

Paper ID: NITET12

DESIGN & MANUFACTURING OF CASHEW NUT SHELLING MACHINE PAPER

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ABSTRACT

This paper deals with the mechanical characteristics of cashew nut and cutting the shell in a mechanized way to reduce the time. Presently shearing of shell of cashew nut is done manually, which is labour intensive and hazardous. During shearing of cashew nut shell a liquid is coming out which is corrosive which is hazardous and in turn consumes the lot of time because of its oily property. This automatic power operated cashew nut Sheller may be operated by unskilled worker. The release of kernel from the shell with no damage and breakage is possible with this. An automatic power operated cashew nut Sheller is based on the principle of shear with respect to cutters is mounted on sliding guide ways. Now-a-days few automatic cashew nut shelling machines are present but there are some problems such as it cannot be adjusted along the guide as per the size of cashew nut therefore efficiency of machine may get reduced and cost may increase. This research overcomes the problem by manufacturing automatic cashew nut shelling machine using spring adjustment guide with respect to size of cashew nut and in turn improves the efficiency.

Firstly fracture point of cashew nut shell and depth required for cutting the shell is determined, after that as per fracture point the guide Vee is designed near cutting section. An automatic cashew nut Sheller is having two cutters to shear the cashew nut

shelling with automatic feeding of cashew nut one after another through Vee guide. Cutter is mounted on sliding guide ways which move between the two Vee guides which carries two blades which creates impact load on cashew nut. These two blades are used to split the kernels from shell by operating the cutter. After de-shelling, nut falls freely in tray due to the gravity. The finding suggests the capacity of the machine as 25kg/hr.

This paper summarizes a semi automatic method over manual method. It also deals with the advantages of semi automatic method in terms of enhanced productivity, quality and cost. The drafting and modelling phase is carried out by using CATIA and part design is done by referring the design data book. The practical implications of this paper plays a very significant role in cashew nut producing industries as the cost of production drastically comes down.

KEYWORDS: shearing, Vee guide, feeding mechanism, productivity improvement

INTRODUCTION

The cashew tree (*Anacardium occidentale*) is a tropical evergreen tree that produces the cashew nut and the cashew apple. It can grow as high as 14 m (46 ft), but the dwarf cashew, growing up to 6 m (20 ft), has proved more profitable, with earlier maturity and higher yields (Morton, Julia F (1987). [1] It produces the cashew seed and the cashew apple. The shell of the cashew seed

yields derivatives that can be used in many applications from lubricants to paints. Cashew nut is found very commonly in Brazil, it has come in India in half of sixteen century for the purpose of forestation and soil conservation. It is also made into cashew butter and nut milk, and used in baking and confectionaries (Davis, 1999; Rosengarten, 1984). Processing of the raw nuts releases the by-product CNSL that has industrial and medicinal applications (DermNet, 2007; Davis, 1999). [3] The skin of the nut is high in tannins and can be recovered and used in tanning of hides. The fruit of the cashew tree surrounds that kernel can be made into a juice with a high vitamin C content and fermented to give a high proof of spirit (Azam-Ali and Judge, 2004)

The purpose of shelling is to produce clean, whole kernels free of cracks. In India, this operation was previously and in most of the nations has always been done manually, which is still relevant to the small-scale processor, although the mechanization of shell remover process is advisable option in all cases.

The development of cashew nut shelling machine suited for cashew nut is to accommodate better mechanism in order to avoid major risk of spilling of liquid which causes of skin diseases & physical disability. Present machineries are manual & semi-automatic which is bulky, costly and hectic for processing. These causes promote to build a fully automatic machine which should fulfil the all requirements of the farmers. This machine allows to atomization and reliability of the process.

LITERATURE REVIEW

Jain, R.K. et al.; [4] has explained, Presently shelling of cashew nuts is done manually, which is not only labour intensive but also hazardous because of corrosiveness of cashew nut shell liquid. Therefore, a power-operated cashew nut Sheller was developed based on the principles of compression and shear. The cashew nut processing industry is typically located in the rural and backward areas of India. The general steps in cashew nut processing are: conditioning, drying (sun), roasting, shelling, kernel drying (oven), peeling and grading. The shelling, peeling and grading unit operations are carried out manually. The shelling of cashew nuts means breaking and complete removal of the shell and taking out the kernel without causing much damage. The shelling has always presented the greatest problem in the processing of cashew nuts. This is because of irregular shape and brittleness of the kernel. The manual shelling process is tedious, time consuming and labour intensive and thus it indulges drudgery in the system. Moreover, quantity and quality of out-turn depends upon the skill of the person (Jain and Sivala, 1996). The cashew nut shell liquid which comes out during the

operation of roasting and shelling is highly corrosive and requires special care during manual shelling.

Oloso and Clarke (1993) mentioned different methods of shelling roasted nuts. In the Sturtevant system, roasted cashew nuts are thrown by centrifugal force on to a metal plate for shelling. It resulted in poor shelling efficiency. In the Oldsmar system, well graded nuts are held by a nut-shaped blade and cut along a natural line. The capacity of shelling is very low because each nut has to be placed for cutting. In spite of these developments, presently shelling is mainly carried out manually by hitting the nut with a wooden hammer along its longitudinal axis. Average shelling Capacity was reported to be 8 kg/day every worker, which consists of 36% whole, 30% Half-splits and 34% broken as stated by (Jain, 1982; Kumar, 1989). Therefore, there is a need to develop a mechanical or mechanized cashew nut Sheller, which should be able to meet the wide range of cashew nut shelling requirements, reduce the drudgery and improve the quality of the product.

S.J.Ojolo et al.; [2] has stated the traditional method of cracking roasted cashew nuts manually, using harmer or knife cutter is very labour -intensive, slow and tedious; besides, most mechanical crackers do not give satisfactory results in terms of whole kernels percentage. A prototype machine was developed to crack roasted cashew nuts. Nuts get cracked by the impact of the lid against the feeding tray. The lid provides for a minimum clearance from the feeding tray on which nuts are preloaded; this prevents the applied force compared is in excess of the required cracking force. The machine was tested with various cashew nut sizes, and placement orientations. The percentage of whole kernels produced was around 67 %. The capacity of the machine was estimated to be about 18.3 kg/hr.

O. Damisa, et al.; [5] have explained in their paper that machine which is affordable to peasant farmers and requires little or no training for operation and maintenance. The advantage of reduced unit cost can be derived from large-scale commercial production of this Sheller. Physical and mechanical characteristics of the roasted cashew nut during fracture, by subjecting the nut to varying impact load tests at different orientations to ascertain the critical impact load that fractures the shell without damaging the kernel within. This load value was correlated with other parameters; shell/kernel moisture content level and average nut mass to determine the required projection velocity to achieve this force.

ELEMENTS AND MATERIALS

Materials: - The selection of materials of the components for the system on the basis of mechanical properties such as strength, reliability, life, durability, for the components like selection of motors, guides, springs etc.

Reciprocating Unit: Reciprocating unit consists of guiding block, feeding mechanism, scraper etc. The sliding bar was needed for "up and down" motion of the guiding block. Thus a pair of cylindrical polished rod of length 540 mm with gun metal bush was selected for the guide. The material used for guiding block should be light in weight and durable. Therefore aluminium block of having 35 mm external diameter and 25 mm internal diameter of bush were selected.

Speed reduction Motor with gear box:- The reason behind considering of AC motor is that it has having high torque and low in maintenance. AC motor required for this is with a low speed of 48 rpm. Hence we used 30:1 ratio as a speed reduction for the input speed of single-phase AC motor is 1440 rpm;

MECHANISM OF CASHEW NUT SHELLING

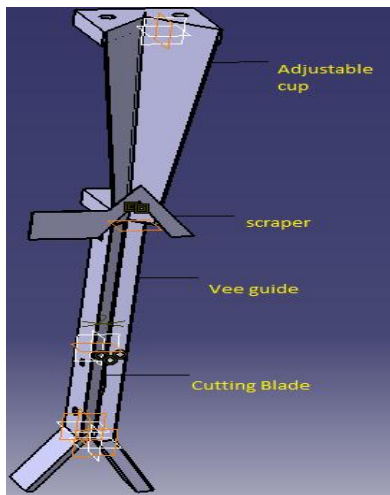


Figure 1: Assembled view cashew nut shelling unit.

As shown in Figure Mechanism of Cashew Nut Shelling Machine consists of following main parts:-

1. Fixed and movable Vee guide.
2. Scraper.
3. Adjustable cups.
4. Cashew cutting blades.
5. Cashew nut size adjustment mechanism.
6. Reciprocating unit.

As shown in Figure 1 Cashew nut falls into the adjustable cups. As per shape it locates in cutting position as required because of adjustment of cups. Cashew nuts were drawn in between the fixed and movable cutters due to driving force caused by scraper. Scraper can move up and down to meet the size variance of cashew nuts as per the size of cashews Vee grooves goes on adjusting with giving spring force on nuts. at the point where blades are positioned the nuts gets impact load by movable

blades results in cracking of shell without damaging internal kernel. The Vee grooves are opened to 30 degrees in order to get collected into the tray.

THE DESIGN OF SCRAPER

The cutting force required to crack the cashew by impact load.

The average weight of cashew nut is 4.2 g.

$$\text{Impact energy} = \frac{mv^2}{2} \text{ J}$$

$$\text{Impact energy} = 0.0024v^2 \text{ J}$$

By considering the highest impact load of 115 N [6], the force required in order to crack the shell of cashew nut Therefore,

$$\text{Work of deformation} = 115 \times e \text{ J}$$

E is the maximum deformation.

$$e = 7.25 \text{ mm [2]}$$

$$e = 0.00725 \text{ m}$$

Hence:

$$\text{Work of deformation} = 115 \times 0.00725 \text{ J}$$

$$\text{Work of deformation} = 0.83 \text{ J}$$

Equating to the kinetic energy:

$$0.0024v^2 = 0.83$$

$$v^2 = 345.83$$

$$v = 18.59 \text{ m/s}$$

MATERIAL SELECTION AND ELEMENTARY DESIGN

As adjustment of Vee guide is needed with spring to sustain repeated loading as load on spring is less therefore, the material selected for spring is hard drawn spring steel (patenting and cold drawn steel wires). The patented and cold drawn steel wires are the least expensive of all spring materials. The minimum tensile strength is given below and modulus of rigidity of these material is 81370 N/mm^2

Maximum deflection required for spring is 10 mm (as per size of cashew nut) and force acting on spring is 14.65 N (vee guide movement (to and fro) as per size of cashew nut)

As per requirements standard spring is available with following specification,

1. Wire diameter(d) = 2 mm
2. Mean diameter(D) = 21 mm

For 2 mm wire diameter spring (grade 1) tensile strength is 1420 N/mm^2 as stated by V B Bhandari.

CALCULATIONS

$$1) \text{ Spring index (c)} = D/d = 10.5$$

$$2) \text{ Spring rate (k)} = \frac{\text{force acting on spring}}{\text{deflection of spring}}$$

$$= \frac{14.65}{10}$$

K = 1.465 N/mm

ADVANTAGES

1. Besides, the Automatic Shelling Machine (ASM) can be operated round the clock in 3 shifts, which is not possible in conventional as well as in manual processing system.
2. Production rate increases as productivity increases.
3. Due to use of ASM, human fatigue is eliminated
4. It avoids health issues of operator due to hazardous liquids during handling of process.
5. Increase in efficiency and reliability of processing.

LIMITATIONS

1. Significant increase in machine cost.
2. Drastically increases the weight of machine.
3. Moisture content should be in proper manner for effective cutting.
4. After cutting there is no separate arrangement for sorting of cashew and shell.

APPLICATIONS

1. It is widely used in konkan areas.
2. It is mostly applicable in SME's.

CONCLUSION

This project deals with cashew nut Sheller and it has been designed to improve the efficiency of the shelling operation by means of automation in processing equipment designed for cashew nut. Automatic Shelling Machine (ASM) has achieved same broken percentage as the manual shelling. Besides, the ASM and shelling system can be operated round the clock in three shifts, which is not possible in conventional processing system thus increase in productivity. The demand of mass production can easily be coped off also cashew processing may be so cheap. Thus solution developed is optimal and reliable enough in order to get quality in the cashew nut processing.

FUTURE SCOPE

The proposed automatic shelling machine avoids health issues due to hazardous liquids during handling of process and reduces human intervention during processing of cashew nut shelling by complete atomization of machine. Further research work will be suggested towards reducing the initial cost of automatic shelling machine. Following are the suggested work that can be implemented in future.

1. Automatic separation of kernel and shell of cashew nut.

2. Increase in production rate by means of multi cutters.
3. The machine can be redesigned to reduce overall weight.

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