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Biomass Briquettes: A Sustainable and Eco-friendly Energy Option

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Abstract— Solid waste is a problem that must be properly managed. Hence Solid waste management is one among the basic services provided by municipal authorities in country that helps to protect human health ,environment and preserve natural resources from degradation due to production of green house gases and other harmful gases, toxic substances; contamination of soil, water and air. This paper addresses the use of biomass briquettes made from organic solid waste which is a sustainable and environment friendly energy option . In this paper, five kinds of biomasses i.e. agricultural waste, fruit waste, news paper, used tea powder, and sawdust were briquetted in different combinations with each other.

Keywords— Biomass; briquettes; Ecofriendly method; Sustainable energy option; Development of society; Cleanliness.

I. INTRODUCTION

Energy resources are classified into two, namely renewable and non-renewable. The renewable are thought to be a better option since the non-renewable such as kerosene, diesel, gasoline etc have the capability not to be replenished and would be exhausted. More so, the environmental impacts as a result of emissions of CO_2, SO_2, and NOx etc during combustion of the non-renewable resources prompted the use of renewable for cooking and heating purposes .Out of the renewable sources of energy, agricultural waste is one of the most versatile. Energy from biomass which includes agricultural waste has made the greatest contribution to national energy consumption in both developed and developing countries. Fuel is any material that can store energy and releases it through combustion[1] The modern way of life is intimately dependent on the use of fossil fuels. However, the increased consumption of nonrenewable resources may lead to the overproduction of carbon dioxide, which is one of the major causes of global warming. Excessive reliance on fossil fuels may cause it to be used up. The use of fuel made from biodegradable wastes is ideal, since it recycles agricultural residues .Also the principles of solid waste handling include many methods, such as incineration, sanitary landfills, and municipal waste composting. However, incineration and sanitary landfills have adverse environmental impacts. Thus, nowadays the focus of solid waste handling is to reduce the quantity of solid wastes. Composting of municipal waste is a widely used method, but it involves the subsequent handling of rejected material. The rejected material consists of a large amount of resistant organic matter that cannot be transformed in the composting process and must be disposed off[2] Therefore, if it can be utilized to produce beneficial things such as solid fuel briquettes, it will significantly reduce unnecessary use of landfills. Biomass is defined as organic products of the agriculture and forestry systems developed to provide food, fuel, and organic matter captured in sewage and waste treatment facilities. Biomass is currently the largest renewable source of energy globally and accounts for a significant share (normally 20–40%) of the total energy consumption in developing countries. Waste biomass can be made into a usable fuel form by densification. These biomasses can replace some coal in power plants, which reduces carbon emissions and greenhouse gas effects. The process of residue compaction into a product of greater density than the original raw material is known as densification or briquetting [3].Fuel briquettes are essentially a thick, compressed disk of organic waste materials, shaped into blocks used for cooking and/or heating. They are often used as a development intervention as a replacement for firewood, charcoal, or other solid fuels. Depending on materials used to make the briquettes, they may burn cleaner than charcoal and firewood. Briquettes production thereby turns waste materials into fuel source. This is therefore attractive because it is a sustainable process.

Briquette making has the potential to meet the

additional energy demands of urban and industrial sectors, thereby making a significant contribution to the economic advancement of developing countries. Besides, briquettes have advantages over fuel wood in terms of greater heat intensity, cleanliness, convenience in use, and relatively smaller space requirement for storage [5]. The purpose of this research is to provide an alternative fuel for heating using biodegradable wastes may actually be converted into useful fuel briquettes.

II. NEEDS

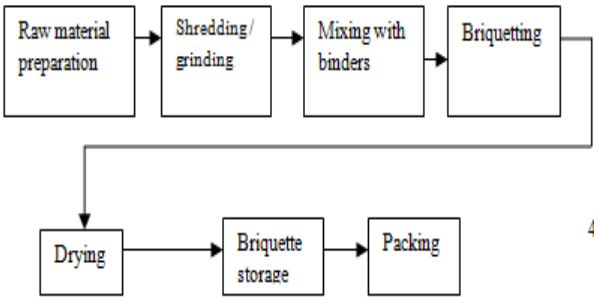
1. To look forward for the better environment by using organic solid waste.
2. The goal of cleanliness can be achieved by reducing the solid waste.
3. It prevents the non renewable sources like oil, kerosene etc from getting exhausted.
4. Using renewable sources for the energy we can maintain the balance in the environment.
5. It utilize the raw waste material for ecofriendly energy option.

III. OBJECTIVE

1. India is heavily dependent on imported oil. To decrease this dependency, it is necessary to develop indigenous energy resources.
2. To bring out the development of the country, use the biomass as alternative sources of energy.
3. To enhance the living standard of society by application of 3 R's that is recovery, recycle and reuse to the waste products.
4. To verify the efficiency of renewable material for an ecofriendly and sustainable alternative for energy sources.
5. To protect the environment by using organic deposits.
6. To generate useful energy source from non useful biowaste.

IV. METHODOLOGY

Briquette making process involves preparation of raw materials which includes sorting, chopping and drying. The prepared raw materials are then subjected to grinding. Shredding might be required depending on the waste being processed. These ground materials are then coated/ mixed with a film of binders usually starch or fevicol to enhance adhesion and produce uniform briquettes if required. In case of lignin rich biomass waste, there is no need to use binders since lignin liquefies during carbonization and acts as natural binder. The briquettes usually contain about 10% of binder and about 30% of water before drying down to about 5% moisture content. This mixture is then transferred into a briquettizer / molder which form uniform-sized briquettes. The calorific value is then determined by using the bomb calorimeter. These are then sun-dried and packaged



V. MATERIALS

A)Preparation of briquettes from :

1. News papers

2. Saw dust

3. Used Tea waste

4. Fruit waste

5. Yard waste

B) Combinations for briquettes :
1. Only news paper
2. News paper and sawdust
3. News paper and tea waste
4. Fruit waste and sawdust
5. fruit waste and yard waste

VI. PROCEDURE OF BRIQUETTING

1. Only Newspaper Briquettes-
   a) Quantity : 75 gram
   b) Cutting of paper in to small pieces and soak them in to suitable amount of water for 3 days. Then making paper pulp by grinding it.
   c) Hand press the paper pulp and remove extra water .Give the shape by hands.
   d) Dry the briquettes by natural drying

2. News Paper And Sawdust Briquettes-
   a) Quantity : wt. of news paper = 125 gram and wt. of sawdust 375 gram
   b) Ratio = 1/3 resp.
   c) Cutting of paper in to small pieces and soak them in to suitable amount of water for 3 days.
   d) Then making paper pulp by grinding it.
   e) Mixing of paper pulp and sawdust. Add some water if required for mixing.
   f) Take a mould and give a shape to mixed material by hand press. And removed excess water.
   g) Dry the briquettes by natural drying.

3. News Paper And Tea Waste-
   a) Quantity: wt. of paper = 75 gram and wt. of tea waste 250 gram and Ratio = 1/3 (aprox.)

4. Fruit Waste And Sawdust-
   a) Quantity: wt. of fruit waste = 400 gram and wt. of sawdust 100 gram
   b) Ratio = 4/1 resp.
   c) Make pulp from fruit waste by grinding it. Mix it with sawdust.

5. Fruit Waste And Yard Waste-
   a) Quantity: Wt. of fruit waste = 250 gram and wt. of yard waste= 125 gram
   b) Ratio = 2/1.

VII. TESTING FOR CALORIFIC VALUE USING BOMB CALORIMETER

Calorific Value - one of the most important characteristics of a fuel is its calorific value, that is the amount of energy per kg it gives off when burnt. The amount of heat released by a unit weight or unit volume of substance during complete combustion is called calorific value of fuel. The calorific value can thus be used to calculate the competitiveness of a processed fuel in a

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given market situation. There is a range of other factors, such as ease of handling, burning characteristics etc., which also influence the market value, but calorific value is probably the most important factor and should be recognized when selecting the raw material input. There are two types of calorific values as follows-

1] Higher or gross calorific value (HCV)
2] Lower or net calorific value (LCV)

In general, L.C.V. = H.C.V – Latent heat of water.

Bomb Calorimeter is used to measure the calorific value (CV) of solid as well as liquid fuel. The heat energy measured in a bomb calorimeter may be expressed either as calories (cal), British thermal units (Btu) or Joules (J).

1 cal = 4.1868 Joules

Time (min)	Temp. (°c)				
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
0	00	00	00	00	00
1	1.10	0.88	0.6	1.19	0.70
2	1.47	1.2	1.25	1.5	1.17
3	1.56	1.36	1.4	1.72	1.30
4	1.69	1.42	1.52	1.83	1.41
5	1.85	1.55	1.59	1.96	1.47
6	1.94	1.59	1.65	1.97	1.52
7	2.02	1.63	1.71	1.98	1.55
8	2.09	1.65	1.73	1.98	1.57
9	2.11	1.65	1.74	1.98	1.57
10	2.12	1.65	1.74	1.97	1.57
11	2.12	1.65	1.74	1.96	1.56
12	2.12	1.64	1.74	1.96	1.55
13	2.12	1.63	1.74	1.95	1.54
14	2.11	1.63	1.73	1.94	1.54
15	2.11	1.62	1.73	1.93	1.53
16	2.10	1.62	1.72	1.93	1.52
17	2.09	1.61	1.71	1.92	1.51
18	2.08	1.59	1.71	1.90	1.49

1 Btu = 1055.06 Joule
1 Btu = 251.996 calories

Here ,

Sample 1 : Fruit pulp and Sawdust briquette
Sample 2 : Sawdust and Newspaper briquette
Sample 3 : Used tea powder and Newspaper briquette
Sample 4 : Only Newspaper briquette
Sample 5 : Fruit pulp and Yard waste briquette

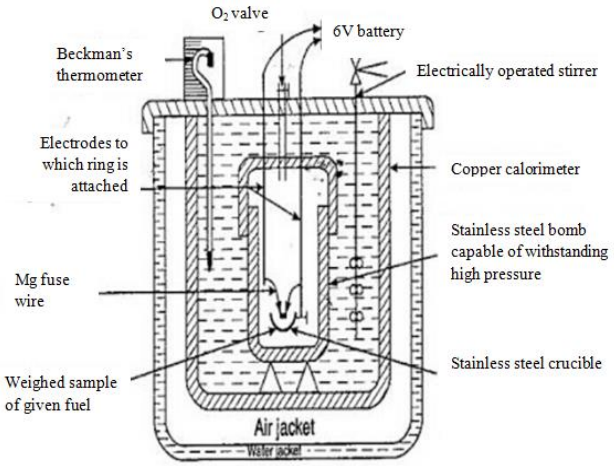

Fig. Schematic sketch of a bomb calorimeter

VIII. WORKING OF BOMB CALORIMETER

To start with, about 1 gm of fuel sample is accurately weighed into the crucible and a fuse wire (whose weight is known) is stretched between the electrodes. It should be ensured that wire is in close contact with the fuel. To absorb the combustion products of sulphur and nitrogen 10 ml of water is poured in the bomb. Bomb is then supplied with pure oxygen through the valve to an amount of 25 atmospheres. The bomb is then placed in the weighed quantity of water, in the calorimeter. The stirring is started after making necessary electrical connections, and when the thermometer indicates a steady temperature fuel is fired and temperature readings are recorded after 1 minute intervals until maximum temperature is attained. The bomb is then removed; the pressure slowly released through the exhaust valve and the contents of the bomb are carefully weighed for further analysis. The heat released by the fuel on combustion is absorbed by the surrounding water and the calorimeter. Table shows Temperature variation with respect to time.

Time Vs. temperature for the each sample

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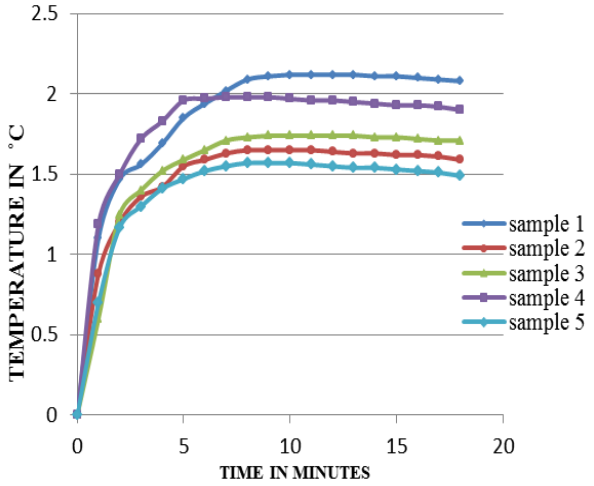

IX. CALCULATIONS FOR CALORIFIC VALUE

Following formula is used to calculate calorific value of briquette samples:

$$\text{Calorific value, C.V.} = \frac{(W+We)*C*(t_2-t_1+t_c)}{m}$$

Where,
W= water equivalent of bomb calorimeter= 545.43gm.
We = 2000 ml
t2 = Final temperature of water and calorimeter
t1 = initial temperature of water and calorimeter i.e. 0◦c .
tc = radiation corrections, 0.02
c = specific heat of water.
[Value of c is 4.18 in SI units and unity in MKS units]
Δt = t2 – t1
m= unit mass of sample, 1 gram
Calculating .C.V using above formula, we obtained following results –

Examples of calorific value (cal/kg) and ash percentage of major agro wastes briquettes available:

Table. Calorific values of briquettes

Agro Wastes	Cal./kg.	Ash Contents
Groundnut shell briquettes	4524 k.	3.80%
Paper briquettes	**4841 k.**	**1.5%**
Palm kernel briquettes	4985 k.	2.0%
Papyrus briquettes	3965 k.	5.6%
Bagasse briquettes	4380 K.	1.80%
Castor seed shells briquettes	3862 k.	8.00%
Sawdust Briq briquettes	**3898 k.**	**8.20%**
Cotton stalks/chips briquettes	4252 k.	3.00%
Bamboo dust briquettes	4160 k.	8.00%
Coffee husk briquettes	4045 k.	5.30%
Tobacco waste briquettes	2910 k.	31.5%
Tea waste briquettes	**4237 k.**	**3.80%**
Paddy straw briquettes	3469 k.	15.5%
Wheat straw briquettes	4100 k.	8.00%
Sunflower stalk briquettes	4300 k.	4.30%
Jute waste briquettes	4428 k.	3.00%
Palm husk briquettes	3900 k.	4.90%
Soya bean husk briquettes	4170 k.	4.10%

I. ADVANTAGES

1. They are one of the alternative methods available to reduce consumption and dependency on fuel wood.
2. Densified fuels are easy to handle, transport, and store.
3. Briquettes are uniform in size and quality.
4. The process helps to solve the residual disposal problem.
5. Briquettes are clean to handle and can be packed in bags for ease of handling and storage.
6. Briquettes are usually produced near the consumption centers, and supplies do not depend on erratic transport over long distances.
7. The technology is pollution-free and environmentally friendly.

Sr. no	Name of sample	Max. temp. t_2 (◦c)	C.V. (Cal/gram)
1	Fruit pulp and Sawdust briquette	2.12	5446.94
2	Sawdust and Newspaper briquette	1.65	4250.69
3	Used tea powder and Newspaper briquette	1.74	4479.72
4	Only Newspaper briquette	1.98	5090.60
5	Fruit pulp and Yard waste briquette	1.57	4047.03

8. The briquette is easy to ignite, burns continuously, and has a long burning duration.

9. The briquettes can be used for domestic purposes (cooking, heating, barbecuing) and industrial purposes (agro-industries, food processing) in rural and urban areas.
10. Indoor air pollution is minimized.
11. Briquettes produced from biomass are a reasonably good substitute for coal, lignite, and firewood.
12. Briquettes are cheaper than coal, oil, or lignite.
13. There is no sulfur in briquettes.
14. Briquettes have a consistent quality, high burning efficiency.
15. There is no fly ash when burning briquettes.
16. Briquette combustion is more uniform than coal combustion.
17. Unlike coal, lignite, or oil, briquettes are produced from a renewable energy source.
18. Loading/unloading and transportation costs are much less and storage requirements are drastically reduced.

X. APPLICATIONS

Briquettes are widely used for any thermal application where coal can be utilized i.e. steam generation in boilers, heating purpose etc. They are used as a flammable material in brick kilns, paper mills, chemical plants, distilleries, pharmaceutical units, dyeing houses, food processing units, oil mills etc.

Textile process houses	Dyeing, bleaching etc.
Agro-products	Tobacco curing, tea drying, oil milling etc.
Clay products	Brick kilns, tile making, pot firing etc.
Domestic	Cooking and water heating
Gasification	Fuel for gasifiers
Charcoal	Suitable for making charcoal in kilns

XI. RESULTS

Arranging the briquettes in descending order according to their respective calorific values, results are shown as follows-

1. Fruit pulp and Sawdust briquette has calorific value 5446.94 cal/gram.
2. Only Newspaper briquette has calorific value 5090.60 cal/gram.
3. Used tea powder and Newspaper briquette has calorific value 4479.72 cal/gram.
4. Sawdust and Newspaper briquette has calorific value 4250.65cal/gram.
5. Fruit pulp and Yard waste briquette has calorific value 4047.03 cal/gram.

XII. CONCLUSION

Briquettes made from materials that cost little or no money such as newspaper or partially decomposed plant waste or sawdust can be an alternate source of domestic and industrial energy to charcoal, firewood, gas, coal and electricity. In the proper context fuel briquettes can: save money, decrease local deforestation rates, and provide income generating opportunity. It gives ecofriendly environment to society.

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