PRINCIPLES OF PHYSICAL CLEANING OF SPICES

AMERICAN SPICE
TRADE ASSOCIATION

PREFACE

The American Spice Trade Association (ASTA) was established in New York City in 1907 to provide representation for the American spice trade. Today, ASTA is based in Washington, D.C. and its members include companies involved in all aspects of the spice trade — importing, growing, processing, and marketing at the wholesale and retail levels. On behalf of its members, ASTA works with federal and state regulators and legislators, and assists its members in addressing a variety of issues to help its members provide an adequate supply of safe and wholesome spices for their industrial, food service, and consumer customers.

The information contained in this publication is intended as a resource for spice companies to ensure appropriate physical cleaning of spices. ASTA has produced other educational materials to cover other aspects of production, including *Clean, Safe Spices*, guidance for the industry on pathogen control, the *HACCP Guide for Spices and Seasonings*, and, in conjunction with the International Organisation of Spice Trade Associations, a *Good Agricultural Practices Guide.* All of these resources are intended to help members of the spice industry develop and implement programs to ensure the spices they sell are clean and safe.

ASTA is committed to assisting companies in the spice trade, regulators, and the public in assuring an adequate supply of clean, safe spices. This guide is intended to serve as a resource for anyone with an interest in the spice trade. For companies in the spice trade, the information may assist you in providing clean, safe spices to your customers, including food manufacturers and the public. For members of the spice trade, we encourage you to use this guide together with other sources of information to develop and implement your programs to assure that the spices you sell are clean and safe. ASTA is not responsible for either the use or non-use of this guide and the information in it, or any actions or failure to act by anyone using this guide. It is each individual's responsibility to verify the information in this publication before acting on it, and to comply with all relevant federal, state, and local laws, regulations, and ordinances. We urge you to consult with appropriate experts regarding circumstances relevant to clean, safe spices.

INTRODUCTION

All spices imported into the U.S. are required to meet federal regulatory requirements for safety and cleanliness. The U.S. Food and Drug Administration (FDA) is the primary regulatory agency with authority to regulate the safety and cleanliness of spices. FDA considers contamination from "filth" to be a potential hazard to humans consuming spices. FDA considers ''filth'' to mean ''extraneous materials'' as defined in FDA's Defect Levels Handbook: "Any foreign matter in a product associated with objectionable conditions or practices in production, storage, or distribution." This includes "objectionable matter contributed by insects, rodents, and birds; decomposed material; and miscellaneous matter such as sand, soil, glass, rust, or other foreign substances" (FDA 2009 Defect Levels Handbook).

In developing this guide on physical cleaning of spices, the assumption is made that preliminary separation and scalping has been done. Therefore, this publication addresses the equipment for cleaning and preparing goods prior to export or use as a food product.

Materials that require physical cleaning may also require microbiological cleaning and thus an approved and validated process for microbial reduction may be required after physical cleaning.

CLEANING AND RECONDITIONING

The Principles of Cleaning

The process of separating good from unwanted materials is referred to as "cleaning" which encompasses all similar terms such as classifying, separating, and reconditioning.

For centuries, it has been clear within the spice trade that the purer the final product, the higher the price. Both buyer and seller know that the value of the spice is directly related to its food safety status and the quality of flavor, color, and/or size. Today, we are concerned not only with the flavor and appearance of the spice, but also any potential health hazards to the consumer. Signs of poor sanitation and health hazards include not only such items as stones, stems, and foreign seeds, but also insects, excreta, mold, bacteria, hair, and illegal chemicals.

Realizing the wide range of impurities that can contaminate spices and the immediate need for products that meet basic macroscopic specifications, the following information concentrates on systems and equipment that remove or reduce the percentage of extraneous materials such as excreta, foreign seeds, leaves, stones, hair, stems, insects, metal, wood, glass, etc.

Many models and types of machines with a wide range of capacities are available to spice processors. Properly operated, these machines allow the removal of contaminants, which differ from the desired product in size and dimension, shape, specific gravity, different behavior in air currents, and magnetic properties. To use the machines effectively, the processor must understand the working principle of each machine, its capacities, and its proper place in the overall processing operation. The physical properties of the product being processed and the physical properties of the contaminants in these products must also be known. After the differences between the spice and the contaminants are determined, machines that will make the most efficient separation can be selected.

Processing equipment should be of the correct construction to ensure that the equipment itself does not become a source of potential contamination. It should not be made of wood and food contact surfaces should not be painted. The equipment should be easy to clean, and, wherever possible, there should be no loose fittings. The best quality of stainless steel available is highly recommended for food contact surfaces

It is imperative to understand that successful use of this equipment depends on the management and training of the operator and staff and the use of quality control systems throughout the production facility. The key points are:

- There is no single piece of equipment that can do all jobs. Variables of nature, such as weather or insects, will cause differences in physical characteristics of the plant as well as the type and degree of contamination. Thus it is important when purchasing equipment to ensure that it is adjustable so that the equipment can cope with these natural variations.

- Equipment is engineered to process a certain volume of material, pounds or kilograms per hour. Feeding more product into the equipment will not result in cleaner product. It may well result in product that is not well cleaned.

- Adequate quality control procedures must be established. Periodic checks must be made during processing to ensure that the removal of contaminates is occurring as planned.

- For a successful cleaning operation, the costs of well trained people and useful laboratory facilities must be considered as important as the costs of equipment and installation.

Physical Consideration for Cleaning

The major physical differences that can be used for separating impurities are as follows:

- **Size and Dimension** - Spices, seeds, and herbs are grown in various parts of the world. They are all different in size and even the varieties grown in the same country may vary in their dimensions. Knowing the sizes of the products offers an opportunity to separate by size. Impurities, which have dimensions different from the spice products, are easily separated. Size dimensions are overall volume, width and length.

- **Weight and Specific Gravity** - Many products differ in weight and specific gravity/density. The gravity separator, the stoner, vacuum gravity air table, and the aspirator are all designed to make specific separations by differences in weight or specific gravity of the product.

- **Different Behavior in Air Currents (Aspiration)** – The rate at which an object falls in an air flow depends on its size, density and shape. Aspiration makes use of this principle by subjecting a steady flow of material to an air current that is adjusted so that the heavier material will fall and the lighter material will be drawn forward by the air current.

- **Metallic Properties -** Sanitary plates, grates and traps are highly efficient permanent magnetic units that remove ferrous metal (iron) from spices. Metal detectors placed at strategic points in the process flow can reject aluminum, brass, stainless steel, ferrous and other metals.

- **Others -** the use of color/laser sorters and x-ray equipment can have a very beneficial effect on the food safety and quality of the product being produced, as they have the additional capacity to remove potential foreign bodies that cannot be removed by the other equipment.

SUGGESTED CLEANING EQUIPMENT

This chart matches the spices to the machines best suited for separation. This is only a general guide and actual equipment should be selected on a case by case basis. Color/laser sorters and X-ray equipment can be used on any herb or spice. There are a number of equipment manufacturers and their marketing materials, available on-line, includes photographs and diagrams detailing the function of the equipment. ASTA does not recommend any particular equipment manufacturer.

	Mag	RK	DS	Asp	GT	IC	Spir	Siev	MD
Allspice	X			X			X	X	X
Anise	X		X	X				X	X
Annatto	X								X
Sweet Basil	X			X	X	X		X	X
Caraway	X		X	X				X	X
Cardamom	X		X	X				X	X
Cassia/Cinnamon	X	X		X				X	X
Celery Seed	X		X	X				X	X
Chillies whole	X			X				X	X
Chillies crushed	X	X	X	X				X	X
Cloves	X		X	X				X	X
Coriander	X		X	X				X	X
Cumin Seed	X		X	X				X	X
Dill Seed	X		X	X				X	X
Fennel Seed	X		X	X				X	X
Fenugreek	X		X	X				X	X
Ginger (Whole & Split)	X	X		X				X	X
Laurel (Bay) Leaves	X							X	X
Mace	X	X		X				X	X
Marjoram	X			X	X	X		X	X
Nutmeg (Broken)	X	X						X	X
Nutmeg (Whole)	X								X
Oregano	X			X	X	X		X	X
Parsley	X			X	X	X		X	X
Pepper, Black	X		X	X			X	X	X
Pepper, White	X		X	X			X	X	X
Poppy Seed	X		X	X				X	X
Rosemary Leaves	X			X	X			X	X
Sage	X			X	X			X	X
Savory	X			X	X	X		X	X
Sesame Seed (Natural & Hulled)	X		X	X				X	X
Tarragon	X			X	X			X	X
Thyme	X			X	X	X		X	X
Turmeric	X	X	X					X	X

Equipment

Asp = Aspirator (Air Separator)
GT = Gravity Separator (Air Table)
Spir = Spiral Gravity Separator
RK=Rotary/Knife Cutter
IC = Cylinder Separator (Indent)
Mag = Magnets
DS = Destoner
Siev = Sifter / Sieve
MD = Metal Detectors

DESCRIPTION OF EQUIPMENT

Primary magnets - it is recommended that a magnet is installed prior to any process equipment to remove tramp metal but also to ensure that the equipment is protected from damage

Aspirator (Air Separator)

Many different types of air separators are manufactured for spice processing. There are both aspirators and pneumatic separators, but all use the movement of air to divide materials. As aspirators use a significant amount of air, it is important that there is a filtration system to ensure that this air does not introduce potential foreign bodies.

Each spice has a size, shape, and density that react to an air current. For aspiration, a steady stream of material is subjected to a steady flow of air. The air pressure can be regulated so that the heavier materials will fall and the lighter materials will be drawn forward. Generally, there are several aspiration steps in a cleaning process.

There are various types of aspirators, scalping, fractionating, and pneumatic separation, which all work on the same principles, differing only in the location of the air moving unit. Aspirators can be used alone or in combination with other machines such as sifters, spirals, vacuum gravity separators, and cylindrical separators. Aspirators are used to remove such items as feathers, dust or dirt, stems, and sometimes insect fragments from spices.

Cutting Machines

Magnets should be placed in the cleaning system prior to the cutting machine to prevent knife damage and the potential for metal fragments getting into the product. Rotary knife cutters, screen classifying cutters, dicers and other cutting machines are used to reduce products to a smaller, more uniform size to allow for better cleaning and separation of unwanted materials in spices. The cutters generally provide high capacity product reduction and are in widespread use for cutting, chopping, and producing spice products of a specific size or granulation.

The various knife configurations in the cutters can provide for strip cuts, square cuts, rectangle cuts, and other geometrical shapes and particle sizes for spices that can be reduced by cutting or shearing. The cutting machines use a mix of knife types such as slicing knives, circular knives and crosscut knives. As knives are often made of brittle materials, it is important that they are regularly inspected to monitor for potential contamination.

These cutting devices are essential for processing spices such as cinnamon, ginger and turmeric, before they are physically cleaned.

Destoner

A de-stoner is effective for removing stones. The principle used is similar to that of a gravity air table, but it simply sorts heavies and lights.

The basic principle of the de-stoner involves flowing dry material over an inclined, vibrating, screen covered deck. Air from a pressure fan located in the body of the machine below the deck is forced up through the deck and through the bed of material. This steady air flow holds the material in stratified flotation. The lighter material stays in the upper strata as it flows down the inclined vibrating deck. The heavier material, such as stones, coarse sand, glass, and metal, travels up the inclined vibrating

deck and out. The fine sand falls through the screen and into the body of the de-stoner where it is removed. The tilt of the table and the air velocity can be varied to adapt to different density materials.

De-stoning eliminates contaminants and improves purity of the product and is essential before grinding because items such as stones and sand can wear out various mills and reduce the efficiency of these pieces of equipment.

Vacuum Gravity Separator (Air Table)

The vacuum gravity separator or air table separates material on the principle of density. Three basic rules of gravity separation are:

- Particles of the same size but different densities can be separated.
- Different size particles of the same density can be separated.
- A mixture of particles of different sizes and densities **cannot** be separated.

The essential device mechanism consists of a perforated, vibrating deck or screen through which an air current is blown. The angle at which the screen is set, the frequency of vibration and the air velocity are adjusted to achieve the desired separation. The oscillation of the deck "walks" the heavy material, such as dirt or stones uphill, while light material, such as stems and leaves, float on the air and go down the table. The medium density material, usually the intended product, goes to the center. By means of movable splitters, the discharge can be divided into a number of density fractions.

Separation efficiency is dependent on air distribution through the deck, inclination and movement of the deck and deck covering. The rate of the material entering the gravity deck greatly affects operational efficiency. Optimum rates vary according to the difference in density or specific gravity of the mixture components.

This machinery requires constant monitoring of product flow and subsequent operating adjustments.

Cylinder Separator (Indent)

Indent cylinders use centrifugal force and length differences to lift material from a seed or leaf mass, making a length size separation. The indent cylinder consists of a rotating, horizontal cylinder and a movable, horizontal separating trough. The inside surface of the cylinder has small, closely-spaced, semispherical indentations. In operation, the seed or leaf masses to be separated lie on the bottom of the cylinder. As the cylinder rotates on its axis, the short seeds or leaves in the mass are lifted from the mixture by the numerous indents. At some point before reaching the top of the rotation, the good seeds or leaves drop from the indents and are received by an adjustable trough or vibrating tray to the discharge conveyor. It is not unusual for a facility to have more than one indent cylinder with differing indent sizes to allow for the effective cleaning of materials given the natural variability of the product.

The speed of the cylinder shell must be properly controlled to ensure that good separation is maintained. Too high a speed will hold the long or heavy contaminants against the side of the cylinder. Too long and low speed will not hold the small materials long enough.

Sifter Aspirator

The sifter aspirator combines the use of air movement with sifters to separate materials. Initially the material passes through a sieve which rejects oversize particles and then feeds through to a second sieve which removes undersize particles. The resultant material is then fed into the aspiration channel over an oscillation conveyor. A vibrating motor causes the feeder table to swing horizontally. At the same time, the weight of the material being cleaned opens the feeder uniformly and a thin stream

along the entire width of the aspirator is discharged. In the aspiration channel, the adjustable stream of suction air passes vertically upward through the thin horizontally-fed stream of material and carries the undesirable materials (dust, husk particles, light seeds, etc.) into the expansion chamber. The cleaned product then falls directly out of the aspirator and is ready for further processing. The back wall of the aspiration channel is adjustable to obtain optimum separating action. The double-valve airlock discharges materials without difficulty which would normally adhere to surfaces.

Sifter/Sieves

A sifter separates dry materials by particle size, allowing for the removal of undersize and oversize materials. The sifter mechanically shakes a sieve or sieves. The sieve screens can be the same size or can be various sizes, depending on how many separations are to be made. In the sifter, the finer material drops through the screen, and the coarser material rides over and is discharged. The opposite will sometimes occur where the material required remains on the sifter deck and dust and small particles pass through the screen and are removed.

Sieves/sifters can be located in various places in the production flow. There are numerous types and shapes of sifters, and they can be floor mounted or suspended in other locations. Hole shapes in the sifter sieve can be round, slotted, triangular, or square. The larger number of the screen mesh the smaller the hole size, as the mesh number relates to the holes per inch. Alternatively mesh screens are sometimes classified by their micro size and this relates to the size of the hole in the screen.

Sifters are dependable equipment requiring little maintenance. They provide dependable continuous performance and allow for removal of contaminants such as large stems, bits of paper, or plastic and/or dust.

The screens within a sifter should be inspected to ensure that they are undamaged both prior to use and after processing a batch of material. A damaged screen not only indicates that a batch may have been contaminated but it could also mean that is was not processed correctly.

Spiral Gravity Separator

The spiral separator is a device used primarily for separating round seeds from fractures, shriveled kernels, or other impurities. It consists of a number of descending spiral chutes around a central column. The spiral separators separate seeds according to shape and their ability to roll or slide.

To operate, material is dropped from a feed hopper into the top of the inner most steel spiral at a steady rate. The uniformly pitched slides of the separator carry the material down by gravity. After attaining optimum speed, the faster moving spherical seeds, roll toward the outer edge of the slide and are discharged. The flatter kernels and oddly shaped contaminants discharge near the center.

The equipment has no moving parts, is easy to clean, is compact and takes up little floor space. The spiral will operate steadily with little maintenance.

Air Screen Separator

The air screen separator separates materials based on differences in spice size, shape, and density. The separators use three cleaning elements:

- Aspiration, in which light material is removed.
- Scalping, in which material larger than the product desired is removed;
- Grading, in which separation of the product can be classified as either large or small.

The separator units come in a variety of models with two to eight vibrating screens.

Material to be separated falls through the inlet onto the top sieve, which scalps and removes such impurities as string, straw, and stones. Air streams remove the trash and impurities, and the product moves into the second sieve which holds acceptable material allowing sand and smaller impurities to fall through.
Numerous types and sizes of screens are available. The rate of feed, airflow, oscillation of the screens, and the screen pitch are adjustable. Screens must be checked to ensure they do not clog because of faulty cleaning. Additionally, the outlets of the separators should be checked to see that are no leaks in the screens, and the aspirator tip outlets and separator dust collector outlet must be monitored to determine that the air is adjusted properly

Magnets

The most common and simplest devices used for cleaning ferrous metal are magnets. Magnets come in many forms but all are designed to remove iron metals from materials and product flows. Magnets are placed at raw material inlets and usually before and after milling equipment. They can also be installed in chutes, spouts, ducts, feed tables, and housing as well as in suspension over non-magnetic screens.

The equipment is dependable and provides economical protection against tramp iron damage in processing lines. Magnets catch and remove damaging iron contamination from material flows. They help prevent machinery damage and costly shutdowns, spark-caused fires and explosions, and product contamination.

When installing magnets, it is important to ensure that they are correctly positioned, so that the product flows over or through them at a constant rate. The gap between the magnet and the product should be small enough to ensure that magnetic materials remain within the magnet's magnetic field. They should be designed so that they are easy to remove for cleaning purposes, as trying to clean a magnet in place risk contaminating the production unit.

Magnets come in many different shapes and sizes. Self-cleaning grates eliminate the need to shut down product lines in order to remove, clean, and reinstall magnetic elements. Easier, more frequent cleaning prevents excessive iron contamination buildup on the magnets and assures maximum separating efficiency.

Magnetic tubes within stationary stainless steel tubes are used in the self-cleaning grate. To clean the grate, the magnetic elements are withdrawn from the stationary housings in the area of product flow. A powerful circuit within the inner tubes produces highly magnetic gaps that pull the entrapped iron contamination sideways along the surface of the stationary tubes. At a point outside the product flow, contamination is discharged. The entire cleaning operation takes place within a few seconds. A one-finger pull on the smooth-sliding moveable tubes of the manually operated model is all that is required to clean the magnetic elements. The automatic model, designed for hard-to-reach locations or for installations that require very frequent cleaning, is pneumatically operated and equipped with a timer so the cleaning cycle can be adjusted to the amount of contamination to be removed.

Self cleaning drum magnets are also an effective way to remove tramp metal. They are often located within the structure of a conveyor belt, where the magnet is the final drum of the conveyor belt. Using this design, the product falls vertically from the end of the conveyor but the magnetic materials are still attracted to the magnetic drum. As the conveyor belt start to pull the magnetic material way from the drum magnet it falls into a separate chute and is removed from the product stream

Metal Detectors

Metal detectors are used to detect all types of metals, both magnetic (iron), and non-magnetic, such as aluminum and other non-ferrous metals, including stainless steel. These devices operate on the

inductive measuring principle. A high frequency electromagnetic alternating field is generated. If a metal object passes through the metal detector, the detector experiences a change in the field based on the magnetic and electrical properties of the metal object.

Metal detectors, like magnets, are used in various locations in the production stream. Most common areas are raw material inlets, before and after milling, and as close as possible to the end of the production flow. Consideration needs to be given to the possibility of recontamination after the metal detection process and this is what often drives the location of the metal detector to being close to the end of the production line.

Metal detectors help protect both the processors and end consumer from metal contaminates.

It is important that metal detectors are checked for operational effectiveness on a regular basis. This should be done at least once every shift, however, an hourly check is preferred.

This check is carried out by inserting a calibrated test piece into the induction coil and ensuring that the test piece is rejected correctly or the belt stops, dependent upon the type of equipment. Calibration with the test piece is best performed while product is flowing through the detector to allow for the background signal that the product will have. The date and time the metal detector is calibrated and then checked should be recorded. Auto rejection devices are preferred, as the process flow continues while the foreign material is separated. The size of metal particles allowed is driven by customer specifications, but there are U.S. Federal standards for foreign material, including metal.

Metal detectors with smaller apertures generally will have better sensitivity than one with larger apertures. For example a metal detector which is in flight (designed within a vertical drop of a product stream) or one that is detecting individual retail spice containers, will normally have a detection sensitivity of less than 1 mm Ferrous particles.

Metal detectors that are testing the final industrial pack, for example a 10 kg paper sack of herbs, will probably have a sensitivity closer to 2.5mm for Ferrous particles.

Color / Laser Sorters

The principle of operation for a color sorter is that material is fed into channels that pass through an imaging camera. Various light and laser lamps can be used in this unit to help highlight a difference between the reflected light of the contaminant and that of the product. A good product flow is essential for this unit to work correctly.

Through the use of a PLC or Computer control panel the required reflective ‘color’ of the product is establish and if material of another ‘color’ is detected by the camera the particle is rejected through the use of compressed air.

Usually a system is in place to regularly check both accepted and rejected materials to ensure that the unit is working correctly throughout the production run.

X-Ray Detection

Similar to the x-ray units within a hospital, the principle of operation is that via x-ray technology it is possible to detect items of differencing densities, under x-ray conditions.

Rejection systems are somewhat similar to some metal detection units. Through the use of this technology items can be detected that are not rejected by a metal detector or via color sorting.

Item such as hard plastic and stones etc. can be rejected, provided they have a different density to the product. As with a metal detector the unit is usually supplied with test pieces that are used on a regular basis to ensure the unit is working correctly.

GLOSSARY OF CLEANING TERMS

Aeration – Forcing air to flow through a stationary layer or column of spice to remove the end products of aspiration and for cooling and drying.

Aspiration – The use of controlled velocities of flow-directed air to secure separation of particles with different resistance to air flow due to size, density, shape, or other physical characteristics.

Aspirator – A machine, apparatus, or device employing aspiration to extract dust, light chaff, hulls, etc. from spices.

Bolting Cloth – A term applied to any of the sieving or sifting materials (wire, silk, nylon, and other synthetics) used as covers on frames in milling machines to secure separation according to particle size.

Brush Machine – An apparatus designed to remove surface dirt, loose bran layers, etc. by use of brushes.

Capacity – A rating in units of mass or volume, which in some instances, are further rated in units of time. Example: pounds or cubic feet per bin, per hour.

Cleaning House – A building or area that contains equipment to remove undesirable material and foreign substances.

Cylinder Machines – A machine containing a rotating cylinder used principally for separation of various seed mixtures.

Destoner – A machine for separating, by density, stones or other heavy material from spices.

Destoning – The process of extracting stones from spices.

Drawer Type Sieve – A term which describes arrangement of sieves which extend to the outside of the sifter and can be withdrawn and replaced like a drawer, except that a lock latch of some sort is used to prevent their working out while operating.

Dry Cleaning – The process of freeing spice of all extraneous materials (e.g. chaff, dust, stems, and seeds) without the use of water.

Elevator – Any of several types of conveying machines used for vertically lifting spices.

Grader – An apparatus which separates products into uniform lots according to size, density, or other desired quality controlling factors.

Grading – Separation according to particle size.

Liftings of Cleaning Equipment – Light weight materials separated by air currents in the cleaning machines.

Mesh Aperture – The dimension in microns of the openings in any of the wire screens or bolting cloths.

Particle Size – The apparent diameter of particles expressed either as a profile (percent of total in different size-ranges or as a single figure) or as the mean or average particle size.

Pneumatic Conveying – The use of air under positive or negative pressure for moving spices in pipes from one location to another. Both vertical and horizontal movement is implied.

Pneumatic Conveying Systems – A systematic arrangement of tubes, valves, air compressors, and dust collectors designed to convey mill stocks and/or finished products by utilizing the flow and carrying power of moving air.

Receiving Separator – A large cleaner using screens and aspiration for rough cleaning at a high rate. This machine is usually located at the beginning of the cleaning sequences.

Reciprocation Brush – A fiber brush moving back and forth on the underside of a sieve or screen to keep its apertures open.

Scalping – The separation of flat, coarse particles by sifting.

Scalps – The stream of particles passing over the largest opening screen in any set of sieves within a sifter section.

Screenings – The undesirable non-millable materials such as dust, hulls, foreign seeds, rocks, etc., separated from the raw materials prior to milling or other processing.

Screenings Removed – A term pertaining to the amount of screenings or foreign material removed from incoming raw material.

Screw Conveyor – A mechanical device for moving material both horizontally and vertically by means of revolving a spiral ribbon inside a tough tube.

Sifter – A machine that separates products by particle size through a sieve media.

Sifter Area – The total area of cloth in a sifter that is not binded by frames, binding, or cross braces in the frames.

Sifter Box – The housing, which encloses one or more stacks of sieves.

Sifter Flow – Arrangement of the several sets of sieves within a sifter section.

Sifter Sections – The housing, which encloses one stack of sieves.

Sifter Throw – The diameter of the circle on which the sifter boxes operate.

Sifter, One Section – A separating machine, which contains only one stack of sieves.

Sifter, Two Sections – A machine which uses two separate stacks or series of sieves to separate particles according to size.

Silo – A structure for the bulk storage, which is usually tall, cylindrical, and constructed of reinforced concrete or steel plates.

Stratification – To form in strata or layers by size and density due to agitation.

Suction Dust Collector – Any of several dust separating equipment that operates under negative (lower than atmospheric pressure).

Tapered Screw Feeder – A spiral ribbon shaft mounted in a trough, having progressively increasing diameter, designed for evenly withdrawing material from bins.