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# Development of Coconut De-husking Machine for Large Scale Production

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***Abstract*: According to recent studies India ranks third in the world among top coconut producing countries with 11.9 million tons of coconuts coming out every year. However the fruit produced is not of much use unless it is de-husked and the husk is separated from its shell. This step is mandatory as it is an important step in the extraction of the coconut's various products such as the outer husk, shell, coconut water and the softer internal kernel or endosperm. Although modern machinery is available to simplify this process and speed up production, it is restricted to large scale industries where the produce is of a larger quantity. Small scale farmers even now rely on manual and conventional methods to de-husk coconuts and its components. Due to these laborious and time consuming activities and lack of cheaper alternatives, the coconut industry is depleting in the agricultural field. This presentation provides an alternative and cheaper method to effectively de-husk the coconut, extract the inner shell, and grind out the soft internal kernel using the machine.***

***Keywords*: De-husking process, hydraulic piston, spider expander, cutter and scrapper***

## I. INTRODUCTION

The concept involves a hydraulic piston with a three jaw chuck to hold the coconut in place. The spider expander pierces the coconut from the top. As the spider expands under hydraulic pressure the holder piston simultaneously moves upwards facilitating the de-husking process. The extracted coconut shell is directed towards the cutter through a line pathway where it splits the coconut into two thus separating the shell. Then the cut shells will be moved towards the scrapper for the final scrapping process. This mechanism shows an effective and efficient way to dehusk, cut and grind the coconut in an automated process from start to finish with minimum time consumption. This machine does not require skilled labor to operate and since the hydraulic piston is separate from the motor, each operation can be carried separately if required. Its low cost of fabrication and simple design which requires low maintenance makes it user friendly and can be easily afforded by small scale farmers and smaller industries.

## II. PRESENT STUDY

India is an agricultural country. But the increasing costs for living and the unstable agricultural market has made many people to opt out from agriculture. Even the industrialization has made many people to think that in a long run agriculture may not help them to lead a better life. On the basis of these facts the Indian Government have introduced many schemes and projects to help the farmers in trouble and also to welcome the next generation into the agricultural field. For attracting the young people who had no interest towards the conventional methods of farming the Government had taken several initiates for making agriculture more simple and efficient. Coconut Cultivation was one such field wherein the people followed the conventional farming techniques for plucking and processing the fruit. But assigning a person to climb on each tree one by one and plucking the coconut was a tiresome and time consuming job. Researches were done on this and machines which could climb coconut trees were introduced. At the time of inception it had many defects in it and as years passed by engineers came with solutions and those defects were rectified. Now the coconut tree climbing machines have become quite popular even in small villages. Still researches are going on in this field for making these machine more efficient. Not only climbing the processing operations of coconuts which includes the de-husking, Cutting and Scrapping of the fruit were also a difficult job. Many machines were developed for this but those were either less efficient or costly. Now engineers are working for developing a machine which could do all these operations by itself in much more efficient way through which the cost of the machine can be reduced and thereby making it affordable for a common man.

## III.LITERATURE SURVEY

From studying previous journal articles on similar topics based on coconut de-husking various discoveries were found. In 2012, Venkataraman S. et.al studied the various sizes of coconuts found in different tropical areas and carried out their testing on the Universal Testing Machine to understand its physical properties. The spider mechanism and the unique fruit holder were the result of the findings from S.D.S. Piyathissa's article in 2015 on "Introducing an appropriate mechanical way for coconut de-husking".

James Jerry et.al. proposes different methods of scraping and breaking along with a new extraction system for a de-husking machine in their paper "Design and Fabrication of Coconut Breaker Extractor Grater Machine" in 2016.

## IV. COMPONENTS

### A. *Hydraulic Power Pack*

The power pack consists of a hydraulic fluid reservoir which stores the fluid and also houses a pump and a motor. Using established calculations a hydraulic power pack of 1 HP power is chosen to be used in the project.

### B. *4/ 2 Direction Control Valve*

A 4/2 DCV has 4 ports and 2 positions when operated. Two inlet ports and two outlet ports. This DCV helps in the forward and return strokes of the piston.

### C. *Cylinder*

A hydraulic cylinder of 50 mm bore diameter and 200 mm stroke length is used here. The spider expander is attached to the piston in such a way that when the piston advances the tool moves downwards and this de-husks the coconut. gets expanded and vice versa.

### D. *Spider Expander*

This is a set of tool which contains two parts.

### E. *Fruit Holder*

A fruit holder is placed at the bottom which holds the coconut at the time of de-husking. The height of the fruit holder can be increased or decreased based on the height of the coconut.

### F. *Cutter and Scrapper:*

Both the cutter and the scrapper is powered by a 0.5 HP motor which is coupled to each other. For the cutter the torque is reduced and the speed is increased but for the scrapper the torque is increased and the speed is reduced. This is achieved by using the pulley and lever mechanism.

### G. *Tubing*

The cylinder, valve and the power unit are connected through tubing. The hydraulic fluid passes through these tubing under high pressure.

## V. CONSTRUCTION AND WORKING

The design of the de-husking machine is done using Solid Works and is relatively simple in construction. First the base frame work is constructed using mild steel of tensile strength 370 MPa. Since the frame of the machine is made up of Mild Steel, it can withstand the large amount of stresses developed on it during its operation. The 50mm bore cylinder was attached onto the top of the frame with the piston action acting downwards. The stroke length of the piston is around 200mm and is used as reference to attach the fruit holder to the base. The tool pathways are drawn on thin polystyrene sheets and traced out on mild steel plates. The pathways are cut out using gas cutting methods. The pathways are later attached to the framework and the back supports are held in place using 10mm bolts and washers. The tool holder is welded onto the piston cylinder at the piston end. The expander mechanism is completed after welding the tool blades to the base of the tool holder. The tools will move along the path cut out to facilitate the de-husking action. The height of the tool from the fruit holder is measured and fabricated accordingly to accommodate all sizes of coconuts for the de-husking process from different parts such as Kerala, Tamil Nadu and Karnataka. The rounded edges and corners of the tool path way assures a smooth downward and upward action of the piston attached knife edged tools.

## VI. POWER CALCULATIONS

Amount of force required= 5KN
Pressure required P=F/A
Diameter = 50mm (assumed)
Pressure Required = $5000 \div ((\prod \div 4) \times (0.050)^2) = 2546479$ Pa $= 25.46$
Bar Stroke Length= 200 mm (based on the size of different coconuts)
Number of coconuts to be de-husked in an hour = 40

Time available for de-husking one coconut = 3600÷40 =90 Secs
Velocity of Piston = 400÷90 = 4.44mm/s
Flow Rate = Area × Velocity = 8.71×10-5 m3/s
Hydraulic Power = Pressure × Flow Rate = 2546479×8.71×10-5/745(assuming an efficiency of 50 percent)
=0.82 HP
Approximately 1 HP Motor is required to operate this machine

## VII. COMPARISON BETWEEN HYDRAULICS AND PNEUMATICS

| Hydraulics | Pneumatics |
|---|---|
| This system works well when the system requires high accuracy and better response. | Works at a low pressure when compared with hydraulics. |
| This system can work in any speed without any difficulty | This system finds application mainly in ON/OFF or pick and place operations |
| It is much more costly than pneumatic system | Much cheaper than hydraulics |
| Chances of leakage for this kind of system is more. So this won't be good for some clean room applications. | It is noisy, Works on pressurized air so it is required to have a filter unit for it. |
| Hydraulics comes into picture when there is a need of high torque or high pressure. It is usually used for heavy duty applications | This system has very low stiffness and usually its response is inaccurate. |
| The power to weight ratio for a hydraulic system is high | The power to weight ratio of the pneumatic system is the lowest |
| Reduction gears are not required for this type of system | Pneumatic components are usually reliable than others |
| Since the viscosity changes with temperature this type of system may not be suitable in all type of climatic conditions | It is very much difficult to control the linear position of a pneumatic system |

## VIII. 3D MODEL OF THE PROPOSED MACHINE

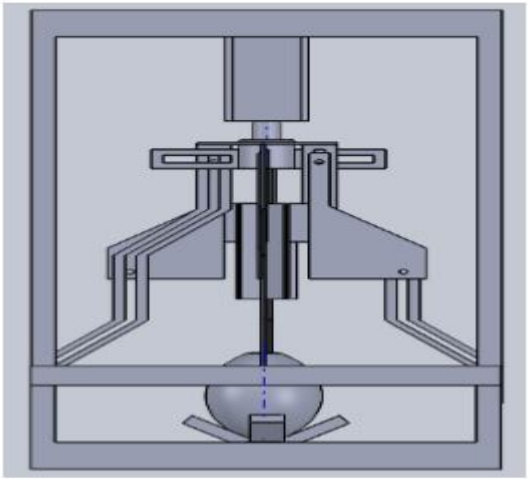

Fig 2-D Model of Coconut De-husking Machine

## IX. TESTING OF THE MACHINE

The machine was successfully tested with different varieties of coconuts. A hydraulic power of 1 HP power was used for testing this machine. But it is not necessary that a hydraulic circuit should be used. The same operation can be done in pneumatics by using a high pressure compressor. If hydraulics is used the efficiency of the machines can be increased. When worked with hydraulics the machine was able to de-husk 40 – 60 coconuts in an hour and when worked in pneumatics it is nearly 30-35 coconuts per hour. Since hydraulics is expensive than pneumatics, pneumatics is preferred for small scale farmers. But if the rate of de-husking have to

be increased then hydraulics have to be used. The only human effort in this machine is that one person should keep the coconut one after the other in the fruit holder. But this can be automated.

## X. ADVANTAGES OF THE PROPOSED MACHINE OVER THE EXISTING MACHINE

The existing machine which is used for coconut de-husking is aimed at large scale industries which uses coconut as their prime raw material. This machine has two rollers which are employed with spikes. These rollers rotate in opposite directions and when a coconut is forced into the small gap between these rollers then the rotating action of the spikes helps in the de-husking coconut. This machine operates on a high power motor preferably an AC motor. The main drawback with this model are

Chances of the coconut shell breakage is unavoidable

Difficult to de-husk both dry and tender coconuts together at the same time

coconuts grown in different areas differ in shape and size the gap between the above mentioned rollers have to be changed every time which cannot be practical.

These drawbacks can be rectified when the new model comes into picture. This model will be much simpler in design and construction. We aim mostly on small scale farmers rather than larger companies who can afford machines of any cost. The main advantages which we point out in our machines when compared with the existing machine are Fruit holder fixed on a screw jack allows to adjust the height of the machine at any point of time making it suitable for coconuts of any shape and size.

Chances of shell breakage are completely eliminated. Both tender and dry coconuts can be de-husked simultaneously without making any changes in the machine.

Simple in design and construction.

Since the proposed machine is much lighter in weight than the existing machine transporting this machine from one place to another is easier.

All the parts in the machine can be disassembled and assembled by anybody making it easy to maintain.

In the existing machine a human has to force the coconut continuously to the gap between the rollers. But in the proposed machine human aid is required only in keeping in the coconut to the fruit holder one after the other

## XI. CONCLUSIONS

In this modern world the cost and time has more weightage for each and every operation. So a new coconut de-husking machine has been designed, fabricated and tested named as “Coconut de-husking machine with cutting and scarpering” to save energy and to reduce the cost of machine. By differentiating with many types of existing models and methods, includes traditional, and automatic, we can finalized that this machine require less human effort and less power.

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