UNIT 8 GRADING AND SORTING

Structure

8.0 OBJECTIVES

After reading this unit, you should be able to:

- state the meaning and purpose of grading and sorting;
- explain construction and working principles of flat screen grader, cylindrical graders, colour sorter and gyratory sifter; and
- explain the effectiveness of screen and cleaning efficiency.

8.1 INTRODUCTION

Cleaning and grading are important post harvest operations undertaken to remove foreign and undesirable matters from the threshed crops/grains/seeds and to further separate the grains/products into various fractions.

Grading is the classification of materials on the basis of commercial value, end usage (product quality), and official standards. For, example, grading is necessary to avoid the further processing of blemished, spoiled, or products not meeting the quality requirements. Grading is done mostly by hand (e.g. inspection of fruits after washing), but when physical characteristics are also indicative of product quality, grading can be done through machinery. In rice, the white kernels are separated optically from the off colour grains or from foreign matter, and the lighter unripe tomatoes can be separated from the ripe according to their specific weight.

8.1.1 Hand Grading

The effectiveness of hand grading depends on the following factors

1) Quality of the product
2) Quantity per inspector
3) Experience and physical condition of the inspector
4) Kind of inspection
5) The ergonomics during work
6) The speed at which the product move in front of the inspector

The inspector can assess a number of quality factor simultaneously, and separate physically the product into certain quality categories, using sets of comparison standards, e.g. colour cards or plastic models. Fruits and vegetables are graded on the basis of state, federal, and international standards. Quality classifications such as "free from damage" or "free from serious damage" are used.

Grading of larger quantities of food or products, such as grains, is based on testing of smaller quantities. The lots are taken out randomly, and are subsequently evaluated in the laboratory, using proper instrumentation.

Besides skilled personnel, special machines are used increasingly for grading. The trend is to develop quality control methods that enable a continuous and quick estimation of the products. Nondestructive optical and physical methods such as colour measurements use X-rays, lasers, infrared rays, and microwaves are promising. Most of the machines which are used in grading can also be used in sorting. X-rays are also employed to detect foreign matter, such as glass splits and stones in packed materials. Machine grading of the product is based on a representative index of quality, e.g. colour, firmness, and pH, or a reasonable combination of these properties.

8.1.2 Sorting

Sorting, like grading, facilitates subsequent processing operations, such as peeling, pitting, blanching, slicing, and filling of containers. It is beneficial for heat and mass transfer operations, where processing time is a function of the size of the product (e.g. heat conduction, mass diffusion).

Sorting is done by equipment specific for each product of product category. It is based on the criteria specified in Table 8.1 below.

Table 8.1: Criteria for sorting of materials

Sl. No.	Category	Criteria
1	Physical criteria	Size, weight and shape
2	Technological criteria	Processing suitability or compatibility to existing equipment
3	Organoleptic	Texture, colour, aroma, taste, ripeness or freshness
4	Commercial	Attractiveness, tradition, variety, utility, price

Most of the mechanical sorters are based on the size of the materials, but some equipment utilizes differences in shape, density, and surface properties of the products to be sorted.

Screens (flat or drum type) are used extensively in sorting various grains, seeds, crystals, and other products of relatively small size. Inclined screens, one on top of the other with horizontal and vertical oscillations, are effective in grain and seed sorting.

8.2 GRADE FACTORS

Grade factors that apply in various combinations to all the products produced on the farm could be classified as:

1. Physical characteristics
   a) Moisture content
   b) Unit size
   c) Texture
   d) Colour
   e) Foreign matter
   f) Shape
2. Chemical characteristics
   a) Analysis (Composition)
   b) Rancidity, free fatty acid index (for fat containing material)
   c) Odour and flavour
3. Biological
   a) Germination
   b) Type and amount of insect damage
   c) Type and amount of mould damage
   d) Bacterial count

Classification of graders and sorters

Various types of graders and sorters on the basis of their grading principle are grouped in Table 8.2 below:

Table 8.2: Classification of graders and sorters on the basis of their grading principle

Sl. No.	Basis of grading	Graders and Sorters
1	Size and Shape	Trammel, spiral separator, disc and indented cylinder separator
2	Specific gravity	Specific gravity separator, destoner
3	Surface roughness	Inclined drapper, velvet roll separator
4	Aerodynamic property	Pneumatic/aspirator separator, fluidized bed separator, cyclone separator
5	Magnetic property	Magnetic separator
6.	Optical property	Colour sorter

8.3 SORTING FRUITS AND VEGETABLES

Fruits and vegetables are sorted on the basis of colour, damage and size. Mostly sorting on the basis of colour and damage is done manually, but electronic eye has been used successfully in the pilot studies, and its future general application appears promising. The shape of the fruits and vegetables should be suitable for mechanical handling and processing. The size and shape of some fruits pose problems in processing operations, e.g. apples, mangoes, and papayas.

Some of the equipment used for sorting of fruits and vegetables are as follows

1) Screens
2) Diverging belts
3) Roller sorters
4) Weight sorters

8.4 CLEANING AND SORTING GRAINS, NUTS AND SEEDS

No distinct division can be made between cleaning and sorting of grain and various seed stocks since the process is carried on simultaneously and the procedures are common to both.

Cleaning, sorting and partial or perhaps final grading or classifying of the products being considered are based on the following characteristics:

1. Size
2. Shape
3. Specific gravity
4. Surface characteristics

The first three are the most important. Surface characteristics as differentiated from shape affect the drag coefficient where an air blast is used for separation. Although it is known to be an effective factor, its importance thus far has not been demonstrated. A corn grader is shown in fig.8.1a and a schematic diagram of seed grader is shown in fig 8.1b below.

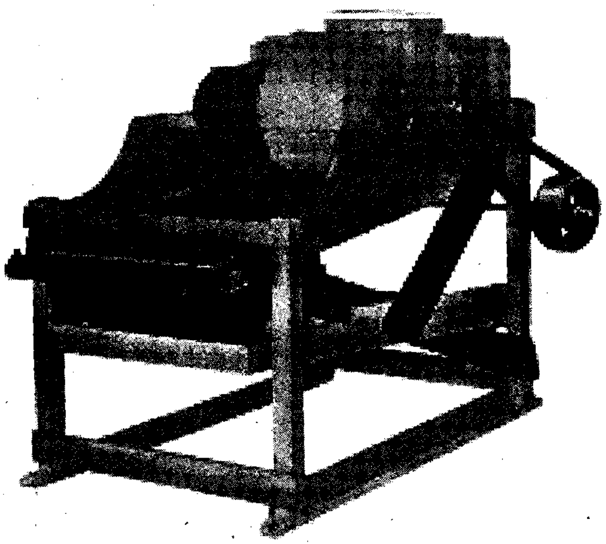


Fig.8.1(a): Corn grader

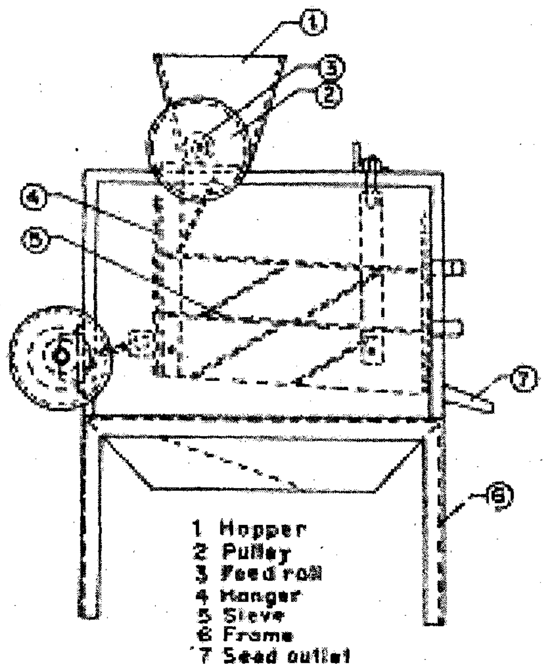


Fig. 8.1(b): Schematic diagram of a seed grader

8.5 FLAT SCREENS

Flat screens consists of flat screening surfaces of several sieve sizes, arranged vertically or in line and usually inclined which can separate and classify various solid particles. Flat screens are usually vibrated at 600-7000 strokes per min and they can separate particles of sizes down to 400 mesh (38ìm).

Vibration of screens can be vertical or horizontal (shaking or reciprocating; Fig.8.3c). In vertical vibration, the best sieving is achieved when there is resonance vibration and no contact between moving grain and screen. Shaking and reciprocating screens are inclined slightly and vibrate at 30-1000 strokes/min, separating particles in the size range of 0.2-25 mm.

The width of the screen relates to the capacity (kg/h) of the system, while the length affects strongly the screening (separating) efficiency.

Typical operating characteristics of flat screens are: capacities 10-80 tonnes/h; screen dimensions, 75 cm × 150 cm to 200 cm × 365 cm: and motor power, 2-10 kW. The overall dimensions of the screening equipment, consisting of 30 screens, are about 3 m × 4 m × 2.5 m, and the weight is about 5-6 tonne.

8.5.1 Flat Screen Grader

It performs the separation according to size alone. The mixture of grain and foreign matter is dropped on screening surface which is vibrated either manually or mechanically. A single screen can make the separation into two fractions. The screening unit may be composed of two or more screens as per the cleaning requirement.

8.5.2 Principles of Operation

Products to be sized are deposited from the feed hopper on the top of the upper-most screen. This screen can be either a slotted screen or a round-hole screen, according to the first separation to be made and the flexibility of the machine. In operation, the screens move forward and backward, all screens in a single block moving simultaneously in the same direction. This motion causes the products to move down the inclined screens toward the discharge spouts. Product larger than the hole-openings in any particular screen remain on top of the screen and are discharged at the end of the screen. Product smaller than the openings, because of gravitational force, drop through and are deposited on the top of the next lower screen in the machine. This screening action continues until the products are appropriately sized and discharged according to screen types and sizes in the machine.

8.5.3 Adjustments

To achieve a precise, efficient separation of differently sized particles, the machine must be properly adjusted. Rate of feed and rate of vibration are two adjustments common to all separators of this type.

8.5.3.1 Rate of Feed

Machines with variable rate of feed, usually equipped with a variable speed feed roll or a feed gate to permit accurate metering of the product onto the upper-most screen. When properly adjusted, seed flow on the screen carrying the heaviest product load should be one layer deep.

8.5.3.2 Rate of Vibration

Rate of vibration controls the speed at which product flow through the machine. In general, faster the rate of vibration faster will be the flow. However, rate of vibration also affects the precision of the separation being made. A slow vibration rate causes the screen openings to become plugged, thus permitting some product to travel the entire length of the screen without contacting a free opening. Conversely, a fast vibration rate causes product to "bounce" or "skip" down the screen, failing to seat themselves long enough or often enough to be properly sized. To determine the optimum rate of vibration, products being discharged should be checked for uniformity of size, then capacity requirements should be determined and adjustments made accordingly.

A hand operated screen cleaner is shown in Fig. 8.2. This equipment is made of mild steel. The separation takes place due to differences in size of grain and foreign matter. The cleaner is operated by hanging on an elevated point with the help of four ropes. Grain is fed on the screening surface in batches. The screens can be changed as per the grain to be handled. The cleaned grain is retained by the bottom sieve which can be discharged by pulling a spring loaded shutter. Impurities of larger size stubbles, chaff etc. are retained on the top sieve and can be removed easily. Down stream from the bottom sieve consist of dust, dirt, brokens, and shriveled grain etc. drop down during the operation.

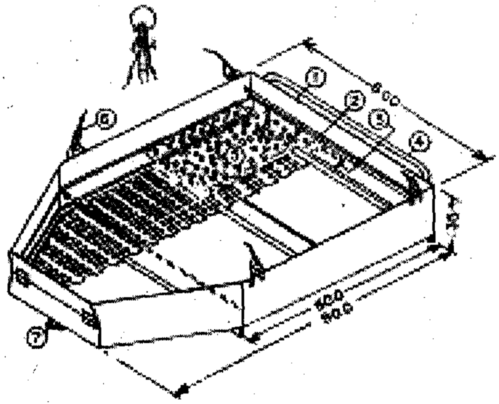


Fig. 8.2: Hand operated double screen grain cleaner

1. Frame 2. Draper rod 3.Screen handle 4. Handle 5. Scalper and grader screens 6. Rope attachment 7. Shutter opening attachment

8.6 GYRATORY SIFTER

Gyratory sifter consists of a series of square or round sieves (0.6-1.0 m), stratified on springs and placed atop one another, which rotate in a gyratory motion. Such sieve system may consist of more than 24 rotating sieves which are grouped so that product is classified in four to eight categories (grades). A gyratory sifter of 30 m^2 filtering surface requires 2.2 kW. Its main dimensions can be 2.5 X 2.5 X 2.5 m and its weight, 2.5 tones. Some gyratory sifters use bouncing balls on the sifter surface for auxiliary vibration and efficient separation (Fig.3-d).

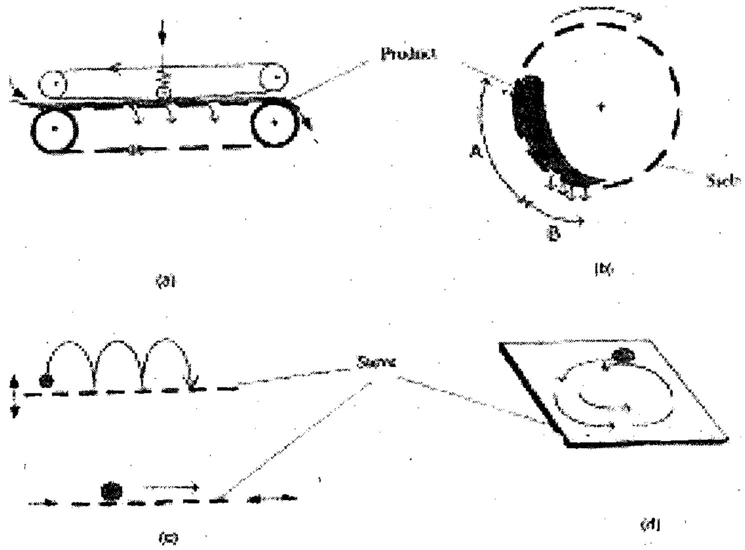


Fig. 8.3: Screening systems

(a) Belt (b) Rotating trammel (c) Vibrating flat (d) Rotating sifter

8.7 CYLINDER SEPARATOR

The cylindrical separator consist of a horizontal rotating cylinder which has indents on the inside surface. The indents are closely spaced and hemispherical in shape (Fig. 6.4a and 6.4b). When the mixture of grain is fed into one end of the cylinder, short grains are picked up by combined effect of fitting into the indents and centrifugal force. These grains are dropped into an adjustable trough inside the cylinder near the top of rotation. A screw conveyor is provided in the bottom of the trough which conveys the material. Generally, the cylinder is kept at slight inclination to facilitate gravity flow of grains in the cylinder.

The cylinders with indents of different sizes are available, but the size of all indents in a particular cylinder is same. For different separation needs, indented cylinder has to be changed.

The speed of operation of cylinder and the position of adjustable trough are important adjustments for obtaining the desired level of separation. Since the centrifugal forces helps to handle the grain in the pocket, it affects the distance traveled by grains before they fall.

The excessive speed will not allow grains to drop from the indents. Too slow speed will not lift short grains from the mixture. The position of separation edge of the adjustable trough should be such that it can catch the desired fraction of the dropping grain.

8.7.1 Principles of Operation

Products to be cleaned are fed into the upper, or feed, end of the rotating cylinder. Since all indents in a single cylinder are of the same type and size, all indents lift essentially the same size particles.

Short product, or particles, drops into the indents, as the indents pass under the grain bank in the cylinder. They are lifted, and held in the indents until force of gravity overcomes centrifugal force and they drop into the receiving trough. From the receiving trough they are discharged out of the machine.

The long product travel the entire length of the cylinder and are discharged over retarder into a hopper that removes them from the machine.

At the end of the cylinder separator there is naturally a large quality of under sized particles, two or three of which may fall into an indent at one time. As these are depleted, intermediate sizes are lifted out of the mass at approximately the center of the cylinder length. At the tail end of the cylinder the final and most critical size selection by the indent is accomplished.

8.7.2 Adjustments

The indented cylinders operate on the centrifugal force principle by which the speed of the cylinder holds the shorter seeds in the indent, lifting them out of the mass until the indents are inverted to the point where gravity causes the lifted particles to fall out of the indents.

8.7.2.1 Rate of Feed

It is necessary to control the rate of feed. If the rate is too slow, then, failure to attain capacity becomes a problem. If the rate is too fast, not enough time is allowed for cleaning. If the feed varies, all particles will not have the same length of time to be separated as other particles. Rate of feed is controlled by opening and closing the feed gate.

8.7.2.2 Position of Trough

The degree of separation is controlled by the position of the separating edge of the receiving trough. The separating edge is the edge adjacent to the rising side of the cylinder. If some of the long seed are lifted out by the indents, the trough is set too low. If the trough is set too high, short seed picked up by the indents will fall back into the mixture and be discharged with long product at the end of the cylinder.

8.7.2.3 Speed of Cylinder

The desirable speed can be determined by setting the trough level and then adjusting the speed of the cylinder so that the seed picked up by the indents will fall into the trough from the top of the cylinder. If speed is too slow, the indents will reject some of the short seed that should be lifted. Speed adjusted by changing variable speed drive.

8.7.2.4 Action of Level or Conveyor

In those machine that use an increase in elevation of the feed end of the machine as a means of conveying, an adjustment is sometimes necessary. This is done by increasing or decreasing the elevation to properly convey the material through the cylinder.

8.7.2.5 Position of the Retarder

The retarder is adjusted to maintain a proper level throughout the entire length of the cylinder. The adjustment of the retarder will depend on the type of seed being processed, and the amount and the size of the material being lifted.

8.7.3 Critical Speed

The capacity of indented cylinder grader increases with increase in speed up to a point where blinding occurs due to crowding through the screen. Increasing rotational speed to its critical value results in material being carried around the cylinder without cascading over its surface. The critical speed (Ns) is given as:

$$Ns = \frac{251.48}{D}$$

Where Ns = critical speed in rpm

D = diameter of the cylinder

8.7.4 Capacity of Grader

The permissible load on a grader is governed by its parameters, the constituents of the material loaded and the quality of the cleaning desired.

An equation which interrelates these parameters has been obtained from the practical experience on graders. The equation is

$$Q = 2\,\pi\,q_o\,r\,L$$

Q = capacity of grader, kg/h

q_o = specific load per unit area of cylinder, kg/h-m^2

r = radius of cylinder, m

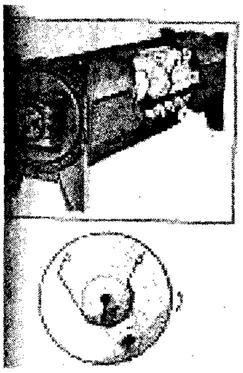
L = length of cylinder, m

The specific load per unit area may be used assumed as 0.16 to 0.18 kg s^{-1} m^{-2} for separation of wheat from long stem impurities which may go up to 70% and 0.15 to 0.17 kg s^{-1} m^{-2} for separating wheat from short stem impurities which may go up to 1.5%.

Diameter of cells of indented cylinder grader is given in Table 8.3.

Table 8.3: Diameter of cells of indented cylinder grader

Sl. No.	Crop	Diameter of cell, mm	
		For long stem impurities	For short stem impurities
1	Wheat, oats	8.0, 8.5	4.5,5.0
2	Barley	11.2,11.8,12.5	5.6,6.3,7.1
3	Buck wheat	8.5	6.3



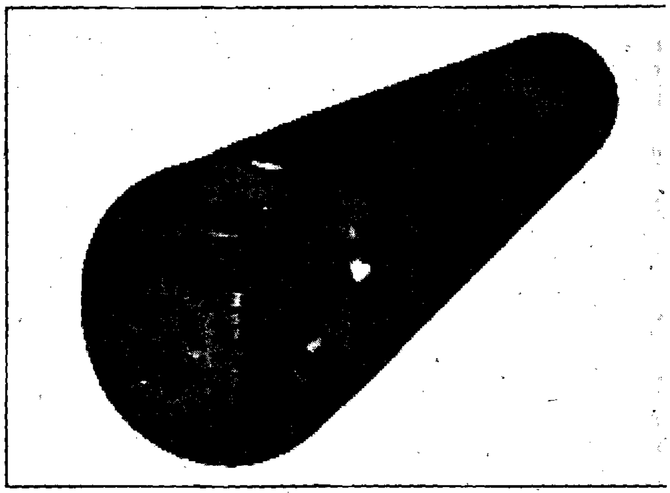


Fig. 8.4(a): Cross section and phantom showing view of trough Cylinder sorter **Fig. 8.4(b): View of indented cylinder adjustment**

8.8 COLOUR SEPARATOR/SORTER

The colour separator separates the fruits, vegetables or grains due to differences in colour or brightness. The colour separator is generally used for larger crop seeds like peas and beans. These seeds differ in colour because of varietal differences and also due to immaturity or disease. The mud balls and discoloured or defective seeds can be removed with the help of electronic separator.

The grain mixture is fed uniformly into the optical chamber of the separator. Two photocells are fixed at a particular angle which direct both beams to one point of the parabolic trajectory of the grains. A needle is placed on the other side which is connected with a high voltage source (Fig. 8.5). When a beam falls on dark object through photo-electronic cells, current is generated on the needle. The needle end receives a charge and imparts it to the dark seeds. The grains are then passed between two electrodes with a high potential difference between them. The seed is compared with selected background or colour range, and is separated into two fractions according to difference of colour. Since each grain is viewed individually by this machine, the capacity is low.

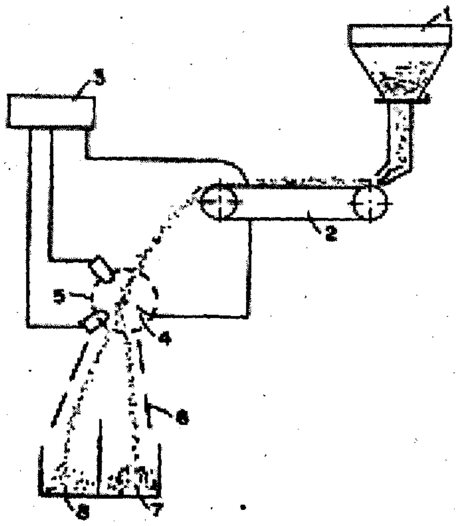


Fig. 8.5. Schematic diagram of colour separator

1. Hopper 2. Belt conveyor 3. Amplifier 4. Charging needle 5. Optical chamber 6. Deflecting electrodes 7. Foreign material 8. Desired material

8.9 ROLLER SORTERS

A roller sorter shown in fig. 8.6a is used extensively in the fruit industry. Each roll rotates in counterclockwise direction. The fruit is continuously rotated so that each individual piece has an opportunity to register its minimum dimensions with the space in the sorter. The roller sorter is divided into three roll units, which are hinged so that the gauging space increases progressively through the sorter. When the rolling unit closes the space at the end of its travel, the turning roller ejects without damage any fruit trying to pass through the space (fig. 8.6a).

Roller conveyor with fixed space between the rolls is used for removing small fruit, twigs and leaves. The roller size which gauges on minimum diameter only works well on objects of uniform geometric proportions, i.e. all spheres or all ellipsoids of a given ratio of major to minor axis. If proportions in a lot vary, a given size grade will contain a greater range of volumes than defined by the minimum diameters (fig.8.6b).

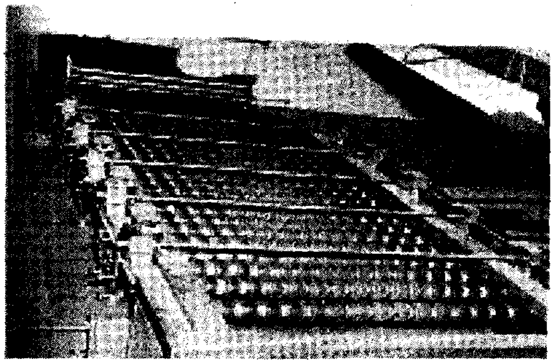


Fig. 8.6(a): Roller sorter for providing relatively uniform size when proportins vary

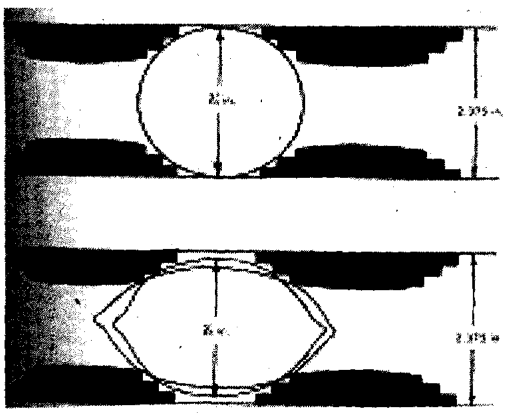


Fig. 8.6(b): Roller profile for the sorter

8.10 SPIRAL SEPARATOR

The spiral separator separates the grains as per their roundness. The main component of the separator is stationary, open screw conveyor standing on the one end (fig.8.7). The mixture is fed at the top of the unit. The round material of the mixture pick up speed as they slide or roll down the inclined surface until their centrifugal force becomes sufficient enough to throw them in the outer helix, while the non-round materials are caught in the inner helix and are discharged through a separate spout.

There is no moving part in the spiral separator. The rate of feeding is the only adjustable component. The feeding should be such that each grain/particle roll independently for effective separation. The main limitation of the spiral is lack of flexibility.

Separation of mustard, rape, soybean, wild peas or other round seeds can be performed from wheat, flax, oats etc. This device is less versatile as compared to other mechanical cleaners, but is simple, inexpensive and quite useful for seed cleaning purposes.

8.10.1 Principle of Operation

In operation, the grain mixture is fed onto the inner spiral flights from the feed hopper. Rate of feed is regulated by the size of the opening in the disc attached under the hopper. As the grain move down the inclined inner flights, spherical seed roll readily and attain a higher velocity than non-spherical grain, which tend to slide or tumble. The orbit of the round seed on the flights around the axis increases as velocity increases until the seed roll over the edge of the inner flight, drop onto the outer housing flight and discharge through a spout in the bottom of the machine. In contrast, the non-spherical or irregular shaped seed do not attain sufficient velocity to roll over the edge of the inner flight and continue to slide toward the bottom of the machine where they discharge through another spout. Some spirals have multiple inner flights arranged in order of increasing size. These units grade the grain in the mixture according to shape and density ranging from low-density flat grain on the inner unit flight to high-density round grain on the larger outer flight. Each flight terminates in a different discharge spout.

8.10.2 Adjustments on Spiral Separator

Rate of feed: The rate of feed is the only significant adjustment on the spiral separator. The disc that contains the various size holes is rotated until the desired size is directly under the opening in the bottom of the hopper and directly above the cone divider.

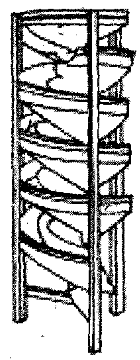


Fig. 8.7: Spiral Separator

8.11 EFFECTIVENESS OF SCREEN

The screen effectiveness may be defined as the ability of a screen in closely separating the feed into overflow and underflow according to its size. If the screen functions properly, all material 'O' would be in the overflow, while all the material 'U' would be in the underflow. Graphical representation of various flows of a screen is shown in fig. 8.8 below.

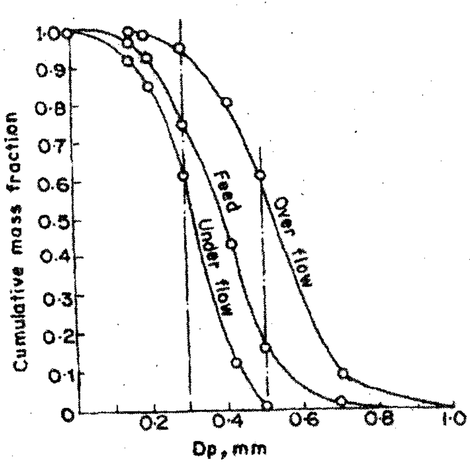


Fig. 8.8. Graphical representation of various flows of a screen

The material balance in a screening operation can be derived as follows.

F = mass flow rate of feed, kg/h

O = mass flow rate of oversize, kg/h

U = mass flow rate of undersize, kg/h

m_f = mass fraction of material in feed

m_o = mass fraction of material in overflow

m_u = mass fraction of material in underflow

The total quality of the feed is the sum of overflow and underflow

F= O+U

Substituting O = F-U

and U=F-O

$$\frac{O}{F} = \frac{m_f - m_u}{m_o - m_u}$$

and $$\frac{U}{F} = \frac{m_o - m_f}{m_o - m_u}$$

A common measure of screen effectiveness is the ratio of actual amount of oversize material in the overflow to the amount of oversize material entering with the feed.

Thus,

$$E_o = \frac{Om_o}{Em_f}$$

and $$E_u = \frac{U(1 - m_u)}{F(1 - m_f)}$$

Overall effectiveness E = X

$$= \frac{OUm_o(1 - m_u)}{F^2 m_f (1 - m_f)}$$

Substituting the value $\frac{O}{F}$ and $\frac{U}{F}$

$$E = \frac{(m_f - m_u)(m_o - m_f)m_o(1 - m_u)}{(m_o - m_u)^2(1 - m_f)m_f}$$

Effectiveness of screen

The effectiveness of screening or cleaning efficiency for an air screen grain cleaner as suggested by the Bureau of Indian Standards (BIS) is given below

$$\text{Cleaning efficiency} = \frac{E(F - G)(E - F)(1 - G)}{F(E - G)^2(1 - F)}$$

Where, E = fraction of clean seed at clean seed outlet

F = fraction of clean seed feed

G = fraction of clean seed at foreign matter outlet

8.11.1 Screen Analysis

Objective

To determine the effectiveness of the screen

Requirements

Sieve shaker, set of sieves, timer, wheat flour, mustard seeds etc.

Sieve analysis

1. Weigh appropriate amount of two different sample
2. Put the material on the top of most sieve
3. Fix the number of shaker and take out the first two sieves
4. Switch on the sieve shaker and take out the first sieves.
5. Separate the material retained on these two sieves and weigh them separately.

Observations

Particle size analysis of sample

S. No.	Sieve number and size	D (mm)	Mass retained (mg)

Calculations

1) Plot a graph between mass and particle diameter of the sample that has been obtained
2) Calculate the average diameter of the product from the graph
3) Calculate the effectiveness of the second sieve of the system from equation.

Results

Report the following

1) Average diameter of the feed from the graph
2) The effectiveness of screen for two different materials.

Check Your Progress

Note: a) Use the spaces given below for your answers.
b) Check your answer with those given at the end of the unit.

1. What are the factors which affect the rate of throughput in screening?

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2. How effectiveness of screen is calculated?

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3. Distinguish between sorting and grading.

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4. Explain the construction of flat screen grader.

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5. Enumerate the various factors on which the effectiveness of hand grading depends.

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6. Explain the working principle of colour sorter.

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7. What is effectiveness of screen?

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8. List out the various factors that apply in various combinations in grading of agricultural products.

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9. What are the important adjustments in cylinder separator?

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10. Classify the graders and sorters on the basis of their grading principle.

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8.12 LET US SUM UP

Cleaning and grading form a very important post harvest operation for all agricultural crops. While cleaning refers to removal of foreign and undesirable matter from the main crop, grading refers to the classification of material on the basis of commercial value, end use and official standards. A number of equipments such as flat screen grader, gyratory sifter, cylinder separator, colour sorter, roller sorter and spiral separator are used for the purpose of cleaning and grading depending upon the crop and need. Effectiveness of screen and cleaning efficiency depends upon a number of factors such as size, shape, specific gravity and surface characteristics in order of importance.

8.13 KEY WORDS

Grading : Grading refers to classification of cleaned products into various quality fractions depending upon various commercial values and other usage.

Sorting : Sorting refers to the separation of cleaned products into various quality fractions that may be defined on the basis of size, shape, density, texture and colour.

Screening : Screening is a method of separating grain/seed into two or more fractions according to size alone.

Cleaning : Cleaning generally means the removal of foreign and undesirable matters from the desired grain/products. This may be accomplished by washing, screening, hand picking etc.

Scalping : Scalping refers to the removal of few large particles in an initial process.

Colour sorting : Colour is used as a basis for separating products for which a premium is placed for colour uniformity.

Screen effectiveness/ Screening efficiency : Screen effectiveness may be defined as the ability of a screen in closely separating the feed into overflow.

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8.15 ANSWERS TO CHECK YOUR PROGRESS

1. Factors which affect the rate of throughput in screening are as under

Nature and shape of the particles

Frequency and amplitude of shaking

Methods used to prevent sticking or bridging particles

Tension and physical nature of the sieve material.

2. The effectiveness of screening or cleaning efficiency for an air screen grain cleaner is calculated by the following equation.

$$\text{Cleaning efficiency} = \frac{E(F-G)(E-F)(1-G)}{F(E-G)^2(1-F)}$$

Where, E = fraction of clean seed at clean seed outlet

F = fraction of clean seed feed

G = fraction of clean seed at foreign matter outlet

3. Sorting refers to the classification of cleaned product into various quality fractions depending upon the basis of size, shape, density, texture and colour.

Grading refers to the classification of cleaned products into various quality fractions depending upon various commercial values and other usage.

4. Flat screens consists of flat screening surfaces of several sieve sizes, arranged vertically or in line and usually inclined which can separate and classify various solid particles. Flat screens are usually vibrated at 600-7000 strokes per min and they can separate particles of sizes down to 400 mesh (38ìm).

Vibration of screens can be vertical or horizontal. In vertical vibration, the best sieving is achieved when there is resonance vibration and no contact between moving grain and screen. Shaking and reciprocating screens are inclined slightly and vibrate at 30-1000 strokes/min, separating particles in the size range of 0.2-25 mm.

5. The effectiveness of hand grading depends on the following factors

1 Quality of the product

2 Quantity per inspector

3 Experience and physical condition of the inspector

4 Kind of inspection

5 The ergonomics during work

6 The speed at which the product move in front of the inspector

6. The colour separator separates the fruits, vegetables or grains due to differences in colour or brightness. The colour separator is generally used for larger crop seeds like peas and beans. These seeds differ in colour because of varietal differences and also due to immaturity or disease.

7. The effectiveness of the screen is the ability of the screen in closely separating the feed into over flow and under flow based up the size of particles to be separated.

8. The screen effectiveness may be defined as the ability of a screen in closely separating the feed into overflow and underflow according to its size. If the screen functions properly, all material 'O' would be in the overflow, while all the material 'U' would be in the underflow.

9. The important adjustments in cylinder separator are rate of feed, position of trough, speed of cylinder, position of retarder and the action of lever or conveyor.

10. Various types of graders and sorters on the basis of their grading principle can be grouped as follows:

Size and Shape	→	Trammel, spiral separator, disc and indented cylinder separator
Specific gravity	→	Specific gravity separator, destoner
Surface roughness		Inclined drapper, velvet roll separator
Aerodynamic property		Pneumatic/aspirator separator, fluidized bed separator, cyclone separator
Magnetic property	→	Magnetic separator
Optical property	→	Colour sorter