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# Density Separations

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# DENSITY SEPARATIONS

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Density separation is accomplished in seed conditioning plants by two basic machines; they are the gravity separator and the stoner. The gravity is designed to separate a small amount of light product from the heavy product and the stoner is designed to separate a small amount of light product from the heavy product and the stoner is designed to separate a small amount of heavy product from the lighter product.

I will discuss the gravity separator today, as it is used more in the seed conditioning plant than the stoner.

Before we get into the basics of how a gravity separator works, let's set some ground rules.

1. The gravity separator is not a "cure all" for your seed cleaning problems.
2. The gravity separator will not raise the germination of seeds.
3. The gravity separator is not a cleaning machine.
4. The gravity separator is not a replacement for spiral separators.

The gravity separator is a specialized machine designed to do one job very well. The gravity separator will separate particles of a similar size but differing in weight to eliminate light trash and undesirables and produce a good purity and germination for the seed lot.

There are three rules which state what can and cannot be separated on a gravity separator.

RULE # 1. Particles of the same size but differing slightly in specific gravities can be separated.

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RULE # 2. Particles of the same specific gravities but differing in size will be graded according to the size of the particles.

RULE # 3. Particles differing in both specific gravities and also differing in size cannot be efficiently separated on a gravity separator.

In all seed conditioning situations the best results are obtained on the gravity separator when the product has been thoroughly pre-cleaned and sized using the proper equipment designed for those purposes. The gravity separator can then show what it can really do.

Density separation or specific gravity separation is defined by stating that all bodies floating in or submerged in a liquid are buoyed up by a force exactly equal to the weight of the liquid they displace. Therefore, the specific gravity of a particle is the ratio of its density to some standard substance, the standard usually employed is water with a unit of one. Particles having a specific gravity of less than one will float and particles with a specific gravity greater than one will sink.

Gravity separators used in the seed industry utilizes air as a standard rather than water, and, since air is lighter than water, the relative difference between particles of differing weights is widened. For this reason the gravity separator is a very sensitive machine and, when operated correctly, can make a very precise separation.

Air is used as the separating standard through the process of seed stratification. Stratification occurs by forcing air through the seed mass in such a manner that the seeds rise or fall by their relative weight to the air. Figure 1A represents a cross section of the seedbed on the gravity separator deck with the fan turned off. The bed is a mixture of both light and heavy seeds with no stratification.

In Figure 1B the fan has been adjusted so stratification has begun so that the heaviest seeds rest on the surface of the deck and the lightest seeds are completely free of the surface of the deck and floating on top of the seedbed. Figure 1C illustrates the result of too much air flow which created a mixture of both heavy and light seeds. If you operate your gravity separator with too little or too much air flow through the seedbed, you will not have stratification, will not make a "density separation" and all you will have is a high priced, glorified, vibrating conveyor and the results will be no improvement in the quality of seed you are cleaning.

With the correct air flow through the seedbed you will have stratification. Now with the deck shaking at the correct eccentric shaft speed, the heavy seed that rested on the surface of the deck starts moving to the high end of the deck and the lightest seeds that

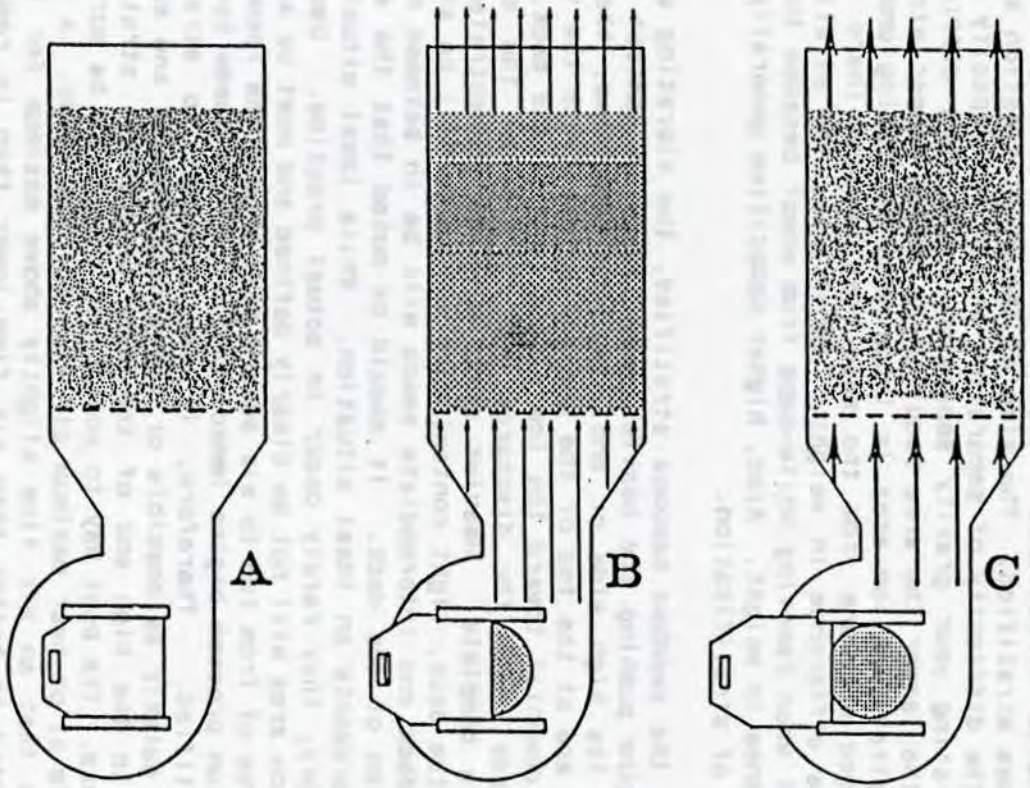


Figure 1. Gravity Table. (A) Fan intake closed; no stratification. (B) Proper volume of air flow through the deck; the seed layer is stratified. (C) Excessive volume of air flowing through the deck breaking the stratification.

are floating on top start moving to the low end of the deck. Separation has begun.

As the seed mixture discharges from the feeder onto the deck the area immediately around the feeder is called the stratifying area. In this area the vibration of the deck and the lifting action of the air combine to stratify the seeds into layers, with the heavier seeds on the bottom and lighter contaminants and seeds on the top and moving them in opposite directions. Separation cannot occur until the seedbed becomes stratified. The size of the stratification area will depend upon the difficulty of separation and on the capacity of which you are operating your gravity separator. The more difficult the separation, the larger the area required to obtain proper stratification. The stratification area is large when separating undesirable weather damaged soybeans from the seed mass because there is relatively little difference in weight. Conversely, the stratification area is small when removing white-caps from wheat because there is a large difference in weight. Also, higher capacities generally require larger areas of stratification.

Once the seedbed becomes stratified, the vibrating action of the deck begins pushing the heavier seed layers in contact with the deck toward its high side or end. At the same time, the lighter layers which are at the top of the bed and do not touch the vibrating deck, float downhill toward the low side or end of the deck. By the time the seeds reach the discharge end or side of the deck, the separation is complete. Heavier seeds will be concentrated at the high end of the deck, light contaminants and seeds will be at the low end of the deck and intermediate seeds will be in between or in the middle portion of the deck. It should be noted that the sketch in Figure 4 represents an ideal situation. While ideal situations are nice in theory, they rarely occur in actual practice. Usually the stratification area will not be clearly defined and must be assumed to occupy an area of from two to six square feet around the feeder. Also, the separation process begins immediately after the seeds become even partly stratified. Therefore, it is important to stratify the material as quickly as possible or light contaminants and seeds will be carried to the high end of the deck before the stratification process occurs. The best way to accomplish this is to be sure the air adjustment is at or near maximum air flow for the seeds. A good rule of thumb is that an air flow slightly above maximum for the seeds being separated is better than air flow lower than is required for startification.

In some separations, the distinction between heavy, good seeds and lighter, poor quality seeds is not visible to the unaided eye. In this case, periodic testing for weight per test volume at various points along the clean seed discharge and off-grade discharge would be necessary to determine if the correct separation is being made.

The discharge from the gravity separator is a continuously graded product ranging from the heaviest seeds to the lightest contaminants and seeds. In practice this continuous grade is broken down into two or three products. When a large weight difference is present between the desirable seeds and off-grade product, only two grades of product is generally required. However, if the weight difference is small it may be necessary to divide the discharge grades into; (1) the heavy acceptable product; (2) a small middling product which has not fully separated; and (3) the light reject product. In separations where rocks or other heavy trash is present, a fourth product is sometimes divided by means of the rock-trap.

All gravity separators have five variable adjustments which must be properly set and balanced to obtain optimum separation. These are feed rate, end raise, side tilt, eccentric speed and air control.

The feed rate control is located on the feeder and controls the amount of seed fed onto the separating deck. The feed rate, whether fast or slow, should be uniform and free from surges. Surges in the incoming feed will show up in the discharge of the gravity separator as a poor quality separation. I suggest the use or a surge bin above the feeder if cleaning will be interrupted. A minimum feed rate would be one at which the deck can be kept completely covered. If the deck is not completely covered at all time, you get a open sport and loose separation. One gravity separator on the market has a automatic discharge system that compensates for slow down or interruptions in feed rate to maintain separation at all times. Maximum feed rate is the maximum rate the deck can be fed and still obtain the necessary separation. When starting the gravity separator for the first time always start at the minimum feed rate, obtain your required separation and then increase the feed rate to the desired capacity. Remember that the seedbed must be deep enough to allow for stratification of seeds.

End raise is the slope from the feed end of the deck to the discharge end. This slope determines the rate of flow from the feed end to the discharge end of the deck. The higher the discharge end of the deck the slower rate of seed flow from one end of the deck to the other and consequently more exposure time for the seeds to be separated. The lower the discharge end of the deck the faster the send will flow across the deck resulting in less exposure time for the seeds to be separated. Quality of separation can be related to exposure time for seed mass. In general, the longer the seed mass is exposed to a separating action, the cleaner it becomes. End raise and feed rate controls are closely related. As feed rates are increased, the discharge end of the deck must be lowered so that the depth of the seedbed on the deck will not become too great.

Some gravity separators only have end raise and side tilt at the discharge end, as the deck pivots at the feed end of the deck. Side tilt is only adjusted at the high end of the deck.

Side tilt is the difference in height or elevation in the sides of the deck. Normally the best separations are obtained when the discharge side on the deck is set at or near the maximum steepness. However, care should be taken not to set the side tilt too steep. Side tilt is too steep when material cannot be made to flow toward the high side of the deck by increasing the eccentric speed.

Eccentric speed, side tilt, and end raise controls are closely related. Increasing eccentric speed will cause the seed mass to be shifted toward the high side of the deck. It is easy to remember the higher the eccentric shaft speed the higher the seedbed will be on the deck and the lower the eccentric shaft speed the lower the seedbed will be on the deck.

Air regulation is probably the most important adjustment to be made on a gravity separator. The most common mistake in air regulation is the use of too much air-flow. Separation is not made by blowing the light material from the heavy but by using a controlled air flow to create the stratified layers which are then separated by the vibrating action of the deck. Too much air will cause a boiling or bubbling action lifting the heavier seeds from the deck surface and mixing them with the lighter top layers. Too little air will cause the seedbed to appear sluggish and pile up at the high side of the deck. With proper air regulation the seedbed will seem to be almost fluid in appearance with the seeds on the surface agitated and free flowing.

Some more recent models of gravity separators incorporate an automatic discharge system. The bellows senses the static pressure in the plenum chamber under the deck. The bellow is connected to a gate in the clean seed discharge and if the feed rate slows down or stops, the static pressure will change, the bellows will start to drop and thus start closing the gate. As the gate closes the discharge rate is reduced thus maintaining a separation at all time. Once the feed rate starts again, the gate will re-open to it's proper setting. Attached to the bellows shaft is a arm with moveable weights that you adjust to control the seedbed depth on the deck. This feature allows the seedsman to end his cleaning operation in the evening and re-start the cleaning process the next morning without loss of cleaning efficiency.

As we will have a gravity separator demonstration this afternoon, lets review some sides showing the gravity separator and the different adjustments so that you will be able to recognize them during the demonstration.

In closing let me say that there are very few seeds for which the gravity separator will not improve seed quality. Once installed in the cleaning line, utilize the gravity separator for all your seeds. Different sizes of deck materials are available for use on the very smallest of seeds to the very largest.