Mrs.K.Vaidhegi, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 12, Issue 2, (Series-II) February 2022, pp. 23-30

RESEARCH PAPER OPEN ACCESS

Green Fuel Briquettes Using Municipal Solid Waste And Wood Industry Residue

[1]Mrs.K.Vaidhegi, [2]Ms.S.Sridevi, [3] Ms.D.Kousalya, [4] Ms.V.Anitha
[1]Assistant Professor, Department of Civil Engineering, Sri Sai Ram Engineering College, Chennai-44.
[2]UG Student, Civil Engineering, Sri Sai Ram Engineering College, Chennai-44.
[3] UG Student, Civil Engineering, Sri Sai Ram Engineering College, Chennai-44.
[4] UG Student, Civil Engineering, Sri Sai Ram Engineering College, Chennai-44

Abstract
This study examines the production of green briquettes for commercial use from municipal solid waste in combination with wood industry residue. Development of an alternative fuel for conventional fuel is the need of the day. Briquetting technology is a potential method to produce biomass fuel briquettes, which will facilitate global warming and use of coal as a major source of fuel. The Wastes are collected from household and wood processing industries. In this work extract of water hyacinth plant is used as the natural binding agent. The collected ingredients are crushed into grains which are less than 4mm using a crushing machine or cutting blades. The briquette material properties such as ash content, volatile matter, density, fixed Carbon, and calorific value were studied in the laboratory. From this study we conclude that briquetting technology using MSW, saw dust and natural binding agent is best way to effectively reuse waste as energy is the production of green fuel.

Keywords: Ash content, Briquettes, Calorific value, hyacinth plant, saw dust, Solid wastes, Volatile matter.

Date of Submission: 09-02-2022 Date of Acceptance: 23-02-2022

I. INTRODUCTION

Global warming and climate change is a major pivotal threat to the environment caused due to municipal solid waste (MSW). The waste generated all over the world is high in amount which leads to the major pollutants which causes harm to the living organisms' day to day. In India, about 68.8 million tons of MSW waste is generated per day in every way. If this continues, it will become a great challenge to our future. Most of the wastes are being dumped and which causes land and water pollution. As of now lots of materials used in our daily life (plastics, tyres, agricultural waste) remain as waste dumped in landfill which takes several years to decompose. More than one third, the non-recyclable plastics end up as waste landfills as waste. Plastics can take about more than 100s of years to degrade or break down . When dumped in landfills it takes up high volume of space and others end up in oceans, rivers, and other waterways. In major, the landfill consumed for dumping the wastes is high in area. Due to this the ground water gets stagnated, and the fertility of the soil is lost. At some point, the incineration of such Municipal hazardous wastes is done, which leads to ozone and acid rain.

In this study a substitute to reduce the pollution, GHG effect, Global warming, and reduction in area of landfill is to recycle and reusing the waste materials. When these materials are taken under several treatments, they can be used as an alternative for many resources. On the other hand, due to the rising cost and historical lack of electricity, heat energy for cooking is obtained from the combustion of fuel wood and coal.

To overcome such problems, Briquettes are manufactured using the municipal solid wastes, which can be used as a fuel for cooking and in several industries.

II. MATERIALS AND PROPERTIES

A. Materials Used:

The waste materials were collected from the dump sites, households, and industrial areas. The composition of waste materials differs from time and place. Combustible waste materials were segregated from the municipal solid waste. Materials such as composite plastic, wrapping paper, and non-recycled papers such as paper towels, toilet paper, and tissues, paper coated with plastic, waxed paper were also used as the raw material. To overcome the decomposition of paper into ground and production

of methane, which is a powerful greenhouse gas? Fig no. 2.1 shows the main ingredients used for production of Briquettes.

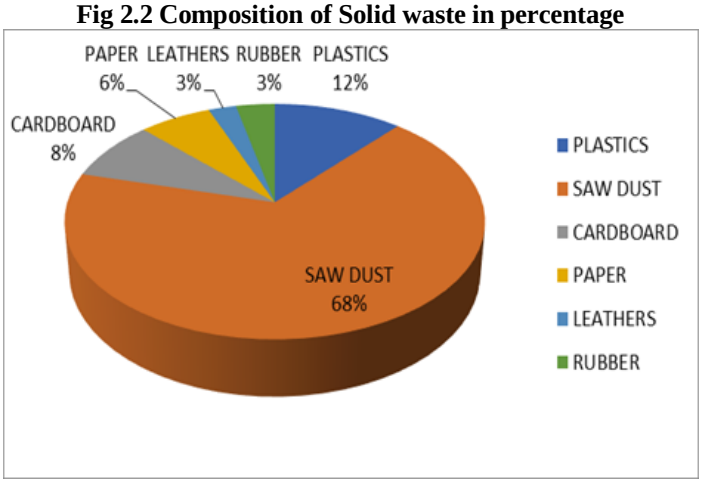
Fig. No 2.1 Waste Materials used for Briquetting

B. Composition of Solid waste:
The main solid ingredients used in briquettes and theircomposition are listed in below table 2.1.

Table 2.1 Material Composition

Materials	Composition in percentage	Weight in gram
Plastics	11.6	500
Saw Dust	67.5	1000
Cardboard	8.4	1000
Paper	6.5	1000
Leathers	2.5	500
Rubber	3.5	500
Total weight = 4.5 Kg		

Fig 2.2 Composition of Solid waste in percentage



C. Material Characteristics Study:
Waste materials were collected from different sources like household, commercial and industrial areas. The following characteristics study was carried out for the collected samples.

1.**Density:**
It is a defined as the measure of mass per unit volume. The average density of an object equals its total mass divided by its total volume. An material which is made from a comparatively dense material will have less volume than an object of equal mass made from some less dense substance

Density=Mass/Volume

2.Calorific Value:
It direct the physical properties of a substance, including density, weight, viscosity and others. It is generally determined by weight loss upon drying.

3.Ash Content:
Following steps were followed to determine the ash content of the raw materials.
Step 1: Crucible Preparation - Crucibles is placed in Oven for drying and maintain the temperature at 105o for 20 minutes. After 20 minutes drying the Crucible is taken out from the Oven and cooled in the Desiccator. Then the Crucible was ready to use for further analysis.
Step 2: Sample Preparation - The weight of the Blank Crucible noted. 2-6 g of sample was placed in the Crucible. The weight of the crucible was noted along with the sample. Then the sample was covered with the lid of the Crucible.
Step 3: Combustion / Burning – The sample containing Crucible was placed inside the furnace. The temperature was maintained at 700o C and set the time for 2 hours. After that time the crucible was pulled out from the furnace. Then, transfer to the desiccator for cooling if it is hot.
Step 4: Final Weight (After combustion) –Ashes were stuck in the crucible with whitish brown colour. Then the final weight of the crucible containing Ash was taken.

Ash content in percentage % = (W2 –W1) / Ws * 100
Where,
W1 = Weight of Crucible
W2 = Weight of Crucible with Ash Ws = Weight of Sample

4.Moisture Content Test:
Clean Glass Petri Dish (120mm in diameter) was placed in Oven for drying at 105o for about 20minutes. The Dish was taken out from the Oven and cooled in the Desiccator. After cooling 10g of samples were kept in the dish. Samples were put on Hot Air at 135oC for 2 hours. Then samples were taken out and the final weight of the dish with the sample was taken.

Moisture in percentage = {Ws – (W2-W1)} / Ws*100
where, W1= Weight of dish.
W2 = Weight of dish after drying. Ws = Weight of Sample.

5. Chlorine Content:
The Sample were acidify with an original solution with dilute nitric acid and pinch of silver nitrate solution (2g in 100ml distilled water was added in it ; kept the solution in the dark or in a brown flask).A white, flaky precipitate that dissolved again on the addition of an excess of ammonia indicated the presence of chlorine.

6. Volatile Matter:
The samples were kept in the oven for 5 to 7 minuts at 100 degree Celsius. Then the sample is taken out and cooled in a desiccator for Iso thermal cooling. The weight loss of the sample is denoted as A. Now the sample is to be heated in a furnace, the temperature is around 950-degree Celcius in 7 Minutes. Then the cooled sample was denoted as B.

Volatile Matter = {(A – B) / A} *100

7.Fixed Carbon: The Sample were placed in a crucible of known mass and oven-dried to constant mass, after which it was heated in the furnace at temperature of 600°C for 10 min. The volatile matter was then expressed as the percentage loss in mass to the oven dried mass of the sample.

Fixed Carbon = (Volatile matter + Moisture Content + Ash Content) - 100

The Characterization result values were listed in below table no 2.2.

Table No: 2.2 Physical and Chemical characteristics of collected waste materials

Sample	Ash Content (%)	Moisture Content (%)	Volatile Content	Fixed Carbon	Density (Kg/m^3)	Chlorine Content (%)	Calorific Value (KJ/Kg)
Paper	16.5	15	76	7.5	1.34	-	3220
Cardboard	17	19.8	80	16.8	689	-	2299
Saw Dust	0.8	22	75.82	15	402	-	4654
Leather	8.58	31.57	90	30.15	0.86	13	4336.31
Rubber	19	7	87	13	1.2	18	4684.01
Plastics	0.9	33	89	22.9	0.94	47	9787

III. METHODOLOGY

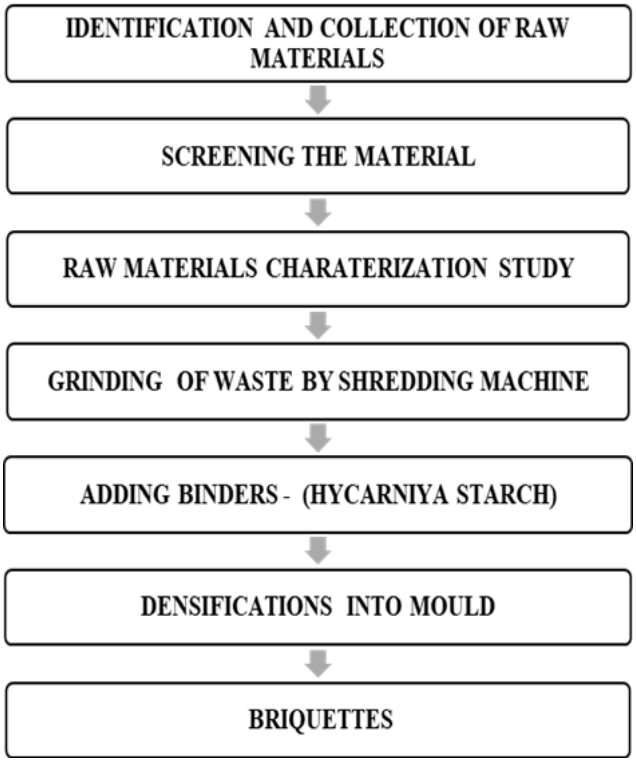


Fig 3.1 Methodology flow chart

The work has been initiated with the raw materials identification and collected by segregate the waste solid materials. Separation of raw materials (non - combustible waste) are done by magnetic separation and manual separation. Initially the hand separation is done under basic knowledge of classification. The Magnetic separator machine HS-8474 was used in this work. This type of magnetic separator is used for recovering steel and iron. This work was done by the magnetic drum separator and overhead belt magnet separators. This machine separates ferrous material from non-ferrous materials. The mixture of iron filling sand, ceramic magnets, iodine to attract ferrous particles and extract them has output. The segregated waste ingredients were dried in natural sunlight, which are uniformly distributed on an open paved place of about 2.8m for 24 to 48 hours.

The ingredients are sized less than 4mm by using shredding machine code HS-8441 and then

blended with water hyacinth starch for getting the high binding property. Then the densification process was carried out by compacting the loose material under pressure (hot pressing – 14.7Mpa) to reduce its volume under either Dynamic compaction or Rapid impact compaction or vibro compaction. Briquettes of different shapes and dimensions such as cube, flat, cylindrical, hollow cylindrical were prepared for this study. These cylindrical shape briquettes having outer diameter 50mm and length 300mm was shown in Fig no. 3.2. Briquette molding machine capacity of 200kg/h with the code HS-84798992 was intended for manufacture of briquettes from municipal waste. The Briquettes can be prepared either by machine or hand pressing. More efficiency and accuracy are found under machine technique. This study machine technique was adopted.

Fig 3.2 Cylindrical Green Fuel Briquettes

Table No: 3.1 Various samples and their materials mix composition

Waste	Trail 1	Trail 2	Trail 3	Trail 4
Papers	-	10	25	20
Cardboard	-	-	25	20
Saw Dust	100	50	50	-
Leathers	-	5	-	20
Rubber	-	5	-	20
Plastics	-	30	-	20

IV. RESULTS & DISCUSSION A.TEST ON BRIQUETTES

1. Compressive strength:

The briquette can withstand a maximum crushing load. Compressive strength can be determined using Universal Testing Machine. The sample briquettes were placed in-between two plates of the Instron UTM machine. The pressure was applied to one of the plates which is pushed upward to compress the materials against the second plate. The test load fixture of constant rate 0.305 mm/min till the briquettes failed by cracking. The Compressive stress (N/mm2) and Maximum forces were recorded.

Compressive strength = 3* load at fracture point (N)/ [l1 + l2 + l3]

2. Durability:

The sample briquettes were dropped at a height of 1.83m on a flat steel plate four times to find out the durability.

Durability = Material weight in plate after 4 drops (mb) / Initial weight of materials (ma) *100

3. Ash content:

The ash content of the briquette was determined by heating the briquette in an oven (18-20 mesh) using a crucible in a muffle furnace at 575o C for 4 hour. Following formula is also used for ash content.

Ash Content = (Weight of ash / weight of the briquette) * 100

4. Moisture content:

It directs the physical properties of a substance, including weight, density, viscosity, and others. It is usually determined by weight loss upon drying. Moisture Content = {(Initial with of sample – Weight of sample after drying) / Initial weight of sample} *100

5. Efficiency:

The state or Quality of being efficient. "Greater energy efficiency" Here we consider the efficiency is how long the briquettes will able to withstand and provide flame prolong takes place.

Efficiency = Initial timing when the flame starts/Final time where the flame extinguished. * 100

Comparison of efficiency and ash content were studied from the test results. Under study reference 4 different sizes of briquettes are finalized; they are Cube, flat, hexagonal and cylinder/stick. Here the testing is done with cylindrical shape. Further we planned to study the efficiency of different sizes. Sample 2 satisfies the efficiency which gives long time to burn and easy to initiate. And also the ash content will be less when compared to rest of samples. By using the plastics the durability will be increased. Table 3.2 Briquettes properties for various sample gives the values of efficiency, density, moisture content, ash content , durability and compression strength which satisfies the maximum and minimum ranges. Discussion based on Sample 1 and Sample 2.

Table No: 3.2 Briquettes properties for various sample mix

Briquette Samples	Efficiency (%)	Density (Kg/m^3)	Moisture Content (%)	Ash Content (%)	Durability (%)	Compression Strength (Kg/m^2)
SAMPLE 1	68.890	54.07	7.6	8.5	98.15	8.598
SAMPLE 2	89.760	55.45	6.3	5.4	97.33	8.664
SAMPLE 3	56.889	43.2	7.10	9	70.89	6.991
SAMPLE 4	59.567	47.67	8.9	8.7	89.45	8.300
COAL	48.97	50.45	39	6.2	85.24	4.237

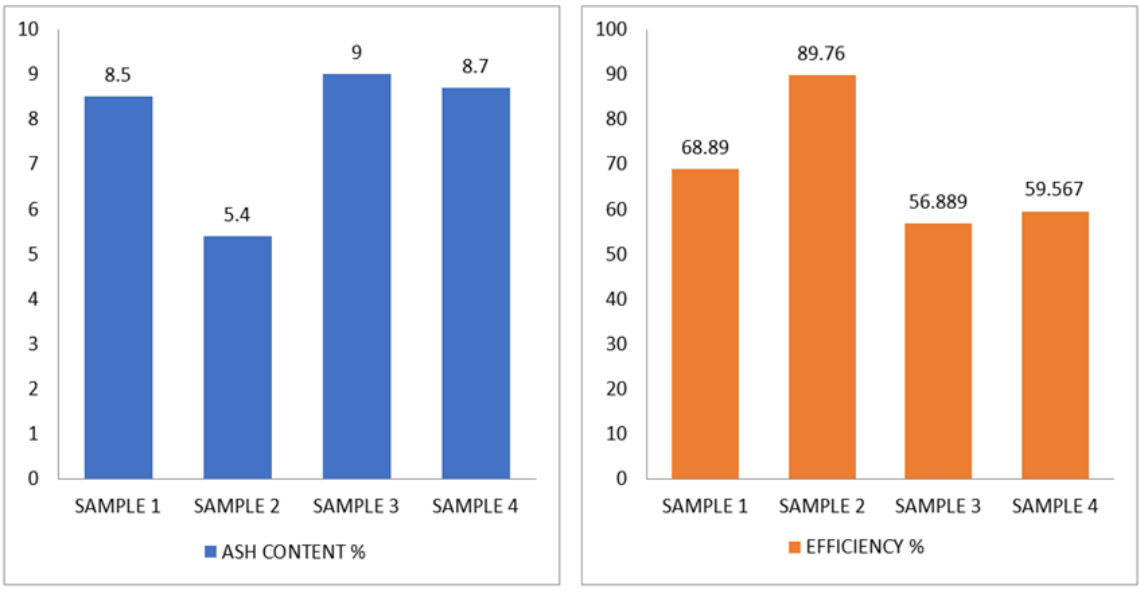


Fig 4.1 Efficiency and Ash Constant for different samples

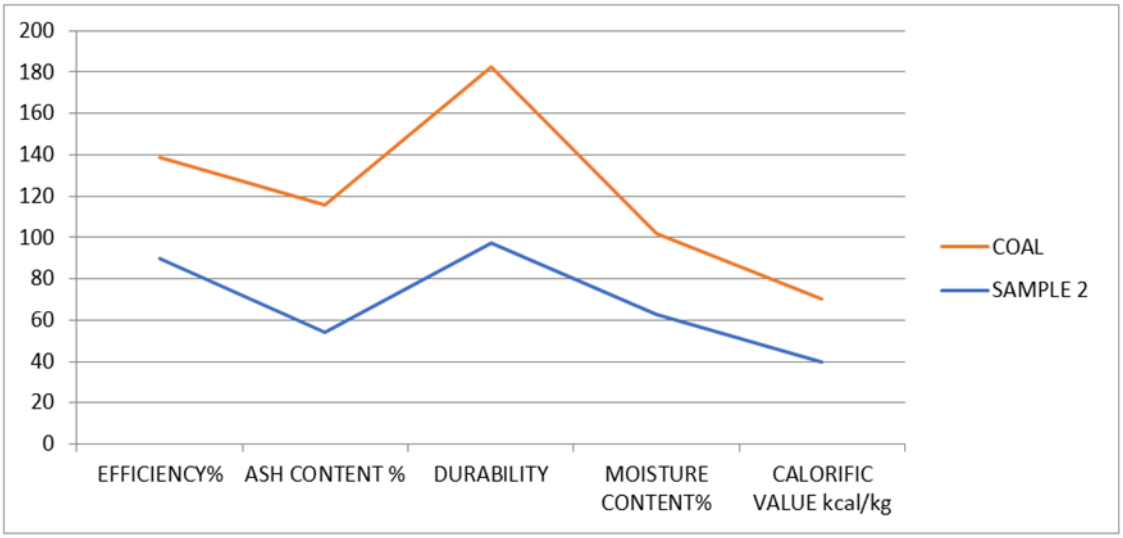


Fig 4.2 Comparison of coal and sample 2

HIGHLIGHTS OF GREEN FUEL BRIQUETTES

● Due to low moisture and higher density, briquettes have high boiler efficiency.

● When we compare with coal it has high combustion property

●Green fuel briquettes are cheaper than coal.

●These are easy to handle.

●Ash content is less when burning.

●Briquettes are replaced by conventional fuels like diesel, kerosene, Lignite, Coal, Furnace oil and Firewood.

FUTURE SCOPE OF THE WORK

In this work our objective is to reduce the waste generation and to minimize toxic emission from wastes. This study promises that the green fuel briquettes are the best potential alternative resource to the conventional fuel materials and to save the earth planet from emission of fossil fuels and greenhouse effects. Green fuel briquettes have higher combustion than coal and are cheaper. So, it is highly possible to satisfy the fuel needs of household and industrial processes such as boiler heating etc.

V. CONCLUSION

Among which we concluded that, the efficiency and ash content will be inversely proportional to each other. The Sample 2 gives the favorable outcomes which satisfies the above conclusion. The binder which we used is Starch gives better binding property. We are using the plastics for the getting better durability that also satisfies. The moisture content were high in sample 3 because the non – bio degradable materials were not absorb water easily. While in sample 2 the moisture content were is less compared to others. Along which we compared with coal briquettes and Sample 2. The efficiency of Sample 2 is 20% greater than Coal. And also very less moisture content in Sample 2. The above graphs shows clearly the comparison between coal and sample 2. If the coal is exhausted it would be an alternative fuel. And also reduced the landfill area, incineration, and open burning which pollute the air and atmosphere.

INNOVATION IN THE PROJECT

- In present years mostly briquettes are in markets usage of compression of Saw dust, Coconut shells ,Groundnut shells etc..
- By the combination of wastes from Municipal Solid waste such as Plastics , leathers, papers gives more efficiency of than existing ones.
- And also to replace the coal into green fuel briquettes by using municipal solid wastes.
- Green Fuel Briquettes – Renewable Energy.

ACKNOWLEDGMENTS

We sincerely thank to M.A.V.Agro Fuels, Mogappair West, Ambattur Industrial Estate,Chennai for allowing us to make the briquettes. The experimental works are carried out in Environmental Laboratory, Sri Sai Ram Engineering College, West Tambaram, Chennai. We also thank our project guide Mrs.K.Vaidhegi and Department of Civil Engineering Dr.S.Bhavathi Permal who support us throughtout the end of the project.

REFERENCES:

[1]. Maria Angeles Garrido, Juan A. Maria, **"Production of fuel briquettes made from biomass and plastic mass"**, 2017.

[2]. R.M.Davies and O.A.Davies , **"Physical and combustion characteristics of Briquettes Made from Water Hyacinth and phytoplankton scum as binder",** 2013.

[3]. Deepika Susmitha ,Shwetha Priya, Ramakrishnan**,"Reuse Potential of Municipal Solid Waste by Refuse Derived Fuel"** 2019.

[4]. O.A. Sotannde, A.O. Oluyege, and G.B. Abah, **"Physical and combustion properties of charcoal briquettes from neem wood residues".** 2009.

[5]. JaanKers ,PriitKulu , Aare Aruniit , Viktor Laurmaa , Peter Križan , LubomirŠooš and ÜloKask **"Determination of physical, mechanical and burning characteristics of polymeric waste material briquette"** , 2010.

[6]. Maria Angeles Garrido , Juan A. Conesa and Maria Dolores Garcia **,"Characterization and Production of Fuel Briquettes Made from Biomass and Plastic Wastes"**,2017

[7]. Rabier, F. Temmerman, M. Böhm, T. Hartmann, H.Daugbjerg Jensen, P.; Rathbauer, J. Carrasco, J.Fernández, M. **"Particle density determination of pellets and briquettes. Biomass Bioenergy",** 2006

[8]. Hakkila P. and Parikka M. **"Fuel resources from the forest. In: Bioenergy from Sustainable Forestry: Guiding Principles and Practice"** 2002

[9]. Wilaipon P.,. **"Physical characteristics of maize cob briquette under moderate die pressure"-** 2007

[10]. Wilaipon P., **"Density equation of bio-coal briquettes and quantity of maize cob in Phitsanulok"-** 2008

[11]. Olorunnisola A., **"Production of fuel briquettes from waste paper and coconut husk admixtures"** 2007.

[12]. Jindaporn J., Chadchawan P., Aurawan T., and Songchai W., **"Physical properties and combustion performance of briquettes produced from two pairs of biomass species".** 2005.

[13]. O.A. Oyelaran , O. Balogun, A.O. Ambali , J.K. Abidoye, **"Characterization of Briquette Produced from Tannery Solid Waste"** 2017.

[14]. D.Y. Goswami, F. Kreith, Global energy system. In: Kreith F, Goswami D, editors. **"Handbook of energy efficiency and renewable energy"** 2007

[15]. Schilling, C.; Wohler, M.; Yazdanpanah, F.Bi, X.; Sokhansanj, S. **"Development of a Novel Wood Pellet Durability Tester for Small Sample Conference of World Sustainable Energy Days",** 2015.