Design and Development of Coconut De-husking Machine

Mr.Vinod P.Sakhare[#1]
Assistant Professor, Department of Mechanical Egineering , Datta Meghe Institute of Engg. Technology and Research. (Wardha), India

Mr. Ketan K. Tonpe [#2]
Assistant Professor, Department of Mechanical Egineering , Suryodaya College of Engineering and Technology, Nagpur, India

Dr. Chandrashekhar N. Sakhale[#3]
Assistant Professor, Department of Mechanical Egineering , Priyadarshini College of Engineering and Technology, Nagpur,India

***Abstract*—Coconut De-husking machine mainly consists of four major parts as frame, hydraulic power unit with cylinders and valves arrangement following with operating mechanism to de-husk the coconut fiber. Coconut de-husking machine has the average capacity to de-husk the Coconut on an average at 12.1 seconds. When the observations were taken on ten Coconuts and only one skilled operator is required for operating the entire machine. The labor cost is nearly half the cost of de-husking the Coconut by using the conventional method.**

Keywords—Coconut, De-husking Machine, Mechanical operating jaws, Safety factor.

I. INTRODUCTION

Agriculture is the potential area that has to be automated which can be applied for activities like irrigation, harvesting, ploughing, weeding etc. This project aims at automating the process of removing the outer husk of coconut by some pure mechanical oriented thoughts. This machine is designed to remove the outer husk from the coconut fruit using mechanical jaws operated by a hydraulic power producing unit which engages with the husk and opens in such a manner to get the husk removed from the coconut fruit.

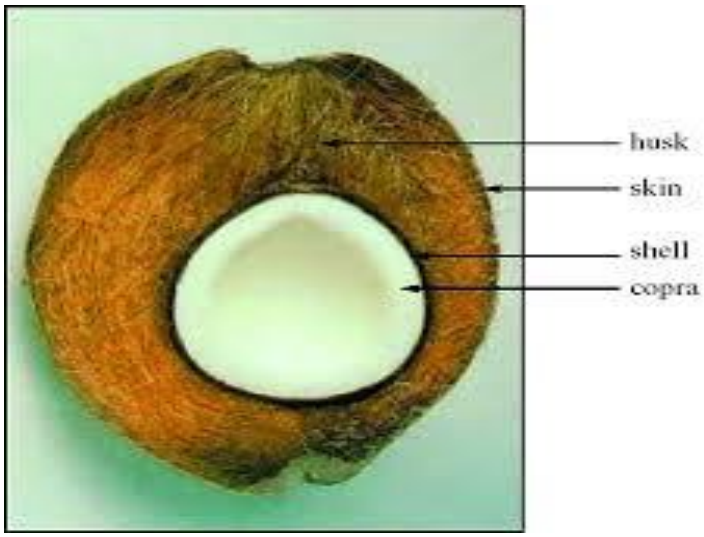

Fig 1:- Structure of Coconut Fruit.

The process remains safe and only one operator is required to operate this machine with a process of no breakage of coconut. This serves added advantage to this machine. The fiber production (both white and brown) in the country at 3.75 tonne.

Coconut is commercially cultivated in 93 countries especially on the small and marginal holdings over an area of 11.8 million hectares about 10.26 million tons of copra equivalent were produced in the year. India contributes to 15.30 % of the global area and 19.49 % of global production, and is the largest single market for Coconut, consuming almost its entire production of 12.6 billion nuts.Indonesia is the next largest market for Coconut, consuming nearly 11.2 billion nuts accounting about 74 % of its production. As much as 50.8% of the total coconut area in India is concentrated in Kerala and the state account for 43.6 % of the total production of the country. Kerala is small state along the west coast of the India, which accounts for only 1.18% of the total land area of the country.

Lack of an effective husk collection mechanism and consequent inadequate raw material availability is the main bane of the industry affecting its development. Meanwhile, the husk available with the small holdings, are now wasted in the absence of an organized system for collection of husk and its mobilization for being to the industry.

There is a shortage of fiber as the industry is the industry is able to use only 35 percent of the 13,000 million coconut husks produced in a year. The coir board has urged the center to allow duty free imports of 20,000 tonne of coir fiber from Sri Lanka in a bid over its shortage. According to senior coir board official, the country produced around 13,000 million coconut husks a year .Yet, there is a shortage of fiber as the industry is able to use 35 percent of these husks.

II. MATERIAL USED AND METHODOLOGY

Machine Description:-

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

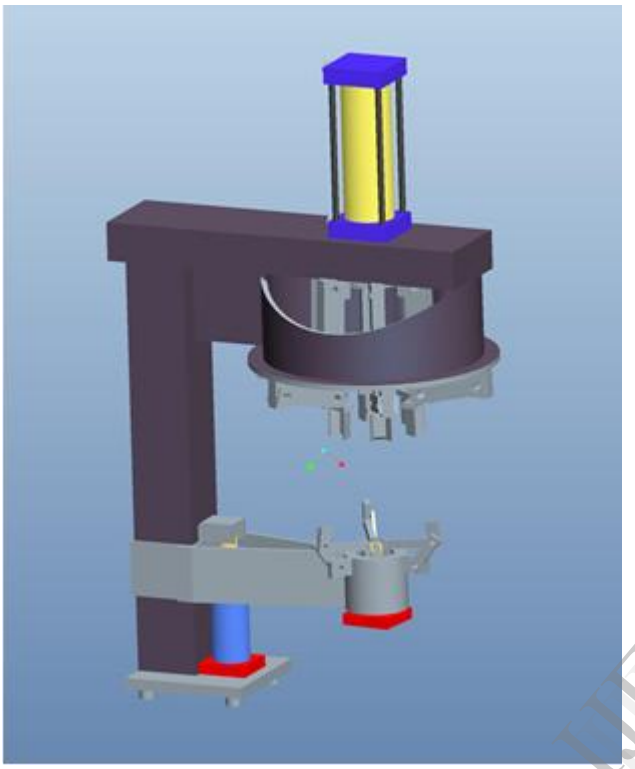

Fig 2:- Cad Model of Coconut De-husking Machine.

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 coconut 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.

III. METHOD OF OPERATING THE MACHINE

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.

VI. DESIGN AND CALCULATIONS OF MACHINE.

A) *Calculation of Pressure required at the Mechanical jaws operating cylinder*

$$P_{cylinder} = \frac{W}{A} \quad \text{..... (1)}$$

Where,

$P_{cylinder}$ = Pressure inside the Cylinder
W = Weight of Piston and Cylinder Rod (kg)
A = Area of the cylinder (mm^2)

Also,

$$P_{cylinder} = \frac{Force\ acting}{Area\ of\ links \times n} \quad \text{..... (2)}$$

Where,

n = Number of links

B) *Calculation of Angular Velocity ω (rad/sec)*

$$F = mrw^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where,

m = Mass of Link.*(kg)*

r = Radius of Circular plate *(mm)*

w = Angular Velocity (rad/sec)

C) Space Diagram of the Coconut De-husking Mechanism.

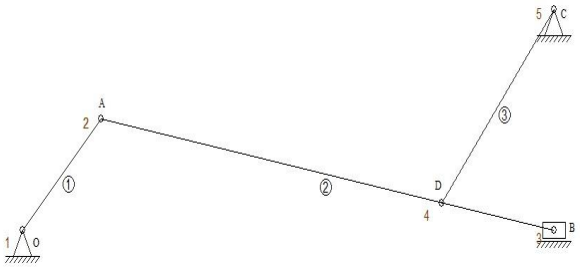

Fig 3:- Space Diagram of Coconut De-husking Machine

D) Velocity distribution of Coconut De-husking Mechanism.

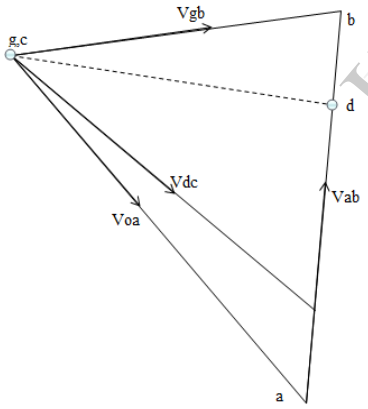

Fig 4:- Velocity Polygon of Coconut De-husking Mechanism..

$$V_{oa} = W_{oa} \times L_{oa} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

E) Acceleration Distribution of Coconut De-husking Mechanism

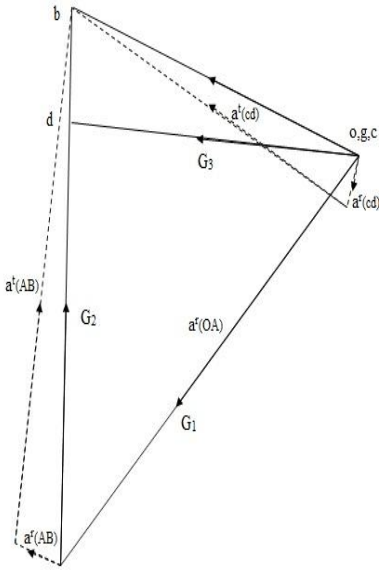

Fig 5:- Acceleration Polygon Of Coconut De-husking Mechanism.

$$\alpha^r_{OA} = \frac{V^2_{OA}}{L_{OA}} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

$$\propto_{AB} = \frac{a^t_{AB}}{l_{AB}} \quad \ldots\ldots\ldots\ldots\ldots (6)$$

$$\frac{OG_1}{OA} = \frac{og_1}{oa} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

F) Free Body Diagram of Coconut De-husking Mechanism.

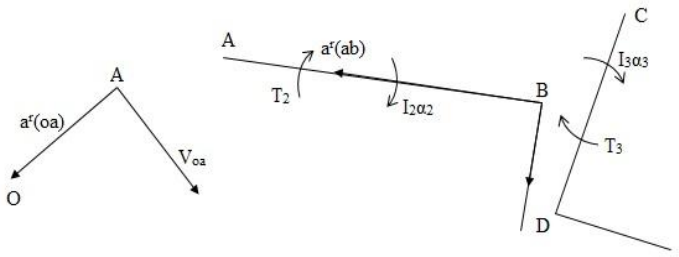

Fig 6:- Free Body Diagram of Coconut De-husking Mechanism.

G) Force and Torque diagram of Coconut De-husking Mechanism.

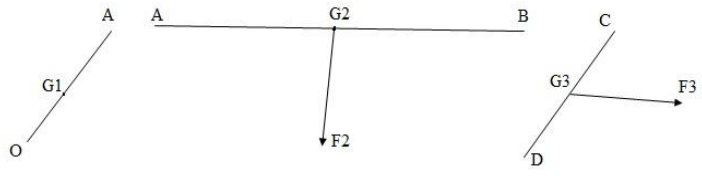

Fig 7:- Force and Torque Diagram of Coconut De-husking Mechanism.

Force required opening the links freely when not engaged with Coconut fiber

$$F_1 = M_1 \times og_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$F_2 = M_2 \times og_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$F_3 = M_3 \times og_3 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Total force required to open the links freely

$$F_{1(Total)} + F_{2(Total)} + F_{3(Total)}$$

Therefore,

De-husking Force = *Force acting* -

$$F_{1(Total)} + F_{2(Total)} + F_{3(Total)}$$

H) Graphical Symbols of the hydraulic circuits of Coconut De-husking Machine.

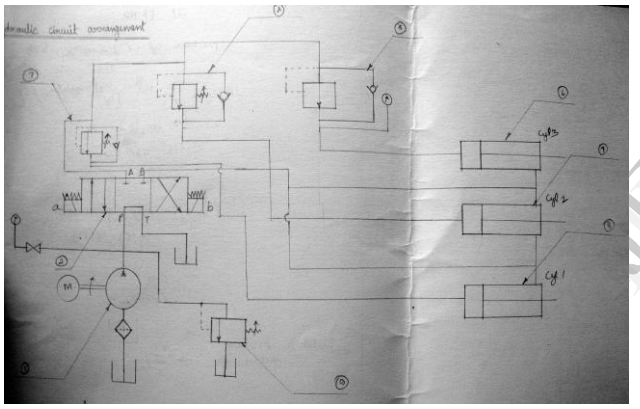

Fig 8:- Hydraulic circuit

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

V. EXPERIMENTATION AND TESTING ON MACHINE

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 blade rotating type the Coconut De-husking time required is 275 Coconuts / hour.

For hydraulic type Coconut De-husking method the de-husking time required is **300 Coconuts /hour**.

Traditional Method of Coconut De-husking Machine										
Time required for Dehusking (sec)	18	19	18	18	19	17	18	20	19	18
Average time taken	18.4 sec									
Roller Type Coconut De-husking Machine										
Time required for Dehusking (sec)	45	44	45	45	43	44	46	44	47	44
Average time taken	44.7 sec									
Two blade rotating type Coconut De-husking Machine										
Time required for Dehusking (sec)	13	14	15	13	13	14	12	13	14	13
Average time taken	13.4 sec									
Hydraulically Operated Coconut De-husking Machine										
Time required for Dehusking (sec)	12	11	12	12	13	14	11	12	12	12
Average time taken	12.1 sec									

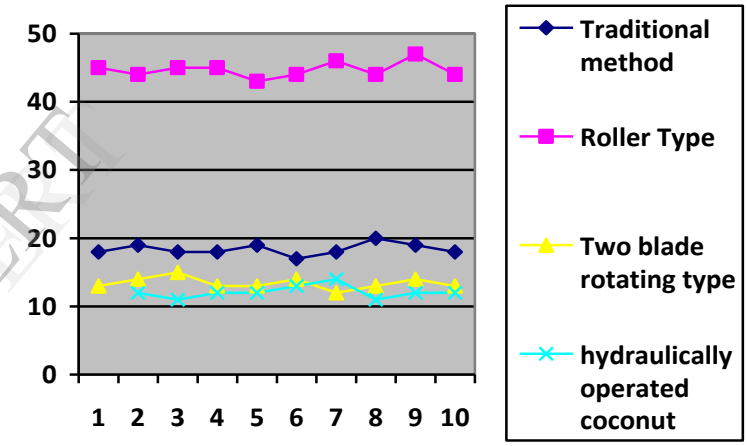

Fig. 9 No. Coconut-De husk Vs Time (second)

And the results obtained was the hydraulically operated Coconut de-husking machine has the average capacity to de-husk the Coconut on an average at **12.1 Seconds** when the observations were taken on ten Coconuts with only one skilled operator.

VI. CONCLUSION.

Hence, the objective to de-husk the Coconut fruit is been achieved by designing the mechanism. The Productivity rate of de-husking the Coconut increased. Time required to de-husk the Coconut has been reduced comparing to other machines available in the market. Minimum chances of accidents while de-husking the coconut. Decrease in Labor cost for Coconut de-husking, can be minimized up to greater extent.

VII. REFERENCES

[1] Foale, M.A. The Coconut Palm. In: Chopra, V.L. and Peter K.V. edited *Handbook of Industrial Crops*. Haworth Press, New York, 2005.
[2] Tilledaratne, H.A. Processing of Coconut Products in Sri Lanka. Asian and Pacific Coconut Information Document. Arancon, Jr., R.N., ed. Asian and Pacific Coconut Community. Jakarta, Indonesia. 1995.
[3] B. N. Nwankwojike, "Development of a Coconut Dehusking Machine for Rural Small Scale Farm Holde "international journal of innovative technology & creative engineering (issn:2045-8711)vol.2 no.3 mar 2012rs.
[4] Dr. H.D Ramchandra, Hydraulics & Pnuematics, Sudha Publications, Bangalore, Edition:2005
[5] APCC. Coconut Food Process – Coconut Processing Technology.Information Document.
[6] Thampan, P.K. Handbook on Coconut Palm. Oxford & IBH Publishing Co. New Delhi 1996.
[7] Ohler,J.G.Coconut Tree of Life.FAO Plant Production and Protection Paper 57.FAO ,Rome,Italy ,1984.
[8] S S Rattan, Tata McGraw Hill Education Private Limited, New Delhi. Third Edition.
[9] Khurmi, R.S and Gupta, J.K. A Text of Machine Design (S.I Units),Eurasia Publishing House (PVT) Ltd, Ram Nagar,New Delhi-110058,2005.