MAGNETIC SEPARATORS

T. Wayne Still[1/]

Magnetic separators are not a new principle of seed separation, but only in recent years have they received much attention. Industry has used the magnetic separator for many years. Industrial applications range from removing tramp iron from coal to the purification of pharmaceuticals. The most common use is the separation of ores and in the removal of tramp iron from non-ferrous materials.

It has been said that the first application of the magnetic process to the separation of seed was made in England some 30 to 40 years ago. In the English method, iron oxide was mixed with red clover containing dodder, after which the mixture was passed through a magnetic field. The English were not too happy with the results as the red clover was badly discolored and removal of the dodder was incomplete.

The magnetic cleaner is not a complex piece of machinery. In fact, its operation is quite simple as there are fewer adjustments to make on the magnetic separator than on most other seed cleaners. It is by no means the answer to all seedsmen's unsolved problems, as, like conventional cleaners, it has certain limitations. However, the magnetic cleaning process has proven to be effective in making some seed separation which are difficult, if not impossible, on other types of cleaners. An increasing number of seedsmen in the clover and alfalfa producing areas are installing magnetic cleaners in their plants and are finding the performance to be quite satisfactory. A few have found their way into the Southeastern States.

The most common use of the magnetic separator is the separation of ores and the removal of tramp iron from non-ferrous materials. As seeds 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.

1/ Mr. Still is Assistant Agronomist in the Mississippi Agricultural Experiment Station and Assistant Director of the State Seed Testing Laboratory, State College, Mississippi.

Several different makes of magnetic separators are used in the seed industry today, representing United States, German, and English developments.

Many of the magnetic separators used by the seed industry were developed for other purposes. However, several machines currently on the market were specifically designed for seed cleaning. Several types of cleaners are available such as the drum, induced roll, and the crossbelt types. The induced roll and crossbelt cleaners were designed as industrial machines and have been adapted to seed separation. A revolving cylinder or drum is the most common type of separating device used. Regardless of the make or type, all utilize the same principle of 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 operation. If the dosage materials are not applied to the seed thoroughly, uniformly, and in the 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 utilizes an electro-magnetic drum, while the commercial model 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 Johnson grass, 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 is some question as to whether the iron powder may be salvaged and re-used in future cleaning operation. It is generally believed, however, that enough properties of the powder may have been changed or altered to render the powder ineffective for use a second time. I am of the opinion that the iron powder should not be used a second time, and I base this observation on past experience. The iron powder is relatively inexpensive. Enough to treat 100 lbs. costs in the neighborhood of 30 cents.

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.

The magnetic separator is a relatively simple machine to operate as there are few adjustments 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 electro-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.