorporated rice straw in different sizes into a Hg-contaminated paddy soil [13]. Agricultural residues, mainly cereal straws, are generated globally in a great amount. Utilization of straw doesn't compete with human food, land or feed [14].

2.2 Sorghum stem

Sorghum stem is material which is collected from Namakkal district, this also mainly used in village sides for agricultural waste. The latitude and longitude of the material is 11.3263, 78.2431NE

Fig 2, Sorghum stem

The sweet sorghum plant is a plant with a high photosynthetic efficiency. It is a common sorghum variety with high biomass production, extensive adaptability, excellent resilience to salinity/alkalinity and drought, and one of the greatest dry matter accumulation rates on a daily basis when compared to other species [9]. Grasses are the most productive and commonly produced crop family on the planet, but they are prone to structural breakdown (lodging) when subjected to mechanical stress [10, 23]. Sweet sorghum is a promising alternative sugar crop for ethanol production because its stalks are abundant in fermentable sugars (fructose, glucose, and sucrose) that can be fermented straight to ethanol [11]. Energy sorghum that comprises both sweet and biomass varieties, produces more leaf and stem biomass than grain sorghum, making it an ideal candidate feedstock crop for biofuel production [12].

2.2 Wheat Starch

Wheat starch is used as a binder, where binder can be solid or liquid. Where we collected ½ kg of wheat flour and mixed with boiling water and stirred for 30 mis until the thick condensed stage is arrived, where preparation of wheat starch is shown below. Binder is a liquid or solid that initiates a chemical reaction to form a strong interparticle connection [15]. Binders can improve particle adherence, compressive strength, abrasion resistance, and energy content in densified biomass, such as briquettes. They may also cut the energy cost of creating such briquettes by lowering the compaction pressure, conditioning temperature, and equipment wear [16,22]. As a binder, starch is used. The greater carbohydrate content would improve the quality of the densified products. Pregelatinized starch is preferable to raw starch [17].

3 Result and Discussion

3.1 Density

By measuring all of the briquette samples and calculating the size with a vernier, determine the density of the briquettes using the weighting balance. use $\pi r^2 h$ to find the volume, and the following formula to calculate the density.

$D=M1/V1$

Where D, M1 and V1 are denoted as the denoted as the density, mass and volume of briquettes respectively.

3.2.Density ratio

The density ratio is calculated as the difference between the relaxed and maximum densities.

$DR=R1/M2$

Where, DR, R1 and M2 is denoted as density ratio, relaxed density, and maximum density of the briquettes respectively.

3.3.Relaxed density

Relaxed density, also known as spring back density [ASTM] which is defined as the density of briquettes obtained after the briquettes mass remain stable. The output of the mass (relaxation phase) is divided by the total mass volume of briquettes.

$RD=M2/V2$

Where, RD, M2 and V2 is denoted as weight of the sample after drying and volume of the briquettes.

3.4.Relaxtion ratio

The relaxation ratio was determined by using the following equation,

$RR=MD/RD$

Where RR, MD, RD is denoted as relaxation ratio, density of the briquette relaxed density of the briquette.

3.5.Shattered index

This property is calculated in accordance with ASTM D440-86 (21). The procedure involves measuring and recording the initial mass, and then allowing the sample to fall from a constant gravity height of 1m. Every time the sample was passed through the filter (<2.36 mm), the dripping was replicated three times, whereas the mass of the clumps remaining on the screen was registered.

The shatter index is determined using the following formula for each briquette.

SI= [BTW (after shattering) / BTW (before shattering)]*100

Where SI, BW, BTW and are specified as the shattered index, briquettes weights and charge of briquettes weight for all the sample.

3.6 Samples of Produced Biomass Briquettes

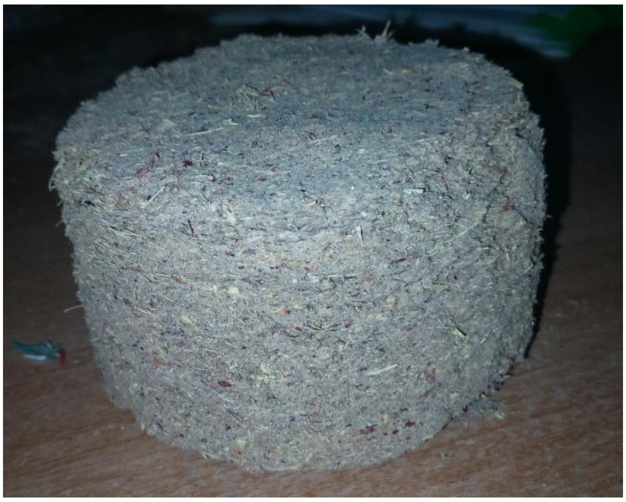

Fig 3, Mix ratio-80:20

Table 1, Physical properties of Sorgam stem and straw

Samples	Ratio	Parameters						
		Height (mm)	Volume (m^3)	Density (kg/m^3)	Mass (g)	Texture	colour	Diameter (mm)
S1	0:10	52	0.26	765.5	200	Rough	Brown	40
S2	20:8	53	0.26	751.1				
S3	40:60	50	0.25	796.17				
S4	50:50	54	0.27	737.20				
S5	60:40	55	0.27	723.79				
S6	80:20	52	0.26	765.55				
S7	100:0	50	0.25	796.17				

Table 2 : Physical properties of Sorgam stem and straw with Density Evaluation

Samples	Parameters			
	Relaxed Density (kg/m3)	Density Ratio	Relaxation ratio	Shattered Index (%)
S1	764.99	0.999	1.001	95.21
S2	743.18	0.989	1.011	96.10
S3	791.84	0.994	1.005	97.25
S4	725.74	0.984	1.016	97.84
S5	712.79	0.984	1.015	97.35
S6	754.87	0.986	1.014	97.31
S7	795.46	0.999	1.001	97.62

In the above table 1, we found the physical properties of biomass briquette like height, volume, density, mass, texture, colour and diameter. Where S1 to S7 are samples taken. The mass, texture, colour and diameter of the briquette are same and the height, volume and density may differ. The density of the briquetting process is a crucial metric to consider. In terms of transportation, storage, and handling, higher density means a higher energy/volume ratio, which is desired. The density of bio waste briquettes is determined by the original bio waste density, briquetting pressure, and, to a degree, briquetting temperature and duration [8]. In the table 2, shows the value of the physical properties of briquette such as relaxed density, density ratio, relaxation ratio, shattered index, which has different value. The shatter index was calculated by dropping each briquette onto a steel plate from a height of 1.8 m and measuring the percentage of sample retained on a sieve with a 20 mm hole. This process was continued until all briquette components had passed through the sieve. The shatter index of the briquette is the total of the percentages [18].

4. Conclusion

At last, we shown the energy demand, physical characteristics, application and advantages of biomass briquette. Where density has minimum value 723.79 kg/m3 and maximum value 796.17 kg/m3. Height of the minimum value of the sample is 50mm and maximum height is 55mm. Relaxed density has minimum value 712.79 kg/m3 and maximum value 795.46 kg/m3. Shattered index has minimum value 95.21 % and 97.84%. Density ratio of minimum value of the sample is 0.984 and maximum value is 0.999. Relaxation ratio of the minimum value of the sample is 1.001 and maximum value is 1.015. In the table 1, all the samples has mass is 200g, and colour of all samples are brown in colour. Where the texture of all sample are rough and diameter of all the samples are 40mm. Briquettes are made with a cylindrical mould and a UTM machine that produces 250kN of pressure. After extensive testing and analysis, briquette has proven to be a useful and renewable source of energy as well as a blessing to the environment; farmers may profit from selling their agricultural waste using this briquette. It is used to cut down on the utilisation of non-renewable resources. It leaves no residue after being burned. The briquettes' size can be maintained. Finally the sample was ready, where taken by all the test and good in condition for burning.

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Manoj Shanmugamoorthi, Nirmal Krishnaswami has implemented the testing procedures
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