SPECIAL REPORT

WWW.CHEMICALPROCESSING.COM

CHEMICAL PROCESSING

LEADERSHIP | EXPERTISE | INNOVATION

Conveyors

PutmanMedia®

THE RIGHT CONVEYOR WILL PRODUCE THE BEST RESULTS FOR YOUR OPERATION – BUT WHICH **ONE IS THE RIGHT ONE?**

No matter what industry you're in, chances are you use some form of conveying. Whether it be pneumatic, flexible screw, aeromechanical or other, different conveyors are required to handle different products. But which conveyor is best suited for your operation? Despite the fact that conveyors have been around for almost a hundred years, this question still baffles many industries.

Research and careful consideration are prerequisites for the selection process. For instance, consider how the conveyor will be used. Is it for production? Processing? Packaging? There is a big difference between handling large pieces and handling powder, and some products simply are too heavy or large to convey. Your type of business will impact which conveyor you choose.

Also consider the purpose of conveying. Is it to improve operations? Reduce labor? Speed up throughput?

These important factors are crucial to the selection process because the right conveyor will:

- Improve operations by maximizing process efficiency
- Balance material flow through various systems
- Increase processing rates
- Reduce labor requirements
- Avoid back-ups and spillovers
- Offer a constant, controlled material flow
- Avoid unnecessary equipment maintenance or downtime
- Operate compatibly with other process equipment and systems
- Maintain high product quality

The right conveyor should be able to supply material at a rate that effectively matches the system's processing capacity. The conveyor's size should also meet or exceed the capacity of the processing machine center or equipment it is servicing.

Listed below are common conveyors used in powder handling and what to expect from each:

Flexible screw conveyors are the most common conveyor because of their low cost and size variety. Flexible screw conveyors operate using a continuous shaftless helicoid screw that moves almost any type of solid material through it. They typically operate on an incline and can transport up to 80 feet. Standard sizes range from 2 in. to 8 in. diameter and can convey up to 1,800 cfh. Flexible screw conveyors, however, are typically used for smaller capacities.

Flexible screw conveyors are cost-effective, able to fit into tight spaces, easy to clean, low maintenance because of few moving parts, smaller capacity, and offer flexible installations. But be aware that flexible screw conveyors generally are impractical for long distances, and are not self-cleaning. These conveyors also must run fully charged.

Pneumatic/Vacuum. In this type of conveying, the solid is carried by a gaseous stream, which imposes a pressure gradient along the conveyor line.

Pneumatic/vacuum conveyors can move almost any type of dry material and offers moderate degradation, depending on the product and the number and degree of conveyor bends.

Pneumatic/vacuum conveyors are best suited for high capacity applications over distances of up to about 400 feet. Pneumatic conveying is also appropriate for multiple sources and destinations. Vacuum or low pressure is used for generating air velocities from 35 to 120 ft/s.

Pneumatic/vacuum conveyors are dust-tight, can operate at varying volume levels, are compact, sanitary, and offer self-contained filtration. The disadvantages are higher power consumption and higher installation costs.

A tubular drag chain conveyor consists of a tubular steel casing that carries a "flighted" chain that catches material and pulls it along the conveyor. Tubular drag chain conveyors operate best at low to medium volume, work well with wet, dry or fragile material, and offer low degradation.

Tubular drag conveyors are completely enclosed and suited to convey up to 150 ft. Sizes range from 3 in. to 12 in. diameter. Travel velocities can range from 30 feet to 100 feet per minute with conveying capacities up to 70 cfm.

Tubular drag chain conveyors are quiet and require minimal maintenance. Other advantages include gentle handling, low degradation, high capacity, heavy duty 24/7 operation, are dust-free, and can convey at different planes – allowing for great flexibility in system layout.

The disadvantage: the higher capital costs associated with it, especially where long distances are involved. Also, power requirements are slightly higher than other types. On the other hand, the versatility and ability to handle diverse materials under various temperatures and pressure conditions far outweigh the disadvantages.

Aeromechanical conveying utilizes the features of both pneumatic and mechanical conveying. The aeromechanical's tubular design uses a wire rope assembly with evenly spaced polyurethane discs that move at high speed. The rope assembly runs in specially designed sprockets at each end of the conveyor. The action of the rope assembly traveling at high speed creates an air stream running at the same velocity. As the material is fed into the air stream, it is fluidized and conveyed to the outlet where it is centrifugally ejected.

Aeromechanical conveyors can convey almost any type of material. The conveyor has the capability of bending at 90° angles. This allows many system layout options, which optimizes available factory space.

The disadvantages: aeromechanical conveyors cannot start or stop under a full load, suffers from rope fatigue, and requires a metered feed.

Vibrating conveyors consist of a flat-bottomed metal trough that transports material through controlled vibrations.

But what vibratory conveyor is right for your application? There are many factors involved in the selection. The No. 1 most important factor: the material being processed. What is the size? Is it fine? Mid-sized? Coarse? Also, what is the moisture content? Product moisture content may cause severe feeding problems because moisture increases surface tension and material tends to build up on the surface.

Another factor to consider is product weight and density. Lighter materials do not have as much mass and feed more slowly than heavier products.

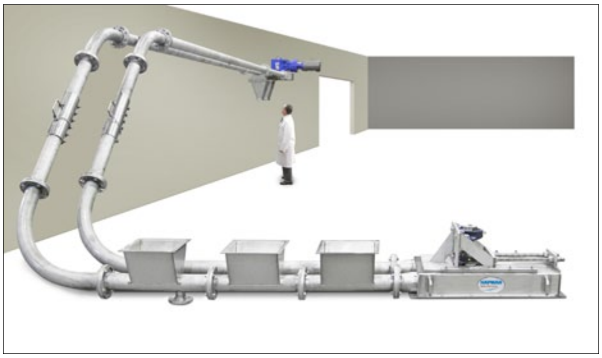
Thirdly, how flexible is the product? Rigid or solid products feed more successfully than other less-flexible product.

A vibrating conveyor can handle multiple processing tasks and convey dry, hot or cold materials over long distances but may require high maintenance due to the vibrations.

As you can see, there are many factors and considerations that go into choosing the right conveyor for your operation and application. But with careful thought, research and planning, the right conveyor will give you the best results, improve operations, reduce labor, operate compatibly with other equipment and systems, and much more.

MOVING MATERIAL IN A SEALED TUBULAR DRAG CONVEYOR

Engineering conveying systems for today's processing plants requires far more than just moving product from one point in the plant to another. It means factoring in environmental considerations both for the product and for the people working in the plant. Housekeeping is critical particularly when conveying toxic, hazardous or extremely dusty materials. Furthermore, with the in- creased cost of producing material, it must be handled gently with minimal degradation. (tubular drag multiple inputs example in room - below)



With these requirements, enclosed conveying systems are becoming more important. While there are several conveyor types on the market that can qualify as en- closed units, there is no one single type of conveyor that is best suited for all applications. In most instances, there are requirements that will narrow the range of choices to a few types. When the application involves the transfer of finely-divided bulk materials, the mechanical tubular drag conveyor offers strong advantages. The system is truly a "conveyor in a pipeline." Normally selected on performance values alone, these conveyors can fit into the most confined spaces and demonstrate functional values unmatched by other conveyor types.

Tubular Drag Conveyor Description

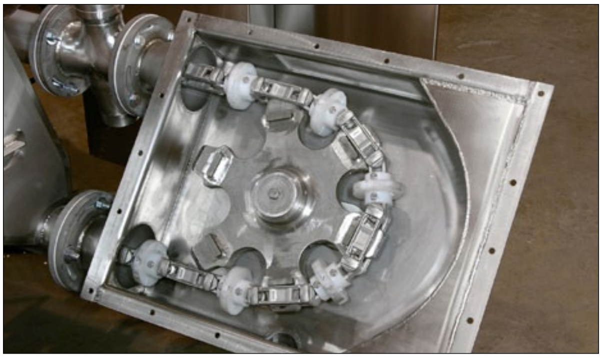
The tubular drag conveyor consists of a stationary outer housing, usually round in shape, through which a chain is pulled by a sprocket drive arrangement (tubular drag flites in clear casing - below).

Flights are attached to the chain at regular intervals. As this endless chain and flight assembly moves through the stationary housing, bulk material is pulled from the infeed points to the discharge ports. Conveying capacity is established by varying the housing size, flight size and the chain speed.

The stationary outer housing, or casing, is manufactured of carbon steel or stainless pipe in sizes ranging from 3 in. diameter up to 12 in. diameter. Casing sections are supplied in lengths as required by the predetermined conveyor path. To provide for a change in direction, the casing is formed into a sweep elbow. All sections are usually constructed with male/female ends to further assure total enclosure.

Solid circular flights are available in polyurethane, cast iron, ductile iron, nylon, stainless steel or other material as required including ultra-high molecular weight polyethylene.

Link and pin type chains are less prone to fatigue, wear and stretch than steel cables or ball-and-sprocket bar type chains. The drive sprocket



engages the chain links directly (tubular drag conveyor drive sprocket - above) which further assures positive and dependable conveying, even during a fully loaded startup. Also, as wear occurs in the link and pin chain, individual parts may be replaced. This is not necessarily the case with other types of conveyors.

Tubular Drag Conveyor Circuitry

By virtue of the flexible chain and the custom made conveying sections and casing bends, virtually unlimited variations of conveyor circuits are possible. These conveyors are provided with bolted flange connections for easy assembly in the field.

Typically, units are used to transfer materials less than 100 feet and involve two or three changes in direction. However, transfer distances over one hundred meters are not unrealistic or uncommon. As a result, this type of conveyor can be installed in existing facilities (tubular drag circuitry example - below), bypassing obstacles that would interfere with the path of other types of conveyors. Many variations of these circuits are possible. Numerous inlet hoppers may be incorporated into a single

conveyor. As a rule, material can be "flood fed" into these inlets. The conveyor chain assembly will fill with product as it passes each opening. A tubular drag conveyor system can likewise have multiple outlets or discharge ports. Discharge from the drive box housing is also common.

To provide selective discharge points on multiple discharge units, manually or pneumatically operated gates may be used. While conventional knife gates can be used for this purpose, it is more common to use a self-cleaning discharge gate (discharge gate - below). In this mechanism, the lower portion

of the conveyor housing is cut away. The cut out blank is retained and hinged in and out of position to open and close the discharge port. It is not uncommon to find one, two, or as many as a dozen or more of these gates in a single tubular conveyor system. Most materials will flow freely from the discharge of the tubular drag conveyor. For sluggish or sticky materials, a special chain vibrator is used. This mechanism consists of a fractional horsepower motor driving through a V-belt to a set of adjustable eccentric weights mounted on a shaft. The assembly is mounted to a spring plate connected to a shoe positioned slightly above the conveyor flights. A controlled, low frequency, vibration causes the shoe to "tap" against the conveyor flights further inducing the product to flow from the conveyor.

Enclosed, Sealed Tubular Drag Conveyor System

The single most important feature of this conveyor is the enclosed construction. This design effectively protects the product being conveyed from contamination from the outside atmosphere and/or protects the atmosphere and the worker from the product. If required, material can be conveyed under a slight negative or positive pressure or under a purge blanket of inert gas. This enclosed construction also serves well in containing odors.

The slow moving, positive displacement action of the conveyor chain assembly makes the system ideal for handling blended materials without separation and assures gentle product handling with an absolute minimum amount of product degradation. This slow movement also assures long conveyor life, dependable service and operation at minimum noise levels. This system is designed to operate 24 hours a day, seven days a week. In addition, horsepower is minimized, thereby conserving energy.

Handling Hazardous Materials

The enclosed construction protects the conveyed product from the effects of the elements when the product is conveyed out of doors. Furthermore, this type conveyor contains harmful dust and keeps it from escaping into the atmosphere. These systems are effective in handling an increasing number of hazardous materials. The tubular conveyor frequently operates under an inert purge to eliminate the undesirable reaction that occurs when the product is exposed to the atmosphere. With this mechanical conveyor, there is no air volume added to the system. This factor makes tubular drag conveyors ideal for moving hydroscopic materials either with or without dry air or inert gas purge. Because there is no air added to the system, there is no need for product/air separation equipment at the discharge points. More important, there is no need for an expensive baghouse filtration system.

Multiple Chain Choices

There are several types of chains used in the Tubular Drag conveyor, depending upon the service desired. Round-link, Rivetless, and Seal-Pin chains are

the most common (tubular drag chains - above). Design parameters, such as: material to be handled; chain strength; cleanability; and wear resistance enter into the proper chain selection. Most chains are available in both carbon steel and stainless steel.

Low Operating Cost

The typical tubular drag conveyor is operated by a single low horsepower electric motor. This fact makes it one of the most energy efficient conveyors available today. Lower operating and maintenance cost, easy installation around existing equipment and the elimination of product loss through dusting combine to make this conveyor very economical to own and operate.

Tubular drag conveyors can be paired up with a wide variety of components to full fill most any system requirement.

INSTALL PNEUMATIC CONVEYORS CORRECTLY

Follow these 10 tips to prevent a variety of common problems that could occur with your pneumatic conveyors.

Pneumatic conveying is one of the most versatile ways to move solids over moderate distances. So, not surprisingly, Chemical Processing over the years has published a number of articles (e.g., Ref. 1) on the design, installation and operation of dense- and dilute-phase pneumatic conveyors. Several models and a whole host of data from research groups also are available. However, even the best model and data can only go so far. Actual performance depends upon mechanical accuracy. For instance, a small unnoticed leak can kill the performance of a pneumatic conveyor — so much for having a good model. Additional problems may result from non-uniformity of the flow or local changes in the solids-to-air ratio.

The reality of most plant environments is that the quest to keep costs low can dictate design considerations and spell trouble, particularly when using old equipment for a new project.

However, you can take a number of steps to prevent problems.

Top 10 tips

I have found the following pointers useful both for planning new systems and modifying existing ones.

1. Put lifts before horizontal runs. In most conveyors the feed point has the lowest gas velocity and particles may fall out of suspension. This can be offset by line size changes but standard line sizes can force you to push the velocity higher than desired, especially near the end of the line. As the pressure along the line goes down, the velocity goes up. By raising the conveyor in front of horizontal runs instead of at the end, particles have a chance to accelerate toward the gas velocity and gain momentum, mainly because the choking velocity is generally lower than the saltation velocity. The downside is cost. Unless you are going over a building, the extra support can be expensive.
2. Minimize elbows and angled runs. Pressure drop and attrition are highest in elbows (for the effective distance solids travel). Most of the wear and maintenance seen in pneumatic conveyors is due to the elbows; so it often is best not

Figure 1. Sometimes no detailed analysis is needed to spot a bad layout.

to use too many. The major exception to minimizing the number of elbows in a system is for a line that needs to go up and then horizontal. While an angled run offers the shortest distance between two points, it does not have lowest pressure drop. Indeed, a convey line going up at a 45° angle has much higher pressure drop than a horizontal and vertical line with three elbows. Putting elbows too close together is another major mistake, due to acceleration effects. Many models just count the amount of elbows — but placement in the layout is more important. The lowest number of elbows is not always optimum.

3. Calculate velocity every 10 ft. to 20 ft. on the line. Don't rely only on measurements of the pickup velocity or the maximum and minimum velocities in the system. The velocity of the gas and particulates should be determined along the entire length of the line, to ensure that the correct density is used to determine the choking and saltation velocities. This makes the design a trial-and-error calculation. Shortcut design methods often overlook this critical step.
4. Check acceleration lengths at feeders and around elbows. It takes time for a particle to reach its slip velocity (effective velocity below the gas velocity). Particles also must be dispersed across the convey line so the solids-to-air ratio is uniform — otherwise the saltation effects will be drastically different. You could have high localized solids-to-air ratios that would throw a dilute-phase conveyor into dense phase and slug flow. The acceleration length can be determined using the graphic technique of Rose and Duckworth [2] or the Jotaki and Tomita method [3]. For a quick estimate of the optimal spacing of elbows or feeders from each other, use a value between the square root and the cube root of the stopping distance for the particle in feet:

$$X_s = (V_g\, d_p^2\, r_s)/(18\, \mu_g)$$

where V_g is gas velocity, ft/s; d_p is particle diameter, ft; r_s is effective particle density, lb/ft^3; and μ_g is gas viscosity, lb/ft-s.

Sometimes it is obvious by looking at a conveying line that the elbows are too close together and the layout was not well planned (e.g., Figure 1).

5. Be careful with pipe joints. Piping should be carefully aligned during installation. The use of slip-couplings can allow for gaps or pinched gaskets, even with tie-bars. Even welded pipe can be improperly fabricated at the flange due to misalignment and "cat teeth" from the welds. When joining pipe, specialized welding methods can prevent slag inside the pipe.
6. Slow the particles down before the collector. Particle-to-particle impact is the biggest source of attrition. Even discharge into a bin can result in a significant amount of attrition as the particles strike the pile. Bag collectors increase the particle-to-particle contact unless there is a cyclonic inlet or an expansion of the line prior to the collector. The acceleration velocity can be used to judge the length of any deceleration spool piece, generally about 25% of the acceleration length, or the optimal distance between elbows, as described in Tip 4.
7. Watch for leaks. Small leaks can cripple operation by reducing or increasing the

difference between the gas and saltation velocity. High velocities lead to high pressure drop and attrition; low velocities lead to transitional flow (dilute to dense). The obvious location of a leak is at the feeder. When several feeders are on the same convey line, check for leakage at each one. Diverters and misaligned pipe also can contribute to the problem. In vacuum systems, the area around the collector, including the discharge valve, can be a major leak source.

8. Match the type of compressor to your convey line. On most dilute conveyors the pressure rises rapidly during the feeding of solids and usually falls off after leaks and the compressor slip have stabilized. A large surge tank can help but adds cost to the system. Volumetric feeders are just that — the solids-to-air ratio will vary over a conveying cycle. As the compressor heats up, the gas velocity can increase in small or light-weight compressors, leading to attrition of the solids. When a conveying system is used continuously, this usually is not a problem, except maybe during start-up. Oversized compressors that run at low speeds can be sluggish and unable to keep up with leaks or sudden changes in solids-to-air ratio. This is especially true when spare equipment is being re-used.
9. Vent the feeder valves and factor the amount lost into the design. If there is one thing that can upset a pneumatic conveyor it's sudden changes in solids-to-air ratio. An unvented solids feeder prevents the pockets from filling uniformly and can fluidize the solids in the tank or bin above the feeder. The solids can flood the valve, prompting over-consolidation and bridging. Not only does the solids-to-air ratio change but particles also can be pinched in the feeder and break. Figure 2 shows a way to vent the valve in the absence of a vent port supplied by the manufacturer. Note in particular in the figure the use of an insert to prevent particles being pinched between the housing and rotor.

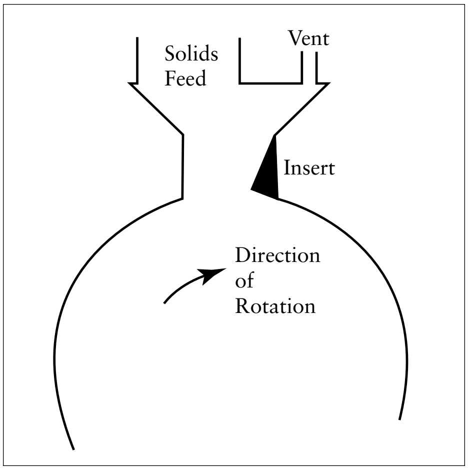


Figure 2. This modification enables venting if a valve lacks a vent port.

10. Look for frictional differences between products. Sometimes after conveying one material and either making a change to the ingredients or trying to convey a different material we forget that the particles may not behave the same. While basic physical properties can be helpful in predicting a problem you can't go wrong with a few tests. Frictional changes can be subtle. Even the same product can have different shear rates and pickup velocities. In addition, don't forget to check the characteristics of an existing material after conveying a new material. A fine coating or change in surface may alter the pressure drop in the system.

About the Sponsor

Hapman, with world headquarters in Kalamazoo, Michigan; is a global provider of powder and bulk material handling conveyors and equipment. For more than 60 years, Hapman has been designing and manufacturing the highest in quality and leading edge technology from its manufacturing facilities in the U.S., Europe and India. Hapman products are found in practically every industry worldwide and are relied upon for improving efficiency, maximizing production and reducing labor costs.

Hapman provides each and every customer with engineering expertise, application excellence and unsurpassed customer service – all backed by PERFORMANTEE, the only Performance Guarantee in the industry. That is why so many customers come back to Hapman time and time again for the best in material handling equipment.

Hapman | (800) 427-6260, | info@hapman.com

Ideas that **tailor** the
broadest line
to **move** your product.

Performanteed™

Hapman's **Tubular Drag**: no downtime, no dust, no worries. **Guaranteed!**

Replace several conveyors and eliminate multiple transfer points with the Hapman tubular drag conveyor. **Gentle handling eliminates product degradation, and the completely sealed system provides dust-free operation**. Hapman's exclusive self-cleaning discharge gate provides 100% discharge for faster material changeover.

Unlike cable conveyors, **Hapman's heavy-duty chain allows for starting and stopping under load, day in and day out**. Performanteed™.

3 ways to convey. One Performanteed™ solution.

Only Hapman offers three types of conveyor systems—and the 60+ years expertise to determine which is best for your specific application. Our tailor-made solutions and broadest material handling line carry the industry's only true performance guarantee

Helix™ flexible screw conveyors

MiniVac™ pneumatic conveyors

Bag dump stations

PosiPortion™ feeders

Bulk bag fillers

Bulk bag unloaders

*"**Only Hapman offers Performantee™, the first and only true performance guarantee** in the industry. We guarantee that **our equipment will achieve the specific results for which it was designed** and manufactured. If it doesn't, we'll revise, repair, or make whatever changes are necessary. **Performanteed**."*

Ned Thompson, president, Hapman

Hapman Performantee™ performance guarantee

HAPMAN
Ideas that move™.

6002 East Kilgore Rd
Kalamazoo, MI 49048

(269) 343-1675 main
(800) 427-6260 free
(269) 349-2477 fax

www.**hapman**.info