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Design and Improvement of Existing Briquette Making Machine

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Abstract: ***There has been a recent push to replace the burning of fossil fuels with biofuel. The replacement of this non-renewable energy resources with biological waste lowers the overall pollution of the world. The waste biomass similar to dry leaves, sawdust, rice husk, coffee husk etc. are gathered and compressed into the briquettes, these briquettes can also transport and used as fuel to generate heat and energy. It is a time to take initiative to turn Biomass into a source of energy. Hence here we are taking responsibility in converting agricultural and forestry wastes into useful biomass briquettes, which can also be used as a substitute for Coal and other non-renewable resources.***

Biomass briquettes are a biofuel substitute or replacement to a coal and charcoal. Biomass briquettes can be manufactured by using agricultural and forestry waste. The low-density biomass Is converted into high density biomass briquettes with the help of a briquetting machine that Uses binder or without binder i.e., binder less technique, as there is no any type of chemical is used so it is 100% natural. The mostly used raw material for biomass briquettes, Mustard Stalks, Sawdust, Groundnut Shell, Coffee Husk, Coir Pitch, Jute Sticks, Sugarcane Bagasse, Rice Husk, Cotton Stalks, Caster Seed Shells / Stalk, Wood Chips, Paddy straw, Tobacco Waste, Tea Waste, maize stalks, bajra Cobs, Arhar stalks, Bamboo Dust, Wheat Straw, Sunflower Stalk, Palm Husk, Soya bean Husk, Veneer Residues, Barks & Straws, Leaf's, Pine Niddle, Seeds Cases etc. are used. Biomass Briquette are largely used for any type of thermal application, like steam generation in Boilers, in furnace & foundries (It can be used for metal heating & melting where melting point Is less than 1000d/cel.), for heating purpose (Residential & Commercial Heating in winter, Heating in Cold areas and Hotels, Canteens, Cafeterias and house hold kitchen appliances, restaurants etc.),

There are several machines available in market but those machines are bulky and are costly, hence here we have developed a portable, low-cost briquetting machine, which makes use of simple mechanism to convert the biological waste into useful briquettes. Any waste or any proportion of Agri waste can be used but with proper binding agent. Some raw materials doesn't require any binding material high pressure compression is used. The paper presents the results of a project focused on the development of briquettes from the sawdust (Waste Wood) resulting from the primary waste from timber companies. This sawdust currently lacks a useful purpose, and its indiscriminate burning generates CO and CO2 emissions which are harmful to nature. Sawmill Agri waste is a huge problem specially in urban cities. These wastes are burnt openly which is causing environmental pollution and also becomes reason for human health care.

Key Words: Briquettes; Briquettes Density; Design; Calorific Value.

I. INTRODUCTION

Large quantities of Agri Waste are produced after the harvest process by many of the developing countries, but they are used inefficiently causing high pollution to the environment. The major Agri Wastes are rice-husk , coir pith, jute sticks, coffee husk, groundnut shells, mustard stalks and cotton stalks**,** Saw dust is also available in huge quantity in India. Problems associated with the utilization of these Agri wastes are for transportation, storage and handling. The direct burning of agroresidues in conventional grates is associated with very low thermal efficiency and causes very high air pollution**.** In addition, the high percentage of unburnt carbon contained ash has to be disposed off. Briquetting of Agri Wastes at the very site of its production would solve the pollution problems with the merits of making use of them as a source of nonconventional energy resources.

Briquetting is in fact converting the low bulk density of Agri Wastes into high density and energy concentrated fuel. Briquettes are a good substitute for a coal and wood in industrial boiler and brick kiln for thermal applications. This briquettes are non-conventional, as well as are renewable, eco-friendly, non-polluting, economical and high calorific value as compared to fire-wood or raw Agri Wastes.

Briquettes are capable to replace conventional fuels for the thermal application in various plants or industries. Different industries are Ceramic, Solvent Extraction Plant, Dyeing units, Food Processing industries, Textile Unit, Chemical Industries, Milk Plants, Leather Industries, Rubber industries etc. Here we used paper Screw Extrusion machine which is designed and fabricated to get briquettes of saw dust at the rate of 7kg per hour. Effects of binder percentage in a briquette have been studied on briquette density, power consumption per kg of briquettes produced and calorific value per kg of briquette.

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II. MATERIALS AND METHODS

A. *Starch*

Starch is the most commonly used binder though it is also usually expensive. In general, about 4-8% of starch is needed for the manufacturing of good briquettes. Starch sources can be obtained from maize floor, wheat starch, corn starch, wheat flour, rice flour, cassava flour, potato starch, etc. To use the starch as a binder you must first gelatinize the starch by adding some water and heating the solution which forms a sticky consistency, then added to the mixer to get mixed with the charcoal powder.

B. *Gum Arabic*

second name of Gum Arabic is acacia gum. It is a natural gum obtained from acacia tree, which is very commonly found in Africa , especially Senegal, Sudan, Somalia, etc. Gum Arabic is being used as binder material for charcoal briquette for a long time. It does not emits heavy smoke, and no extra thermal treatment is required.

C. *Molasses*

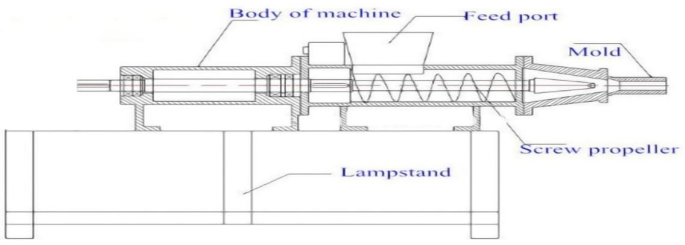
The by-product of the sugarcane industry is Molasses. One ton of briquettes needs near about 20-25% molasses. Briquettes which are binded by molasses burn very well but have an unpleasant smell during combustion. Thermal treatment is applied before using the briquette to avoid the smell problem, which is also called ”curing”.

D. *Cow dung*

The cow dung has the properties of an ideal binder and also it is having higher calorific value it helps in burning. That’s why it is highly used.

E. *Design of Briquetting Machine*

Designing the machine for compaction of Saw dust, detailed study has been done on different part of the machine and its function. Sectional view of briquetting machine is shown in Fig.1 .Technical specification has been considered to fabricate the machine on lab scale for biomass densification production. The details of design procedure & technical specification are given below:



Line sketch of machine

III. DESIGN AND CONSIDERATION

A. *Raw Material used for Briquette*

- Density of saw dust = 415 kg/m³
- Density of charcoal= 200 kg/m³
- Density of tree gum =445 kg/m³
- Density of starch low =1500 kg/m³
- Density of cow dung = 1847 kg/m³
- Bulk density = 891 kg/m³

B. *Dimensions of Briquette (Product)*

Diameter of briquettes = 30 mm

Length of briquettes= 150 mm

Volume of first flight at the feeding zone

$= \frac{\pi}{4} \times$ (Outer diameter of conveyor screw ^{2} – diameter of shaft of screw conveyor ^{2})

$= \frac{\pi}{4} \times (100^2\text{-}50^2) \times 50$

$= 294375 mm^3$

$= 294375 \times 10^{-9}\ m^3$

Mass flow rate

= Bulk density × volume of first flight at the feeding zon

$= 891 \times 294375 \times 10^{-9}$

= 0.2622 kg/ rotation

Volume of the briquettes

$= \frac{\pi}{4} \times$ (Diameter of briquette) $^2 \times$ length of briquette

$= \frac{\pi}{4} \times 30^2 \times 150$

$= 105975 \times 10^{-9}\ m^3$

Mass of briquettes

= Bulk density × volume of briquette

$= 105975 \times 10^{-9} \times 891$

= 0.09442 kg

No. of revolution to make one briquette

$= \frac{Mass\ of\ briquette}{Actual\ mass\ flow\ rate\ of\ briquette}$

$= \frac{0.09442}{0.131144}$

= 1 revolution

Screw conveyer with 350 rpm.

Volume of cylindrical Casing

$= \frac{\pi}{4} \times$ diameter of casing × length of casing

$= \frac{\pi}{4} \times 110^2 \times 500$

$= 4.751658 \times 10^6\ mm^3$

$= 4.751658 \times 10^{-3} m^3$

Calorific values:

C.V. of charcoal = 25000 kj/kg
C.V. of sawdust = 17000 kj/kg
C.V. of cow dung = 6000 kj/kg
Calorific value of tree gum and starch powder is very less as compared to others.

Calorific value per kg of mixture:

= (C.V. of charcoal × 0.15) + (C.V. of sawdust × 0.3) +

(C.V. of cow dung× 0.3)

= (25000 × 0.15) + (17000 × 0.3) + (6000 × 0.3) = 10650 kj/kg

C.V. of briquette

= C.V per kg of mixture × mass of briquette

= 10650 × 0.09442

=C. V. of briquette = 1005.573 kj

General Specification of Machine: General Details of fabricated machine is given in

TABLE1: Specification of Briquetting Machine for the Production Rate in Kg/hr

Length	Width	Height	Motor Power	Speed of Screw
80cm	30cm	100	0.25hp	350RPM

Specification of Screw: The specification of Screw is shown in Table2

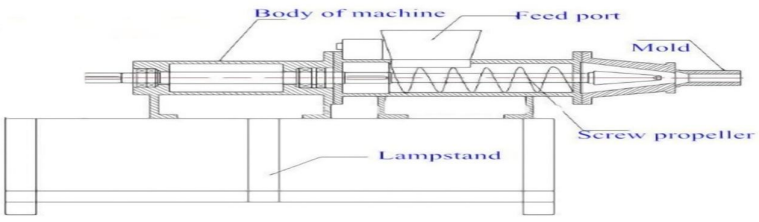
TABLE 2: Specification of Screw

LENGTH	DIA. OF THREAD TOP	MATERIAL
500mm	100mm	EN8 (Mild Steel)

Specification for Die: Specification for Die is shown in Table 3

TABLE3: Specification of Die

LENGTH	MATERIAL
100mm	(Hard Chroming Material)



Line sketch of modified briquette machine

III. EXISTING BRIQUETTE MAKING MACHINE

The briquette making machine is operated by electric motor. The agriculture such as rise husk ground nut shell and husk of soy bean has been poured through hopper. Then jet start the motor and it is coupled with the screw by the help of v belt and pulley. due to this mechanism the sliding screw goes towards and it exerts pressure on plate which is attached to screw.

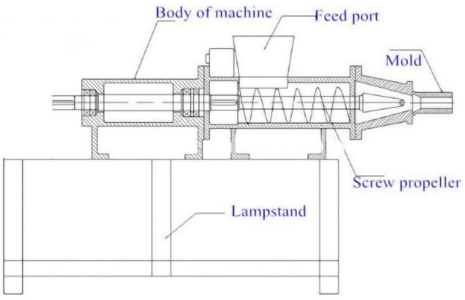
This plate presses the raw material. The raw material which is fed into the chamber and compressed the raw material into briquette solar finish product briquette. We get are complete clean i.e., perfect for use boiler, furnace and open fires. The density of biomass briquette is higher than black coal.

A. Limitation of Existing Briquette making Machine

- Slow production of briquettes per hour due to low pressure inside the chamber
- Pitch of helical screw conveyer is constant
- Takes more time to burn due its low calorific value
- Overall machine size is large and occupies more space
- Initial cost of machine is high
- Diameter of briquette is small

IV. MODIFIED BRIQUETTE MAKING MACHINE

Present machine has certain changes in the dimension and screw conveyer pitch, while working is almost same as existing machine. The suitable raw material such as agricultural waste, corn waste, charcoal, nut shell etc. is fed to the hopper then after, the material is conveyed by the screw inside the briquette machine. The rotating screw takes the material from the hopper i.e., feed port, and compacts it against a die which build-up of a pressure gradient along the screw. Finished briquette output from the end of machine called as mould with stick type. Normal cross-section shapes we usually find can be round, taper for smooth finish. As the screw briquette machine works with a pressure which is quite high as compared to previous machine, binders are always needed forming the briquette. Equipped with a heating system will help the biomass material melt the internal lignin and turn it to a high-performance binder. Besides, other materials also work with this briquette like coal, charcoal, etc. These materials should be well mixed with the binder to get the briquette forms.



A. Features of Modified Briquette Making Machine

- Production of briquette per hour is high due to more pressure generated by conveyer.
- Pitch of the screw conveyer is variable i.e., gradually decreasing at the end, giving more pressure to pass briquette.
- Size of the machine is compact and occupies less space.
- Briquette which is obtained is smooth and finished.
- Calorific value of briquette is high and takes less time to burn

- On burning briquette doesn't produces less smog and reduces air pollution.
- Production of hazardous gases after burning briquette is prevented.

V. RESULTS AND DISCUSSION

A. *Effects of Moisture Content in Feed*

The saw dust which has used for compaction, has the moisture content of near about 7- 8 %. But for the appropriate briquetting of saw dust the moisture content is maintained in the range of 10- 13%. Moisture content is maintained just by adding sugar molasses & some water. It is possible to get smooth densed process and good strength of briquette.

B. *Effect of Particle Size of Feed*

Particle size and shape are of great importance for densification.. It was decided to use saw dust and binder in the size range of 0.15-1.5 mm as feed .The presence of different size particles will improve the packing dynamics and also it contributes to high static strength.

C. *Effects of External Additives/Binders*

By using the additives, densification of biomass becomes very easy . A 15-20 % of binder (sugar molasses) amount was used along with the saw dust for producing good quality of briquettes. It also upgrades the calorific value and combustibility of briquettes by using external binder.

D. *Briquette Density*

As the data shown in Fig. ,the briquette density stays constant, near about the value 1.4 gm/cm^3 for the composition of binder in the range of 12-20%

E. *Power Consumption*

The power consumption (Wh/kg) to convert the feed material into the briquettes for the different composition of saw dust and the binder,it is observed that it is varying from 920Wh/Kg to 750Wh/Kg.It is clear from the Fig. that as the percentage of the binder increases, the power consumption decreases.

F. *Calorific value*

The calorific value of briquettes are calculated by using the bomb calorimeter. It is observed from Fig.4 that the calorific values of briquettes increases with increase in the percentage of binder from 12 to 16 %, but beyond binder percentage of 16 % the calorific values of briquettes remain constant.

G. *Thermal Efficiency*

The Thermal Efficiency of all binder composition is determined. As per the observation from Fig. near about constant thermal efficiency of 5 % is obtained for all the binder compositions of the briquettes.

VI. CONCLUSION

There are several machines are available in the market but those machines are bulky and are quite costly, hence here we developed a portable, low-cost briquetting machine which makes use of simple mechanism to convert the biological waste into the useful briquette. We can use any waste and any proportion and with proper binding agent. Some raw materials do not require any binding agent if we use high pressure compression. The paper presents the results of a project focused on the improvement of briquettes from the sawdust (waste wood) resulting from the main Agri waste and also from timber companies and similar. This waste wood currently has a very limited useful purpose, and its indiscriminate burning generates CO and CO2 emissions which are harmful to environment. These wastes are burnt openly which is causing environmental pollution and becoming the reason of humans weak health system.

VII. ACKNOWLEDGEMENTS

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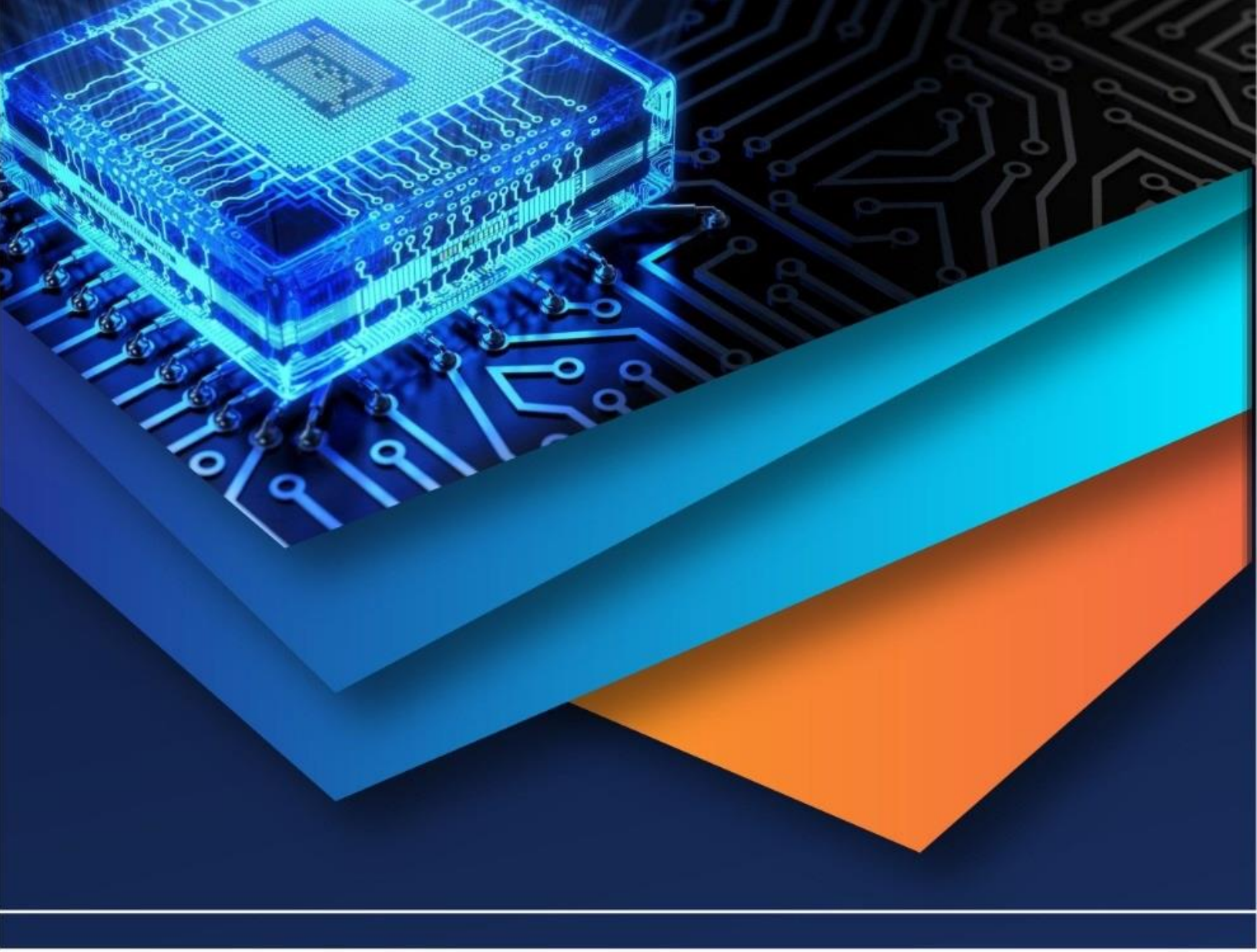

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