Design, Fabrication and Testing of Pellet Making Machine

Devendra Mahadik[1], Tanvesh Patil[2], Tushar Meher[3], Sonam Patil[4], Ashish chaudhari[5]
[1, 2, 3, 4, 5] Department of Mechanical Engineering
[1, 2, 3, 4, 5] University of Mumbai V.C.E.T., Vasai Road (W), Palghar, Maharshtra 401202

Abstract-*In India, biomass is the most dominant source of energy and is used significantly in the domestic sector notably charcoal and wood fuel. Despite huge amount of agricultural waste generation in the rural areas, the rural folks use charcoal and wood fuel, which leads to deforestation.*

In this Project, an appropriate, cost effective and easy to use semi-automatic operated biomass pellet making machine suitable for use in rural communities is to design, construct and test using paper pulp and saw dust as raw materials. This study is conducted to design and evaluate the performance of an electric motor-driven pellet machine. The design of pellet machine is consist of major parts like pelleting chamber, pellet roller, die plate, discharge chute, and frame. It is driven by a 0.25 Hp electric motor. It is operated using a disc-type extrusion press to force the formulated feeds out of the die plate. As the roller rotates, force is also applied creating rearrangement of the particles in order to fill the voids or holes of the die plate. The pressure is increased in compression step causing brittle particles to break and malleable particles to deform forcing them to be fed in the die and come out as pellets. The pellets then fell naturally due to impact created by the rotating die plate. The investment to this project including housing can be paid back in less than three months approximately. The pellet mill was able to convert waste into pellets and it can produce significant amount of pellets per day.

Keywords-Cost effective, Paper pulp, saw dust, Electric motor, Pellet mill

I. INTRODUCTION

From the rapidly depletion of the petroleum energy resources, alternative energy has gained more attentions. The burning of the agricultural waste in loose form results in loss of fuel and widespread air pollution. However, briquetting the agricultural waste forestall the aforementioned problems. Agricultural waste briquettes have the following advantages over the loose ones, there is increase in the net calorific value per unit volume, the fuel is easy to transport and store, uniform in size and quality. Biomass fuels are long term potential sources of renewable energy because of its abundant availability and CO2 neutral. Depends on the technology selection, biomass can be utilized as fuel in different forms; liquid, gas and solid. Chemical, biochemical, thermochemical and physical processes have been interested [1]. The former three methods have the limitation by high investment and complex technology. So the utilization of these materials has a few weak points of low energy density, less heating value, difficulties in transportation and storage [2, 3]. Therefore, the physical technology is simply applied on the conversion of these materials into alternative fuel. To meet the national energy policy which taking into account the energy demands, economic and environmental impact, the agro-residues are the potential energy feedstock, Pelleting process is the most promising way to compress biomass residues into the solid biofuels. However, this technology should be cheap, simple and easy maintain. For this work, the hydraulic press machine was designed to prepare briquettes, and the fuel properties of solid fuel were investigates.

II. PROBLEM DEFINITION

The purpose of this study concentrates on the waste paper utilization as fuel for rural area. The most efficient solution for this is the pelleting of waste papers. So that the energy content of it raised to a great extent which can efficiently be utilized for combustion. In order to achieve this objective the compact pelleting machine is to be designed and developed for producing significant amount of pellets from waste news paper and saw dust.

Further the machine manufactured will be experimented with verities of dies and to be analyzed.

III. LITERATURE REVIEW

A. Densified Biomass

Raw biomass materials, such as forest slash and construction waste, are irregular in shape low in energy density, greatly affected by moisture and can be difficult to transport. Biomass densification solves these problems by compressing sawdust, paper pulp and chipped wood to create solid bio-fuel pellets that provide consistent quality, low

moisture content, high energy density and homogenous size and shape.

Densification increases the energy density of biomass by approximately 10 to 15 percent [4], so more heat is produced per unit of pellets burned than if the same amount of raw wood was burned.

B. Required Parameters of Good Pellet

A change in raw material moisture content, pellet quality and production rates one of the reasons pellet fuel is so popular is pellets have moisture content below 10%.this enables the pellets to burn very efficiently and produces virtually no smoke during combustion. Pellet production is a high temperature process. The right moisture content will produce the best quality pellets, reduce energy consumption and reduce pellet mill downtime. Changes in raw material composition and the inclusion of binders and lubricants in pellet production every raw material behaves differently, and some materials produce quality pellets easier than others. Depending on the equipment used, the composition of the raw material may need to be changed to produce quality pellets at a reasonable productivity. Changing the composition can include adjusting particle size or moisture content. However, it may also include adding binders and lubricants to help produce higher quality fuel pellets. Changes in raw material pellet mill feed rate another adjustment that is not well known to impact on pellet production is the rate of feed into the pellet mill. Adjustments on feed rate and maintaining a consistent feed rate can be the key difference to how well the pellet mill operates, even if the raw material is perfectly prepared.

C. Moisture Content

The moisture content of biomass is often a very predominant factor when determining what kind of energy conversion process to use. When considering biomass with high moisture content, bio-conversion technology will more likely be used, where when dealing with low moisture content, usually less than 50%, a thermal conversion process is recommended. In the analysis of moisture content, there are two forms to consider. There is intrinsic moisture content, which only reflects the moisture content of the biomass excluding the influence of the weather and its environment, and extrinsic, which includes the influence of weather and gives the actual moisture content of the biomass after it has been harvested.[5]

D. Bulk Density

The bulk density of biomass that is to be used in a conversion process plays a major role in the transportation, storage requirements, handling and will influence the efficiency of combustion or biodegradability. The best scenario is to have a low volume per mass ratio hence 12 a high mass per unit volume ratio. A common practice to obtain these conditions is to process bulky biomass feed stock into a more compact form such as pellets. Notice the pellet properties on the following table.[5]

IV. MATERIAL AND METHODOGY

A. Feedstock

For the pellet forming process, jigat powder and saw dust was used as the binder and reinforced material. After grinding, the sieved material was mixed with saw dust at the ratio of 4:1. Mixture contains 30-35% of binder. The mixture was fulfilled into the dies with the help of roller and disc arrangement; pellets were produced under the applied pressure with the help of roller. After performing operation, removed product were kept for 2-3 hours in ambient condition before subjected to analysis.

We had also carried some trial with the different material such as paper pulp and rice husk and the obtained results are recorded

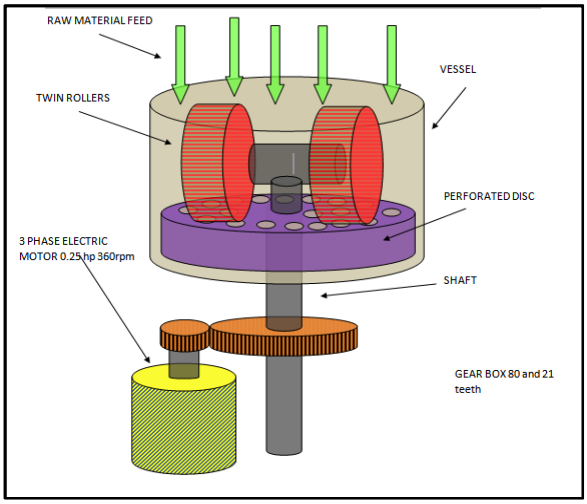


Fig.1 Flat-die pellet mill with other accessories

B. Methodology

Figure (1) shows rotating die type or disc type flat die roller mill. Adopting vertical principle, the raw materials drops down by its own weight into the pelletizing chamber where they are compressed between the rollers and die to form pellets by going through the die holes.

The pressure of flat die pellet mill is adjustable. The diameter of rollers in the flat pellet mill is placed over perforated disc and its downward motion restricted by the diameter of the disc which also act as die so that the roller pressure can be increased by tightening the screw which is provided on either side of roller shaft.[6]

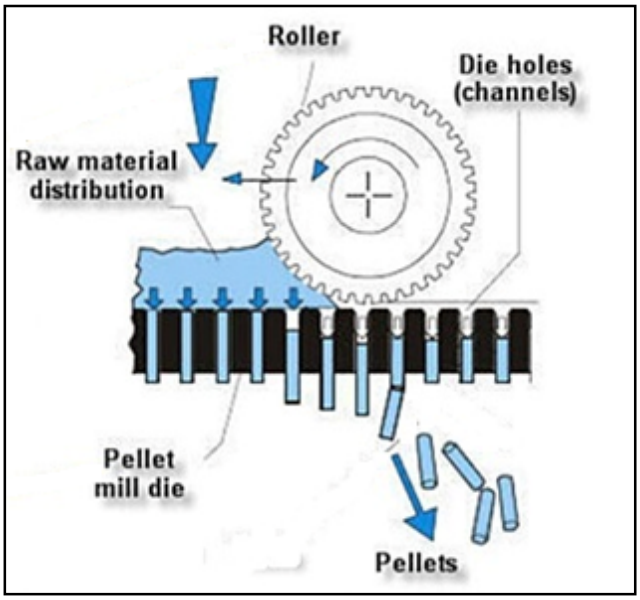


Fig.2 Disc type pellet mill

C. Tested Parameter

The calorific heating value of material was determined using Bomb Calorimeters. The individual pellet density was determined from dividing mass by the volume of pellet. Pellet size was measured with a standard vernier caliper. Moisture content was determined with help of weight basis system.

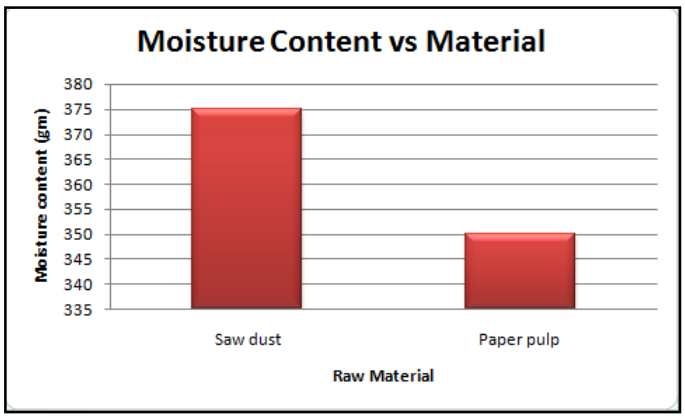
V. RESULTS

A. Moisture Content

The moisture content of biomass is often a very predominant factor when determining the amount of energy produced by a pellet.[7-8]

Table1.Characteristics of raw material

Raw Material	Material fed (gm)	Wet Pellets (gm) W_w	Dry Pellets (gm) W_D	Moisture content(gm) $M= W_W - W_D$
Saw dust	1000	775	400	375
Paper pulp	1000	800	450	350

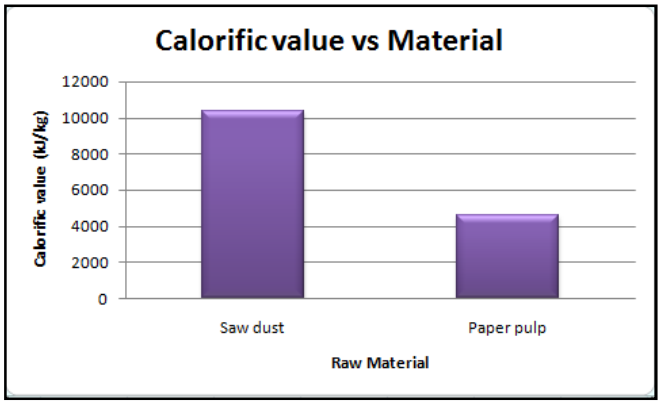


B. Calorific Value

The calorific value indicates the heat content in the pellets.

The calorific value obtained by saw dust pellets is more than that of paper pulp pellets.

Raw Material	Calorific value (kJ/kg)
Saw dust	10356.5
Paper pulp	4572.22



(b)

C. Effect of Binders

The amount of binder affects property of pellets. With the increase in binder content the drop strength of the binder increases first then reduces. It reaches maximum value when its amount of binder is 30% after this value the drop strength of the pellets decreases. When the binder content reaches 30% the mechanical properties of the pellets are the best.

VI. CONCLUSION

The following conclusion can be drawn from this research:

For pellet quality control, physical parameters such as density, moisture content and compressive strength were found to be the best indicator of additive quality.

The physio-chemical characteristics of the pellets assessed in this study showed that pellets manufactured from :

Saw dust – moisture content (375 grams) , high calorific value (10356.5 kJ/kg or 2475.27 kCal/kg)

Paper pulp - moisture content (350 grams), calorific value (4572.22 kJ/kg or 1092.79 kCal/kg)

Pellets made from saw dust and paper pulp offers environmental advantage over traditional fuels.Carbon dioxide that is released when pellets is burned is considered to be carbon neutral, i.e., this fuel doesn't add to or reduce the amount of carbon in the atmosphere.

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REFERENCES

[1] Medic D, Darr M, Shah A, Potter B, Zimmerman J. Effects of torrefaction process parameters on biomass feedstock upgrading. Fuel 2012; 91(1): 147-154.

[2] Zannikos F, Kalligeros S, Anastopoulos G, Lois E. Converting biomass and waste plastic to solid fuel briquettes. Journal of Renewable Energy 2013; Article ID 360368.

[3] Mythili R, Venkatachalam P. Briquetting of Agro-residues. Carbon 2013; 42(41.80): 42-08.

[4] www.energy.wsu.edu

[5] Pongsak Jittabut.. Physical and Thermal Properties of Briquette Fuels from Rice Straw and Sugarcane Leaves by Mixing Molasses. Energy Procedia Volume 79, November 2015, Pages 2-9

[6] www.gemcopelletmill.com

[7] A. López, I. de Marco, B.M. Caballero, M.F. Laresgoiti, A. Adrados, Pyrolysis of municipal plastic wastes: Influence of raw material composition, Waste Management. 30 (2010) 620-627.

[8] S. Luo, B. Xiao, Z. Hu, S. Liu, Effect of particle size on pyrolysis of single-component municipal solid waste in fixed bed reactor, International Journal of Hydrogen Energ y. 35 (2010) 93-97