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CONVEYING: A NECESSARY EVIL

Bob Park ¹/

If we could design the perfect seed plant, it would not contain conveyors. The seed would be grown on a high plateau, harvested and dumped into the top of a plant in the valley below, flow by gravity throughout the plant, and wind up in a bag or truck at the bottom of the plant. There is no such system in existence today; therefore, one must, by necessity, convey seed to get from A to B horizontally, and from down to up and up to down.

Most conveying is a compromise. The perfect conveyor, like the perfect seed plant, does not exist. Each conveyor is designed with only one purpose for its use, and seldom has all good features. Finding the right conveyor is the trick.

In most seed plants I've visited, innovation seems to run rampant. Seedsmen are especially ingenious when it comes to customizing their plants to get seed from one place to another. It's my impression that the average seedsman feels the perfect plant would allow him to go from every bin to every machine and from every machine to every bin. The results of such attempts are sometimes awesome.

However, there is nothing wrong with any system, basic or sophisticated, if it accomplishes the goals set for it.

Many of you have not had the opportunity to plan and build a seed handling facility from scratch and to your own specifications. While it sounds great, most of the headaches of design are from trying to get from one place to another. Most people set the problems aside with the thought that it will be simple, and, when they are done, their dream plant has become something else.

It doesn't have to be that way - all you need to do is spend some time analyzing the needs and problems and, usually, the answer is there.

Two prime problems are associated with conveying:

1. Seed mixture
2. Seed damage

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Our objective is to see that no mixture occurs in the conveying system, and that the seed germination is not affected or the seed is not abraded, dehulled, split or chipped. There is really no point in throwing away precious seed revenues because our equipment damaged the seed. Moving equipment is not the only source of damage, since even raw edges on spout joints can be rough on seed, but the opportunity for damage is higher in moving equipment.

There are many factors to consider in selecting a conveying system:
1. Movement - vertical, horizontal, inclined
2. Product - heavy, light, trashy, bulky
3. Multiple feed points - single discharge
4. Multiple feed points - multiple discharge
5. Single feed point - single outlet
6. Single feed point - multiple outlet
7. Dust or water-tight
8. Access for maintenance
9. Prevention of plugging
10. Mixing characteristics
11. Damage characteristics
12. Capacity needs

These are not all of the factors, a notable exception being Price. It would be ideal to disregard price, but, realistically, most decisions are made in the light of price - thus the compromise. The trick is to get the maximum number of factors covered.

The basic categories of conveyors are:
1. Bucket Elevators - centrifugal type
2. Bucket Elevators - continuous type
3. Screw Conveyors
4. Belt Conveyors - pan and trough-tube
5. Vibrating Conveyors
6. Drag Flith Conveyors - standard and mass flow

7. Pneumatic Conveyors -
   a. Positive
   b. Negative

8. Gravity Spouting

Each category could take a session to go into the design and uses, and we cannot now, so we will briefly describe each one and give its relative merits and disadvantages.

Bucket Elevators - Centrifugal (Fig. 1)

The bucket elevator is the most widely used and misunderstood piece of elevating equipment. Since we can't see inside, we surmise what happens - and the cost is often damage. The seedsman is presented with many choices in the market and, unfortunately, the best units are large, costly, and rare. The seed are carried from the bottom to the top by a belt which has buckets fastened to it. At the top, the seed is dumped, thrown, or shot from the buckets, according to the design, and the buckets return to the boot for reloading. The idea is so old, King Tut had one painted on his tomb. The capacity is a function of belt speed and bucket capacity up to the point where speed does not allow bucket filling.

Properly sized and run at proper speed, the centrifugal forces involved can be used to carry the seed over the top of the pulley and drop it into the discharge opening. Under-speeded, it drops out too soon. Over-speeded, the seed becomes a projectile.

Some smaller head pulley elevators have taken advantage of the centrifugal effect and cause the seed to follow the outside curve of the head to discharge, thus avoiding impact, but still attaining a high speed, although susceptible to abrasion.

On the other hand, a large head pulley can handle a much faster belt speed (and capacity) because the tip of the cups passing over a larger arc generates less force than over a small one. Therefore, handling of high volumes is easier. The relationship of head pulley diameter to belt speed follows:
FIGURE 1. BELT-BUCKET ELEVATOR.
Head Pulley Dia. | RPM | Belt Speed FPM
---|---|---
12" | 60 | 188
16" | 52 | 218
24" | 45 | 283
30" | 39 | 306
36" | 37 | 349
42" | 34 | 375
48" | 32 | 402
60" | 28.5 | 448

The manner of feeding the boot is also a factor: up leg feed is considered standard because of the access to the bucket. However, very dry soybeans, edible beans, trash or light products feed better on the down side.

Centrifugal elevators are not self-cleaning as they are marketed; however, special modifications of the boot can make cleanout easy.

Maintenance is low. Initial cost is lowest on small-head pulley units. Initial cost is moderate on large-head pulley units. Life is long and operating cost is low.

Gravity Discharge Elevators (Fig. 2)

One of the best elevators for fragile seed, the gravity elevator has buckets mounted on a chain in a continuous manner. The chain moves slowly in comparison to centrifugal elevators.

Loading is through a metering feeder and discharge is caused by tipping the buckets in a gimbal. The buckets can be divided for simultaneous carrying up to four products.

There are two kinds:

A. Internal discharge
   The chain travel is rectangular and discharge is at the center top.

B. External discharge
   The chain returns very close to the up side and discharges by rotating over the head pulley. This elevator can go around corners.
FIGURE 2. GRAVITY DISCHARGE ELEVATOR.
<table>
<thead>
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<th>Damage and mixture</th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial cost</td>
<td>high</td>
</tr>
<tr>
<td>Maintenance</td>
<td>average</td>
</tr>
<tr>
<td>Cleanout</td>
<td>none</td>
</tr>
<tr>
<td>Space Required</td>
<td>very large</td>
</tr>
<tr>
<td>Changeover</td>
<td>quick</td>
</tr>
<tr>
<td>Capacity</td>
<td>low (compared to size)</td>
</tr>
</tbody>
</table>

**Screw Conveyors**

The screw conveyor is a very old, respectable, way to move material - but it has to be used cautiously with seed. Available in "U" trough and tube styles, they are considered a definite "No" for fragile products. They are not self-cleaning. Screw conveyors are good for easy multiple inlet and outlet usage. They work very well on inclines up to 15° losing about 25% capacity. At 25° incline, they lose 50% capacity. In the tube configuration, they will convey straight up but with considerable attrition and high power usage.

Most people do not realize that there are choices in flighting and, in some applications, the use of double flighting or half-pitch flighting can help feeding problems or keep up capacity.

Initial cost is low.

Maintenance is good on non-abrasive products, but is more than with other types of conveying.

Damage and mixture features preclude use of the screw conveyor from most clean seed operations.

**Belt Conveyors**

There are two kinds of belt conveyors:

A. Slider - where the belt runs over a pan that forms side walls and supports the belt. This is used for lengths up to 100 ft. for up to 6,000 bu./hr.

B. Idler - consists of a head and tail pulley and multiple rollers at angles to form the belt into a trough. This is primarily used in high volume operations carrying many thousands of bushels per hour.
However, smaller units are used for long runs to keep horsepower requirements down.

Belts are non-choking, well adapted to multiple feed points but poor for multiple discharges. A tripper is the only really effective discharge device for a multiple outlet belt. Most trippers are too large and too dirty to use in seed operations. Spillage is bad.

Seeds are treated well on a belt, but cleanliness is a problem. Pan conveyors are not self-cleaning and are difficult to clean.

Generally, the heavier the material, the higher the belt speed: 700 FPM being the highest practical speed. Seed and light materials should travel about 200 FPM.

Maintenance is high.

Operating costs are low.

Inclines over $12^\circ$ are not good.

Initial cost is reasonable.

**Vibrating Conveyors**

The vibrating conveyor is 100% self-cleaning. Available in balanced and unbalanced models, its low cost and clean, damage-free operation is very attractive. The unbalanced unit can be used up to about 100 ft. if firmly anchored; the balanced units, over 100 ft. (but also anchored). Very few vibrating conveyors are available for use unanchored, since each one must be custom balanced and is, therefore, expensive.

While maintenance is low over the first couple of years, they can become unreliable when worn.

Stroke varies from $1/8"$ to $1"$, with speeds slowing as the stroke increases.

Vibrating units are non-choking, and the electric units with very short strokes are excellent modulated feeders.

Multiple inlets and outlets are possible, but carryover can be a problem.

Operation costs are low.

Initial cost is low.
Installation is simple on a firm base.

Cleanout is excellent.

Drag Flight Conveyors

A. Standard Drag - available in 6-inch to 36-inch units and capacities from 800 to 40,000 bu./hr: the single chain with nylon flights operates in a standard "U" trough. They are easy handling, and have fairly good cleanout. They can be readily inspected and repaired by local people. Using the by-pass inlet, they are non-choking and readily start and stop under load.

Power usage, especially in long runs is low, and multiple inlets and outlets are easy. Caution: there is a slight carryover on multiple outlets. While this can be reduced by addition of chain brushes, no guarantee is given on stopping entirely.

Price is about 1.5 times that of the screw conveyor but drive costs are less. Flights can be half-spaced for use on inclines.

B. "En Masse" Flow - used for large volumes in a small conveyor, the flighting is a plastic or metal bar at periodic intervals on a chain which runs near the bottom of the flat-bottom trough. The trough itself is filled nearly to the top with product, leaving only enough room for the return chain to pass. The material moves en masse as though it was on a belt and with very little abrasion. Costs are comparable to drag flight conveyors, but they are not widely used in clean seed operations because the chain running on the bottom causes seed damage. This conveyor operates more efficiently on material that is fibrous or trashy. As a rule of thumb - "if it's hard to get out of a bin, the en masse conveyor will work well."

Pneumatic Conveying

Since 1950, pneumatic conveying has developed into its own. Everything from sawdust to live chickens are conveyed by air. The systems are clean, all-inclusive, requiring no elevator legs or conveyors, can take multiple inlets, multiple outlets - almost perfect - except for seed. The velocity of conveying makes fragile seeds fracture, and the cost of purchase, plus very high operating costs, rule out their use.

Both suction and pressure pneumatics are simple as far as handling the product, but very expensive to handle the carrier air. Expensive
pumps or fans, high horsepower motors, collectors and filters are necessary. Valves and fittings are precision and expensive.

Europeans are reporting use of low velocity systems in soybean plants, but no details are available as yet.

While this discussion has been brief and simplistic, I hope you will remember that solving your conveying needs is a matter of planning ahead. Pick what you like as long as it helps you go to the bank regularly and balances the system.