

Design and Fabrication of Biomass Pellet Manufacturing Machine- A Concept

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Abstract—Pellet fuels (or pellets) are biofuels which are made from compressed organic matter or biomass. Constituents of these pellets may include industrial waste and co-products, food waste, agricultural residues, energy crops, etc. The shape of the pellets are cylindrical, having diameter 6–10 mm and length 10–30 mm. The Project work presented in this report is based on design and fabrication of pellet manufacturing machine. The main objective in building this machine is to find a low cost and high energy burning fuel. Also, an effort in reducing pollution and to use the large agro residues that goes wasted.

Keywords—Biomass pellet machine, pellets, wood pellets, sawdust, pelleting technology.

I. INTRODUCTION

Many of the developing countries produce huge quantities of agro residues but they are not able to use it efficiently causing extensive polluted environment. Apart from transportation, storage, and handling problems, the direct burning of loose biomass in conventional grates is having very low thermal efficiency and widespread air pollution. The conversion efficiencies are as low as 40% with particulate emissions in the flue gases in excess of 3000 mg/Nm³. In addition, a large percentage of the ash of unburnt carbonaceous has to be disposed of. This amounts to more than 40% of the feed burnt. in the case of rice husk. As a typical example, about 800 tonnes of rice husk ash are generated every day in Ludhiana (Punjab) resulting in burning of 2000 tonnes of husk. Pelleting of the husk could lead to mitigation of these pollution problems while at the same time this important industrial/domestic energy resource can be utilized. With a motive to solve this problem, it is required to convert waste agro residues and other biomass constituents in the form of pellets for easy use, transportation and trade. However, it must be ensured that this technology should be cheap, simple and easy maintain. Biomass pelleting is basically the process of densification of loose biomass material, in order to produce compact solid composites of different sizes with the application of pressure. Under the the application of pressure, heat and binding agent on the loose materials, pelleting of residues takes place to produce the pellets. These pellets are often used as an alternative development intervention to replace firewood, charcoal, or other solid fuels. In the proper context biomass pellets can save time, save money, decrease local deforestation rates, and provide income generating opportunity.

II. WORKING

In the pelleting vessel, the mash is forced through the holes in the die by roller pressure. Die thickness is a major factor in the production of high-quality pellets and must be accurately balanced with the formulation and conditioning. Speed reduction devices that can be used include directly coupled gear trains, V-belts, cog belts and combinations of belts and gear trains. Pellet mills are installed with an electric motor as the prime mover. Die thickness and hole sizes varies with the type of product to be pelleted. The pellets normally flow by gravity into a device for cooling and drying the pellets. This is to be accomplished by passing a stream of air through a bed of pellets. This evaporates the excess moisture, causing cooling both by the evaporation of water and by contact with the air. Air has tendency to double its capacity to hold water with every 20° rise in temperature. Hence, the hotter the air the more moisture it should remove from the processed pellets. There are three points of pressure: (1) the roller acting upon the material compresses the material into the die, (2) the die itself has a resistance that can hold back the flow of material through the holes in that die, and (3) the pressure exerted by the rollers combined with the frictional pressures of the formulation itself. This pressure keeps the material compressed together and keeps it from squirting along the face of the die in front of the roll.

III. OBJECTIVES

1. The main objective of this study is to design, fabricate and test a pelleting machine
2. It is important to have a low-cost apparatus or machine for making pellets,. For research and development work and for the production of small quantities of pellets for specific applications,
3. Designing and constructing a pelleting machine with the main feedstock being saw dust and paper pulp.
4. To convert waste biomass into pellets with help of proper binder so that they can be stored and transported.
5. To obtain pellets with high calorific value
6. A Substitute for other types of fuel with all features
7. Acceptability of price per unit of heat produced
8. Production of combustion with low emission rates

IV. FIVE STEP METHODOLOGY

4.1 Step 1: Design of components: This is a critical stage where we design each and every component of the machine for its safe working in the given condition and also checking for their compatibility with other parts in the machine.

4.2 Step 2: Selection of material: It is the stage where we select the appropriate material for the respective components considering various parameters like the forces and environment it is exposed to and also the cost and availability of the material.

4.3 Step 3: Solid modelling: In this stage we prepare a 3D model of the machine based on our design of our components and assemble it to get a rough idea about the size, fit and aesthetics of the machine

4.4 Step 4: Fabrication: This is the stage of manufacturing the parts that are not available as stock in the market. Following are the fabrication processes that we will be using in our project

- **Cutting:** This process will be used in preparing the frame of our machine using C- channel section. Cutting will be required to cut the C-channel in the required dimensions using electric power machines etc.
- **Welding:** Welding is a joining process in which pieces of metal are heated using electricity or a flame so that they melt and stick together. In our project, welding will be used in joining the different parts of the C-channel. We will be using arc welding process in our project
- **Drilling:** Drilling is the process of cutting circular holes in solid materials using drill bits. We will be using this process to drill multiple holes on the disc(Die), On C-channel for fixing nuts and bolts
- **Counter boring:** Counter boring is the process of creating a cylindrical cavity with a larger diameter at the head of an already-drilled hole. In our project, we will be using this process to enlarge the pre-drilled holes on the perforated disc, ensuring smooth removal of pellets
- **Turning:** Turning is a form of machining (material removal process), in which rotational parts are created by cutting away unwanted material. In our project we find the use of this process in manufacturing of gear shaft according to our design diameter

4.5 Step 5: Assembly and working: This is the final stage where we assemble every components in the machine and check for the desired working and output of the machine.

V. RESULTS AND DISCUSSION

The proposed methodology targets at the elimination of pollution through combustion of harmful substances. It also aims at making an alternative fuel available in the market, and to some extent trying to eliminate the use of coal for burning purposes in order to increase the burning efficiency and increasing the use of pellets for domestic applications in rural areas.

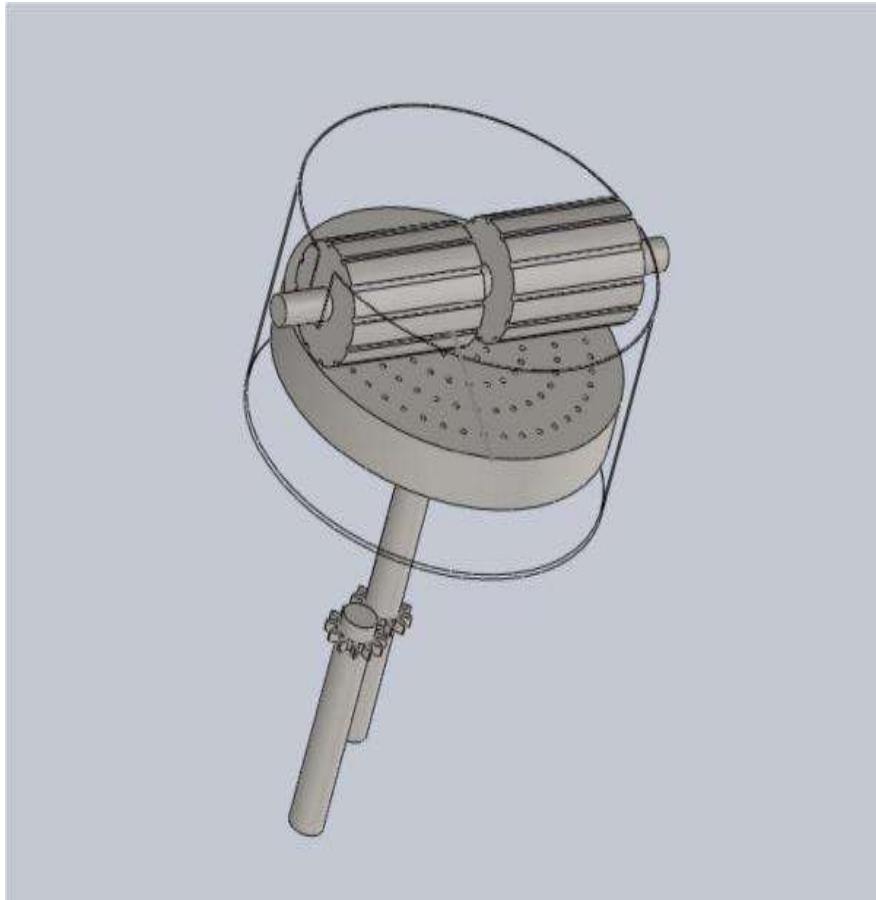


FIG 1: SOLID MODEL OF OUR PROJECT

VI. CONCLUSION

- **High calorific value and cost-effective:** the calorific value of biomass pellets is 17MJ/kg, which is cost-effective regarding its much lower price.
- **Environmentally friendly:** biomass pellets are carbon neutral, which means they only emit the amount of CO₂ they absorbed during growth. They do not release other air polluting gases into the air.
- **Renewable:** different from fossil fuels such as coal and natural gas which is expendable (formed in a very long time), biomass pellets are renewable, because plants grow every year, and we can have endless supply of biomass materials.
- **Independent:** the price of coal, oil and gas are controlled by the government, especially in these days when fossil fuels are decreasing, no one can assure the stability of their prices. However, the cost of pellets can be controlled by us.
- **Highly efficient:** in current time, the pellet burning system is more advanced than before with high efficiency and minimal emission.
- **Reliable continuous operation:** The ability of the machine to be used for its activities is reliable since one can be able to operate it any time that one feels. This is because one does not require any assistance from other people during its operation which is the best choice for those who would like to employ themselves as the workers in their farms.

REFERENCES

- [1] Milan Protic, Dragan Mitic Velimir Stefanovic, " Wood Pellets Production Technology" pp.23-26

- [2] Arifa Sultana, Amit Kumar, Don Harfield, "Development of agri-pellet production cost and optimum size", Elsevier Ltd, Bioresource Technology 2010, pp.5609-5621
- [3] Jaya Shankar Tumuluru, Christopher T. Wright, J. Richard Hess and Kevin Kenney, "Review of biomass densification systems to develop uniform feedstock commodities for bioenergy application" John Willey and Sons, Biofpr April 2011, pp.683-707
- [4] Tanakorn Unpinit ,Thanaporn Poblarpa ,Narongrit Sailoona ,Prasong Wongwichaa, Mallika Thabuota, "Fuel Properties of Bio-Pellets Produced from Selected Materials under Various Compacting Pressure" Elsevier Ltd. Energy Procedia, 2015, pp.657-662
- [5] A. Yank, M. Ngadi, R. Kok "Physical properties of rice husk and bran pellets under low pressure densification for rural applications" Elsevier Ltd, Biomass and Bioenergy, 2016, pp.22-30
- [6] Wolfgang Stelte "Fuel Pellets from Biomass. Processing, Bonding and Raw Materials" Technical University of Denmark, DTU Library, pp.1-47
- [7] Wolfgang Stelte, Lei Shang, "Recent Developments in Biomass Pelletization-A Review" Research Gate, Bio Resources 2012, pp.4451-4490
- [8] Harshal Pandya, "Frame Work for Checking Wood Pellets Quality & Production System", 2016 IJEDR | Volume 4, Issue 4, pp.201-205
- [9] Malgorzata Peksa-Blanchard, "Global Wood Pellets Markets and Industry: Policy Drivers, Market Status and Raw Material Potential", Research Gate, pp.5-120
- [10] Adam Sprague, Ben Cayer, Blaine Conner, Cole Predom, James Blakely, "Pelletizer Interim Assessment", Summer of Applied Research July 2012, pp.1-22.