Preparation of Design and Development of Automatic Coconut Processing Machine

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Abstract The vegetable oil extracted from coconut milk is virgin coconut oil (VCO). Coconut is a plant that's very productive. Dehusking coconut is one of the main processes that takes a lot of time and energy to extract oil. With the assistance of instruments made of iron or wooden crowbar for the dehusking process, most farmers still use human manual labour. Its aim was to help the local farmers decrease the necessary labor time in de-husking and crushing the coconuts. The proposed system integrates all the sections taking out the virgin coconut oil. The process combines all the three process such as dehusking, grating and crushing of the dehusked coconut. The system is an automated process. The aim of the project is to design and build a coconut processing machine and a machine that can dehusk and prepare the coconut in less time for oil extraction. The construction of machine will be simple in design so that it can be manufactured easily.

Keywords: Virgin Coconut oil (VGO), Automation, Conveyor, Sensor, Crusher, Grater, Etc.,

1. Introduction

India is third highest producers of coconut all over the globe. The production rate was about 11.47 million metric tons by the survey taken in 2017. This paper shows that rub it and crush it to get coconut milk and other edible parts among many methods used to extract the coconut husk, but these methods have many problems and limitations while running those machines. The production rate of virgin coconut oil is affected by these issues. These strategies are even more risky for the consumer. In order to remove the existing limitations to a greater degree, the automated and less damaging approach is proposed. This eliminates the need for skilled operators involved in the preparation of virgin coconut oil. In our survey, we found that in terms of their climate, the dimensions of coconuts differ with each other. Based on the location and dimensions the machine is designed. There are numerous factors which determine the output of the virgin coconut oil from the process. The factors are constantly monitored to achieve high output.

There is a vast opportunity in our area for marketing this machine. There is unavailability of skilled farm workers is the first and foremost reason for the development of the project. Since
separate machines are there for all these processes, we integrate it as a single automatic
machine. We felt that delivery of quality product in a short span of time with assured
productivity rate will be a great deal in this modern era. All the process of getting the oil is
made in a single machine. Irrespective of environment and product factors, labor problem can
be eradicated with it. Safety of workers are also assured by this process.

2. Proposed Methodology

2.1 Overview
Since the existing system is semi-automated and not much valuable in production output. The
proposed system integrates all the sections taking out the virgin coconut oil. Roller
mechanism is used to de-husk, which is conveyed to the grater and then the pulp is taken out.
By the way reducing the harm created from oil extraction and increasing gross output. The
livelihood and the income of the rural people is increased. It includes the replacement of
traditional methods and gives an advanced way of marketing method. It is better in giving a
desired output for agro-industries since the system undergoes a controlled operation. The
controlling of system includes the smart operation of the de-husker and grater. Where it
excludes the defective coconuts and the usable one is taken for oil extraction. As it is an
automated system man power is not much needed. It increases the income of agro-industries
and total cost of the production becomes feasible.

Figure 1 Proposed Model Setup

2.2 Process
There are three different processes namely starts with loading the coconut over the de-
husking roller, then this de-husked coconut is moved into the arrangement, cutting lever to
cut it right from the middle and get the two halves, The grating instrument used on the roller
grates those halves and forms the edible chips. We have planned to fix processors and sensors
to identify the condition of coconut at end of the process near the grating compartment.
Quality and safety are our motto. Some features of Integrated Development of Automatic Coconut Processing Machine to reduce human efforts is as follows:

- Detect the spoiled and defective coconuts so the quality is assured.
- Saves power by optimized design and operational parts under programmable controls.
- Contains in-built adjustable slots for coconut bowls of different size to align in grater unit so that maximum coconut edible part can be obtained.
- Provides safe working environment for the person in control.
- This is an automated integrated machine so we can obtain high productivity.

3. Design Calculations

3.1 Proposed Contributions

Considering various size and shape of coconut available, the average dimension is figured through detailed study for performing design calculation study.

- Shape and Size: Ovoid and (300 x 200) mm
- Range of fibre thickness: 20 to 40mm
- Weight Ranges: 0.65kg to 1.25kg
- Range of husk width: 120 to 240 mm.

3.2 Tynes

Tynes are the major component, which involves in direct process of dehusking operation. Designing the tynes effectively will make the result more effective and good quality. Below parameters are finalized through the analysis of various values in all aspects of assembly and functioning of dehusking.

- Shape: Conical.
- Height and Diameter: 30mm and 25mm.

Figure 2 Tynes
3.3 Cylinder
Some assumptions are made during the design of cylinder to achieve an effective mesh are follows
- At least 1/5th of coconut width to be inserted into an intermediate space of cylinders.
- Contact of coconut to cylinder at an average of 350
From the above assumptions, Figure below is drawn to take the mechanical design calculations.

![Diagram of cylinder and trigonometric relation sketch](image)

**Figure 3 (a) Representation of cylinder (b) Trigonometric relation sketch**

The values that are faded in colour are the results obtained by applying trigonometric relations. The length and radius of the arc is found as 56.57mm and 95mm (approx). Although the acceptable cylinder diameter obtained by the above measurement is 190 mm, 165mm and 195 mm cylinders are chosen in the design to obtain the different velocity.

3.4 Horizontal Pitch
We are using both Horizontal and Circular pitch in our design. The horizontal pitch is the gap between the tynes, the gap between the tynes is horizontally aligned and the circular pitch is the gap between the tynes, circular in aligned. The assumptions that are made before the design calculation is that tynes are arranged in a particular manner to obtain an effective mesh result and optimum number is mounted over the cylinder. From the data collected, the average length of the cylinder is found to be 300mm. The design is expected to have a length above 300mm, decided to use 400mm as the length of cylinder by considering the error margins. Our aim is to make the maximum tynes to get contacted to coconut. This would result in reducing the load on tynes and increase its efficiency in mesh process. The minimum gap for the tynes has to at 30mm range, so that while rotating one don’t contact the other. For this, 7 and 6 series of tynes are mounted respectively on larger and smaller tynes. Horizontal Pitch, therefore, = 58.00 mm.
3.5 Circular Pitch

The average width of the cylinder is found to be 200 mm from the data collected. With the measurement of 165 mm and 195 mm for smaller and larger cylinders, the diameter of the cylinder is already set. For that, 12 and 10 tynes are mounted respectively on larger and smaller respectively.

- Larger cylinder
  - Diameter of \( (d1) \) = 195mm
  - Circumferential length = 612.30mm
  - Number of tynes = 12
  - Circular Pitch = \( \frac{\text{Circumferential length}}{\text{Number of tynes}} \)
    = 51mm

- Smaller cylinder
  - Diameter of \( (d2) \) = 165mm
  - Circumferential length = 518.10mm
  - Number of tynes = 10
  - Circular Pitch = \( \frac{\text{Circumferential length}}{\text{Number of tynes}} \)
    = 51.8mm

Therefore, the total number of tynes mounted on smaller and larger cylinder is 60 and 84.

3.6 Motor selection

The maximum force required to dehusk the coconut has been tested by several processes. The highest value found by the Tensile Test is 1.3kN. The motor parameters are considered based on the power required to dehusk and rotate the mass.

- Power required for dehusking
  
  From the results obtained through Tensile test, the force required is 1.3kN.

  Torque \( (T_1) = \text{Force required} \times \text{Perpendicular distance} \)
  = 1.3kN \times 200mm
  = 260Nm

  Average Speed (\( N_A \)) = 30rpm

  Power \( (P_1) = \frac{(2\pi\times NA \times T)}{60} \)
  = 0.816kW or 1.1hp
- Power required to rotate mass

\[
\text{Total mass} = \text{mass of cylinder} + \text{mass of tynes} + \text{mass of coconut} \\
= 25 \text{ kg (approx. at maximum)} \\
\text{Force due to mass} = 245.25 \text{Nm} \\
\text{Torque (T}_2\text{)} = \text{Force required} \times \text{Perpendicular distance} \\
= 245.25 \text{Nm} \times 200 \text{mm} \\
= 49.05 \text{Nm} \\
\text{Average Speed (N}_A\text{)} = 30 \text{rpm} \\
\text{Power (P}_2\text{)} = \frac{(2\pi \times \text{NA} \times T)}{60} \\
= 0.154 \text{kW or 0.2hp}
\]

- Motor required

\[
\text{Total Torque (T)} = \text{T}_1 + \text{T}_2 \\
= 260 \text{Nm} + 49.05 \text{Nm} \\
= 309.05 \text{Nm} \\
\text{Total Power to operate (P)} = \text{P}_1 + \text{P}_2 \\
= 0.816 \text{ hp} + 0.154 \text{hp} \\
= 0.97 \text{kW}
\]

From the above calculations, the motor selected with the following specification in single phase is 1kW.

4. Conclusion

Oil industries need coconut meat as their raw material. Coir companies need dry coconut husk as their raw material. As their raw material, the coconut farm wants the edible portion. So, all the parties need complementary coconut components. There is also a need to bridge the gap between industry and coconut farms. Because of this, it is desirable to have a machine that meets both requirements. This model suits every environment and eliminates the need of skilled operator involved in virgin coconut oil preparation. A hybrid machine which could perform the operations of removing of the coconut husk, grate and crush it to get coconut milk has been introduced through this paper to overcome the issues and easy production of virgin coconut oil. This Automated machine is suggested for the coconut age of below 10 days after harvesting.

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