

# Case Study of Coconut dehusker

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**Abstract**—Generally, coconuts are DE husked manually using either a machete or a spike. These methods require skilled labour and are tiring to use. Attempts made so far in the development of DE husking tools have been only partially successful and not effective in replacing manual methods. The reasons quoted for the failure of these tools include unsatisfactory and incomplete DE husking, breakage of the coconut shell while DE husking, spoilage of useful coir, greater effort needed than manual methods, etc.

The present work involved the design, development and testing of a coconut DE husker which overcomes the drawbacks of the previously reported implements. The design and developmental stages called for a closer look at the magnitude and direction of the dehusking forces and their generation mechanisms. Details of a simple, sturdy and efficient hydraulic dehusker unit, financially beneficial to laborers and producers, are given here. Comparative assessment of this unit in relation to those reported in the literature is provided. Test results and assessment of the present unit in both laboratory and field conditions are also reported. Safety aspects are incorporated. The unit can dehusk about 70 coconuts per hour compared with about 40 nuts per hour from a skilled worker using the spike method. It can be operated by unskilled laborer's. Cost benefit analysis indicates that it should be commercially viable.

**Index Terms**—Hydraulic dehusker, Design of DE husker, use of DE husker machine

## I. INTRODUCTION

Coconut, the fruit of the coconut palm tree which has the scientific name as “Cocos nucifera”. India is one of the leading producers of this coconut. It is usually grown in coastal areas. Coconuts are large, dry drupes, ovoid in shape, up to 15" long and 12" wide. The coconut is smooth on the outside, yellowish or greenish in color. Within the outer shell is a fibrous husk one to two inches (2.5 to 5cm) thick. The inner

shell is brown and hard, surrounding the white coconut meat. Coconut husks are the rough exterior shells of the coconut. This outer shell or husk has to be removed for the usage of coconut.

### Present study

We have many methods to DE husk the coconut. It is by manually, mechanically and also by the use of machines. Manual DE husking with knife is a common practice.

Need for the improvement in present method is the lack of sufficient manpower. This necessitates the use of appropriate machinery to aid in various tasks in coconut plantation. Traditional devices currently in use, such as the blade and spear are dangerous and minimum productive. Based on this realization we are planning to make the device that simplifies an important process as well as increases the productivity of the coconut industry. This new mechanism will indirectly boost any economy that relies on coconut plantations.

### Machine description

This coconut DE husking machine peels off the coconut husk from coconut fruit to obtain DE husked coconut fruit via mechanical controlled DE husking devices. The coconut is placed on the holder in vertical position. The holder is moved up by the foot operation mechanism. The top assembly which comprises the gripper pokers held vertically with link mechanism and is pivoted to the coconut body. The top assembly movement effects the pokers to move in the downward slide to poke into the coconut and at certain depth will make the pokers to move apart at 45 degree by the pusher link mechanism to tear apart the husk with force. The foot operated holder can be adjusted to the required height by the height adjuster. The foot lever is operated to continue the pumping till the mechanism is pulled down to its lowest position till the coconut is

de-husked from the fruit. The foot operation is returned to the original position and also the top assembly is lifted back to its original position by the release valve operation of the pump and cylinder facilitating the removal of the coconut.

The main parts involved in the project are hydraulic pump, cylinder, coconut holder mechanism, height adjusting knob, and poker arms.

#### Field of use and benefits

This machine is useful to the coconut estates and co-operatives, coconut growers and coconut processing factory. The machine can provide faster work rate and less human interaction. This machine is expected to increase the coconut production, hence an additional income to coconut growers. It is useful to the coconut growers by many ways. It does not require direct human force as in normal methods because in this hydraulic pump and cylinder is used to enhance the force at the head of the coconut to put pressure on poker assembly. Also, the coconut of any size and shape can be DE husked easily. It is easy to operate, does not need skilled labour, rapid, safe operation and simple maintenance. It can be easily assembled and disassembled and it can be carried from one place to another.

The cost of this machine is lesser as compared to the present available machines. Also, these available machines require external electrical power supply and the worker should be skilled with the machine. Also, these machines are not safe because they work with a very high speed and a large tools and equipment's.

## II. LITERATURE REVIEW

In this paper following details are done. A detailed description about the topics given below.

1. Traditional coconut dehusking machine
2. Hydraulic pump
3. Control valves
4. Cylinders
5. Hydraulic fluid or oil
6. Composition
7. Tubes, pipes and hoses
8. Seals, fittings and connections
9. Mild steel
10. Springs

#### Traditional coconut DE husking machines

Here we studied about the traditional methods of husking machines and their efficiency, durability, ease of operation etc. There are many different methods followed by the farmers of our region. In that some are more effective and some are costlier. Some of those machines are described below.

In the figure 2.2.1 is one of the traditional model of coconut husking machine which consists of a solid vertical shaft and a poker which has two parts one of which is fixed two solid shafts and another one is movable. The movable poker is fitted to the arm which can be lifted to husk the coconut. It is cost effective but it requires large force to operate which makes it not to use in some places.

In the figure 2.2.2 shows one of the traditional methods of coconut husking machine which consists of one vertical sharp column like structure in which poker is fixed at the top. This is worked by using human energy. This is cost effective and efficient also but danger to the worker involved is more because if his hand slips from the coconut the sharper edge will directly move into his hands and it may create injury to the hands. And hands may be pained if the worker is continuously worked for about three to four hours. Now a day the availability of labours is a very big problem, if available daily wages will be very high.



Figure 2.2.1 Traditional tool



Figure 2.2.2 Traditional method of DE husking

#### Two blade DE husking machine

In this two-blade model one blade would be inserted inside the husk of the nut and the other blade would help in the process of peeling.

A 1.5hp motor is coupled through a belt to a long, cylindrical metal rod. Two sharp blades were fixed at the tip of the rod. The blades were three quarter of an inch long and placed one inch apart. The rotating motion of the blades would dehusk the coconuts easily. A switch was used to operate the machine. Initially, the switch could be turned only by hand.

This coconut-dehusking machine, works on the principle of conversion of electrical energy from electrical motor into mechanical energy in terms of rotation of the centrally mounted iron shaft. The power is being transmitted to the rotating shaft from the electric motor through the belt-drive. This rotation of the machine blades facilitates the dehusking process. A better grip on the coconut is provided by the iron plate, which acts as the stopper that prevents the nut to slip away vertically. But the problem in this machine is that the hands may get damaged because the worker has to hold the coconut in his hand during dehusking.

#### Change of attention towards hydraulic systems

Now a day the hydraulic machines are more efficient and easier to use. And also, we can get more force at the output by applying a small amount of force at the input. Hence, we studied about the hydraulic system to make a hydraulic machine. Some of the details about the hydraulic systems are discussed here.

In the recent there has been a significant increase in the use of hydraulics in our industries. The use of

hydraulic systems as a means of power transmission in modern machines evolved a few decades earlier in the western world. But its application in Indian industries is of comparatively recent choice. Hydraulic systems are now extensively used in machine tools, material handling devices, transport and other mobile equipment, in aviation systems, etc.

There are six basic components required in a hydraulic system,

1. A tank is a reservoir to hold the liquid, which is usually hydraulic oil.
2. A pump to force the liquid through the system.
3. An electric motor or other power or manual sources to drive the pump.
4. Valves to control liquid direction pressure and flow rate.
5. An actuator to convert the energy of the liquid into mechanical force or torque to do useful work.
6. Piping which carries the liquid from one location to another, in this case the piping is not there, the tank, pump, and actuator are inbuilt.

#### Hydraulic pump

Basically, a hydraulic system consists of a pipe of liquid ending in a piston at each end. One piston is small and the other one is large; effort is applied to the smaller piston pushing it into the liquid and creating pressure throughout the liquid. The pressure then causes the larger piston to move, thus transmitting the effort. The force produced is equal to the liquid pressure multiplied by the area of the piston, so the large piston produces a greater force than that exerted on the small piston depending upon the difference in their areas. It will also move a shorter distance than the smaller piston. This is as shown in the figure 2.3.1 below.

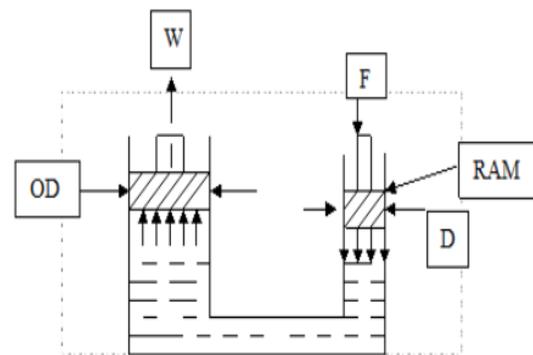


Figure 2.3.1 Schematic representation of a hydraulic pump

$F$  = force applied on the plunger

$W$  = weight lifted by the ram

$D$  = diameter of the ram

$OD$  = outer diameter of the piston

Hydraulic machinery offers a very large amount of power and force with relatively small components. A typical hydraulic cylinder with a 75mm (3inch) bore, for example, can supply 89000 N.

Hydraulic pump supplies fluid to the components in the system. Pressure in the system develops in reaction to the load. Hence a pump rated for 1000psi is capable of maintaining flow against a load of 1000psi.

Pumps have a power density about ten times greater than an electric motor. They are powered by an electric motor or an engine, connected through gears, belts, or a flexible elastomeric coupling to reduce vibrations [1].

Common types of hydraulic pumps to hydraulic machinery applications are

**Gear pump**

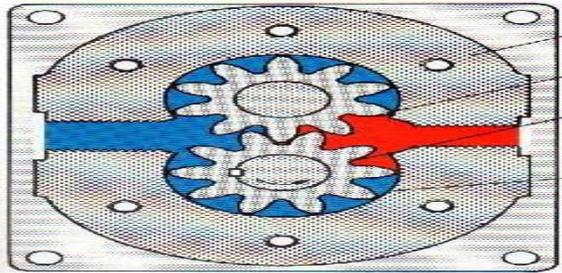


Figure 2.3.1 Gear pump with external gears

This pump is cheap, durable, simple, less efficient, because they are constant displacement, and mainly suitable for pressures below 200 bar (3000 psi). The advantage of this pump includes simple construction, only two moving parts, no reciprocating parts, running at constant speed and experience uniform force. However, they have very low efficiency due to leakage between teeth. The figure 2.3.1 shows gear pump with external gears [1].

**Vane pump**

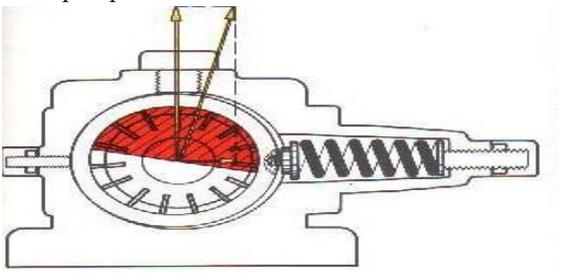


Figure 2.3.2 Vane pump

This is cheap and simple, reliable (especially in gerotor form). Good for higher flow low pressure output. The advantages of the vane pumps are more efficient than the gear pump. They can be operated even with moderate contamination of the fluid. They are suitable for 30 to 130 bar pressure operations. The figure 2.3.2 shows the vane pump [1].

**Axial piston pump**

This is designed with a variable displacement mechanism, to vary output flow for automatic control of pressure.

There are various axial piston pump designs, including swashplate (sometimes referred to as a valveplate pump) and checkball (sometimes referred to as a wobble plate pump). The most common is the swashplate pump. A variable-angle swash plate causes the pistons to reciprocate. The figure 2.3.3 shows the axial piston pump where A is input and B is output [1].

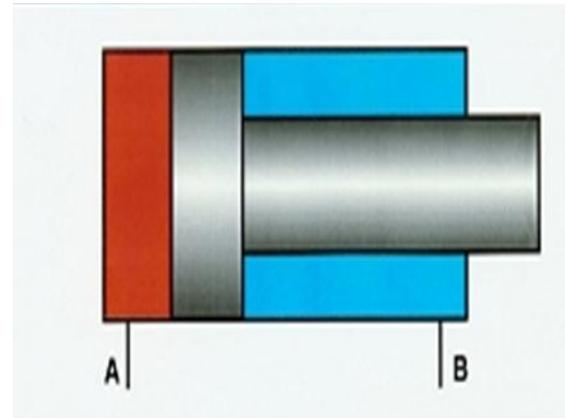


Figure 2.3.3 Axial piston pump

**Radial piston pump**

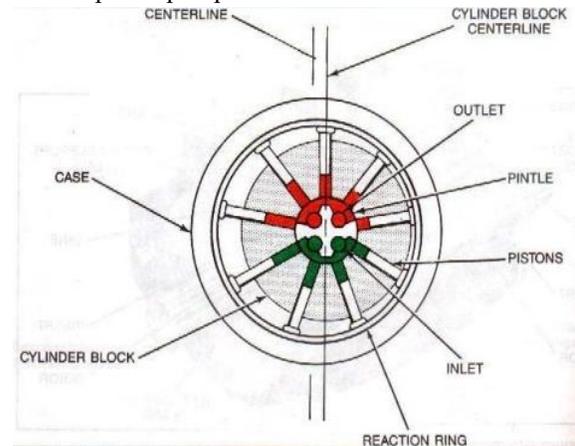


Figure 2.3.4 Radial piston pump

This pump is normally used for very high pressure at small flows. The pistons are parallel to the axis of rotation. The in case radial piston pumps, the pistons are located radially around the pump axis. Hence the name radial piston pumps. The figure 2.3.4 shows the radial piston pump<sup>[1]</sup>

#### Control valves

##### Directional control valves

These valves route the fluid to the desired actuator. They usually consist of a spool inside a cast iron or steel housing. The spool slides to different positions in the housing, intersecting grooves and channels route the fluid based on the spools position.

The spool has a central (neutral) position maintained with springs; in this position the supply fluid is blocked, or returned to tank. Sliding the spool to one side routes the hydraulic fluid to an actuator and provides a return path from the actuator to tank. When the spool is moved to the opposite direction the supply and return paths are switched. When the spool is allowed to return to neutral (center) position the actuator fluid paths are blocked, locking it in position. Directional control valves are usually designed to be stackable, with one valve for each hydraulic cylinder, and one fluid input supplying all the valves in the stack.

Tolerances are very tight in order to handle the high pressure and avoid leaking, spools typically have a clearance with the housing of less than a thousandth of an inch. The valve block will be mounted to the machine's frame with a three point pattern to avoid distorting the valve block and jamming the valve's sensitive components.

The spool position may be actuated by mechanical levers, hydraulic pilot pressure, or solenoids which push the spool left or right. A seal allows part of the spool to protrude outside the housing, where it is accessible to the actuator.

The main valve block is usually a stack of off the shelf directional control valves chosen by flow capacity and performance. Some valves are designed to be proportional (flow rate proportional to valve position), while others may be simply on-off. The control valve is one of the most expensive and sensitive parts of a hydraulic circuit<sup>[1, 2]</sup>.

##### Pressure relief valves

These are used in several places in hydraulic machinery; on the return circuit to maintain a small

amount of pressure for brakes, pilot lines, etc... On hydraulic cylinders, to prevent overloading and hydraulic line/seal rupture. On the hydraulic reservoir, to maintain a small positive pressure this excludes moisture and contamination.

##### Pressure reducing valves

They reduce the supply pressure as needed for various circuits.

##### Sequence valves

The sequence valves control the sequence of hydraulic circuits; to insure that one hydraulic cylinder is fully extended before another starts its stroke.

##### Check valves

These are one way valves, allowing an accumulator to charge and maintain its pressure after the machine is turned off.

##### Pilot controlled check valves

One way valve can be opened (for both directions) by a foreign pressure signal. Often the foreign pressure comes from the other pipe that is connected to the motor or cylinder.

##### Counterbalance valves

A counterbalance valve is in fact a special type of pilot controlled check valve. Whereas the check valve is open or closed, the counterbalance valve acts a bit like a pilot controlled flow control.

##### Cartridge valves

It is in fact the inner part of a check valve; they are off the shelf components with a standardized envelope, making them easy to populate a proprietary valve block. They are available in many configurations; on/off, proportional, pressure relief, etc. They generally screw into a valve block and are electrically controlled to provide logic and automated functions.

##### Auxiliary valves

Complex hydraulic systems will usually have auxiliary valve blocks to handle various duties unseen to the operator, such as accumulator charging, cooling fan operation, air conditioning power, etc... They are usually custom valves designed for the particular machine, and may consist of a metal block with ports and channels drilled. Cartridge valves are threaded into the ports and may be electrically controlled by switches or a microprocessor to route fluid power as needed.

##### Relief valve

This is a manual control valve, which is opened by unscrewing the bolt which is in the way of the ball port again pressed to the port by the pressure of the spring.

When unscrewed, the spring tension is released on the ball due to which the ball retracts back from the port making the way to the oil to enter the tank chamber <sup>[1]</sup>.

Details of non-return valve:

The non return valve is required in this system to withhold the pressure in the suction chamber when ready for the downward stroke of the handle yoke. The construction of this type of valve is a port which is blocked by the ball which is held against the port by the spring pressure. The pressure is such that when suction is carried, the spring tension is less compared to the suction force due to which the oil from the tank enters the suction chamber, when suction is completed, the oil pressure is more which forces the ball to close on the port.

Hydraulic fuses

These are in-line safety devices designed to automatically seal off a hydraulic line if pressure becomes too low, or safely vent fluid if pressure becomes too high <sup>[1]</sup>.

Cylinders

As per their functions, cylinders are classified as

Single acting cylinders

In these, the oil pressure is fed only on one side of the cylinder either during extension or retraction. When the oil pressure is cut-off, these cylinders return to the normal position either by a spring or by an external load.

Double acting cylinders

These are operated by applying oil pressure to the cylinder in both directions. Due to inherent mechanical problems associated with the spring, single acting cylinders with spring return are not used in applications using larger stroke lengths. They may be either single rod ended or double rod ended type.

Plunger or ram cylinders

These are used as a single acting cylinder in a vertical position so that the load on the cylinder can retract when the oil supply is stopped. Eg. Cylinders used as lifts in automobile service stations.

Telescoping cylinders

These cylinders provide long working strokes in a short-retracted envelope and are used in mobile applications such as tilting of truck dump bodies and fork lift trucks, hydraulic cranes etc.

Cable cylinders

These are double acting cylinders that can be powered either pneumatically or hydraulically and find usage in

applications requiring relatively long strokes and moderate forces and can be operated in limited spaces.

Diaphragm cylinders

These are often used in pneumatic applications and are either of the rolling diaphragm or flat diaphragm type. They have very low break-out friction with absolute zero leak across the piston.

Bellows cylinders

These are used for very low force applications in sensitive pneumatic control systems. The pressure and the spring rate of the bellows determine the amount of tension and contraction and may be used for basic servo-control systems since metal bellows have a linear spring rate.

Tandem cylinders

These are commonly used in hydraulic and pneumatic systems; two cylinders are mounted in line with the pistons connected to a common piston rod in order to multiply the force in a limited lateral space <sup>[1]</sup>.

Hydraulic fluid or oil

Hydraulic fluids or liquids are the medium by which power is transferred in hydraulic machinery. Common hydraulic fluids are based on mineral oil or water. The primary function of a hydraulic fluid is to convey power. In use, however, there are other important functions of hydraulic fluid such as protection of the hydraulic machine components from corrosion, wear and tear etc <sup>[5]</sup>.

Biodegradable hydraulic fluids

Environmentally sensitive applications (e.g. farm tractors and marine dredging) may benefit from using biodegradable hydraulic fluids based upon rapeseed (Canola) vegetable oil when there is the risk of an oil spill from a ruptured oil line. Typically, these oils are available as ISO 32, ISO 46, and ISO 68 specification oils. ASTM standards ASTM-D-6006, Guide for Assessing Biodegradability of Hydraulic Fluids and ASTM-D-6046, Standard Classification of Hydraulic Fluids for Environmental Impact are relevant <sup>[1]</sup>.

### III. SUMMARY

The main expectations of coconut customers are to have high quality product. That means the farmers should provide more qualitative products. Along with the quality, the farmer also needs high capacity and most efficient equipment for more productivity.

But from the above discussions we came to know that the machines available are not much economical. The hydraulic systems are easily usable, economical and we can get a large force at the output by applying small input force. Hence, we conclude some of the design criteria to fabricate an economical and perfect working coconut dehusking machine.

Thus, the following design criteria's have to be fulfilled to reach farmer's goal

The quality of peeled coconut is the main criteria. The dehusking capacity of machine per hour. Contamination of coconut with lubricating system of the machine.

Collection of properly peeled coconut. Collection of separated husk. The requirement of manpower. The volume occupied by the machine. The electrical power requirement. Flexibility of machine with respect to handling.

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