Cleaning and grading, methods of grading, equipment for grading

All food raw materials are cleaned before processing. The purpose is obviously to remove contaminants, which range from innocuous to dangerous. It is important to note that removal of contaminants is essential for protection of process equipment as well as the final consumer. For example, it is essential to remove sand, stones or metallic particles from wheat prior to milling to avoid damaging the machinery.

The main contaminants are:

- unwanted parts of the plant, such as leaves, branches, husks;
- soil, sand, stones and metallic particles from the growing area;
- insects and their eggs;
- animal excreta, hairs etc.;
- pesticides and fertilizers; mineral oil;
- microorganisms and their toxins.

• Cleaning is essentially separation in which some difference in physical properties of the contaminants and the food units is misused.
• There are a number of cleaning methods available, classified into dry and wet methods, but a
combination would usually be employed for any specific material.
• Selection of the appropriate cleaning regime depends on the material being cleaned, the level and type of contamination and the degree of decontamination required. In practice a balance must be struck between cleaning cost and product quality, and an _acceptable standard‘ should be specified for the particular end use. Avoidance of product damage is an important contributing factor, especially for delicate materials such as soft fruit.

1. Dry Cleaning Methods

The main dry cleaning methods are based on screens, aspiration or magnetic separations. Dry methods are generally less expensive than wet methods and the effluent is cheaper to dispose of, but they tend to be less effective in terms of cleaning efficiency. A major problem is recontamination of the material wit dust. Safeguards may be necessary to avoid the risk of dust explosions and fires.

Screens are essentially size separators based on perforated beds or wire mesh. Larger contaminants are removed from smaller food items. Eg: straw from cereal grains, or pods and twigs from peas. This is termed as scalping. The main geometries are rotary drums and flatbed designs.

1.1 Principle of aspiration cleaning

The principle is to feed the raw material into a carefully controlled upward air stream. Denser material will fall, while lighter material will be blown away depending on the terminal velocity. Terminal velocity in this case can be defined as the velocity of upward air stream in which a particle remains stationary; and this depends on the density and projected area of the particles. By using different air velocities, it is possible to separate wheat from lighter chaff or denser small stones. Very accurate separations are possible, but large amounts of energy are required to generate the air streams. Obviously the system is limited by the size of raw material units, but is particularly suitable for cleaning legumes and cereals.

1.2 Magnetic cleaning

Magnetic cleaning is the removal offerrous metal using permanent or electromagnets. Metal particles, derived from the growing field during transport or preliminary operations, constitute a hazard both to the consumer and to processing machinery, for example cereal mills. The geometry of magnetic cleaning systems can be quite variable: particulate foods may be passed over magnetized drums or magnetized conveyor belts, or powerful magnets may be located above conveyors. Electromagnets are easy to clean by turning off the power. Metal detectors are frequently employed prior sensitive processing equipment as well as to protect consumers at the end of processing lines.

1.3 Electrostatic cleaning

Electrostatic cleaning can be used in a limited number of cases where the surface charge on raw materials differs from contaminating particles. The principle can be used to distinguish grains from other seeds of similar geometry but different surface charge; and it has also been described for cleaning tea. The feed is conveyed on a charged belt and charged particles are attracted to an oppositely charged electrode according to their surface charge.

2. **Wet Cleaning Methods**

- Wet methods are necessary if large quantities of soil are to be removed; and they are essential if detergents are used. However, they are expensive, as large quantities of high purity water are required and the same quantity of dirty effluent is produced.
- Treatment and reuse of water can reduce costs. Employing the countercurrent principle can reduce water requirements and effluent volumes if accurately controlled.
- Sanitizing chemicals such as chlorine, citric acid and ozone are commonly used in wash-waters, especially in association with peeling and size reduction, where reducing enzymatic browning may also be an aim. Levels of 100–200 mg l–1 chlorine or citric acid may be used, although their effectiveness for decontamination has been questioned and they are not permitted in some countries

Soaking is a preliminary stage in cleaning heavily contaminated materials, such as root crops, permitting softening of the soil and partial removal of stones and other contaminants. Metallic or concrete tanks or drums are employed; and these may be fitted with devices for shaking the water, including agitators, paddles or mechanisms for rotating the entire drum. For delicate produce such as strawberries or or products which trap dirt internally, e.g. celery, sparking air through the system may be helpful. The use of warm water or including detergents improves cleaning efficiency, especially where mineral oil is a possible contaminant, but adds to the expense and may damage the texture.

2.1 Spray washing

Spray washing is very widely used for many types of food raw material. Efficiency depends on the volume and temperature of the water and time of exposure. As a general rule,

small volumes of high pressure water give the most efficient dirt removal, but this is limited by product damage, especially to more delicate produce. With larger food pieces, it may be necessary to rotate the unit so that the whole surface is presented to the spray. The two most common designs are drum washers and belt washers. Abrasion may contribute to the cleaning effect, but again must be limited

in delicate units. Other designs include flexible rubber discs which gently brush the surface clean.

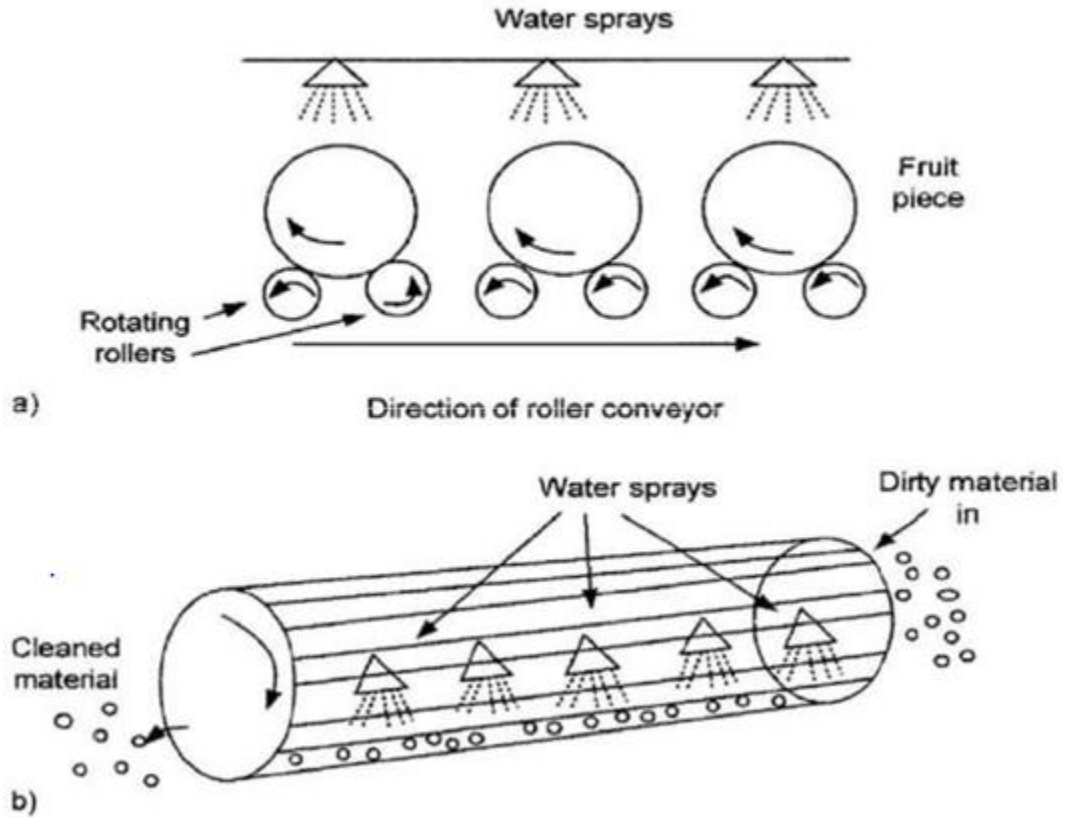


Fig 1. Water spray cleaning:(a) spray belt washer (b) drum washer

2.2 Flotation washing

Flotation washing employs buoyancy differences between food units and contaminants. For instance, sound fruit generally flats, while contaminating soil, stones or rotten fruits sunk in water. Hence fluming fruit in water over a series of weirs gives very effective cleaning of fruit, peas and beans. A disadvantage is high water use; thus recirculation of water should be incorporated. Foam flotation is carried out to separate beans from contaminating weed seed and exploits surfactant effects. The beans are dipped in an oil/detergent suspension and air is blown through the bed. This forms a foam which washes away the contaminating material and the cleaned beans can be spray washed.

3. Sorting

Sorting is the separation of foods into categories on the basis of a measurable physical property. Like cleaning, sorting should be employed as early as possible to ensure a uniform product for subsequent processing. The four main physical properties used to sort foods are size, shape, weight and color.

Shape and size sorting

The particle size distribution of a material is expressed as either the mass fraction of material that is retained on each sieve or the cumulative percentage of material retained.

The shape of some foods is important in determining their suitability for processing or their retail value. For example, for economical peeling, potatoes should have a uniform oval or round shape without swellings. Shape sorting is accomplished either manually or mechanically. Size sorting (termed sieving or screening) is the separation of solids into two or more fractions on the basis of differences in size. It is particularly important when the food is to be heated or cooled as the rate of heat transfer is in part determined by the size of the individual pieces and variation in size would cause over-processing or under-processing. Additionally, foods which have a uniform size are said to be preferred by consumers. Screens with either fixed or variable holes are used for size sorting. The screen may be stationary or, more commonly, rotating or vibrating.

3.1 Fixed aperture screens

Two common types of fixed aperture screen are the flat bed screen (or sieve) and the drum screen (rotary screen or reel). The multi-deck flatbed screen (Figure 2,3) has a number of inclined or horizontal mesh screens, which have aperture sizes from 20 μm to 125 mm, stacked inside a vibrating frame. Food particles that are smaller than the screen apertures pass through under gravity until they reach a screen with an aperture size that retains them. The smallest particles that are separated commercially are of the order of 50 μm.

Many types of drum screen are used for sorting small-particulate foods (for example nuts, peas or beans) that have sufficient mechanical strength to withstand the tumbling action inside the screen. Drum screens are almost horizontal (5–10º inclination), perforated metal or mesh cylinders. They may be concentric (one inside

another), parallel (foods leave one screen and enter the next) or series (a single drum constructed from sections with different sized apertures). All types have a higher capacity than flatbed screens and problems associated with blinding are less severe than with flatbed screens. The capacity of drum screens increases with their speed of rotation up to a critical point. Above this the food is held against the screen by centrifugal force and results in poor separation. Similarly, there is an increase in capacity with the angle of the screen up to a critical angle. Above this the residence time is too short and products pass through without separation.

3.2 Variable-aperture screens

Variable-aperture screens have either a continuously diverging aperture or a stepwise increase in aperture. Both types handle foods more gently than drum screens and are therefore used to sort fruits and other foods that are easily damaged. Continuously variable screens employ pairs of diverging rollers, cables or felt-lined conveyor belts. These may be driven at different speeds to rotate the food and thus to align it, to present the smallest dimension to the aperture

Stepwise increases in aperture are produced by adjusting the gap between driven rollers and an inclined conveyor belt (Refer Figure on belt and roller sorter). The food rotates and the same dimension is therefore used as the basis for sorting (for example the diameter along the core of a fruit)

4. Grading

Grading is carried out by operators who are trained to simultaneously assess a number of variables. For example, eggs are visually inspected over tungsten lights (termed _candling ‘) to assess up to twenty factors and remove those that are for example, fertilized or malformed and those that contain blood spots or rot. Meats, for example, are examined by inspectors for disease, fat distribution, bone to flesh ratio and carcass size and shape. Other graded foods include cheese and tea, which are assessed for flavor, aroma, color, etc. Apples are graded with the assistance of colored cards that show the required characteristics of different grades in terms of color distribution across the fruit, surface blemishes and size and shape of the fruit.

In some cases, the grade of food is determined from the results of laboratory analyses (for example wheat flour is assessed for protein content, dough extensibility, color,

moisture content and presence of insects). In general, grading is more expensive than sorting owing to the higher costs of skilled operators. However, many qualities that cannot be examined automatically can be simultaneously assessed, and this produces a more uniform high-quality product.

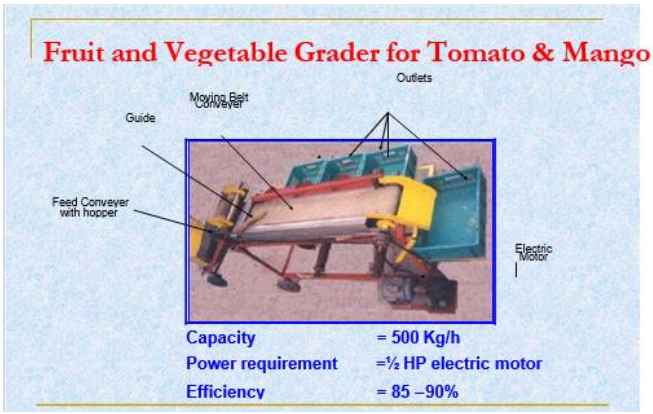
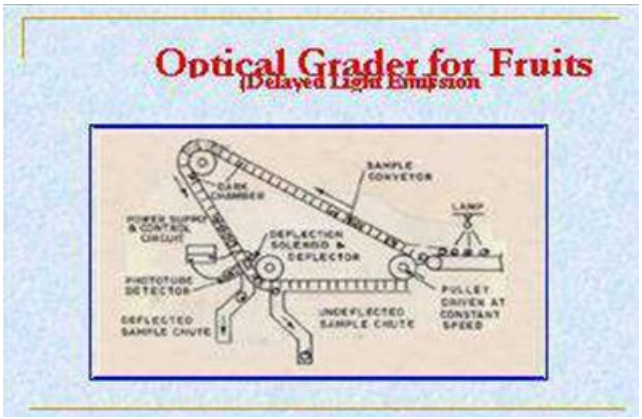



Plate 3.5 Orange grading (weight basis) machine in operation



Potato grader

Features

- Capacities range from 5 to 30 tonne/hr
- Washing
- Dry brushing lines
- Sizing
- Bagging lines

Onion grader

Features

- Capacities range from 8 tonne/hr to 30 tonne/hr
- Bulk receiver