

# Design and Development of Coconut Dehusking Machine

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**Abstract-** Generally, coconuts are dehusked manually using a hand cutting tool. These methods require skilled labor which is difficult and painstaking process. Attempts made so far in the development of dehusking tools have only been partially successful and not effective in replacing manual methods. The reasons stated for the partial success of these tools includes unsatisfactory, incomplete dehusking, breakage of the coconut shell. Based on this a power - operated coconut dehusking machine is being designed and fabricated to solve the existing problems. To reduce the human efforts, the power operated machine is designed and developed. The new power operated de husking machine works on the principle of gear mechanism. Here the labor efforts and the time consumption for the de husking are reduced.

**Keywords -** Coconut, dehusking, tynes, power transmission, pitch.

## I. INTRODUCTION

The coconut de husking is post harvesting operation which is necessary step towards making the coconut ready for the further utilization. The coconut de husking process is complicated and studies are still in the initial stage in all coconut cultivation countries all over the world. The coconut also has cultural and religious significance in certain societies, particularly in India, where it is used in Hindu ritual.

## II. OVERVIEW

Considering all the existing powered and non-powered coconut dehusking machines, world market require a better coconut dehusking machine, which is both economically viable and efficient. Major disadvantages of existing power operated coconut dehusker are: High initial cost , Low rate of dehusking and Operational difficulty.

## III. LITERATURE SURVEY

### 3.1 Hydraulic Coconut De-husking Machine

Hydraulic power was used for operating the arm like structure which was used for opening coconut husks. Holding mechanism was used to hold the coconut in a standing position in which the eye was on the top position. It also consisted of some lifting mechanism (hydraulic powered) for lifting the holding mechanism. Husking was due to the combined action of lifting the holder and the arm. The major problem related to this machine was that it was bulky and had high power consumption. It also required skilled labour to lift the coconut according the husk opening.

### 3.2 Mechanical Coconut Husking Machine

In this machine, power was transmitted to the roller through helical gears. The powered rollers mounted in the right row rotate at a speed of 50 rpm, the outermost one carrying a series of slightly curved sharp hook-like knives that engage with the husk when coconuts are fed from the mouth of the throat. The whole nut was fed through the feed chute holding it vertically by hand, towards the converging throat where it was caught between the two rollers. In the process, the sharp right roll consisting of slightly curved hook-like knives engage with the husk and left spring loaded rollers press the coconut towards the right spiked rollers. As the rollers rotated, the husk gets detached from the shell, effecting a complete dehusking of coconut. The de-husked coconuts falls outlet below the roller where the gap between the spiked rollers and spring loaded rollers and were collected.

### 3.3 Coconut De husking Machine

Locate the coconut onto the mechanical hand, the mechanical hand will clamp the coconut tightly and rotate itself. The cutter starts to cut while the mechanical hand is rotating. In the cutting process, the cutter could automatically adjust the cutting depth and thus avoid the spilling out of the coconut milk resulted from the damage of the coconut flesh. The mechanical hand is equipped with a pressure pickup on its subject site. The cutter will continue to poke in until it touches the pickup, and then the control system react and executive the order to pull out the cutter. The mechanical hand reset itself and the de husking process is completed.

### 3.4 Foot Operated Coconut Dehusking Equipment

The Coconut is struck manually against the closed toothed blades. The paddle is accelerating turn around and the clamp action dehusk the coconut in two pieces. One or two subsequent operations are needed to separate the core completely. We can

easily operated this equipment. Pedal operated Coconut de husking equipment has a simple construction, it is light weight and handy which makes it portable. Pedal operated Coconut de husking equipment also is handled by unskilled person. This equipment is simple and there is no need of power source as it is manually operated. This coconut de husking equipment able to de husk 80-100 coconuts per hour. Pedal operated Coconut de husking equipment used in hotels, houses, and canteens etc. and also for commercial purposes. The fabrication cost of Pedal operated Coconut de husking equipment is in mass production is around four hundred rupees only. The efficiency of this equipment is higher when compared to other manually operated de husking methods.

#### IV. CONCEPTUAL ANALYSIS

*Concept 1-hand operated coconut dehusking tool*-It comprises mainly:

1. Stationary wedge/blade
2. Movable wedge/blade
3. Hinge pin
4. Hinge boss/seat
5. Hand-lever
6. Pedestal with a base

As shown in figure 4.1 it consists of two wedges movable and fixed. Movable wedge is operated by hand lever.

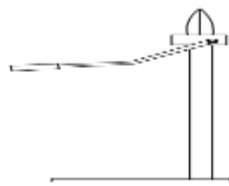


Figure 4.1 hand operated coconut dehusking tool.

- operator is required for performing the operation.
- It is not safe to operator due to long blades.

*Concept 2-Power operated Dehusking Machine with twin blades.*

In Twin Blade Dehusking machine shown in Figure 4.2, a twin-blade was been developed in such a way that the husking of the coconut was done by inserting coconut onto one of its twin-blade and the other flat blade would help in the process of peeling. The rotating motion of the blade aided to husk the coconut easily. This rotation of the blade facilitated the husking process. The disadvantages of this machine are:

- It is not safe to operator due to long blades.
- operator is required for performing the operation.



Figure 4.2 Power operated. Dehusking Machine with twin blades.

*Concept 3- Power Operated Coconut Dehusking Machine.*

*Coconut De husking Machine* – A Coconut de husking machine involves or consists of two rollers which has spikes over them. The coconut is inserted through the holes from the top which falls on the rollers, the rollers rotates in opposite direction. The spikes on one roller holds the husks while spikes on other tears the husk from the shell. Such a machine is bigger in size due to its long rollers. Large force is required due to small mechanical advantage.

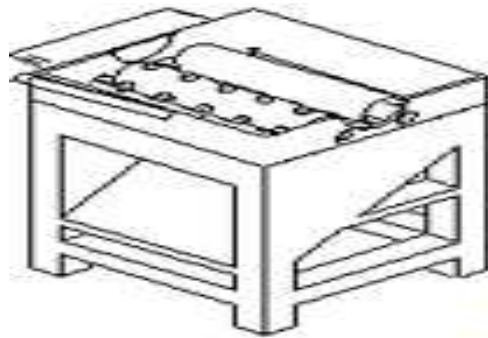


Figure 4.3 CAD design for Coconut De husk Machine.

**Concept Selection**

Concept selection is the convergent process of evaluating concepts with Respect to customer needs and the other criteria, comparing the relative’s strength and Weakness of the concepts and selecting one or more concepts for further investigation testing or development. Each concept under consideration is described with the sketches. In this method of concept screening, the concepts are entered along the top of the matrix. The selection criteria are listed along the left-hand side of the screening Matrix and selection criteria should be chosen to differentiate among the concepts. A reference concept which is straight forward is chosen. A relative score of “better than”(+) , “same as”(0) or “worse than”(-) is placed in the each cell of the Matrix to represent how each concept rates in comparison to the reference concepts Relative to the particular criterion after rating all the concepts, the sum of the number Of “batter than”, “same as”, and “worse than” scores and the sum of each category is Entered in the lower row of the matrix. After summation the Concepts are ranked. The concepts with the more pluses and fewer minuses are ranked higher. Concept evaluation is done using pugh’s chart as shown in table 5.1.

**V. CONCEPT EVALUATION**

Table 5.1 Pugh concept selection matrix

SL NO	SELECTION CRITERIA	CONCEPTS		
		1	2	3
1	Easy to Operate	0	0	+
2	Easy to carry	+	0	0
3	Easy to manufacture	0	0	0
4	Time consumption	0	0	+
5	Durability	0	0	+
6	Initial Cost	0	0	+
7	Portability	-	0	0
8	Safety	0	0	+
9	Power consumption	-	0	0
10	Assembly time	0	0	+
11	Capacity	-	0	+
12	Speed	-	0	+
13	Quality of dehusked nuts	0	0	+
	Sum of +’s	1	0	10
	Sum of 0’s	8	13	3
	Sum of -’s	4	0	0
	Net score	-3	0	10
	Rank	3	2	1
	Continue?	No	No	yes

**Conceptual Screening and Scoring**

In Pugh concept selection matrix (Tables 5.1), the criteria’s are entered in the left most side of the matrix. The various concepts are entered in the top most rows. The concepts are compared as mentioned below. The concept 3 is selected as Reference concept.

Table 5.2 Description of the concepts

1	2	3
Concept 1	Concept 2	Concept 3

Based on this concept 3 are ranked first, and Concept 1, and 2 ranked as 2rd and 3th rank. So concept 3 is selected for further review improvement and design purpose.

Table 5.3 Relative performance and rating.

RELATIVE PERFORMANCE	RATING
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Worse than reference	3
Same as reference	2
Much better than reference	1

## VI. DESIGN

In the designing of machine, it is very important to consider the shape and size of the coconut. After the detailed study, average dimensions of the coconut were found.

Those values are described below.

Shape : Ovoid

Dimension : 300mm long × 200mm

wide Thickness of fiber: 20 to 40mm

Weight : up to 2Kg.

While dehusking the coconut, husk removes as 3 to 4 parts.

Each of width : 40 to 80 mm.

### Design of Tynes:

Tynes are the major component in this machine, which has direct involvement in the dehusking operation. As shown in the Figure-1, tynes are specially designed in a manner to get effective penetration with the coconut.

Shape : flat v shape

Height : 39mm

Diameter : 35mm

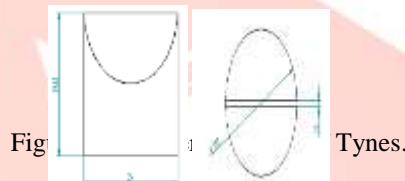
Material: EN 8

4 rows × 5 teeth and 4 rows × 4 teeth

Total number of teeth = 36

Distance between two teeth = 87mm

Distance between two rows = 110 mm



### Design of Pitch:

In the design, we have both Horizontal and Circular Pitch. Horizontal pitch is the distance between the tynes, that are horizontally arranged, whereas circular pitch is the distance between the tynes, circularly arranged around the cylinder. Design of the pitches is same for both the cylinders.

Assumptions taken for the design:

- Tynes are arranged on the cylinder to obtain effective mesh with the coconut husk, in a particular manner.
- Optimum number of tynes is mounted over the cylinder.

### Horizontal Pitch:

Average length of coconut is founded as 300mm, for making this working model, the length of the cylinder is limited to 400mm. This specially designed tynes are mounted on the cylinder in a manner that maximum number of tynes to be in contact with the coconut. It reduces the load on each tynes and increases the efficiency on the dehusking operation. For that 5 series of tynes are mounted on both cylinder respectively.

Thus, Horizontal Pitch = 124 mm.

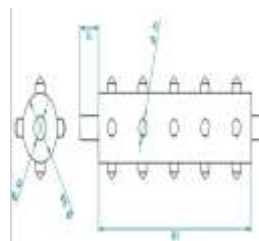


Figure 6.2. Horizontal Pitch.

### Power transmission and speed reduction

unit:

The power from 3hp electric motor is transmitted to the rotating cylinders through pulleys and gears. The same system is also used to reduce the speed of cylinders. It includes 4 pulleys and 2 gears. Selections of these gears and pulleys are according to the availability in the market. Since the machine is designed and fabricated as a working model, major priority is given to the cost factor.

Speed of the motor = 1440 rpm

### Dimension of the gear:

- $d_1 = 150\text{mm}$  (inner Diameter)

- b.  $d_2=250\text{mm}$ (outer Diameter)
- c.  $Z_1=50$  Teeth
- d.  $Z_2=60$  Teeth
- e.  $n_1=800$  rpm
- f.  $n_2=800$  rpm
- g. Inner Pitch dia= $7.6\text{mm}$
- h. Outer Pitch dia= $10\text{mm}$   
 $M=\text{Module}$   
 $M = 3\text{mm}$

### Dimensions of the Pulley

- a. Diameter of the first pulley, attached to the shaft of motor,  $D_1=31.75\text{mm}$
- b. Diameter of the second pulley,  $D_2 = 304.88\text{mm}$
- c. Diameter of the third pulley, attached to the shaft of second pulley,  $D_3=31.75\text{mm}$
- d. Diameter of the fourth pulley,  $D_4=254\text{mm}$

### Selection of Motor:

Different types of coconuts are tested using U.T.M. machine (Tensile Test) for finding the maximum force required to dehusk the coconut. The maximum value found to be  $1\text{kN}$ .

Selection of motor is based on the following:

1. Power require to dehusk the coconut
2. Power require to rotate the mass

$$T = 14.84 \text{ NM.}$$

### VII. FABRICATION

Mainly, the tynes and cylinders are prepared by lathe operations; such as turning, cutting, drilling, facing, taper turning etc. The different shafts are turned on the lathe to get smooth and good surface finish. Along with this drilling, milling and shaping machines are also used for many operations. Different types of drilling bits are used to drill holes for the seating of bolts and nuts. Another main operation on this fabrication stages is the welding. Tynes and cylinders, angle irons are joined together using welding operations. The welding methods used here are arc welding and gas welding. The fabrication consists of different steps as follows:

1. Machining of the tynes are done using lathe, manually.
2. Cylinders are machined to  $610\text{mm}$  length and  $140\text{mm}$  diameter for both cylinders, respectively.
3. Cylinders are welded to the shafts of diameter  $30\text{mm}$ , using circular plates.
4. For fixing the tynes, holes are made over the cylinders using drilling machine.
5. Tynes are welded over the cylinders, by inserting the lower portion of tynes in the holes.
6. The major load carrying component, frame was constructed by joining angle irons as in the design.
7. Bearings, Bushes, blocks, etc are welded to the shafts.
8. Using cast iron plate, seating for motor is made on the frame.
9. Transmission system is attached to the frame, as per in the design.

### VIII. WORKING PRINCIPLE

This power operated coconut dehusking machine operates on single phase,  $1\text{ hp}$  electric motor. It consists of main parts like,

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

Frame was constructed by welding, angle iron to the dimensions of  $100 \times 100 \times 80\text{ mm}$  using cast iron. Single phase electric motor of specification  $3\text{hp}$ ,  $1440\text{rpm}$  is used. To transmit the power from motor to the cylinders, with required speed, gear and pulley transmission system are incorporated. The dehusking unit consists of two cylinders, of different diameters with different speed of rotation in order to cause tearing effect over the coconut husk. The two diameters provide different speeds at opposite directions. This eliminates the use of number speed reduction unit in the machine. The tynes are mounted on the cylinders in a particular manner, to get more grip and effective dehusking. The dehusking process is very simple, place the coconut in between the two rolling cylinders, rotating in opposite directions and press it by a manually operated mechanical linkage. As the cylinders rotate, tynes provided on the periphery will penetrate into the husk and tear it away. Tynes are designed in such a way that it will not cause any damage to the coconut shell. Removed husk is in the form of separated fibers, so these fibers are more useful in coir industry. Thus the dehusking can be done, effectively.

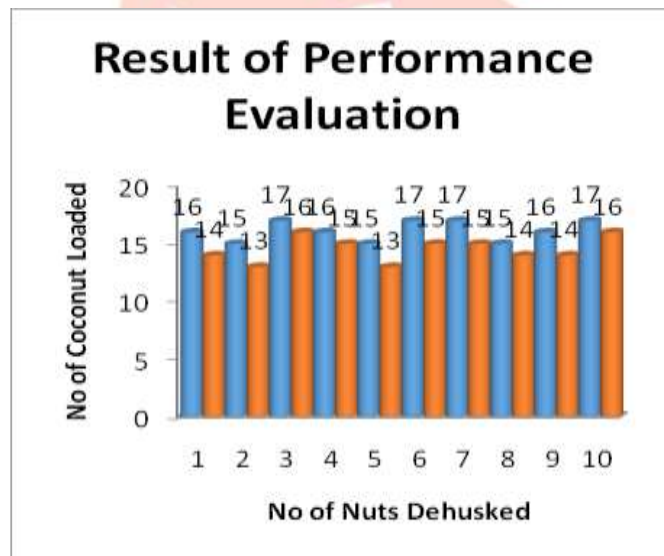
### IX. RESULT AND EVALUATION



It is observed that the machine has the capacity to dehusk the commonly available coconut of different thickness and hardness, effectively. The machine can normally dehusk about 120 to 150 coconuts per hour even though, time require to dehusk is related with the age of coconut. Graph 1. Shows time taken to dehusk, different aged coconut.



Graph 1 : Time v/s Number of coconut dehusked.



Graph 2 : Number of nuts dehusked v/s Number of coconut loaded.

The results of the performance evaluation graphs shows that the machine performed above 86% efficiency in all the tests cases as expected. It is also obvious from this table that the capacity of the developed machine ranges between 191 and 206 nuts per hour depending on the operator, however, on average an operator can de husk 195 nuts per hour with this machine. This machine was fabricated with standard and locally sourced materials and its estimated cost is Eighteen Thousand Five Hundred (Rs.18500.00) thus, the machine is affordable to small scale farmers and maintainable.

**X. CONCLUSION**

In this modern world the time and cost has more weight age for each and every operation. So a new machine has been designed, fabricated and named as “Coconut de husking machine”. By comparing with many types of existing methods, includes traditional, and automatic, it can be concluded that this machine require less human effort and the test results substantiate the above.

- The developed model is simple, efficient, requires less time and cost effective when compared to the existing available model.
- Importance is given towards user friendly in operation and mainly safety. The rotating elements like belt, pulley and gears are provided with safety cover.

- The overall performance of coconut de husking machine is satisfactory by husking coconut effectively and economically.

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