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Design and Fabrication of Compact Coconut Shell Crusher

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***Abstract*: The scope of this project was to design and development of coconut shell crusher machine focus on chopping of coconut husks and shells. The crushers are mounted on two shafts, which rotate parallely driven by a spur gear. The power from the electrical motor is transmitted to cutter shaft through a belt drive. Crushing is made inside the crushing house due to the effect of tensile, friction, and impact effect in crushing process. The coco powder gets crushed and powder is collected at the bottom. Compact shell crusher machine is a fibre extracting machine from the husk and shell of coconut and used as an excellent soil conditioner and is being extensively used as a soil-less medium for agri-horticultural purposes. With its moisture retention qualities, coir pith is ideal for growing anthuriums and orchids. Available in raw form or converted into organic manure. Although a water Irrigation Sprinkler system could meet the needs with presence and monitoring during the growing season, continual presence of the worker to control irrigation automatic instruments is not economic. Through advancements in technology and advent of processors and controllers, it will be more serious improving the role of farmer as an observer off-field particularly in the light of new irrigation systems.**

***Keywords*: coconut shell, crusher, powder, roller mechanism.**

1. Objectives

- To reduce the cost of machine.
- To reduce the space and makes it compact.
- To reduce the man power.
- To avoid large power consumption.

2. Literature Review

Y. Prashant, C. Gopinath, Vignesh Ravichandran et al., [1] (2014) designed a coconut fiber extraction machine for farmers and small scale coir industries in India to provide an effective solution to the difficulties in existing process, reduce time and labour cost and to develop a compact coconut fiber extraction machine.

I. M. Sanjay Kumar et al.., [2] (2015), [1] presented a paper of pieces of coconut leaves, which dry the coconut leaves to make lice compost. Traditional agro-waste disposal is the disposal of traditional and ancient waste, in which agricultural waste is decomposed. Because waste is thrown away, it takes longer time to decompose so it may pollute the environment. The crumbling machine is to reduce the amount of agricultural waste used to fertilize.

S. Nithyananth et al., [3] (2014) developed a Design of waste shredder machine. The waste shredder machine is an attachment as like a ploughing attachment. Shredder can be operated with a Tractor – power take off shaft (PTO). The Assembly consists of one fixed blade and five circular blades. The organic matter shredded will be in small pieces to enable the farmer to make use to prepare for vermin Compost.

Ajinkya S. Hande et al., [4] (2014) in their research work carried out project on Methodology for Design & Fabrication of Portable Organic Waste Chopping Machine. Organic waste is fed uniformly through feeding drum and tray. The cut is also made inside the chopping house due to the effect of tensile, friction, and impact effect in chopping process. Then the cut pieces pass through the concave holes of the sieve & come out of the machine. The sieves of different sized holes can be used.

Y. Prashant et al., [5] (2014) they carried out a project on Design and Develop a Coconut fiber extraction machine for small scale coir industries. Coconut husk is fed from one end in between barrels and round coconut shell is moved automatically towards other end and separated fiber material is collected in sack below. In this concept cutting pins has been press fitted on indexed hole on barrel surface. Cutting pins helps to remove fiber and to give linear motion to coconut shell to exit. Cutting pin indexing angle and distance plays the major role to extracting the coconut fiber.

Kishana Naiki [6] et al., (2014) they are focused project on Fabrication of areca fiber extraction machine. This is basically removing fiber from areca husk. This machine consists of 3 phase 5 hp ac motor which is directly coupled to drive shaft. The driven shaft is enclosed in a casing which is designed in such a way that only dust is removed and fiber comes out of rectangular duct at lower side of casing. The driven shaft is supported by two bearings and has blades which are designed by modifying the blade design of coconut husk decorticating machine.

P. B. Khope and J. P. Modak et al., [7] (2013) Proposed the Design of experimental set-up for establishing empirical relationship for chaff cutter energized by human powered flywheel motor. This machine used to chop the forage into small pieces for easy consumption by the animals. In the human powered flywheel motor concept, the bicycle mechanism for converting and transmitting human energy through paddling to

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rotational kinetic energy of flywheel is hereby proposed. The energy stored in the flywheel can be used for actual cutting process.

3. Methodology

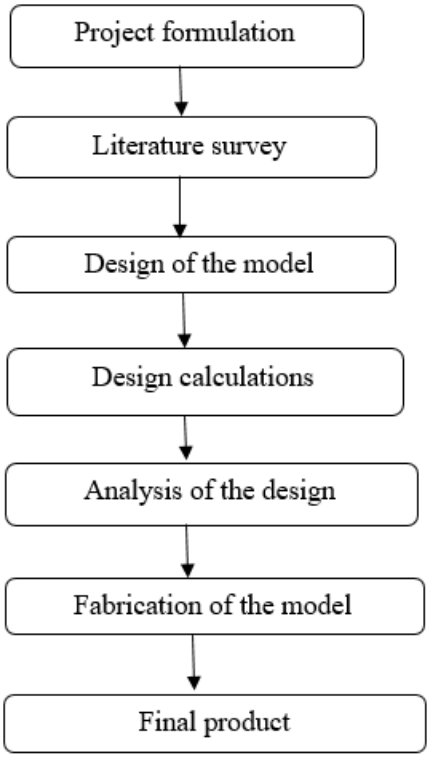

Fig. 1. Methodology

4. Components and their Functions

A. Motor

A single phase induction motor is used to drive the mechanism. This motor is generally used in various kinds of industrial drives. The motor acts as the driver wheel connected through a belting system directly to the gear box that acts as the driven wheel. The rotation speed of the output shaft of the motor is 1500rpm. The motor's output shaft is connected directly to the gear box through a belting system that will completely reduce the transmission losses. The motor bed is rigidly fixed onto the frame of the machine. Caution was taken such that the motor shaft and the gear box input shaft were attached in a parallel line to minimize vibrations and completely utilize the power of the motor.

B. Mild steel

Mild steel is steel in which the main interstitial alloying constituent is carbon in the range of 0.12–2.0%. The American Iron and Steel Institute (AISI) definition says. Steel is considered to be carbon steel when no minimum content is specified or required for chromium, cobalt, molybdenum, nickel, niobium, titanium, tungsten, vanadium or zirconium, or any other element to be added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40 percent; or when the maximum content specified for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60, copper 0.60.

C. Gears

The worm gears are widely used for transmitting power of high velocity ratios. The gear box used in this machine has a speed ratio of 70:1. This reduces the speed from 1500 rpm to 21 rpm. The mechanism used in the gear box is the worm gear mechanism. The gear box is coupled with the motor using a pulley connected to a v-belt. The output of the gear box is coupled to a long shaft that protrudes out from the centre of one of the rollers for the attachment to the holding mechanism. It consists of the worm and the worm wheel. The worm is, in essence, a cylinder having threads of the same shape as that of an in-volute rack. The worm is generally made of mild steel while the gear or wheel is made of bronze or cast iron for light service.

D. Shaft

A shaft is a long rotating cylinder that transmits power from one place to another. The power is delivered to the shaft by tangential forces and the resultant torque on one end of the shaft is connected to the output of the gear box, meanwhile, the other end is connected to the main roller and also acts as a support to the rolling system.

E. Holding mechanism

Bearing blocks are used to reduce vibrations or wobbling during the rotation of a long shaft with heavy loads. Therefore, to mitigate the vibrations of the machine, two bearing blocks are used between the reduction gear box and the roller blade while another two are placed at the right end of the roller shaft. Bearing blocks are also known as plummer blocks. Its construction is simple such that a bearing is concealed within a metal block and the metal block is rigidly fixed onto the frame of the machine. The bearing block is carefully centred so that the axis of the shaft and the bearing block are parallel to each other to reduce vibrations and wobbling during operation.

F. Roller type blade mechanism

The roller type mechanism is such that two rollers, each having an elongated configuration is disposed and spaced apart, substantially parallel to one another with respect to the base and in a readily accessible position. A drive means is also provided in support of the base and with direct driving engagement with the rollers. Interconnection of the rollers to the drive means is such that the rollers are forced to rotate in an opposite direction relative to the other and in a preferred embodiment to be described in greater detail hereinafter, at relatively different speeds. Collectively, the rollers define two outer exposed surfaces, which may be considered as the upper portions of the roller. In such orientation, the rollers rotate in a direction towards the centre such that a coconut, placed thereon, will be forced into the spacing between the rollers.

G. Crushing spikes

The spikes that are attached to the rotating shafts play a key role in peeling the coconut. It acts as the tool for the machine.

The existence of penetrating means, formed on each roller blades in the form of multiple spikes, helps in delivering effective crushing of the coconut shell and husk. The spikes are sharpened and spaced from one another at substantially an equal distance to each other, whereby the array of spikes are positioned to facilitate the penetration, gripping and tearing of the coconut shell husk. However, the sharpened spikes are interspersed with the blunt spikes. The sharp spikes grip the coconut husk by penetrating into it after the coconut is fed into the machine while the blunt spikes tear off the husks. In other words, if the coconut is exposed to a larger surface area consisting of sharpened spikes, it will increase the tendency for the nut to break-off because of larger penetrating forces. Thus, this design arrangement is suitable for the purpose of crushing a coconut shell with optimum efficiency.

5. Design Calculation

A single phase motor with 1hp, speed of 1500rpm and 230v is used. Power will be transferred from the motor through several power transmission components designed to rotate the roller. Below is the calculation for the mechanisms showing all the calculation for the theoretical design.

A. Design of Belt on Main Shaft Pulley

1) Selected motor 1hp, 1440 rpm
2) Speed of main shaft N2 = 360mm
3) Velocity ratio is 4 for shredding
4) Motor pulley diameter, D1 = 90mm
5) Shaft pulley diameter, D2 = 360mm
6) Design power, P_d = 1.0444kw
7) V_p =407.15/min
8) For v-belt drive V_p =300 to 1500 m/min V_p in range so selected velocity ratio is correct.
9) Power/belt = 1.60246 KW
10) No. of belts, n = 1
11) Length of belt, L = 1.3m
12) Bending load, Fb = 506.66N

B. Design of Bigger Pulley on Main Shaft Pulley

1) Width of pulley, w = 26mm
2) Pitch diameter, D_p = 200mm
3) Arm-construction (4 arms)
4) Rim thickness, t = 11mm
5) No. of sets = 1
6) No. of stand = 1 (single stand pulley)

C. Design of Main Shaft

1) Design torque, T_d = 34.629 N-m
2) Belt tensions, T1 = 168.166 N,
2) T2 = 360.54N
3) Force Calculation
4) Wt. of bigger pulley,
5) W_p = 53.955 N
6) wt. of main shaft with blades,
7) W_{sh} =131.9 N
8) R_{vd} = 129.813 N
9) R_{va} = 56.13 N
10) Resultant moment, M_b = 150.162 N-m
11) Selecting shaft material SAE 1040
12) T_{max} = 39.375 Mpa
13) Diameter of shaft, D_{sh} = 32mm
14) Pulley Hub diameter, D_h =55 mm
15) Pulley Hub length L_h =30mm
16) P cutter = 396.910 Watt
17) P hammer = 327.4946 Watt
18) Total power required = 724.404 Watt

6. Working

This power operated coconut crushing machine operates on single phase, 1 hp electric motor. It consists of main parts like,

1. Frame,
2. Electric motor,
3. Power transmission and speed
4. Crushing unit.

Frame was constructed by welding and single phase electric motor of specification 1hp, 1440rpm is mounted on the frame. To transmit the power from motor to the cylinders, with required speed, gear and pulley transmission system are incorporated. The crushing unit consists of two cylinders with different speed of rotation in order to cause tearing effect over the coconut husk and shell. The two cylinders provide with different speeds at opposite directions. This eliminates the use of number speed reduction unit in the machine. The spikes are mounted on the cylinders in a particular manner, to get more grip and effective crushing. The crushing process in very simple, place the coconut in between the two rolling cylinders, rotating in opposite directions. As the cylinders rotate, spikes provided on the periphery will penetrate into the husk and shell and tear it away. Removed husk and coco powder are in the form of separated fibers, so these fibers are more useful in coir industry. Thus the crushing can be done, effectively.

7. Conclusion

The project comprises of research and user study. Literature study is carried out based on the existing patents on coconut fiber extraction machine, and it is observed that there are difficulties for remote village. So there is a need to give solution to overcome their difficulties Below are some of the conclusions based on new derived process and new designed product and its functions.

Based on the Design concepts and development, output of the product. This product can crush 100 coconuts per hour and it will be good for Farmers and small scale coir industries.

- Easy to assemble.
- Easy Maintenance.
- About the market, this model is compact with good range of productivity with low cost and safety.

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