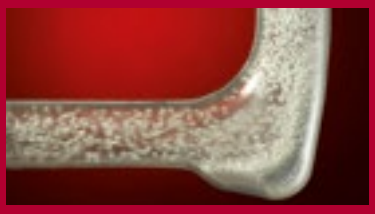
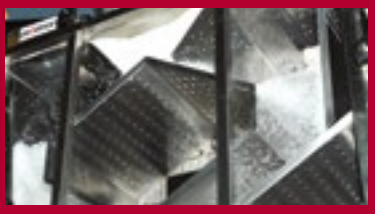
pelletron

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

The New Thinking in Pneumatic Conveying





Content

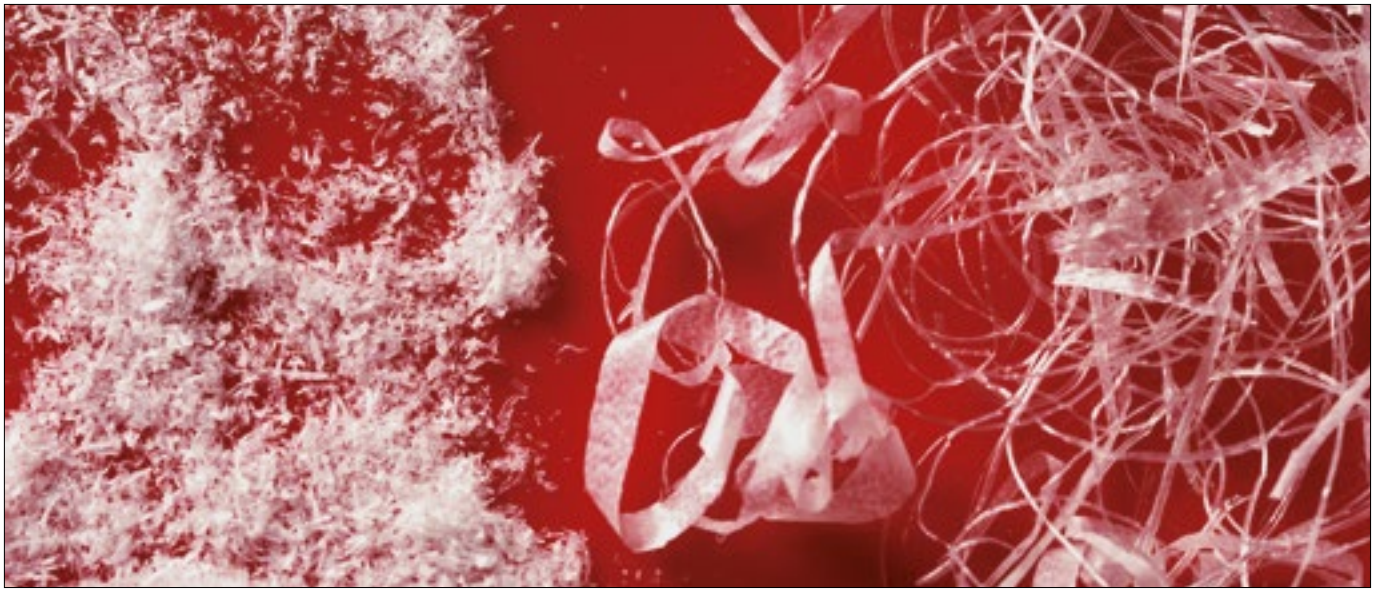
Introduction – Pneumatic Conveying Technology

Selection of the suitable pneumatic conveying transfer system for dry bulk solid materials (pellets, granules, chips, regrind and powders) is important for the function and the economical, reliable operation of an entire plant. Complex and unreliable systems lead to high maintenance costs and plant shut downs.

Material properties vary in size, shape, surface, weight and other factors, all of which have a significant influence on the sizing and selection of a 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 pneumatic conveying test lab is necessary to determine the parameters for the correct system calculation. For this reason, Pelletron maintains its own test lab to perform a wide range of pneumatic conveying tests for its customers. The test lab is also the platform for the development of new conveying technologies.

The test center is designed to provide short-loop attrition tests for granular bulk materials to determine the amount of dust, angel hair and streamers that are created by friction during conveying. For an attrition test, material is pneumatically conveyed through a piping loop for a predetermined time to simulate a customer's approximate conveying distance. The test center conveying loop can be configured with standard 5D or 10D bends as well as Pellbows® to operate the system in dilute phase, STRANDPHASE® or dense phase modes for comparison purposes. To calculate the amount of dust generated during conveying, technicians measure the material's dust content before and after each test, taking the loop apart and washing out the piping to collect every dust particle created during a test to ensure accurate results. The dust and streamers in the pellets are removed with a DeDuster and the remaining dust content is measured using the dry and wet test ASTM methods.

Pelletron provides conveying system attrition tests that help determine the best conveying system settings and components for minimizing material degradation during conveying.



What Causes Attrition?

All types of conveying systems cause attrition because of factors like conveying method, plant layout and pellet type. There are two major rules to remember:

The higher the velocity – the higher the friction i.e. dilute conveying systems.
The higher the pressure – the higher the friction i.e. slow motion dense phase systems.

Friction creates heat and abrasion and is the main cause for the creation of fines. In pneumatic conveying systems, other major factors include:

Blurry surface caused by dust

Black spots caused by burned dust

Build-up on reciprocating screw caused by dust

Major Factors

Product

- Specific density
- Bulk density
- Temperature
- Particle diameter
- Particle size distribution
- Product friction
- Additives
- Pipe roughness
- Moisture content

Operation

- Conveying gas density
- Conveying velocity
- Product-to-gas ratio
- Conveying gas temperature
- Conveying capacity
- Capacity variation

Plant layout

- Length of piping
- Pipe diameter
- Height
- Number of bends
- Type of bends
- Product feeding
- Number of diverter valves
- Closed/open loop

Why are dust and streamers bad?

Undesirable results:

- High “scrap“ rates from fines burning in mold
- Blurry surfaces caused by vaporized dust particles
- Weak spots in fibers
- Flaws in wire insulation
- Gels in films
- Housekeeping problems caused by dust and streamers
- Crusting of feed throat of screw
- Reduced mold and screw life resulting from carbonization of dust
- Mold vents clogged by dust
- Equipment and machines clogged by streamers
- Dust accumulation on silo walls and roofs

Recommendations to Reduce the Formation of Dust and Streamers

Selecting a pneumatic conveying system design is important for economic and reliable operation of any plant that transfers dry bulk products, and is critical for plastics manufacturing and compounding plants. Poorly designed systems lead to plant-wide inefficiencies and high maintenance costs.

When designing pneumatic conveying systems, many design parameters must be considered from the length of piping and number of elbows to material properties and temperatures. These parameters, and many more, all have a significant influence on the determination and sizing of a pneumatic conveying system.

The quality of plastic pellets is essential to the economical success of plastics manufacturing companies and compounders alike. High dust and streamer (angel hair) content in plastic pellets leads to higher customer rejects and lower market prices. Dust and streamers in pellets can create undesirable flaws in the molding and extrusion processes. The aim of each plastics manufacturer and compounder is the production of the highest quality resin grade with low dust content and no angel hair at the lowest possible production cost. In order to help customers achieve this goal, Pelletron recommends using a reduced velocity at reduced pressure. This conveying method is trade named STRANDPHASE®.

STRANDPHASE® is a conveying technology for gentle conveying of granular products. Moderate velocities prevent breakage and attrition of the conveyed product, keeps the generation of dust at a very low level and prevents the creation of long angel hair. The average design velocities for STRANDPHASE® conveying range from 15 to 25 m/sec at medium product-to-gas ratios. The system operates at conveying pressures up to 2 bar. STRANDPHASE® does not require the specially treated pipe that is usually used in dilute phase systems. These STRANDPHASE® systems do not create the pipe forces characteristic of dense phase systems, eliminating the need for special pipe supports or additional steel structures necessary for most slow motion systems. Most importantly, STRANDPHASE® does not create fine micro-dust typical of slow motion, dense phase systems or long streamers created in dilute phase systems. In many cases, the pipe diameters are smaller in comparison with dense phase systems. Because of these advantages, the investment costs for large scale STRANDPHASE® systems are much lower when compared to slow motion, dense phase systems. STRANDPHASE® systems guarantee high quality resins, are easy to operate and to maintain, all at a low investment cost.

The advantages of STRANDPHASE® conveying

- Economical, reliable and **SIMPLE** pneumatic transfer technology
- Reasonable investment costs
- End product with low dust content and no long streamers
- Easy operation
- Low maintenance costs

Design rules

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

The table shows the differences between the three conveying types.

System Parameters	Dilute Phase	STRANDPHASE®	Dense Phase
Product range	wide	wide	narrow
Gas velocity	high	medium	low
Product-to-gas ratio	low	medium	high
Product dispersed	yes	partly	no
Pressure loss/m (=D)	medium	low	high
Pressure range typical	blower	up to 2 bar	3 – 6 bar screw
Air management system	no	no	yes
Pipe size	medium	small	large
Energy consumption	high	small	medium
Installed cost	low	medium to low	high

SOLUTION

In the beginning, there was a thought ...

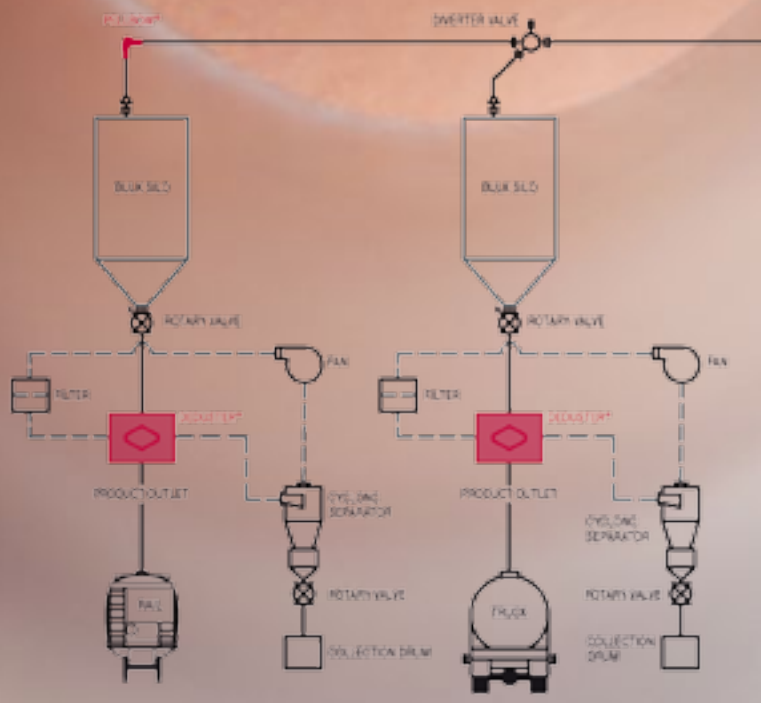
Pelletron's Solution for Gentle Material Handling – pellcon3®: The New Conveying Process

Any pneumatic conveying system creates friction and fines. In addition to optimized STRANDPHASE® conveying, Pelletron uses Pellbow® pipe bends to further reduce the creation of fines and the DeDuster® to remove remaining fines. Pelletron calls this new process pellcon3®. Its consists of three components:

- STRANDPHASE®
- Pellbow®
- DeDuster®

This pellcon3® process does not require special pipe supports or high pressure compressors. It is very economical, and most importantly, it does not create the fine micro dust that is characteristic of dense phase systems or the long streamers that are characteristic of dilute phase systems.

New, high-capacity plants can be designed to utilize this modern technology. Existing dense phase and dilute phase systems can be upgraded to take advantage of the benefits of the pellcon3® technology. This new pellcon3® process fulfills the customer requirements for highest quality end products with dust levels well below 50ppm and no streamers.



This generic flow sheet shows the layout of a modern pellcon3® system. The DeDuster® can be stationary or mobile

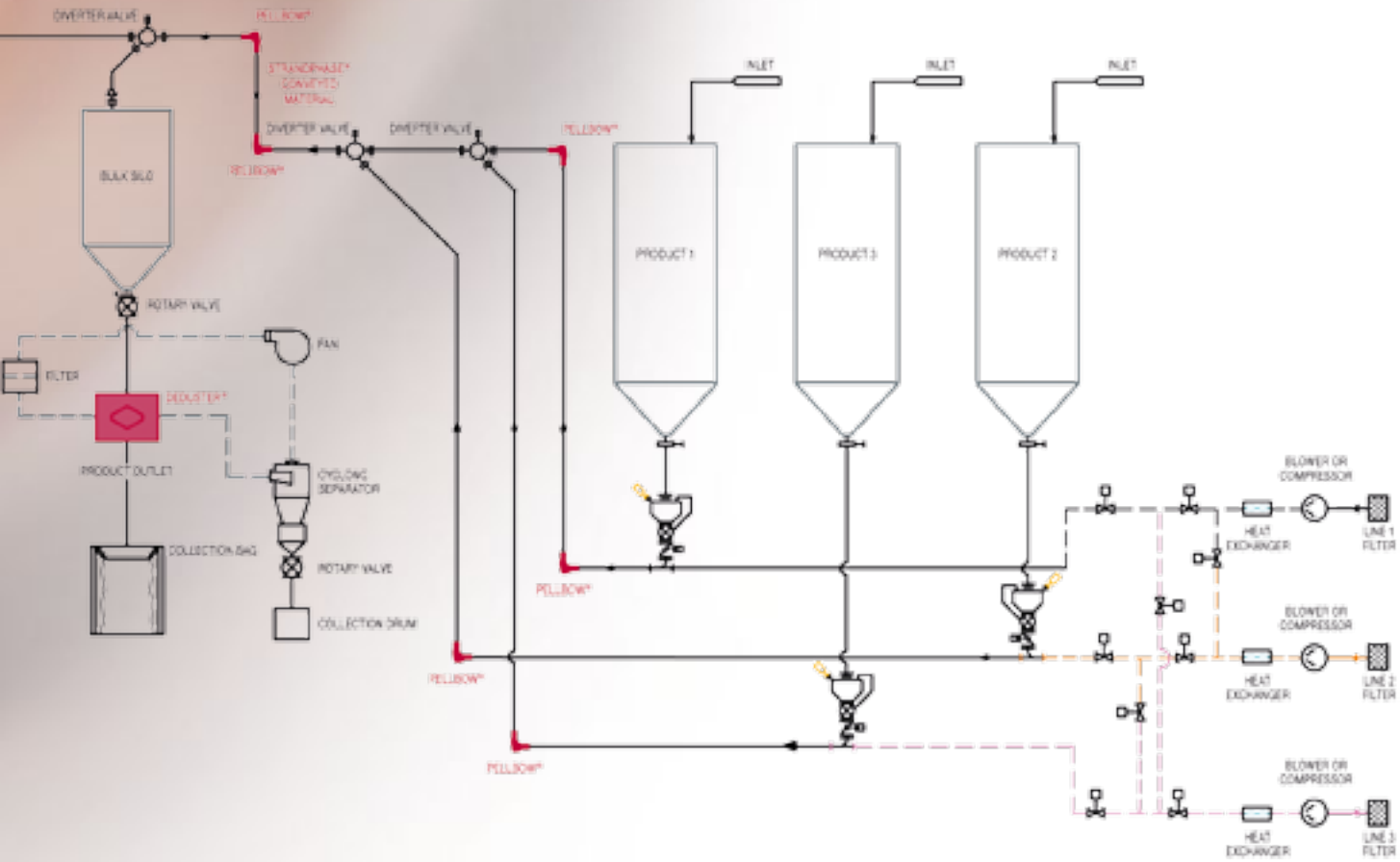
pellcon3®

The New thinking in Pneumatic Conveying

STRANDPHASE®

Pellbow®

DeDuster®



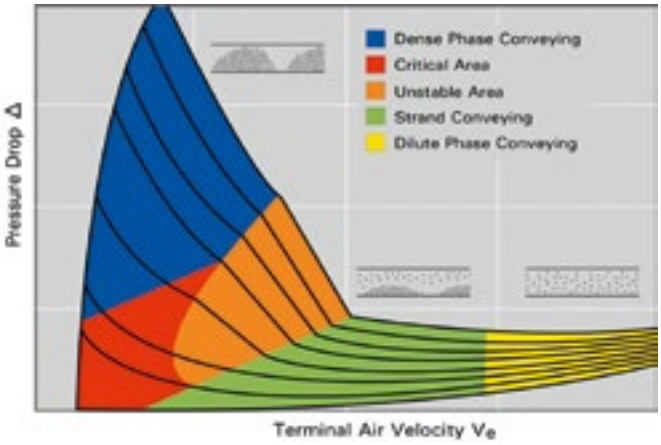
Blower Stations and Heat Exchanger

Rotary Valve Stations

Overview of Conveying Technologies

Traditionally, dilute phase was the technology of choice for conveying. Today, other options are available from slow motion, dense phase and STRANDPHASE® conveying to special by-pass systems for sticky powders. The major characteristics of dilute, dense and STRANDPHASE® conveying are described on the right and illustrated in the graph below.

Conveying Phase Diagram



Dilute Phase Conveying

Product completely dispersed in gas flow
High gas velocities: v = 25 – 40 m/s (5,000 – 8,000 ft/min)
Low product-to-air ratio: range 1 – 5 to 1
Low to medium pressure drop: p = 0.1 – 1.0 bar (1.5 – 15 psig)

Dense Phase Conveying

Product moves in plugs throughout the pipe
Low gas velocities: v = 2 – 10 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 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 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 – 2.0 bar (7 – 30 psig)

Diverter Valve

Dilute Phase Conveying System with Long Radius Elbows

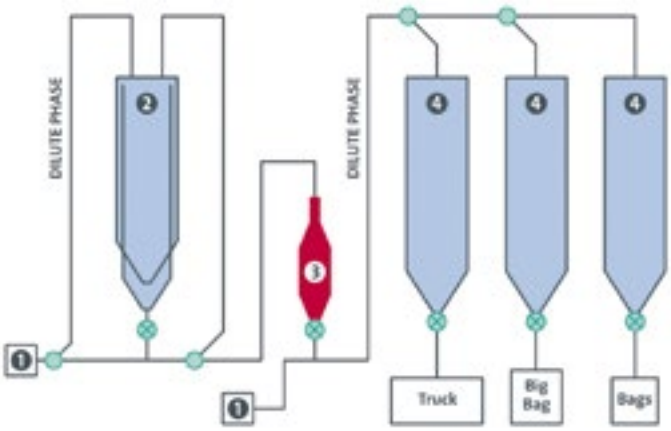
Dilute Phase Conveying

Dilute phase conveying uses high gas velocities at low pressures and the conveyed product is completely dispersed in the gas flow. Vacuum conveying systems are available for small conveying capacities and distribution of product from one source to multiple destinations. Pressure conveying systems are available for larger capacities and longer distances.

The investment cost for dilute phase conveying systems is very economical, but the technology has a number of disadvantages. Due to the high velocity, there is significant degradation of conveyed pellets resulting in the generation of dust and streamers. The use of dilute phase for abrasive products also causes wear of the conveying line and the pipe elbows.

In the past, 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 because of the low quality of the conveyed pellets and high product loss due to the formation of dust and streamers. In order to solve these problems, other technologies including dense phase conveying were developed.

Layout of a traditional polyolefin plant using dilute phase conveying.



1 *Compressed Air Supply* **2** *Blender* **3** *Elutriator (dedusting)* **4** *Storage Silos*

These systems can be *upgraded* easily with mobile or stationary DeDusters® located under the silos.

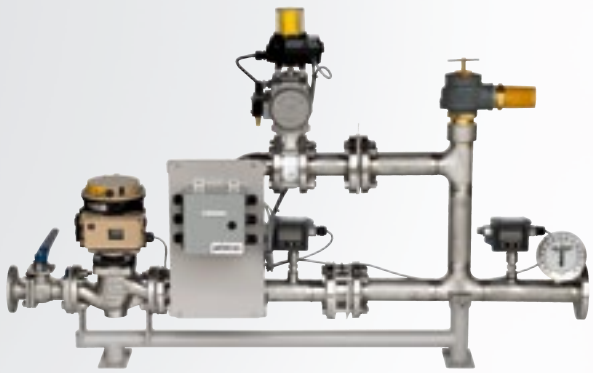
Traditional solution with elutriator

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 < 63 µm	20.984	%	1.0006
< 20 µm	15.785	%	0.7527
TOTAL	**100.000**	**%**	**4.7684**

The table above shows an analysis of the fine micro dust content and the distribution of dust after cleaning pellets in a PET dense phase system with a DeDuster®. 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.



Air management system for slow motion dense phase conveying. Trade name: PAR-station

Typical plug in a dense phase conveying system

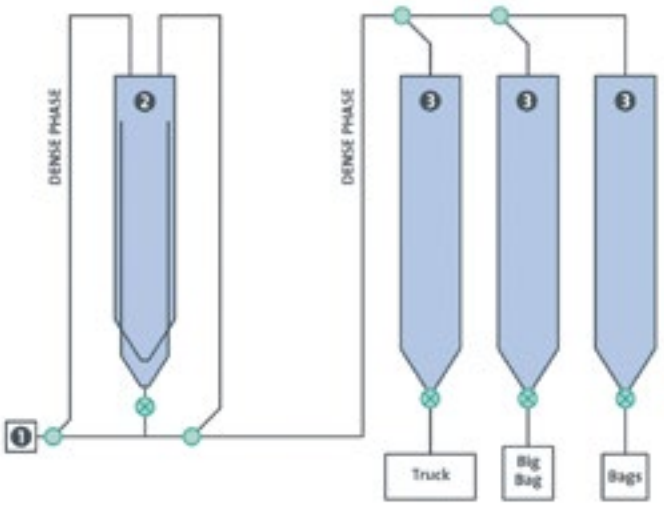
Dense Phase, Plug or Slow Motion Conveying

The demands of the market for high quality end products were the driving force behind the development of systems that produced less degradation of both 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 requirement for dedusting of the conveyed material. This effort was only partially successful. Dense phase conveying eliminated the creation of streamers (angel hair), but the friction between pellets and between the pellets and the wall caused by high pressure generates a very fine dust. This dust is difficult to remove because of its high electrostatic charge. The dust sticks to the pellets, silo walls and roofs. The sudden dust surges that occur when emptying the silos are common problems in dense phase conveying systems. As a result, dense phase conveying systems required dedusting, preferably installed under the storage silos before packaging or final processing.

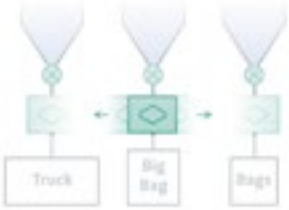
The pipe forces created by the plugs in large-scale dense phase systems with large pipe diameters and long distances posed another challenge. Special pipe supports and additional steel structures are necessary to compensate for the pipe forces. These additional requirements increase the cost of equipment, installation and maintenance. Therefore, further research was necessary to find better conveying solutions.

Layout of traditional polyolefin plant based on dense phase conveying without dedusting.



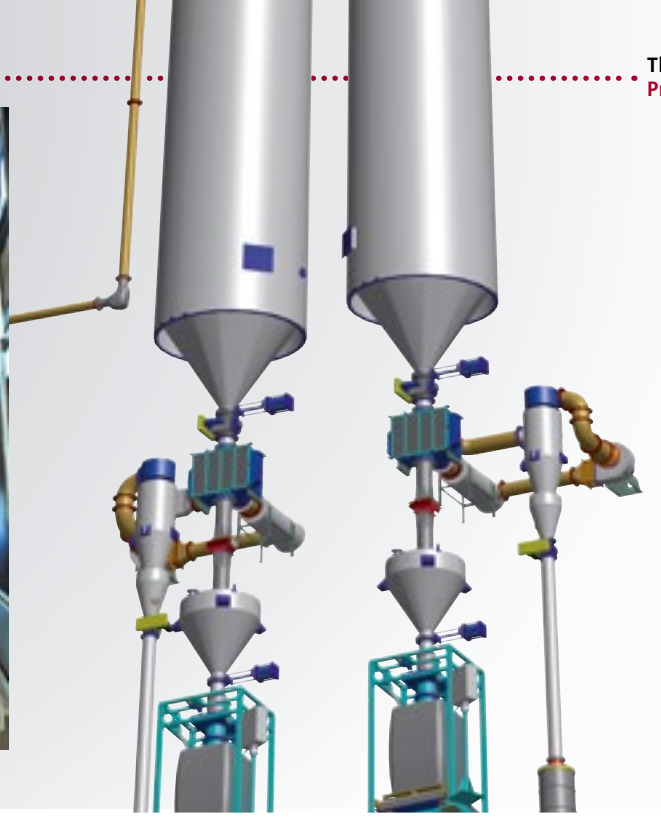
1 *Compressed Air Supply* **2** *Blender* **3** *Silo*

These systems can be upgraded easily with mobile or stationary DeDusters® located under the silos.



Modern dense phase system with stationary or mobile DeDuster®

Moving a mobile DeDuster® into operating position

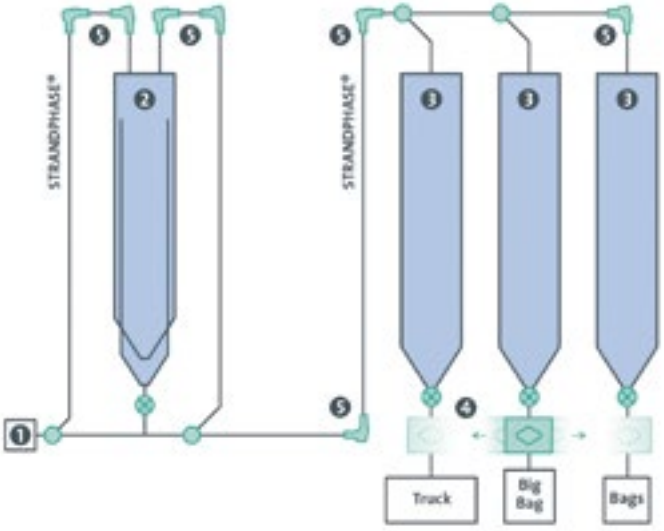


STRANDPHASE® Conveying

For large scale transfer systems, Pelletron recommends using STRANDPHASE® conveying. The characteristics of this process are a high product-to-air ratio with conveying pressures up to 2 bar (30 psi), within the typical range of positive displacement blowers and oil free screw compressors. It uses optimized conveying velocities in combination with Pellbows® (specially designed pipe elbows) and a DeDuster® installed before packaging or processing of the conveyed pellets.

With STRANDPHASE® conveying, attrition is moderate and the Pellbows® prevent the creation of streamers. A DeDuster® removes the moderate dust content and guarantees a very high quality end product. For silo farms, Pelletron offers mobile dedusting systems that can be moved easily under the silos to remove the dust before rail car/truck loading or bagging of the product.

STRANDPHASE® conveying does not require any special pipe supports or additional steel structures. In many cases, the pipe diameters are smaller when compared to dense phase systems. Because of these advantages, the investment cost for large-scale STRANDPHASE® systems is much lower than for slow motion dense phase systems. STRANDPHASE® systems offer low investment costs and are easy to operate and to maintain.

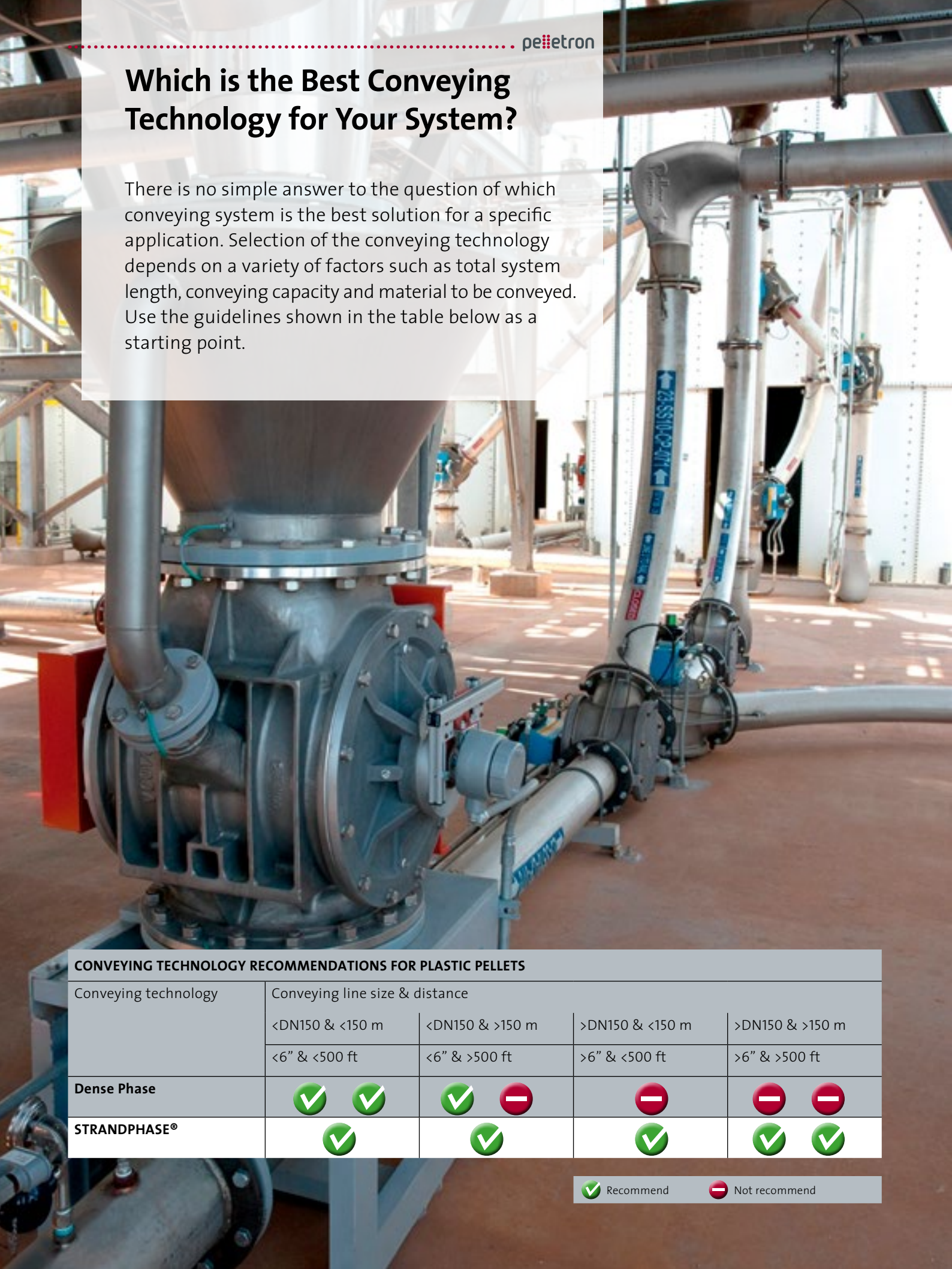


1 *Compressed Air Supply* **2** *Blender* **3** *Silo* **4** *DeDuster® (mobile or stationary)* **5** *Pellbow®*

For new installations, Pelletron recommends the pellcon3® system, utilizing STRANDPHASE® conveying, Pellbows® and DeDusters®.

Which is the Best Conveying Technology for Your System?

There is no simple answer to the question of which conveying system is the best solution for a specific application. Selection of the conveying technology depends on a variety of factors such as total system length, conveying capacity and material to be conveyed. Use the guidelines shown in the table below as a starting point.



CONVEYING TECHNOLOGY RECOMMENDATIONS FOR PLASTIC PELLETS

Conveying technology	Conveying line size & distance			
	<DN150 & <150 m	<DN150 & >150 m	>DN150 & <150 m	>DN150 & >150 m
	<6” & <500 ft	<6” & >500 ft	>6” & <500 ft	>6” & >500 ft
Dense Phase	✓ ✓	✓ ⊖	⊖	⊖ ⊖
STRANDPHASE®	✓	✓	✓	✓ ✓

✓ Recommend ⊖ Not recommend

Comparison Between STRANDPHASE® and Dense Phase Conveying

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

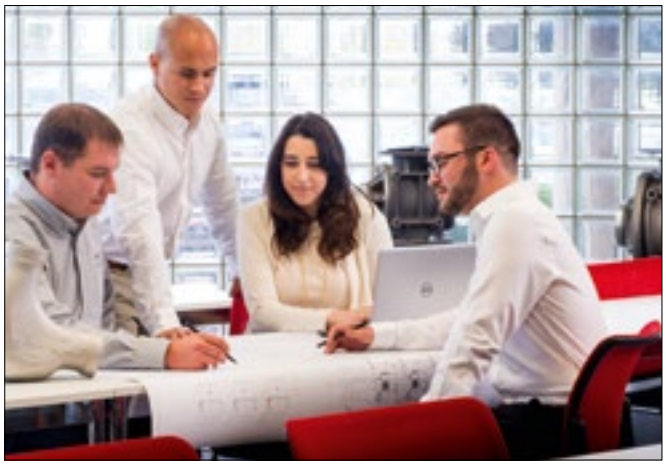
PNEUMATIC CONVEYING DATA COMPARISON

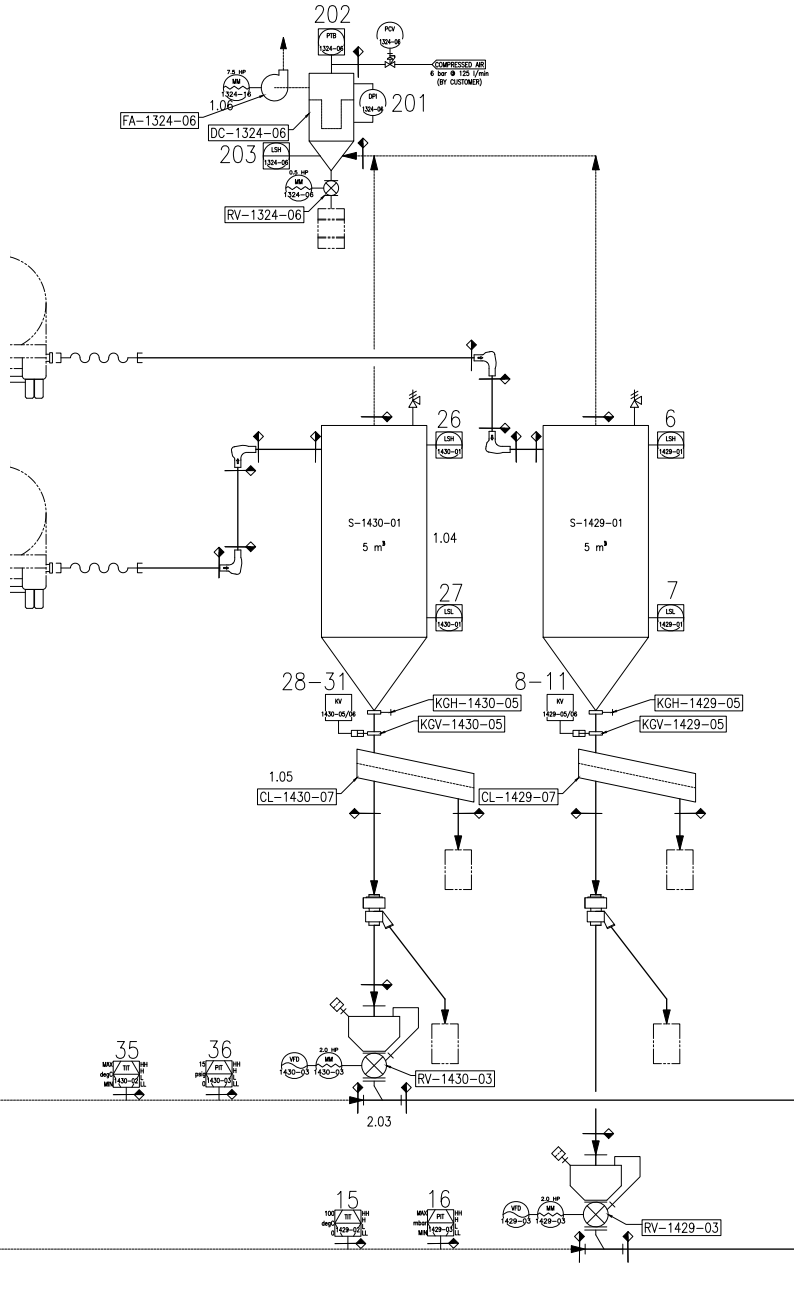
	REFERENCE	
Product	PET pellets	
Bulk Density	640 kg/m³	40 lbs/ft³
Capacity	15.000 to 30.000 kg/hr	33,000 to 66,000 lbs/hr
Distance	91 m horizontal, 31 m vertical	300 ft horizontal, 100 ft vertical
Elbows	10 elbows 90°	

	STRANDPHASE®		Slow Motion Dense Phase	
CONVEYING DATA COMPARISON				
Pipe Diameter	DN 150	6” sch10	DN 200	8” sch10
Conveying Air Flow	35 m³/min	1,230 scfm	21 m³/min	750 scfm
Purge Air Flow	N/A		45 m³/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 1.52 bar	22 psig	High Pressure Up to 3.1 bar	45 psig
Conveying Air Source	Positive discplacement blowers		Screw Compressor or Compressed Air Network	
Pipes	Standard Surface		Smooth Surface	
Elbows	Pellbows®		5D or 10D Elbows	
Cleaning Equipment	DeDusters®		DeDusters®	

System Engineering

Pelletron's highly specialized Bulkmatology® team has many years of knowledge and experience in designing and building systems that meet the unique and individual needs of its customers. Whether it is 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, and are supported by local service providers and suppliers.



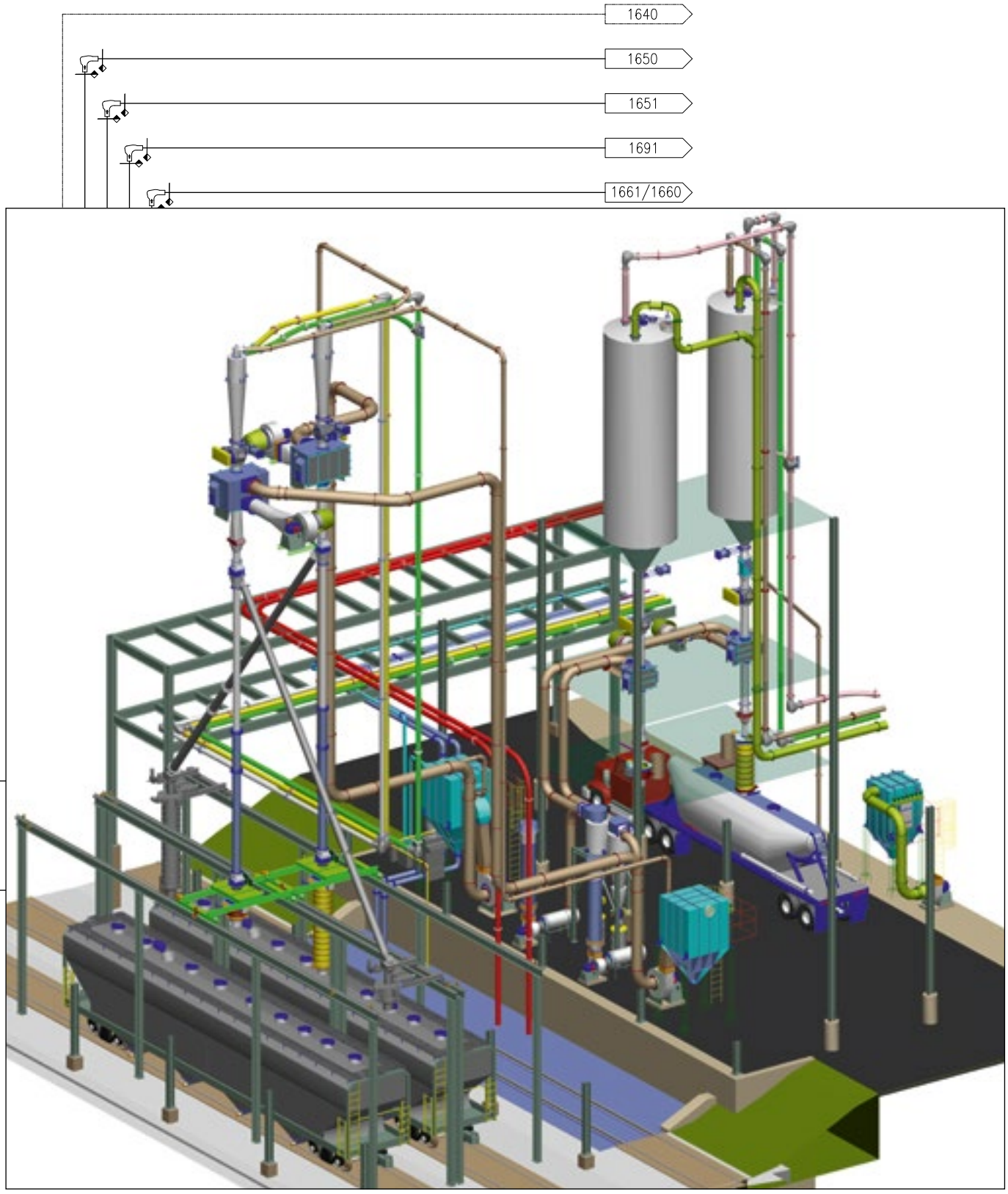


Pelletron's system services include:

- System design/engineering
- System analysis and optimization
- Project management
- Instrumentation and controls
- Installation
- Field service
- Global sourcing
- Commissioning
- Pneumatic conveying and dedusting tests
- Toll cleaning
- Spare parts and refurbishing
- And more ...

Pelletron's application experience includes:

- Railcar loading and unloading systems
- Pneumatic transfer systems
- Bagging stations
- Big bag filling stations
- Truck loading and unloading systems
- Extruder feeding
- Upgrading dilute and dense phase systems to pellcon3® systems
- And more ...



The pellcon3® process shown here includes a DeDuster® system, Pellbow® pipe bends and STRANDPHASE® conveying in use for truck an railcar loading.

Pellbow®

✓ Wear resistant
✓ Eliminates streamers
✓ Reduces fines

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® provides ideal features when used in combination with STRANDPHASE® conveying.

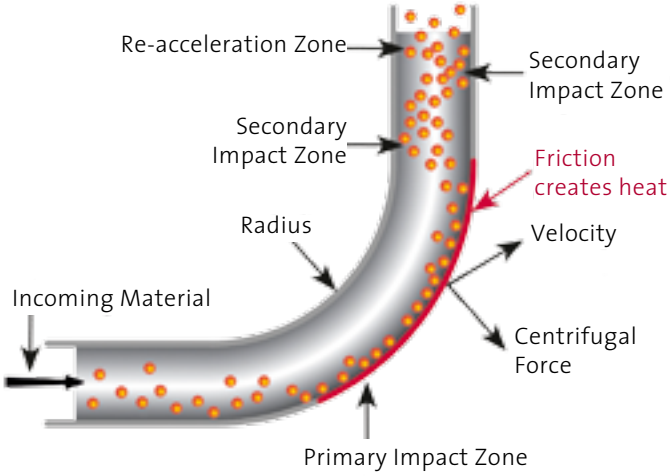
The Pellbow® has a patented elbow design that resembles a standard, short-radius elbow with a large expanded chamber between the inlet and discharge of the elbow. After the inlet, a sharp step (Bernoulli Step) creates an area of expansion within the elbow and a deceleration zone for the incoming particles. This slowdown leads to the formation of a fluidized slurry in the product-to-product primary impact zone. The slurry constantly moves upward toward the discharge and re-acceleration zone at the Pellbow® 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 cleanout that is less sensitive to the actual conveying velocity than other elbows.

The benefits of Pellbows® over other elbows include a defined primary product-to-product impact zone, compact design with low space requirements and low noise levels. The soft impact of pellets and the low wall friction in the slurry zone eliminates the creation of streamers. Its pressure loss is only slightly higher than that of standard long- and short-radius elbows. The creation of the product-to-product impact zone requires a minimum product-to-gas ratio of approximately 3:1.

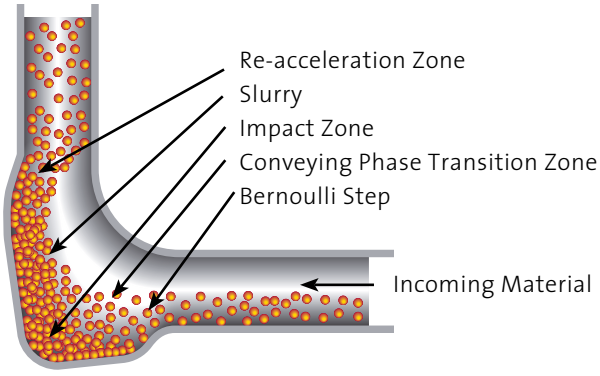
Recommended Pellbow® applications include the handling of fluidizable powder products and any resins or pellets that are abrasive, heat-sensitive and/or fragile, and they can be used in dilute and STRANDPHASE® systems. Pellbows® are available in aluminum, stainless steel, carbon steel and other special alloys, and are suitable for pellet and powder transfer.

Standard Long-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.

Pneumatic Conveying Components

Modern conveying systems require reliable and economical components. Pelletron developed new energy saving rotary valves including a special device to avoid the cutting of granular products. Valves are designed in stainless steel or with an aluminum, hard-coated housing and stainless steel rotor. For special applications, Pelletron provides quick clean rotary valves, valves with v-shaped rotors, powder valves and blow-through valves.

For the diversion of the conveyed material in the pipelines, Pelletron provides diverter valves for granular and powder applications. The diverter valves are available in stainless steel or with an aluminum hard-coated housing and stainless steel rotor. For information about other components including the slide gate valves, filters and cyclones, refer to the Pelletron Component brochure.

Medium Pressure Rotary Valves – GRM-Series

Applications
- For use with granular products and pellets
- For metering
- For feeding pneumatic conveying systems
- Suitable for differential pressure up to 22 psi (1.5 bar)

Features
- Anti-shearing device (patent pending) for gentle product handling
- Low leakage rotor (patent pending) with expanded vane tips
- Integrated leakage air vent for improved filling efficiency
- Heavy duty housing and bearing support for minimized rotor tolerance
- Closed end rotor with 10 vanes

High Pressure Rotary Valves – GRH-Series

Applications
- For use with granular products and pellets
- For metering
- For feeding pneumatic conveying systems
- Suitable for differential pressure up to 50 psi (3.5 bar)

Features
- Anti-shearing device (patent pending) for gentle product handling
- Low leakage rotor (patent pending) with expanded vane tips
- Integrated leakage air vent for improved filling efficiency
- Heavy duty housing and bearing support for minimized rotor tolerance
- Closed end rotor with 12 vanes

Diverter Valves for Granular Products – GDV-Series

Applications
- Suitable for granules and pellets
- For distributing or merging of product flow
- For differential pressure up to 60 psi (4.0 bar)

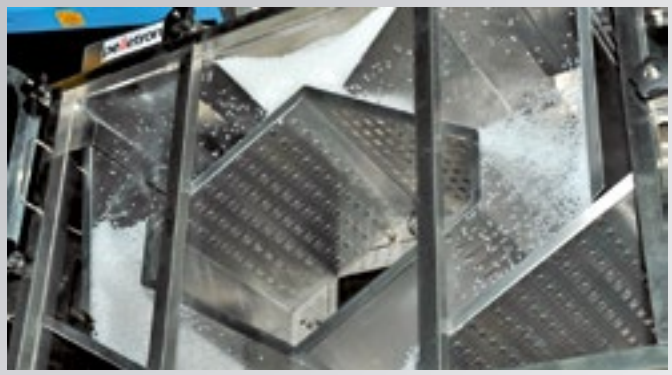
Features
- Seal rings at each port
- Full round pass through design
- Heavy duty body design
- Manual or pneumatic operation
- Heavy duty pneumatic actuator with integrated mechanical stops

Diverter Valves for Powder Products – PDV-Series

Applications
- Suitable for powder, granules and pellets
- For distributing or merging of product flow
- For differential pressure up to 90 psi (6.0 bar)

Features
- Zero leakage ball valve
- Protected seat rings at each port
- Full round pass through design
- Heavy duty body design
- Heavy duty pneumatic actuator with integrated mechanical stops

DeDuster®



DeDuster® in use cleaning plastic pellets

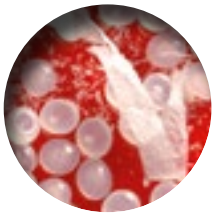
RC DeDuster® in use cleaning regrind

Dust Removal – The DeDuster® Technology

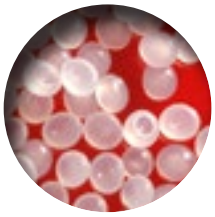
Pelletron has developed a variety of DeDusters® to remove dust and streamers.

The Pelletron DeDuster® uses a magnetic flux field to disrupt the electrostatic charge between micro-dust and pellets, and a patented air wash deck to separate and remove these contaminants.

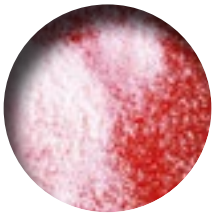
Pelletron provides DeDuster® solutions for the plastic processing and plastic manufacturing industries, as well as for food, mineral, pharmaceutical, chemical and other applications. The DeDuster® is available in sizes ranging from 100 lbs/h (50 kg/h) up to 200,000 lbs/h (100 t/h).



Dusty Material

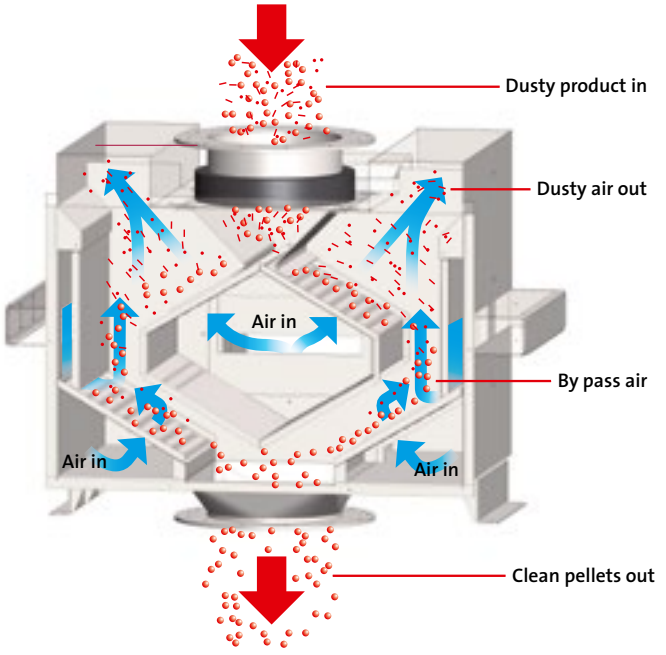


DeDusted Material

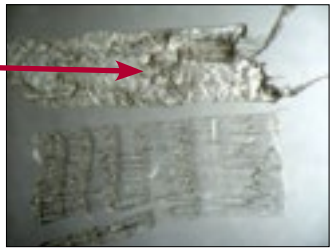


Dust

OPERATING PRINCIPLE



Removed streamers



> 2000 µm

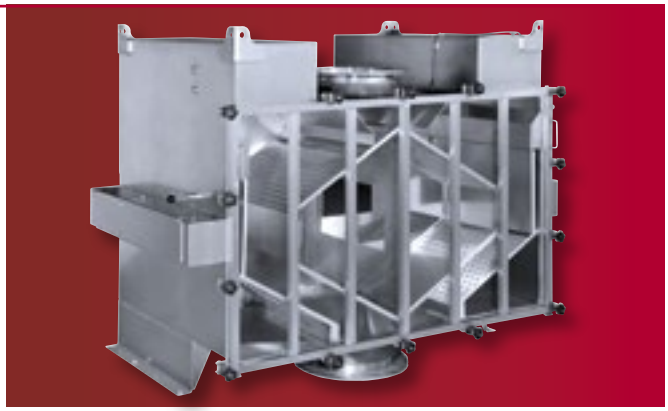
Customers investing in dedusting equipment want to compare the dust and streamer content before and after cleaning and, in many cases, require a performance guarantee. Therefore, Pelletron recommends a complete dust analysis to define the contaminants before and after dedusting. Pelletron has developed procedures and analysis equipment for this purpose. Free-of-charge dedusting tests, including a dry and wet test analysis presented in an electronic report format, are available. The dry and wet dust analysis for dry bulk materials is provided in accordance with ASTM and European standards.

DeDuster® Product Line

XP-Series DeDuster® X-tra low height & energy consumption

DeDuster® type	capacity range in lbs/h			in kg/h		
XP5	650	–	1,100	300	–	500
XP15	1,000	–	3,500	600	–	1.600
XP45	8,000	–	11,000	3.500	–	5.000
XP90	12,000	–	22,000	5.500	–	10.000
XP180	20,000	–	45,000	9.000	–	20.000
XP360	60,000	–	90,000	27.000	–	40.000
XP540	80,000	–	130,000	36.000	–	60.000
XP720	120,000	–	180,000	54.000	–	80.000
XP900	150,000	–	220,000	70.000	–	100.000

Note: Selection of the DeDuster® model depends on the bulk density of the product being cleaned, the shape of the pellets and the type and quantity of the fines.



XP15 to XP900 are equipped with double wash decks

RC-Series DeDuster®

The RC-Series offers low height DeDuster® options designed for a wide range of products with capacities up to 11,000 lbs/hr (5.000 kg/hr). The round design allows for a reduction in height and lower energy consumption. Models up to 100,000 lbs/hr (90.000 kg/hr) are available upon request.

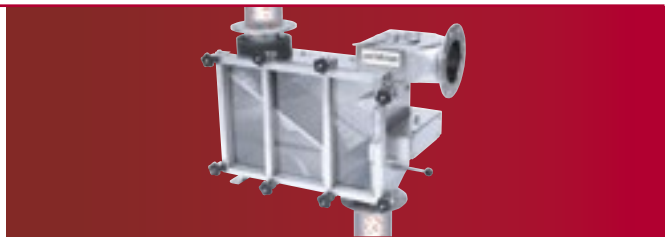
DeDuster® type	capacity range in lbs/h			in kg/h		
RC1	10	–	750	5	–	350
RC20	3,000	–	5,500	1.500	–	2.500
RC45	9,000	–	11,000	4.000	–	5.000

C-20 DeDuster®

The lightweight C-20 DeDuster® weighs 20 lbs (9 kg) and requires only 9.5 in (240 mm) for installation between the transition hopper from the hopper loader to the injection molding machine inlet hopper. The high cleaning efficiency offers exceptional results. It features stainless steel construction, 110 or 220 V operation and only consumes 2–3 CFM (3.4–5 m^3/hr) compressed air at 20–30 psi (1.5–2 bar) pressure.

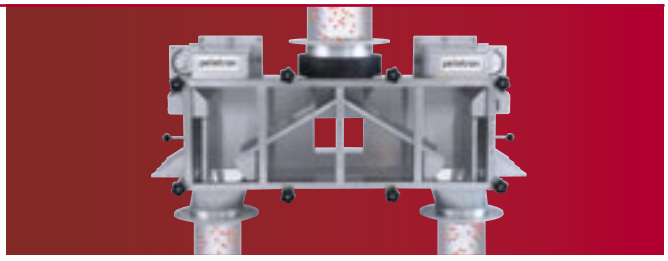
OS-Series

This DeDuster® has an offset inlet/outlet design. It can be used for applications with inclined piping or other configurations that require an offset design. Various sizes are available. Others can be designed based on unique customer requirements.



DO-Series

This DeDuster® has a single inlet and a dual outlet. It can be used for special applications where narrow or shallow packaging machines are installed or for other configurations that require a dual design. Various sizes are available and others can be designed based on unique customer requirements.



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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.

Pelletron Corporation
Corporate Headquarters
1866 Colonial Village Lane
Lancaster, PA 17601
USA

t +1.717.293.4008
f +1.717.293.4011
www.pelletroncorp.com
info@pelletroncorp.com

pelletroneurope GmbH
European Headquarters
Ahornstraße 28
88285 Bodnegg
Germany

t +49.7520.956620
f +49.7520.9566215
www.pelletroneurope.com
info@pelletroneurope.com

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BPC E10/14