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DESIGN AND FABRICATION OF LOW COST COCONUT DEHUSKING MACHINE

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Abstract— This paper presents the design and fabrication activities involved in developing an automated coconut de-husking machine. The main purpose of this machine is to eliminate the skilled operator involved in de-husking the coconut and to completely automate the dehusking and crown removing process. Although coconut dehusking machines have already been demonstrated in the work and also in some small-scale industries, the process is either manual or semi-automatic. A completely automated machine with manual loading and unloading of coconuts will yield productivity higher than the existing process. Because of that, the current work is mainly focused on an automated machine for dehusking and crown removing. Also, we can yield lot of useful and commercial products from coconut at various stages of its lifecycle. The machine aims at de-husking and removing the crown of the de-husked coconut of various sizes. In order to get to know about the different sizes of the coconut, various places are visited where exuberant yielding of coconuts are made. Also, dimensional data of coconuts have been collected. Based on the survey the maximum and minimum sizes of the coconut are determined. The machine is designed to accommodate different sizes of the coconut that are cultivated anywhere in the world. Also, various experiments have been conducted on both dry and mature coconuts in order to determine the force required to de-husk the coconut.

Keywords— Coconut de-husking, Crown, Automation, Manual loading, Semi-automatic, Skilled operator, Commercial product, Productivity.

INTRODUCTION

Farm mechanization increases the effective utilization of machines to increase the productivity of land and labour.Besides it helps in reducing the drudgery, time and cost of cultivation in farm operations. In farm mechanization, the operations are divided into three i) Pre-harvesting operation ii) Harvesting operation iii) Post-harvesting operation. Coconut (cocosnucifera) is one of the world's most useful and important perennial plants. The coconut fruit is made up of an outer exocarp, a thick fibrous fruit coat known as husk; underneath is the hard-protective endocarp or shell.

The coconut palm is widely cultivated in the tropics. India is the world's third largest producer of coconuts after the Philippines and Indonesia. Other producers are Thailand, Malaysia, Papua New Guinea and the Pacific Islands. With coconut plantations extending over more than a million hectares, India produces about 5500 million nuts a year. Copra produced in the country is about 0.35 million tons and India accounts for about 50% of the world trade in coir. Coconut plantations are mostly concentrated in the coastal and deltaic regions of south India. In India, the crop is produced mainly by small and marginal farmers who number about 5 million. The average size of holding is as small as 0.25 hectares. With agricultural labour problems worsening and water resources dwindling, more and more plantation acreage is being converted from arca to coconut since the latter is easier to grow and more remunerative

Almost all the parts of coconut are useful. The meat of immature coconut fruit can be made into ice cream while that of a mature coconut fruit can be eaten fresh or used for making shredded coconut and livestock feed. Coconut milk is a refreshing and nutritious drink while its oil is use for cooking and making margarine. Coconut oil is also very important in soap production. The shell is used for fuel purpose, shell gasifier as an alternate source of heat energy. The husk yields fibres used in the manufacture of coir products such as coir carpets, coir geo-textile, coir composite, coir safety belts, coir boards, coir asbestos and coir pith. Coir is a versatile natural fibre extracted from mesocarp tissue, or husk of the coconut fruit. Generally,fibre is of golden colour when cleaned after removing from coconut husk. Coir is the fibrous husk of the coconut shell. Being tough and naturally resistant to seawater, the coir protects the fruit enough to survive months floating on ocean currents to be washed up on a sandy shore where it may sprout and grow into a tree, if it has enough fresh water, because all the other nutrients it needs have been carried along with the seed.

1.1Physical properties of coconut

Coconuts are of different shapes and sizes[7] not all are the same. so that we can analyze the average of a coconut shape and size.

Table No. 1 Physical properties of coconut

Particulars	**Dry coconut**
Shape	Ovoid
Length, (mm)	210-270
Diameter, (mm)	160-206
Weight, (kg)	0.62-1.25
Shell Diameter, (mm)	80-120
Husk Thickness-at pedicel end, (mm)	62
Husk Thickness-at apex end, (mm)	34
Husk Thickness-1/4 distance from pedicel end, (mm)	32
Husk Thickness-1/2 distance from pedicel end, (mm)	24
Husk Thickness-3/4 distance from pedicel end, (mm)	28

2. Design and working

The experimental setup of our project consists of a frame on which the entire components are mounted. The dehusker is present at the Centre which is delivered motion with the help of a motor and the chain drive. Also at the top of the dehusker, a plate is mounted which helps to prevent the slipping of the coconut fibres while the dehusking operation.

Figure No.1: CAD Model

Placing the coconut on the rollers which having spikes, the rollers are connected with shaft which is rottated by an electric motor. Thus the husk can peel of due to the opposing motion of rotating rollers. We can peel any coconut which is having dimension as mensioned earlier.

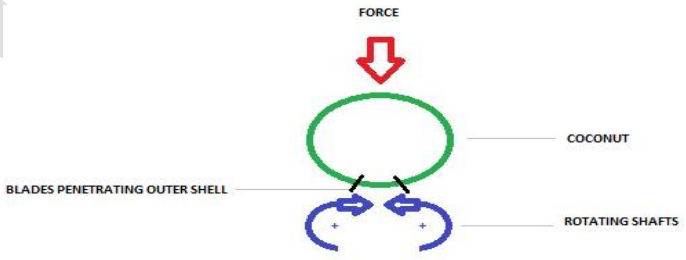

Figure No.2: Principle Of Working

3. Components and Description

[1] Hollow Shafts with Spines
[2] Worm and worm wheel
[3] Cutting Pins
[4] Spur Gear
[5] Bearing with Bearing Cap
[6] Chain Drive
[7] Electric Motor

3.1 Hollow Shafts with Spines

The dimensions of cylinders are designed in a manner to obtain effective mesh with coconut husk. Assumptions used,

1. Coconut contacts with cylinder at an average angle of 30-degree contact sector .
2. The 1/6th of width of coconut should be inserted into the intermediate space between cylinders. (Approximately 30mm).

Figure No.3: Roller with Spines

3.2Worm and worm wheel

A worm drive is a gear in which a worm meshes with a worm gear. The two elements are also called the worm screw and worm wheel. [1-3]The terminology is often confused by imprecise use of the term worm gear to refer to the worm, the worm gear, or the worm drive as a unit. Like other gear arrangements, a worm drive can reduce rotational or transmit higher torque. The image shows a section of a gear box with a worm gear driven by a worm. A worm is an example of a screw, one of the six simple machines.

[12]A gearbox designed using a worm and worm-wheel is considerably smaller than one made from plain spur gears, and has its drive axes at 90° to each other. With a single start worm, for each 360° turn of the worm, the worm-gear advances only one tooth of the gear. Therefore, regardless of the worm's size (sensible engineering limits not withstanding), Given a single start worm, a 20-tooth worm gear reduces the speed by the ratio of 20:1. With spur gears, a gear of 12 teeth must match with a 240-tooth gear to achieve the same 20:1 ratio Therefore, if the diametrical pitch (DP) of each gear is the same, then, in terms of the physical size of the 240-tooth gear to that of the 20-tooth gear, the worm arrangement is considerably smaller in volume.

3.3 Cutting Spines

The adhesion between fibers in the husk is greater than that between the shell and the husk; hence separation occurs at the husk-shell interface.The thickness of fiber is in the range of 20 to 40mm.[4] The dimension of tynes should be so selected that to get effective penetration with coconut. The tynes can be attached to cylindrical rollers either by welding or by using fasteners. The advantage of using fasteners is that the damaged tynes can be easily replaced.

Figure No.4: Spine

3.4 Spur Gear

Gears are commonly used to transmit rotational motion between machinery shafts. The spur gears, which are designed to transmit motion and power between parallel shafts, are the most economical gears in the power transmission industry. [10-12]The internal gears are spur gears turned "inside out". In other words, the teeth are cut into the inside diameter while the outside diameter is kept smooth. This design allows for the driving pinion to rotate internal to the gear, which, in turn, allows for clean operation. Intended for light duty applications, these gears are available only in brass. When choosing a mating spur gear, always remember that the difference in the number of teeth between the internal gear and pinion should not be less than 15 or 12.

Perhaps the most often used and simplest gear system, external spur gears are cylindrical gears with straight teeth parallel to the axis. They are used to transmit rotary motion between parallel shafts and the shafts rotate in opposite directions. They tend to be noisy at high speed as the two gear surfaces come into contact at once. Internal spur gears: The internal spur gear works similarly to the external spur gears except that the pinion is inside the spur gear. They are used to transmit rotary motion between parallel shafts but the shafts rotate in the same direction with this arrangement.

3.5 Bearing with Bearing Cap

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

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.

3.6 Chain Drive

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. [7-8]It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear

Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotates once, it causes the gear that drives the wheels to rotate more than one revolution.

3.7 Electric Motor

It is found to drive the roller shaft which fixed on the end of the frame structure. [8-9]The free end of the shaft in the motor a large pulley is found around which the belt runs. Single phase induction motors require just one power phase for their operation. They are commonly used in low power rating applications, in domestic as well as industrial use.

An induction motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor can therefore be made without electrical connections to the rotor. An induction motor's rotor can be either wound type or squirrel-cage type.

4. EXPERIMENTAL SETUP

Figure No.5: Experimental setup

5. ADVANTAGES

1. Skilled labor is not required.
2. Easy operation
3. It can be transported easily from one place to another since dismantling and assembling is simple.
4. Maintenance is easy.
5. Investment is very low(below 5000 rupees)

CONCLUSION

An automated machine for coconut dehusking and crown removal has been developed for the small-scale farm holders in the agricultural and rural areas. The operation of the machine is simple and the maintenance of the machine is also not expensive. The machine can dehusk an average of 200 coconuts per hour. Introducing this machine in the farm areas can reduce the risk involved in the use of spikes in dehusking the coconut and also eliminates the skilled manpower required for dehusking the coconuts. The machine can also be integrated along with the further processing steps of the nuts such as the production of copra.

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