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Design and Development of Chopper and Compression Machine for Developing Green Briquettes as Domestic Fuel Alternate

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Abstract – *This study aimed to design development of low cost chopper (shredder) and compression machine for producing green briquettes which addresses the disposal issue of agro/garden waste by converting this biomass into green fuel briquettes as alternate to conventional fuels like dung cakes and its production process for group of farmers. The study begins with collection of information data of available models in the market. The concept designs for both machines were developed. Special attention was given towards operational performance, safety, economy and maintenance. The chopper machine consists of cutters/, shaft, structural steel frame, bearings, hopper and machine is connected to 3-phase 2hp motor. Four bar mounted cutter assembly consisting 20 cutters welded to shaft. The power is transmitted to shaft cutter assembly from electrical motor with pulley belt. The agro/garden waste introduced inside the hopper part gets chopped in the powered form inside chopping chamber due to impact, friction and tensile effects. The waste chopped gets collected on the other side of the machine. The compression machine consists of frame, pressing unit, cylindrical mould assembly and hydraulic jack. The chopped wet biomass of agro/garden waste mixed with binder was poured inside cylindrical 4-mould assembly. The pressing unit consisting of 4-circular plates welded to 4-pipes at bottom and plates at other end. This assembly was put on the filled up mould assembly. The pressure is applied with 10T hydraulic Jack who densifies the biomass inside moulds; the briquettes were drawn from bottom by unscrewing the bottom plate. The perforations were made to the mould and bottom plate to drain off the excess water from biomass during densification.*

Key Words: **Chopper machine, Compression machine, Briquettes, Cutter assembly, Hopper, Agro waste, Hydraulic jack, Performance test**

1. INTRODUCTION

It is proven fact that city authorities like municipal corporations, Nagar panchayats, etc. spends huge amount on clearing and disposing the tree litter, garden wastes generated from roads, gardens etc. Leaf litter and garden waste is commonly collected by municipalities and can be treated like composting, burial or direct incineration. At the same time the crop residues, agricultural wastes, fallen tree leaves are increasing burden on farmers also garden wastes, fallen tree leaves, etc. are burden on village or city administration, which have to dispose of properly. The farmers are usually burn the agro residue/waste in the fields after crop cultivation, resulting huge pollution in the air, land and water. The burning of farm residue causes loss of nutrient value components like nitrogen, sulphur, carbon and removal of major existing minerals from the soil. The smoke emitted in the residue burning process, if added to atmospheric gases like ammonia, nitrogen oxide, methane, etc. can cause severe atmospheric pollution, this also indirectly affects in increasing the ozone pollution. The off side impact to human health due to degraded air quality results in diseases like respiratory (like asthma, bronchitis ailments) skin and eye. The burning of crop residue/wastes by farmers in the fields is increasing problem in India particularly in the northern sates of India like Punjab, Haryana and Rajasthan causes the air pollution and visibility issues. This study aimed to design development of low cost chopper (shredder) and compression machine for producing green briquettes which addresses the disposal issue of agro/garden waste by converting this biomass into green fuel briquettes as alternate to conventional fuels like dung cakes and its production process for group of farmers.

1.1 Objectives of study

- To Design and develop low cost semi-automatic agro/garden waste chopping machine.
- To design and develop low cost compression machine to compress shredded material.
- To study the performance of developed mechanism.

1.2 Literature Survey

K. Malak, et al. [1]Green Coal: a New Energy Source from Leaves their study have discussed a "Green Fuel" produced from waste leaves on the ground; The objective was to use leaves (biomass) as raw materials and convert them into solid biofuel briquettes/pellets using drying process, shown to be more effective than usual carbonization by using simulation techniques. The process starts with the required type of leaves and their calorific value, after being collected, dried in sun and submitted to drying process. Because of poor energy characteristics, the dried end product was to be crushed and densifyed with specific additives chosen for binding the biomass and increases its calorific value. Finally, after processing, these leaves were converted into briquettes by densification process.

J.T. Oladeji: [3] "Fuel Characterization of Briquettes Produced from Corncob and Rice Husk Resides", year 2010, the findings of his study had shown that, the briquettes produced from rice husk and corncob would make good biomass fuels. However, from the study, it can be concluded that, briquette from corncob has more positive attributes of biomass fuel than rice husk briquette. Finally, the study also concluded that, both briquettes will not crumble during transportation and storage because the values obtained for their relaxed densities are closed to the maximum densities of the briquettes from the two residues.

Kishan Naik et al, [2] in their research work on "Design and fabrication of Areca fibre extraction Machine" they had studied design and fabrication of Areca fiber extraction machine. The extraction machine was used to remove fiber from husk of areca. The machine was equipped with 5hp electric motor connected to drive shaft with pulley and belt arrangement in such a way that dust gets removed and fiber comes out from duct at lower side of casing. The driven shaft was coupled with two bearings has blades which are designed by modifying the blade design of coconut husk. This machine would be useful in small enterpriser and farmers in rural areas.

2. FABRICATION AND DEVELOPMENT LOW COST SHREDDER MACHINE:

The machine comprises of following components:

- Cutter or blade
- Shaft
- Structural steel Frame
- Electric Induction Motor
- Bearings
- Hopper

The concept of machine was started with collection of data about the lifestyle of the user and current process or system they follow to complete their activities. To develop a concept of the machine the emphasis was given on parameters like – type of raw material to be chopped or shredded, needs of end users, minimum labour requirement, and cost economy in developing the machine, Safety of user/operator during operation as well as maintenance of the machine. Keeping in mind parameters mentioned above, a machine prototype was prepared and fabricated. The machine consists of 2-HP, Three-phase Squirrel cage foot mounted motor, spur gear, bearings, structural steel frame, cutter and shaft. The machine frame was built using mild steel and blades are made out of C80 grade alloy steel (hot press and harden). Five number of cutters each mounted on four shafts welded to two circular plates on either sides, which rotate parallel driven by a spur gear. The power from the electrical motor transmitted to cutter shafts through a belt drive by converting electrical energy to mechanical energy. The waste got cut/ chopped due to the effect of tensile, friction and impact in chopping process inside the chopping area. The agricultural, garden waste, fallen tree leaf litter gets chopped and this chopped material collected at front side of machine.

Table -1: Shredder Machine Design specifications:

Sr. No.	Description	Specification
1	Name	Agro /Garden and leaf litter waste shredder machine
2	Input Feeding	Top feeding with front side discharge
3	Mechanism	Single shaft with 4- bar mounted rotary blade with fix chopper blades. Gears and Pulley with belt drive.
4	Target users	A group of 10-15 farmers having agro farms. A colony of 25-35 households having garden areas around house.
5	Process operation	Electric Motor operated
6	Material used	Plain carbon steel for Shaft, C-80 grade alloy steel hot press and harden for cutters. Structural steel for frame & plate.
7	Development Steps	Machining, Indexing, Bending and Fabrication
8	Safety measures	Safety guards/coverings.
9	Cost of machine	INR. 35000/-
10	Machine Life	5-10 years
11	Electric Motor	2-HP, Three-phase Squirrel cage motor, 1450 RPM
12	Weight	60 kg
13	Production Rate	115-130 kg/hour of agro/garden waste shredding.

Fig -1: Developed model of Shredder Machine

3. FABRICATION AND DEVELOPMENT LOW COST COMPRESSION MACHINE:

The machine comprises of following components:

- Frame
- Pressing unit assembly
- Cylindrical mould assembly
- Hydraulic Jack

The concept of machine was started with collection of data about the lifestyle of the user and current process or system they follow to complete their activities. To develop a concept of the machine the emphasis was given on parameters like desired densification of type of raw material chopped or shredded needs of end users, minimum labour requirement, and cost economy in developing the machine, Safety of user/operator during operation as well as maintenance of the machine. Various existing Compression machine are observed based on this, literature review was done. From on the field survey, it was observed that high end compression machines with labours are commonly used for densification/ compressing the garden, agro wastes, and the cost of these machines is also found very expensive. To overcome these difficulties while designing and developing the Compression, machine is designed with manually operated hydraulic Jack. Also special care was taken for producing minimum four briquettes in one go. Considering these parameters, a compression machine prototype is prepared and fabricated. The machine consists of 4 hollow cylinders welded in the base plate which fixed to frame of structural steel square pipes; pressing assembly consists of four circular plates welded to circular pipes which were welded to square plate at top. 10T capacity hydraulic Jack used for applying the desired pressure. The cuts are made to the cylinders to remove excess water during densification of raw material. Due to the effect of hydraulic pressure generated by hydraulic jack, the pressing assembly moves downward and the cylinders filled with wet raw material gets densifyed by removing excess moisture out of it through perforations made to cylinders. Four wet briquettes produced at once and collected below the cylinders by removing bottom plate gradually.

Table -2: Compression machine Design specifications

Sr. No	Description	Specification
1	Name	Agro, Garden waste Compression machine
2	Type	Manually operated
3	Mechanism	Hydraulic Jack operated compression.
4	Target Customer	• A group of 10-15 farmers having agro farms .
5	Material	Mild steel for Structural frame, plates & pipes.
6	Manufacturing	Machining, Bending and Fabrication
7	Safety	Avoid sharp corners
8	Cost	INR.10000/-
9	Life of the product	5-10 years
10	Hydraulic Jack	10MT manually operated.
11	Weight	70 KG
12	Production Rate	24 briquettes per hour.

Fig -2: Developed model of Compression Machine

4. RESULT AND DISCUSSION

The performance Chopper/ shredding machine was measured using total quantity of agro/garden waste chopped in desired powder form at different durations of time. It was observed that machine is capable of shredding/chopping 115-130kg material per hour. The machine is equipped with vertical mesh which produces two types i.e. coarser and powdered waste. The graph plotted below shows Time (min) V/s weight of powder (kg) and performance found to be satisfactory. The test was conducted for 4 different intervals of times.

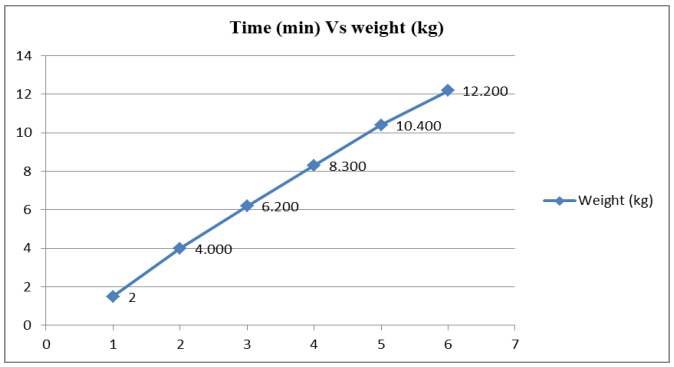

Chart -1: Time V/s weight graph of chopper Machine

The Chopper/shredding machine fabricated and developed cost Rs. 35000/- which is cost effective compared to other machine available in the market.

The designed and developed compression machine performance is measured by densifying the shredded biomass with the machine. The number of briquettes produced and time taken for same. In present case, machine is capable of densifying four briquettes at one cycle. The time taken to produce one cycle of briquettes at different time intervals is noted. The machine is capable of producing 24 briquettes per hour. Accordingly, in a shift of one day (eight hours) 192 briquettes can be produced. The graph below shows Time (min) V/s no. of briquettes and performance found to be satisfactory.

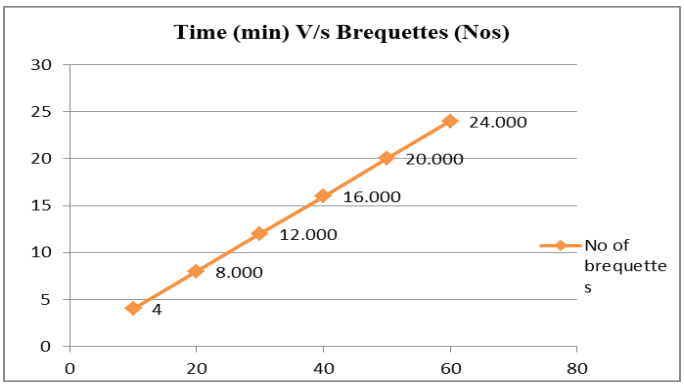

Chart -2: Time V/s weight graph of Compression Machine

The Compression machine fabrication and development cost is Rs. 12500/- which is cost effective compared to other high cost machines in the market.

5. CONCLUSIONS

Shredder/Chopper machine:

- The developed machine model is simple in design and operation, efficient in its designed functionality.
- The machine assembly was checked for its sturdiness and found reliable.
- The machine is compact and can be accommodated in less space. The shredding/chopping is possible at less time. The Machine is very cost effective when compared with models in market.
- The less labour involvement is required, no special skill required for operations i.e. user friendly. Special attention is given towards safety during operations; all rotating parts of machine are well covered.
- The overall performance of the machine is found satisfactory.

Compression machine:

- The developed model of machine is simple in design and operation, efficient in its designed functionality.
- The machine assembly was checked for its sturdiness and found reliable. It is compact and required less space.
- The Machine found to be very cost effective compared to existing models in market.
- The machine is user friendly and no special skill required for operations.
- The machine is safe during operations as no rotating part is involved in it.
- The overall performance of the machine was found satisfactory considering briquettes production time, quality and quantity.

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