

# Pneumatic Conveying Guide

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## What is Pneumatic Conveying?

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Pneumatic Conveying is a cost- and energy-efficient method of transporting dry bulk materials such as powders and granules from one place to another.

A typical example of a pneumatic conveying system that we engineer and manufacture involves conveying a material (such as polymer, lime, soda ash, plastic pellets/powder, dry milk etc.) from a railcar or truck to a silo (or vice versa).

Other applications include intermodal/transloading, in-plant transfer, dust control, and portable solutions.

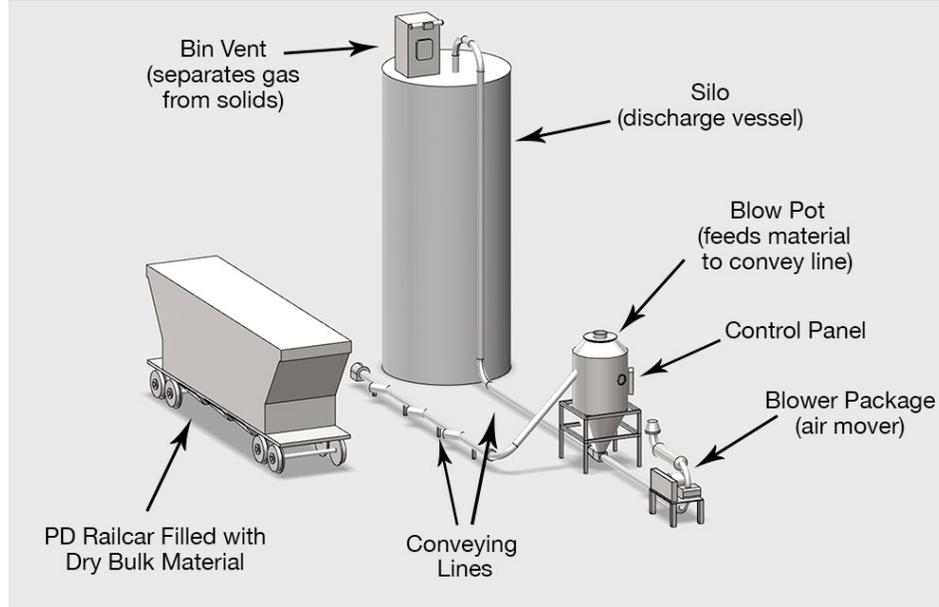
It's important to understand that "pneumatic conveyor" is not a single component. It's a collection of components working in concert as a system.

The basic components of a pneumatic conveying system:

- An air mover (blower package)
- Conveying line from vessel containing material (header)
- Blow Pot (temporary vessel that feeds material into the line)
- Conveying line to discharge vessel (up to top of silo)
- Discharge vessel (silo)
- Filtration system to separate the solids from the gas (air) at the end of the system (bin vent)
- A control panel to control and automate functions of the system

The 'brains' reside in the industrial control panel. This panel starts the blower, receives information from sensors, and times the operation of the equipment to achieve high rates.

The panel typically uses electricity but we've developed pneumatic logic controls for applications where electricity is unavailable or undesirable. Programmable Logic Controllers (PLC's) are utilized on more complex installations.



US Systems Basic Pneumatic Conveying System Diagram

This diagram shows the basic components of a pneumatic conveying system. In this particular system the operator connects the intake convey lines to the PD railcar and after a safety check starts the system.

1. The blower motor starts and then turns the shaft of the blower via belts or direct drive. The blower intakes filtered air, compresses it, and then pushes it through the line.
2. The pot then utilizes a proprietary venturi system to induce a vacuum and the material is vacuumed from the railcar into the Pot.
3. Either by sensor automation or by manual control, the system will switch from vacuum to pressure mode and the material is blown through the convey lines and into the silo.
4. This process continues at high rates until the car is empty.



## Why is Pneumatic Conveying Better?

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Pneumatic Conveying is a deceptively simple and clever solution to many traditional conveying problems. It's an elegant alternative to mechanical conveyors that utilize moving parts such as belts, screws, rollers, vibrating plates, elevator buckets, drag chain, cables, discs, etc.

These systems can work well for conveying large objects, although they are limited in the ability to safely and effectively convey small and fine materials such as plastic (pellets/powders), polymer, lime, soda ash, cement, alumina, talc, silica, etc.

This is especially true for foods such as flour, grain, milk, seeds, sugar, etc. In a pneumatic conveying system, these materials cannot be ground down by the pneumatic conveyor or stuck between mechanical components, as they can in a mechanical conveyor.

If you don't want your material scattered, spilled, ground up, or undesirably dispersed then suspending these particles in air through a pneumatic conveyor tube is an exquisite solution to these problems.

### Advantages of Pneumatic Conveyors

1. Cost savings in freight rate of bulk materials.
2. Savings in the elimination of packaging costs of smaller bags and containers.
3. Closed system conveying reduces cross-contamination.
4. Routing flexibility – can be transported to remote areas of plant, vertically and horizontally
5. Easy dust control
6. Can have several pick-up points and routes controlled with valves.
7. Lower maintenance, power, and labor costs.
8. Wide variety of materials can be conveyed, even ground up car batteries (re-grind)!
9. Ease of automation and control

Adapted from these sources: *Kraus, Milton N., Pneumatic Conveying of Bulk Materials*, and *Marcus, Leung, Klinzing, and Rizk, Pneumatic Conveying of Solids*

### Our Pneumatic Conveying Solution Eliminates:

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- Blow-by Air
- Worn Shaft Seals
- Bent Rotors
- Holes in Elbows
- Wasted Horsepower and Energy
- Worn Out Housings
- Chain Drive Maintenance
- Valves with Inherent Leaks

## **One Size *Does Not* Fit All**

Our competitors may not take the time with you to fully understand your needs and design a customized solution. Our philosophy is that it's nice to get sales, but not to the detriment of our customers process! That's why our motto is "Total System Responsibility".

Pre-fab systems forced into what should be a custom application can lead to disruptions and problems once a system is installed. The problems of a one-size-fits-all solution can present themselves months later, leading to costly fixes of a problem that could have been solved by more carefully evaluating the specific circumstances of the customers material handling needs.

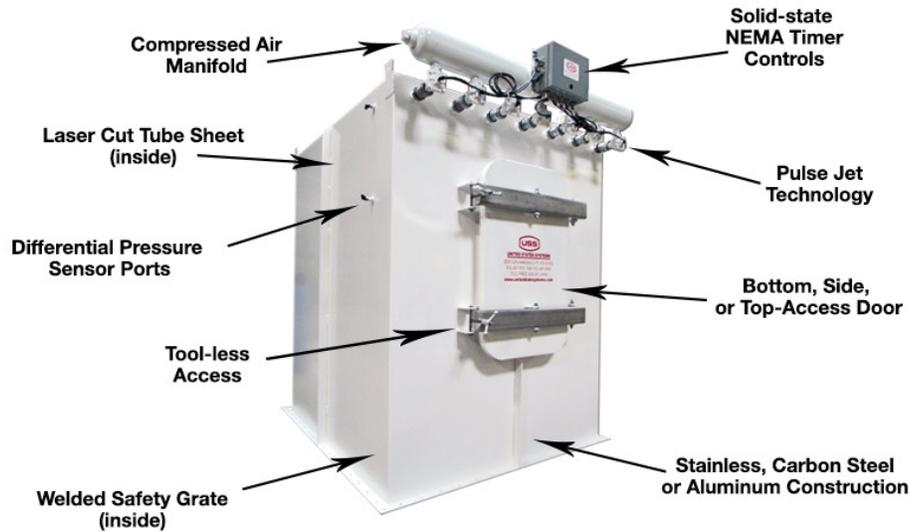
We hate to see customers spend more on their system than they have to. That's why we guarantee our equipment and don't build you anything we can't or aren't willing to support.

A custom solution doesn't necessarily cost more, as it will often work better with less problems. Pneumatic conveying should solve a lot of headaches not create new ones.

US Systems goes the extra mile, we take the time to carefully analyze your needs, and we work harder than anyone to create the perfect customized solution, saving time, effort, money – and headaches. All at a price that competes with the pre-fab 'solution'.



## Bin Vent with Pulse Jet



US Systems Bin Vent

## Blower Assembly with Starter Panel



### Blower Assembly Features:

- Capacities from 100 CFM to 2600 CFM
- 15 PSI - 18" Hg operation
- High capacity intake filter
- Filterminder service indicator
- Rigid structural steel frame and mounting table
- Variable speed, direct or belt drive
- OSHA belt guards for safety
- Configured for portable or fixed applications
- Premium quality TEFC or XP Motor
- International voltages available
- Air to air heat exchangers/after-coolers available

US Systems Blower Package with Starter Panel

## Commissioning and Education

Pneumatic conveying saves time and money in many applications by providing consistent service and uptime, labor costs, and energy costs upwards to a factor of a quarter of the costs of mechanical system. It can convey materials where others can't, and do so elegantly. Where our competitors might ship their system and call it quits, we provide our clients with commissioning services to ensure that you are up and running right away, the system is balanced, and that your operators know exactly what they're doing.

## Support After Installation

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US Systems is here to support you long after your system is installed. We offer a full compliment of consumables and replacement parts. With installations running for decades, we've even refurbished machines and placed them back into service. It's easy to call and order a replacement part such as a filter or fitting. Just call 888-281-2454 and we'll make sure you get what you need, fast.

### How We Control Excessive Fines and Protect Friable Material

Fines occur when pellets stick to the wall and leave material behind called angel hair, it breaks off and appears in the system. Sometimes they create a coating on the inside of the pipe and then it peels off called a snakeskin. Sometimes the pellets have small imperfections after they are cut and have an 'ear' sticking out. That breaks off and creates a fine. This affects the melting of the pellets and causes defects. The causes vary with the application, it's important that your company has experience working with these problems.

If heat is an issue we can use vacuum. We may also opt for an after cooler. Velocity changes over the length of a conveying line. An experienced engineer can often balance the system by controlling velocity to avoid these problems in the first place. We are mindful where we put the energy in the system for your particular application so it doesn't show up places you don't want it to.





Portable Pneumatic Railcar Unloading Pot on Castors

**We have the experience and expertise to ensure common problems don't arise when conveying your material:**

- Mixtures becoming de-mixed because one ingredient absorbs moisture from the air and sticks to the wall, while the remainder of the mixture is conveyed through the line.
- A dry powdery mixture that pours readily out of a container may become a pasty mass in the conveying line due to the conveying air absorbing the heat of compression from the air blower.
- Perfumed materials may lose their odor during conveying, whereas other materials may absorb odors carried into the air inlet of the conveying system.

- An abrasive material that is successfully conveyed without erosion suddenly causes excessive erosion because the source of the material, and the method of pulverizing it has changed.
- In some cases, friable materials become degraded when air-conveyed through a pipeline that has several bends.
- Dry, finely pulverized materials will become fluidized in the conveying system and will flow uncontrollably from a bin and may even flush through screw conveyors.
- Plastics may require inert gas to prevent oxidation

Only through careful design and engineering can we preserve the properties and characteristics of the material handled.

## **Materials**

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Virtually all powder and granule materials can be conveyed. The characteristics of the material are extremely important because the system has to be tuned to the application. This is what allows for high rates and all of the benefits of pneumatic conveying.

### **Material Characteristics:**

- Specific Gravity
- Aerated or Loose Specific Weight
- Settled Specific Weight
- Particle Size
- Abrasiveness
- Moisture Content
- Corrosiveness
- Tackiness
- Aeration and De-Aeration Characteristics
- Angle of Repose
- Toxicity
- Temperature Limitations
- Crystal Structure, Form of Particles
- Absorption of Odors

### **Best materials are:**

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- Free-flowing
- Non-abrasive
- Non-fiber



Material Samples at the US Systems Office

## Dilute-Phase or Dense-Phase. Pneumatic Conveying Systems

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These “phases” refer to how the material flows through the pneumatic convey line. You usually hear about these three types:

### Three Types of Systems:

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1. **Dilute-Phase** systems in which material enters a stream of air under either negative or positive pressure, or is induced into the stream of air by vacuum. These comprise the familiar so-called pressure systems, negative pressure or vacuum systems, and variations of them.
2. **Semi-Dense Phase** systems in which air and material are intermixed simultaneously at the entrance of the conveying line. These systems operate at a lower velocity (medium-rate) than dilute systems, often used with abrasive or friable materials such as concrete and flyash.
3. **Dense Phase** systems in which air enters a mass of material to cause flow. Vacuum dense-phase systems can only use atmospheric pressure so the pressure is limited, thereby limiting the distance of convey lines. Pressure-tank bulk trailer systems and in-plant blow-tank systems.

### Dilute-Phase:

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Dilute-phase is a material-into-air-stream system. The material will enter the airstream and will be carried by means of lift and drag forces actin on the individual particles. These systems can handle a wide variety of materials over a wide range of conveying velocities. Velocities can be reduced to handle many friable materials without breakage, and many abrasive materials without excessive erosion of piping and equipment. In addition the

low material-to-air ratio used permits handling of materials with a minimum of contact between particles. This makes the system ideal for handling a variety of particle shapes and sizes without blockage of the conveying line. These constitute the most widely used of pneumatic conveying systems.

## Dense-Phase

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There is no universally agreed-upon demarcation of when a dilute-phase (material-into-air-to-stream) system becomes a semi-dense phase or dense-phase plug-flow system. For US Systems, a dense-phase system is a system that requires a rated pressure-vessel. These systems are the most expensive and make up only a small percentage of the overall pneumatic conveying market.

## We Achieve High Rates with All Types of Railcars:

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- Hopper
- Airslide
- Pressure Differential Cars

## We Provide Choices:

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Depending on the application, proven solutions could include header systems for multiple tracks and car spots, choices of vacuum, pressure, or combination systems and portable and self-powered units.

## Options:

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- Booster for Multiple Trailers
- Choices of Vacuum, Pressure, or Combination Systems
- Portable and Self-Powered Units

## Automation

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Our systems feature industrial-duty NEMA-rated control panels that automate much of the process, allowing your system to run smoothly, with less downtime.

We build control panels to meet your application needs and may include:

- NEMA-Rated Panels
- Disconnect Switch
- Primary Circuit Protection
- Industrial-Duty Buttons, Selector Switches, and Door Devices
- PLC – Programmable Logic Controller
- Motor Starters
- HMI – Human Machine Interface

- LED Indicator Lights
- Variable-Speed Controls
- Touchscreen
- Remote Networking Capability
- Data Collection

## Supporting Systems:

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To match the environment of our customers operations, US Systems Pot, boosters, and supporting systems are designed to be especially rugged. Unlike our competitors, we custom-design our systems to *fit your existing systems*, not the other way around.

## Each US Systems Pot features:

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- Stainless, Aluminum, or Carbon Steel Construction
- Visual Inspection Sight Glasses
- User-Friendly Access/Clean-Out Ports
- Manual or Automatic Controls of Pneumatic and Electrical Functions
- Premium Components Designed to Last
- We Offer 12VDC, Pneumatic, or 120VAC Options for Controls



A US Systems vacuum filter receiver used to pneumatically convey sodium sulfate from a railcar to a silo at a packaging plant in Louisiana.

## Accessories:

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Accessories that enable the operators to work safely and efficiently include easy to connect aluminum vacuum gate adapters with leak proof connections, manifolds, and flex hoses of stainless steel and food-grade rubber to mate railcars to systems.

### **System Support:**

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To adjust our scope of supply to meet your needs, US Systems can also supply peripheral components:

- Storage Silos
- Dust Collectors
- Convey Piping
- Couplers
- Elbows
- Industrial Automation Controls
- Manifolds
- Gate Adapters
- and more.

### **Good Piping Recommendations:**

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1. Always short as possible.
2. Keep the piping strictly vertical or horizontal when possible.
3. Route the piping with as few bends as possible.
4. All pipe bends should have four to five foot radius turns (sweeps or 15 X diameter of pipe).
5. Adequate venting (12" diameter minimum) on receiving bin.
6. Adequate dust collector on receiving bin when necessary.
7. Ample ground clearance (4-6ft.) at hose hook-up to allow liberal natural bend of hose.
8. Tight and smooth joints.
9. Use 5" line when high unloading rate is required – providing adequate CFM is available.

### **Poor Piping:**

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1. Sharp turns or elbows.
2. Useless bends or turns.
3. Shut-off or diverter valves in line.
4. Longer line than necessary.
5. Diagonal piping. Any deviation of 5 degrees or more from strictly horizontal or vertical will increase air requirement; otherwise surging plugging will result.
6. Any leak in conveying line will have similar results to no. 5.
7. Inadequate venting may result in pressure build-up in receiving tank, and may cause it to bulge or rupture. Note: never use other fill pipe as venting.

8. Fill pipe connection at bottom of hopper. Unloading against static pressure of product in bin reduces unloading rate substantially.
9. Horizontal hook-up connection to hose.
10. Reduction in pipe size. If trailer or portable storage unit has 4" or 5" piping, 4" or 5" piping should be provided the full distance.

## **Have a question?**

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**Our experienced engineers are standing by to help: 1-888-281-2454**

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