# Pneumatic Conveying Systems

## for granular, powdered and sensitive bulk materials

Pneumatic conveying systems (especially vacuum pneumatic systems) provide an ideal way to link manufacturing stages in production processes. Thanks to AZO's many years of experience, intensive research and continuing refinement of these systems, even fragile and abrasion-sensitive products can now be conveyed without any risk of damage. (For extremely delicate materials, AZO provides low velocity conveying with enhanced capabilities by tailoring system parameters to specific materials characteristics and tasks.) This was inconceivable just a few years ago!

**5800**

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# Pneumatic conveying systems mean greater efficiency

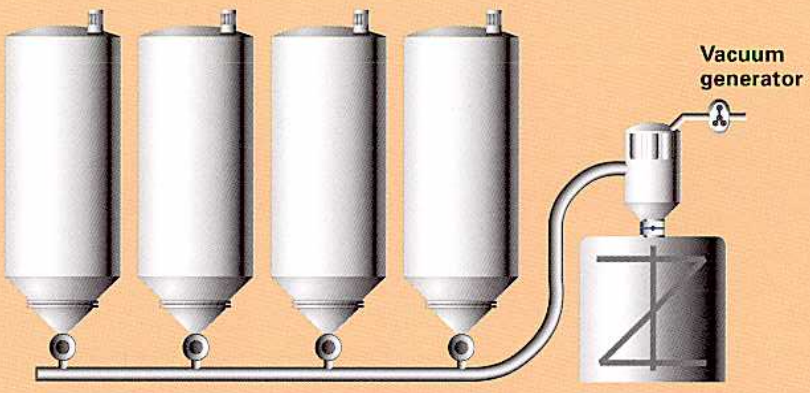
## Comparison of operating principles of pneumatic conveying systems

In principle, the conveying of bulk materials in the production process can now be automated in virtually all instances. A variety of pneumatic conveying solutions is now available for use according to the respective bulk material, the nature of the task, and the available space.

The advantages are impressive:
- Extremely high efficiency
- Dust-free, closed systems
- Space and height saving design
- Dependable and gentle conveying

There are two different basic systems – suction and pressure – which can also be combined.

## Vacuum pneumatic conveying systems




### Applications

Vacuum pneumatic conveying systems are best employed where the product is to be conveyed from **several** feeding points to **one** delivery point. Product entry to the system is extremely simple and dust-free since there is no excess pressure.

### Vacuum generation

The blower is always situated at the end of the system and generates the vacuum level required to motivate the conveyed product through the pipelines.

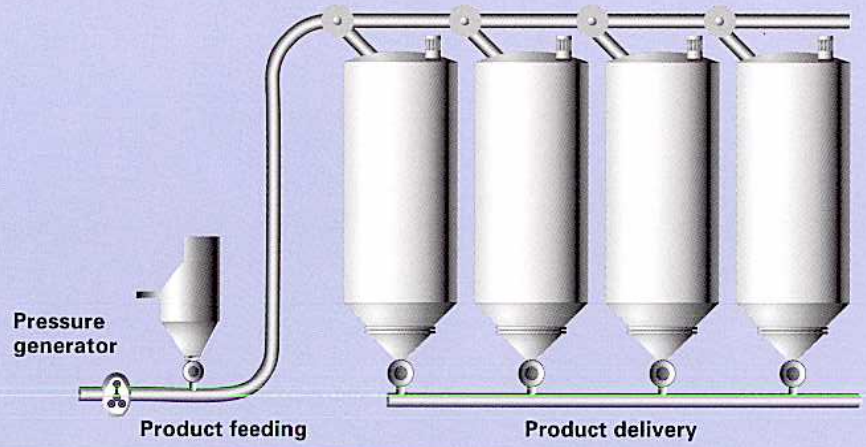
## Pressure conveying systems

### Applications

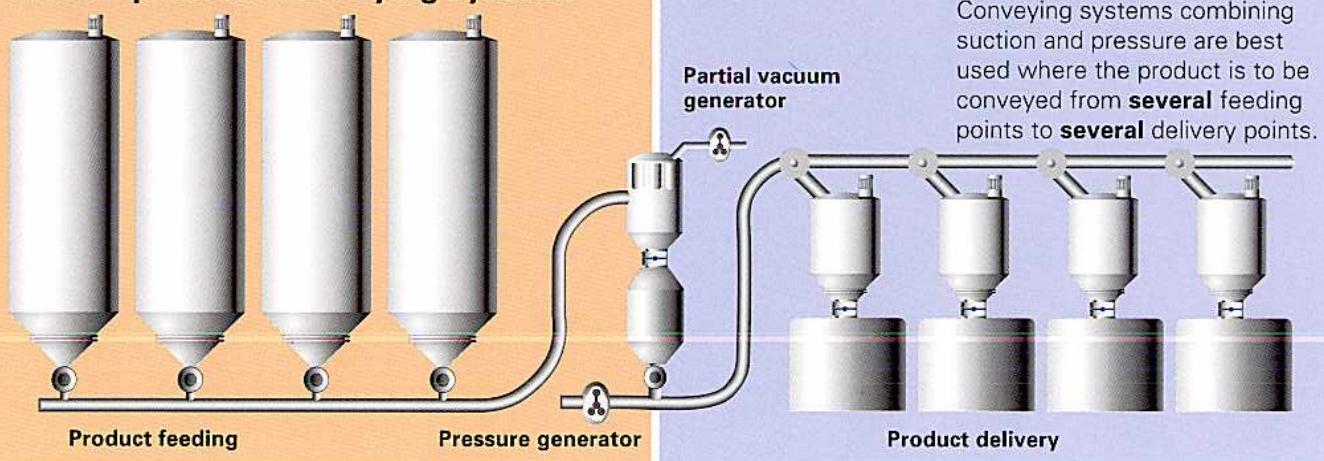
Pressure conveying systems are best employed where the product is to be conveyed from **one** feeding point to **several** delivery points over long distances. Due to conveying with positive pressure, airlocks or pressure vessels are required to introduce material into the system. Product delivery at the destination point is simple.

### Pressure generation

The blower is always situated at the beginning of the system and generates the pressure required to transport the product through the conveying lines.




## Suction-pressure conveying systems




### Applications

Conveying systems combining suction and pressure are best used where the product is to be conveyed from **several** feeding points to **several** delivery points.

# Important criteria for selecting pneumatic conveying systems

The wide range of bulk materials and production processes calls for different conveying technologies. Essentially, there are four different types of conveying: dilute-phase conveying, low-velocity conveying, semi-dense phase conveying and dense-phase conveying.

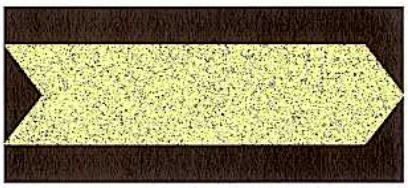
Terms of reference and conveyed product :

C/V = velocity ratio
V = air velocity
C = product velocity m/s
$Q_S$ = solids mass flow
R = solids loading = $Q_S/Q_A$
$Q_A$ = air mass flow

## Basic conveying characteristics and their applications

### Dilute-phase conveying and low-velocity conveying

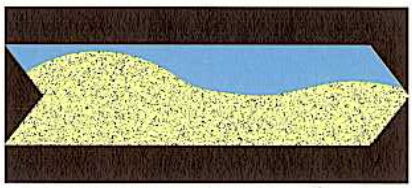
*C/V < 1* | *my < 10* | *V > 20 m/s*



- Classic method of pneumatic conveying
- Conveying velocity above the saltation point (all particles suspended)
- Uniform distribution of product in the pipe
- Higher product charging for granular product possible
- Abrasion of product and pipe possible

### Semi-dense phase conveying

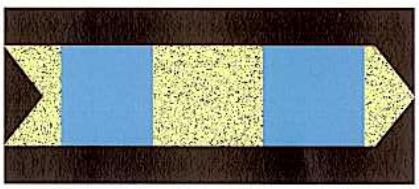
*C/V < 0,7* | *my < 10* | *V < 20 m/s*



- Dilute-phase conveying in top half of pipe
- Product accumulation in bottom half of pipe
- Residual product in pipe
- Reduction of product velocity down to saltation point
- More gentle than dilute-phase conveying

### Dense-phase conveying

*C/V < 0,5* | *my = 10-100* | *V = 3-10 m/s*



- Extremely gentle conveying for product and pipe
- Residual product in pipe
- Rule of thumb for dense-phase conveying: 1/3 air volume, 3-fold pressure, same energy requirement
- Stepped line sizes are often recommended for long distance applications

### Criteria for selecting pneumatic conveying systems

| Product characteristics \ Conveying systems | Suction conveying systems | | | | Pressure conveying systems | | |
|---|---|---|---|---|---|---|---|
| | *(Dilute-phase)* | *(Low-velocity)* | *(Semi-dense phase)* | *(Dense-phase)* | *(Dilute-phase)* | *(Low-velocity)* | *(Dense-phase)* |
| ***Superfine powder*** e.g. carbon black, fire-extinguishing powder | ●● | ○ | ●● | ●●● | ●● | ●● | ●●● |
| ***Particularly light*** e.g. styrofoam, aerosil | ●● | ○ | ●●● | ●●● | ● | ●● | ●●● |
| ***Powdery*** e.g. flour, PVC | ●●● | ○ | ●● | ●● | ●●● | ●● | ●● |
| ***Pourable*** e.g. PE grit, sugar | ●●● | ● | ● | ○ | ●●● | ●● | ● |
| ***Mixtures*** e.g. baking mixtures | ○ | ○ | ● | ●●● | ○ | ● | ●●● |
| ***High fat content*** e.g. cocoa, milk powder | ○ | ○ | ● | ●●● | ○ | ○ | ●●● |
| ***Abrasive*** e.g. glass-filled pellets, granules, powdered minerals | ○ | ○ | ●● | ●●● | ○ | ●● | ●●● |
| ***Granular*** e.g. rice, granulated products | ●●● | ● | ●● | ●●● | ●● | ●● | ●●● |
| ***Delicate, fragile*** e.g. tablets, capsules, chips | ○ | ●●● | ●● | ● | ○ | ○ | ● |
| ***Size & Shapes fragile*** *e.g. noodles, tea, molded parts* | ● | ●●● | ● | ○ | ○ | ○ | ○ |

●●● *to be recommended* ●● *good* ● *conditional* ○ *not suitable*

### Advice and Service

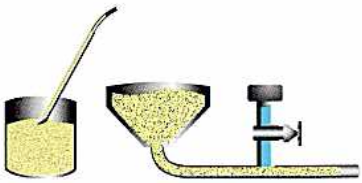
When a conveying choice exists for a particular material, AZO's highly-experienced professional staff uses several criteria to determine the most appropriate system. The installation situation, investment costs and required output are all determining factors.

Additionally, we run customer application tests and conduct conveying trials in our exceptionally well-equipped technology center.

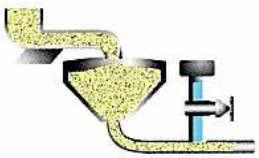
Testing continues until we find the optimum conveying system.

# Vacuum pneumatic conveying systems: components

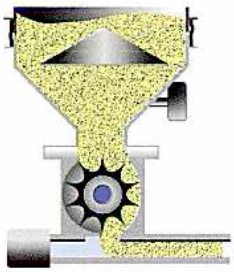
## Product feeding



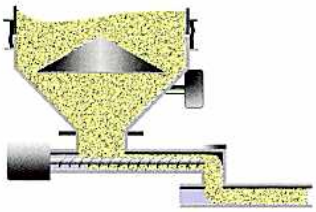
**Pick-up tube, pick-up hopper**
Most cost-effective method of product feeding. For granular, free flowing bulk materials that are not metered when feeding. With impulse systems, conveying air is fed in at timed intervals.



**Pick-up hopper with metering**
For free flowing products whose size and/or shape requires metered feeding in order to achieve gentle low-velocity conveying.

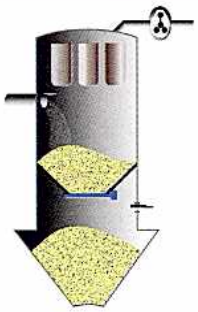


**Product feeder, airlock**
Cost-effective solution for free flowing products that require metered feeding. Switching from coarse to fine flow possible.

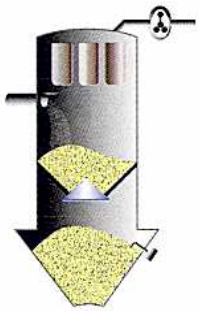


**Vibratory metering screw**
Very precise metering with coarse/fine switching. With several vibratory screws one above the other, optimum line allocation possible. Handles wide range of materials including those with difficult flow properties.

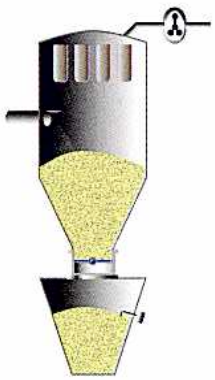
## Product delivery (separator)



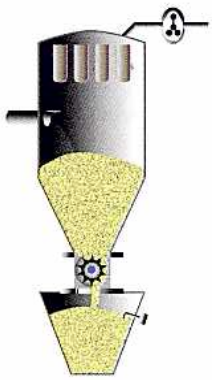
**Separator with flap valve**
Simplest product delivery for batch operation, e.g. for feeding discontinuous processes such as injection molding machines, filling machines, tablet presses, etc. Suitable for all free flowing and granular bulk materials. Flap valve serves as a demand signalling device.



**Separator with closing cone**
Interesting solution for lumpy or delicate bulk materials in batch operation, e.g. feeding of capsule-filling plants, packing machines for tablets, etc. Closing cone prevents crushing. Separate demand signalling device necessary.

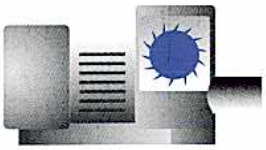


**Separator with butterfly valve**
Used for all types of flowable bulk materials that tend to separate out and downstream processes that demand selective emptying, such as gravimetric metering hoppers. Version with compressed-air operated butterfly valve provides a large outlet diameter. Separate demand signalling device necessary.

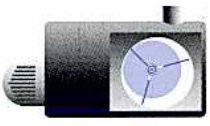


**Separator with airlock**
For continuous conveying and discharging of free flowing as well as difficult bulk materials with simultaneous metering into downstream processes such as cyclone screeners, compactors, mills, etc. Typical conveyed products are any powdery and granular bulk materials. Separate demand signalling device necessary.

## Partial vacuum generators



**Regenerativer blower**
For low differential pressures. For vacuum generation in negative pressure pneumatic systems up to 7" Hg.



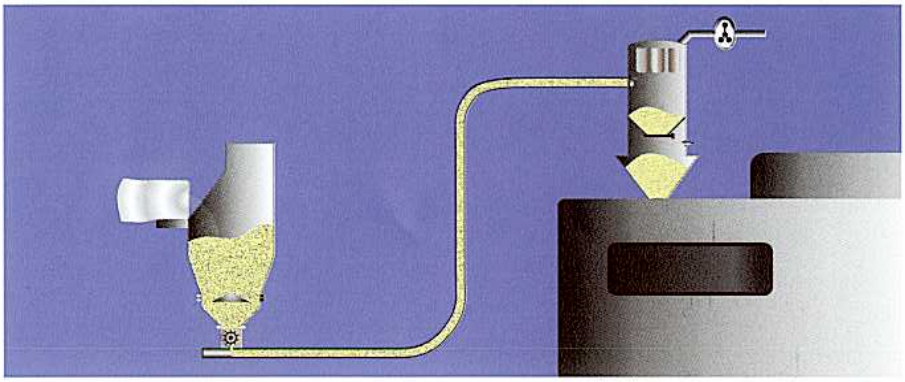
**Vacuum pump**
Use in vacuum pneumatic systems up to 28" Hg
Design:
- Rotary valve, oil-lubricated
- Water ring, oil-free
- Side channel, oil-free

No noise insulation necessary.

**Rotary piston blower**
For operation in vacuum pneumatic conveyor systems up to 15" Hg. High noise level – noise insulation necessary.

**All components shown here for product feed, product delivery and vacuum generation can be freely combined.**

# Pull-Push conveyor systems



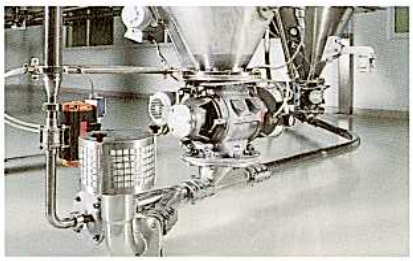
## Dilute-phase conveying

### Recommended applications

Classic method of pneumatic conveying. For feeding of filling and packing machines, injection molding machines, dryers, mills and other processing machines together with containers, tanks and silos. Typical conveyed goods are any flowable powder and granular bulk materials.

### Particular advantages

- Simple and cost-effective conveying solution
- No product sediments in pipe
- Dust-free process – large filter
- Automatic demand and level control

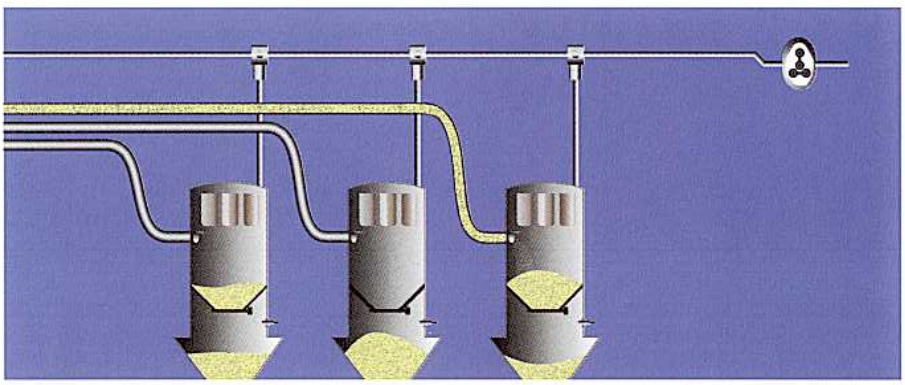


Metered feeding via lock

Container feeding from barrels

### Operating principle

Bulk materials can be fed from virtually all kinds of packaging such as sacks, barrels, containers, silos, etc. From the bulk goods feeding point, a partial vacuum conveys the product via a conveying pipe into a receiver where it is then separated. After each conveying interval, the filter is automatically cleaned off by means of compressed air pulses. All systems are ready for connection, fitted with the latest electronic control systems and signal when there is insufficient bulk material at the feeding point.



## Centralized feeding

**with common vacuum generator**

Centralized feeding for several processing machines

### Recommended applications

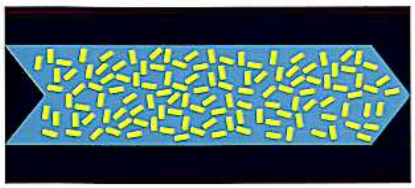
When product is to be conveyed to several processing machines at low to medium rates, centralized feeding with only one common vacuum generator is recommended.

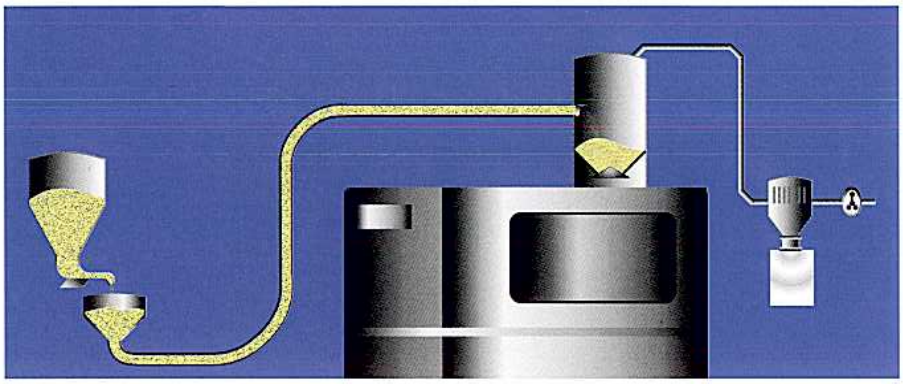
### Operating principle

All separators are connected on the clean air side to a common vacuum generator. The electronic control system scans demand signals in turn and switches the appropriate separator to suction mode by means of an angle valve. As soon as the receiver full signal is reached, conveying stops and the receiver empties. For non-dusty materials, the receiver is outfitted with course screen, and a remote filter is installed upstream of the vacuum generator.

# Vacuum pneumatic low-velocity conveying systems

## Dense-phase conveying





### Recommended applications

Newly-introduced, this innovative system conveys materials with a fragile size and/ or shape, all of which were previously thought to be too difficult for pneumatic conveying.

E.g. frozen vegetables, onion rings, mushrooms, noodles, sweets, nuts, tea, chocolate chips, tablets, capsules, pellets, plastic moldings, bottle caps, electronic parts, etc.

### Particular advantages

- Gentle conveying of fragile bulk materials
- Pneumatic conveying without destroying sensitive particle structure
- Conveying of heat-sensitive products without damage
- Feeding of filling machines without increase in bulk weight

**Metered bulk material feeding**

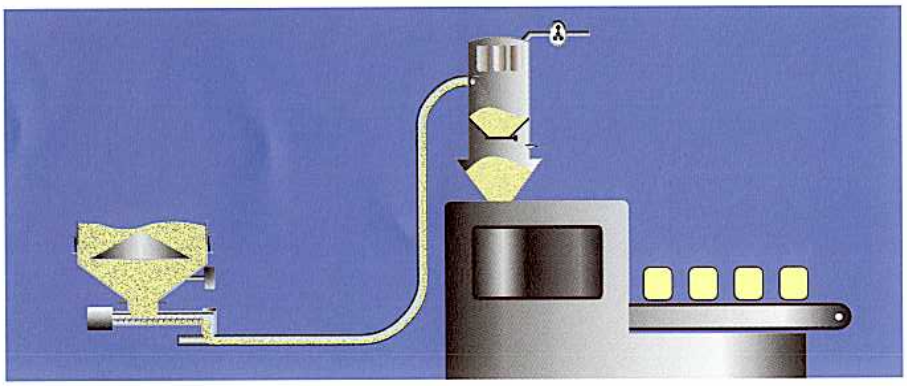
### Operating principle

Depending on the form and structure of the bulk product, feeding demands special attention. Metered feeding is necessary in certain cases. Lumpy bulk materials in the suction stream are conveyed into the receiver by the vacuum generated in the system, gently separated and emptied.
In many cases, the separator is designed only as a cyclone.
A secondary filter is then employed upstream of the vacuum generator.
For demand signalling, an external demand sensor is necessary.

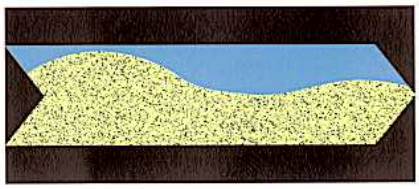
**Vacuum pump with upstream secondary filter**

**Feeding of a capsule filling machine**

# Vacuum pneumatic semi dense-phase conveying systems



## Semi dense-phase conveying



## Recommended applications

Depending on the nature of the task, for batch or continuous feeding of processing machines with powdery, particularly light (e.g. styrofoam, aerosil) or abrasive products (e.g. glass-fiber reinforced granules).

## Particular advantages

- Very gentle conveying solution for product and pipe
- Optimum line loading for the respective conveyed product
- Dust-free process
- Automatic demand and level control

## Operating principle

In the top part of the pipe, semi dense-phase conveying acts in the same way as dilute-phase conveying. In the lower half of the pipe, product accumulation occurs; consequently, conveying proceeds in a wave-like manner. For gentle conveying, the velocity can be reduced almost to the saltation point.

Feeding of internal silos

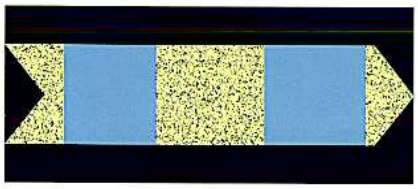
Pick-up hopper for styrofoam

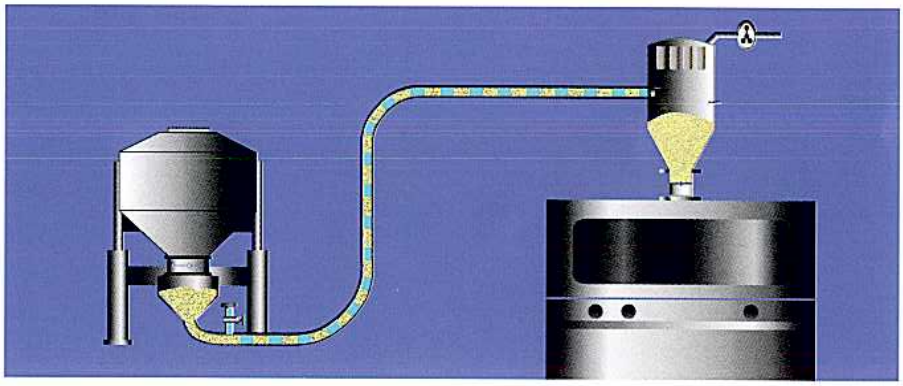
Vibratory metering screw for feeding of product

Large filter with service facility

# Vacuum pneumatic dense-phase conveying systems

## Dense-phase conveying





### Recommended applications

Most gentle method of pneumatic conveying.
It is especially suitable for batch or continuous feeding of processing machines with moist, high-fat content bulk materials that tend to stick together (e.g. milk powder, cocoa), with finished mixtures or delicate particle structures (e.g. cosmetic mixtures, baking mixtures, instant powders) as well as for conveying very fine or light products such as carbon black or aerosil.

### Particular advantages

- Extremely gentle and segregation-free
- Highly energy-efficient due to low air and product speed
- No abrasion and destruction of particle structure
- Optimum line loading to the respective conveyed product

### Operating principle

At the product feeding point (sack, barrel, container or silo), the conveyed product is transferred by means of timed air impulses through the conveying line and into the receiver in which product slugs and air cushions are alternated.
In the receiver, the conveyed product is gently separated from the conveying air and emptied into the downstream processing machine.
The filter cleans itself automatically.
A level sensor on the machine hopper functions as the demand signal.

**Easy-to-clean filter**

**Mobile vacuum hoppers with impulse valve**

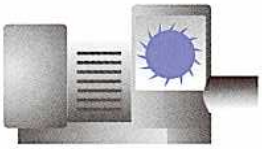
**Gentle feeding of tablet presses**

**Segregation-free feeding of filling machines**

# Pressure conveying systems: components

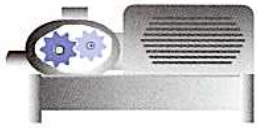
## Pressure generators

**For temperature-sensitive bulk materials, air cooling is needed with all pressure generators.**



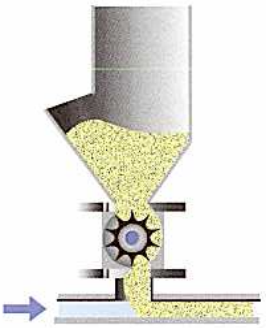
**Regenerative blower**
For low differential pressures in pressure conveying systems up to 6.5 psig.

**Rotary piston blower**
For generating positive pressures in conveying systems up to 15 psig. Noise insulation is necessary.

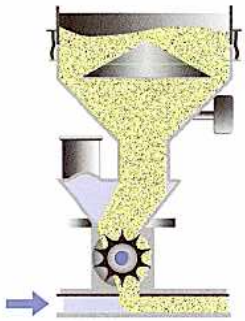


**Helical piston compressor**
For generating positive pressures up to 45 psig. Noise insulation is necessary.

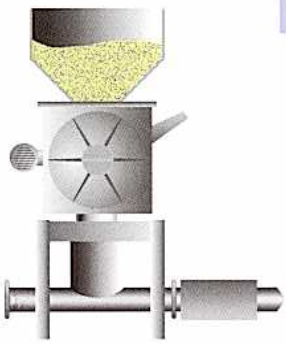
## Product feeding



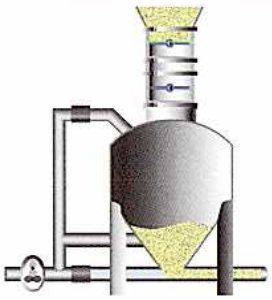
**Drop-through valve with pick-up pan**
For feeding granular products into pneumatic pressure conveying systems. Lock must be vented for better product feeding.



**Blow-through valve**
For feeding difficult powders and bulk materials. A vent hopper with filter is used to achieve optimum product feeding.



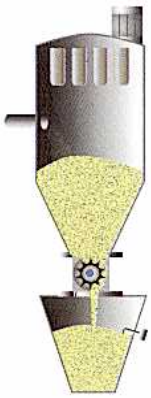
**High-pressure airlock**
For feeding granular bulk materials into low-velocity conveying systems. Compact height and space-saving design.



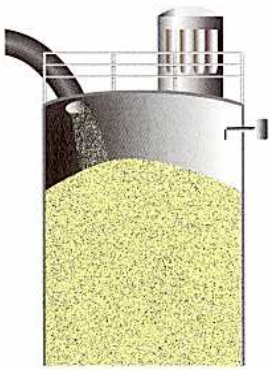
**Pressure vessel**
Product feeding in batch operation at high pressures. Long conveying routes possible. Can also be used with Laval nozzle for gentle low-speed conveying.

## Product delivery (separator)

**Separator with butterfly valve**
Used for batch separation of bulk goods. The conveying air is dissipated via large venting filters. When conveyed product reaches the full level sensor, conveying is stopped and the receiver is emptied. A new conveying cycle is started by means of the demand signal.



**Separator with rotary airlock**
Used for continuous separation, delivery and simultaneous metering in downstream manufacturing processes.

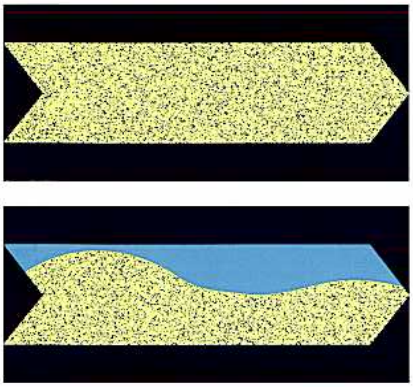


**Silo filling**
With pressure conveying systems via tangential conveying inlet or from above. Conveying air escapes via silo bin vent filter. When conveyed product reaches the full level sensor, conveying is stopped.

**All components shown here for pressure generation, product feeding and delivery can be freely combined.**

# Pressure Conveying Systems

## Dilute-phase conveying/ semi dense-phase conveying

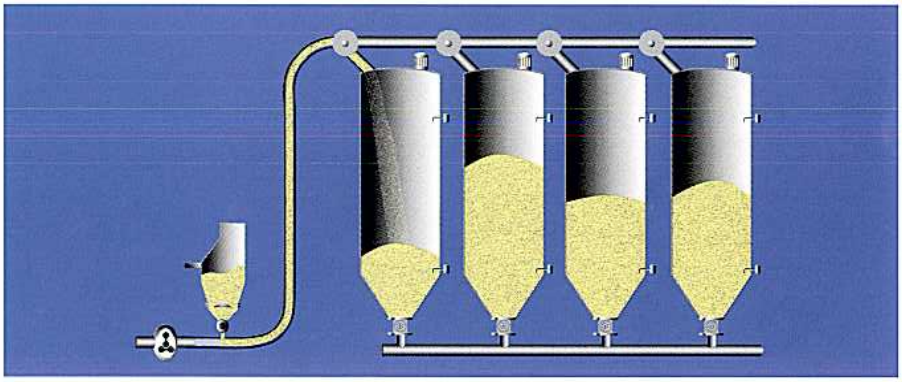


### Recommended applications

Typical conveyed products are any powder and granular bulk materials such as flour, semolina, sugar, salt, PVC powder, or granules.

### Particular advantages

- Long conveying distances
- High throughput rates
- Advantageous when one feeding point and several delivery points are involved

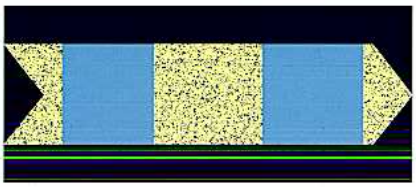


**Feeding into pressurized pneumatic system with vent hopper and venting filter**

### Operating principle

The bulk material is fed by means of a rotary airlock valve (drop-through valve with pick-up pan or blow-through valve). It is important to ensure appropriate valve venting. The pressure required for conveying is generated by a blower package. The bulk material is conveyed continuously and distributed to the respective receivers, tanks or silos via diverter valves. Adequately sized filters are required at the product destination points.

## Dense-phase conveying



**Distribution via diverter valves to internal silos**

### Operating principle

The high-pressure lock can be filled by sack feed, tank, silo or scales. Product and air are introduced with alternating pressure impulses into the conveying pipe. Even with high product charging, air consumption is very low and operating costs are markedly low.

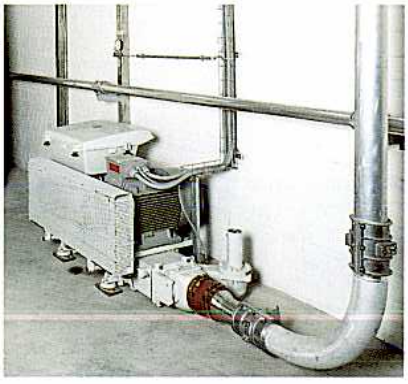
### Recommended applications

Gentle conveying of granules in low-velocity conveying systems with minimal abrasion and formation of 'angel hair'.

### Particular advantages

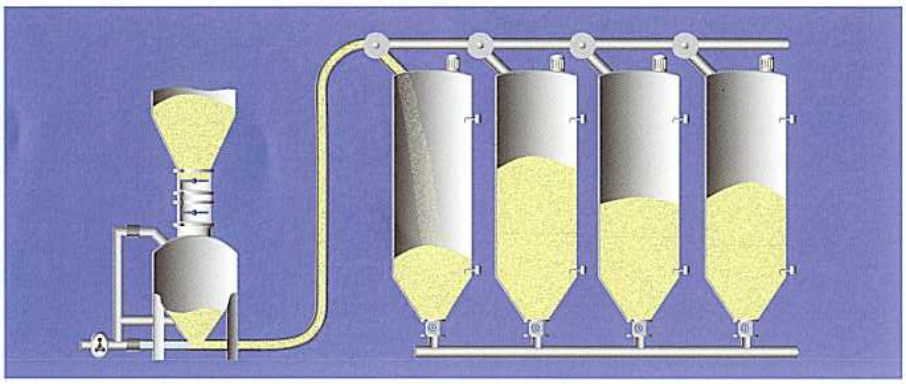
- Compact construction, height and space saving
- High operational safety, low control system costs
- Can be used for high pressure differentials

**High-pressure airlock for gentle conveying of granular materials**



**Positive pressure generator**

# Pressure-vessel conveying systems



## Recommended applications

Typical conveyed products are any granular and/or powder bulk materials that cannot be conveyed via airlocks due to abrasion. This applies to highly abrasive products (limestone, salt, minerals) or situations with very high conveying rates.

## Particular advantages

- Conveying of abrasive products
- Equipment wear kept to a minimum
- High throughput rates
- Conveying over long distances
- Conveying of bulk materials that have a wide range of particle densities

## Operating principle

The pressure vessel is filled from above, for example, scales, tank, silo or sack feeding station. The pressure vessel is then sealed pressure-tight and the required conveying pressure is applied to it. This can be generated by a rotary piston blower or taken from the central compressed air source. The distribution of compressed air to product and bypass is controlled and monitored according to pressure by an electronic self-optimizing control unit. Only when the empty state is signalled can a new filling cycle be started. In many cases, the emptying is monitored according to weight.

**Pressure impulse conveying system for feeding a bag-filling machine and big bag filling**

## Recommended applications

For gentle conveying of heat-sensitive and fragile bulk materials at high rates over long conveying distances.

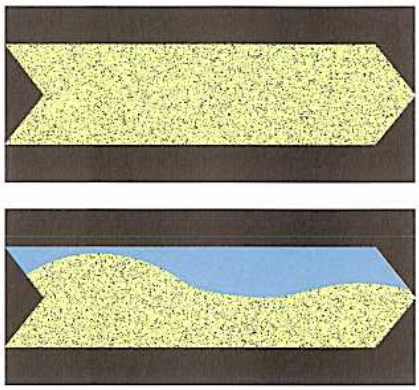
## Particular advantages

- Extremely gentle conveying
- Segregation-free conveying of mixtures
- Conveying with high pressures
- Low operating costs

## Operating principle

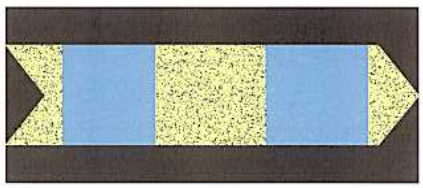
The pressure vessel can be filled by bag dump, tank, silos or scales. This conveying system works discontinuously with pressure impulses, i.e. an air cushion is forced into the conveying pipe between each product slug by means of a special conveying air feed device (Laval nozzle). The product is distributed via diverter valves to receivers designed for pressure conveying systems and equipped with appropriately-sized filters.

## Dilute-phase conveying/ semi dense-phase conveying



**Pressure vessel conveying systems**

## Dense-phase conveying



**Pressure vessels for conveying heat-sensitive bulk materials**

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