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Seed Conveyors - Comparison & Contrasts

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SEED CONVEYORS-COMPARISON & CONTRASTS

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What is conveying! Two of the definitions given by Webster are "to bear from one place to another", and "to move in a continuous stream or mass".

When I think of conveying in a seed conditioning plant, it means anytime material is moved form one point to another. This applies to conveying horizontally, vertically or inclined, as well as by gravity to or from bins or through spouting.

Two prime problems are associated with the conveying of seed.

1. Seed Mixture
2. Seed Damage

When conveying seed ahead of any conditioning system, some mixing of physically dissimilar commodities may be tolerated because the conditioning equipment can make the necessary separation. Examples of mechanical mixing could be wheat in soybeans, clover in wheat, or very light seed mixed with heavy seed.

When conveying cleaned seed, mixing cannot be tolerated. To avoid mechanical mixing, we should use either self cleaning conveying systems or clean-out features must be designed into the plant equipment. Down time for clean-up between lots or varities is costly to production and manpower should be kept to a minimum.

Seed damage in seed conditioning plants should not be tolerated.

All who are in the seed conditioning business must remember that a "Seed" is a living organism. When seed damage occurs it is detrimental, regardless or where in the conditioning system. Seed damage may show up in one or more ways, for example:

1. Destroy germination
2. Splitting or chipping

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3. Loosening or skinning of seed coat

4. Dehulling

Once the seed is damaged, nothing can be done but to try to remove as much as possible, which results in loss. There is no point in throwing away precious seed revenues because our equipment damaged the seed. Moving equipment is not the only cause of damage. Too often the most unexpected places within a plant can be causing seed injury. Offsetting joints of spouting, unlined elbows, transitions, rough bin surfaces and unusual impact points.

In selecting conveyors to convey seed, care must be taken to ensure minimal damage, economical cost, ease of clean out and that it will not cause mixing.

Several factors should be considered in selecting a conveying system. The equipment must be adaptable to the following:

1. Movement - vertical, horizontal, incline or combination
2. Product - heavy, light, trashy, or bulky
3. Multiple feed points, single discharge
4. Multiple feed points, multiple discharges
5. Single feed point, single outlet
6. Single feed point, multiple outlets
7. Dust or water tight
8. Accessible 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 comprise. 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 Flight conveyors
   a. Standard
   b. Mass flow
7. Pneumatic conveyors
   a. Positive
   b. Negative
8. Gravity spouting

Each basic category could take a session to go into the design and uses. But, time will not allow, so let's briefly make "Comparisons and Contrasts" of each type of conveyor as listed.

Bucket Elevators

Bucket elevators are manufactured in two basic types. Centrifugal discharge, and gravity discharge.

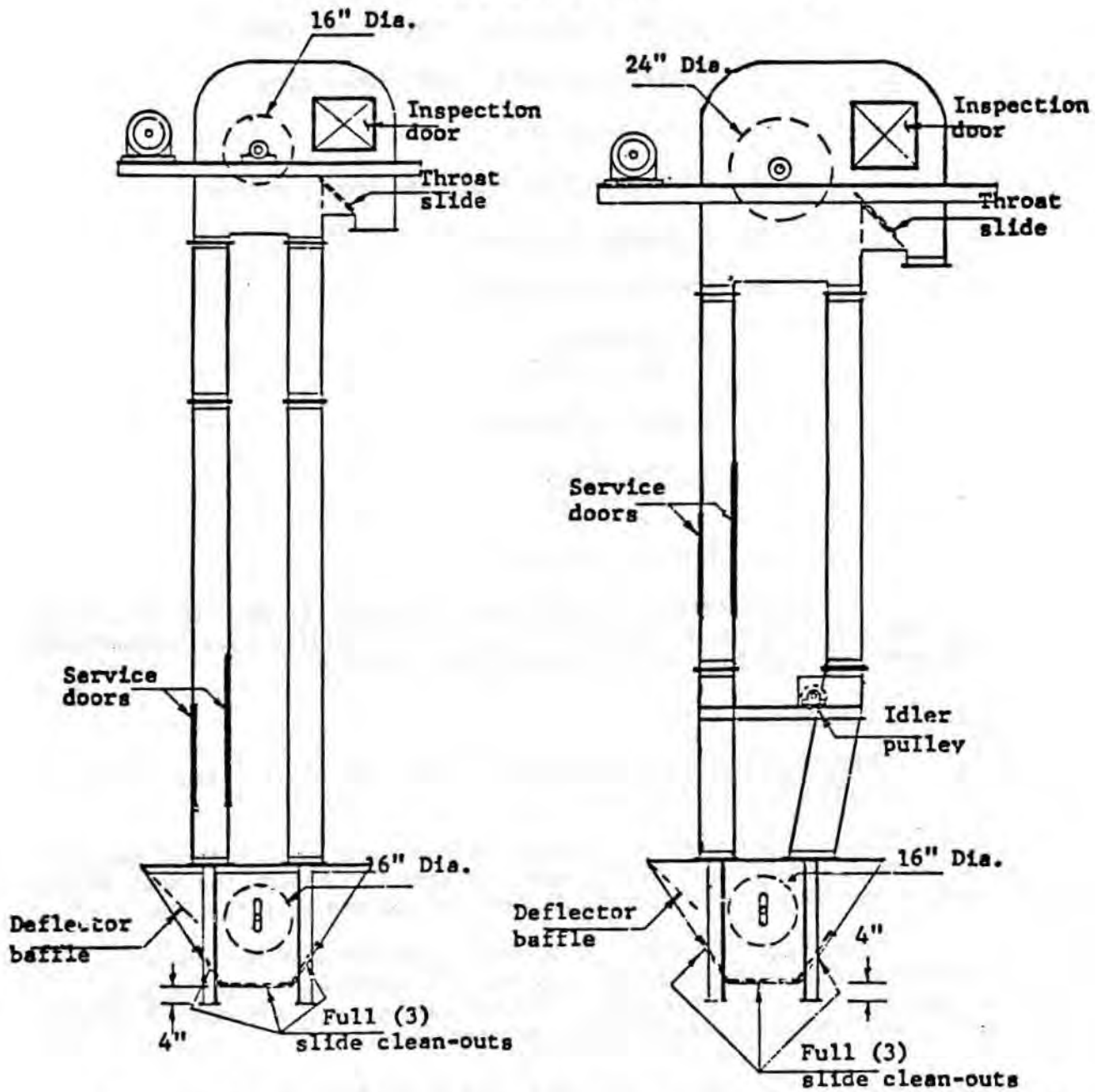
Centrifugal type as illustrated in Figure No. 1 without question is the most widely used in the seed industry. Although the most widely used it is the most misunderstood piece of equipment in the Seed Plant.

There are hundreds of bucket elevator manufacturers in the United States. Unfortunately very few are designed to handle Seed. For a centrigual bucket elevator to handle seed with a minimum of damaged seed, several design factors must be considered.

1. Select size and type of bucket and spacing.
2. Select diameter head pulley consistent with power applied, bucket size, F.P.M. travel most adaptable to product handled.
3. Select proper head design to assure good discharge and clearance for good flow of material.

FIGURE #1

"A" BELT & BUCKET ELEVATOR "B"



(A) Unit with head & boot pulley same size. This often done on elevators of smaller size or where height is not excessive.

(B) Unit with larger head pulley than boot. Preferred for permitting use of lower boot inlets, better cup filling & less material left in boot cavity. Head pulley size determined by required lift load and proper pulley and belt contact for horsepower employed.

4. Select proper boot design to allow proper filling of buckets, and easy clean-out.

5. Select inside leg clearances for safe operation.

All of these features are designed into a high quality elevator. Light duty economy elevators are built with short cuts to proper design and unfortunately it is the user who must live with the deficiencies.

Basically, bucket elevators of centrifugal design involve head and boot pulleys over which belting travels and onto which buckets are attached. Material picked up by buckets pass over the head pulley. The material is directed to the elevator throat discharge chute. The capacity of the system is solely related to the quantity of the material, usually referred to as cubic feet or bushels per running foot of belt. Running feet refers to speed at which belt travels over surface of head pulley.

We refer to two very different designs. Both are rated at about the same capacity, yet bring to focus some rather interesting evaluations. The illustrations on Figure No. 2 shows how a slower speed, large head pulley, and a high speed, small head pulley elevator may be rated at about the same capacity. There are other factors to be considered. The high centrifugal force caused by buckets passing over a small head pulley will account for high impact force. Additional negative effects occur in the boot because buckets will not fill properly until the mass of material builds up several feet in the up leg. High speed boots cause great impact between the cup lip and the product.

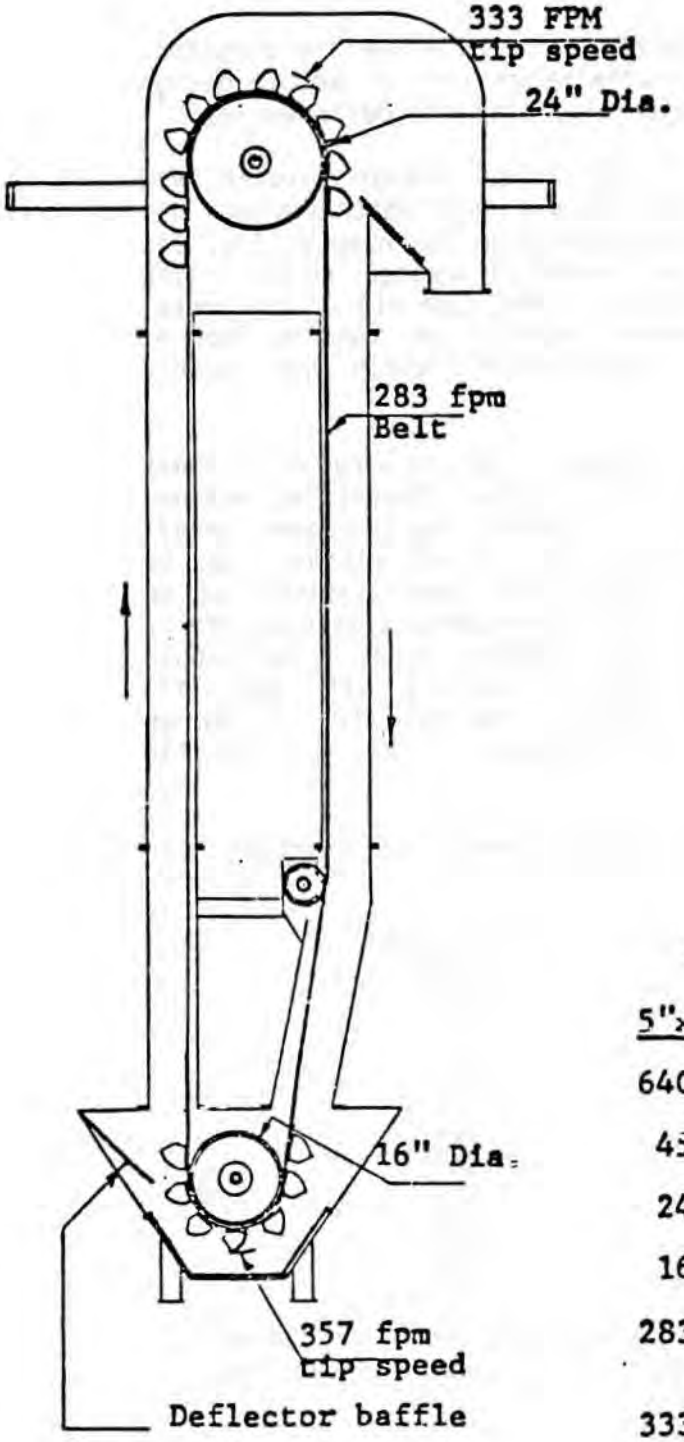
A comparison table below shows proper speeds for elevator head pulleys.

Head Pulley Dia	Head Shaft R.P.M.	Belt Speed F.P.M.
12"	60	158
16"	52	218
24"	45	283
30"	39	306
36"	37	349
42"	34	375
48"	32	402
60"	28.5	448

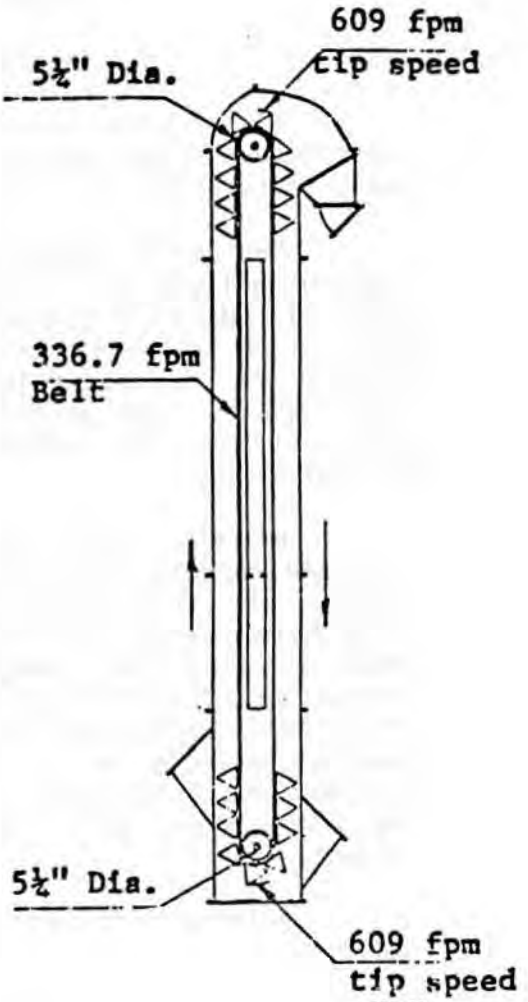
The larger the head pulley, the better the friction contact on the belt, avoiding head pulley slippage. If the head pulley slips, it allows leg plugging and the belting burns.

FIGURE #2

ELEVATOR "A"



ELEVATOR "B"



"A"		"B"
5"x4" Bucket		6"x4" Bucket
640 Bu.	Rated Capacity	700 Bu.
45 rpm	Head speed	245 rpm
24"	Head pulley Dia.	5½"
16"	Boot pulley Dia	5½"
283	Belt speed fpm	337
333	Cup tip speed over head pulley	609
6"	Bucket spacing	4½"

EFFECT OF PULLEY DIAMETER ON TIP SPEED OF BUCKETS

By using the correct speed elevator, buckets will discharge with proper trajectory so as to avoid product damage, excessive wear on metal surfaces, and will eliminate turbulence at the point of discharge. Turbulence will cause back-legging and poor flow of product into spouting.

One must recognize that the same centrifugal forces are in effect in the boot as in the head, although not as readily apparent.

Another key factor to consider in elevators is the manner in which a product is fed into the boot. Feeding on the up leg is considered standard because of feeding directly into the bucket, thus filling it to its best capacity. This might be true if all material fed alike and intake chutes were properly positioned. Generally speaking, however, non-fragile free flowing commodities are fed into the up leg. Easily damaged commodities such as very dry soybeans and edible beans should be fed on the down leg. Trashy or light products like bluegrass should always be fed on the down leg side.

Centrifugal elevators are not self-cleaning, but there are features that can aid in clean up. Pulleys can be equipped with solid ends and spacers can be inserted behind buckets. Boots can be equipped with full slide clean-outs, drop bottoms or with air suction adaptations.

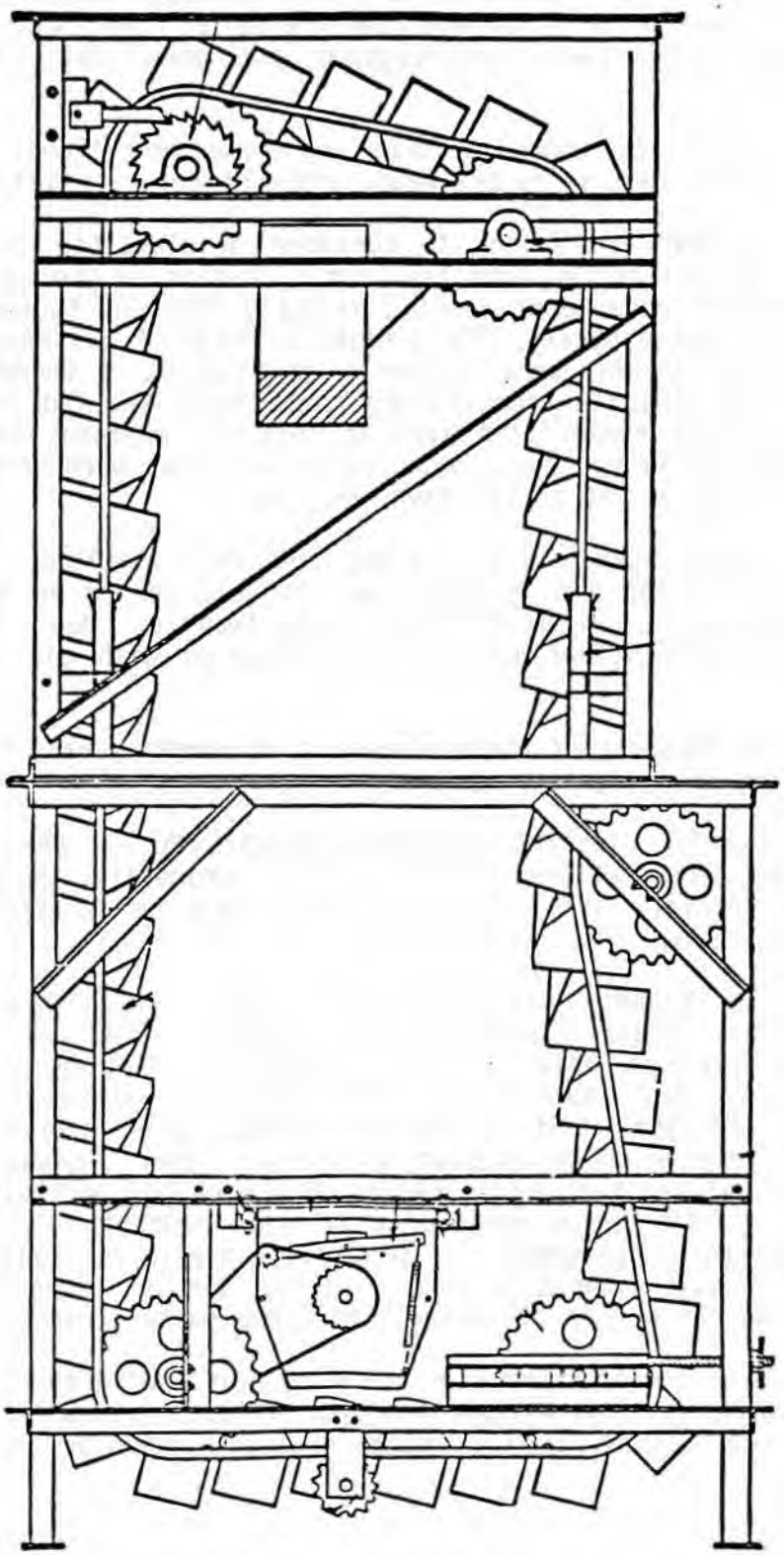
Maintenance of these elevators is normally very low unless basic principles of design are ignored.

Gravity discharge elevators (Figure No. 3) are manufactured in two types, external and internal design. Normally, we do not find the external gravity type in seed plants, but we do find the internal discharge type.

The buckets are mounted on chains in a "continuous bucket elevator". These elevators are ideally suited to handle fragile products such as edible beans. Loading is internal, by gravity or metering feeder. Buckets are close together with overlapping lips to prevent spillage. At discharge, buckets are inverted for internal dumping into a chute spouted to either side. Because buckets are attached between two chains riding on sprockets, various configurations at head or boot can be adapted to fit requirements. Buckets with up to four separate compartments can be used to handle four different products simultaneously without mixing. Using single compartments buckets, capacities range from 420 bushels to 2,000 bushels per hour.

Due to design and slowly moving overlapping buckets, the product is carefully handled without mixing. This is probably the most gentle way to handle seed. Units can be housed or unhoused depending on the

FIGURE #3



INTERNAL DISCHARGE ELEVATOR

installation. Damage or spillage of seed is held to an absolute minimum.

The chief opposition is greater use of internal gravity discharge elevators is the initial cost and greater space required. Nevertheless, if the operation demands gentle handling, minimum clean-up, no mixing and quick changeover of product or variety, then these units will answer your need.

Screw Conveyors

These units are one of the oldest means of conveying horizontally, on incline, and even vertically. They are available in a wide range of capacities and in either "U" trough or tube housings. They are not considered to be self-cleaning or to be gentle with friable products. They are adaptable for multiple inlets and outlets with the chance of a small carry over past intermediate discharges. Caution should be taken to prevent over-feeding.

Screw conveyors should not be used in a seed conditioning plant with the exception of the handling trash or screenings. They are difficult to clean and are considered abrasive on most seed.

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 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 RPM being the highest practical speed. Seed and light materials should travel about 200 RPM.

Maintenance is high.

Operating costs are low.

Inclines over 12 degrees 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 feet if firmly anchored; the balanced units, over 100 feet (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. Be sure to use lock-out valves at discharges to prevent mechanical mixture.

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 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

Pneumatic or air conveying has developed rapidly since the 1950s. It is employed to convey dry products from flour to products in all granular forms, including wood chips in lumber and pulp plants. Under development now is a unit to convey live chickens in broiler houses. One chief advantage is to convey assorted products for long distances through a combination of vertical, horizontal, and inclined pipes. They fit into compact areas and conveying runs are tightly sealed and self-cleaning. The few moving parts are located at the feed and discharge points only. Systems are used in complicated flour mills, corn and soybean oil plants, and plastic operations. They add appreciably to cleanliness and beauty of plants.

While these systems are highly successful, they are not as common in seed or grain operations due partly to the higher power requirements and because they are used only during seasonal operation. Each system must be engineered for established requirements. Also, seed plants handling fragile seeds may not be able to use pneumatic systems.

Very few seed plants use pneumatic systems to handle seed because of damage to fragile seed, high horsepower demand, and installation cost.

Gravity Spouting

Gravity flow is used for conveying wherever possible, yet spouting can be a source of product damage, wear, poor flow, or

choke-up. To select proper spouting, one must know something about the product flow, angle of repose, and the area of spout required for the volume.

On the chart below is shown the normal minimums I use in a plant layout:

Spout Angles Generally Applied

Product	Degree Slope	Carpenters Square
Wheat	30°	7/12.
Barley	33°	8/12
Oats	37°	9/12
Corn, dry (uncleaned)	37°	9/12
Corn, damp	45°	12/12
Soybeans	40°	10/12
Grasses (general)	45° (unless trashy)	12/12
Grasses, trashy	60°	20/12
Feed, ground	53°	16/12

The above chart is based on normal conditions, dry clean smooth piping and normal product. The slope should be increased above minimums if extreme contingencies demand.

The volume a spout is capable of handling is directly related to flow characteristics. Flow is determined by type and variety of commodity as well as moisture content. Square or rectangular spouting may be advisable if degree of fall is less than desired. Also, square spouting can be formed of heavy material with abrasion-resistant, or other type liner material inserted to prevent wear. The top side of square spouting can be bolted in place for easy access to liner replacement.

Joints of all spouting should be flush and as smooth as possible to avoid both product damage and turbulence which will rapidly dish-out metal surfaces.

Dead boxes are desirable on longer spout runs to decrease speed of flow and absorb impact of points of directional flow change. Many types are built but the self-cleaning types are preferred.

"E-Z Down" vertical ladders are used successfully to reduce cracking of soybeans, edible beans, and other fragile products. These

consist of rubber lined baffles, each in counter flow to the other, giving the material a walk down action. These are available in closed units for spouting or open units for inside bin let-downs. For best results, a starter box or trap is used to properly introduce the stream to the ladder.

In summary let's evaluate these basic characteristics of seed.

1. Flow - This governs the ability to bin, feed through cleaner feed mechanisms, flow across cleaning screens, and slope of gravity spouts.

2. Density - Applies more generally to weight in bins or against feed hoppers but also governs that light grass seed is not conveyed well on average speed belt conveyors.

3. Susceptibility to damage - Will usually clearly indicate what type of conveying equipment should or should not be used.

4. Moisture condition - This is of particular concern when handling such commodities as edible beans, soybeans and seed corn when moisture is low and susceptibility to cracking is high. Certainly, when designing a conveying system, the extreme or poorest conditions should be the governing decision in your selection.

5. Damage most feared - Equipment should be selected considering the product's susceptibility to damage.

6. Storability precautions - When thinking of seed stock, of course, no mixing can be allowed and breakage of certain commodities must be closely guarded. However, when handling market corn, for instance, some mixing can be tolerated, but breakage can be costly and a factor to proper aeration in storage. If final moisture of bulk commodities is on the higher side, breakage or improper cleaning causes a concentration of "fines" and is very risky.

Seed conveying is not high technical; it's common sense.

1. Know the products you will handle.

2. Plan your system to handle the products without damage or mixture.

3. Rely on competent equipment manufactures and their Rep's.

Remember the seed you are handling are "Living Organisms". The life you save may be your own!

References

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2. Park, Bob 1981. Conveying: A Necessary Evil, Proceedings, Mississippi Short Course for Seedsmen, Volume 23, 1981.