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DESIGN AND DEVELOPMENT OF SEMI AUTOMATIC COCONUT DECORTICATING MACHINE

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Abstract :*There is compelling need to mechanize and automate harvesting and post harvesting operations of fruits, vegetable, medicinal and aromatic plant and fruits to increase the throughput yield of consumable fruits and vegetables. In this project, we have designed and fabricated a semi-automatic set up to decorticate the outer husk of coconut fruit which is found in abundance in South Indian states. The coconut fruit has several outer protective layers and shells, which needs to be decorticated for accessing the fruit kernel (white layer of meat) and water. The project focuses on the design and fabrication of coconut husk chipper machine which will expedite the husk removal that is presently done by coconut sellers and household users either manually or mechanical means. The machine is built with a cold rolled and cold annealed shaft fitted with sharp steel blade bars and operated by motorized drive mechanism. The set up designed and configured not only automates the decorticating operation, but can increase the throughput propagation of coconut plant harvesting and fruit decortication. The decorticating set up is aimed at circumventing the possibility of injuries and physical exertion to vendor and users.*

IndexTerms–Copra -White Kernel, Shell, Coconut De-Husking, Shear force .

I. INTRODUCTION

A decorticating machine was developed in response to the need for a low cost but durable coir- extraction machine. Coir fiber is an important material in the manufacture of coir wood-cement board (CWCB) used for housing, furniture and other finished products. The decorticating machine set up is composed of a cylindrical decorticating drum, gearbox, the rotary drive mechanism and run with 0.5HP, 1-Phase/3 Phase electric motor. The set up is operated from a control box pendant. Processing coir fibers is a large industry and husks removal machine will increase the throughput propagation of husks to the coir processing industry. Coconut is one of the world's most edible fruit producing perennial plants.. Coconut provides food, edible oil, industrial oil and health drink to humanity. All parts of coconut tree is useful in one way or other and the crop profoundly influences the socio economic security and development of millions of farm families.

1.1 LITERATURE SURVEY

Coconut decorticating machines are used to remove the outer shell or husk of coconuts, allowing access to the valuable meat or copra inside. There are several types of coconut decorticating machines available, including manual, semi-automatic, and fully automatic machines.

Literature on the design and development of semi-automatic coconut decorticating machines can provide insights into the various factors to consider when building such a machine. Some key considerations include the type of power source, the size and shape of the machine, the materials used for construction, and the efficiency and speed of the machine.

One study published in the Journal of Engineering and Applied Sciences described the design and development of a semi-automatic coconut decorticating machine powered by a 2 HP electric motor. The machine was designed to process up to 60 coconuts per hour and had a decorticating efficiency of 99.4%. The machine consisted of a motor-driven decorticating wheel and a conveyor system that transported the coconuts into the machine and removed the husk after decorticating. The study found that the machine was effective in removing the husk and could be easily operated by a single operator.

Another study published in the Journal of Agricultural Engineering and Technology focused on the design and development of a semi-automatic coconut decorticating machine that was powered by a 1.5 HP electric motor. This machine was designed to process up to 50 coconuts per hour and had a decorticating efficiency of 98.5%. The machine consisted of a motor-driven decorticating wheel, a conveyor system, and a husk disposal system. The study found that the machine was effective in removing the husk and was easy to operate, making it suitable for small-scale coconut processing operations.

A third study published in the Journal of Engineering Research and Technology focused on the design and development of a semi-automatic coconut decorticating machine that was powered by a 1.5 HP electric motor. This machine was designed to process up to 60 coconuts per hour and had a decorticating efficiency of 99%. The machine consisted of a motor-driven decorticating wheel and a conveyor system that transported the coconuts into the machine and removed the husk after decorticating. The study found that the machine was effective in removing the husk and was easy to operate, making it suitable for small-scale coconut processing operations.

In summary, the design and development of semi-automatic coconut decorticating machines has been the focus of several studies, with common features including a motor-driven decorticating wheel, a conveyor system, and a husk disposal system. These machines are effective in removing the husk and can be easily operated by a single operator, making them suitable for small-scale coconut processing operations.

1.2 OBJECTIVES

The objective of designing and developing a semi-automatic coconut decorticating machine is to:

- **Increase productivity:** The machine should be capable of processing a large number of coconuts in a relatively short period of time. This will increase the productivity of coconut processing and reduce the time required to extract the coconut fiber.
- **Improve efficiency:** The machine should be able to extract the maximum amount of fiber from the coconut while minimizing wastage. This will improve the efficiency of the decorticating process and ensure that the maximum amount of fiber is extracted from each coconut.
- **Reduce labor costs:** The machine should require minimal manual labor, reducing the need for human operators and thus reducing labor costs.
- **Improve safety:** The machine should be designed with safety features to reduce the risk of injury to the operator.
- **Simplify maintenance:** The machine should be designed with simplicity in mind, making maintenance and repairs easier and less time-consuming.
- **Minimize environmental impact:** The machine should be designed with eco-friendliness in mind, minimizing waste and reducing the impact on the environment.
- **Cost-effectiveness:** The machine should be designed with cost-effectiveness in mind, ensuring that it is affordable and provides value for money.

2. METHODOLOGY

The design and development of a semi-automatic coconut decorticating machine requires a thorough methodology that involves several steps, including research, design, prototyping, testing, and optimization. Below is a general methodology for designing and developing a semi-automatic coconut decorticating machine:

- **Research and Conceptualization:** The first step in designing and developing a semi-automatic coconut decorticating machine is to conduct thorough research on the existing decorticating machines in the market. This research should include studying the features, advantages, and limitations of the machines. This information will help in conceptualizing the machine's design, which should address the limitations of the existing machines.
- **Design and Modeling:** After conceptualizing the machine's design, the next step is to create a 3D model of the machine using computer-aided design (CAD) software. The model should include all the necessary components of the machine, such as the feeding mechanism, cutting mechanism, and waste disposal system.
- **Prototype Development:** Once the design is finalized, the next step is to build a prototype of the machine. The prototype will allow the design team to test the machine's functionality and identify any design flaws that need to be addressed.
- **Testing and Optimization:** After building the prototype, the machine should undergo several tests to evaluate its performance, reliability, and durability. The tests should include checking the machine's efficiency in decorticating coconuts, its speed, and the quality of the output. The test results will guide the design team in optimizing the machine's design to enhance its performance.
- **Manufacturing:** Once the prototype has been optimized, the final step is to manufacture the machine. The manufacturing process should ensure that the machine is of high quality, durable, and reliable.

- **Installation and Training:** After manufacturing the machine, it should be installed and tested on-site.The machine's operators should be trained on how to use and maintain the machine.

- **Maintenance and Upgrades:** Regular maintenance should be carried out to ensure that the machine operates optimally. Additionally, upgrades can be made to the machine's design to enhance its performance and efficiency.

In conclusion, designing and developing a semi-automatic coconut decorticating machine requires a systematic methodology that involves research, design, prototyping, testing, optimization, manufacturing, installation, training, maintenance, and upgrades.

Table -1: Components of the De husking

Preparation of Manuscript			
S. NO	**DESCRIPTION**	**MATERIAL**	**DIMENSIONS**
1	Frame (L Angle)	Mild Steel	63*63*3mm
2	Gear Box	Speed Reduction	O/P 30 rpm
3	Motor	3Ø	O/P 15 rpm
4	Bearing	Mild Steel	Ø20* 6202 Series
5	Spur Gear	Mild Steel	Ø27*20mm 85t
6	V-Belt	Synthetic Rubber	2500mm
7	Rollers	Mild Steel	635mm
8	Shoft	Mils Steel	Ø30*700mm
9	Bolts & Nuts	Mild Steel	M12*26mm
10	Blade	Mild Steel	610*50*7mm--

Frame: The frame provides the foundation for the machine and supports all the other components. It should be sturdy enough to withstand the weight and force of the other components during operation.

Power source: The machine can be powered by electricity, diesel, or gasoline. The power source should be reliable and efficient.

Motor: The motor is responsible for driving the machine's various components. It should be powerful enough to handle the load and operate at the desired speed.

Conveyor belt: The conveyor belt is used to transport the coconuts from the feeding end to the processing end. It should be durable, non-slip, and easy to clean.

Decorticating drum: The decorticating drum is the main component that removes the coconut husk. It should be made of high-quality materials such as stainless steel and have a serrated surface to grip the husk.

Husk outlet chute: The husk outlet chute is used to collect the removed coconut husk. It should be positioned in a way that allows for easy disposal or recycling.

Control panel: The control panel is used to regulate the machine's speed, direction, and other settings. It should be easy to use and provide clear feedback to the operator.

Safety features: The machine should be equipped with safety features such as emergency stop buttons, guards.

The scope of the project will also include collaboration and communication with stakeholders, including coconut processing businesses and operators, to ensure that the machine meets their needs and expectations. The project will aim to design a machine that is cost-effective, user-friendly, and efficient in reducing the labor and time required for coconut decorticating

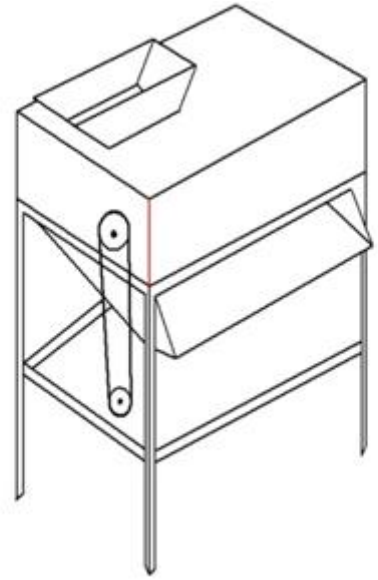

Fig -1: Semi-Automated Coconut Decorticating Machine

Different factors are to be considered while selecting the components of machine, viz., material properties, factor of safety, speed, torque, different types of loads, capacity to sustain the load and withstand vibrations . For designing the gear, the factors are to be considered such as speed reduction ratio, module, diameter, number of teeth, etc. Various loads are acting on the shaft. So by considering these loads, correct sizes of shafts and bearings have to be selected.

3. PROPOSED DESIGN

The proposed DE husking machine is driven my motor and it peels the husk from the dry coconut with the help of systematically arranged spikes on shafts. The dry coconuts are placed in between the two shafts. The shafts have spikes welded on them and rotate in opposite directions. The rolling motion of the roller shafts allows the spikes to penetrate the husk and peel them off the nuts. The proposed design consists of a power source to drive the shafts, a gear box to reduce the speed, chain and gear drive to transmit power, bearings and a frame to mount and support all the components. A 3 phase induction 740 watts' motor is used to drive the mechanism. The drive from the motor is transmitted to the gear box for speed reduction. The speed of rotation of the output shaft of the motoris 1440rpm. The motor output shaft is connected directly to the gear box using a love jaw coupling which completely reduces the transmission losses. The gear box and the motor is mounted on the lower part of the frame. Care was taken that the motor shaft and the gear box input shaft were in straight line to minimize the vibration and completely utilize the power of the motor.

Motor Requirement Calculation

- 3 phase induction motor with 1440rpm
- Shaft radius = 25mm • Tearing force required = 20kgf
- Power required in tearing: [(20*9.81) (2*3.14*.025) (100/60)] * 4 = 210W
- Power required for driving the coconut: [(20*9.81) (3/60)]= 10W
- Total power required= 210+10= 220W The gear box used in this machine has a speed ratio of 48:1. This reduces the speed from 1440 rpm to 30 rpm. The worm gear mechanism is used in the designed gear box for reducing the output speed. Reducing the output speed, increases the torque produced from the motor.

Gearbox Specification

- Speed ratio is 48:1.
- Speed Reduction: 960rpm to 30rpm.
- Diameter of output shaft =25mm

Belts and ropes drive could slip and strain hence there are not preferred. Chain and gear drives are preferably used for small distance power transmission. The power from the chain is transmitted to the shaft by means of sprocket.

- No of teeth in the sprocket attached to the gear box = 18
- No of teeth in the chain pulley attached to the spur gear=40 Total length of the chain=2400mm Two 30mm shafts are stepped into 20mm at the both ends of the shaft. This stepped end is connected to the bearings that are supported by the frame. The bearing to be used should provide proper balancing of shafts. The 6200 series maintenance free, self-lubricating bearing suits the requirement well.

Bearing Specification

- Bearing series=6200 series
- Bearing Number= 6202
- Diameter of the bearing=20mm

Shaft Specification

- Shaft– Mild steel

• Length of the shaft = 750mm.
• Number of shaft = 2
• Diameter of the shaft =30mm
• Stepped diameter at the both ends of the shaft = 20mm
• Stepped length at the both ends of the shaft =100mm
A Spur gear is attached to the other stepped end of each shaft and they mesh with another to rotate the shafts in opposite direction.

Gear Specification
• Gear type – Spur gear
• Number of teeth in the driver gear = 40
• No of teeth in the driven gear=40
• Diameter of the gear=60mm
• Centre distance between gears =120mm
• Spikes are made from the shaft of 10mm diameter.
They are cut into smaller pieces. Sharp edge is been formed and then the spike has been welded on to the rotating shaft. It is necessary that the material used has more hardness. The design of the spike The spikes are sharpened and spaced from one another substantially equal distance where by the patterned array in which the plurality of spikes are positioned which facilitates the penetration through the husk and peel them off.

4. EXPERIMENTAL RESULTS

The experimental results recorded and major specifications of the Semi Automatic Coconut Decorticating Machine are listed below:

Semi Automatic Coconut Decorticating Machine			
S. NO	**DESCRIPTION**	**Unit**	**Value**
1	Payload capacity	Kg	3
2	Coconuts feed rate	No/Hr	180
3	Throughput (Qty of Coconuts decorticated/unit time)	No/min	3
4	Coconuts de husked	No/ day	900
5	Total working time	Hrs/day	5
6	Cost of worker (5 Hrs day)	Rs/day	250
7	Power required for de-husking	Watts/KW	220/ 0.22
8	Power required per day	Watts-hr (5Hr/day)	1.1 KW
9	Power cost	Rs. / Watt	0.35
10	Total Power cost	Rs.	385
11	Total cost (Labor + Power)	Rs.	635
12	No of axes / Motors	No.	1
13	Motor speed	rpm	1440
14	Gear reduction	Ratio	48:1
15	Gear output speed	Rpm	30

5. CONCLUSIONS

Automated Coconut Decorticating set ups enhances the safety of coconut decorticating process and circumvent the possible spillover and loss of coconut water, the liquid endosperm in the cavity of the coconut and damage to kernel, white edible endosperm of the fruit.

As Coconut fruit is an unwieldy fruit in terms of weight and volume, the machine built should be sturdy and tough to withstand mechanical loads and vibrations, that entail backlash free configuration.

With further improvisation indesigndecorticating set ups can be made fully automatic to propagate the decorticating process to circumvent the present labor-intensive processes applied for removing outer husk from coconuts, while preventing the possible injuries and physical exertion to vendors and users.

The most prominent performance metrics to measure the performance of decorticating machine set up are speed, decorticating propagation and payload capacity.

The decorticating and de fibering capacity can be enhanced with increased automation technologies encompassing electricals and electronically controlled synchronous motors and control system to command and control different varieties of coconutfruits.

The coconut processing industry constitutes on an average 25% of total cultivated lands and is a major livelihood and GDP contributor in India, Indonesia and Phillipines and thus automating the coconut fruit decorticating process is imminient.

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