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Pepper Threshing, Grading and Drying Machine

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Abstract - *Processing* of pepper involves different unit operation such as threshing, cleaning, grading and packaging. The threshed and dried black pepper has many matters like spent spikes, pinheads, soil particles …etc. Cleaning is done by winnowing and hand picking which removes some of the impurities.

For hundreds of years grain was separated by hand and it was very time consuming. Apart from this, in many industries even now the peppers are separated manually. However, during this manual process in industries there is a huge wastage of money as well as time. In order to avoid this wastage a model pepper thresher machine is designed and fabricated. The main components of this machine include a rotating drum, hopper, vibrator, grading system and dryer. The graded peppers are collected separately. A vibratory mechanism and tray system are used which results in a rich grade of pepper collected in a separate beaker and small size pepper and dust is collected in the bottom. A dryer is used in the machine to dry the pepper, it helps to dehydrate water content.

Key Words: Threshing, Grading, Drying, Cleaning, Vibrator.

1. INTRODUCTION

Black pepper is a flowering vine in the family Piperaceae, cultivated for its fruit which is usually dried and used as a spice and seasoning, known as a peppercorn. When fresh and fully mature, it is approximately 5 millimeters (0.20 inch) in diameter. South Indian state of Kerala is one of the leading producers and exporters of pepper. They are widely used as flavours and as traditional medicine from a long period of time.

The crop is harvested mainly in the months of December and January at proper maturity of the berries, as it greatly influences the quality of the final product; pepper vine grows on supporting trees; the flowers are small, produced on spikes at leaves nodes. One stem bears 20 to 30 fruiting spikes. When one or two fruits at the spikes begin to turn red the peppercorns are either stripped of the spikes using hands or by spreading it on a larger surface and stamping them manually with bare feet. This is the process used by farmers and exporters.

This is a very time-consuming process and may damage the peppercorns. The extraneous matters like spent spikes, pinheads, stones may mix with the peppercorns. It requires more human effort. Here we designed and fabricated a machine for the purpose of threshing peppers and grading. In many industries even now, the pepper is separated manually. Due to this manual process in industries there is wastage of money and time. In order to avoid this wastage, we have designed the following model called Pepper Threshing, Grading and Drying machine. This is an advanced and automated process to our needs. Pepper separator and grader machine is used for separating pepper berries from spikes and grading the pepper based on the vibrating motion of this machine.

2. METHODOLOGY

The pepper threshing machine is used to perform multiple operations. The pepper that is introduced into the hopper will fall onto the rotor of machine. The rotation of rotor separates the berries. The rotor rotates at a uniform speed. The berries then fall into the grading part and graded according to its size. Vibration motion is given to the grading part, so that proper grading will occur and berries with different sizes are graded. Vibration is provided by dc motor. Berries of different sizes are fallen into different trays. The collected berries are dried using a dryer.

3. DESIGN AND FABRICATIONS

Mild steel sheet, mild steel angle and mild steel flat is mainly used for building the machine. Mild steel has a high resistance to breakage. Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms.3.1 Material Selection.

Hopper and the thresher are made using MS sheet. The frame of thresher rotor is made using MS flat. The frame of grading system and legs the machine is made up of MS angle these are joined together by means of welding. Drilled roofing sheet is used at the upper part of grading system to get the required size of holes on it and aluminium net is used in the lower part. They are bolted to the MS angle. Using roofing sheet and aluminium net helps to reduce the cost.

3.2 Components Description

3.2.1 DC Motor

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

3.2.2 Ball Bearing

The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. Bearing is made up of steel material and bearing cap is mild steel. Ball and roller bearings are used widely in instruments and machines in order to minimize friction and power loss. While the concept of the ball bearing dates back at least to Leonardo da Vinci, their design and manufacture has become remarkably sophisticated.

3.2.3 Hopper

Food processing hoppers are holding containers utilized for dispensing food products. Featuring a chute that restricts product flow, these containment vessels assist in better management of foods being processed and are also used for short storage or collection in several processing operations. Some types include rectangular hoppers, conical hoppers, dry ingredient hoppers as well as customized specialty hoppers. Food processing hoppers are used in various facilities for meats, seafood, poultry, fruits and vegetables, snack foods, beverages, and other applications.

3.2.4 Grading Section

It is used to grade the pepper coming from the thresher. Mainly perforate sheets are used for grading purpose. Grading is used to separate pepper berries according to their sizes. As a result, different size peppers can be collected separately. And the wastes in pepper can be removed.

3.2.5 Frame

It is defined as the engineering structure of different shapes like curved or straight. It contains one multi-force member. The frame structure is the combination of beams, column, and slab. The use of frame is to resist the moments which developed during the applied loading. Different types of frame structures can be constructed from various materials such as reinforced concrete, steel, and wood. A Frame structure is a structure having the combination of beam, column and slab to resist the lateral and gravity loads. These structures are usually used to overcome the large moments developing due to the applied loading.

3.2.6 Gear Wheel

A gear or cogwheel is a rotating machine part having cut teeth or, in the case of a cogwheel, inserted teeth (called cogs), which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source.

3.2.7 Thresher Casing

The thresher which is used to thresh the pepper berries mechanically as well as manually. The thresher consists of a feeding hopper made of an iron sheet, a rotating type threshing drum and a concave metal sheet with a perforated bottom, all of which are mounted on the main frame. The machine also has the facility of manual operation. The harvested pepper spikes are directly fed to the hopper through the rotating drum. The threshed pepper passes down through the perforations and gets collected at the berry outlets.

3.2.8 Rotating Drum

Roller drum rotates inside the hopper with the help of motor. The motor drives the roller drum, as the roller drum rotates it pulls the pepper spikes over and force it to passes through a narrow passage between the roller drum and fixed thresher tray.

3.2.9 Vibrator

A Vibrator is a mechanical device to generate vibrations. The vibration is often generated by an electric motor with an unbalanced mass on its driveshaft.

3.2.10 Mesh

Mesh is the important part in the “Pepper Separation and Cleaning Machine” through which pepper is separated and cleaned from dust. The machine consists of two type of mesh. Through the 5mm mesh rich grade pepper is collected. In the 3mm mesh low grade pepper is collected.

3.2.11 Shaft

Shaft is a rotating machine element, usually circular in cross section it is used to transmit power from one part to another. The various member such as pulleys and gears are mounted on it.

3.2.12 Dryer

A dryer is used to dry the pepper that is coming out from thresher. The dryer consists of heating coil and solar collector. The heating coil is used to heat the surrounding air. The fan is used to transfer the heat from heating coil to the chamber in which peppers are stored. The fans which

are fixed at the top of the dryer helps to maintain the required temperature. When electricity is not available the solar collector is used to collect the energy and this energy is used for drying the pepper.

3.3 Specification

3.5 Design and Calculations

Hopper is designed and it is provided at the top of the thresher for the smooth flow of black pepper. The thresher is used for threshing the pepper. The thresher contains two parts Rotor and Stator. The rotor has projections of triangular prism blades separated at uniform distance apart.

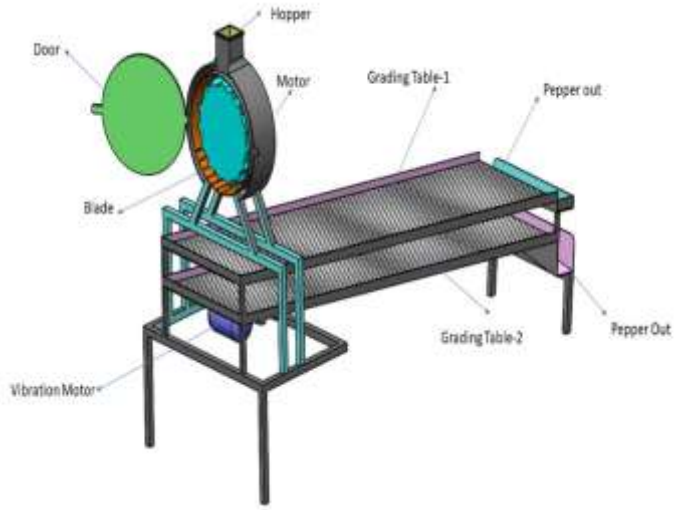


Fig-1: Pepper Thresher, Grading and Drying Machine CAD Model

The stator is designed with holes which has erections through halfway in the direction opposite to the pepper flow. The rotor is rotated with the help of a shaft. The shaft is connected to a gear which is driven by a driver gear which rotates with the help of Dc viper motor.

A casing is provided around the thresher to direct the flow of threshed pepper. It then falls on the grading system which contain two roofing sheets fixed parallelly. The upper roofing sheets has holes of 5mm diameter each and lower roofing sheet has holes of 3 mm diameter each.

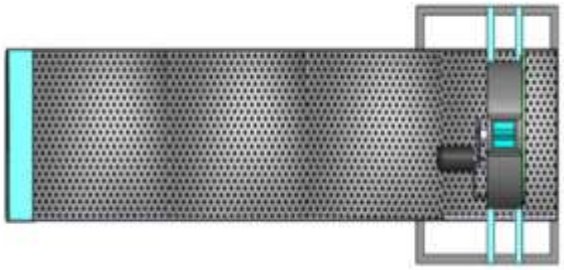


Fig-2: Top View

A vibrater is fixed at the bottom of grading system. The vibrater is made by welding a circular disc of radius 2 cm eccentrically to a Dc motor having 1200 rpm. A dryer is attached to the grading system for drying the graded pepper.

3.4.1 Calculations

3.4.1.1 Ball Bearing

Selection of Bearing No. 6202

Outer Diameter of Bearing (D) = 35 mm

Thickness of Bearing (B) = 12 mm

Inner Diameter of the Bearing (d) = 150 mm

Radius (r_1) = 1

Maximum Speed = 15,000 rpm

Mean Diameter (dm) = (D + d) / 2

= (35 + 15) / 2

dm = 25 mm

3.4.1.2 Dimensions of Machine

Rotor diameter =15 cm

Stator diameter = 20 cm

Covering diameter = 24 cm

Eccentric disk for vibrator, diameter = 4 cm

Blade = 2*2.3

Standing angle = 5 degree

Shaft length = 15 cm

Bed width = 25 cm

Leg height (Back) = 30.5 cm

Leg height (front) = 23.56 cm

Hopper width = 7 cm

Hopper height = 7 cm

Hopper length = 9.2 cm

Total length = 106 cm

Total height = 86 cm

Total width = 66 cm

3.4.1.3 Gear Calculation

Inclination of the Grading Part = 5 Degree

Module = Pitch Diameter/Module

Addendum = Module

Dedendum = 1.157*Module

Working Depth =2*Module

Whole Depth = 2.157*Module

Pitch Diameter = Module*Teeth

Outside Diameter = Module*(Teeth+2)

Number of Major Teeth = 38

Number of Minor Teeth = 12

3.4.1.4 Major Gear

Major Teeth, M = 3.4/38 = .089 cm

Addendum for Major = .089 cm

Dedendum for Major = 1.157*.089 = .102 cm

Dedendum for Major = 1.157*.089 = .102 cm

Whole Depth for Major = 2.157*M =.191 cm

Outside Diameter for Major = M*(T+2) =3.56 cm

Pitch Diameter for Major = M*T = 3.38 cm

3.4.1.5 Minor Gear

Minor Teeth, M = 1/12 = .0833 cm

Addendum for Minor = .0833 cm

Dedendum for Minor = 1.157*.0833 = .096 cm

Working Depth Minor = 2*M = .166 cm

Whole Depth for Minor = 2.157*M = .179 cm

Outside Diameter for Minor = M*(T+2) = 1.16 cm

Pitch Diameter for Minor = M*T = 99 cm

3.5 Working Principle

The fresh green pepper which is directly extracted from the pepper plant is transferred into the pepper threshing machine through a hopper. Hopper then directs the fresh pepper to thresher where it undergoes threshing. The thresher contains two parts Rotor and Stator. The rotor has projections of triangular prism blades separated at uniform distance apart.

The stator is designed with holes which have erections through halfway in the direction opposite to the pepper flow for the smooth threshing of pepper. The rotor rotates in anticlockwise direction with the help of a shaft. The shaft is connected to a gear which is driven by a driver gear which rotates with the help of Dc viper motor having 1400 rpm. The rotation of the rotor is maintained at 20 rpm for producing maximum power.

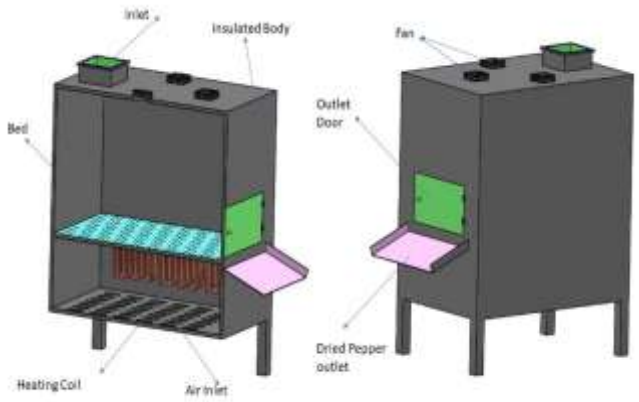


Fig-3: Dryer

A casing is provided around the thresher to direct the flow of threshed pepper. The spikes of pepper will remain at the thresher and can be removed later. Then the threshed pepper falls on the grading system which contains two roofing sheets fixed parallelly. The upper roofing sheet has holes of 5mm diameter each and the lower roofing sheet has holes of 3 mm diameter each. The pepper which has size above 5mm can be collected from the upper roofing sheet and the pepper which has size of 4mm can be collected from the lower roofing sheet. Small buts and other unwanted particles are also filtered at the lower sheet and it can be collected from the bottom of the grading system.

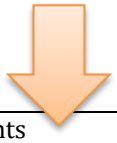
Fig-4: Pepper Threshing, Grading and Drying Machine

A vibrater is fixed at the bottom of the grading system for the proper movement of particles which are stuck across the grading system and grading is done properly and smoothly. The vibrater is made by welding a circular disc of radius 2 cm eccentrically to a Dc motor having 1200 rpm. The graded pepper from grading sheets are directed to different paths and is collected according to the required size.

3.6 Fabrication

Modeling of Structure Frame

Process Used: Material Selection, metal cutting, welding, punching etc.



Assembly of components

Rotor to shaft, drive gear to driven gear, motor is welded to the grading system.

Assembly of machine

Joining upper part and lower part using bolts,

Attaching perforated sheet to the upper and lower frames of the grinding system, Painting.

4. RESULT

The project pepper threshing grading and drying machine for agriculture purpose is very compact and it is more helpful for small scale agricultural sectors to reduce the effort of threshing, grading and drying of the pepper. It also helps to minimize the human interaction, here the machine is powered by dc supply so it is very economical.

5. CONCLUSION

Conclusion is drawn on the basis of the information collected on each aspect of this project. Traditionally Separation, grading, cleaning and drying of pepper is done manually, which involves labour cost, time, physical activities, and dust. All the above problems can be completely eliminated by using the “PEPPER THRESHING, GRADING AND DRYING MACHINE”. This project aims at giving separated, cleaned and dried pepper without lowering the grade of pepper which is of very important, with minimum cost. This machine will be a boon for the pepper growing farmers, as pepper separation and cleaning can be done by minimum time, less or no labour, and at minimum cost. It also helps to sort the pepper according to size. Thus, addressing all the problem aspects that are faced by present day pepper grower.

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