SEED COAT CHARACTERISTICS -
ROLL MILL AND MAGNETIC SEPARATOR
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To those who have moved through a field of cocklebur seed dispersal becomes a reality. This is made possible by a seed coat especially designed for this purpose. This dispersal mechanism also makes it possible to separate one kind of seed from another, although less dramatic than the cocklebur example. This characteristic is commonly referred to as "Texture of seed coat", and may include spiny, rough, gelatinous or granular seed coats.

The roll mill and magnetic separator both utilize a difference in texture of seed coat in order to make a separation.

The Roll Mill

The roll mill is always used after the basic cleaning machines in the processing line. It is often used to finish lots that contain dodder, dock, flat or immature seed and inert matter that passed the previous machines.

The rough seed are separated from the smooth seed by the action of the rolls. A pair of rolls covered with a velvet-like material are placed side by side close enough to touch lightly. The rolls are mounted in an inclined position and turn in opposite directions, outwardly when viewed from the top.

The seed mixture is fed onto the rolls at the high end of the machine. As the seed travel downhill between the revolving, inclined rolls, the rough seed are caught by the velvet-like rolls and thrown against the baffles, deflected back against the rolls, etc. until they have been thrown out. The smooth seed continue bouncing downhill between the rolls and discharge off the end. The seeds thrown over the sides are caught in graduated grade hoppers underneath the machine. The intermediate grades can be re-run to recover the smooth seed that were thrown out with the rough seed.

The feed hopper of many machines consists of a vertical shaft from which individual feed spouts lead directly to each pair of rolls. This vertical shaft is equipped with a fast, complete clean-out pull slide. The rate of feed

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is adjusted by opening or closing the feed slide in the vertical shaft underneath the feed hopper. This increases or decreases the size of the opening in the shaft through which the seeds flow into the individual feed spouts.

The rate of feed is adjusted and controlled for two reasons. First, the effectiveness of the separation may be controlled somewhat by the rate of feed. If the space between the rolls and the baffles becomes crowded the agitation necessary to make an effective separation is reduced or prevented. Second, the capacity may be increased by opening the feed slides.

The rolls are the separating parts of the machine. They are covered with a velvet-like material and placed side by side close enough to touch lightly. The rolls are always used in pairs and each pair of rolls is a separate cleaning unit.

The length of rolls may vary with different machines, as a certain length is not absolutely necessary for maximum cleaning. The number of rolls may also vary from machine to machine. An increase in the number of rolls does not increase efficiency but merely increases capacity.

The speed of the rolls is the most important adjustment on this machine. In general, the faster the rolls revolve, the cleaner the seed. However, too fast a speed is not recommended because it results in unnecessary throw-over of good seed. The recommended way of making the adjustment is to start with a minimum speed and the desired rate of feed, then increase the speed of the rolls until the product is clean.

The tilt mechanism is located at the bottom of the feed end of the machine. On some machines it is a large hand wheel screw; whereas on other machines it is a combination lever-screw device. This variable tilt mechanism permits quick, easy adjustment of the machine's pitch for various types of seeds. A continuous incline range from $7^\circ$ to $13^\circ$ may be obtained. This adjustment is used less by most operators once a desirable tilt has been established. Increasing the tilt has the effect of shortening the rolls and also reduces the amount of throw-over.

The baffles are shields that conform fairly close to the shape of the rolls as viewed from the top and are positioned directly over each pair of rolls. Rough-coated seed lifted by the turning rolls are deflected by the baffles back on the rolls with the result that these seed are removed rapidly from the smooth-coated seed which are not lifted. The baffles are independently adjustable at either end of the machine. The range of separations possible may be increased by changing the distance between the rolls and the baffles. For most cleaning problems, a 1/4 inch spacing seems to be best.
Below are listed a few rough-coated seeds and objects which are thrown out by a roll mill.

- Dodder
- Catchfly
- Wild Winter Peas
- Mustard
- Cockle
- Wild Carrot
- Foxtail
- Timothy
- Pieces of Clay or Stones

These rough-coated seeds or objects may be removed from clovers, alfalfa, hulled lespedeza, hairy vetch and other smooth coated seeds. Because of its triangular shape and sharp corners, dock is commonly and easily removed from the clovers.

The removal of buckhorn can be accomplished with this machine if prior treatment has been given the seed lot containing buckhorn. This prior treatment involves adding a foreign material such as wood dust to the buckhorn which creates a rough surface. Separation is then an easy matter.

The roll mill is a very economical machine because the cost of operation and maintenance is extremely low. The minimum attention needed to operate the roll mill, once it is adjusted, is also a point to remember when considering this machine.

**Magnetic Separators**

Magnetic seed cleaners have been in use for a long time but only recently have they received much attention. An increasing number of seedsmen in the alfalfa and clover producing areas are installing these cleaners in their plants and, in general, are finding the performance of the equipment quite satisfactory.

The most common use of the magnetic separator is the separation of ores and the removal of tramp iron from non-ferrous materials. As seed contain no free iron and are not attracted to a magnet, how can the method be applied to seed separation? The answer is that seeds must be pretreated with a magnetic material such as finely ground iron powder. If the iron powder can be made to stick on the weed seeds, inert material, and other undesirable components in the seed lot, then these materials will respond to a magnetic field while the uncoated crop seed remains non-magnetic. This can be accomplished only if the materials to be separated differ in seed coat characteristics.

Generally, the seed to be cleaned must have a smooth seed coat such as that found in legumes, while the seed to be removed will have a rough, gelatinous, or granular surface which will retain a fine iron powder when pretreated with water or a combination of oil and water. The degree of successful cleaning depends largely upon the magnitude of the seed coat differences and the thoroughness of the mixing operation.
A magnetic cleaning system, regardless of the type or make, consists of a mixing unit and a cleaning unit.

The mixer distributes a specific amount of water, oil, and iron powder throughout the seed lot. The amount of each varies with the kinds of seed being separated and other factors.

A magnetic separator utilizes one of two general types of mixers. One is the **batch type** in which measured amounts of dosage materials are added to a given quantity of seed and mixed for a certain length of time. The material is then transferred to the separating or cleaning unit. The second type of mixer is the **continuous flow type** in which the seed is passed through a series of auger-type mixing chambers. At different points in the system the dosage materials (iron powder, water and oil) are metered into the stream of seed where they are thoroughly mixed together in the course of being transferred to the separating unit. Both types of mixers require careful attention. **It must be emphasized that the key to the success of magnetic cleaning lies in the mixing operations.** If the dosage materials are not applied to the seed thoroughly, uniformly, and in correct proportions some of the undesirable seed will not be coated with the iron powder and will pass over the cleaning unit with the clean seed.

The most common type of cleaning or separating unit used by the seed industry is the revolving cylinder or drum. The drum may be an electro-magnet, with the amount of magnetism easily controlled, it may contain permanent magnets with constant magnetism, or the magnetism may be introduced into the drum by stationary electric poles. The laboratory model separator in the adjoining room uses an electromagnet, whereas the separator downstairs utilizes permanent magnets. Both offer advantages and limitations. A more precise separation can be made with the electro-magnet as the intensity of the magnetism can usually be varied by use of a variable transformer to suit the particular lot of seed being cleaned. You can expect to pay more for machines equipped with the electro-magnet as the drum is more expensive and a rectifier is required for converting alternating current to the direct current necessary to magnetize the surface of the drum.

Regardless of the type of separator used, or whether or not the drums are magnetized with permanent or electro-magnets, the general principles of seed separation are the same for all magnetic cleaners. The iron powder is introduced onto the seed that have been slightly moistened, after which the mass is agitated in the mixing apparatus. The rough or gelatinous coated seed retain the iron powder whereas the smooth coated seed do not. With some separations, such as johnsongrass, it may be necessary to apply oil before the iron powder is applied. After the application of the iron powder, the seed are then passed over the magnetized rolls. Those seed which have magnetic powder sticking on
them are retained on the surface of the drum by magnetic force and those to which no powder adheres pass over the drum without their trajectory being affected. The seed clinging to the rolls either fall off due to gravity or are brushed off the back into containers provided for the waste material. There is no rerun of rejected material.

There are a number of factors that affect magnetic cleaning of seed. Some of these factors are as follows:

The Condition of the Crop Seed Coat

High crop seed losses sometime accompany magnetic cleaning. These high losses can usually be attributed to the treatment the seed received during harvesting and processing operations prior to cleaning on the magnetic separator. Crop seed which have received careful treatment during harvesting and subsequent handling operations are likely to have less broken and damaged seeds than those which are roughly handled. Cleaning losses are higher with scarified and badly broken seed because the roughened seed coats collect more iron powder than the unscarified seed.

Seed to be cleaned on the magnetic separator should be thoroughly cleaned with other machines, especially seed high in inert material. A good screening and aspirating job will result in a better job and less worry.

Inert Materials

The presence of dirt, sticks, straw, leaves, and other contaminating debris in a seed mixture results in a higher dosage requirement for effective cleaning. The inert material competes with the weed seed for the available dosage materials and enough dosage must be applied to coat both the weed seed and inert matter.

The Kind of Crop Seed

Not all crop seeds which can be cleaned with the magnetic separator respond equally to similar dosage applications. Seeds with extremely hard and slick seed coats, such as sericea lespedeza, take up less iron powder than seeds with slightly roughened or irregular seed coats such as alfalfa and red clover. Sweet clover will take up even more iron powder than alfalfa and red clover as a result of having a still rougher seed coat. Generally speaking, the crop seed which have the slicker coats will require smaller dosages, have a lower cleaning loss, and will result in a more effective separation.

The Kind and Concentration of Weeds

An ideal mixture is one in which the two species to be separated differ in physical characteristics to such an extent that a separation can be made on basic cleaning machinery. Unfortunately, the weed seeds of many
species cannot be satisfactorily removed by the magnetic method because of the similarities in physical properties of the seed coat of the weed and the crop in which it is mixed. In mixtures that can be separated some considerations relative to the amount of water, oil, and iron powder should receive attention. A seed lot containing a high weed seed concentration requires a higher dosage for effective cleaning than a lot with a lower concentration. Since the gelatinous seed coat of buckhorn absorbs water quite readily, the water requirements of a mixture containing this weed seed is higher than lots of the same crop seed contaminated with a similar amount of dodder.

Kind of Magnetic Powder

Even though the iron powders available for use with the magnetic separator are similar in that each contains a high percentage of iron, they differ in other important respects such as particle size, shape, apparent density, and to some extent color. The better performing powders are effective on most seed lots that may be magnetically cleaned but in some instances certain powders seem to be somewhat specific. That is, one material or powder adheres to a particular species of weed seed better than to another.

Adjustments

The magnetic separator is a relatively simple machine to operate as there are few adjustment to be made once the correct proportions of dosage material has been ascertained. However, these few are extremely important if satisfactory results are to be obtained.

One adjustment is the dosage material. Getting the right proportion of iron powder and liquids mixed with the seed lot is the real problem in magnetic seed cleaning, and the problem differs with each seed lot. Too little liquid results in inadequate coverage by the iron powder and consequently poor cleaning results. Excessive amounts of liquid and powder results in discoloration of the seed and excessive cleaning loss.

A second adjustment is the mixing time. This particular adjustment is all important. An incorrect mixing time for any lot of seed will result in ineffective separation. Too long a mixing time will allow the water to evaporate and the iron powder to be rubbed from the seeds. Too short a mixing time will not permit thorough coverage of the weed seed with the iron powder.

A third adjustment is the rate of feed. For accurate and economical cleaning the rate of feed must be controlled and adjusted properly. An incorrect feed adjustment will result in either a loss of capacity or ineffective cleaning depending upon whether the rate is too slow or too fast. For efficient cleaning the feed should not be more than one seed thick when fed onto the magnetized drums. This enables every seed to contact the drum.
A fourth adjustment is the intensity of magnetism. The strength of magnetism can be adjusted on separators equipped with elector-magnets and a rectifier with a variable transformer. Such an adjustment is advantageous since over or under dosage with water, oil and iron powder can be partially compensated with varying intensities of magnetism.