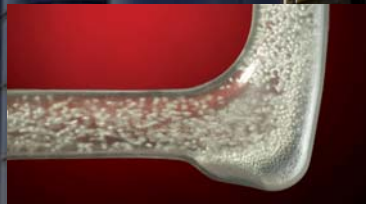


The New Thinking In
Pneumatic Conveying



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Introduction – Pneumatic Conveying Technology

The selection of the suitable pneumatic conveying transfer systems for dry bulk solids materials such as pellets and powders is important for the economical and reliable operation and function of the entire plant. Complex and unreliable systems lead to high maintenance costs and plant shut downs.

Material properties vary in size, shape, surface, weight and others factors that have a significant influence for the sizing and determination of the conveying system. The length of the system and the number of elbows are also very important design factors in the sizing process. In many cases, a conveying test in a test lab is necessary to determine the parameters for the correct system calculation. Therefore, Pelletron maintains its own test lab to perform a wide range of pneumatic conveying tests for our customers. The test lab is also the platform for the development of new conveying technologies.



**Pneumatic conveying Test lab
with elbows and Pellbows®.
We provide comparison tests
for dilute, dense and STRAND-
PHASE® conveying.**



Pneumatic Conveying creates dust and streamers

All types of conveying systems create contaminates, depending on various factors of the conveying system, plant layout and the pellet type.

Major Factors

Pellet Characteristics

- Hardness
- Particle shape, size and surface

Temperature

- Product temperature
- Conveying air temperature

Velocity

Conveying Line

- Wall Material
- Pipe Surface
- Number of Elbows
- Elbow Design
- Pipe routing and length



Blurry surface caused by dust



Black spots through burned dust



Build-up on a screw caused by dust

Why are dust and streamers bad?

Some examples

- High "Scrap" Rates from fines burning in mold
- Blurry surfaces through vaporized dust particles
- Weak spots in fibers
- Flaws in wire insulation
- Gels in films
- Housekeeping problems through dust and streamers
- Crusting of feed throat of screw
- Carbonizing of dust results in reduced mold & screw life
- Mold vents clogged by dust
- Streamers clogging equipment and machines
- Dust accumulation at silo walls and roofs

Generation of dust in the three conveying types.

Conveying type	Dilute Phase	Dense Phase	STRANDPHASE®
Dust type	Fine and coarse dust, long and short streamers, depending on the material	Very fine dust, high electrostatic charged	Fine and coarse dust, short streamers, depending on the material
Dust removal	Difficult because of high dust volume and streamers	Very difficult to remove electrostatic charged micro dust	Easy
Dust volume	High	Low	Moderate
Investment costs	Low	High	Moderate
Dust removal system	DeDuster®, removes dust and all kinds of streamers	DeDuster®, removes electrostatic charged dust	DeDuster®, removes dust and all kind of streamers

Recommendations to reduce the formation of dust and streamers

In order to minimize the formation of dust and streamers, the selection of the systems operating conditions and design is of high importance. The following criteria are recommendations for the design of a system.

Operating conditions

- Minimize the product temperature
- Minimize the conveying air temperature
- Minimize the conveying velocity
- Minimize the conveying pressure

System design

- Optimize pipe routing
- Reduce the number of pipe elbows
- Select suitable pipe material and surface
- Avoid offsets and gas at pipe connections

Rules for conveying design

Various granules

The higher the velocity in pneumatic conveying systems, the higher the damage to the conveyed granules

Plastic Pellets

High velocities create dust and streamers in plastic resin conveying systems

Abrasive Material

High velocities create severe erosion of pipes and components when handling abrasive products



solution

In the beginning, there was a thought...

Pelletron's solution – The new conveying process pellcon3™

Based on the intensive experience in the design and layout of conveying systems, Pelletron created the pellcon3™ process, consisting of the 3 major process components.

STRANDPHASE®

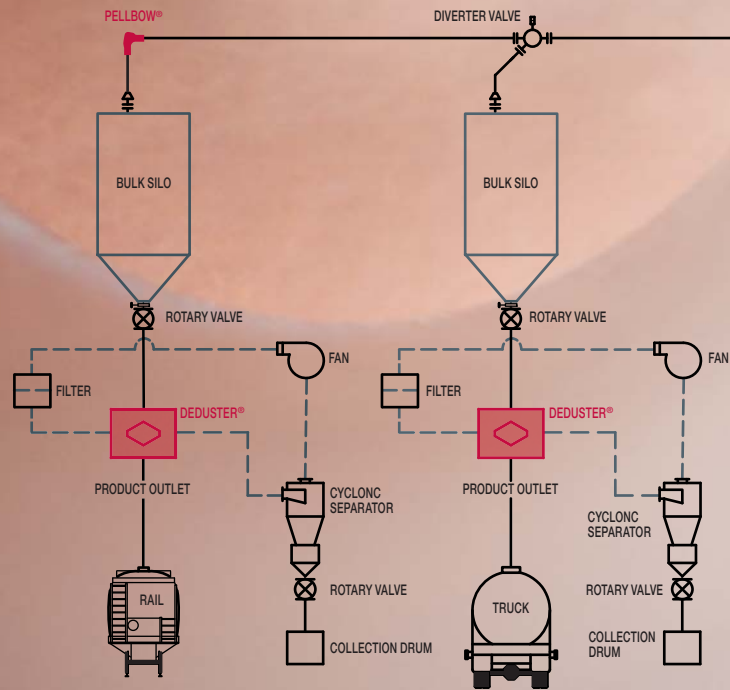
Pellbow®

DeDuster®

This process requires neither special pipe supports, nor high pressure compressors, is very economical, and most importantly, it doesn't create fine micro-dust as seen in dense phase systems or long streamers as created in dilute phase systems.

New plant designs with high capacities use this modern technology. Existing dense phase and dilute phase systems can be upgraded to the pellcon3™ technology.

The generic flow sheet shows the layout of such a modern system.

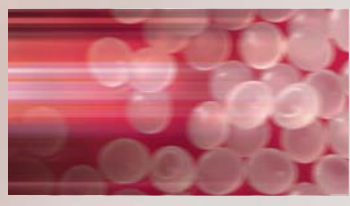


DeDuster® can be stationary or mobile.

PATENT PENDING

pellcon3™

The New Thinking In Pneumatic Conveying



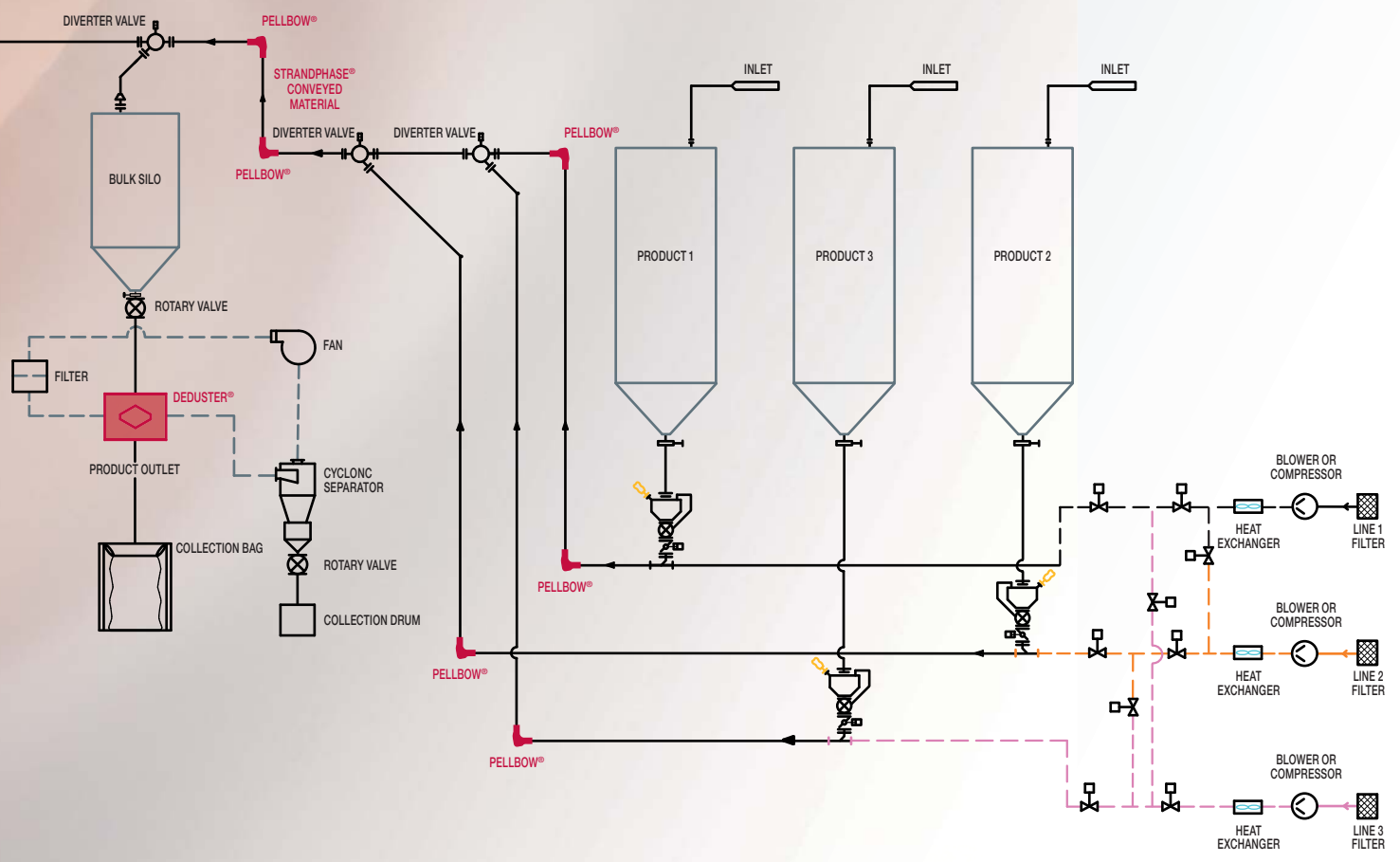
STRANDPHASE®



Pellbow®



DeDuster®





Blower Stations And Heat Exchanger

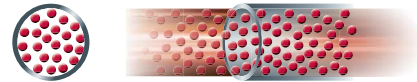


Rotary Valve Stations

Various conveying technologies overview

Traditionally, dilute phase was the technology generally used for conveying. Today, there are other systems available such as slow motion dense phase and STRANDPHASE® conveying, or special by-pass systems for sticky powders. The major characteristics of dilute, dense and STRANDPHASE® conveying are illustrated on the right and described as follows.

Dilute phase conveying



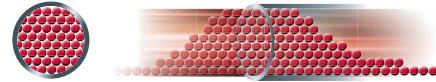
Product completely dispersed in gas flow

High gas velocities: $v=25 - 40 \text{ m/s}$ (5,000 – 8,000 ft/min)

Low product to air ratio: range 1 – 10 to 1

Low to medium pressure drop: $p = 0.1 - 1.0 \text{ bar}$ (1.5 – 15 psig)

Dense phase conveying



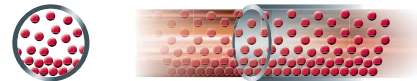
Product moves in plugs throughout the pipe

Low gas velocities: $v=2 - 10 \text{ m/s}$ (400 – 2,000 ft/min)

High product to air ratio: range 15 – 50 to 1

High pressure drop: $p = 0.5 - 3.5 \text{ bar}$ (7 – 50 psig)

STRANDPHASE® conveying



Product partially dispersed in gas flow, partially moving at higher concentration at bottom of horizontal runs

Optimized gas velocity: $v=15 - 25 \text{ m/s}$ (3,000 – 5,000 ft/min)

Medium product to air ratio: range 5 – 20 to 1

Medium to high pressure drop: $p = 0.5 - 2.5 \text{ bar}$ (7 – 30 psig)



Diverter Valve



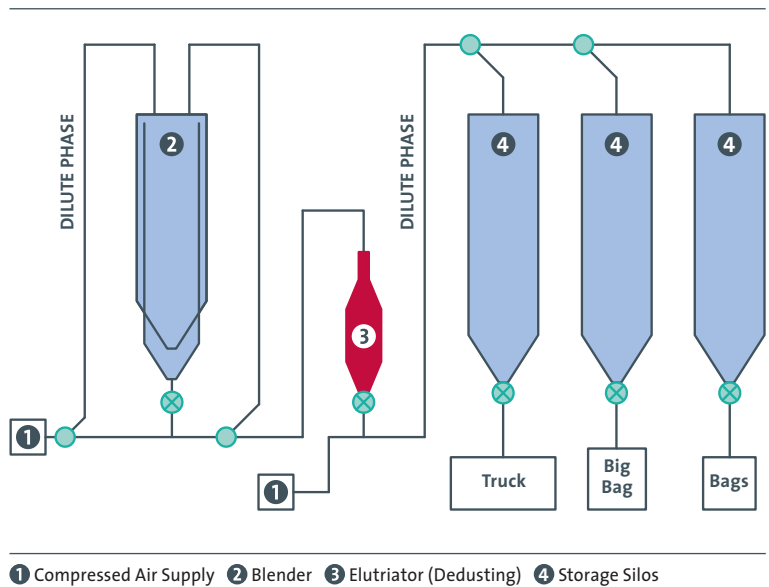
Dilute Phase Conveying system with long radius elbows

Dilute Phase Conveying

This method uses high gas velocities at low pressures and the conveyed product is completely dispersed in the gas flow. These types of systems are available as vacuum conveying systems, used for small conveying capacities and distribution of product from one source to multiple destinations, as well as for pressure conveying systems for larger capacities and longer distances.

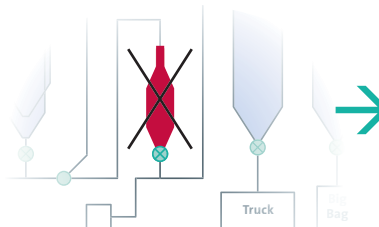
The investment costs for dilute phase conveying systems are very economical, but the technology has a number of disadvantages. Due to the high velocity, the degradation of the conveyed pellets is high, which results in the generation of dust and streamers. The use of dilute phase for abrasive products results in wear of the conveying line and the pipe elbows.

In former times, pressure dilute phase systems were used in combination with an elutriator, located in front or on top of the receiving silos, to remove the dust generated during conveying. These technologies were not completely satisfying, due to the quality problems of the conveyed pellets and high product loss in form of dust and streamers. In order to solve these problems, other technologies have been developed, such as dense phase conveying.

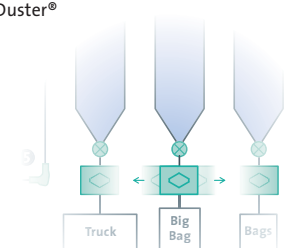


Traditional polyolefin plant lay-out based on dilute phase conveying. These types of conveying systems can be upgraded easily with mobile or stationary DeDusters®, located underneath the silos.

Traditional Solution with Elutriator



Modern Solution with stationary or mobile DeDuster®



Dust Distribution Table

Dust particle size	Dust Analysis (wet)	
	Percent %	Grams g
>500 µm	2.246 %	0.1071
63 to < 500 µm	60.985 %	2.9080
20 to < 500 µm	20.984 %	1.0006
< 20 µm	15.785 %	0.7527
TOTAL	100.000 %	4.7684

Analysis of dust after dense phase conveying

An analysis of the fine micro dust content after cleaning pellets in a PET dense phase conveying with a DeDuster® shows the distribution of the dust in the table above. The fine dust content below 63micron was in the range of 35%. The wet test was carried out in accordance with ASTM standard D7486-08



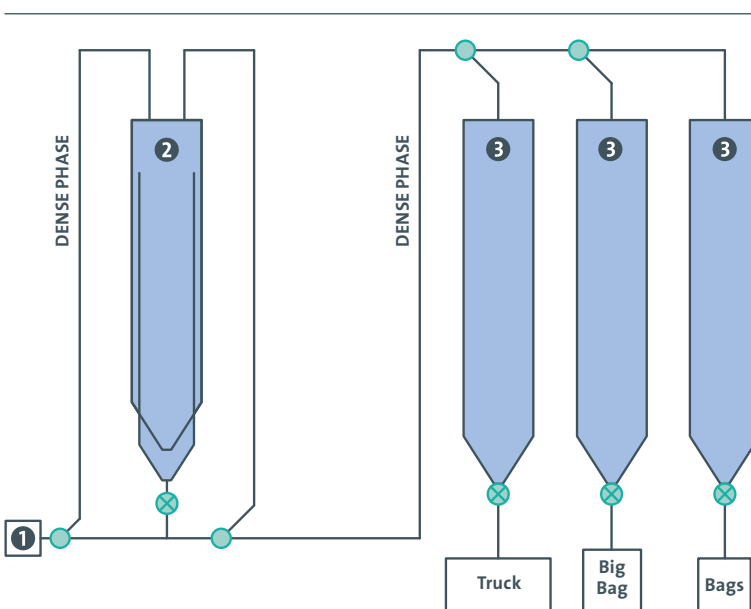
Typical plug in a dense phase conveying system

Dense Phase, Plug or Slow Motion Conveying

The demands of the market for high quality end products were the driving factor for developing systems that produce less degradation of the conveyed material and the piping. Moving pellets with low velocity and high pressure through piping systems was the next step in the development.

The idea was to generate less dust and eliminate the dedusting of the conveyed materials. This was only partially successful. Dense phase eliminates the creation of streamers (angle hair), but creates very fine dust, due to the high wall friction under high pressure.

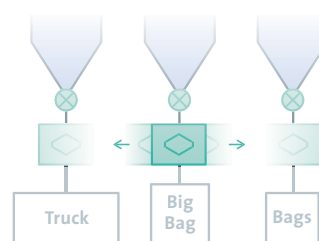
This dust is difficult to remove, because of its high electrostatic charging. The dust sticks to the pellets, silo walls and roofs. Sudden dust surges when emptying the silos are common problems in dense phase conveying systems. Therefore, dense phase conveying systems need also dedusting, preferably installed under the storage silos before packaging or before final processing. Another problem in large scale systems with large pipe diameters and long distances are the pipe forces, created by the plugs. Installation of special pipe supports and additional steel structures to compensate for the pipe forces are necessary. These factors increased the installation and maintenance costs of such systems. Therefore, further research was necessary to find better conveying solutions.



1 Compressed Air Supply 2 Blender 3 Silo

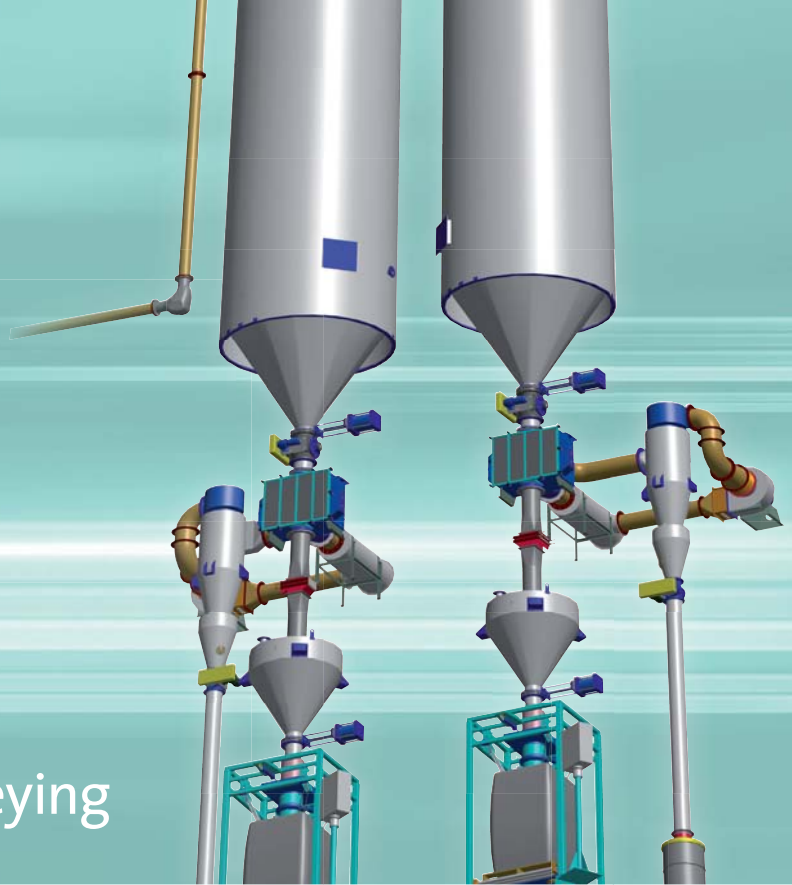
Modern dense phase system with stationary or mobile DeDuster®

Traditional polyolefin plant lay-out based on dense phase conveying without dedusting. These types of conveying systems can be upgraded easily with mobile or stationary DeDusters®, located underneath the silos.





Moving a mobile DeDuster® into operating position

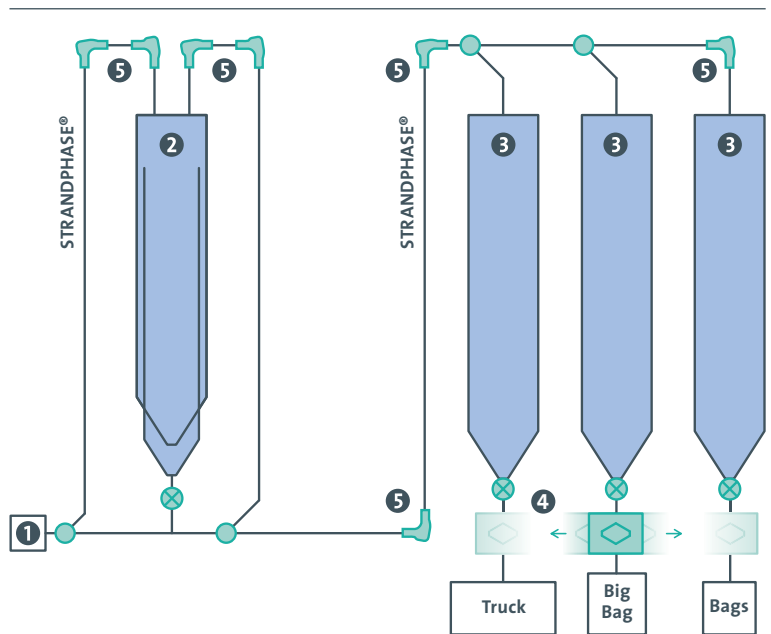


STRANDPHASE® Conveying

For large scale transfer systems, Pelletron recommends using STRANDPHASE® conveying. The characteristic of the system is a high product to air ratio with conveying pressures up to 2 bar (28 psi), within the typical range of roots type blowers and oil free screw compressors. This type of system uses optimized conveying velocities, in combination with Pellbows® (special designed pipe elbows) and a DeDuster® before packaging or processing of the conveyed pellets.



The attrition in these systems is moderate and the Pellbows® avoid the creation of long streamers. A DeDuster® removes the moderate dust content created in these systems and guarantees a very high quality end product. For silo farms, Pelletron offers mobile Dedusting systems. DeDusters can be moved easily under silos to remove the dust before rail car or truck loading or bagging.

STRANDPHASE® doesn't need any special pipe supports or additional steel construction. In many cases, the pipe diameters are smaller compared with a dense phase system. Because of these advantages, the investment costs for large scale STRANDPHASE® systems are much lower when compared to slow motion dense phase systems. In summary the STRANDPHASE® systems are easy to operate, easy to maintain, and low in investment costs.










1 Compressed Air Supply 2 Blender 3 Silos 4 DeDuster® (mobile or stationary) 5 Pellbow®

For new installations, Pelletron recommends the pellcon3™ system, based on STRANDPHASE® conveying, Pellbows® and DeDuster®.

 recommended
 not recommended

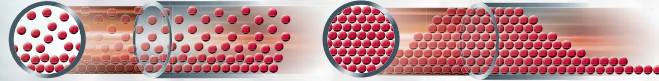
CONVEYING TECHNOLOGY RECOMMENDATIONS FOR PLASTIC PELLETS

Conveying technology	Conveying line size & distance			
	<DN150 & <150m	<DN150 & >150m	>DN150 & <150m	>DN150 & >150m
	<6" & <500ft	<6" & >500ft	>6" & <500ft	>6" & >500ft
DENSE PHASE	 	 		 
STRANDPHASE®				

Which is the best conveying technology for your system?

There is not a simple answer as to which conveying system is best solution for a specific application. The selection of the conveying technology depends on various factors such as total lengths, conveying capacity, and the material to be conveyed. Pelletron provides a guideline for the selection of a conveying technology in the table above.

The tables below show a comparison of the main characteristics of a STRANDPHASE® system and a dense phase system.



Comparison between STRANDPHASE® and Dense Phase Conveying

PNEUMATIC CONVEYING DATA COMPARISON

REFERENCE

Product	PET pellets		
Bulk Density	640 kg/m ³	40 lbs/cuft	
Capacity	15.000 to 30.000 kg/hr	33,000 to 66,000 lbs/hr	
Distance	91 m horizontal, 31 m vertical	300 ft horizontal, 100 ft vertical	
Elbows	10 elbows 90°		

STRANDPHASE®

Slow Motion Dense Phase

CONVEYING DATA COMPARISON

Pipe Diameter	DN 150	6" SCH10	DN 200	8" SCH10
Conveying Air Flow	35m ³ /min	1,230 SCFM	21 m ³ /min	750 SCFM
Purge Air Flow	N/A		45 m ³ /min	1,600 SCFM
Conveying Pressure	0.83 bar	12 PSIG	2.5 bar	36 PSIG
Product to Air Ratio	12 to 1		25 to 1	

CONVEYING EQUIPMENT COMPARISON

Rotary Valves	Standard Design Up to 1.52bar 22 PSIG		High Pressure Up to 3.1 bar 45 PSIG	
Conveying Air Source	Roots Type Blowers or 2 bar (30 PSIG screw compressors)		Screw Compressor or Compressed Air Network	
Pipes	Standard Surface		Smooth Surface	
Elbows	Pellbows®		5D or 10D Elbows	
Cleaning equipment	DeDusters®		DeDusters®	



Prevention of dust and streamers – the Pellbow® technology

The Pellbow® eliminates streamers and reduces dust

To minimize the creation of dust and streamers, the pellbow® is the ideal feature in combination with the STRANDPHASE® conveying.

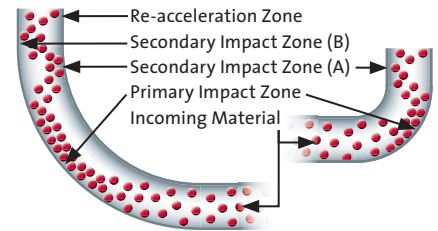
This patented elbow design resembles a standard short-radius elbow with a large expanded chamber between the inlet and discharge of the elbow. After the inlet, a sharp step creates an area expansion within the elbow and a deceleration zone for the incoming particles. This slow-down leads to the formation of fluidized slurry in the product-to-product primary impact zone. The slurry constantly moves upward toward the discharge and re-acceleration zone at the elbow exit.

The step just inside the elbow inlet creates a low pressure zone that draws the product from the primary impact zone back across the elbow's bottom toward the inlet and into the main product stream. This allows a complete clean-out that is less sensitive to the actual conveying velocities than other elbows.

This elbow's benefits include a defined primary product-to-product impact zone, a compact design with low space requirements, and low noise levels. The soft impact of pellets in the slurry zone and the low wall friction eliminates the creation of streamers. Its pressure loss is only slightly higher than that of standard long- and short- radius elbows. It is available in aluminum, stainless steel, carbon steel and special alloys, and is suitable for pellet and powder transfer. The step eliminates the build-up of product within the elbow, allowing for a complete purge. The creation of the product-to-products impact zone requires a minimum product-to-gas ratio of approximately 3:1.

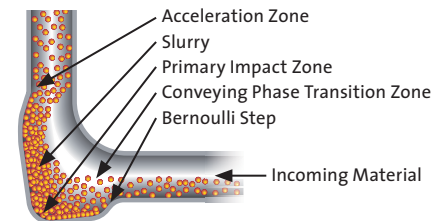
Recommended applications include the handling of fluidizable powder products and all type of resins and pellets that are abrasive, heat-sensitive and/or fragile. It can be used in dilute and STRANDPHASE® systems and dense-phase transfer of powders.

Standard Long-Radius Elbow / Short-Radius Elbow



Standard elbows are made by bending a straight section of pipe.

The Pellbow® Technology



A step near the Pellbow's inlet prevents particle accumulation by creating a low-pressure zone that draws product across the elbow's bottom.

DeDuster®



DeDuster® in use. Cleaning Plastic Pellets.



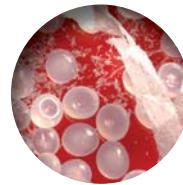
RC DeDuster® in use. Cleaning regrind.

Dust removal technologies – the DeDuster®

Pelletron developed various types of DeDusters® to remove dust and streamers

Pelletron DeDusters® use a magnetic flux field to disrupt the electrostatic charge between contaminants and pellets, and a patented air wash deck to separate and remove the contaminants.

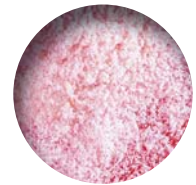
Pelletron provides DeDusters® for the Plastic Processing and Plastic Manufacturing Industry, as well as for Food, Mineral, Pharmaceutical, Chemical and other applications. DeDusters® are available in sizes 100lbs/h (50kg/h) up to 200,000lbs/h (100t/h).



Dusty Material



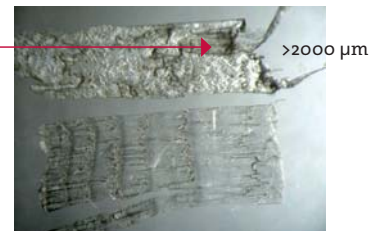
Dedusted Material



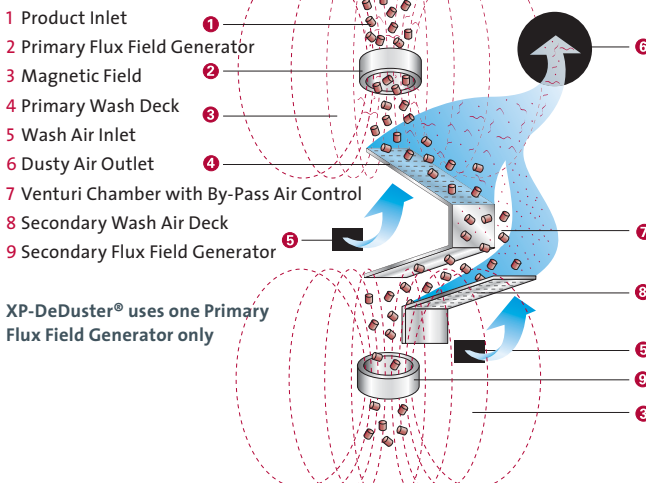
Dust



Removed streamers in DeDuster®

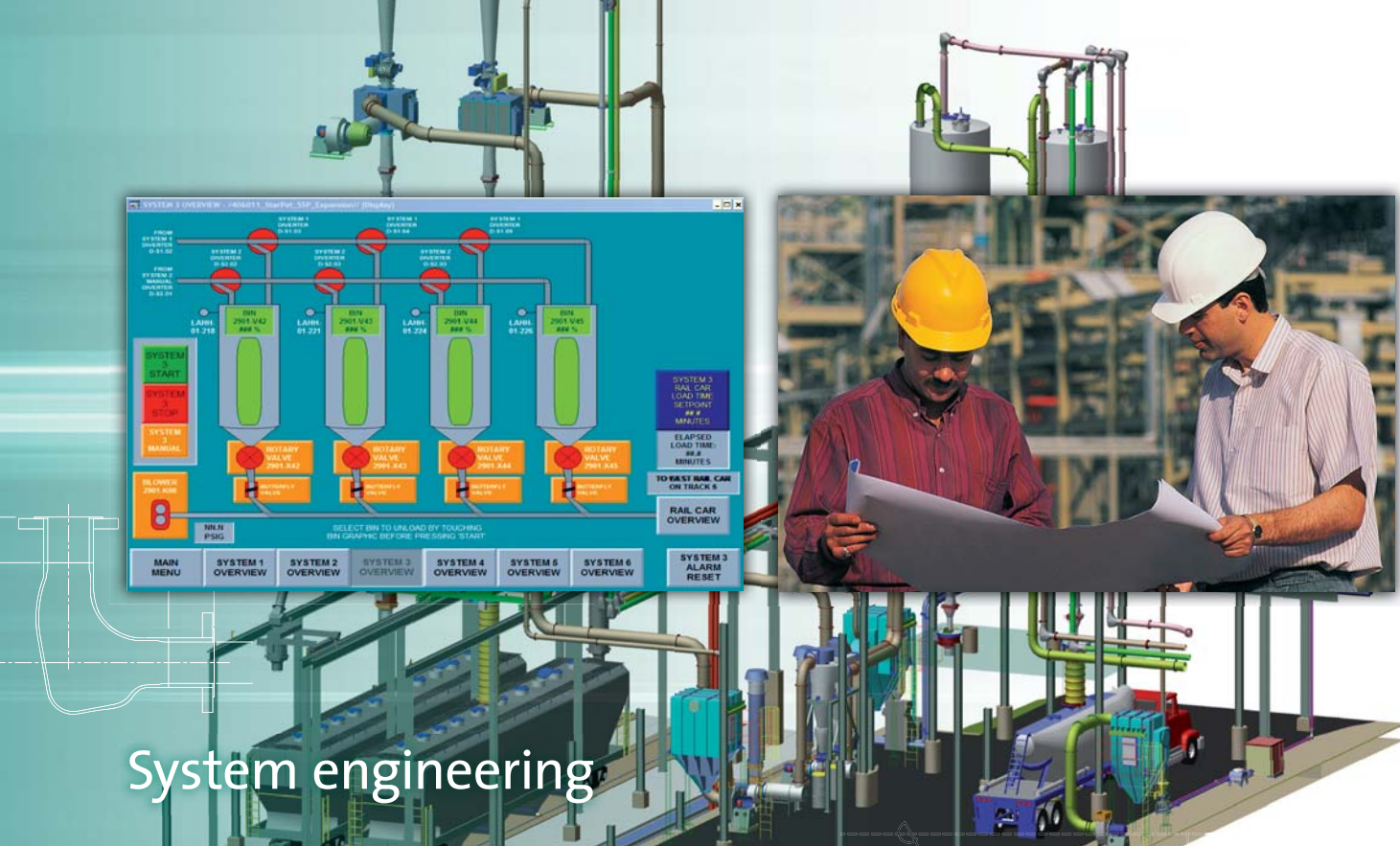


OPERATING PRINCIPLE



Customers investing in DeDusting equipment want to know the dust and streamer content before and after cleaning, and in many cases require a performance guarantee. Therefore, Pelletron recommends a complete dust analysis test to define the contaminants before and after dedusting. Pelletron offers **free-of-charge DeDusting tests**, including a

dry and wet test analysis, presented in an electronic report format. Pelletron developed procedures and analysis equipment to determine the dust and streamer content before and after cleaning of a particular material. Pelletron provides dry and wet dust analysis for dry bulk materials in accordance with ASTM and European standards.



System engineering

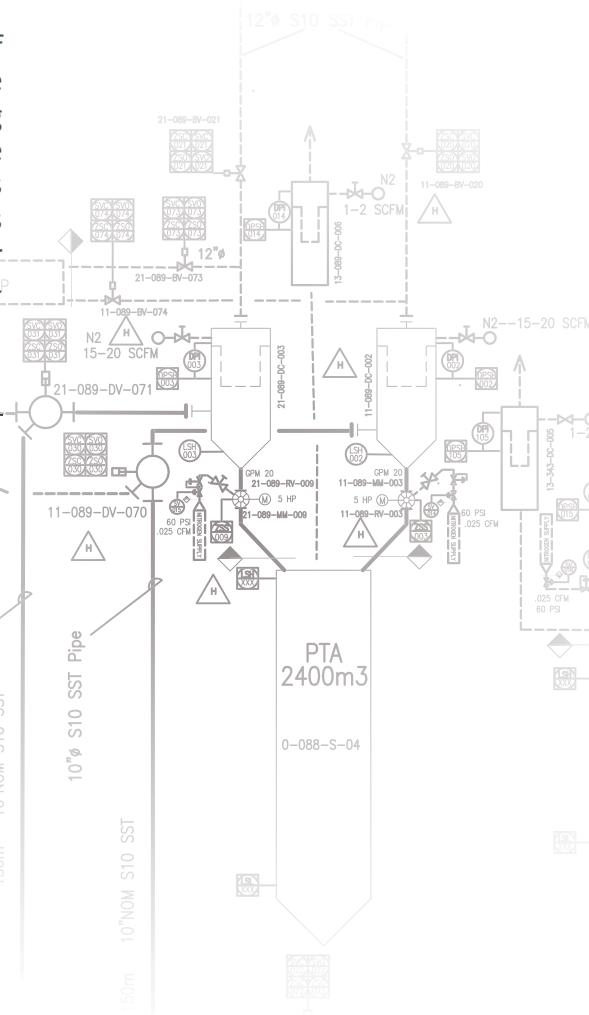
Pelletron's highly experienced Bulkmatology® team has many years of knowledge in designing and building systems that meet the unique and individual needs of our customers. Whether it's de-bottlenecking an existing system or designing a complete turnkey plant from the ground up, Pelletron's extensive know-how and experience ensures that solutions are efficient, cost-effective and meet the industry's highest standards of quality. Pelletron's project managers are familiar with national and international standards, supported by its local service providers and suppliers.

The system service includes the following services:

- Services**
- System design/engineering
 - System analysis & optimization
 - Project management
 - Instrumentation & controls
 - Installation
 - Field service
 - Global sourcing
 - Commissioning
 - Pneumatic conveying and DeDusting tests
 - Toll cleaning
 - Spare parts & re-furbishing

Pelletron has extensive experience in specific systems applications such as:

- Applications**
- Railcar loading and unloading systems
 - Pneumatic transfer systems
 - Bagging stations
 - Truck loading and unloading systems
 - Big bag filling stations
 - Extruder feeding
 - Upgrading dilute and dense phase systems to pellcon3™ systems



FlowEnhancer™



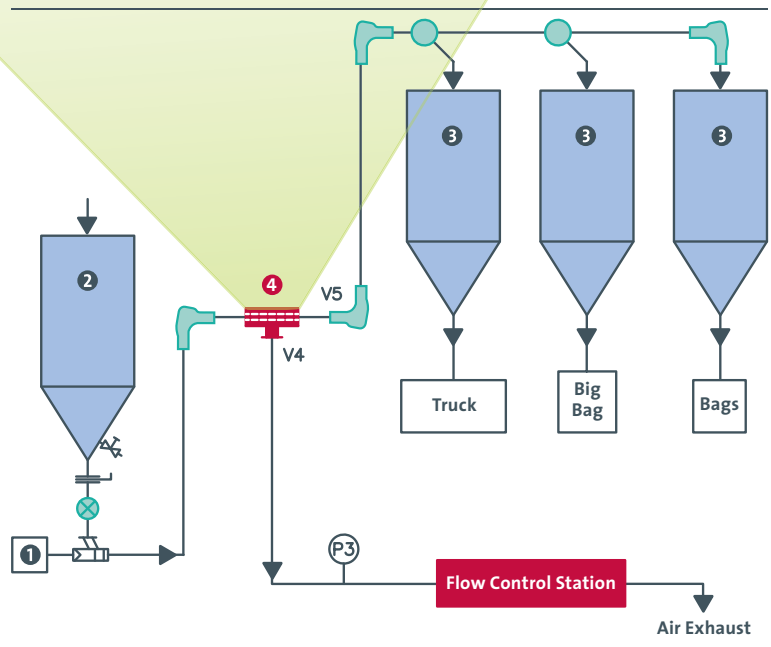
FlowEnhancer™ shown in open position

System optimizing – the FlowEnhancer™

Long conveying systems require stepping of pipes in order to achieve a continuous velocity profile throughout the system. Instead of stepping the pipe, Pelletron offers the patent FlowEnhancer™, an air extraction solution.

The advantages of an air extraction system are:

- Reduction of air velocity in existing or new pressure conveying systems without stepping of the pipeline
- Increase of conveying capacity in existing or new pressure conveying systems without modification of the pipeline, blower and components
- Expansion of the length of existing pipes in a pressure conveying systems without modification of the pipeline
- Changes of conveyed material grades possible due to simple adjustments of the air extraction.
- Locations of air extraction more flexible compared with stepped pipelines
- Air extraction makes retrofit possible
- Easy to install
- Moderate costs to retrofit an existing system
- Economical alternative to dense phase system. Lower costs, easy to operate, moderate product degradation



1 Compressed Air Supply 2 Silos 3 Receiving Silo 4 FlowEnhancer™

The location of the FlowEnhancer™ in a conveying system is critical for maximum precision and efficiency.

Modern conveying systems require reliable and economical components. Pelletron developed new energy saving rotary valves, special pipe elbows, tradenamed Pellbow® and DeDusters® that provides solutions for all kind of applications.

Pneumatic conveying components



Rotary valves
for conveying of granular and powder products. Available in medium pressure and high pressure design.



Diverter valves
for granular and powder products, designed for medium and high pressure



Slide gates
for granular and powder products, designed for medium and high pressure



Pellbow®
Special pipe elbow to reduce dust, eliminate streamers. Wear resistant design.

DeDusters for various applications

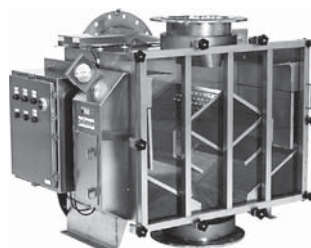


RC-Series with CentraCone™
available in various sizes.



Mid Series

P10	1,000 lbs/h	500 kg/hr
P30	3,000 lbs/h	1,500 kg/hr
P50	5,000 lbs/h	2,500 kg/hr
P80	8,000 lbs/h	4,000 kg/hr
P120	12,000 lbs/h	6,000 kg/hr
P200	20,000 lbs/h	10,000 kg/hr



Max Series

P400	40,000 lbs/h	20,000 kg/hr
P600	60,000 lbs/h	30,000 kg/hr
P800	80,000 lbs/h	40,000 kg/hr
P1200	120,000 lbs/h	60,000 kg/hr
P2000	200,000 lbs/h	100,000 kg/hr



XP Series

XP5	1,000 lbs/h	500 kg/hr
XP15	3,000 lbs/h	1,500 kg/hr
XP45	9,000 lbs/h	4,500 kg/hr
XP90	18,000 lbs/h	9,000 kg/hr
XP180	36,000 lbs/h	18,000 kg/hr
XP360	72,000 lbs/h	36,000 kg/hr
XP720	144,000 lbs/h	72,000 kg/hr
XP900	180,000 lbs/h	90,000 kg/hr





Discover **Bulkmatology**[®]
The Nature of Bulk Material Handling

Global sales and service network

With an international network of Bulk Material Handling Experts, Pelletron is committed to providing the highest level of quality, service and expertise to our valued Bulkmatology[®] customers all around the world.



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