

Design and Development of Mobile Tender Coconut Crusher

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Abstract—Tender Coconut Crushing Machine is intended to crush the tender coconut husks after consumption. The main goal of this machine is to reduce the amount of tender coconut waste produced after consumption thereby eliminating the environmental pollution. The machine is made up of four shafts with 14 blades each; they are arranged on radial axis and fixed into 3 discs to apply pressure on the tender coconut shell and husk during the crushing process. During the crushing operation, the four shafts connected to the discs at a specific pitch circle diameter rotates creating a centrifugal action and thereby the blades pivoted to the four shafts acts as a hammer. This hammering process shreds tender coconut husk and its shells into crushed form making it suitable for agricultural applications. The machinery is capable of processing 4000-4800 tender coconut husks with shells during 8-hour shift generating 900-1200 kg of crushed product. For easy conveyance for better operation onsite, the machinery is connected with a tractor. The drive for the operation of the machinery is obtained from the tractor's PTO shaft. Finally, the aiding the attainment of goals by lessening tender coconut husk waste and converting it into value added agricultural produce.

Keywords—Tender coconut; crushing process; hammer blade; PTO shaft; agricultural application

I. INTRODUCTION

The tender coconut crushing machine is designed for crushing tender coconut husks and shells. The crux objective is to reduce the consumed tender coconut waste. This equipment is ideal for small farmers who want to supplement their revenue by reusing this product which is considered as waste, at present. The final product obtained in finer particle form from the crushing process is found effective as an agricultural potting mixture. The crushed husks product can be utilized for varied agricultural purposes specifically for moistening the soil and improving soil quality.

The coconut palm is one of the most useful tropical trees, used for food, beverage, shelter, and animal feed, as well as being grown industrially for the edible and highly saturated oil contained in the flesh of its fruits. The tree has a life span of 50 years without much care, and the fruits fall throughout the year. The smooth epidermis of the nut is covered by a fibrous mesocarp (husk) that protects the hard endocarp (shell). A thick brown layer (1-2 cm) (testa) separates the shell from the endosperm (kernel, flesh, meat). The coconut water is kept in a cavity within the kernel

Tender coconut is fresh, natural, and healthy because it is unprocessed young coconut. It is a pure and delicious energy drink that is high in vitamins, minerals, glucose, fructose, and proteins. It has high potassium content and antioxidants.

Consumed Tender coconut husks with shell are an agricultural waste that is abundant in tropical countries around the world. The potential value addition of tender coconut husks can be increase by proper conversion into a useful form.

This paper will present the design and testing of a machine that will convert consumed tender coconut to crushed product that can be used as a plant growing medium.

A. Advantages of crushed tender coconut

Water Retention: It has an innate ability to retain moisture for extended periods of time.

Aeration: It provides excellent aeration for your plants' roots. It is a wise decision to limit environmental impact.

Naturally pH Balanced: This is close to neutral on the pH scale, making it suitable for a wide range of plants without the need for additives. It has a high nutrient density and contains potassium, iron, manganese, copper, and zinc. Plants benefit significantly from these nutrients.

Beneficial Bacteria: This beneficial bacterium fights harmful bacteria that can harm your plants.

Cost-effective: After consumption, it has a lower value, which can be converted into a higher-value product.

B. Applications

Potting Soil: It is a growing medium used in hydroponics, container gardens, and pots. Also ideal for indoor plants, particularly soilless planting.

Ground Cloth: It's ideal for use as ground cover outside, doing an excellent job of retaining moisture and outgrowing weed growth.

Soil conditioner: It can be used as a soil conditioner in different situations. It improves aeration and provides nutrients to the soil.

II. DESIGN

Fig.1 depicts the design and construction of a tender coconut crushing machine. The machine has a horizontal shaft that spins at 2018 RPM and holds a number of hammer plates with steel discs. These hammer plates are mounted on horizontal shafts that are radially connected in steel discs and rotates clockwise. Hammer plates, made of hardened steel with a specially profiled impact surface does the crushing of the tender coconuts. The hammers are swing-type, so that centrifugal action causes all hammer plates to act as independent hammers to beat the husks.

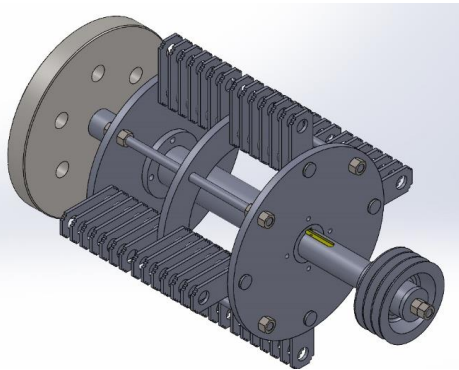
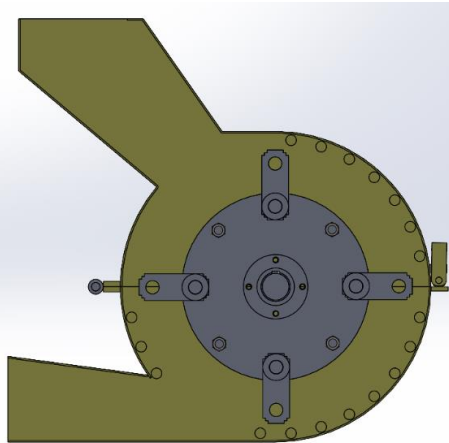


Fig.1 Design Outline of the Machine

The tender coconut husks fed into the hopper, which flows vertically down under gravity and then passes into crushing chamber through a inclined chute. The hammers are in continuous motion inside the crushing chamber as the husk fed into it. These uniformly rotating hammers smash the husks, and crushes into finer particles. The particles are then expelled through the exit hopper. Because of the tangential exit, the particle size is significantly reduced.

This crushing blade system is covered by a mild steel shell having square and hardened rods that are welded radially to the internal surface. The hammer plate's convergent design compresses the husk particles to the blade tips, resulting in finer crushed tender coconut husks.

A. Drive

The main drive of the machine is taken from a 20 HP tractor through a PTO shaft having 540 RPM with the help of universal joint. For attaining a crushing speed up to 2000 RPM in desired direction, series of spur gears, idle gears and V pulleys and V belts are used. Fig.2 illustrates the drive layout of the machine.

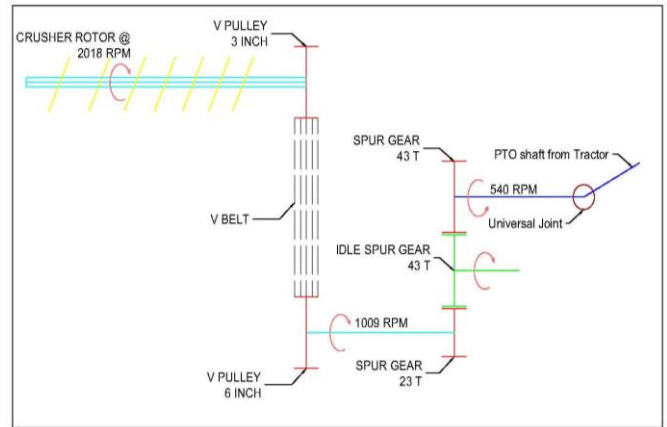


Fig.2 Drive Layout

B. Speed Calculation:

PTO speed 540 RPM

To increase the speed from 540RPM to 1009RPM, $(540 \text{ RPM} \times 3M43Z \text{ Spur Gear}) / 3M23Z \text{ Spur Gear} = 1009 \text{ RPM}$, therefore the 6-inch V pulley Connected with the 3M23Z Spur gear rotates at 1009 RPM.

To increase the speed from 1009RPM of 6 inch V Pulley to 2018RPM of 3-inch Pulley and crusher rotor, $(1009\text{RPM} \times 6'' \text{ V pulley}) / 3'' \text{ V pulley} = 2018 \text{ RPM}$

III. MANUFACTURING PROCESS

Weldment structure is used to construct the machine's supporting frame, which is made up of 100x50x6 mm MS C Channel and 50mm, 40mm MS Square Tubes. Hammer is made from Hardened steel and En8 rods are used to make the center and pivoted shafts. Discs are from MS plates and Cold Rolled Sheets of 3 mm and 2 mm are used to construct the top and bottom chambers. En8 rods are utilized for V pulleys and En24 round rod for the spur gears. The crusher disc assembly is supported by pillow block bearings. Conventional Lathe, Universal Milling Machine, Radial Drilling Machine, Hydraulic Iron Worker, Hydraulic Press Bread and Shearing Machine, Electrode Welding Machine are being used during various stages of machine fabrication.





Fig. 3. Developed Machine

Figure 3 depicts the coconut shell and husks crusher machine in its final stage of development.

IV. RESULTS AND DISCUSSIONS

The basic performance parameters of the tender coconut crusher prototype have been experimentally tested in our machine shop at NCRMI. The tender coconut crusher's performance was evaluated by counting the total number of consumed tender coconut husks over a period of time. The machine has a capability of processing 4000-4800 consumed tender coconut husks per day, yielding 900-1200 kg of crushed tender coconut powder, with allowances for machine set up time. The machine was put through a performance test to determine its suitability and functionality.

Many environmental difficulties, like as health hazards, are caused by the consumed tender coconut debris. It emits dangerous elements into the air and water, such as sulphur dioxide (SO₂), silicon dioxide (SiO₂), and inhalable articles, which can be negated by using this crusher machine. The crushed output has been experimentally proven to suitable as potting filler & mix and also acts as a soil conditioner. Such a level of eco-friendly and sustainable intervention shall curb the intense use of artificial fertilizers causing detrimental impact on human. A comprehensive and repetitive

experimental trails regarding the functioning and operation machine is carried out.

V. CONCLUSION

The machine proves to be most preferred choice for farmers and dealers for the effective utilization of tender coconut husk. The equipment has been built to meet the diverse needs of farmers and other stakeholders. This machine eliminates the dependence of the electric power supply and support onsite operation.

The capital requirements for procurement of higher capacity crushers are expensive. Also, the use of chemical fertilizers has high cost based impact on the farmers. This present innovation obviously creates significant footprints for the utilization of so called garbage – tender coconut husk into value added potting mix & filler and other agricultural products. It is evident that this developed crushing unit far cheaper from existing counterparts. The unit is easy operable with quick set up operation onsite. Easy maintenance, reduced skill requirement, less space, better safety features makes this machine more attractive.

The machine is found ideal for crushing tender coconuts that have been consumed as well as crop leftovers to produce organic compost. Our ideas and thoughts are protracting towards the mechanisms and technologies of the equipment on completion of this endeavor. Moreover, it is proven fact that for the purpose of crushing consumed tender coconut waste, this machine technology is an economical and excellent significantly contributing towards improving the farmers' economic conditions and their standard of living. The crusher machine encompasses an economical as well as social perspective for farmers by setting up small businesses, providing organic compost. The machine is an effective means for farmers who are poverty stricken to manufacture their own organic compost for meeting their minimum crop yield demand.

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