Knowledge Center Supplement January 2015

Conveying Technology

Conveying Done Right

Practical Ideas, Technology
& Solutions to Plastics Conveying

Minimize Abrasion Damage & Angel Hair
How to Specify Pumps, Receivers & Loaders
When a Central System is Advantageous
Troubleshooting Guides

Conveying Technology

Knowledge Center Supplement

contents | January 2015

Are Abrasives Wearing a Hole in Your Maintenance Budget?

Component wear with abrasive material is inevitable, but extended life is possible.

It's important to understand:

- *Which materials cause wear*
- *Which system components are candidates for wear*
- *Ways to mitigate that wear*
- *The relative costs involved in solutions*

With new resins and new uses for existing plastic materials on the horizon, prepare now for an upcoming surge in abrasive materials coming from at least two sources. First, plastics continue to be mainstay materials both in developing new products and in improving existing products.

Second, the current boom in shale gas in North America makes a variety of refining byproducts intriguing as feed stocks for new resins. In the near future, expect a big rush of new engineered polyethylene and polypropylenes. These softer resins will have to be reinforced with something to make them useful in new applications. Glass, talc, and ceramics are obvious choices, whether mixed in as fibers or encapsulated in the pellets.

The downside: Many new resins, particularly the reinforced ones, are highly abrasive.

The wear these materials cause leads to material degradation and contamination, pipe and elbow leaks, equipment and process failures, operational inefficiencies, added maintenance and replacement costs, and shorter-than-expected lifetimes for plant conveying system and the plant itself.

This pile of pellets looks pretty harmless but see blowup below.

Close up shows sharp edges ong glass-filled pellets that damage conveying components.

The reality is that abrasive materials will always abrade pipes, elbows, receivers, and other conveying system components and production equipment.

Given this inevitability, are component failures going to take two days, two weeks, or two years? What can you do to delay this wear? And what's the cost-benefit of what you do to minimize the wear?

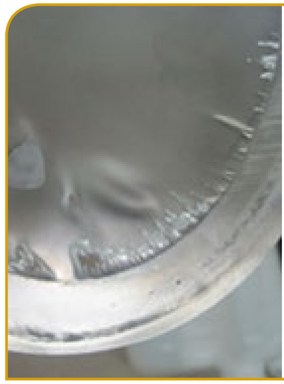
The good news is that you can minimize the effect of abrasive materials in two broad ways: Install wear-resistant components, especially elbows, and reduce material velocities.

OTHER WEAR POINTS

Abrasive materials can cause considerable damage to receiver inlets and outlets, flappers, receiver bodies, and other equipment.

Abrasive Pellets severely damaged this receiver inlet and inlet valve.

Some manufacturers minimize wear in receivers by aiming inlets so material enters tangentially and by placing flappers so that they deflect incoming material from the receiver's impact zone but even this does not help when conveying extremely abrasive materials.



This flapper valve at the bottom of a receiver throat has been damaged and even aluminum castings can have holes worn through them.

Worn Components Should be Replaced With Abrasive-resistant products.

When this happens, the worn-away component, such as the elbow shown above, needs to be replaced—rather than temporarily patched.

You can mitigate the wear on impact zones by installing ceramic-coated parts and ceramic-coated wear plates.

For example, NOVATEC sells an "extended wear package" for vacuum receivers. This package includes a ceramic-lined removable inlet; ceramic-coated inlet flapper check valve; ceramic-coated impact wear plate; and a stainless steel discharge flapper.

Ceramic Coated Parts are a Beneficial Option. Be Sure They Are Replaceable.

And don't forget flexible hoses. Hose leaks reduce air pressure in the line, leading to overall process inefficiencies and material plugs. Even before that point, abraded flexible hose material will join the resin conveyed to the injection molding machines. This contamination can affect the integrity of the plastic and, if colored hoses are used, discolor the finished molded part. Extended-wear flexible hoses exist for these applications. For example, PVC flexible hose with polyurethane lining has about twice the wear life of regular PVC hose.

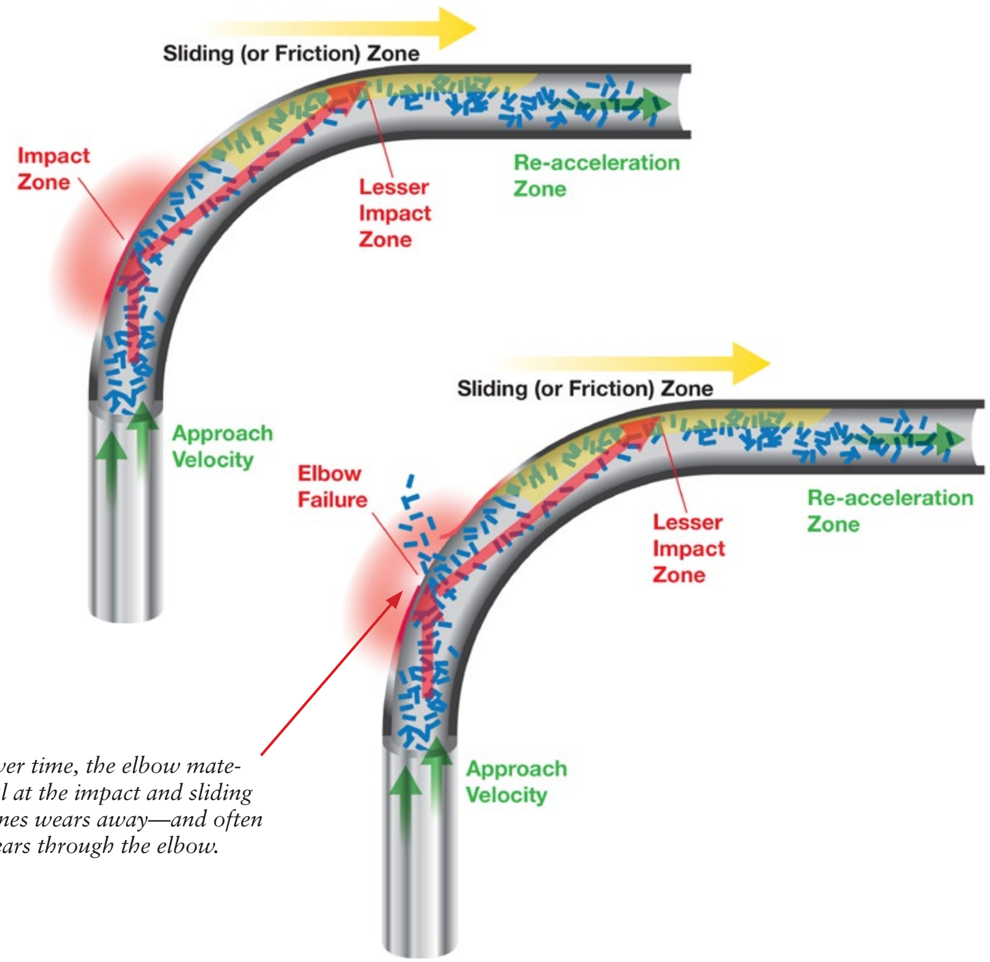
Whether you are designing a new system or retrofitting an existing conveying system, it need not be an all-or-nothing proposition. For example, not all elbows and receivers need to be replaced. The design and operation of your conveying system depends greatly on the physical properties of the resins moving through the system and your expectations for your system's operation, equipment replacement, and on-going maintenance costs, as well as maximizing uptime. Preparing to minimize wear from abrasive materials will go a long way towards keeping your operations running smoothly.

FOCUS ON BENDS

Given the right conditions, conveyed material generally travels down the pipes within a stream of air—except in bends, specifically "elbows," or within the curved walls of receivers. Here, material changes direction. And here is where abrasive materials do the most damage.

When material enters a curve, it hits and deflects off an area called the impact zone (see Figure 1). Material may hit one or more secondary impact zones before leaving an elbow or settling in a receiver. Material will also skid along a sliding or friction zone that extends beyond the impact zone.

FIGURE 1

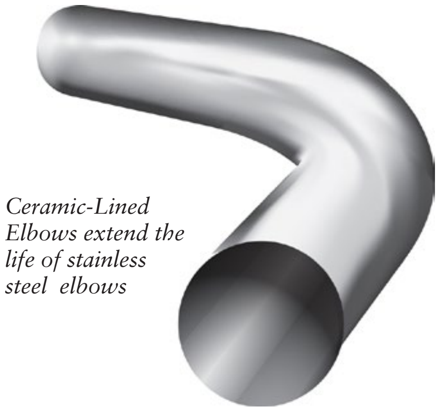


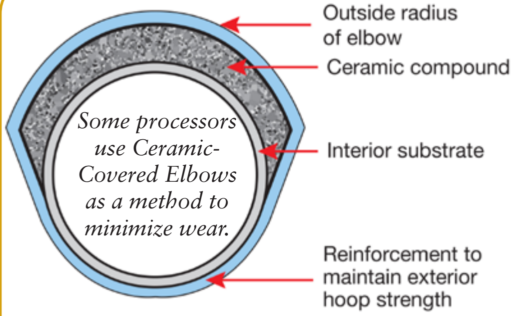
Over time, the elbow material at the impact and sliding zones wears away—and often wears through the elbow.

Some of the Available Solutions:

Aluminum is the standard for non-abrasive materials while stainless steel is the next step up in abrasion resistance.

Ceramic-Lined Elbows extend the life of stainless steel elbows

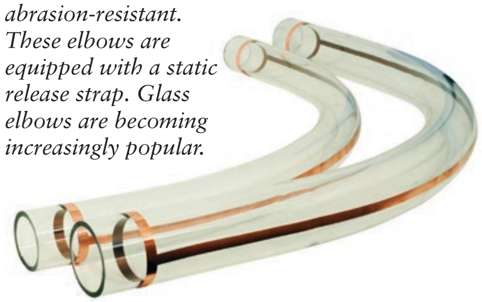




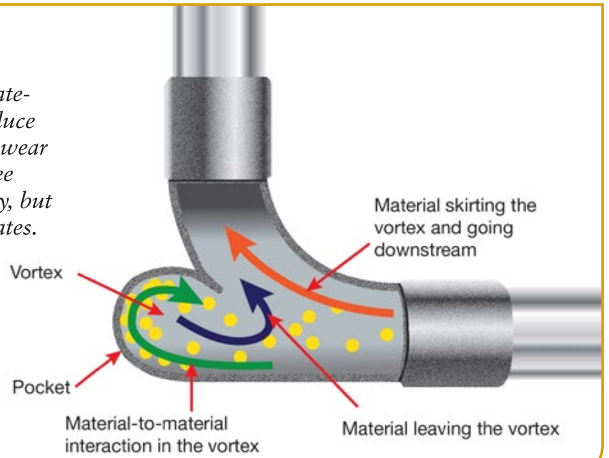
Some processors use Ceramic-Covered Elbows as a method to minimize wear.

Cross section of ceramic-backed elbow

Glass elbows are highly abrasion-resistant. These elbows are equipped with a static release strap. Glass elbows are becoming increasingly popular.



Pocket-type elbows utilize material-to-material interaction to reduce impact, friction, and wear in the elbow. Blind-tee fittings work similarly, but at lower conveying rates.



Elbow selection generally dictates elbow lifetime in a conveying system, which includes time, labor, and cost components. Standard smooth-walled aluminum elbows, while inexpensive, provide little wear resistance. For example, aluminum elbows are soft and easily dented during shipping and installation. In extreme cases can wear through in a matter of hours so they should never be used when there is a potential for abrasion. Therefore, there is little value in making comparisons of any specialty elbow to aluminum.

Specialty elbows with various prices have much better wear resistance. In general, stainless steel elbows offer the minimum level of protection against abrasion and are used successfully in many applications. Ceramic-coated elbows use ceramic to reinforce a standard elbow *Glass elbows* take advantage of glass being highly abrasion resistant. Coupling a short length—2' is enough—stainless steel or glass section to the outlet of a glass elbow reduces additional wear in the friction zone immediately beyond the elbow. *Pocket-type elbows* utilize material-to-material interaction to protect against component wear.

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See Table 1, below for a comparison of the Relative Costs vs. the Relative Life and Relative Value of various wear-resistant elbows.

NOTE: In the past few years, glass elbows have become the primary choice for elbows, with processors who are conveying abrasive materials. The great benefit is that they offer the very best cost vs. performance.

Elbow Type	Relative Cost	Relative Life	Relative Value
Aluminum	N/A	N/A	0
Stainless Steel	$1	1	1
Ceramic Lined	$6	6	1
Glass Elbows	$8	24+	3
Ceramic Backed	$12	24+	2
Pocket Elbows	$24	24+	1

Angel Hair & Streamers Can Tie Up Production

Angel hair and streamers cause issues that slow down production, contaminate end products and increase maintenance costs.

- *Clogged filters and material lines*
- *Contamination of end product*

These are troublesome issues that can be overcome by understanding the causes and employing the right tactics.

Think cobwebs. In houses, they represent messiness, antiquity, and scary. In humans, they symbolize fuzzy thinking. In conveying systems for plastic resins, things like this are called *angel hair, snake-skins, or streamers*. They can mean material degradation and contamination, product flaws and discoloration, plugged filters and pipelines, receiver problems, higher maintenance costs, and general inefficiencies in material conveyance, production, and profit making.

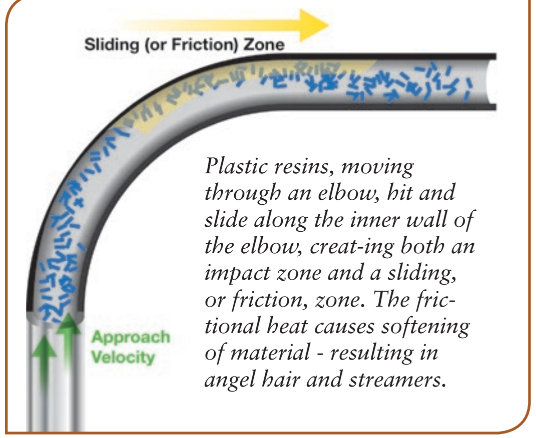
While the best defense is not to have angel hair form to begin with, eliminating all angel hairs (as well as fines and dust) from production might not be possible. What is possible is minimizing the creation of angel hair, and then removing what has been created.

THE PROBLEM

Angel hair and streamers are primarily a result of frictional heat and abrasion caused by relatively soft resins (like PE or PP) rubbing against smooth-walled pipes and elbows.

Most pellets, flowing down a pipeline, travel primarily in an air stream down the middle of the pipe. That's true for "straights." Elbows "bend" the direction of the resin pellets. These bends cause pellets to hit the inner wall of the elbow.

Streamers cause nasty problems in conveying systems – but you can overcome them.



Plastic resins, moving through an elbow, hit and slide along the inner wall of the elbow, creat-ing both an impact zone and a sliding, or friction, zone. The frictional heat causes softening of material - resulting in angel hair and streamers.

Depending on the resin properties, elbow design, and air velocities, some resins get deflected to other areas of the elbow and some get deflected back to the air stream. Most slide against the elbow wall (see previous page). This sliding generates frictional heat. Pellets with low melting points, soften and smear along the wall, much like a crayon smears color on a bedroom wall. Smearing can happen fast, and once started, it often grows as incoming pellets rub against the existing smear.

Incoming conveyed pellets randomly break off the smeared plastic into long, strands. The really thin strands are called angel hair. The wider strands are called streamers or snake skins. In either case they are conveyed downstream, entangling with the unaffected resin already moving downstream, often plugging a feed area and eventually starving a re-ceiver. At the very least, these strands can conta-mi-nate resins at the receiver, including changing the resin's properties and color.

FOCUS ON PROPER PIPE DESIGN

Piping layouts consist of straights and bends—horizontal and vertical lengths of pipe connected by elbows. An effective way of minimizing angel hair is to keep piping paths short and with few elbows and fittings. Doing this minimizes the impact and sliding zones in the conveying system. It also minimizes pressure drops, which affects air velocity—the transport medium for conveying resin materials. If air velocities drop below the material's saltation velocity, (meaning the minimum velocity to transport the material within the airstream) the material will drop out of the air stream and just slide along a pipe or elbow.

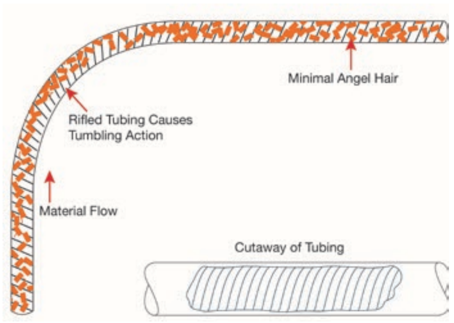
Doing these things also keeps the vacuum source working to maximum efficiency so it is better able to maintain the target conveying speed and transfer rate.

Elbows will always be in a conveying system. For elbows, long-radius elbows should have a CLR six to nine times the pipe diameter. For elbows at the base of a high vertical rise, nine to 12 times is preferred.

USE SPECIALTY ELBOWS

Angel hair formation is worse in standard elbows with smooth inner surfaces. While we think of smooth surfaces as minimizing friction, material winds up sliding more along those surfaces. This generates the frictional heat that's an anathema to resins with low melting points.

Several types of specialty elbows deter angel hair formation.



Surface treatments including shot peening or rifling (spiral groove) shown above are helpful in reducing friction, angel hair and streamers.

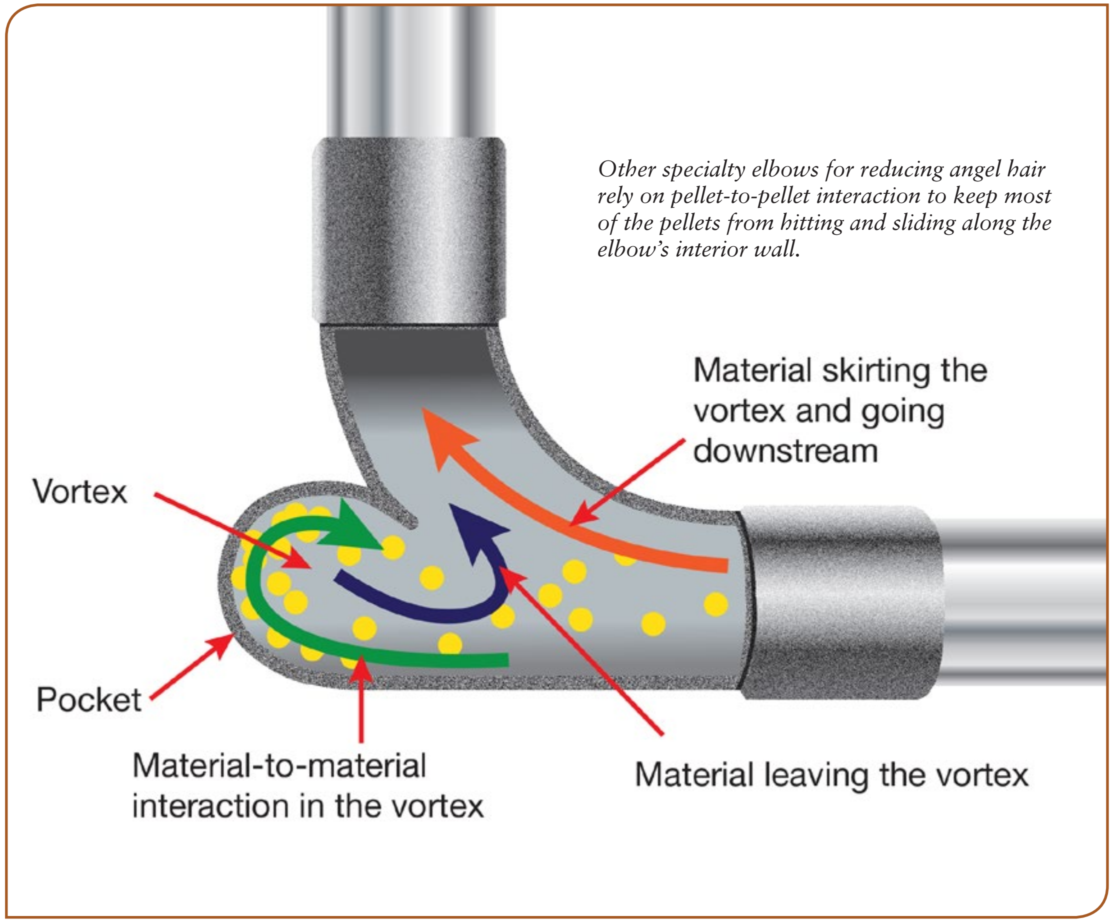
When the interior of an elbow is scored, etched, or shot-peened, the rough surface causes material to roll and tumble, rather than slide, along the surface. The tumbling generates less frictional heat than sliding.

Pocket-type elbows also reduce formation of angel hair by creating a mini cyclone or simple barrier of resin pellets; the pellet-to-pellet interaction between incoming material and the pocket area keeps most of the pellets from hitting and sliding along the elbow wall. *Blind tees*—a standard pipe tee with one outlet capped—acts like a pocket-type elbow; incoming pellets hit those built up in the capped outlet (see below).

RUN SLOWER

Optimizing conveying velocity falls into the "Goldilocks zone." Air velocities below the *saltation velocity* will create instabilities in the conveying system, the worst being the inability to convey material from pickup point to receiver. Just above the saltation velocity, material will get carried and the formation of angel hairs is significantly reduced. With excessive conveying velocities, material travels too fast. This does not lead to higher material transfer capacity, though.

So, regarding the air velocity in pneumatic conveying… less is better. The ideal average conveying velocity for plastic resins *that are susceptible to angel hair formation* is about 4,000 ft/min.



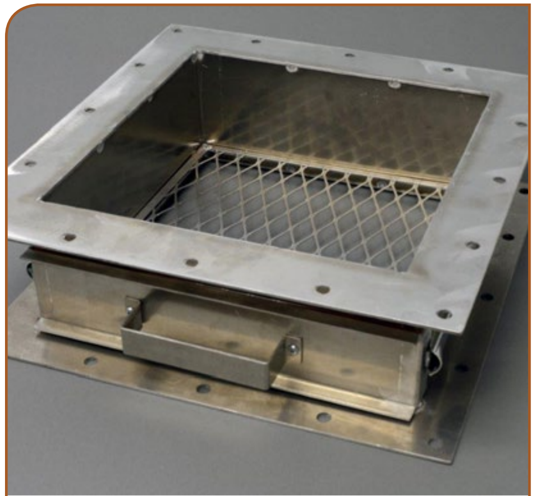
Other specialty elbows for reducing angel hair rely on pellet-to-pellet interaction to keep most of the pellets from hitting and sliding along the elbow's interior wall.

RUN COOLER

Frictional heat is just part of the angel hair problem. The operating temperature of your conveying system should be low to begin with—at the source: The air stream that conveys materials, whether positive pressure or vacuum blower systems (or both). Conveying at a typical 6 psi will raise the temperature within the conveying system about 85°F. It's worth noting that softer materials tend to get sticky at lower temperatures than hard resins. You may need to install an inline cooler (air- or water-cooled) to reduce the temperature of the conveying air below the resin's melting point. Coolers may also be necessary to "air condition" the temperature of ambient air in warmer climates.

REMOVE IT

Whatever angel hair that remains should be removed before blenders, feed hoppers or receivers. There are also in-line angel hair traps that can be used in conveying lines to remove angel hair.



One type of angel hair trap consists of a drawer with an expanded stainless steel insert that fits into the takeoff box at the bottoms of silos and effectively traps angel hair for later removal.

Best Solution to Reduce Angel Hair & Streamers

Here are some ways to manage angel hair and streamer formation:

- Follow proper piping practices with respect to pipe diameter the radius of elbows
- Use specialty elbows
- Reduce conveying air speed
- Run at cooler temperatures
- Collect and remove accumulations of angel hair and streamers

In-line trap is connected to conveying line to collect angel hair and streamers.

feature

High Air Speeds Accelerates Damage & Downtime

Find out why conveying with high air speeds can lead to frequent elbow replacements, maintenance headaches and material supply interruptions.

Q – WHAT PROBLEMS ARE CAUSED BY CONVEYING AT HIGH AIR SPEED?

A – Erosive wear and Angel Hair are two key issues. Abrasive material wears tubing, bends and other equipment, causing leaks that interrupt material supply and lead to expensive replacement costs. Angel hair and streamers cause clogs in conveying lines, filters and hopper discharges – and can even contaminate other materials transferred through line afterward. Both problems lead to downtime and lost profits.

Q – WHY ARE ABRASIVE MATERIALS A GROWING CONCERN FOR PROCESSORS?

A – Resin manufacturers are expanding the use of glass and other abrasive fillers that improve the useful properties of lower cost resins like PE and PP, so more processors are seeing abrasive resins more frequently.

Q – WHAT TYPE OF MATERIALS ARE DAMAGED BY HIGH CONVEYING AIR SPEED?

A – Brittle pellets and regrind fracture and break as air speed increases, leading to more dust. Higher air speeds lead to more friction and heat buildup, so pellets that soften when heated are likely to leave a residue that will lead to angel hair, streamers and contamination.

Q – HOW FAST DOES AIR HAVE TO MOVE IN A CONVEYING SYSTEM?

A – 35-40 mph is a minimum pickup speed for typical plastic pellets, though it can vary with bulk density, pellet size, and pellet flow characteristics. Pellets continue to pick up speed as they move toward a receiver / separator, reaching speeds of 50 to 80 mph or more. Systems designed to pull more vacuum will move air at higher speed as it reaches the pump.

Q – AT WHAT POINT DOES AIR SPEED REALLY BECOME AN ISSUE?

A – Intuitively, we know a car hitting a guardrail at 35 mph will be damaged less, and inflict less damage, than the same car traveling at 75 mph. When conveying abrasives, one study showed an elbow can last nearly 17 times longer when air speed is 35 mph versus 75 mph, and in this range, elbow life nearly doubled for every 10 mph decrease in speed. When conveying LDPE, another study showed steamer generation increased linearly with air speed in a 45 to 75 mph range.

ELBOW LIFE NEARLY DOUBLED WHEN AIR SPEED ↓ 10 MPH

Q – WHY DOES AIR SPEED INCREASE AS AIR MOVES THROUGH A CONVEYING SYSTEM?

A – Air speed increases because of vacuum, which is the pulling force created by the pump. When air first enters a conveying tube, there's very little pulling force needed, and vacuum is low. As the air travels toward the pump, every foot of tube, and each pellet being carried, try to hold it back. As this resistance to air movement grows, the pump pulls harder, 'stretching' and expanding the air so it moves faster and faster until it reaches the pump. These higher air speeds are why problems like angel hair and elbow wear are seen sooner, and more frequently, closer to the receiver and pump than the pickup.

Q – WHAT ELSE AFFECTS AIR SPEED IN A CONVEYING SYSTEM?

A - By nature, most vacuum pumps move more air when facing less resistance, even when rotating at fixed RPM. In a conveying system, shorter conveying distances offer less resistance, and so do empty conveying lines, which occur when material is purged after each fill cycle. Purging is done to prevent dried materials from being exposed to ambient moisture, to preserve the proportion integrity of blended material, or to prevent overloading the pump when conveying very long conveying distances.

In both of these cases, when facing less resistance, the pump moves more air than intended. The result can be substantially higher air speed than expected depending on the pump technology in use.

Summary: When a processor is experiencing damaged components in their vacuum conveying system, or material contamination and plugged lines from angel hair and streamers, air speed can be a significant contributor to the problem. Investing in available solutions to reduce or manage the air speed, along with enhanced elbows and system components, will extend wear service life, and minimize material degradation. Consult with your conveying systems specialist to arrive at solutions that are tailored to your needs.

Lower Speeds Limit Difficult Problems

Too much air speed makes difficult conveying problems like elbow wear and angel hair even worse. When selecting options to reduce their impact, consider managing air speed as well.

BASIC AIR SPEED CONTROL METHODS

When air speed and vacuum conditions in a system remain consistent during material transfer cycles, with minimal variation, basic corrective actions are possible. These actions are generally low in cost and complexity when implemented with a new system.

1 Reduce Airflow Across the Entire Conveying System

Reducing system wide airflow will reduce air speed from source to destination. Elevated pickup air speed can be reduced to target speed with minimal impact on throughput rate. Further system speed reduction also requires lowering the pump operating vacuum, which will reduce throughput rate.

To reduce pump airflow, reduce blower rpm using a Variable Speed Drive (VFD) to adjust motor speed, or changing sheaves if the pump is belt driven. A controlled air leak at the pump creates an alternate path for air to enter the system, like a simple bypass, and can reduce air speed up to 30% when carefully controlled.

1 Dual Diameter (Stepped) Convey Tubes

Stepping a standard conveying tube to a larger diameter between the material source and destination reduces speed in the larger tube section, and allows substantially higher throughput rates when combined with a high vacuum pump. The key is understanding how resistance builds in the conveying line, and how it affects the air speed throughout the entire distance material travels.

ADVANCED AIR SPEED CONTROL METHODS

By nature, most vacuum pumps move more air when facing less resistance. Shorter conveying distances and a purged (empty) conveying line offer less resistance to the pump, which can lead to substantially higher air speeds than intended. Because these conditions can occur intermittently, air speed corrections must be applied dynamically, or only when needed.

3 Mechanical Flow Limiter

A mechanical flow limiter, or flow control valve, acts like a governor on the air speed inside a conveying system. When system resistance drops, air flow is limited to prevent air speed from increasing. When system resistance is already high, air passes through it freely. The flow control valve reacts automatically to changing system conditions, and requires no control interface.

4 Select Air Speed by Station

Advanced conveying controls allow conveying speed selection for individual stations. Pump RPM is adjusted through a motor VFD, so air speed can be reduced for short distances, or increased for heavy and other challenging materials. Some controls can also vary speed during a single fill cycle, starting at full speed to accelerate material then slowing to the target transfer speed, or, slowing speed during a purge cycle as resistance dissipates. This approach offers great flexibility, but settings must be updated to as materials and conditions change to realize its benefits.

Consult with a knowledgeable system designer to help you understand the tools that best fit your needs, and how they can be implemented to deliver maximum value.

Improve Process Consistency with Line Purging

...We are not talking about purging material out of process machines....

Instead, we are talking about purging plastic pellets, additives and regrind out of conveying lines.

It is important to understand the benefits and the cost of line purging.

Purging provides measurable benefits under these conditions:

1. *When blended materials are being conveyed and some material separation may occur.*
2. *When vacuum pumps may not convey material over excessively long conveying distances.*
3. *When material is very sensitive to moisture pick-up.*

In the first two conditions, ambient air is sufficient for the purge cycle. For condition #3, it is necessary to purge conveying lines with dry air.

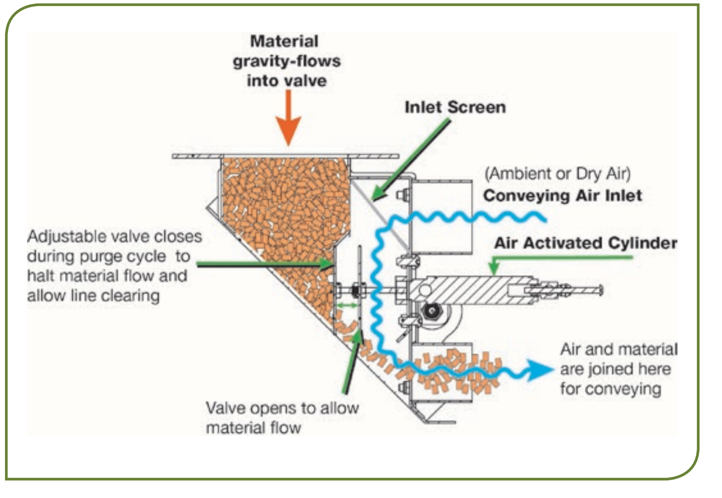
When using standard vacuum takeoff boxes and purge valves, the hose connections could become quite complex – especially if a processor wanted to convey/purge with dry air.

To see how a modern Vacuum Purge Take-off Valve Works take a look at the diagram:

By combining the take-off box and external purge valve, we can use the plunger as a gravity dispense feeder rather than a simple open / close shut off. This provides a smooth, consistent flow. By adjusting the travel of the plunger, we control the rate material enters the air stream. This creates a very effective take off device, reduces the complexity and overall cost of the setup.

As material dispenses, airflow creates velocity to accelerate and convey the material. By bringing the air behind an internal baffle, the dispense area is protected from variations in pickup velocity or system vacuum.

In addition, we can easily connect a dry air source if needed.



This modern Purge/Take-off valve allows adjustable material/air flow, and either ambient or dry air purging of material lines.

AMBIENT AIR CONVEY/PURGE

As the modern purge Take-off Valve illustration shows, ambient air is pulled through the filter on the back of the take-off box, and passes through the vacuum purge valve installed under the drying hopper.

During the convey cycle, the adjustable valve opens for air and material to flow through the valve.

During the purge cycle, the adjustable valve closes to stop material flow, but air continues to flow, removing any material that is left in the conveying line. This ensures that the conveying line is left empty.

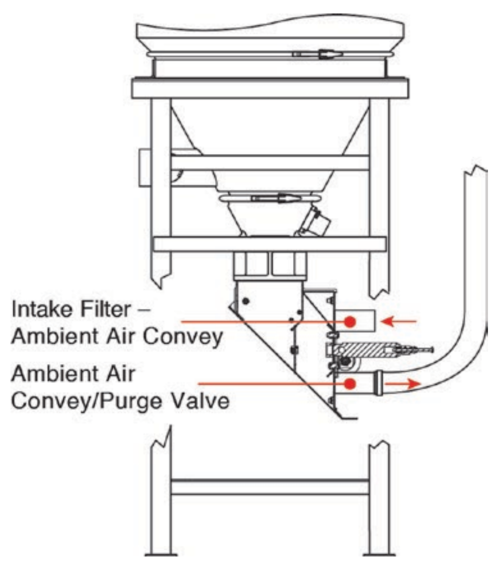
DRY AIR CONVEY/PURGE

In applications where the dried material is particularly sensitive to moisture pick-up it is advisable to purge conveying lines with dry air.

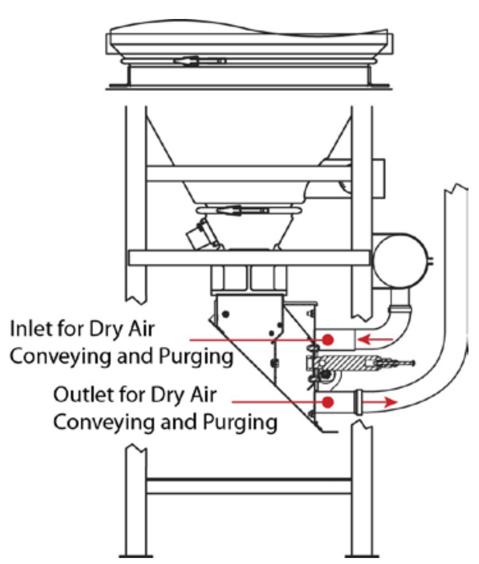
In this case, dry air is tapped from the dry air manifold and is used for conveying the material and line purging.

During the convey cycle, the adjustable valve opens and dry, tapped from the hopper return air line, is used to transport material to the destination.

Duing the purge cycle, the adjustable valve closes to stop material flow but dry air continues to transfer the material and empty the conveying line without introducing ambient moisture to the process.



Single connection for ambient air purge.



Simple dual connections for dry air purge.

THE DRAWBACKS VS. THE BENEFITS

It's important to understand purge reduces the rate capacity of a conveying system. As an example, if your normal load time is 30 seconds to fill a receiver, and your time to purge adds 15 seconds, you're now moving the same amount of material in a longer cycle time…in this example, 50% longer. The net effect is reducing the system delivered rate to about 2/3 of the original capacity. This should be taken into account when designing the system.

Loading & Purging

"FILL" TIME:

Although this term may not appear on all controls, it is helpful to use for understanding the vacuum-on time of an individual receiver. The total vacuum-on time of a receiver (the length of time the vacuum sequencing valve is open) can be referred to as FILL time. All functions that happen while the vacuum valve is open (regrind proportioning, pocket conveying, purging, etc.) is all part of the FILL time.

"LOAD" TIME:

The vacuum time that a receiver uses to introduce material into a material conveying line is LOAD time. The term may be thought of as 'loading the material line'. This term is important to understand with purging systems to distinguish between the time the purge (or pocket) valve is opened (LOAD time) compared to the time it is closed (PURGE time). On systems that have no pocket or purge valves, LOAD time equals FILL time. On systems with pocket or purge valves, LOAD time is just the *first part* of the FILL time. Purge time is the conclusion of FILL time.

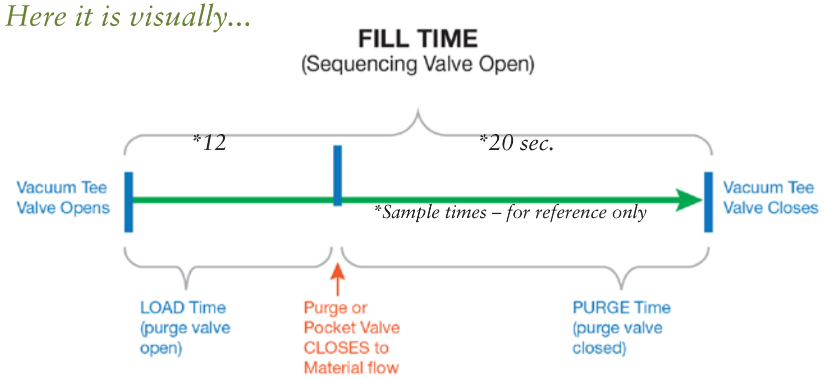
"PURGE" TIME:

The vacuum time that a pocket or purge valve is closed to material flow, but vacuum air continues to flow thru the conveying line to clean out the material conveying line is referred to as PURGE time.

LOAD time + PURGE time = FILL time

Because the functions are identical, the term PURGE time is used for cleaning out the conveying line after loading.

Here it is visually...



Note that it is common to set more PURGE time than LOAD time on the conveying control, to allow the entire conveying line to be cleaned of all pellets and even dust from the conveyed material.

Still, if you face on of the three conditions stated at the beginning of this article, the benefits of line purging overcome any drawbacks.

After reviewing the current and possible future conditions in your process, a material conveying specialist can give you the best advice.

feature

Proper Vacuum Receiver Selection Impacts Central System Operation

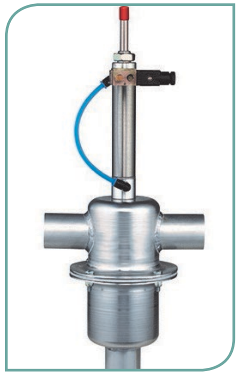
Vacuum receivers are an integral part of any central conveying system. As such, it is important to understand:

- *Types of receivers*
- *Basic receiver features*
- *How receivers operate*
- *Troubleshooting procedures*

Vacuum receivers, also called vacuum chambers, vacuum stations, or just stations, are integral parts of a central conveying system. Think of them as intermediate holding points for resins conveyed by vacuum. Vacuum receivers have one primary job: separate material from air. They accept resin from a source that is pulled by vacuum, separate the material from the air flow and transfer that resin to a destination.

Vacuum receivers come in several designs with all sorts of features aimed at offering a variety of advantages in conveyance, maintenance, and ease of use. Some receivers are designed for pellets, some for regrind, and others for powders.

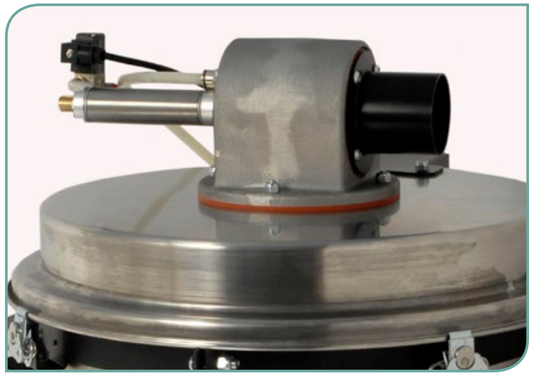
Some receivers mount atop hoppers or bins; others are mounted directly to the throat of a processing machine.



Separate station T sequencing valve

All receivers have a sequencing device. Some receivers require a separate sequencing valve to connect to the vacuum line; others have a built-in fill valve. The sequencing device allows vacuum to pull material into the receiver and while the bulk of the material falls to the bottom of the receiver, the vacuum pulls the air up through the top of the receiver and back to the vacuum pump.

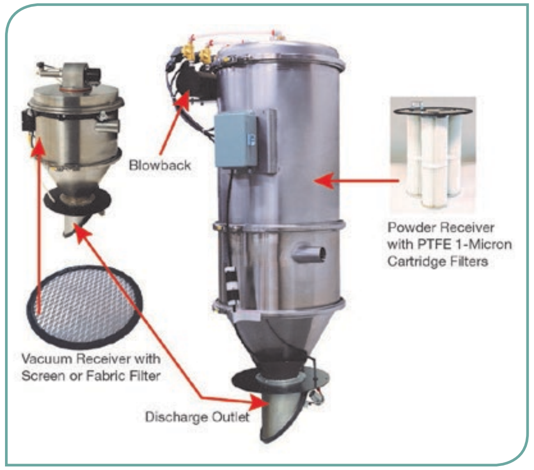
Most dust and fines are trapped by a filter.



Built-in Fill (Sequencing) Valve

Receivers come in various capacities, from small (1.5 lb.), to medium (75 lb.), to large (114 lb. and more). The multitude of designs, capacities, and feature sets is what makes it possible to specify a vacuum receiver that perfectly matches the needs of a plastics conveying system.

MAJOR PARTS OF A RECEIVER



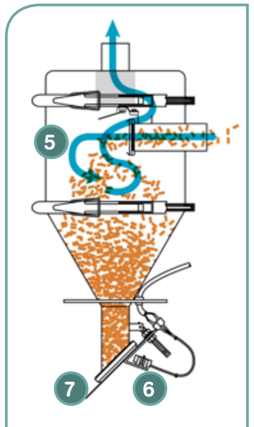
1 ***Receiver lid*** - allows access to the receiver chamber. Access is necessary to clean and/or change filters, if present, and perform other maintenance within the receiver. The lid can be hinged or completely removable, and typically can be rotated to the orientation required by the layout of the conveying system.

This receiver has a hinged lid with a built-in sequencing/fill valve

2 ***Vacuum breaker or sequencing valve*** - at each receiver directs vacuum to that receiver. The vacuum draws resin through the conveying lines to the vacuum receiver. Sequencing valves can be either a "T" valve located above the receiver in the vacuum line or an external fill valve (EFV) located right on the receiver lid.

3 ***Receiver chamber or body*** - is usually a cylinder connected to cone-shaped lower section - that collects resin from the conveying system before discharge. The slant of the cone helps material slide down to the discharge valve.

Machine mount receivers feed material directly to the process machine throat.



Filterless receivers use a cyclonic principle to separate air from the material stream.

4 ***Machine-mounted receivers*** – typically have a glass hopper and are connected directly to the throat of the process machine. Often referred to as J.I.T. receivers.

5 ***Filter or some type of filter-less system*** - separates powders, dust, fines, and other contaminates from the resin entering the receiver. The filter-less receiver shown below uses a cyclonic action to separate material from the air flow. The material is heavier than air so it falls into the body of the receiver while vacuum and cyclonic action pulls the air into the vacuum stream.

Continued on p. 24...

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6 ***Material level switch*** - detects the amount of resin in the machine-mount receiver and controls the discharge of the resin. The mechanism to detect the level of material in the receiver can range from simple, non-automated devices to sophisticated electronically controlled sensors.

7 ***Discharge valve*** – allows collected resin exit the receiver chamber. The resin can be dispensed to a hopper or some other type of container. Machine-mount receivers typically gravity-feed directly to the throat of the process machine

RECEIVER FEATURES TO CONSIDER

- Receiver selection is determined by the flow rate required and the type and bulk density of the material transferred.
- Large receivers are better than small ones; their increased capacity reduces the number of fill-cycle times, which reduces the wear and tear on pumps and valves. Also, large receivers are better suited for the increased capacity of today's vacuum pumps.
- Powder receivers are used for powders (such as PVC) and dusty regrind. These receivers include special filters and blowback systems to avoid clogging and to maintain energy efficiency.
- Machine-mount (JIT) receivers are used on process machines.
- Stainless steel is the most durable material for most applications.
- Receivers for operations with abrasive materials require custom options, such as thick-walled wear plates, electro-less nickel plating, and interior ceramic coatings. (See Delay Abrasive Wear As Long As Possible)
- Receivers having a tangential inlet with flapper and gasket exhibit minimal material degradation while also eliminating the damaging effects of direct impact on receiver bodies.
- The discharge valve should allow material to exit the receiver quickly. Larger-diameter discharge outlets are preferred for regrinds or difficult-to-flow materials.
- Receiver and related connections must be air and leak-tight. Neoprene seals on a dump throat ensure against vacuum loss.
- "No-tools access" in receivers makes cleanout and other maintenance easy and fast.
- Machine-mount receivers typically come with height-adjustable photoelectric level sensors.

Receivers are designed to operate within the specifications of the conveying system.

That means the receiver must be matched to the line size of the conveying system (tubing diameter and vacuum pump), controller voltage and both the throughput (capacity) and conveying distance. A system may have many vacuum receivers. The limiting factor is the amount of vacuum which - is provided by one or more central vacuum pumps.

Receivers with an integral sequencing valve on a hinged lid are, by far, the current choice for use in central systems. There are several benefits:

- *Safety – easy to open lid and inspect filter with one hand.*
- *Easier access to sequencing valve.*
- *Convenient ON/OFF switch at receiver – no trips to central control.*

When properly maintained, receivers are relatively trouble-free but see Trouble Shooting Vacuum Systems.

Problem: Poor or No Conveying

1 SEQUENCING VALVE OPERATION

Vacuum "T" valves or a built-in sequencing valve isolates the vacuum conveying power of the pump to one receiver at a time for conveying. Each valve in the system must close off air flow when it is NOT in operation, allowing other receivers to receive full vacuum. One 'stuck' valve can ruin the vacuum supply for the entire system. Check that each valve operates in response to its receiver's turn in the vacuum system. Each valve should open for loading and close when loading is complete. The extended shaft of the T valve's cylinder is a good indication of valve operation. Where the valve is built into the receiver lid, the valve operation can viewed through the vent or there may be an indicator light.

2 RECEIVER DISCHARGE FLAPPER STUCK OPEN

If the flapper valve is stuck open or does not fully close, conveying cannot take place. A problem receiver can be easily checked for proper, free movement of its flapper valve:

- *If conveying is not triggered when the flapped is closed, there is an issue with the electrical demand switch.*
- *If the flapper does not swing nearly shut by its own weight, there is a pivot point (hinge) or counterweight issue.*
- *If the flapper is 'stuck' in the open position, there is a material contamination issue with the pivot point (hinge) of the valve.*

3 INLET CHECK VALVE STUCK OPEN

Many receivers are equipped with swinging check valves on their material inlets. A check valve that is stuck open, either by hinge wear or a trapped pellet, will leak valuable vacuum air, decreasing vacuum capability at other receivers or even preventing conveying throughout the system.

Rule of thumb: On systems that convey material from one source to multiple receivers via a common material line; If only one receiver in the system conveys correctly, the problem is probably at THAT receiver.

CONVEYING CONTROLS NOT PROPERLY (RE) PROGRAMMED

Central material conveying systems that include a network of pumps, receivers and material sources provide high efficiency and a multitude of flexibility. But often, new requirements are not completely programmed after material or system configuration changes. Items to check:

- Is the new material source further away than the previous source? More conveying time and/or purge time might be required to accommodate this difference in distance.
- Is the new material as free-flowing as the last material? Does the material have a tendency to clog the conveying lines, or simply convey slower due to weight or shape? Changes to load/purge times as well as material pick-up tube changes may be required.
- Has the receiver been assigned to the proper vacuum pump? The proper material valve?
- Has system piping and or wiring been modified to accommodate this new configuration for conveying?

CONFIRM VACUUM BREAKER OPERATION

(See System Vacuum Breaker Valve – pg.40)

CHECK THE MATERIAL SOURCE

(See Material Source Issues - pg.40)

FEED TUBE / TAKE-OFF BOX AIR SETTINGS

(See Feed Tube / Take-pff Issues - pg.40)

feature

Correct Pump Selection is Critical to Conveying System Health

Like the heart that keeps our blood flowing through our bodies, vacuum pumps keep resin flowing through

your processing facility so they are critical to the health of your conveying system.

It is important to understand the differences between pump types so you can:

- *Maximize the efficiency of your resin conveying system.*
- *Minimize line plugs, maintenance and machine starving.*
- *Expand an existing conveying system without ripping out existing lines.*

Air and vacuum work together to make everything happen in a resin conveying system. Airflow creates the velocity to pick up and move the resin through the pipes. Vacuum energy overcomes the resistance created by air and material as they move through the pipes. The conveying system's "engine" is the pump, which is the source for airflow and vacuum.

Regenerative Pumps are direct drive pumps whose speed can only be adjusted with a variable speed motor drive. Wide air flow variation can only limited with sophisticated control or mechanical flow limiter.

Pump Types

SINGLE-STAGE REGENERATIVE PUMPS

Single-stage regenerative pumps are the smallest, quietest, and least expensive. They also have the lowest vacuum capacity (about 6-9"Hg maximum depending on tube diameter). These pumps are ideal for conveying light loads across shorter distances in systems with up to about 2.5-inch diameter tube.

TWO-STAGE REGENERATIVE PUMPS

Two-stage regenerative pumps are physically similar to single-stage regenerative pumps. Equivalent single and two-stage models have the same housing diameter, but two stage housing are about twice as deep. They also use more horsepower than the single-stage pumps to create higher vacuums, up to 12"Hg. These pumps are best suited for conveying materials across moderate distances and rates, with tubing diameters up to 2.5" diameter.

Regen pumps, by nature of their operating principles and direct drive motor arrangement, start out at a considerably higher velocity, and see larger velocity increases at lower vacuums, than other types of pumps, which lead to ramifications discussed later in the article.

POSITIVE DISPLACEMENT (PD) PUMPS

Positive Displacement (PD) pumps, considered by many the industry standard, provide the widest range of airflow (e.g., 55 to 470+ cfm) and vacuum levels up to 14"Hg. These pumps are often installed for conveying resins across long distances in systems with tubing up to 4" diameter and larger. PD pumps are more efficient than Regenerative pumps when pulling a comparable vacuum and airflow. They also offer a more consistent airflow as vacuum varies across typical system applications. And belt drives can be configured for lower velocity from the start.

The biggest drawback to PD pumps – until now – has been their noise level – At times over 90 dbA. NOVATEC is now offering PD pumps with sound levels less than 80 dbA without additional sound attenuation, providing a huge improvement for the work environment.

PD pumps are typically belt driven, so their speed and airflow can be set with sheaves to deliver the appropriate system conveying speed. This is particularly important with difficult to handle resins, and thinner air at high elevation installations.

HIGH EFFICIENCY PD PUMPS

High Efficiency PD Pumps can also re-sheaved to adjust their speed to handle difficult-to convey materials and for use in higher elevations.

High efficiency PD pumps provide 20% more vacuum capacity than standard PD pumps. Higher vacuum yields higher conveying rates and longer distances. These pumps produce operating vacuums up to 14"Hg (maximum vacuum up to 15"Hg) through a rugged design that includes a heavy-duty roller bearing, helical gears, and a tri-lobe rotor, with models ranging from 7.5 hp to 20 hp. They are more energy efficient than regenerative pumps and quieter than traditional PD pumps operating at the same vacuum level.

CLAW PUMPS

The claw type vacuum pump is a unique design intended to operate at very high vacuum levels. The claw design compresses air while it's inside the pump housing, increasing the operating vacuum for conveying up to 15"Hg (17"Hg relief vacuum). These pumps come in models ranging from 4 hp to 15 hp, and they are also more energy efficient, requiring nearly half the energy of regenerative pumps and up to 15% less energy than standard PD pumps for a given vacuum and airflow target. They are also quieter than PD pumps in comparable vacuum ranges. Claw pumps provide the higher conveying rates and plug-breaking capability than any other pump. However, the high relative cost of these pumps (Table 1) generally limits their use except for unusual conditions that can't be overcome by other pumps.

Claw pumps are most often used when conveying distances are so long that other pumps do not develop sufficient vacuum levels to transfer the required resin rate.

Basic Performance Characteristics of Pump Types

Table 1: Typical Vacuum Capability of Conveying System Pumps

Pump	Typical Line Sizes	Operating Vacuum	Maximum Vacuum	Relative Cost
Single-Stage Regenerative	1½"- 2½"	6.5"- 8.5" Hg	10" Hg	$
Dual-Stage Regenerative	1½"- 2½"	10"-11" Hg	12" Hg	1.4 $
Positive Displacement (PD)	1½"- 4"	11"-12" Hg	13" Hg	1.6 $
High Efficiency (PD)	2"- 3½"	13"-14" Hg	15" Hg	$$
Maximum Efficiency Claw Pump	2"- 3"	14"-15" Hg	17" Hg	$$$

Above you can easily see the range of system line sizes available with each type of pump, as well as the vacuum in inches of mercury (Hg) developed by each pump, and their relative costs.

Maximum vs. Operating Vacuum

To get the maximum benefit from your conveying system, it's important to understand what these terms mean and why they are important.

Maximum Vacuum (measured in inches of mercury) is the maximum safe pulling capacity of the pump. Vacuum relief devices are often included with a pump to prevent operating above this level, though operating at maximum vacuum on a continuous basis will lead to more frequent maintenance and reduced blower life due to elevated operating temperatures.

Operating Vacuum is the highest vacuum level a conveying system should pull during normal operation, and it's the basis for calculating the system's maximum conveying rate. Operating a conveying system at the specified operating vacuum, as opposed to the pump's maximum vacuum, leaves "wiggle room" for unexpected changes, such as a dirty filter or varying material types, and leaves some extra vacuum in reserve to help clear an overfed conveying line of material slugs.

Free Vacuum is the vacuum that results from pulling air without material through the connected system tubing. The difference between Free Vacuum and Operating Vacuum represents the approximate vacuum energy available to move material when using PD and Claw type pumps. Regenerative pumps move much more air as vacuum levels decrease, so excessive air speeds create an artificially high Free Vacuum level with these pumps.

Basic Rules for Pump Selection:

Rule #1 - The pump must generate enough vacuum to overcome the resistance of the air and material as it moves through the length of tubing for the installed system.

Calculating the resistance of air and material in a conveying tube requires a complex set of equations and variables that are beyond the scope of this format. Key factors include velocity pressure, tube diameter and length, friction constants, and pellet characteristics.

Many equipment suppliers rely on rules of thumb relating "Equivalent Distance" conveyed to expected resin transfer rate. These rules are often derived from testing, so they're reliable when evaluating applications that fall within the tested range.

"Equivalent Distance" is often confused with actual horizontal distance to be conveyed. Other factors add resistance as well, and must be included with horizontal distance to accurately estimate the resulting resin transfer rate. The typical factors associated with Equivalent Distance include:

1' horizontal =1 equivalent ft.
1' flex hose = 3 equivalent ft.
1' vertical = 2 equivalent ft.
Each elbow = 20 equivalent ft.

1' vacuum line = 0.2 to 0.6 equivalent ft. (depends on diameter and distance)
(vacuum line = tubing between the resin receiver and the vacuum pump).

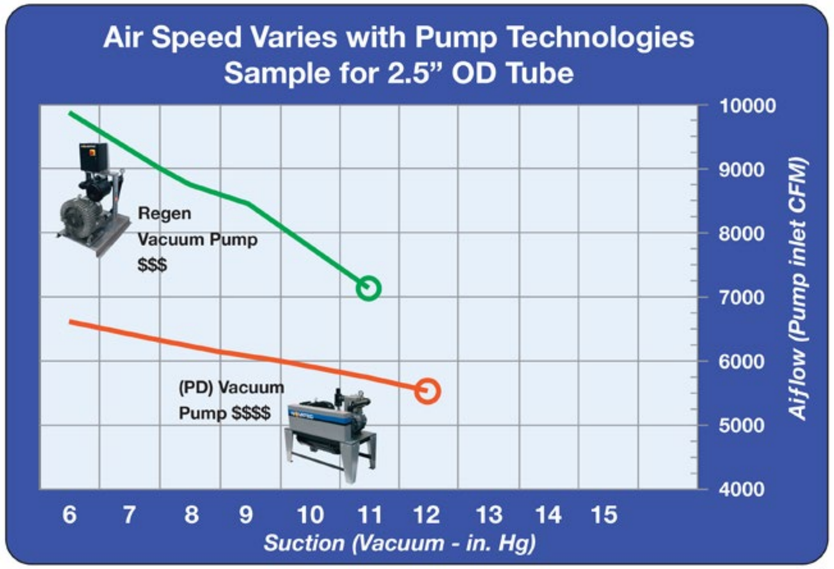
The key for this step is to understand the vacuum pulling capacity of the available pump technologies, and whether they meet or exceed the system requirements.

Rule #2 – The pump must create the appropriate air velocity at the material source to sweep resin into the tubing and carry it to the destination receiver.

The first consideration is creating the airflow and resulting velocity required to sweep resin into the tubing at the material source. This velocity is often called pickup velocity, or saltation velocity. There are a number of methods used to calculate this value, and they rely on material specific factors that are usually verified through testing. For commonly used plastics, the range is 3000 feet per minute (fpm) at the low end, and 4500 fpm on the extreme high end. Most plastics can be transferred using a pickup velocity between 3000 – 3500 fpm.

The second consideration is the material's sensitivity to variations in air velocity. Some resins can break down as speed increases, and others can break down your system's elbows and other impact points through erosive wear as speed increases.

The following chart compares the airflow versus vacuum for both Regen and PD pumps operating at constant speeds. Note that the Regen pump starts out at a higher speed than a PD pump due to its direct drive arrangement. This creates higher starting velocity. Also note the Regen pump airflow, and resulting velocity, increases more dramatically than PD pump airflow as the system vacuum requirements decrease.



The differences in speed variation has significant results.

Result #1: Regen pumps move materials at higher speeds than PD pumps, which can lead to excessive material degradation or erosive wear on your system components. Examples of material degradation for sensitive materials include angel air, streamers, contaminating buildup or excessive dust, depending on material.

Result #2: Since velocity increases resistance to movement in a conveying system, Regen pumps use more of their operating vacuum just to pull air through a vacuum line (as compared to a PD pump), leaving LESS of their operating vacuum to pull material from source to destination. (See Tables 2-3)

These two results often lead to Regen pump suppliers adding velocity control devices into their systems. It's important to understand the complete operating picture of a given pump technology before deciding which to use, and what optional features may be needed.

System Design

You probably would not try to design and build your own automobile and the same is true of vacuum conveying systems. Talk to a professional systems design specialist who represents a company with a full range of options for receivers, pumps, abrasion-resistant components and velocity control.

The system designer will ask a lot of questions about the types of materials you will be conveying, machine capacities and more. He will calculate the equivalent distances, the line sizes required and use pump curves to suggest the type of vacuum pump that best suits your current and expected future needs. It is always best to plan ahead for expansion.

Being able to choose from a full range of pumps is of can be a great benefit to maximizing a conveying system's performance. The following 2 tables show how Free Vacuum, or the resistance to moving only air (without material) helps to estimate relative pump technology capability for a given installation. Higher Free Vacuum leaves less Available Vacuum to transport material.

As distance increases, Free Vacuum can begin to overpower the pump's Available Vacuum for moving material. Suppose you want to expand a system to include more machines, which also increases the Equivalent Distance for conveying to 1000 feet. Traditional Regen and PD pumps have limited Available Vacuum energy at this distance, so you'll be faced with 2 choices:

1. Increase system capacity with larger diameter conveying tubing. Unfortunately, this requires tearing out your existing pump(s), and all of your existing conveying lines.
2. Investigate alternative higher vacuum pump technologies to replace the existing pump(s), but can still use the existing installed tubing.

Option 1 means you'll rip-and-replace the existing system, and could incur excessive capital costs and suffer major interruptions to existing production, so the smart thing to consider is alternate pump technologies associated with Option 2.

In the table, we see when the system is lengthened to 1000 feet, the first three types of pumps have little or NO Available Vacuum for transporting material. At the same time, the pumps with higher operating vacuum capacities will be able to transport material. When this is the case, the wise choice is to replace the existing pumps with either a

Table 2: Typical 2" System Conveying 400' (equivalent)

Pump	Operating Vacuum	Free (Air) Vacuum	Available Vacuum
Single-Stage Regenerative	6.5" Hg	4" Hg	2.5 Hg
Dual-Stage Regenerative	10.5" Hg	4" Hg	6.5 Hg
Positive Displacement (PD)	11" Hg	3" Hg	8.5 Hg

You can see in this 400 foot system, the 4"Hg Free Vacuum needed for a single stage Regen pump uses most of the Pump's Operating Vacuum – leaving only a small amount of Available Vacuum to transport material. Longer distances benefit from the added vacuum and lower velocity available with PD pumps.

maximum efficiency PD pump, or a Claw pump. In almost all cases, the maximum efficiency PD pump is chosen because of the comparatively high cost of the claw pump technology.

Pump selection is key to your system's effectiveness and efficiency. To reap the maximum benefits from your investment, work with a supplier who can offer a full range of pump technologies to ensure the proper solution for your conveying needs.

Table 3: Extended System Conveying 1,000' (equivalent)

Pump	Operating Vacuum	Free (Air) Vacuum	Available Vacuum
Single-Stage Regenerative	6.5" Hg	10" Hg	0" Hg
Dual-Stage Regenerative	10.5" Hg	10" Hg	0.5 Hg
Positive Displacement (PD)	11.5" Hg	9" Hg	2.5 Hg
High Efficiency (PD)	14" Hg	10" Hg	4" Hg
Maximum Efficiency Claw Pump	15" Hg	10" Hg	5" Hg

In table 3, when the Equivalent Distance is increased to 1000 ft., neither single nor dual stage regen pumps will transport material. The PD pump will transport limited material rates with little margin for error. Higher vacuum technologies are most likely be required.

Positive Displacement Pumps Can be Stacked to Save Space

Regenerative Blower Pumps Shown in a Row

Basic Startup / Troubleshooting Checklist Vacuum Pump

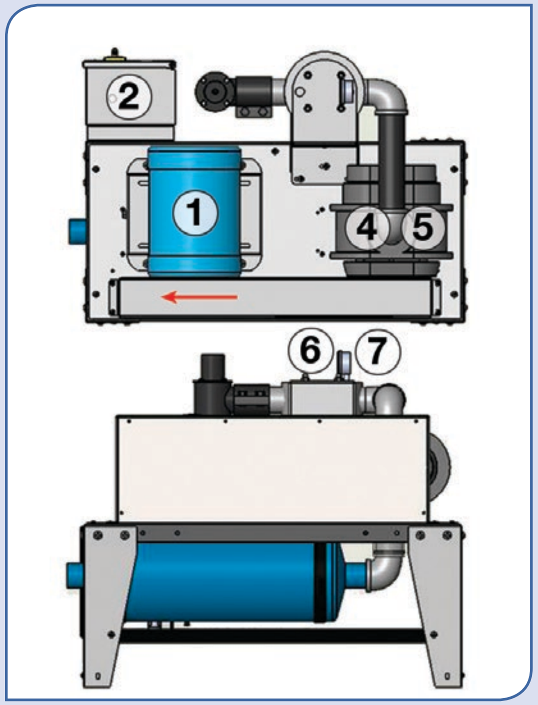
1. Check direction of rotation of the pump / motor If incorrect, change phase.
2. Check that motor amperage draws are correct.
   If not, check wire terminations at motor starter. Also check resistance across motor voltage legs, and between each leg and ground.
   - *No resistance indicates shorted windings.*
   - *An open circuit between voltage legs indicates damaged windings.*
3. Check belts for proper tension and alignment, as well as wear and tear.
4. Check blower for wear and tear, such as bearing play, leaking seals excess backlash.
5. Check oil level in Positive Displacement and Claw pumps. Replace if necessary per Instruction Manual.

NOTE: Regen pumps do not require oil changes but they should have their bearings lubed per instruction manual.

6. Check pump and system vacuum capacity:
   – Remove vacuum line from inlet to the cyclone (or central dust collector).
   – Partially cap off the cyclone inlet with a rigid, flat object (wood, sheet metal, etc.).
   – Begin operating the pump, and begin to slowly block more air at the cyclone inlet to increase the vacuum being drawn. The vacuum gauge should be able to reach maximum inches Hg vacuum for the pump (see pump instruction manual). This will let you know the pump is sealed properly. Confirm the high vacuum relief valve opens to prevent pulling more than maximum rated vacuum.
   - *If the vacuum level fails to reach maximum, there is an air leak at the dust collector or pump. Check the seal on the dump can on the cyclone, the filter housing lid seal at the pump, the vacuum breaker valve, (verify it has air 85 to 100 psi), and all piping connections.*

   – If the maximum vacuum is reached, and the relief valve functions properly, reconnect the vacuum line to the system and perform another vacuum check. If maximum vacuum is reached, and the relief valve functions properly, the system is sealed and all station vacuum valves are closed.
   - *If the valve doesn't open, you have a system vacuum leak. Check for any open lines, open system vacuum valves (Station T Valve or lid mounted External Fill Valve), or loss of compressed air to system vacuum valves.*
7. Check the vacuum while the system is conveying material. Normally, the pump vacuum gauge should read between 4" Hg vacuum and up to 1" Hg less than the pump relief point. Typically, vacuum<4" Hg indicates a vacuum leak or no movement of material. Vacuum >relief point can be caused by:
   - *Line clogging where too much material is in the conveying line without the proper air mixture.*
   - *Stations are being overfilled.*
   - *The filter on the vacuum chamber or at the pump may be clogged.*
   - *The station vacuum valve may not be opening (check control settings and the valve itself).*

Vacuum Breaker Valve
(See System Vacuum Breaker Valve - pg.40)



Self-Contained Loaders Are Not All Created Equal

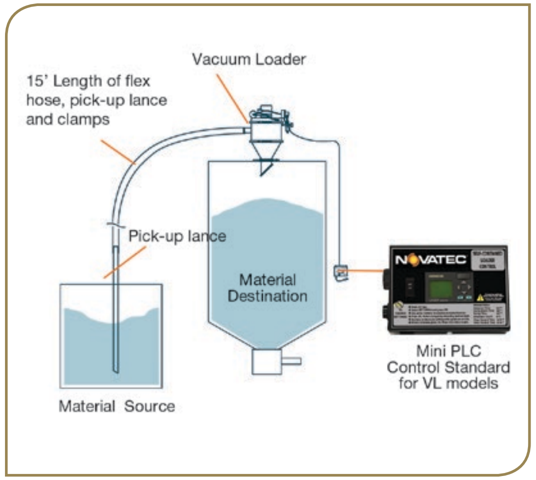
If you do not have a central material conveying system, self-contained loaders are a necessity.

Even plants with central systems find occasional needs for them..

Self – contained loaders are commonly used to convey plastic resins a short distance from a source (typically a bulk box) to a destination - usually a drying hopper or a process machine throat, otherwise they find themselves hand-loading these materials which is time consuming and usually wastes a lot of material.

HOW DO THEY WORK

The most common type of loader, utilizes a lid-mounted motor to create the vacuum to pull material into its body Another type of loader, commonly called air loaders, compressed air loaders or venturi loaders utilize plant compressed air that is directed through a venturi with adjustable flow rates to pull material into its body. JIT machine mount models deliver material directly to the throat of a processing machine.



Loaders package: pickup wand, flex hose, hose clamps and small PLC.

MOTOR LOADER VARIATIONS

The material capacities for motor loaders usually range from about .04 ft.3 to about 2 ft.3 All motor loaders include a blowback feature to help reduce filter clogging and reduce maintenance. There are many loader design variations. We show some of them on the next page.

Brush-type motors are the industry standard and they can convey up to about 650 lb. of material per hour, over a distance of about 15 feet, depending on the type of material and the its bulk density.

Disadvantages of Brush-Type Motors include:

- *The motor has to be replaced after about 1250 hours.*
- *During that time, the brushes have to be replaced 3 times.*
- *After 3 motor changes, complete loader replacement is usually necessary.*

Brushless motors are becoming increasingly popular because they eliminate the maintenance required for brush-type loaders and throughput capacities run - up to 1200 lb./hr. - much higher than brush-type motor loaders.

Commonly Used Vacuum Loader with Brush-Type Motor | *Increasingly Popular Vacuum Loader with Brushless Motor* | *Loader with Popular Brushless Motor plus Pivoting Body and Lid for safety and convenience.* | *Vacuum Loader for Powders Employ Special, Washable Filters* | *Machine Mount Loader Feeds Material to Machine Throat or Blender Hopper* | *Air Loaders Feed relatively small amounts Material to Machine Throat or Blender*

Troubleshooting

Most loader problems are a result of a dirty filter, air leaks or improper adjustments. These items should be checked before assuming equipment failure.

Problem	Investigate
Motor will not run	A, B, C, H, and L
Inadequate or no vacuum	D, E, F, G
Inadequate or no material flow	D, E, F, and G, I
Motor runs but proportioning solenoid not operating	J

CHECK		CONDITIONS	SOLUTION
A	Power	No voltage or voltage incorrect	Check incoming power supply voltage at outlet
B	Stop/Start Switch	No voltage through switch	Replace switch
C	Vacuum motor	No voltage at motor	See A,B, & L
D	Filter	Filter dirty	Replace filter (Also see G & J)
E	Flex Hose	Obstructed	Remove obstruction
F	Leaks in system	Air leaking into system	Replace gaskets & flex hose and discharge Flapper. Replace as necessary
G	Blowback air pressure incorrect	Low pressure	Increase pressure (not to exceed 125 psi)
H	Limit switch	No voltage through switch	Replace switch
	• Load Time	Chamber not filling sufficiently Chamber over-filling	Increase load time Decrease load time
	• Pulse rate	Insufficient to clean filter	Increase rate
	• Dump time	Insufficient to allow complete emptying of chamber	Increase time
I	Pulse solenoid	Correct voltage at solenoid	Replace solenoid

feature

Could a Central Conveying/ Drying System Save You from Continued Losses?

Experience has taught us that processing plants without a central material distribution system are

incurring big losses every year that are often deducting hundreds of thousands of dollars from their bottom line.

Here is what a plant survey by a systems specialist typically discovers:

- *Machine downtime*
- *Excessive labor costs*
- *Material losses*
- *High instances of rejected parts*
- *High energy costs*
- *Safety hazards*
- *Line plugs*
- *High maintenance*

There are other reasons you may need a plant survey:

- *Your customers are demanding improved product and response times.*
- *You want to expand your customer base.*
- *You need space for more processing machines for expansion – or for plant consolidation.*
- *Potential customers are demanding improved material verification/validation.*

Usually, ***the cost to install or upgrade an efficient resin handling system is recovered in a matter of months – not years*** but a thorough review of conditions in your plant is required to identify areas of loss and possible remedies.

YOU ARE A GOOD CANDIDATE FOR CENTRAL DRYING/CONVEYING IF...

- *You have frequent material changes on your machines*
- *You use more material types than you have machines*
- *You want to expand, but do not have sufficient floor space*
- *You are wasting large amounts of materials*

YOU ARE A GOOD CANDIDATE FOR CENTRAL DRYING/CONVEYING IF YOU DRY MATERIALS & FACE THE FOLLOWING ADDITIONAL CONDITIONS:

- *You have dryers on multiple machines*
- *You have a single material that requires drying and it is required at multiple machines*
- *You have dryer to dryer quality issues when drying the same material*

Dryers, Hoppers and Blenders on Mezannine with material storage under mezannine.

PLANT PROCESSES DETERMINE THE TYPE OF SYSTEM REQUIRED

Here are factors that should typically be considered:

- *Does the resin require drying?*
- *Are similar materials being processed - such as PE and PP?*
- *Is a common-line system possible, or are dedicated conveying lines preferred or required?*
- *Do the materials need dry or ambient air for conveying?*
- *Are material selection manifolds required?*
- *Is verification and validation of materials critical?*
- *Does the process require blending?*
- *Is line purging required?*
- *Are process quantities large enough to justify silo storage?*

All of these questions are best discussed with a system designer who will help guide you through your selection process.

CENTRAL VACUUM CONVEYING OF RESIN FROM ONE OR MORE SOURCES TO ONE OR MORE DESTINATIONS

Pros:

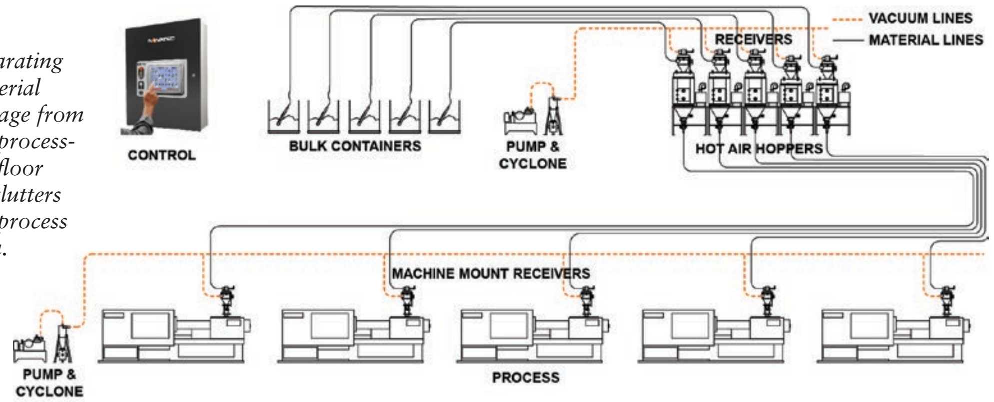
- *Moderately priced*
- *Delivery rates to match any requirement*
- *Maximizes machine up-time*
- *Improves uniformity of product quality*
- *Maximizes use of floor space by minimizing congestion around the machines*
- *Allows material validation and verification*
- *No fines blown into the environment*
- *Greatly improved housekeeping – reducing injuries*
- *Minimizes material waste*
- *Expandable with several system configurations*
- *Easily integrated with silos, blenders, dryers, surge bins, etc.*
- *Can be integrated with plant-wide monitoring and control systems*
- *Minimizes human intervention in the process to ensure lower labor costs*

Cons:

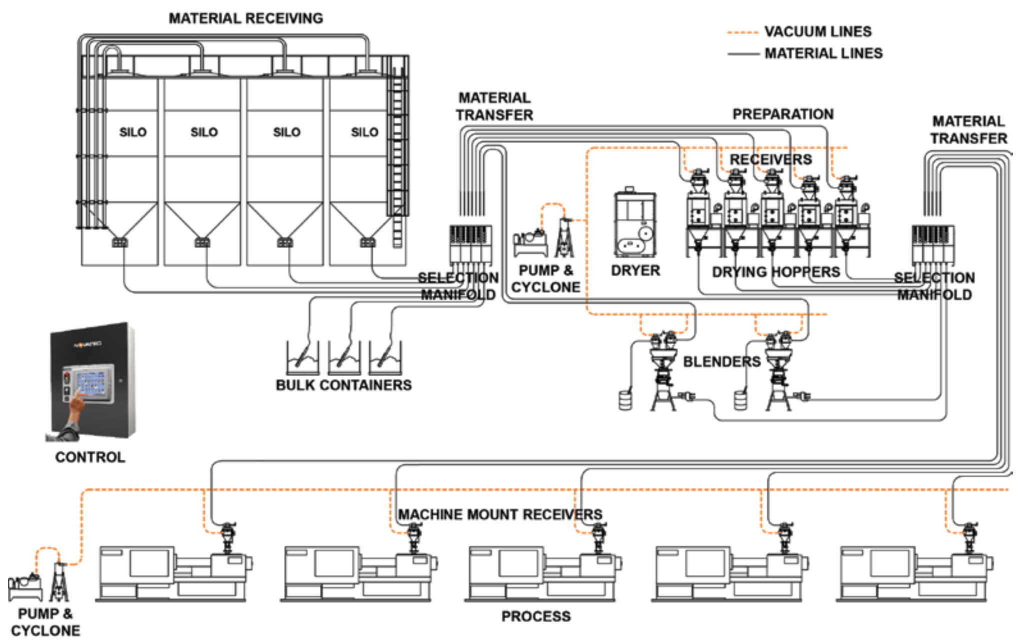
- *Personnel may need to be re-trained to operate larger centralized systems.*

System Integration

Separating material storage from the processing floor de-clutters the process area.



Central material sources open up the process area for additional machines, and it typically reduces waste by helping to ensure that bulk boxes are completely emptied and that the correct material goes to the process machine. It also keeps fork lifts out of the process area. Consistent moisture removal can greatly improve product quality and reduce waste.



Integrating all phases of the process including the blending of additives and regrind is ideal

Larger systems include silos with truck or railcar filling, plus material selection manifolds to distribute various material sources to plant wide destinations. Source-to-destination I.D. Proofing ensures correct selection manifold connections. Central Drying of hygroscopic materials is typical. Central vacuum pumps pull the materials all the way through the system and to the process machines. Central Controls manage the process.

Central System Controls

Touchscreen controls are the typical interface applied to advanced resin conveying / drying systems. A touchscreen can be made to operate either a programmable logic control (PLC) or a microprocessor-based control. Touchscreen interfaces have multiple advantages versus membrane interfaces, which have a limited number of display lines and characters. The touchscreen interface can be graphical in appearance and animated to deliver intuitive setup and monitoring of system operation. An industrial touchscreen interface operating a PLC often uses an open-protocol programming language that can be more easily customized. Proprietary touchscreens often are not easily customized, can be problematic to troubleshoot, and have unpredictable service support life cycles. Industrial touchscreens are readily available, are industry tested and have a predictably long service life.

A good match of control systems to plastics conveying equipment is important for a system to operate efficiently, whatever its size and capability. Some plants use simple self-contained loaders with built-in controls, others use microprocessor controls for just a few stations while larger plants use Color Touch Screen and PLC Controls for central systems with up to 20 or more vacuum pumps and 120 or more receivers. Determining what conveying controls to use can be a complex process, but help is available from a knowledgeable systems specialist.

INVESTMENT PAYBACK IN MONTHS – NOT YEARS

CASE STUDY - PAYBACK FOR 57 MACHINE PLANT

The example for the plant with 57 molding machines includes adding both a central drying and resin conveying system and is estimated to save the processor about $850,000/year by reducing energy consumption, labor, machine downtime, wasted materials and rejects. The total system investment including installation was about $1,000,000 The payback was about 14 months. This processor has also increased production output and sales!

YEARLY SAVINGS:	
Improved Machone Utilization	$ 169,000
Energy Savings	$ 64,000
Waste Material & Rejects from Overdryed/Under dried material	$455,000
Labor Savings	$129,000
Electrical Savings (Loaders etc)	$13,000
Vacuum Pump Energy Savings	$16,000
Total Savings Per Year Payback - About 14 Months!	**$851,000**

Conveying System Troubleshooting

SYSTEM COMPONENT OPERATION DETAILS

RECEIVERS:

1. Vacuum Sequencing Valve Not operating
2. Receiver discharge Valve stuck open
3. Receiver inlet valve stuck open

See – *Poor or No Conveying* in Receivers Article

PUMPS

General Pump Startup / *Troubleshooting Guide* - See Vacuum Pumps Article (pg.33)

SYSTEM VACUUM BREAKER VALVE

Located on the central vacuum pump of the system, the vacuum breaker valve allows ambient air to be drawn into the pump during the control's "seek" (or idle) time when the conveying system is NOT transferring material. This function cools the pump to extend oil or grease life, and prevents excessive starts and stops that can lead to motor and starter failure from over-heating.

The pneumatically-operated breaker valve must close and seal when the vacuum system is conveying material, directing all vacuum force to the job of conveying. Periodically check the following to ensure proper operation:

1. The valve is connected to a reliable source of clean compressed air, which is turned on. Air pressure should be 80-100 psi.
2. The valve must not be leaking vacuum air at normal operating levels. Often a sucking sound can be heard, indicating the valve is not sealing properly. Caution: if pulling maximum pump vacuum when hearing this sound, pump is in overload condition – check for vacuum blockages or excess line loading.
3. View the level of vacuum created by the pump on its vacuum gage while attempting to convey material: although the reading on this gauge will vary greatly depending upon your system configuration, it is a valuable tool for assessing system operation and discovering faults. Vacuum levels below 2" Hg can indicate the breaker valve is not closing when trying to convey material.

FEED TUBE TAKE-OFF BOX AIR SETTINGS

The conveying of material by air cannot be accomplished without air movement. Regardless of the type of pickup device being used; purge valve, wand, take-off box, etc.… these devices must be adjusted to allow the introduction of material <u>and</u> air, in a mixture suitable for conveying the specific material the distance required. When the pickup device is shared by more than one station, it's best to set the pickup device when conveying to the station located furthest from the source. Always start the process with the air adjustment fully open, or material adjustment set for minimum flow. Increase material loading in the system to meet the pump's recommended operating vacuum.

MATERIAL SOURCE ISSUES

<u>Common bulk box issues are:</u> Rat-holing, plastic liner sucked into pic-up lance, no material at pick-up point (box empty).

COMMON MATERIAL SELECTION ISSUES

1. Conveying line connected to the wrong source of material.
2. Wrong purge valve selected: If a purge valve is used at the material source, it must be selected through the system control to operate in conjunction with a specific receiver. Material changes require making a new valve selection at the system control.
3. Purge valve is not operating: If a purge valve is used at the material source, it must be energized to allow material loading (and de-energized for purging). A fault at this valve, such as loss of compressed air, an open access door or jammed dispense gate / piston will prevent material movement.

CONVEYING CONTROLS NOT PROPERLY (RE-) PROGRAMMED

Central material conveying systems that include a network of pumps, receivers and material sources provide high efficiency maximum process flexibility. But it's crucial that new requirements are entered into the logic controller through the control interface when physical changes are made, such as installing a new material source, receiver station or central vacuum pump into the system. Items to check include:

- *Is the new material source further away than the previous source? More conveying time and/or purge time might be required to accommodate this difference in distance, as well as possible adjustments to the feed rate of the pickup device.*
- *Is the new material as free-flowing as the last material? Does the material have a tendency to clog the conveying lines, or simply convey slower due to weight or shape? Again, changes to load/purge times, as well as material pick-up device changes, may be required.*
- *Has the receiver been assigned to the proper vacuum pump? The proper material valve?*
- *Has system piping and or wiring been modified to accommodate this new configuration for conveying?*

SYSTEM CONTROL OPERATION – STATION CONVEYING TIMER SETUP

Once the timers are set to deliver the maximum amount of material per load to the vacuum chamber without overfilling it, they should not be changed.

Exceptions:

When the material source is changed to a location much closer to the receiver or point of use, the pump may operate at a reduced vacuum level, so a dedicated pickup device can be adjusted to increase the material transfer rate until the system vacuum matches the recommended pump operating vacuum. This rate adjustment will often require the load time be reduced accordingly.

The opposite is true when switching the material source to a location much further from the receiver or point of use. In these cases, a dedicated pickup device must be adjusted to reduce the material transfer rate to avoid overloading the pump. This rate adjustment will often require load time to be increased accordingly.

NOTE: When a source and its pickup device are shared by stations or points of use, the pickup device should only be adjusted and optimized when transferring material to the station furthest from the source.

For Purge systems, the purge time should be changed when the distance from the source is changed. Longer distance requires longer purge time.

Dryers, Hoppers, Pumps and Material Selection Manifolds on Mezannine

Vacuum Conveying Application Charts

A GUIDE FOR USING CONVEYING RATE CHARTS

Conveying system designers often use specially designed charts for estimating conveying rate. They offer a consistent, reliable way to evaluate a complex problem using a simplified tool. The information presented in the curves represents a specific material and setup, or a baseline. Because actual conveying performance varies dramatically based on the layout, material transferred, and other operating factors, each application is converted to match the baseline conditions by calculating equivalent distance and rate. The charts should not be used to estimate conveying rate for unspecified conditions.

The resin conveying charts in this guide provide a baseline for estimating system performance conveying free flowing cylindrical PP pellets, with bulk density of 38 lb/cuft. To accurately adapt these curves to your specific application, follow

1. CALCULATE EQUIVALENT DISTANCE - after identifying the piping arrangement for transferring material, calculate equivalent feet from material source to furthest receiver for the chart's horizontal axis:

Equivalent Feet
1 ft Horiz. Tube = 1 Equiv. ft
1 ft Vert. Tube = 2 Equiv. ft.
*1 ft PVC Flex = 3 Equiv. ft
90-deg. Bend = 20 Equiv. ft
*Vacuum Tube (see table)

*Ignore first 10 ft of flex hose & first 50 ft of vacuum tube

vac tube:	= mat'l OD	>mat'l OD
dist.	mult by	mult by
< 200 ft.	0.30	0.15
< 400 ft.	0.40	0.15
< 600 ft.	0.50	0.15
> 600 ft.	0.60	0.20

2. CALCULATE TOTAL REQUIRED SYSTEM RATE - add resin consumption rates for each point of use, as well as intermediate transfer point, such as surge bins, blenders and drying hoppers.

3. CALCULATE RATE ADJUSTMENT FOR MATERIAL - several material characteristics affect resin transfer rate, including bulk density, pellet shape, and surface friction. Calculate rate corrections for material type based on these factors for free flowing materials:

Mat'l Ref.	Rate Multiplier
PET	-20%
HDPE	5%
LDPE	10%
EVA	25%
HIPS	40%

Mat'l Ref.	Rate Multiplier
EVOH	65%
SQ. CUT FPVC	80%
PULVERIZED PE	100%
POWDER PVC	120%

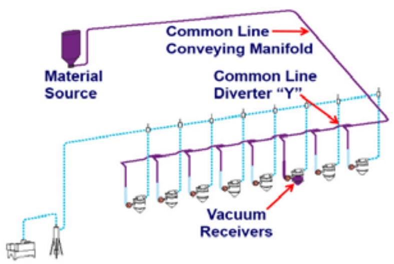
4. CALCULATE RATE ADJUSTMENT FOR REGRIND -

Bulk Density Ratio: (Regrind / Virgin)
Regrind Multiplier (A): (See Table 1)
Process Rate of Regrind (B): (lb/hr)
Regrind Rate Correction: A x B

Bulk Density of Regrind / Virgin	Regrind Multiplier
90%	0.11
80%	0.25
70%	0.43
60%	0.67
50%	1.00

5. CALCULATE RATE ADJUSTMENT FOR COMMON LINE - when using a single conveying line to transfer material to multiple destinations, each having a common line diverter, correct for losses:

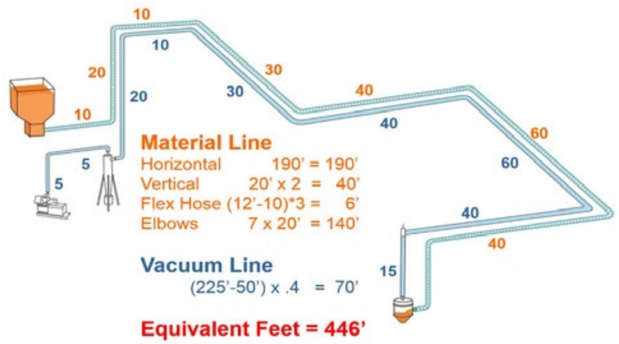
Correction for Losses = 2.5% x Common Line Diverters (installed in a single row)

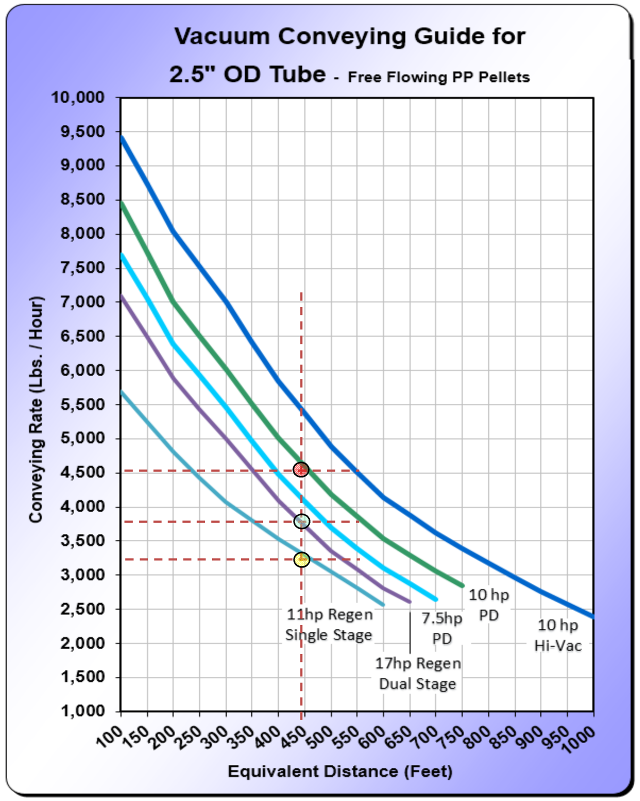


SAMPLE APPLICATION: PUMP SELECTION USING A CONVEYING RATE CHART

This simple example illustrates how a conveying rate chart is used to evaluate a typical application.

1) Calculate Equivalent Distance (see layout below for station furthest from source)	446 equivalent feet	
2) Calculate Total Required System Rate	3,000 lb/hr	(12 machines - actual usage)
3) Calculate Rate Adjustment for Material	150 lb/hr	(5% adder based on LDPE usage)
4) Calculate Rate Adjustment for Regrind	0 lb/hr	(no regrind used)
5) Calculate Rate Adjustment for Common Line	0 lb/hr	(no common line diverters used)
CHART LOOKUP RATE:	3,150 lb/hr	





EXAMPLES

A) Material LDPE (as shown above)
CHART LOOKUP RATE: 3,150 lb/hr

Pump Selections:
Minimum: VRB-17D (10% rate buffer)
Preferred: VPDB-7.5 (20% rate buffer)

B) Change material to EVA
(Instr. item 3 - 25% of 3,000)
System Rate: 3000 lb/hr
Rate ADJ: 750 lb/hr
CHART LOOKUP RATE: 3,750 lb/hr

Pump Selections:
Minimum: VPDB-7.5 (12% rate buffer)
Preferred: VPDB-10 (25% rate buffer)

C) Add 8 common line diverters to B)
(Instr. item 5 - 2.5% x Adj Rate x Common Line Diverters)
Rate for EVA: 3,750 lb/hr
Rate ADJ: (2.5% x 3,750 x8)
CHART LOOKUP RATE: 4,500 lb/hr

Pump Selections:
Minimum: MVP-10 (22% rate buffer)

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