LEARNING FACILITATING MATERIALS

NATIONAL CERTIFICATE LEVEL 1

TRADE AREA: **CASHEW PROCESSING**

UNIT 9

CASHEW KERNEL SORTING, PEELING AND ROASTING MACHINE OPERATION AND MAINTENANCE

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UNIT INTRODUCTION

Welcome to Unit 9 of your learning journey in cashew processing. This guide explains the main steps involved in operating and properly maintaining some machines in processing cashew kernels.

As a general principle, the right handling and maintenance activities involved with cashew processing machines has a lot of benefits which you should commit to memory to influence your general work attitude.

If you follow the steps for operating and maintaining cashew kernel processing machines, you will not only be efficient in producing high-quality products, but also ensure your safety in using them. Do not miss a step! Apply your knowledge and skills accurately to achieve a safe product for the final consumer and a safe working experience for yourself.

In this unit, you will learn about the main steps involved in the operation and maintenance of some machines in the processing of cashew kernels. The learning material covers five sub-units:

1) Operate oven for Drying and Humidification in Cashew Kernel processing.
2) Demonstrate skills for operating Peeling machine in Cashew Kernel processing.
3) Demonstrate skills for operating Sorting and Grading machine in Cashew Kernel processing.
4) Demonstrate skills for operating Packaging Machine in Cashew Kernel processing
5) Demonstrate skills for operating Roaster in Cashew Kernel processing.

Each unit contains theoretical and practical exercises. Each module includes written materials, visuals as well as self-assessments to test your knowledge and skills.

The benefit of learning this information is to ensure safe and efficient use of cashew sorting, peeling, and roasting machines, and assure continuous production of high-quality cashew kernels. Remember that the meticulous application of knowledge and skills from this unit impacts your personal safety and the quality of your final product.

Take note: the right use and maintenance of your cashew kernel sorting, peeling and roasting machines, the longer they would last for your use, the better the chance that they would remain efficient in your process, and the greater will be their impact, positively, on your final product. Ultimately, if you produce good quality, your customers will always buy from you which will ensure you remain profitable!

Even though, this learning material provides essential information on operating and maintaining cashew apple juice extraction machine for the National Certificate Level 1, you should also look out for new information, innovations and technological advances during your practical work that expand your knowledge and skills.

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ICONS

LEARNING OBJECTIVES

ATTENTION

PRACTICALS HANDS ON

SELF ASSESSMENT

WELL DONE!

TAKE A BREAK!

ABBREVIATIONS

Here are some commonly used abbreviations.

SOP	Standard Operating Procedure
PPE	Personal Protective Equipment
GMP	Good Manufacturing Practices
RCN	Raw Cashew Nuts
PM	Preventive Maintenance
LED	Light Emitting Diode
PLC	Programmable Logic Controller
VFD	Variable Frequency Drive
HMI	Human Machine Interface

1. OPERATE OVEN FOR DRYING AND HUMIDIFICATION IN CASHEW KERNEL PROCESSING

a) Identify parts of Oven for Drying and Humidification

Cashew kernel that is shelled still have a layer of skin or protective covering called testa. The testa is known to hold tightly to kernels due to high levels of moisture in kernels. To ease the removal of the testa, manually or by machine, the kernels are heated to reduce the moisture content (to about 3% of dry weight). This heating process makes the testa brittle and loose around the kernel.

The testa is further loosened by immediately cooling the kernels after heating by humidification. The immediate cooling after heating results in what is referred to as thermal shock which occurs to further help loosen testa up for easy and more effective peeling. The humidification process also enhances the moisture content of the kernels to about 5-6% of dry weight.

Easing up the peeling process results in reduction of kernel breakage which is desired in kernel processing. Thus, the heating process is an important one in the cashew processing.

The most common, conventional and specially designed oven used for oven drying cashew kernels is called **Borma Oven**. Ovens are generally like large chambers or metal box in which perforated metal trays are placed, to contain the kernels.

In Figure 9.1 and 9.2, you find photos of the oven with the major parts labelled:

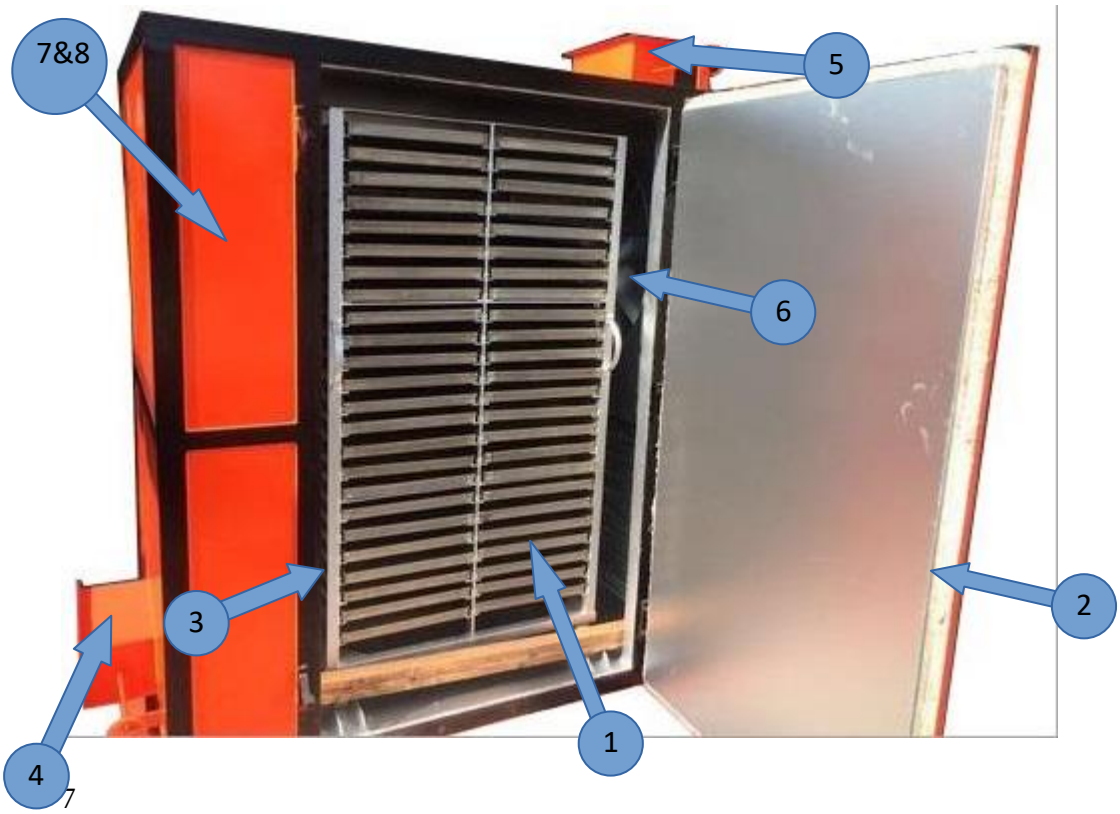

Figure 9.1. Oven Dryer.
Source : https://www.cashewprocessing.com/industrial-cashew-oven.html

Figure 9.2 : Borma Oven
Source : https://www.indiamart.com/proddetail/cashew-hot-house-borma-dryer-13999180388.html

Major parts of oven for drying and humidification:

An important point always worth noting is that for the proper and easy use of a machine, operators must be able to identify and understand the purpose of the various parts of the machine.

In reference to Figure 9.1 and 9.2 above, the major parts of the borma oven for drying and humidification are:

1. **Drying Tray**: rectangular stainless-steel container that hold cashew kernels for drying inside the oven.
2. **Insulated door**: the panel that covers the entry into oven which prevents heat from being conducted out.
3. **Drying Trolley Stack:** the structure into which trays are inserted. It usually has heat/fireproof wheels for movement.
4. **Blower**: motor component that forces air over a heat exchanger through vents inside oven

5. **Exhaust Damper**: valve-like shutter used to control air flow out of oven.
6. **Circulating Fan:** device that forces air around in the oven to enable even distribution of heat for equal drying of kernels in chamber.
7. **Heat Exchanger:** Containing heating and cooling coils over which air is forced to be heated before entering the inner chamber of the oven.
8. **Humidifier**: device that forces moist air into the oven for overall cooling and increase in humidity of air passing through oven
9. **Electronic Control Panel:** the component that has selector switches and push buttons, with indicator lights for starting, monitoring and regulating the operation of the oven.

Oven for both processes of drying and humidification is designed in a way as to ensure that both drying, and humidification will not happen at the same time. Hence air from blower will be controlled by valve to open to either heat exchanger or humidifier depending on what activity is selected on the machine control panel

b) Working Principle of oven for Drying and Humidification.

The working principle of the oven for drying and humidification is as follows:

The trays act as kernel holders to expose them to heated air in the inner enclosed chamber of the oven. Blower forces air currents (air flow) over heating coils at appropriate speeds (velocities) to be heated up and move into inner chamber of oven. The circulating fan moves the air around the inner chamber in a way to ensure even distribution of heated air within oven for uniform drying of all kernels. The heating temperatures usually ranges between 75-85°C.

After heating is complete, humidification is done. This is achieved by the humidifier which adds water vapour or steam to air current from blower resulting in cooling effect inside oven chamber.

The kernels loaded in trays are mounted on trolleys and kept in a hot chamber. The inside temperature of the chamber must be maintained uniformly to preserve the original colour of the cashew kernels. The maximum temperature of the hot chamber should not exceed 85°C (to ensure cashews do not burn/scotch)

There are many types of ovens used depending on the different working conditions of the processing plant, some are hot air blown system based, others work with steam radiators, whereas others are electric based. Steam boilers fueled with cashew shells are the most used.

The temperature (In degrees centigrade/ °C) and duration for drying cashew kernels depend on the type of oven that is used for drying kernels. Consult your in-company facilitator for detailed instructions!

c) Explain Product Requirement after drying and humidification

The drying and humidification processes are employed in the cashew processing after shelling to prepare the kernels for peeling. The desire in the cashew nut process is to obtain white colour and whole cashew kernels as they are of greater value on the market than broken and scorched ones. The product after drying and humidification is required to be white and not scorched and to have sufficiently loose testa of enough moisture content to enhance the peeling process and product yield at that stage.

d) Normal operation of oven for drying and humidification.

A typical step-by-step process involved in operating and properly using oven for drying and humidification is as follows:

1. Load the trays with kernels and place in position in trolley stack.
2. Place trolley stack inside oven and close door firmly.
3. Select heating on control panel and select the heating time and desired temperature range.
4. Turn oven on by pressing start button. This will automatically turn on blower and circulating fans.
    - **Monitor** oven when in operation and look out for leakages at the door and other areas.
    - Oven will keep running at the selected temperature range for the specified time period and give an alarm to indicate end of process when time period elapse.
5. Cool kernel down
6. After the cooling process, select humidification on the control panel and input the time duration.
7. Press start button for process to begin. Oven will sound an alarm when process ends.
8. Open oven and draw out trolley stack to retrieve kernels.

Oven drying and Humidication process explained (From Point 6 above) for semi-mechanised process

Humidification

- Insert the trolleys in the chamber and close the chamber gate
- Increase the pressure of the steam till 8-10 kg/cm2
- Open the steam Valve
- Steaming time is approximately 7-8 minutes
- Control pressure gauge, pressure should not drop below 4 kg
- Open the door after 7-8 minutes,

Cooling

- Cool down naturally for ½ hour

Heat treatment

- Put the trolley in the oven again for 2-3 hours, for drying at 70-80°C
- Take the trolleys out of hot chamber.

Cooling

- Cool kernels naturally for at least 4-5 hours before peeling.

Bar is unit of pressure. Can you name other units of pressure?

Practical Exercise: Go to an oven and follow the steps given to operate.

Use the checklist and follow the stated steps in maintaining a borma oven. Rate your own performance critically and honestly after you have completed each activity.

 Excellent  Okay  Try Again

Steps in operating the oven dryer and humidifier	**Rate**
For a fully mechanised system	
1. Load the trays with kernels and place in position in trolley stack	
2. Place trolley stack inside oven and close door firmly.	
3. Select heating on control panel and select the heating time and desired temperature range.	
4. Turn oven on by pressing start button. This will automatically turn on blower and circulating fans. ○ Monitor oven when in operation and look out for leakages at the door and other areas. ○ Oven will keep running at the selected temperature range for the specified time period and give an alarm to indicate end of process when time period elapse.	
5. Cool kernel down	
6. After the cooling process, select humidification on the control panel and input the time duration.	
7. Press start button for process to begin. Oven will sound an alarm when process ends.	
8. Open oven and draw out trolley stack to retrieve kernels.	

For a semi-mechanized system	**Rate**
1. Load the trays with kernels and place in position in trolley stack	
2. Place trolley stack inside oven and close door firmly.	
3. Select heating on control panel and select the heating time and desired temperature range.	
4. Turn oven on by pressing start button. This will automatically turn on blower and circulating fans. ○ Monitor oven when in operation and look out for leakages at the door and other areas. ○ Oven will keep running at the selected temperature range for the specified time period and give an alarm to indicate end of process when time period elapse.	
5. Cool kernel down	
6. After the cooling process, go on to do humidification as indicated below	
Humidification	**Rate**
7. Insert the trolleys in the chamber and close the chamber gate 8. Increase the pressure of the steam till 8-10 kg/cm2 9. Open the steam Valve 10. Steaming time is approximately 7-8 minutes 11. Control pressure gauge, pressure should not drop below 4 kg 12. Open the door after 7-8 minutes	
Cooling	Rate
13. Cool down naturally for ½ hour	
Heat Treatment	Rate
14. Put the trolley in the oven again for 2-3 hours, for drying at 70-80°C 15. Take the trolleys out of hot chamber	
Cooling	Rate
16. Cool kernels naturally for at least 4-5 hours before peeling.	

Everything you need to accomplish your goals is already in you. Keep on working hard.

e) Maintenance Practices of oven for drying and humidification.

From the previous unit, can you remember the advantages that good maintenance practices will have on your machine, users and final product? What should be the attitude of maintenance technicians and operators with regards to machine manuals and preparation for maintenance? When is the right time to carry out maintenance on a machine and what name is given to that way of maintenance?

The following maintenance activities are typically associated with Oven for drying and humidification and it is very important for technicians and operators to adhere to all safety precautions necessary for working with and on ovens.

Daily PMs

1. Before operating, visually inspect oven paying attention to main structure and other major parts including interior for defects, wear and tear, and loose fasteners (bolts, screws). Tighten all loose fasteners and change parts that are damaged or show strong wearing (seals, cabling, indicator lights, gauges).
2. Clean interior of oven, trays and trolley stack at the end of each production day. Ensure to turn oven off before cleaning.
3. Clean hopper and chutes after each production day.

Monthly

1. Check to ensure heater connections are firm
2. Check for proper working of thermocouples
3. Inspect motors, blower and circulation fan blades and clean them.
4. Check for free movement of door and motors and lubricate bearings and door hinges as required.

Annual PMs

1. Check and calibrate all gauges

Practical Exercise: go to an oven and go through the needed steps for its maintenance.

Use the checklist and follow the stated steps in maintaining a borma oven. Rate your own performance critically and honestly after you have completed each activity.

 Excellent  Okay  Try Again

Daily Preventive Maintenance (PM) Activities	**Rate**
1. Before operating, visually inspect oven paying attention to main structure and other major parts including interior for defects, wear and tear, and loose fasteners (bolts, screws). 2. Tighten all loose fasteners and change parts that are damaged or show strong wearing (seals, cabling, indicator lights, gauges).	
3. Clean interior of oven, trays and trolley stack at the end of each production day. Ensure to turn oven off before cleaning	
4. Clean hopper and chutes after each production day.	
Monthly	**Rate**
1. . Check to ensure heater connections are firm	
2. Check for proper working of thermocouples	
3. Inspect motors, blower and circulation fan blades and clean them.	
4. Check for free movement of door and motors and lubricate bearings and door hinges as required	
Annual PMs	**Rate**
17. Check and calibrate all gauges	

Everything you need to accomplish your goals is already in you. Keep on working hard.

SELF ASSESSMENT

1. Outline the working principle of Oven for drying and humidification of cashew.

2. State the steps involved in safely maintaining an oven.

3. Outline the step by step process involved in safely operating an oven.

Well done! You have completed the first set of questions. This is very encouraging. Let's proceed on your Cashew Kernel processing journey.

2. DEMONSTRATE SKILLS FOR OPERATING PEELING MACHINE IN CASHEW KERNEL PROCESSING

a) Identify parts of a Peeling Machine

The next step in cashew kernel processing after drying and humidification is to loosen the testa. This process is called peeling. Traditionally, peeling is done manually by hand with the help of a small knife. Some machinery has been developed for kernel peeling usually by rotating springs or brushes which wear off the testa which is then further blown away by air.

In this sub-unit, we shall learn about the parts of the peeling machine. Figure 9.3 below is a simplified photo showing the parts of the peeling machine and Figure 9.4 shows an example of a cashew peeling machine

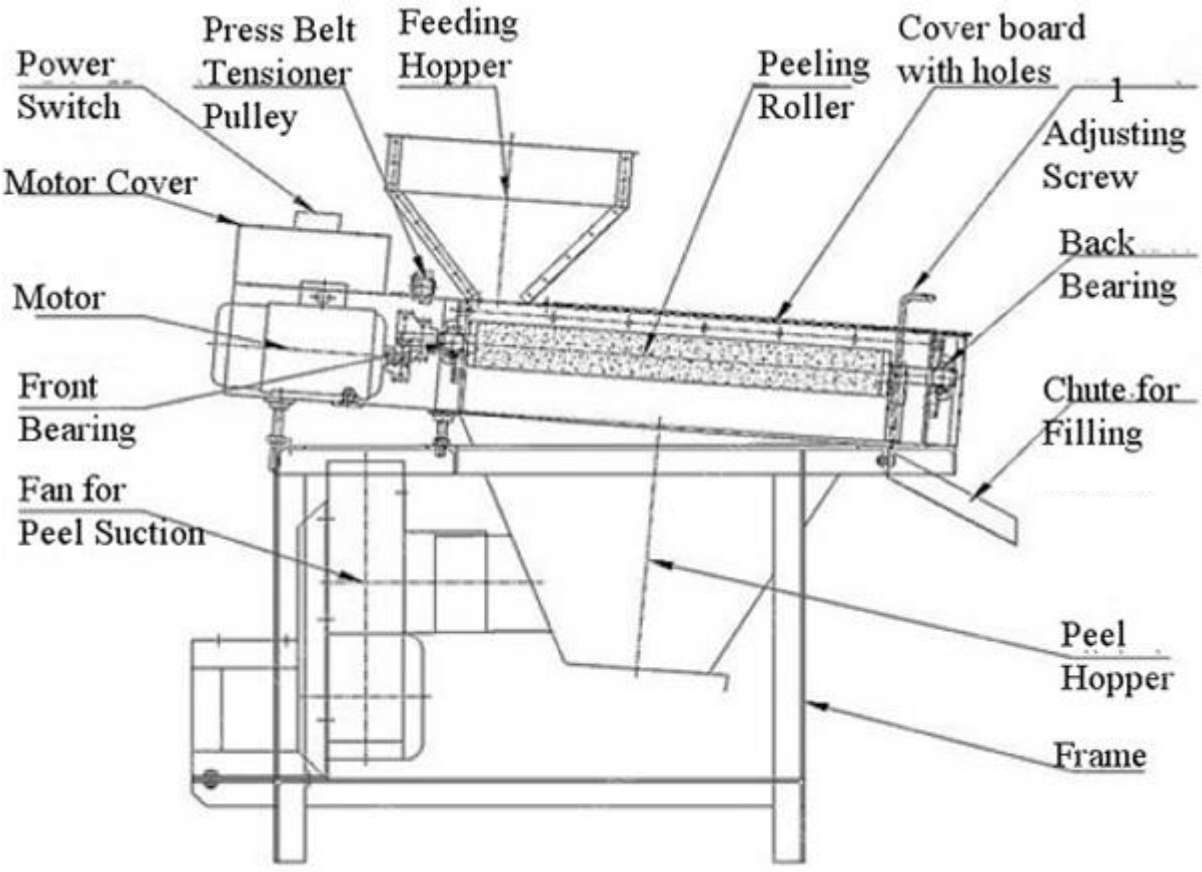

*Figure 9.3. Schematic presentation of Cashew Kernel Peeling Machine (**adapted from peanut peeling machine design**): https://www.google.com/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjipaW25oTkAhW3SRUIHYqvBTgQjhx6BAgBEAI&url=https%3A%2F%2Fwww.alibaba.com%2Fproduct-detail%2Fwet-type-peanut-peeling-machine-peeler_60109615733.html&psig=AOvVaw0G90DUrm3kt_e5oDPOJ6si&ust=1565955879696033*

Figure 9.4; Automatic Peeler
Source: Gayathri Industries; cashewmachines.com

Major parts of a cashew Peeling machine:

Refresh your memory:
Why is it important for users of any machine or equipment to be able to identify and understand the use of the various parts?

In reference to Figure 9.3 and 9.4, the major parts of a kernel peeling machine are as follows:

1. **Main machine frame**: structure that supports other components of machine.
2. **Power Switch**: electronic device that is turned to put machine on or off.
3. **Peeling Roller:** cylindrical component which has brushes around it and rotates by action of motor (or hand) to agitate kernels to knock each other and the inner sides of machine to generate friction forces to wear and peel off testa.
4. **Cover Board with Holes:** top layer that allows suction of air through the peel hopper.
5. **Motor**: moves to rotate the peeling roller to loosen the testa. (hand operated machines will have Peeler Hand Wheel)
6. **Motor Cover:** protective plate mould around motor.
7. **Front and Back Bearing:** mechanical device that enables free rotation with reduced friction and stresses on the peeling roller shaft.
8. **Peel Hopper:** container that receives peeled testa
9. **Fan for Peel Suction:** this is for peeled testa suction from hopper into designated collector.
10. **Feeding Hopper**: Stainless steel container that receives prepared kernels for peeling.
11. **Press Belt Tensioner Pulley:** wheel that supports press belt and is adjusted to tension or loosen belt.
12. **Kernel Chute (Chute for filling):** sloping channel slide for transporting peeled kernels into collection containers.

13. **Cover board with holes**: the top portion of the machine body that allows air to be sucked through extractor fan.
14. **Adjusting Screw**: used for move the peeling roller to achieve the desired slope.

b) Explain the working principle of a Cashew Kernel Peeling machine

The peeling machine works in a similar way to how personnel can use their fingers to rob off loose testa from kernels.

The rotating action of brushes agitate kernels to knock each other and the sides of hopper to generate friction forces to wear off testa from around the kernels. Testa worn off drops to the bottom of the machine body.

An extractor fan generates suction forces to pull peeled off testa through channels into designated containers.

Peeled kernels travel along the slope of main machine body to the kernel chute for final collection to the next stage in the process.

c) Explain Product Requirement after Peeling.

The product after the peeling process is expected to be

1. Free from adhering testa
2. White and intact,
3. There usually should be the presence of a small hole at the proximal end of the whole kernel or a central split or crack is not considered a defect.
4. It must not show signs of rotting or deterioration such as to make it unfit for consumption.
5. Kernels must be free from damage affecting the appearance and must be practically free from any visible foreign matter and pests.

d) Normal Operation of Kernel Peeling Machine

Paying attention to the following steps given on how to properly use a cashew kernel peeling machine will ensure it is safe for use and assure quality of product for the next section. Can you give another good reason?

A typical step-by-step process involved in operating and properly using a kernel peeling machine is as follows:

1. Pour kernels into machine hopper to fill up main container.
2. Ensure collection container(s) for kernels and testa are positioned at designated points
3. Turn on machine and start motor to rotate peeling roller.
4. Start extractor fan.
5. Pour in more kernels as required.
6. Once process is completed, turn off peeling roller and extractor fan.

Note that the proper way is to turn off the peeling roller first before the extractor fan and not the other way round. This is to ensure that much of the peeled testa is extracted from the peeling section and peel hopper.

Practical Exercise: Go to a peeling section and operate a cashew kernel peeling machine.

Use the checklist and follow the stated steps using a cashew peeling machine. Rate your own performance critically and honestly after you have completed each activity.

Steps in operating a cashew peeling machine	Rate
1. Pour kernels into machine hopper to fill up main container	
2. Ensure collection container(s) for kernels and testa are positioned at designated points.	
3. Turn on machine and start motor to rotate peeling roller	
4. Start extractor fan.	
5. Pour in more kernels as required	
6. Once process is completed, turn off peeling roller and extractor fan	

e) Maintaining Cashew Kernel Peeling machine

Never leave out your basic PPEs like hand gloves, overalls and hairnets before carrying out operation and maintenance activities on the peeling machine

The following maintenance activities are typically associated with cashew kernel peeling machine.

Daily PMs

1. Before operating, visually inspect machine paying attention to main structure and other major parts (peeling roller) for defects, rust, wear and tear, and loose fasteners (bolts, screws). Tighten all loose fasteners.
2. Take off cover board to access peeling roller and clean the roller thoroughly with warm water to take out any testa stuck in them. This must be done after each production day.
3. Clean hopper with warm water and mild detergent and clean entire body of machine after each production day

Weekly PMs

1. Lubricate bearings rotating parts.
2. Clean outside of motor and extractor fan of dust and debris.
3. Inspect drive belt to check tension and tension as required.

Semi Annual PMs

1. Thoroughly check peeling roller brushes and change as required.

Practical Exercise: go to a peeling machine and have hands-on maintenance activities.

Use the checklist and follow the stated steps in maintaining a borma oven. Rate your own performance critically and honestly after you have completed each activity.

Daily Preventive Maintenance (PM) Activities	**Rate**
. 1. Clean hopper and chutes after each production day. Before operating, visually inspect machine paying attention to main structure and other major parts (peeling roller) for defects, rust, wear and tear, and loose fasteners (bolts, screws). Tighten all loose fasteners.	
2. Take off cover board to access peeling roller and clean the roller thoroughly with warm water to take out any testa stuck in them. This must be done after each production day	
3. Clean hopper with warm water and mild detergent and clean entire body of machine after each production day	
Weekly	**Rate**
1. Lubricate bearings rotating parts.	
2. Clean outside of motor and extractor fan of dust and debris.	
3. Inspect drive belt to check tension and tension as required	
Semi-Annual PMs	**Rate**
1. Thoroughly check peeling roller brushes and change as required.	

SELF ASSESSMENT

1. Outline the working principle of the cashew kernel peeling machine as described in this section.

2. State the steps involved in maintaining cashew kernel peeling machine making mention of safety precaution that are required.

3. Outline the step by step process involved in operating the cashew kernel peeling machine safely.

Congratulations! You have completed the second set of questions. Let's move on to the next section.

3 DEMONSTRATE SKILLS FOR OPERATING SORTING AND GRADING MACHINES IN CASHEW KERNEL PROCESSING

a) Identify parts of cashew kernel sorting and grading machine

After peeling the cashew kernels are sorted and graded according internationally acceptable standards of classification. Cashew kernel prices on the market are based on the various specified grades. These grades are defined by the size, colour and shape.

The cashew kernel sorting and grading machine is used for this process and arranges the kernels by size and colour.

Figures 9.5, 9.6 and 9.7 below show the schematic (simplified) diagram and picture of an actual sorting and grading machine.

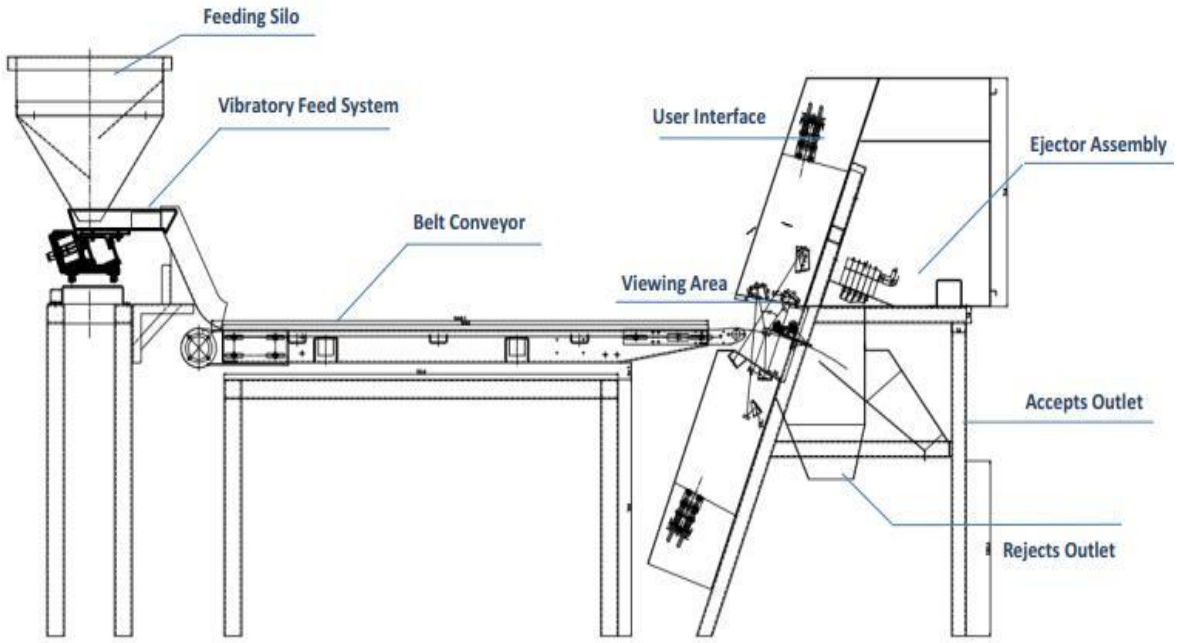

Figure 9.5. Schematic of Cashew Kernel Sorting and Grading Machine.

Source:
https://www.google.com/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwj86Ne9_oTkAhUNXxoKHanZCdcQjB16BAgBEAM&url=https%3A%2F%2Fwww.chinascisort.com%2Fcashew-nuts-color-sorting-machine_p62.html&psig=AOvVaw0fV0jsW-jpRfZC0F3uFbnx&ust=1565962336075609

Figure 9.6. Picture of Cashew Kernel Sorting and Grading Machine. Source. https://www.google.com/search?q=cashew+kernel+sorting+and+grading&rlz

Figure 9.7: Cashew sourcing machine for the separation of all grades cashew kernels, like (whole kernels, split kernels, broken kernels, pieces kernels)
Source: Meyer Optoelectronic Technology Inc.; www.meyer-corp.com

Major parts of a Kernel Sorting and Grading machine:

The major parts of sorting and grading machine from figures 9.5-9.7 are as follows:

1. **Main machine frame**: structure that supports other components of machine
2. **Drive Motor**: converts electrical energy to rotation (mechanical energy) to move other components.
3. **Feeding Silo:** Container that receives peeled cashew kernels and discharges them to the bottom for conveying
4. **Vibratory Feed System**: uses rapid back-and-forth movements to feed cashew kernels from hopper to conveyor.
5. **Chute** (accept and reject outlets): sloping channel slide (as outlet) for transporting sorted and reject kernels into designated containers.
6. **Belt conveyor**: handling equipment that moves material from one location to another.
7. **Sorting Station**: This section comprises the **viewing area** and **ejector assembly**. These arrange kernels according to pre-set size and colour and allows kernels of similar characteristics to be collected together at one common point. This station has identification camera, sensors and solenoid actuators which identifies and ejects kernels which are out of specification.
8. **HMI/User Interface**: screen or interface or dashboard that enables operator to select operations and set values on the machine and associated systems.

b) **Explain the working principle of a Cashew Kernel Sorting and Grading Machine.**

Machine works according to the difference of the optical properties of the kernels, using photoelectric detection technology. Hence kernel size, colour influences their optical properties.

This is achieved using a programmable logic controller (PLC) that continuously monitors the state (size and colour: optical properties) of incoming kernels from the belt conveyor to control solenoid actuated shafts (to shoot out or pull in) to divert kernels unto designated paths.

In the Programmable Logic Controller (PLC) is a computer programme that has kernel parameters defined. Based on these parameters, the PLC uses photoelectric sensors to identify the kind of kernel passing through the viewing area. When kernels are sensed in this manner, the PLC sends signals (message) to solenoids to move shafts (rods) linearly to divert (or eject) kernels into tracks or paths pre-set in the PLC

The action of deflection or ejection leads to sorting of the kernels according to set values selected on the HMI/User interface. On the HMI is usually normal language that operator can read and understand to set or choose parameters of kernels and speed of conveyor belt.

c) **Explain the product requirement after sorting and grading.**

The kernel sorting and grading machine grades the kernels by size and colour, as have been mentioned into international grading system developed by the Specialized Section on Standardization of Dry and Dried Produce of the United Nations Economic Commission for Europe (UNECE) and the Association of Food Industries (AFI). The product is presented essentially in one of two styles according to size:

- whole kernels: have about 7/8th or more of the kernels intact.
- brokens: further classified as butts, splits and pieces.

Some tolerance is given on the market for permissible defects. It is important for you read about this in other units of this manual and also from the internet e. g: Association of Food Industries; www.afius.org

d) **Outline the procedure for operating kernel sorting and grading machine**

A typical step-by-step process involved in operating and properly using a cashew kernel sorting and grading machine is as follows:

1. Feed peeled kernels into the hopper and start machine.
2. Select or set the kernel sizes and colours to be sorted on the HMI as well as machine speed. Remember to save new parameters that are set so they ca be selected later.
3. Start machine by pressing start button on the HMI.
4. Kernels will be transferred from hopper onto belt conveyor through vibratory action of the vibratory feed system in hopper and transported to the sorting station to be sorted.
5. Feed more product into hopper as required.

Practical Exercise: Go to a kernel sorting section for some practical exercise on operating the machine.

Use the checklist and follow the stated steps for using a cashew kernel sorting and grading machine. Rate your own performance critically and honestly after you have completed each activity.

 Excellent  Okay  Try Again

Steps in operating a cashew peeling machine	**Rate**
1. Feed peeled kernels into the hopper and start machine	
2. Select or set the kernel sizes and colours to be sorted on the HMI as well as machine speed. Remember to save new parameters that are set so they ca be selected later.	
3. Start machine by pressing start button on the HMI.	
4. Kernels will be transferred from hopper onto belt conveyor through vibratory action of the vibratory feed system in hopper and transported to the sorting station to be sorted	
5. Feed more product into hopper as required	

e) **Maintaining cashew kernel sorting and grading machine**

Do not use wool, scraper or corrosive material on any part of the machine as this can lead to scratches on machine or contaminate surface of machine, especially vibrator parts, channels and lenses.

The following maintenance activities are typically associated with cashew kernel sorting and grading machines.

Daily PMs

1. Before operating, visually inspect machine paying attention to main structure and other major parts for defects, wear and tear, and loose fasteners (bolts, screws). Tighten all loose fasteners.
2. Ensure to clean equipment thoroughly (hopper, conveyor, sorting station) by air at the end of each production day. Cleaning the equipment is critical to health.
3. Use air to blow dust and other debris on the camera lens and use a soft cloth moistened with cleaning alcohol to wipe camera lens.
4. Check the power and battery Light Emitting Diode (LED) indicators on PLC, if the battery OK light is flickering or on, it is time to change the battery.
5. Check PLC venting filter and clean filter and ensure vent assess is clear and free from sources of heat.

Monthly PMs

1. Open and clean machine electrical panel of dust. Check and tighten electrical connections firmly. Make sure power to machine from mains is off before carrying out this activity.
2. Check conveyor belt motor and rollers. Lubricate rotating parts and rollers.
3. Check vibratory system to ensure it is intact. Tighten all loose fasteners.
4. Check all sensors. Clean surface and also check sensor connections.

Semi-annually

1. Pay attention to main structure and metal parts for rusts and paint required portions
2. Inspect springs and tension if weak.

Practical Exercise: Go to the kernel sorting and grading section and carry out maintenance activities on a sorting and grading machine.

Use the checklist and follow the stated steps in maintaining a cashew sorting and grading machine. Rate your own performance critically and honestly after you have completed each activity.

Daily Preventive Maintenance (PM) Activities	**Rate**
1. Before operating, visually inspect machine paying attention to main structure and other major parts for defects, wear and tear, and loose fasteners (bolts, screws). Tighten all loose fasteners	
2. Ensure to clean equipment thoroughly (hopper, conveyor, sorting station) by air at the end of each production day. Cleaning the equipment is critical to health.	
3. Use air to blow dust and other debris on the camera lens and use a soft cloth moistened with cleaning alcohol to wipe camera lens	
4. Check the power and battery Light Emitting Diode (LED) indicators on PLC, if the battery OK light is flickering or on, it is time to change the battery	
5. Check PLC venting filter and clean filter and ensure vent assess is clear and free from sources of heat.	
Monthly	**Rate**
1. Open and clean machine electrical panel of dust. Check and tighten electrical connections firmly. Make sure power to machine from mains is off before carrying out this activity.	
2. Check conveyor belt motor and rollers. Lubricate rotating parts and rollers.	
3. Check vibratory system to ensure it is intact. Tighten all loose fasteners.	
4. Check all sensors. Clean surface and also check sensor connections	
Semi-Annual PMs	**Rate**
1. Pay attention to main structure and metal parts for rusts and paint required portions	
2. Inspect springs and tension if weak	

SELF ASSESSMENT

1. Explain the working principle of cashew kernel sorting and grading machine and give steps for how to operate it.

2. What in your opinion is the most important maintenance activity to be carried out on the kernel sorting and grading machine?

3. Name the major parts of the kernel sorting and grading machine and explain their purpose.

You are making great progress! You have completed another set of questions. Take a break or go ahead and start with the next section.

4 DEMONSTRATE SKILLS IN OPERATING PACKAGING MACHINE IN CASHEW KERNEL PROCESSING

a) Identify parts of a Packaging machine

Packaging of cashew kernels represent one of the final processes before consumption by customers. Cashew kernel packaging machines are employed in the value chain for this purpose.
Figures 9.8 and 9.9 represent the major parts of the cashew packaging machine.

Video: https://www.youtube.com/watch?v=pa22jNjqRYA

Figure 9.8. Vacuum packaging machine.

Source:
https://www.google.com/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwjYtpHeo93kAhVRJBoKHd6zB60QMwhBKAAwAA&url=https%3A%2F%2Fwww.alibaba.com%2Fproduct-detail%2FNut-Vacuum-Packaging-Machine-IL-65_127273809.html&psig=AOvVaw3XwWJnuqVQcnMPuMLuipzz&ust=1568996006763610&ictx=3&uact=3

Figure 9.9: Vacuum packaging of kernels
Source: GIZ/ComCashew

Major parts of a cashew kernel vacuum packaging machine:

The major parts of vacuum packaging machine are as f ollows:

1. **Main electrical switch**: device that turns machine on.
2. **Vacuum System**: comprises a vacuum pump and motor for creating vacuum as part of the sealing process.
3. **Machine controls**: knobs that are selected to start, set vacuum limit and time in the operation of the machine.
4. **Vacuum gauge**: indicates the vacuum pressure of the machine in operation.
5. **Indicator lights**: shows machine status whether on, in operation or .
6. **Seal bar:** heats up to seal packaging bag during the vacuum sealing process.
7. **Vacuum chamber**: space within which product is placed and vacuuming takes place for sealing.
8. **Vacuum Chamber Lid**: cover to the vacuum chamber that has seals to ensure tight closure with no leakages.
9. **Stainless clips**: spring-loaded devices for holding product bags in place for vacuum sealing.

b) **Explain the working principle of the Packaging machine**

The intent of vacuum packing is usually to reduce atmospheric oxygen from the container of the kernels (usually polybags) to extend the shelf life of the kernels.

Once the product is placed in the machine's vacuum chamber, the lid is closed, and air is removed (oxygen is removed, replaced by carbon dioxide and nitrogen). Then, the heating element inside the chamber seals the bag, after which the chamber is refilled with air by the automatic opening of a vent to the outside (called aspirating hole). The oncoming pressure as a result of the re-filling with air squeezes all remaining air in the bag. The lid is then opened, and the product removed.

c) **Explain the product requirement after Packaging**

The goal of vacuum packaging is to reduce the oxygen in the container of the kernels and keep them in an anaerobic environment, free of moisture, dust and other pollutants. Typical vacuum packaging is required to remove about 99.9% of atmospheric air from the packaging bag. This results in increase in the shelf-life of packaged kernels and slow the growth of spoilage organisms as well as prevent colour changes of the kernels.

d) **Outline the procedure for operating a packaging machine**

A typical step-by-step process involved in operating and properly using a vacuum packaging machine is as follows:

Ensure seal bar is properly inserted in position

1. Turn machine and weigh kernels into designated polybags to about 80% of the polybag size (4/5th full), leaving enough room at the top for good sealing.
2. Place the product into machine vacuum chamber with the top open end of polybag pulled over the sealing bar and clipped into place.
3. Close lid firmly and set the vacuum pressure to the required limit.
4. Adjust vacuum and sealing times on the machine controls as required.
5. Press the start button to begin the vacuuming and sealing cycle.
6. When the cycle ends (with a puff sound), machine gives an alert alarm.
7. Open lid and ensure the seal has no wrinkles where air can enter, then take sealed product out for storage.

Practical Exercise: Go to a vacuum packaging machine and identify its parts

Practical Exercise: Go to a vacuum packaging machine and do a hands-on practise on operating it.

Use the checklist and follow the stated steps for operating a cashew vacuum packaging machine. Rate your own performance critically and honestly after you have completed each activity.

Steps in operating a cashew vacuum packaging machine	Rate
1. Ensure seal bar is properly inserted in position	
2. Turn machine and weigh kernels into designated polybags to about 80% of the polybag size (4/5th full), leaving enough room at the top for good sealing.	
3. Place the product into machine vacuum chamber with the top open end of polybag pulled over the sealing bar and clipped into place.	
4. Ensure expected product weight is attained	
5. Close lid firmly and set the vacuum pressure to the required limit.	
6. Adjust vacuum and sealing times on the machine controls as required.	
7. Press the start button to begin the vacuuming and sealing cycle.	
8. When the cycle ends (with a puff sound), machine gives an alert alarm.	
9. Open lid and ensure the seal has no wrinkles where air can enter, then take sealed product out for storage	

e) **Maintain Cashew Kernel Packaging machine**

Can you remember some important measures to take before maintaining vacuum packaging machine?

The following maintenance activities are typically associated with cashew kernel vacuum packaging machine.

Daily PMs

1. Before operating machine, visually inspect its frame and structure, fasteners and general outlook of machine for wear and loose fasteners; tighten all loose fasteners.
2. Clean vacuum chamber, clips and seal bar with sanitiser at the end of each working day and before start of operation.
3. Inspect vacuum hoses for leakage and firmness.
4. Check clips for firmness and proper working

Weekly PMs

1. Inspect control panel and clean it of dust and other foreign material. Check to ensure vent fan and filter are in good condition. Check to ensure all indicator lights are working.
2. Inspect seal bar and aspirating hole and vacuum ports to ensure they are clean and free of any blockage.
3. Check vacuum filter and clean it by blowing air through

Monthly PMs

1. Inspect motor and pump and clean it free of dust and foreign material. Check that electrical cabling and connections are firm.
2. Check to ensure heater connections of seal bar are firm
3. Inspect lid seals to ensure they are intact.

Semi-annual PMs

1. Open and inspect vacuum pump vanes for breakage and chip-offs on structure and clean vacuum pump rotor.

Annual PMs

1. Check and calibrate all gauges

Practical Exercise: Go to a vacuum packaging machine for some practical hands-on exercise on its maintenance.

Use the checklist and follow the stated steps in maintaining a cashew vacuum packaging machine. Rate your own performance critically and honestly after you have completed each activity.

 Excellent  Okay  Try Again

Daily Preventive Maintenance (PM) Activities	**Rate**
1. Before operating machine, visually inspect its frame and structure, fasteners and general outlook of machine for wear and loose fasteners; tighten all loose fasteners.	
2. Clean vacuum chamber, clips and seal bar with sanitiser at the end of each working day and before start of operation.	
3. Inspect vacuum hoses for leakage and firmness	
4. Check clips for firmness and proper working	
Weekly Preventive Maintenance (PM) Activities	
1. Inspect control panel and clean it of dust and other foreign material. Check to ensure vent fan and filter are in good condition. Check to ensure all indicator lights are working.	
2. Inspect seal bar and aspirating hole and vacuum ports to ensure they are clean and free of any blockage	
3. Check vacuum filter and clean it by blowing air through	
Monthly Preventive Maintenance (PM) Activities	**Rate**
1. Inspect motor and pump and clean it free of dust and foreign material. Check that electrical cabling and connections are firm.	
2. Check to ensure heater connections of seal bar are firm	
3. Inspect lid seals to ensure they are intact	
Semi-Annual PMs	**Rate**
1. Open and inspect vacuum pump vanes for breakage and chip-offs on structure and clean vacuum pump rotor.	
Annual PMs	
1. Check and calibrate all gauges	

SELF ASSESSMENT

1. Explain the working principle of a vacuum packaging machine.

2. Outline the activities required for maintaining Vacuum packaging machine.

3. Give the steps necessary for operating the vacuum packaging machine.

You are making great progress! You have completed another set of questions. Take a break or go ahead and start with the next chapter.

5 DEMONSTRATE SKILLS FOR OPERATING ROASTER IN CASHEW KERNEL PROCESSING

a) Identify parts of a Roaster

Roasting of cashew kernels represent one of the final processes before consumption by customers. Cashew kernel roaster are employed in the value chain for this purpose.
Figures 9.10 and 9.11 represent the major parts of drum roaster for kernel roasting.

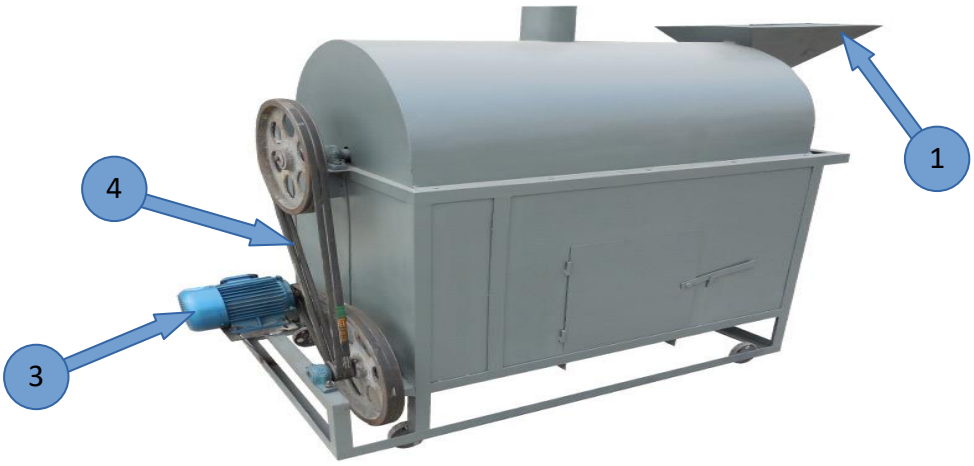

Figure 9.10. Drum Roaster. Source: https://www.alibaba.com/product-detail/Dongyi-Automatic-gas-nut-roasting-machine_60770011184.html?spm=a2700.7724857.normalList.65.6a73b785iIbyS7

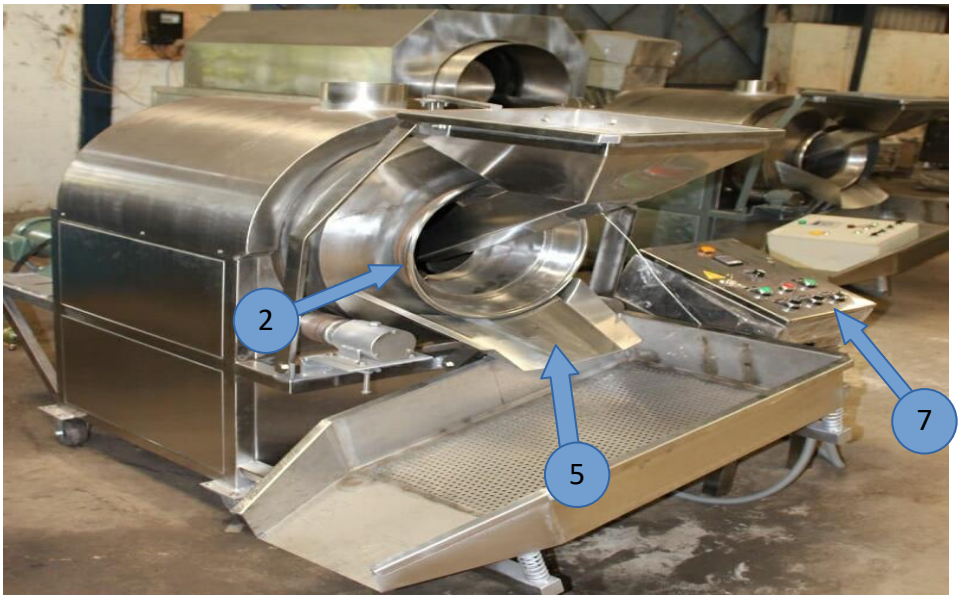

Figure 9.11. Kernel Roasting machine.

MACHINE À RÔTIR ET À SALER À SEC/
DRY ROASTING AND SALTING MACHINE

Figure 9.12; Dry Roasting and Salting Machine
Source: Gayathri

Major parts of a cashew kernel roaster:

The major parts of cashew kernel roaster are as follows:

1. **Hopper:** Container that receives cashew kernels and discharges into roasting chamber/drum.
2. **Roasting Drum:** rotary cylindrical cage that admits cashew kernels to be roasted.
3. **Drive Handle**: manual (by hand) or electric motor (with VFD) that gives force for turning the roasting drum.
4. **Drive Belt:** connects motor to roasting drum.
5. **Chute**: inclined channel that directs roasted kernel into collecting containers.
6. **Heat Source** (Fire): Basic component from which heat is obtained. This can be either electric, fossil fuel, cashew nut shells.
7. **Electric Control panel:** panel from where machine is started and has gauges that read machine operating parameters like speed and temperature.

b) **Explain the working principle of kernel roaster**

This cashew roasting machine adopts rotary cage, with electric heating (or heating from cashew shells or gas heating) as a heat source. The kernels themselves never come into direct contact with the flame or heat source. The machine uses the principle of heat conduction and heat radiation, with (hot) air as medium of heat transfer to a rotating drum.

Rotating drums are therefore externally heated, and the cashew kernels are evenly moved inside as a result of the rotation action of rotating drum to assure uniform roasting of kernels.

c) **Explain the product requirement after roasting**

Kernels are essentially roasted to reduce moisture content to the standard level of required for a final product that meet international standard.

Roasted kernels must have a firm, crisp bite and chew with a fresh nut texture. The kernels shall not contain bitter, musty, sour, rancid, stale, sprouty, or other undesirable flavors and odours. Kernels shall not be excessively hard and there shall be no evidence of burnt nuts.

d) **Outline the procedure for operating a cashew kernel roaster**

A typical step-by-step process involved in operating and properly using a mechanised cashew kernel roaster is as follows:

1. Start heat source to prepare the drum roaster and heat up to about 100°C[1] on the temperature gauge from control panel.
2. Pour kernels to be roasted into the roasting drum through the hopper.
3. Turn machine on for roasting drum to rotate. Drum will rotate in the clockwise direction.
4. Keep machine running as you monitor for the stipulated time production requirements. Also be alert for kernel scent as roasting proceeds to ascertain when cashew is done roasting.
5. Stop machine and select discharge. This will cause roasting drum to rotate in anti-clockwise direction leading to the discharge of roasted kernels.

[1] https://www.omicsonline.org/open-access/optimizing-the-effect-of-temperaturetime-combinations-on-the-quality-attributes-of-roasted-cashew-anacardium-occidentale-kernel-2155-9821-1000313-97699.html

Practical Exercise: Go to a kernel roaster for some hands-on practise on operating it.

Use the checklist and follow the stated steps for operating a cashew roasting machine. Rate your own performance critically and honestly after you have completed each activity.

 Excellent  Okay  Try Again

Steps in operating a cashew roasting machine	Rate
1. Start heat source to prepare the drum roaster and heat up to about 175°C on the temperature gauge from control panel.	
2. Pour kernels to be roasted into the roasting drum through the hopper.	
3. Turn machine on for roasting drum to rotate. Drum will rotate in the clockwise direction	
4. Keep machine running as you monitor for the stipulated time production requirements. Also be alert for kernel scent as roasting proceeds to ascertain when cashew is done roasting	
5. Stop machine and select discharge. This will cause roasting drum to rotate in anti-clockwise direction leading to the discharge of roasted kernels	

e) **Maintain Cashew Kernel Roaster**

Can you remember some important measures to take before maintaining Cashew Kernel Roaster keeping in mind that this is a heat generating equipment?

The following maintenance activities are typically associated with cashew kernel roasting machine.

Daily PMs

1. Before operating machine, thoroughly inspect its structure, fasteners and general outlook of machine for wear and loose fasteners; tighten all loose fasteners.
2. After machine has properly cooled down, thoroughly clean roasting drum, hopper and chute with clean hot water at the end of each production day.
3. Run machine in jog mode which allows you to observe whether rotation is smooth and free.

Weekly PMs

1. Inspect control panel and clean it of dust and other foreign material. Check to ensure vent fan and filter are in good condition. Check to ensure all indicator lights are working.
2. Inspect motor and clean it free of dust and foreign material. Check belt tension and tension as appropriate.
3. Lubricate rotating points and bearings

Monthly PMs

1. Check to ensure heater connections are firm
2. Check for proper working of thermocouples

Annual PMs

1. Check and calibrate all gauges

Practical Exercise: Go to a cashew roasting machine for some practical hands-on exercise.

Use the checklist and follow the stated steps in maintaining a cashew roasting machine. Rate your own performance critically and honestly after you have completed each activity.

Daily Preventive Maintenance (PM) Activities	**Rate**
1. Before operating machine, thoroughly inspect its structure, fasteners and general outlook of machine for wear and loose fasteners; tighten all loose fasteners.	
2. After machine has properly cooled down, thoroughly clean roasting drum, hopper and chute with clean hot water at the end of each production day	
3. Run machine in jog mode which allows you to observe whether rotation is smooth and free	
Weekly Preventive Maintenance (PM) Activities	
1. Inspect control panel and clean it of dust and other foreign material. Check to ensure vent fan and filter are in good condition. Check to ensure all indicator lights are working.	
2. Inspect motor and clean it free of dust and foreign material. Check belt tension and tension as appropriate	
3. Lubricate rotating points and bearings	
Monthly Preventive Maintenance (PM) Activities	**Rate**
1. Check to ensure heater connections are firm	
2. Check for proper working of thermocouples	
Annual PMs	**Rate**
1. Check and calibrate all gauges	

SELF ASSESSMENT

1. Name the parts of a cashew roaster

2. Explain the working principle of the cashew roaster.

3. Outline the activities required for maintaining the kernel roaster.

4. Give the steps necessary for operating the kernel roaster.

You are making great progress! You have completed another set of questions.