Design and Manufacturing of Coconut De-Husking, Cutting and Grating Machine

Kedar Deokar¹, Kevin Malaviya², Karan Mistry³, Pratham Chaudhari⁴, Madhumita Dutta⁵
Student¹,²,³,⁴, Professor⁵
Department of Mechanical Engineering
Vidyavardhini’s College of Engineering and Technology, Vasai, Maharashtra, India

Abstract:
Coconut is very important ingredient of Indian food just because of its versatility in use. Extracting the edible part from a coconut is not so easy task when it comes to process it from its very initial state. To make it possible and easier, we have manufactured coconut de-husking, cutting and grating machine. Design and manufacturing of coconut de-husking, cutting and grating machine consists of three operations, namely: Peeling of coconut fibres i.e. de-husking of coconut, breaking the coconut into two parts i.e. cutting and grating of coconut i.e. removing out the copra (edible white part). For de-husking process, the method selected for removing the fibres is the opposite movements of toothed shafts whose spiked pins are inserted into the fibrous layer of coconut for its removal. After peeling off the fibres, this coconut will be taken out. If copra is the desirable product then it will be sent to cutting process where it will be cut into two halves. If coconut water is required then it is sent to be punched into a punch on the frame to take out coconut water. After this, grating will be executed. Grating tool is hemispherical serrated tool which has notches on its outer periphery which will grate the coconut. Sub-assemblies of each operation are made separately to test the working of each process without any interference. The final products are coconut water and the grated edible coconut and are ready to use.

Keywords: Cutting, De-husking, Grating, Peeling.

I. INTRODUCTION

Conventionally, it is easy to break the coconut which we get in the market which is of daily use. But for a huge scale production, the process starts from de-husking or peeling the fiber off from coconut. After done with peeling the next process will be cutting and grating. But for every process, there exists a separate machine in the market and not all the three processes are done on a single machine. So this necessity i.e. to avail all the three processes at one place made us motivated to combine all the three machines in a single machine with optimum processing time and compactness taken into consideration. To peel the fiber off from a dry coconut manually is a tedious task and also it can cause harm to the operator. So doing this process without a hazard and with minimum time was the need of time. Coir industries need husk of dry coconut as their raw material and a coconut farm wants the edible part as their raw material. So both the parties need complementary parts of the coconut. Hence there is a need to bridge the gap between coconut farms and coir industries. Due to this, a machine fulfilling both the requirements is desirable and hence our project finds its scope.

i. COCONUT

Coconut (Cocos) grows in more than 80 countries in southern and south-western Africa, Latin America and Asia. “Cocos” in old Spanish / Portuguese language and means ”grinning face”, which refers to the facial expressions at the “top” of the coconut's hard shell from which it sprouts [1]. Coconut palms have a total production of coconut fruits of more than 60 million tons per year. The Philippines is the largest producer followed by Indonesia and India, but also Thailand, Malaysia, Sri Lanka, Ghana, Ivory Coast, Tanzania and Brazil are major producers of coconuts [1]. The anatomy of the coconut is as shown in Figure 2.1.

![Anatomy Of Coconut](image)

**Figure 1. Anatomy Of Coconut [2]**

ii. FIBROUS LAYER

Also known as “coir”, is a versatile natural fiber extracted from mesocarp tissue or husk of the coconut fruit, the general process. Generally fiber is of brownish golden color 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. These characteristics make the fibers quite useful in floor and outdoor mats, aquarium filters, cordage, rope and garden mulch [1].

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II. METHODOLOGY

As the model consists of three different processes, methodology and flow of the process are to be understood clearly. It starts with loading the coconut over the de-husking rollers and then forwarding it to get punched up at the tapered punch. This makes the coconut milk or water to escape the coconut and get collected in the provision. This de-husked and empty coconut is fixed into the arrangement done on the end of cutting lever to cut it right from the middle and get the two halves out of that arrangement. Grating tool employed on the roller grates those halves and forms the chips of edible coconut. CAD model of the machine is as shown in Figure 2. So, to make it easy to understand, each of the process is explained in following different sections along with its components.

III. DE-HUSKING PROCESS

Also called as ‘Peeling’, is Motor-operated type coconut fiber extraction process; in this type motor is attached at the base, smaller pulley at the motor end gives drive with the help V-belt to bigger pulley which is connected to gear with help of chain drive mounted on the gearbox. One gear will give drive to other gear, and rollers with tapered and sharp pins rotate in opposite direction with the help of these gears. Coconut with untapped husk is fed onto these barrels (rollers) and round coconut shell is obtained after de-husking and the husks are collected down from the space between two rollers. This process gives the major load to the motor.

Components of De-husking/Peeling:
1. Electric Motor: Power supply to driver pulley.
2. Pulley & Belt Drive: Transmit motion from motor to gears via gearbox employed with no reduction chain drive.
3. Gears: To rotate the rollers in opposite direction.
4. Shafts: Rollers are mounted on shafts.
5. Rollers: Cutting tips are welded on rollers for de-husking.

Figure 2. Cad model of machine

i. TIP DESIGN

Rollers are employed with steel tips which would de-husk the coconut. Opposite rotation of both the rollers causes the tips to pull the fibers off the shell of coconut, and thus exposing the brown shell. There are six tips on the circumference of rollers and such 4 sets on each of the rollers makes 24 tips to de-husk. These tips are welded on the roller and teeth are not in same line on both roller, a small offset is given so that teeth should not stuck with each other while rotating during the de-husking process. Tips are conical in shape and made from a circular rod. Tip design is as shown in the figure 3.

Figure 3. Tip Design

IV. CUTTING PROCESS

In the process of cutting, coconut is cut into two parts with help of the circular cutter which is operated on the motor power. Motor used for cutting is same as for de-husking, this enables us to make a compact design of the final machine and cost of machine is reduced. Nature of cutting process being sophisticated gives no restriction to the fact that motor speed can be used as the cutting speed. It should be noted that before cutting to be done on the coconut, coconut milk/water is removed from it by a punch on the frame. Due to punching-in the coconut, coconut water does not interfere with cutting process because with water inside, cutter blade splashes out the water radially outwards and makes the process untidy.

Components of Cutting:
1. Electric Motor: Power supply to cutting blade.
2. Belt Drive: It transmits power from motor directly to cutting blade without any reduction.
3. Circular Blade: Cutting will be carried out with circular blade.
4. Cutting Lever: This lever is employed with two unequal and non-co-planer rings to fix the coconut. The de-husked coconut is fixed on the arrangement on cutting lever and lever is operated manually to cut the coconut into two parts. The controlled motion of cutting lever is secured with a spring and a welded stopper.

V. GRATING PROCESS

Two pieces of coconut can be removed from the arrangement on lever and grated as per the requirement of type of product the consumer needs. The grating tool is mounted on the shaft which is driven by motor and which is directly coupled to gearbox via a no-reduction chain drive. The hemispherical grating tool is
selected over the other types of tools for removing more amount of material in one pass. Dimensions of tool are selected in such a way that major possible part of the coconut will be grated. The disadvantage of using tool with smaller diameter is that there will be a need of rotating the tool along the inner periphery of coconut for grating and that will be a tedious task. Tool will be having serrated teeth on its flaps which will actually be coming into contact with the part to be grated from coconut. It will chip down the maximum part of the edible part from the shell. This will decide its efficiency. Grating tool is mounted on the roller shaft itself and hence for this process, no extra source of power is required. Grating tool is as shown in Figure 4.

![Grating Tool](image)

**Figure 4. Grating Tool**

VI. EXPERIMENTATION

- As per the literature review, speed of both the de-husking rollers is same. The main disadvantage of this is that, coconut gets jammed between the rollers and this can harm teeth and can cause misalignment of rollers. To overcome this drawback, we have come up with an idea of giving different speeds to rollers and kept the speed ratio as 3:1. The rollers are at relative velocity giving the coconut the time to stay over the slower roller and hence it is equivalent to static de-husking.
- For cutting operation, as the cutter is very high, it is necessary to provide as safe for coconut so that it should not interrupt the cutting process and must not harm the operator. So we have made an arrangement so that the coconut will be held up into two rings which are different in diameter and no coplanar. These two rings are inclined to a small angle with each other so that the coconut should not escape the arrangement while cutting. This cutting is foot-operated and the motion is controlled by a spring and constrained by a chain.

VII. RESULTS

As per the operations performed, readings are obtained and plotted the graph which shows time taken by each process with respect to the different coconuts size. The following graph shows the same.

![Graph](image)

**Figure 5. Graph of time of processing vs. Coconut size**

So, the average time taken for each of the process after taking readings for different coconuts of different sizes are found to be as:

- De-husking: 23 seconds
- Cutting: 11 seconds
- Grating: 19 seconds

Also, the selected parameters and specifications after the testing are finalized as in Table 1. It is to be noted that, it is seen that bigger the size of the coconut, more is the time required to be processed. But this doesn’t mean that very small coconut find the best time. Slender and smaller coconut tends to reduce the efficiency of the operations performed upon it.

**TABLE 1. SPECIFICATIONS OF MACHINE COMPONENTS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Motor</td>
<td>2 HP, 1440 RPM</td>
<td>1</td>
</tr>
<tr>
<td>Gearbox</td>
<td>1:30 RR</td>
<td>1</td>
</tr>
<tr>
<td>Gear Drive</td>
<td>1:3 RR, Gear1: 69 Teeth, Gear2: 23 Teeth</td>
<td>1</td>
</tr>
<tr>
<td>Bearing</td>
<td>Journal Bearing, 25mm ID</td>
<td>5</td>
</tr>
<tr>
<td>Roller</td>
<td>Ø114.30mm, 330mm Length, 4 X 6 = 24 Pins</td>
<td>2</td>
</tr>
<tr>
<td>Cutter Blade</td>
<td>SLS Cutter, 13” OD</td>
<td>1</td>
</tr>
<tr>
<td>Bearing</td>
<td>Journal Bearing, Ø25mm ID</td>
<td>2</td>
</tr>
<tr>
<td>Grating Tool</td>
<td>Ø65mm, 18 RPM</td>
<td>1</td>
</tr>
</tbody>
</table>

VIII. CONCLUSION

The project comprises of research and design study areas of engineering. 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 villages to supply unutilized husks to coir industries directly. So there is a need to give solution to overcome their difficulties and to arrive at solution, importance is given towards user’s operating environment and mainly towards constraints like Safety, Function, Reliability and Time Saving. The project designed is found to incorporate the
components which are found safe theoretically along with some assumptions. All the three processes are incorporated in one machine will be fulfilling the needs like less time consumption, less human efforts and human safety too. As seen in results, the operation time does not only depend on coconut size but also on quality of the coconut. A brown matured coconut is only applicable for this process. A coconut which is dried for more than 20 to 25 days after can result in inefficient processing by the machine. This can be concluded from all the discussions and results that the project so designed and fabricated reduces the cost and saves human energy. The machines such as manual, traditional, electronic need minimum human effort and there are many advantages with these machines. The cost is less, human energy required is less and time taken by this machine is also less so we are able to perform our processes like De-husking, Cutting and Grating quickly and efficiently.

IX. REFERENCES


X. ADDITIONAL RESOURCES

