

Performance Analysis of Hydraulically Operated Coconut De-husking Machine.

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Abstract— 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 and there are also different methods of de-husking of coconut using machines such as two blade coconut de-husking machine and coconut de-husking by two roller machines. Various test and observations were conducted on various machines mentioned above among this performance wise the hydraulically operated de-husking machine was found to be more effective and convenient for coconut farmers. This machine can de-husk the coconuts on an average in 11-13 seconds. With 90-95 % of coconut effectively de-husked. Here we have analyzed the machine on basis of its performance to effectively de-husk the coconuts.

Index Terms— Coconut, Hydraulically operated de-husking machine, Performance.

I. INTRODUCTION.

Coconut: The **coconut tree** (*Cocosnucifera*), is a member of the family arecacea (palm family). It is the only accepted species in the genus *Cocos*. The term **coconut** can refer to the entire **coconut palm**, the seed, or the fruit, which, botanically, is a drupe, not a nut. The spelling **cocoanut** is an archaic form of the word. The term is derived from 16th-century Portuguese and Spanish *coco*, meaning "head" or "skull", from the three indentations on the coconut shell that resemble facial features

Found throughout the tropic and subtropics area, the coconut is known for its great versatility as seen in the many uses of its different parts. Coconuts are part of the daily diets of many people. Coconuts are different from any other fruits because they contain a large quantity of "water" and when immature they are known as tender-nuts or jelly-nuts and may be harvested for drinking. When mature, they still contain some water and can be used as seednuts or processed to give oil from the kernel, charcoal from the hard shell and coir from the fibrous husk.

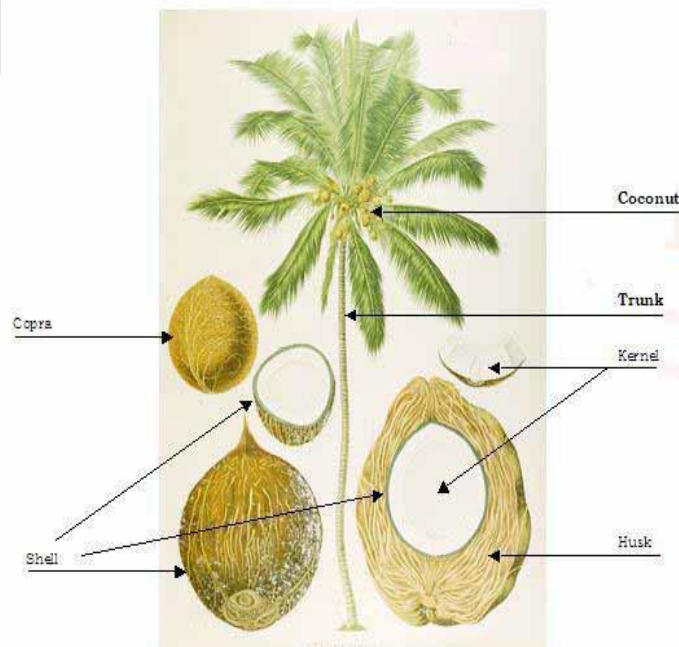


Figure 1 The Coconut Palm and Its Parts

Cocosnucifera is a large palm, growing up to 30 m (98 ft) tall, with pinnate leaves 4–6 m (13–20 ft) long, and pinnae 60–90 cm long; old leaves break away cleanly, leaving the trunk smooth. Coconuts are generally classified into two general types: tall and dwarf. On very fertile land, a tall coconut palm tree can yield up to 75 fruits per year, but more often yields less than 30, mainly due to poor cultural practices. The coconut palm (*Cocos nucifera*) has been called "Kalpa Vriksha" which means "Tree of Life" in the ancient Indian language of Sanscrit, "Tree of Heaven", "Tree of Abundance" and "Nature's Supermarket.". It is the most

important palm and the most extensively grown nut in the world. The main parts of the coconut palm are shown in Figure 1.2. The coconut palm has a single trunk, 20-30 meters tall, its bark is smooth and grey, marked by ringed scars left by fallen leaf bases. The leaves and flowers that turn into coconuts grow at the top of the palm; The fronds in a mature healthy palm describe a sphere with the fronds evenly distributed in all directions from the growing tip. Fruits mature in about 12 months and a normal healthy tall coconut palm produces one mature bunch of coconuts per month on average. The length of a leaf can be up to 7 meters in tall palms, with a leaf area of up to about 10 m², and weighing upto 20 kg when green. Mean annual leaf production is about 14-16 for mature tall palms and 21 for dwarf palms. The coconut palm is unsurpassable in its beauty and its utility because, on small islands where land-based natural resources are scarce, it provides almost all the necessities of life - food, drink, fuel, cooking and cosmetic oil, domestic utensils, medicine, timber and thatch for building houses, coir fiber for making ropes and mats, and others. In many tropical countries, coconut is an important part of the daily diet. Its main product is the oil extracted from the kernel. The residue is an important animal feed. The coconut water from the young nuts is a popular beverage. The jelly-like kernel of the young coconut is considered a delicacy. The shredded kernel is sold as desiccated coconut used in food and confectionary. The husk of the nut provides coir which is an important fiber that can be used for ropes, carpets, brushes, etc. The shell of the nut is used for household utensils and the charcoal made from it is an excellent basic material for activated carbon. Instead of being used for nut production, the inflorescences can be tapped, yielding sap with high sugar content, from which sugar, alcoholic beverages and vinegar can be made. The leaves are used for roof thatching. The midribs of the leaves are used for brooms. Coconut wood is more and more being used for house building and other uses such as furniture or tool handles. All the parts of the coconut palm, except the roots, are used in a peasant's household, so it is no wonder that this tree has also been called 'Tree of life'.

Commercial, industrial, and household use:

Coconut fronds:

The stiff mid-ribs of coconut leaves are used for making brooms in India, Indonesia (*sapulidi*), Malaysia, the Maldives and the Philippines (*walistingting*). The green of the leaves (lamina) are stripped away, leaving the veins (wood-like, thin, long strips) which are tied together to form a broom or brush. A long handle made from some other wood may be inserted into the base of the bundle and used as a two-handed broom. The leaves also provide material for baskets that can draw well water and for roofing thatch; they can be woven into mats, cooking skewers, and kindling arrows, as well. Two leaves (especially the younger, yellowish shoots) woven into a tight shell the size of the palm are filled with rice and cooked to make *ketupat*. Dried coconut leaves can be burned to ash, which can be harvested for lime.

In India, the woven coconut leaves are used as *pandals* (temporary sheds) for marriage functions especially in the states of Kerala, Karnataka, and Tamil Nadu.

Copra:

Main articles: Copra and Coconut oil.

Copra is the dried meat of the seed and after processing produces coconut oil and coconut meal. Coconut oil, aside from being used in cooking as an ingredient and for frying, is used in soaps, cosmetics, hair-oil, and massage oil. Coconut oil is also a main ingredient in Ayurvedic oils.

Coconut trunk:

Coconut trunks are used for building small bridges and huts; they are preferred for their straightness, strength, and salt resistance. In Kerala, coconut trunks are used for house construction. Coconut timber comes from the trunk, and is increasingly being used as an ecologically sound substitute for endangered hardwoods. It has applications in furniture and specialized construction, as notably demonstrated in Manila's Coconut Palace.

Coconut roots:

The roots are used as a dye, a mouthwash, and a medicine for diarrhea and dysentery. A frayed piece of root can also be used as a toothbrush.

Use in beauty products:

Coconuts are used in the beauty industry in moisturizers and body butters because coconut oil, due to its chemical structure, is readily absorbed by the skin. The coconut shell may also be ground down and added to products for exfoliation of dead skin. Coconut is also a source of lauric acid, which can be processed in a particular way to produce sodium lauryl sulfate, a detergent used in shower gels and shampoos. The nature of lauric acid as a fatty acid makes it particularly effective for creating detergents and surfactants.

Role in culture and religion:

A coconut (Sanskrit: *narikela*) is an essential element of rituals in Hindu tradition. Often it is decorated with bright metal foils and other symbols of auspiciousness. It is offered during worship to a Hindu god or goddess. Irrespective of their religious affiliations, fishermen of India often offer it to the rivers and seas in the hopes of having bountiful catches. Hindus often initiate the beginning of any new activity by breaking a coconut to ensure the blessings of the gods and successful completion of the activity. The Hindu goddess of well-being and wealth, Lakshmi, is often shown holding a coconut. In the foothills of the temple town of Palani, before going to worship Murugan for the Ganesha, coconuts are broken at a place marked for the purpose. Every day, thousands of coconuts are broken.

Medicinal uses:

The hexane fraction of coconut peel may contain novel anticancer compounds. Young coconut juice has estrogen-like characteristics. Inside a coconut is a cavity filled with coconut water, which is sterile until opened. It can also serve as an emergency short-term intravenous hydration fluid. This is possible because the coconut water has a high level of sugar and other salts that makes it possible to be used in the bloodstream, much like the modern lactated Ringer solution or a dextrose/water solution as an intravenous solution. Coconut is also commonly used as a traditional remedy in Pakistan to treat bites from rats. In

Brazil, coconut is known as *coco-da-bahia*, *coco-da-baía* or *coqueiro-da-índia*. The tea from the husk fiber is widely used to treat several inflammatory disorders.

Husks and shells:

The husk and shells can be used for fuel and are a source of charcoal. Activated carbon manufactured from coconut shell is considered extremely effective for the removal of impurities. The coconut's obscure origin in foreign lands led to the notion of using cups made from the shell to neutralize poisoned drinks. The cups were frequently engraved and decorated with precious metals.

A dried half coconut shell with husk can be used to buff floors. It is known as a bunot in the Philippines and simply a "coconut brush" in Jamaica. The fresh husk of a brown coconut may serve as a dish sponge or body sponge. Tempurung as the shell is called in the Malay language can be used as a soup bowl and—if fixed with a handle—a ladle. In India, coconut shells are also used as bowls and in the manufacture of various handicrafts, including buttons carved from dried shell. Coconut buttons are often used for Hawaiian aloha shirts. In Thailand, the coconut husk is used as a potting medium to produce healthy forest tree saplings. The process of husk extraction from the coir bypasses the retting process, using a custom-built coconut husk extractor designed by ASEAN–Canada Forest Tree Seed Centre (ACFTSC) in 1986. Fresh husks contains more tannin than old husks. Tannin produces negative effects on sapling growth. In parts of South India, the shell and husk are burned for smoke to repel mosquitoes

1.4 Natural habitat :

The coconut palm thrives on sandy soils and is highly tolerant of salinity. It prefers areas with abundant sunlight and regular rainfall (1500 mm to 2500 mm annually), which makes colonizing shorelines of the tropics relatively straightforward. Coconuts also need high humidity (70–80%+) for optimum growth, which is why they are rarely seen in areas with low humidity, like the southeastern Mediterranean or Andalusia, even where temperatures are high enough (regularly above 24 °C or 75.2 °F). Coconut palms require warm conditions for successful growth, and are intolerant of cold weather.

The conditions required for coconut trees to grow without any care are:

- [1] Mean daily temperature above 12–13 °C (53.6–55.4 °F) every day of the year
- [2] Mean annual rainfall above 1,000 mm (39.37 in)
- [3] No or very little overhead canopy, since even small trees require direct sun

The main limiting factor for most locations which satisfy the rainfall and temperature requirements is canopy growth, except those locations near coastlines, where the sandy soil and salt spray limit the growth of most other trees.

1.5 Cultivation:

Coconut palms are grown in more than 80 countries of the world, with a total production of 61 million tonnes per year. Coconut trees are very hard to establish in dry climates, and cannot grow there without frequent irrigation; in drought conditions, the new leaves do not open well, and older leaves may become desiccated; fruit also tends to be shed.

Traditional areas of coconut cultivation in India are the states of Kerala, Tamil Nadu, Puducherry, Andhra Pradesh, Karnataka, Goa, Maharashtra, Odisha, West Bengal and the islands of Lakshadweep and Andaman and Nicobar. Four southern states combined account for almost 92% of the total production in the country: Kerala (45.22%), Tamil Nadu (26.56%), Karnataka (10.85%), and Andhra Pradesh (8.93%). Other states, such as Goa, Maharashtra, Odisha, West Bengal, and those in the northeast (Tripura and Assam) account for the remaining 8.44%. Kerala, which has the largest number of coconut trees, is famous for its coconut-based products—coconut water, copra, coconut oil, coconut cake (also called coconut meal, copra cake, or copra meal), coconut toddy, coconut shell-based products, coconut wood-based products, coconut leaves, and coir pith.

1.6 Varieties of coconut:

There are mainly two distinct groups of coconut i.e. tall and the dwarf, (semi-tall also exists in between). VHC3 is the recently developed hybrid coconut in variety. Among the plantation and spice crops, India is the first country to exploit hybrid vigor in coconut. Twelve hybrids involving tall and dwarf parents and 4 varieties have been released for commercial cultivation

II. MATERIAL AND METHOD:-

Machine Description:-

Coconut De-husking machine mainly consists of four major parts as frame; hydraulic power unit with cylinders and valves. The actual machine is shown below. Maintaining the Integrity of the Specifications.

A) The Machine Mainly consists of three hydraulic cylinders which are of dimension

- 1.90*270 mm
- 2.60*220 mm
- 3.30*130 mm

B) The Machine consists of Main supporting frame which is used to support the entire mechanical arrangement used to de-husk the coconut. The dimensions of the frame are as follows. Hollow square type L frame, which is made up of mild steel. Dimension of the frame is as follows.

1. Upper support is of 70*150*600 mm.
2. Vertical support is of 80*80*750 mm.
3. Round type mechanism cover diameter 400 mm.

C) The Machine consist of the de-husking mechanism which consists of total 18 links of which the 6 links are the main links through which the mechanism gets actuated. The other 6 links are the links which consists of the knife which de-husks the Co-conut fiber of the fruit. Lastly the supporting links which are of movable type and guides the knife links to stop after coconut

Fiber gets de-husked.

D) The dimensions of the Mechanical links are as follows.

1. Main link is of 41 mm length.(6 no's)
2. Movable link (knife) is of 230mm length.(6 no's)
3. Supporting fixed link is of 110 mm length.(6 no's)

The Machine also consists of the fruit gripping mechanism. It consists of mainly 3 links of L type. Dimensions are as follows. 15*20*45*80 mm.(3 no's).

E) The Machine consists of hydraulic power unit which consists of 1.5 h p pump. Hydraulic fluid operating valve. Due to which the mechanism gets activated through the hydraulic cylinders. The specifications of the valves and pump are as follows.
Four way three position direction control valve.



Figure 2. Photograph of actual machine.

III. MECHANISM OF MACHINE:-

Figure below shows the de-husking mechanism of the hydraulically operated de-husking machine.

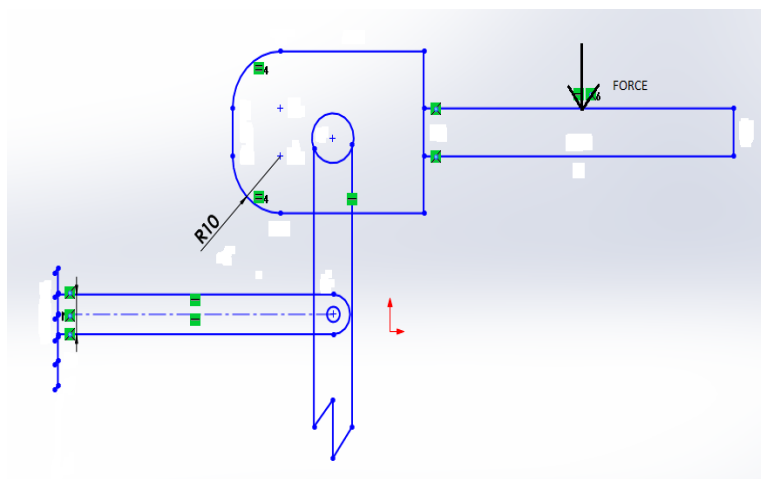


Figure 3.The de-husking mechanism of coconut de-husking machine.

As the force is applied by the de-husking cylinder rod the disc actuates the main link attached to the disc which in turn moves the knifed link at the particular degree of freedom provided to it. The fixed or guiding link supports the knifed link, for opening and closing of the knifed link.

Working:-

The machine mainly consists of hydraulic cylinders, de-husking mechanism, hydraulic power pack, fruit gripping mechanism, and frame. Firstly the fruit (coconut) is placed over the gripping surface. Secondly, the coconut is lifted up to a certain height to reach the working radius of the de-husking mechanism by lifting cylinder such that the upper portion of the coconut engages with the knifed link up to depth of 3-4 cm of the coconut fiber. Thirdly, the Coconut fruit is now gripped tightly by the fruit gripping mechanism. Fourthly, the engaged links with the coconut fruit are opened within its working radius so that the upper half of the fruit gets de-husked. Lastly the lifting cylinder is lifted up to the extreme height the cylinder at its maximum limit which results in removal of husk from the bottom half of the coconut following the gripping mechanism to get deactivated. Then the inner coconut fruit with the harder shell is taken out of the de-husked portion.

Hydraulic circuit arrangement of Coconut De-husking machine:-

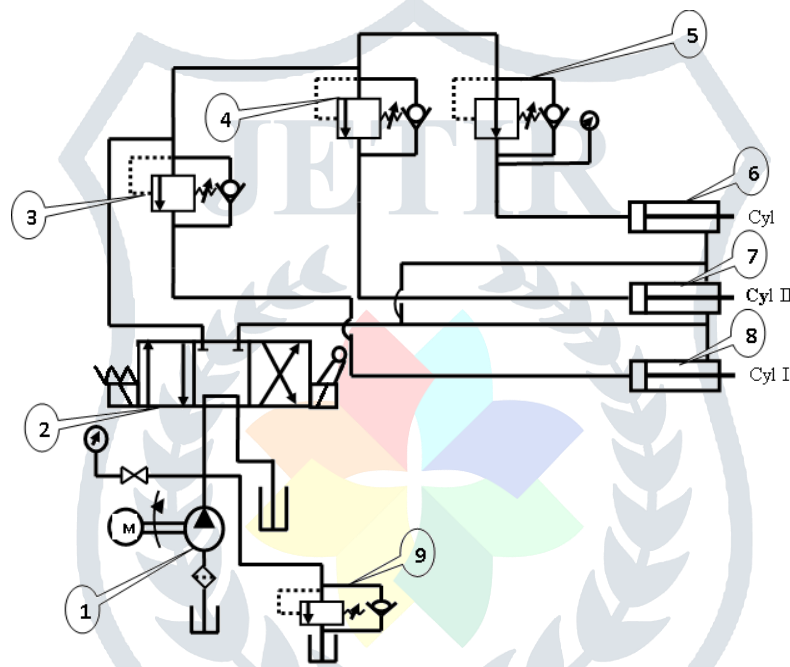


Figure 4.Hydraulic circuit of coconut de-husking machine.

Where,

1. Hydraulic Pump.
2. Four way, three position direction control valve.
3. Sequencing valve, cylinder 1
4. Sequencing valve, cylinder 2
5. Sequencing valve, cylinder 3
6. Hydraulic cylinder 3
7. Hydraulic cylinder 2
8. Hydraulic cylinder 3
9. Relief Valve

Working details of the hydraulic circuit:

The figure 5.10 above shows the hydraulic circuit of the coconut de-husking machine. This consists of the hydraulic pump. The function of the hydraulic pump is to suck the oil from the reservoir which has an arrangement of filter. The oil before entering the pump travels through the filter if it possesses some impurities the filter arrest such impurities and send the filtered oil to the pump. The arrangement also has the motor. The function of the motor is to drive the pump. The circuit above also shows the four way three positions direction control valve. The valve operates for three positions. The positions of the valves are forward, neutral and reverse position. During the forward position of the valve operating using a spool the hydraulic oil enters to the cylinder at the head side and forces the piston rod to move forward. During the neutral position of the spool the piston stops its stroke and there is no further movement of the rod. During the reverse movement of the spool the hydraulic oil enters the rod side in the cylinder and forces back the rod in reverse direction.

The circuit also has the sequencing valves. The function of sequencing valves control the sequence of operation of the multiple cylinders i.e. if we want cylinder 1 for operation it will allow the oil to flow to cylinder 1 keeping the flow to remaining two cylinder 2 and cylinder 3 blocked. If we want cylinder 2 for operation it will allow the flow of oil to cylinder number 2 and block the remaining two cylinders 1 and cylinder 3 and so on.

The circuit also has the hydraulic cylinders. A Hydraulic cylinder (also called a linear hydraulic motor) is a mechanical actuator that is used to give a unidirectional force through a unidirectional stroke.

The circuit also shows the pressure relief valve. Pressure relief valve in a hydraulic system as a fuse or circuit breaker in an electric circuit. An electric circuit never blows a fuse unless it overloads. Protecting the pump and the system from excess pressure is the only valid function for a relief valve.

IV. EXPERIMENTATION AND TESTING CHART:

Some observations in terms of time were taken while De-husking Coconuts on Various types of machines available in market. For Traditional Coconut De-husking the de-husking time required is 200 Coconuts / hour. For Roller type Coconut De-husking method the de-husking time required is 80 Coconuts / hour. For Two blades rotating type the Coconut De-husking time required is 275 Coconuts / hour.

Sr No.	Number of coconut de-husked	Number of well de-husked coconut.	Number of coconut not de-husked well	Time required (Seconds)	Efficiency (%)	Coconut de-husking Capacity /hour
01	10	10	00	11	100	327.27
02	09	09	00	11	100	327.27
09	09	09	00	11	100	327.27
04	10	10	00	13	100	276.92
05	10	09	01	12	90	300
06	11	09	02	12	81	300
07	09	09	00	11	100	327.27
08	09	09	00	10	100	360
09	10	10	00	11	100	327.27
10	10	10	00	10	100	300
Average					97.1 %	317.32/ hour

V. CONCLUSION:

The observations discussed above while experimenting and testing on the hydraulically operated coconut de-husking machine were **317.32 / hour** which is more than any other machines available or the methods used for de-husking of coconuts. The efficiency of the machine when tested, on trial of 10 coconuts found to be nearly about **97.1 %** which is comparatively more than any other machine available in market. Hence performance wise the efficiency of the machine and the number of coconuts de-husked per hour is high. Hence we can conclude that performance wise the hydraulically operated coconut de-husking machine is high.

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