Design and Development of Biomass Briquetting Machine with Grinding and Blending Unit

Harshal Badule [#1], Harish Hedau [#2], Dipanshu Nandgave [#3], Akshay Barapatre [#4],
Vinod P.Sakhare [#5]
1,2,3,4 Students VIII Semester, 5 Assistant Professor
Department of Mechanical Engineering, GNIT Nagpur, Maharashtra, India.

***Abstract* — India is a developing nation and its GDP is dependent mostly on agriculture. And due to agriculture tonnes of biomass waste is being produce, which is mainly used for making manure and also for cooking in some rural area but still most of it goes into waste. But nowadays these biomass is been transformed into briquettes by compressing the biomass with some binder as 100kg/m^2 which increases its density and also calorific value.**

This research paper focuses on modification of the existing design of briquetting machine which includes modifying mixing and blending unit and extrusion unit which is screw type to make a low cost machine. This biomass residue is first turned into small particles of 5mm size in a mixer drum which is powered by a 1/4HP AC single phase motor running at 1440 r.p.m.Then this grinded biomass was blended with binder in another drum in same unit by manually using a blending arm. After that the blended biomass is fed into extrusion unit where it was compressed by screw which was running at 300r.p.m powered by 0.5H.P motor through attachable a nozzle with cylindrical hole and then cut into equal pieces manually. The capacity of machine measured was 20kg/hrs.

***Keywords* - Biomass waste, Mixer and blender unit, Screw press machine, briquette**

I.INTRODUCTION

India is a developing and also an agricultural nation whose GDP is largely dependent on agriculture. Also India is having the second largest population in world which is increasing day by day and so the people requirements such as food, electricity and other important things. Due to which the agriculture production is also increased and with it the biomass residue is also increasing. And these biomass residue is mostly use for making manure and also directly for cooking but still a large amount of it goes into waste. And these biomass which is mostly fluffy and having moisture generate smoke when burnt so it's not healthy and environment friendly way to use it. There are many way to use biomass residue but among them the best one which is much beneficial is briquetting.

So nowadays these biomass residue is been converted into briquettes by mixing with certain binder and additives to increase their calorific value and density. Briquettes are nothing but compressed biomass residue as 100 kg/m^3 and this is being done from ancient time but not at industrial level as now is being done. These biomass briquette which is much denser and having more calorific value than the biomass residue produces lesser smoke as compared to biomass itself and burn at a constant rate. These biomass briquettes are now widely used in industrial furnaces, in small thermal power plants for electricity production and also rural area since it is cheaper and having more calorific value than coal and biomass itself. The briquette are also having more oxygen and less carbon than coal are environment friendly. They can be use in decentralized power generation and also they are easy to transport and store. Also these conversion of biomass into briquettes will produce an earning source for people in rural area plus it will help in reduction of CO^2 emission since it produce less CO^2 than LPG ,coal and other fossil fuel. And it is a renewable source of energy so its production won't end like fossil fuel.

But presently most of the biomass briquette machine which are available in market are mostly available as a big plant and are very costly. Hence, people in rural area cannot afford it. So we design a less costlier briquetting machine so that it can be affordable by rural people.

II MATERIAL USED AND METHODOLGY

The study was conducted with an overall objective of design and fabrication of a low cost screw press type briquetting machine along with a low cost Mixing and blending unit and more calorific value briquette composition.

Procurement of Materials

2.1 Following materials were purchased and used for fabrication of the screw press type briquetting machine

Table-2.1.1:-Procurement of material for screw type briquetting machine

Part Name	Quantity	Description
Electric motor	1	0.5 H.P. with 1440 R.P.M ,AC
Power screw	1	Dimension: 4 Inch outer dia. And 1.5 Inch inner dia. & 16 Inch length .Pitch=
Extruder barrel	1	5 Inch dia. and 16 Inches length
Pulley	2	1st pulley:- 2 inch outer dia. Grade-A 2nd pulley:- 6inch outer dia. Grade-A
V-belt	3	Grade-A
Bearing	2	6200 series - 6206
Hopper	1	made up of tin sheet material Diversion to bottom to feed stuff into the extruder screw.
Angle bar frame	12	The stand for the machine is made from the angle bar
Nut and bolts	5	10 mm diameter and 1 inch length bolts.

2.2 Procurement of Material purchased for mixing and blending unit:-

Electric Motor	1	1440 R.P.M.,230 Volt, Single Phase, AC Only
Bevel Gear & Pinion	2	Gear: ,Pinion:
Mixer blade and drum	1	Stainless steel blade&drum:9Inches length,4Inch dia.
Blender arm & drum	1	Arm shaft length:5Inche,Arm:3Inches
Ball Bearing	2	6205 & 6202 series
Hollow Shaft	1 2	1st shaft :2Inches dia.,28inches length;2nd:-1Inche dia.,8inch length
Nut and bolts	8	10mm diameter and 4 inches length
Plywood Sheet	1	
Angle bar frame	1	

Table-2.2.1:-Procurement of material for Grinding and Blending Unit

III METHOD OF OPERATING THE MACHINE

Grinder unit:-

Grinder unit consists of a food processor blade, Drum, AC motor, and Base supports. The blade rotates at very high speed due to which it achieves the ability to cut any agro waste in small particles the edges of the blade is finished with the rough pattern which make high impression over the stuff to be grind.

The motor is connected to ac current supply and rotated to high speed and the waste stuff is delivered inside the drum the stuff comes in contact with the high speed rotating blades which gets cuts into the small particles after the drum is filled with agro stuff the drum is covered with the cover to prevent the particles to escape from the drum due to impact.

Blender unit:-

The function of the blender is to mix the agro waste stuff homogeneously with the binder to make the dense stuff .After the agro stuff is grinded properly then shifted to the blender drum in blender the blender arm is dipped fully inside the stuff and rotated by means of the gears provided to the arm the agro stuff get rotated to the edges of the blender arm and get mixed with the binder and forms the bonded structure of some density. The mixture us blended enough to make the stuff viscous so that it can take shape from the outlet of the extruder.

Fig: 3.1 Actual photo of Grinding and blending unit

Extruder unit:-The extruder unit contains the barrel, extruder screw, AC motor, pulley and belt. The extruder screw rotates inside the barrel by means of motor and pullet arrangement. The blended agro stuff is delivered from hopper inside the barrel and screw arrangement. The screw rotates and forces the stuff out from in barrel due to the force from screw the stuff is transferred to the outlet of the extruder. The outlet of extruder contains compact shape which makes compression effect over agro stuff due to which the stuff take the form of the outlet pipe and the cylindrical briquette is formed and get out from the extruder as output.

The cylindrical shaped briquettes are wet due to binder so their moisture is soaked by treating them with the smokes created from the fire which can evaporate the moisture from the briquettes so that they can become dry and can be used for fire purpose.

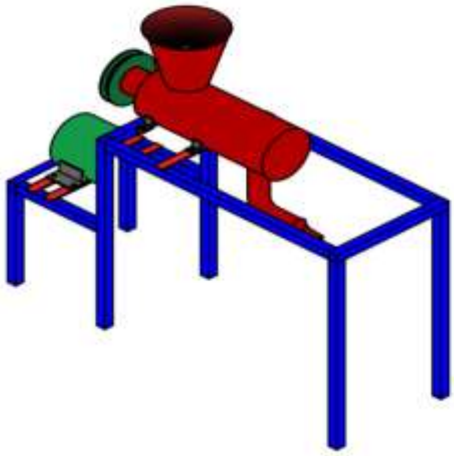


Fig: 3.2 Cad Model of Briquetting machine

Fig: 3.3 Actual photo of Briquetting machine

IV DESIGN AND CALCULATION

The speed of motor selected was 1440r.p.m. and so the design was made according to it:-

Shape of Briquettes	Cylindrical
Outer diameter of Briquette	50mm
Hole diameter of Briquette	10mm
Length of Briquette	100mm
Machine Capacity	50Kg/hrs
Biomass Material Density	100Kg/m^3

Table-4.1:-Assumed Briquette and Machine Specifications

Design of Grinder:-
Mixing capacity:-

Volume of grinding chamber= $\frac{\pi}{4}$ x d^2 x L = mm3

Grinding power:-

Power of motor= 0.25 HP = 196.25 Watt

Blade velocity = V= $\frac{\pi \times d \times N}{60}$ = m/s

Where, d= diameter of blade.
N= rotation per minute of blade.

Design of Blender:-
Blending capacity:-

Volume of blending drum=$\frac{\pi}{4}$ x d^2 x L= m^3

Gear ratio= $\frac{T1}{T2}$ =

Design of Extruder:-

- Shape of Briquette = Cylindrical
- diameter of briquette = mm
- Length of Briquette = mm
- Compaction ratio = 14 (standard)
- Diameter of screw shaft = mm
- Volume at entry (Ve) = Ve = $\frac{\pi}{4}$ x (d^2) x L = mm^3
- Volume at compression zone (Vc) = Vc = $\frac{\pi}{4}$ x (d^2) x L x p = p mm^3

  Assume that compression ratio is 10

  $$10 = \frac{Ve}{Vc}$$

  p = mm^3

- Density of material = kg/m^3
- Mass of material conveyed
  m = kg

  The efficiency of screw conveyor is 50 %
  m = x 0.5 = kg
- Density of compact briquette (ρ) assumed= 1000 kg/m^3
- Volume of briquette = $\frac{\pi}{4}$ x d^2 x L = mm^3

Design of Pulley and V-Belt drive:-

Data: - Motor power = 0.5 HP
Pr = Watt

- Design power
  Pd = Pr x kl Load factor [kl = 1.15]
  Pd = Watt D.D.B [T-XV 2]

Selecting the section of the belt on the basis of design power i.e. kw
From D.D.B [T-XV-8]
For designation A: - W=13, t=18, Dmin=75 mm, kc=2.52 [Centrifugal tension factor]

- Peripheral velocity (Vp)

Selecting smaller diameter of pulley as mm

Vp = $\frac{\pi \text{ D1 N1}}{60 \times 1000}$ = m/min

- Ratio of tensions
  N1 D1 = N2 D2
  [N2 = rpm of extruder screw]
  So, D2 = mm
  Where, D2 = diameter of bigger pulley.
- Centre distance
  C = D1 + D2 = mm
- Length of belt
  L = $\frac{\pi}{2}$ x (D1 + D2) + 2C+ $\frac{(D1-D2)^2}{4C}$
  L= mm

By taking the briquette manufactured by the industry and the briquette manufactured by our machine the calorific value have been calculated and are compared as follows . Formulae for water equivalent of calorimeter

W = $\frac{H\ M}{T}$ x (CvT + CvF)

Formulae for Calorific value of fuel sample
CVs = **T** × **W** − (CvT + CvF)

Specifications:-
T - Final temperature rise of water in degree Celsius
M - Mass of the sample in grams
H - Known calorific value of benzoic acid in Cal / gm =6464Cal/gm
W - Water equivalent of the Calorimeter in Cal / deg
CVs - Calorific value of Fuel Sample
Cvf - Calorific value of Fuse wire = 2.33 Cal /cm
Cvt - Calorific value of the Thread wire = 2.1 Cal / cm

V EXPERERIMENTATION AND TESTING ON MACHINE

We have taken observations. By varying the composition of a briquette made from Saw dust, Dried leaves, coconut husk and binder as a corn starch.

Initial temperature = 30 ^{0}C
Rise in temperature = 30.6 ^{0}C
Difference in temperature = 0.6 ^{0}C
LF - Length of the Fuse wire = 10 cm
LT - Length of the Thread = 10 cm
CF - Heat liberated by the Fuse wire in Cal
= 2.33 × LT. = 2.33× 10 = 23 Cal
CF - Heat liberated by Thread in Cal
= 2.1 × LT = 2.1 × 10 = 21Cal

Composition 1:-

Saw dust =60%, Coconut husk =10%, Dried leaves =25% and Corn starch = 5%
Initial temperature = 29 ^{0}C
Rise in temperature = 29.5 ^{0}C
Difference in temperature = 0.5 ^{0}C.
CV = T × W − (CvT + CvF)
CV= 0.5× 6699.97 − (21 + 23)
= 3305.985 Kcal

Composition 2:-

Saw dust = 40%, Dried leaves = 40%, Coconut husk = 15%

and Wheat flour = 5%

Initial temperature = 29 ^{0}C
Rise in temperature = 29.6 ^{0}C
Difference in temperature = 0.6 ^{0}C.
CV = T × W − (CvT + CvF)
CV= 0.6× 6699.97 − (21 + 23)
= 3975.982 Kcal

Composition 3:-

Saw dust=50%, Dried leaves = 30%, coconut husk = 16%, Corn starch = 4%

Initial temperature = 29 ^{0}C
Rise in temperature = 29.55 ^{0}C
Difference in temperature = 0.55 ^{0}C.
CV = T × W − (CvT + CvF)
CV= 0.55× 6699.97 − (21 + 23)
= 3640.98 Kcal

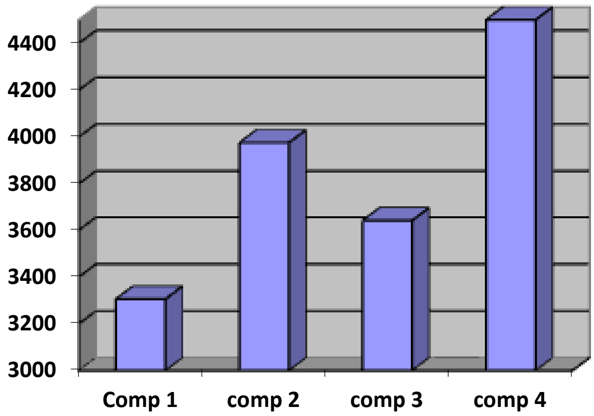
Composition 4:-

Saw dust=30%, Dried leaves=50%, Coconut husk = 10%, Wheat flour = 10%

Initial temperature = 29 ^{0}C
Rise in temperature = 29.74 ^{0}C
Difference in temperature = 0.74 ^{0}C.
CV = T × W − (CvT + CvF)
CV= 0.74× 6699.97 − (21 + 23)
= 4913.97 Kcal

Sr no.	Composition %	Mass kg	Calorific value kCal/kg
1	Saw dust =60%, Coconut husk =10% ,Dried leaves =25% and Corn starch = 5%	0.102	3305.985
2	Saw dust = 40% , Dried leaves = 40% , Coconut husk = 15% and Wheat flour = 5%	0.110	3975.982
3	Saw dust=50% , Dried leaves = 30% , coconut husk = 16% , Corn starch = 4%	0.107	3640.98
4	Saw dust=30%, Dried leaves=50%, Coconut husk = 10% , Wheat flour = 10%	0.100	4913.97

Table 5.1: Observation table of compositions



Graph 5.1: Calorific values in different compositions

Scale:
On X-Axis: No Of Compositions
On Y-Axis: Calorific values in kCal/kg

CONCLUSION:

Hence it is concluded that the Briquette machines can be made at low price along with grinding and blending unit for the rural use and various compositions of briquettes with different shape by using nozzle instead of die can be made from the small capacity machines for rural use and it can be used in small scale for the manufacturing the briquettes.

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