POWDER & BULK SOLIDS

KEYS TO SUCCESSFUL PNEUMATIC CONVEYING

Sponsored By NOL-TEC SYSTEMS

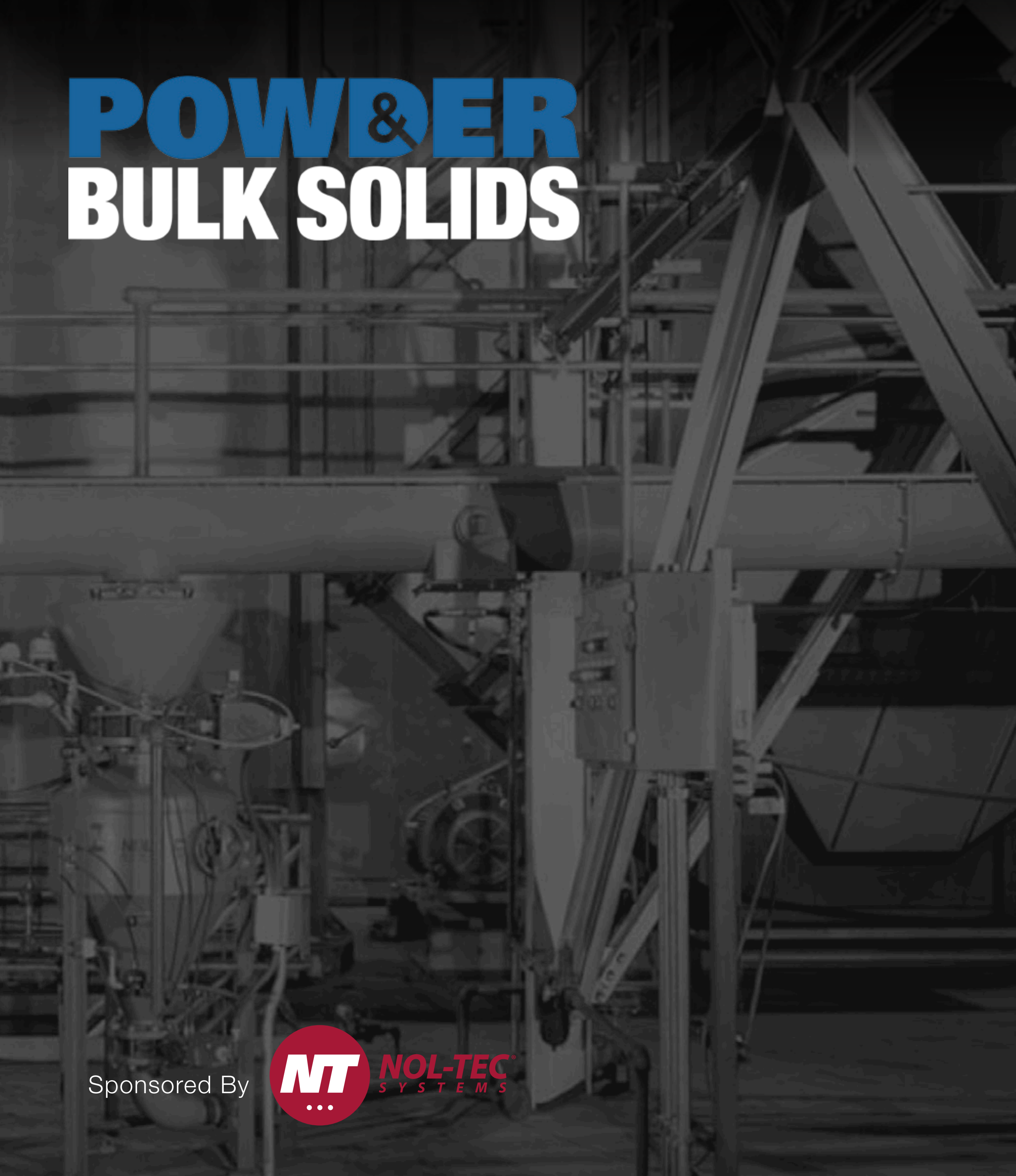

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TABLE OF CONTENTS

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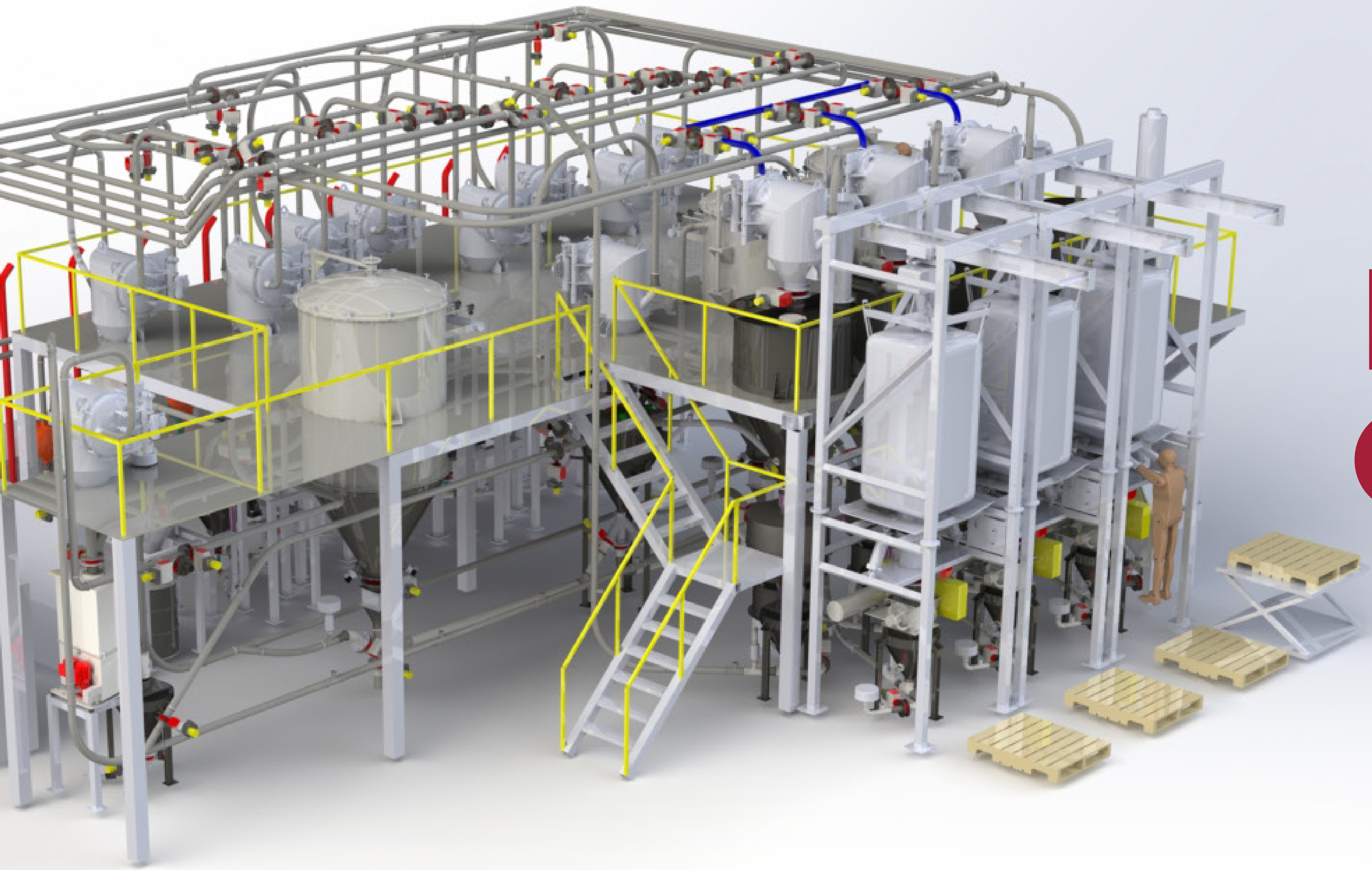
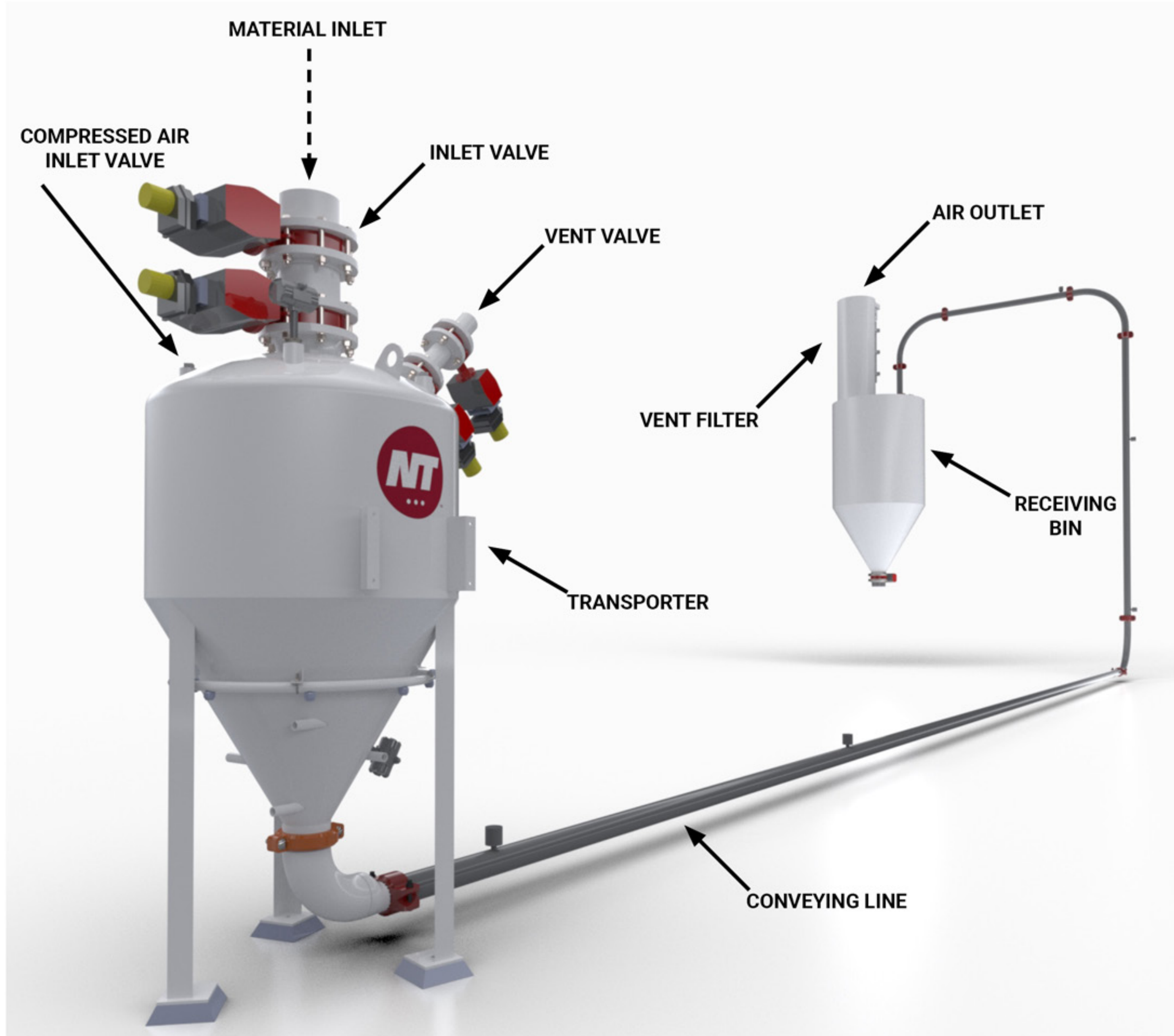


How to Size a Dense Phase PNEUMATIC CONVEYING System

By Iain McNerlin and Brandon Lofquist, Nol-Tec Systems Inc.

Manually sizing a dense phase pneumatic conveying system is often considered a “black art” — a type of tribal knowledge learned and passed down over time by a handful of manufacturers. In this article, we will demonstrate how to size a standard dense phase transporter system. The key system sizing steps are outlined below using alumina powders as the sample dry bulk material to perform the calculations. →

NOL-TEC DENSE PHASE PNEUMATIC CONVEYING SYSTEM



Prior to performing the calculations, a brief overview of dense phase pneumatic conveying is helpful to understand. Dense phase pneumatic conveying is a method for moving difficult, heavy (normally greater than 50-60 lb/cu ft) abrasive, mixed batch, or friable materials at a low product velocity. The system incorporates low gas volume at high pressure, conveying materials through an enclosed pipe in slug form at a controlled product velocity. Dense phase systems are favored for their reduced material segregation and degradation, minimal component wear, low operating costs, and basic maintenance needs. They are typically selected for moving material from a single collection point to either single or multiple destination points. Common materials suitable for dense phase pneumatic conveying include sand, cement, chemicals, metal hydroxides, graphene, lithium, and others.

System Sizing

Alumina powders are used in lithium battery production, high-purity ceramics, coatings, paints, and other specialty applications. This alumina powder has a bulk density of 70 lb/cu ft and is being transferred from a silo to a receiving bin at a rate of 14 tn/hr. The system will be a standard batch blow, purge design (purge design refers to clearing the entire line and transporter with air before refilling the transporter) needing to convey the material over 20 ft vertical plus 145 ft horizontal. In this case, a material test was conducted at our testing facility to establish the conveying rate and air usage. The test was conducted on a 165-ft line, in a 3-in. schedule 40 pipe. The test results indicated a conveying rate of 370 lb/min and an air usage of 150 SCFM.

Transporter - Silo to Receiving Bin	
System Capacity	14 TPH
Conveyed Distance, Horizontal	145 ft.
Conveyed Distance, Vertical	20 ft.
Convey Line Diameter (inches)	TBD
Transporter Size (ft^3)	TBD
Number of Cycles (per hour)	TBD
Batch Size (lbs.)	TBD
Estimated Surge Air Use (SCFM)	TBD
Transport Time (minutes per batch)	TBD
Estimated Average Air (SCFM)	TBD

Calculations

Step #1 Calculate the hourly volume of material to be moved.

(14 TPH x 2,000 lb/tn) ÷ 70 lb/cy cu f = 400 cu ft/hr

Step #2 Select the number of cycles per hour based on the convey distance. Alumina powder conveyed over 165 ft translates to 12 cycles/hour (the longer the convey distance, the lower the number of cycles and conversely the shorter distance the higher number of cycles; Nol-Tec uses a proprietary data set to select cycles/hr).

Step #3 Select a transporter that will use 12 cycles per hour. The hourly volume of material to be moved from step #1 is 400 cu ft/hr.

400 cu ft/hr ÷ 12 cycles/hr = 33.3 cu ft/cycle

Step #4 A 33.3 cu ft transporter is not a standard size. Therefore, select a standard size, in this case a 30 cu ft transporter and readjust the cycles per hour.

400 cu ft/hr. ÷ 30 cu ft /cycle = 13.3 cycles/hr

Step #5 Determine the instantaneous conveying rate required during an individual cycle.

60 min/hr ÷ 13.3 cycles/hr = 4.5 min/cycle. This is the total time allowed to complete one cycle. Every 4.5 minutes the transporter needs to have completed a cycle to make the system rate – note that the total cycle must include filling and conveying.

Step #6 Next select an inlet valve size and determine how much time it will take to fill the vessel. Typically, a standard 8-in. inlet valve is selected and tested to see if the system works. An inlet valve of 8 in. diameter will have a volumetric throughput of 1.25 cu ft /sec. So, the amount of time it will take to fill the transporter is:

30 cu ft/cycle ÷ 1.25 cu ft /sec = 24 sec/cycle (0.4 minutes)

Step #7 Determine how much time is left in the cycle for conveying

4.5 min (total) – 0.4 min (fill) = 4.1 minutes (to convey) →

Step #8 What is the total transporter batch weight?

30 cu ft /cycle x 70 lb/ cu ft = 2,100 lb/cycle

Step #9 What is the required rate to transfer 2,100 lb in 4.1 minutes?

2,100 lb ÷ 4.1 min = 512 lb/min

Step #10 With the transfer rate established, select the proper line size that will deliver the material at a rate of at least 512 lb/min. This step references the testing results which indicated a conveying rate of 370 lb/min in a 3-in. schedule 40 line. A 3-in. line is not large enough, so the test is extrapolated into a 4-in. schedule 40 line. What rate would a 4-in. line deliver?

The rule followed here is that ***the instantaneous conveying rate from testing is directly proportional to the cross-sectional area of the pipe used for conveying***. Meaning a known instantaneous transfer rate through a given internal diameter of conveying line at a given distance, will be the rate through any other size conveying line with the same material at the same distance resulting in a direct proportion of the cross sections of the pipes.

$$\frac{370\text{ lb/min} \times 0.0881\text{ (cross sectional area of 4-in. schedule 40 pipe)}}{0.0513\text{ (cross sectional area 3-in. schedule 40 pipe)}} = 635\text{ lb/min}$$

Therefore, a 4-in. schedule 40 pipe at distance 165 ft will deliver the alumina powder at a conveying rate of 635 lb/min

Step #11 Next, check (at 635 lb/min), how long will it take to convey the material and confirm that it is faster than the required cycle time of 4.1 min..

So, 2,100 lb/cycle ÷ 635 lb/min = 3.30 min. Remember that the material needs to be conveyed in 4.1 min or less, so a 4-in., schedule 40 pipe will work for this application.

Step #12 Next, determine the air usage during conveying so that the compressor can be sized for the system.

Like the rule in Step #10, the instantaneous air usage during conveying is directly proportional to the cross-sectional area of the conveying pipe being used.

$$\frac{150 \text{ SCFM} \times 0.0881 \text{ (cross sectional area of 4-in. schedule 40 pipe)}}{0.0513 \text{ (cross sectional area 3-in. schedule 40 pipe)}} = 257 \text{ SCFM}$$

During the conveying 3.30-min cycle in the 4-in. line, use air at a rate of 257 SCFM.

Step #13 How much air is used per one cycle?

257 SCFM x 3.30 min = 848 SCF

Step #14 How much air is used in one hour?

848 SCF/cycle x 13.3 cycles/hr = 11,278 cu ft /hr

Step #15 What is the "average" air use over an hour?

11,278 cu ft /hr ÷ 60 min/hr = 188 SCFM

Step #16 What is the air velocity during conveying?

257 SCFM ÷ 0.0881 sq ft (cross sectional area of 4-in. schedule 40 pipe) = 2,917 FPM

Step #17 What is the average material velocity during conveying?

$$\frac{30 \text{ cu ft/cycle} \div 3.30 \text{ min/cycle}}{0.0881 \text{ sq ft (4-in. sch. 40 cross sectional area)}} = 103 \text{ FPM}$$

By completing the above calculations, a dense phase pneumatic transport system has been properly sized. The transporter size, inlet valve, convey piping, cycle time, material velocity, batch size, and air consumption are now known values. The key to dense phase sizing--particularly with new materials--is to conduct material testing to help validate the system design. Seeing how the material conveys and then comparing those results to a set of known values makes sizing less guesswork. Nol-Tec has tested hundreds of materials and maintains an extensive database that serves as a valuable resource for our team and clients. ■

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Achieving Greater **Efficiencies** with **Pneumatic Conveying** Lines

By Susan Testa, FLSmidth USA

Image: Shutterstock/Dilok Klaisataporn

Whatever happens next with market dynamics, achieving efficiencies will continue to be foremost in people's minds. Whether you operate a port, a terminal, or a manufacturing plant, the ability to do more with less will be what sets you apart from the competition.

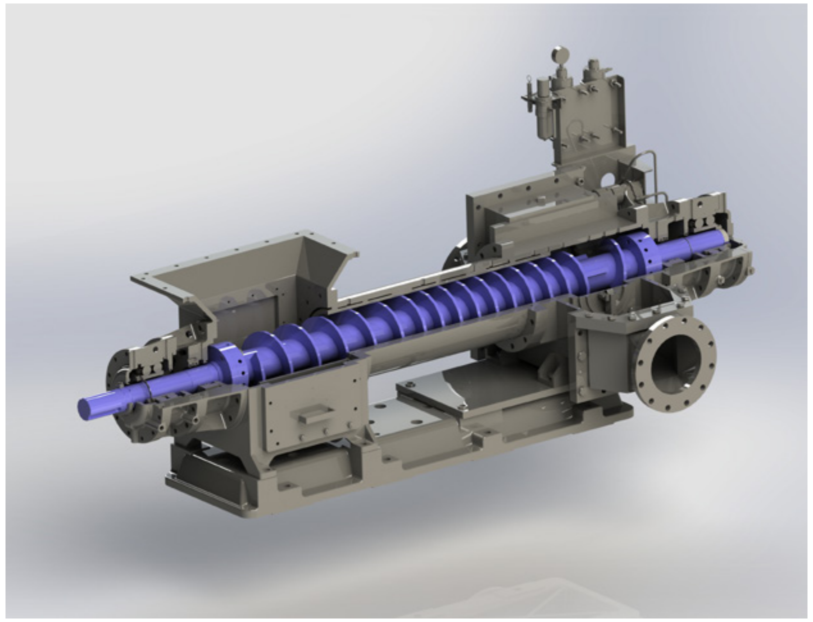
Pneumatic conveying is already widely adopted as the most efficient means of material transport. It's both cleaner and safer than mechanical methods and, with the right technology, you can achieve impressive volumes and speeds. Key to this capability are the core pump and compressor technologies, which can either make or break your process.

This kind of equipment is built to last, so unless you are very unlucky – or if you haven't been keeping up your preventive maintenance strategy – then it's not an area of your process that you would usually replace. However, if you are looking to gain efficiency either by increasing volume or speed of transport, reducing energy consumption, or by regaining control of your maintenance approach, a pump and compressor upgrade is a good place to start.

Increasing Volumes and Speed

As demand on your facility increases, it's imperative that your material handling system can keep up. Bottlenecks not only cause stress and lag in other areas of your operation, but can also result in significant maintenance and material quality issues.

Increasing capacity requires an uptick in the volume of materials that can move through the pump and/or the speed at which materials can move. The latest generation screw pump has



Fuller-Kinyon N pump

been redesigned for greater throughput and higher pressure by lengthening the barrel and screw, improving the seal, and changing the structure of the inlet hopper. This enables a >15% increase in volumetric efficiency, giving you the flexibility to increase throughput when needed.

Reducing Energy Demand

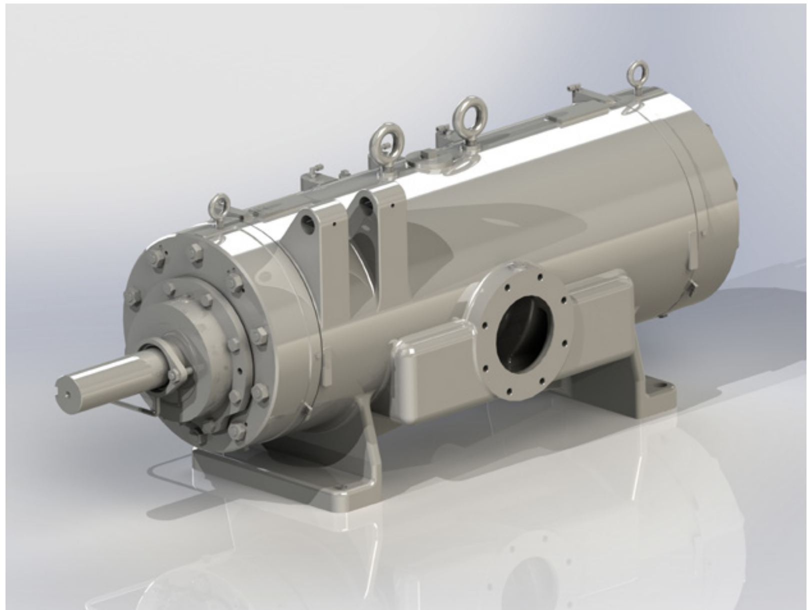
Cutting energy costs can make a significant difference to your bottom line – and have an impact on operational sustainability. Investing in the best available technologies is an obvious way to cut OPEX and meet environmental targets.

With the improved seal on the new screw pump, greater energy savings are possible for higher-pressure applications (20–25 psi and higher) and power savings of up to 15% can be achieved in like-for-like applications. Reducing power consumption not only saves money and reduces your carbon footprint; it also means that your equipment isn't working so hard, giving you better equipment life and reducing maintenance needs.

Increasing Availability

Done well, maintenance is what keeps your system performing optimally. But if maintenance becomes a burden, it's a sign something is not going to plan. A few things can make a real difference here:

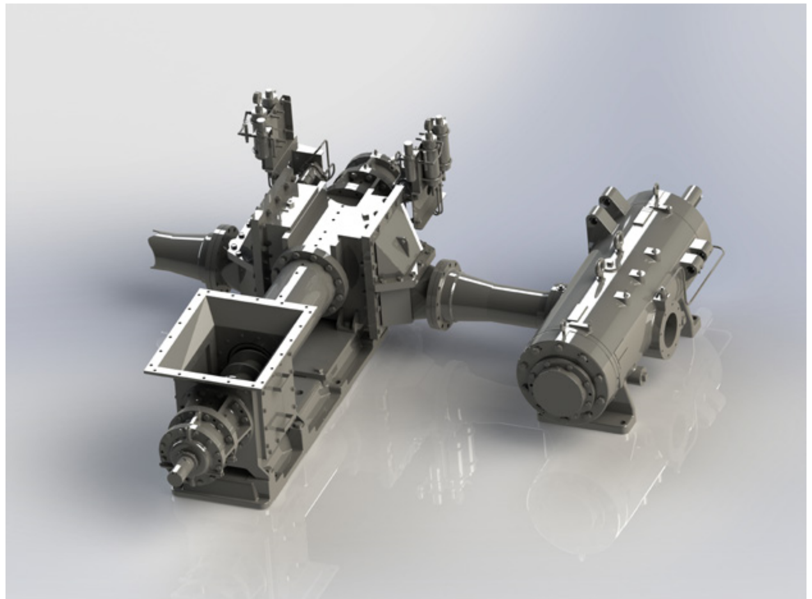
- Spotting the early indications of a problem
- Acting at the right time
- Understanding the root cause



Ful-Vane compressor

With these three things in play, you have a preventive maintenance strategy that will deliver long equipment life, high levels of availability, and low operating costs.

The screw pump and rotary vane compressor have been around for more than 100 years, their robust design proven by the fact that some 100-year-old models are still in operation. In recent years, additional measures have been introduced to make maintenance even simpler and safer. For example, all new screw pumps are equipped with a three-piece screw, which splits the pump screw into three sections – the center section being the replaceable wear part. This eliminates the need to disconnect the coupling to perform maintenance, saving the bearings and seals from being exposed to a dusty, dirty plant environment. Now a screw change takes two technicians just 3–4 hours, about a third of the person hours of the old one-piece screw type.



Ful-Vane compressor and Fuller-Kinyon N pump

Cutting Costs

Increasing throughput, reducing energy consumption, and being more proactive about maintenance are all strategic ways to improve cost-efficiency. Reducing the total cost of ownership (TCO) should be the driver for all process decisions, since that is a core tenet of achieving optimum process efficiency. A quest to reduce both CAPEX and OPEX was behind the recent rotary vane compressor remodel. The new rotary vane compressor design has simplified castings, creating a cost saving that can be passed on. The cooling water jackets have also been redesigned, reducing weight and minimizing costs.

Because operation and maintenance practices are a big part of TCO, training is also important.

Long-Term Performance Goals

Increasing efficiency will continue to be the main goal of manufacturing plants, ports, and terminals for the foreseeable future. It's hard to imagine another target that comes close in terms of importance to an operation's future viability. And while many legacy technologies continue to perform well, there is always room for improvement. ■

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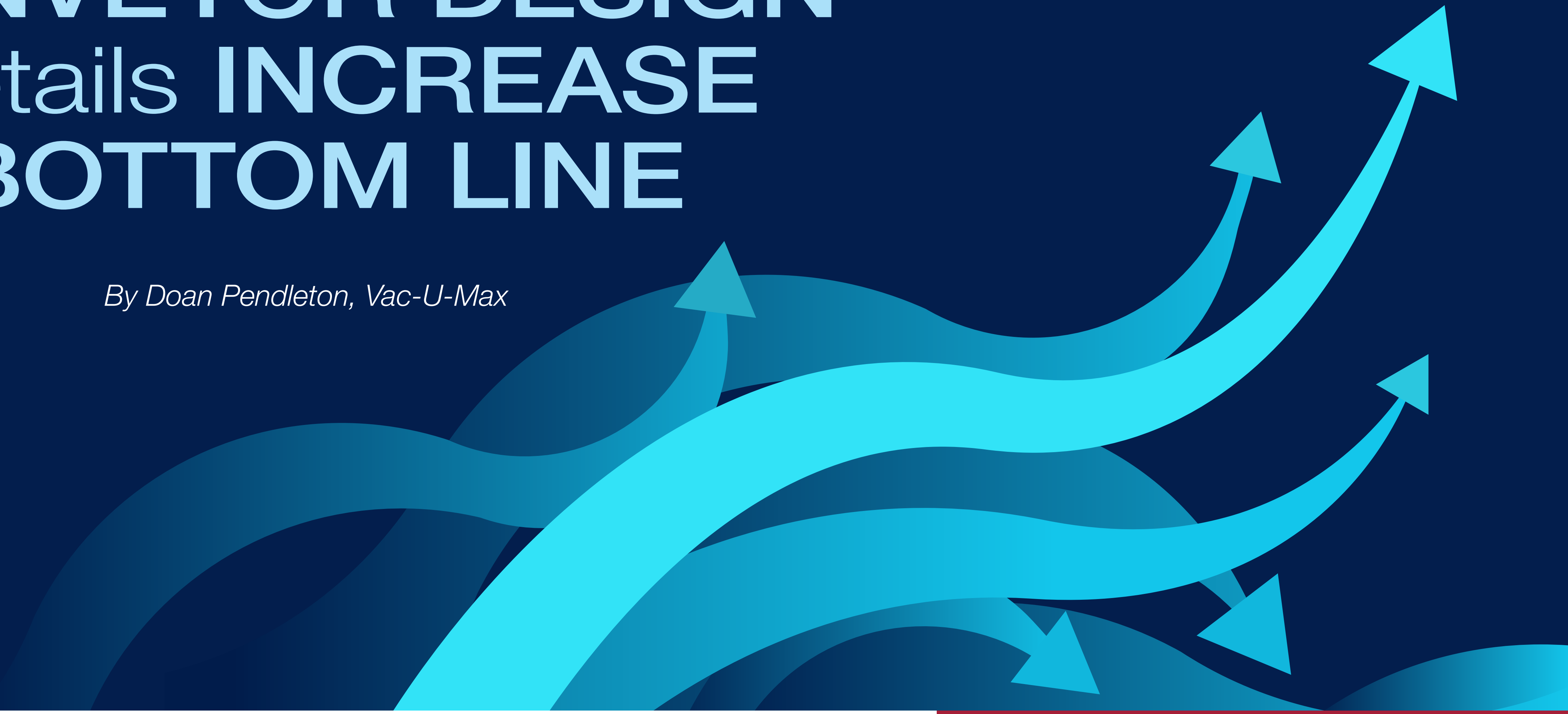
Sanitary Vacuum **CONVEYOR DESIGN** Details **INCREASE BOTTOM LINE**

By Doan Pendleton, Vac-U-Max



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In industries where stringent FDA and USDA sanitary regulations lead to extended downtime for cleaning, time-saving details incorporated into vacuum conveyor design become critical factors in increasing throughput by minimizing downtime and, therefore, reduced costs.

Vacuum conveying is an economical and efficient method of transferring powders and bulk solids materials, eliminating ergonomic hazards, reducing cleaning times, increasing process speeds, maximizing food safety, and preserving formula accuracy.

When a company is looking for a sanitary method to move bulk materials there are several different technologies with sanitary design to choose from, but vacuum conveying is usually the right one for sanitary transfer of powders.

Enclosed vacuum conveyors prevent loose powder from becoming airborne. If a leak occurs in a vacuum conveying system, the leak will be inward preventing fugitive dust from escaping into the environment, making them the preferred method of transfer for sanitary environments where prevention of combustible dust conditions and cross contamination is essential.

There are different thresholds of hygienic design based on specific industry guidelines required of food, pharmaceuticals, nutraceuticals, or cosmetics manufacturers. Although the FDA does not specifically address Hemp processing, the CBD extracted from it classifies as a drug and should follow pharmaceutical guidelines.

Sanitary and hygienic vacuum conveying systems have the same five basic components as standard conveying systems that come together to work as one – a pick up point, convey →

Vac-U-Max 160-cu-ft CIP filter receiver conveys product to CIP rotary batch mixer, increasing productivity while reducing sanitizing downtime from by over 75% (photo courtesy of Vision Conveyor) tubing, a vacuum receiver, a vacuum producer, and a control module.

From the pick-up point, material flows through stainless steel convey tubes to the vacuum receiver which discharges powders through valves on the bottom of the receiver. The vacuum producer is the heart of pneumatic conveying systems and works with the control panel to manage the flow of material through the convey tubes to the vacuum filter receivers.

What makes sanitary vacuum conveyors unique is that all parts and components must be sanitary, meaning easy to clean and constructed with materials and fabrication techniques that meet Current Good Manufacturing Practices (cGMP). cGMPs for food and drug manufacturing specify general regulations for design, construction, and fabrication of sanitary equipment.

In the realm of vacuum conveying there are certain baseline standards that set the trajectory of building out a sanitary design system and every component must comply with the standards.

Vac-U-Max 80-cu-ft vacuum receiver system holds a full batch of ingredients ready for the rotary batch mixer at a leading beverage producer (photo courtesy of Vision Conveyor)

Filters, gaskets, vacuum hoses, and valves, constructed of FDA-approved materials, should include certificates of conformance with project documentation.

While all components included in systems comply with FDA regulations, more sophisticated valves, such as rotary valves and butterfly valves, are specialty designs unique to sanitation. For instance, rotary valves incorporate slide-out rotors and wafer or butterfly valves feature split-valve construction for easy sanitizing.

Stainless steel convey tubing is the standard in sanitary design. In order to facilitate quick take-apart design and support ergonomic standards, manufacturers design systems that limit convey tubing to 10-ft lengths that weigh approximately 50 lb. The easy to take apart ferrules that connect the 10-ft sections comply with cGMP →

Sanitary stainless-steel bag dump station for nutraceutical manufacturer with grate magnet and highly polished interior is ideal for food processing applications.

standards and require no tools and no loose parts for disassembly and re-assembly.

Surface finishes are important in sanitary design to limit places where materials or bacteria can cling to miniscule pockets. The surface finish of product contact surfaces in a sanitary design will involve some level of interior and exterior polishing and mandatory grinding down of welds. Most customers call for maximum roughness measurements of RA25-34, but the best sanitary design practices bring the roughness down to an RA between 10-15 as measured by a profilometer.

Continuous welds and sleeved holes in hollow members should be standard. Well-designed sanitary conveying components include passivation after fabrication. Passivation with nitric or citric acid removes free iron from the surface of components providing a protective oxide layer that is less likely to allow moisture to stick to surfaces.

If there are any control elements located in a washdown environment, stainless steel electrical enclosures are standard and have a water-shedding type of design with a sloped top, sloped door edges, and rated for NEMA 4X.

While most processers establish engineering standards for sanitary design unique to their facility, product, and sanitation process, they may lack the knowledge on how to most efficiently clean the equipment. Working with a seasoned conveyor manufacturer with decades of experience →

Vac-U-Max mobile vacuum conveying system brings vacuum receiver to floor level for easy sanitation.


NEMA 4X control panel for washdown environment with water-shed design.

designing sanitary equipment with efficient design can significantly reduce cleaning downtime.

One of the most important factors in sanitary design is the ability to clean equipment thoroughly and quickly. Processors looking at purchasing sanitary equipment should know how easy it is to take apart and wash.

Vacuum conveyors are often permanently installed above other process machinery and, therefore, more time consuming to clean to the extent required for sanitary applications.

Mobile and column lift conveyors are complete conveying systems that raise and lower the receiver in order to load mixers, reactors, and other processing equipment and then bring the vacuum receivers back down to ground level for easy cleaning or sanitizing eliminating slip and fall hazards while cleaning. Mobile conveyors allow processors to move the equipment to another area for cleaning when necessary.

Clean-in-Place

Cleaning downtime can be devastating to a company, sometimes taking one to two days to tear everything down and clean it. When production throughput demands a high level of cleanliness with minimal labor and time, clean-in-place (CIP) equipment can eliminate hours of downtime.

CIP is a procedure designed to clean all or parts of a process system without needing to completely disassemble or move →


RA25 or lower finish and passivation are standard for sanitary components.

Sanitary vacuum conveyor keeps tablet press filled in pharmaceutical environment.

equipment. CIP is the strategic placement of spray balls, or nozzles, within vessels that circulate water and cleaning solutions. It is automatic and has consistent performance.

Although CIP has been around for a while, it is still a leading-edge technology and is gaining traction in the food, pharma, nutraceutical, and cosmetics industries-—so much so that the acronym is being using like a verb these days with customers saying they need “CIPable equipment.”

In CIP vacuum conveying systems, filter elements can be removed and replaced with insertable spray ball assemblies during cleaning. During the cleaning cycle, the pressure from the water or cleaning solutions extends the retractable balls outward for cleaning and then self-retract after the cleaning cycle, so they don’t interfere with the conveying process.

When a nutraceutical beverage producer landed a large contract, it needed to increase throughput and reduce the eight-hour cleaning cycle that occurred between batches in order to meet demand.

To achieve this, the beverage producer replaced its 90-cu-ft mixer with a 160-cu-ft CIP mixer, a CIP vacuum receiver, and CIP bag dump station. These changes reduced sanitation from 8 hours to 1.75 hours, gaining 6.25 hours of production and reduced labor costs every day.

The CIP system also averted the need to develop a confined space plan with the new larger equipment since the sanitation team didn’t need to enter the process vessel for cleaning.

Good sanitary vacuum conveyor design includes a package of simulated spray ball positioning and surface coverage documentation.

Time-Saving Strategies

To save time some processors have two sets of convey lines and/or two sets of filters so they can quickly switch out dirty components →

Highly-polished bulk bag unloader with food-grade hoist and sanitary rotary valve for baby formula producer

with clean components, cleaning the other while the next process runs.

Other processors--particularly those that run different flavors or colors--might have filters dedicated to certain ingredients (like cherry or licorice, for instance).

The practice of extra filters and tubing can be employed with CIP or traditional sanitary systems, increasing the speed at which processors get systems up and running again.

Sanitary design is a specialized field and expert conveyor manufactures that have worked with more than 10,000 materials and have decades of experience building hygienic vacuum conveyor systems understand the different requirements for food, beverage, pharmaceuticals, nutraceuticals, and cosmetic applications, and know what has to be done to provide processors with the most efficient sanitary powder and bulk solids transfer systems. ■

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Handling Sensitive Materials with VACUUM

By Julie Whitten, Piab USA Inc

Image: Shutterstock/ White_Fox

Many materials needing to be transferred are sensitive in various ways, requiring careful handling. In production lines, avoiding contamination of the product, leakage into the environment, as well as exposure of employees to pathogens are mandatory. Operating in a closed system, vacuum conveying technology meets these requirements and has become an indispensable part in manufacturing. Selecting the right vacuum conveying system requires consideration of numerous specific features.

There are a variety of features and benefits to look for when selecting a vacuum conveying system such as the pump type, filtration system, possible fluidization, flow modulation, and speed optimization capabilities. Additionally, modularity, size, shape, material durability, accessories, warranties, as well as legal compliance aspects should be taken into consideration. With the growing sustainability and automation trends, aspects of energy efficiency and smart operation play a further role for consideration in a vacuum conveying system. An ideal system will optimize performance and increase overall productivity.

Pneumatic vs Mechanical Pumps

The most common types of pumps used in vacuum conveying systems are pneumatic and mechanical. Pneumatic vacuum pumps are significantly smaller, more compact, and lighter in weight. Additionally, pneumatic pumps have no gears or moving parts, which generate heat and noise or require regular lubrication and maintenance.

Mechanical pumps operate properly within an ambient temperature range of 32°F to 100°F. Pneumatic vacuum pumps are less affected by ambient temperature conditions due to their internal multi-chambered design and pneumatic operation.

Filtration System

Filters prevent dust and fine particles

from being drawn into the vacuum pump and escaping into the surroundings and protect the pump from damaging foreign bodies. A simple textile filter material can be ideal for powders or granule material greater than five microns in size. While Herding- or Mahle-type filters may be required for smaller particulates, and high-efficiency particle assay (HEPA) filters filter 99.9% of all dust particles.

Fluidization

Fluidization allows for compressed gas to pass through a porous material, creating a cushion that reduces the coefficient of friction allowing non free-flowing material such as sugars or starches to discharge freely from the vacuum receiver or feed hopper.

Flow Modulation

Flow modulation changes the way material is conveyed and provides the operator with greater control. It is achieved by increasing or decreasing the amount of air at the feed point or by increasing or decreasing the product velocity by adjusting the feed pressure at (a venturi) vacuum pump.

Speed Optimization

A vacuum conveying system should be optimized for speed and performance based on application needs. The key to gentle handling to keep goods intact throughout the entire conveying system is to maintain a controlled low and consistent velocity in the product transfer line regardless of the amount of material in the pipeline. Hence, allowing to convey the maximum amount of product without damage.

Sustainability

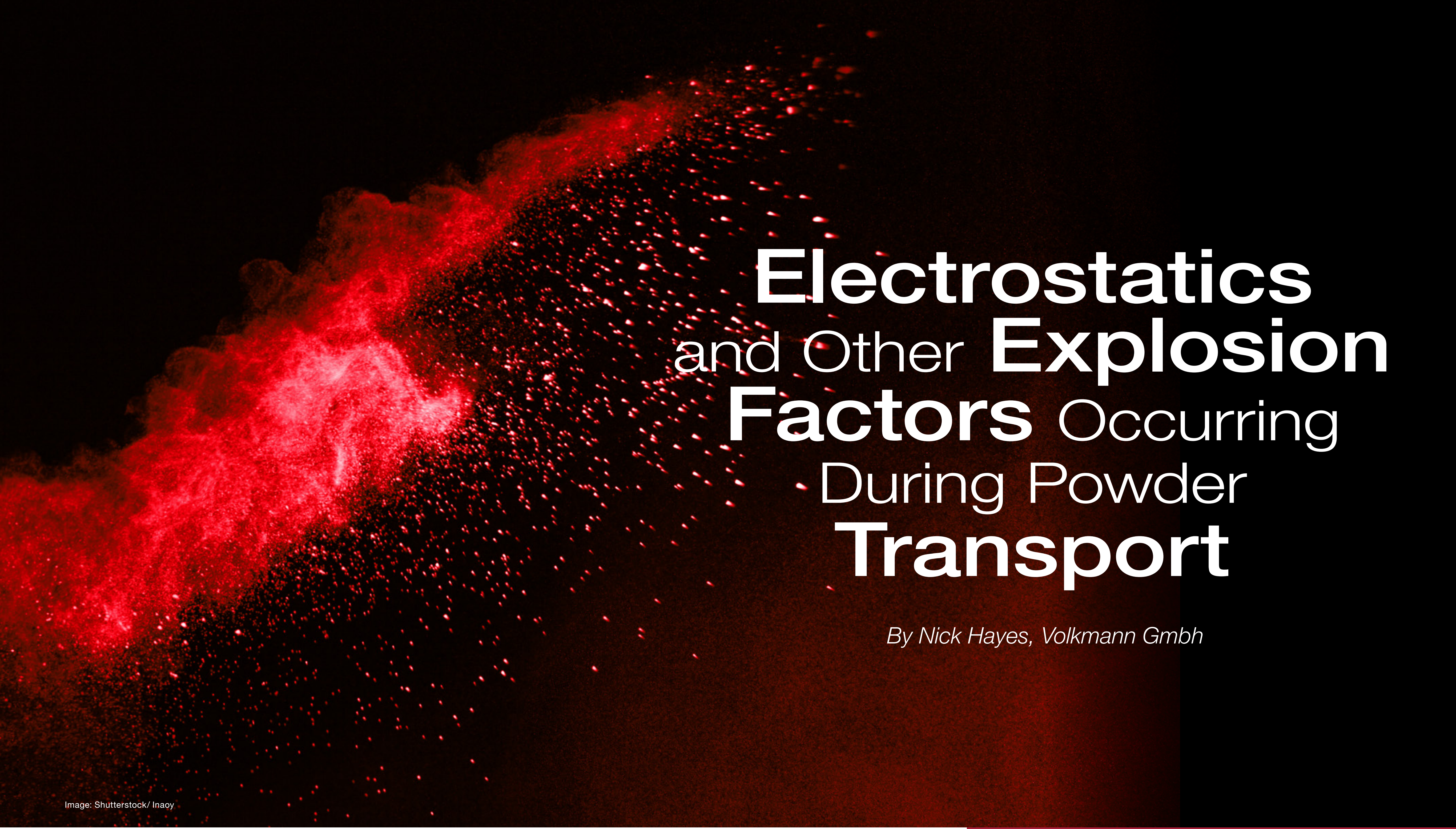
The use of pneumatic vacuum pumps can increase energy efficiency due to their ability to operate intermittently by adding a solenoid valve to shut off air flow to the pump when not transferring product.

Automation

With the advent of Industry 4.0 automating vacuum conveying by establishing processes that allow fast and operator-independent setting of conveying parameters based on machine learning increases in importance. This is further driven by the need for social distancing, i.e. less operators as a result of the COVID-19 pandemic.

Whatever final system design entails, it is advisable to test the chosen solution in a pilot plant or test center environment. This allows for the simulation of the product transfer process to see handling results on sensitive products and validate system performance in the production line. ■

Julie Whitten is sales director for vacuum conveying in North and Central America, Piab USA Inc. Whitten has more than 20 years experience handling powders in the food, chemical, pharmaceutical, and nutraceutical markets. For more information, contact Piab at info-usa@piab.com or 800-321-7422.



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Electrostatics and Other **Explosion Factors** Occurring During Powder **Transport**

By Nick Hayes, Volkmann Gmbh

Once a year, a group of industry engineers gather at Volkmann's corporate headquarters in Soest, Germany to review and discuss how explosion protection factors into powder and bulk material handling. The aim is to bring their explosion protection technology knowledge up to date and establish its connection to powder and bulk goods transport, particularly as it relates to vacuum conveying and other powder handling solutions, in order to make design recommendations and improve equipment as a useful addition to risk analysis programs and develop proper prevention safeguards. Last year's meeting, hosted by Dr. Martin Glor (Swiss Process Safety Consulting), the "mysterious" area of electrostatics was dealt with in detail.

Conveying technologies--and vacuum conveying in particular with its differentiation and advantages over mechanical conveying systems--are specifically reviewed in these meetings, along with the stringent ATEX directives 95 and 137, corresponding to the equipment protection level for dusts (EPL) and to explosion zones 20, 21, and 22 (U.S. Class 1 Div 1 Groups E, F, and G). Unlike many aspects of NFPA standards, ATEX standards are established by testing and can be viewed as proven. The individual assemblies of a vacuum conveyor are easily demonstrated to be safely designed without an ignition source by using a combination of a Multijector multiple Venturi vacuum pump and all pneumatic controls. The risks associated with ignition sources, such as hot surfaces or electrical and mechanical sparks generated from the conveying system, can be safely excluded with this conveyor design. This is fundamental to removing one of the three fire triangle elements necessary for an explosion to occur in combustible dust.

The further characterization of bulk materials in connection with lean, medium, and dense conveying conditions lead to numerous applications of vacuum conveyors in very different industries and production environments. By eliminating sources of ignition in these applications, they are able to safely operate. The group gives close attention to the consideration of the areas of potential ignition. For example, we know that smoldering "nests" of product, hot surfaces, and mechanical sparks are all possible ignition sources. However, when determining causation after an incident, the real source of an explosion may not be readily identified, thereby resulting in a conclusion that "it must be electrostatics."

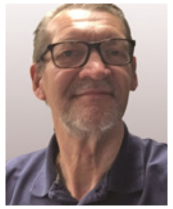
Because of this, it is important to consider charging mechanisms, charge accumulations, or their discharge leading to the basic scheme of electrostatics. If a safe discharge is not possible, and one occurs, the ignition effectiveness of this discharge must be assessed. In addition to the relatively well-known spark discharge shown in practical experiments, brush discharges and their ignition effectiveness must also be considered.

In the case of pneumatic conveying at high velocities (lean phase in particular where velocities typically exceed 4,000 ft/min), another type of discharge can occur, the so-called sliding stem tuft discharge. This energy-intensive discharge can be impressively demonstrated by the loud bang and highly visible sparks that occur. Such discharge only occurs under certain conditions and can ignite dust. It must be avoided in pneumatic conveying systems, and therefore results in the frequently discussed requirement for static dissipating conductivity in conveyor hoses with wire coils.

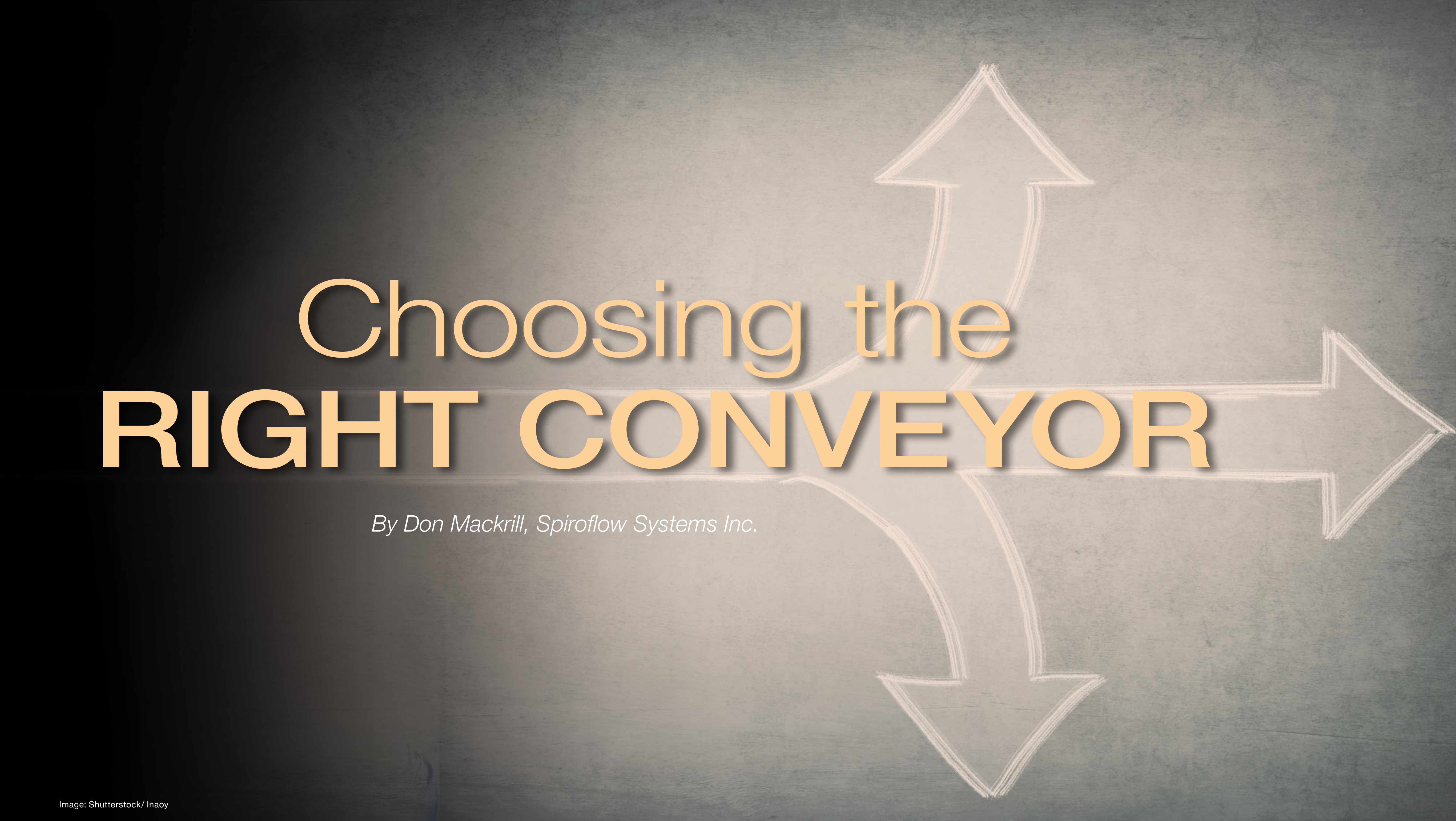
The last of the forms of discharge, corona discharge, also needs consideration. However, corona discharge only has a certain ignition effectiveness when particular gases are present.

Mitigation of risk is a key topic in the discussion of explosion avoidance and effective grounding is certainly the first general protective measure. However, it should not be forgotten that "good housekeeping" (i.e. clean operation without dust deposits spread over a large area) makes a significant contribution to promoting safety. Likewise, it is critical to not only avoid initial fires or deflagrations such as those due to hot surfaces, but also to prevent secondary explosions due to turbulence.

Well-designed powder processing systems that include vacuum conveyors can make a valuable contribution here, as they not only safely transport dust, but also keep the bulk powders in a closed system through the vacuum used, thus automatically ensuring a clean environment. ■



Nick Hayes, CMgr FCMI, former president of Volkmann Inc., is now a senior advisor to Volkmann Gmbh. He is a mechanical engineer and a Fellow of the Chartered Management Institute.



Choosing the RIGHT CONVEYOR

By Don Mackrill, Spiroflow Systems Inc.

Image: Shutterstock/ Inaoy

In this article, we will discuss the selection criteria for flexible screw, aero-mechanical, and vacuum and pneumatic conveying techniques.

Selecting the ideal conveyor can become a daunting task for the buyer who may not be aware of the advantages of the individual types. A product feasibility test is always advisable to determine the most suitable conveyor for the material concerned, the distance involved, and the throughput required. However, the following guidelines can be used as a starting point.

Flexible Screw Conveyor

The simplest and low-cost solution is the flexible screw type, comprising a stainless-steel spiral rotating within an UHMWPE food-grade tube. This type of conveyor suits materials with a bulk density up to 2.5 kg/l and can carry material to a maximum distance of 20m, although multiple units can extend to greater distances as required. Maximum throughput rate is 20,000 kg/hr.

The term 'flexible' means that the tube and the spiral within it can be curved to some extent. This creates installation flexibility to convey around any obstacles between the inlet and outlet.

The spiral itself has a round cross section in most applications, but a flat version can be used for cohesive or fine materials. It is desirable to have a generous head of material in the feed hopper, as this assists the elevation of material when starting. Also, the conveyor is designed to run full of material; empty running will lead to excessive noise and wear. →

This aero-mechanical conveyor is a balanced venting system operates below 85dBA and conveys at a rate from 400 to 1,840 cubic ft/hr.

Flexible Screw Conveyors in Action

Flexible screw conveyors are used at Farley Health Products in Cumbria. The plant is maintained at full pharmaceutical levels demanding stringent operating standards. An intermediate bulk container (IBC) containing blended product is placed above a sealed hopper. Once in place, the valve of the IBC is opened allowing the product to flow into the hopper without any risk of atmospheric contamination or escape of dust.

The conveyor then carries the product at a very steep angle to a packing system. The system fulfils the very highest levels of hygiene and dust containment, despite strict operating parameters.

The main advantage of the flexible screw type is its simplicity. This results in short installation times and low maintenance. USDA 3A-accepted designs for pharmaceutical use are available, and the whole system can be stripped down for cleaning in minutes. Wear is a problem only with abrasive products, and life with other materials is almost indefinite. Tubes and spirals can be easily replaced.

This flexible screw conveyor is a simple, low-cost solution is comprised of a stainless steel spiral rotating within an UHMWPE food-grade tube.

Aero-Mechanical Conveyor

The aero-mechanical conveyor has the alternative and more descriptive name of a rope and disk conveyor. The rope is actually a continuous loop of steel cable with a series of equally spaced disks secured to it. It travels through a tube around a drive sprocket and a number of idler wheels. This type of conveyor is capable of conveying material vertically up to 20-25m. A major advantage of this type of conveyor is that degradation of the product is almost negligible. This is because the material is carried along in moving pockets of air which are created between successive pairs of disks, similar to the effect of a vacuum or pneumatic system but at significantly lower speeds. Another advantage is that the aero-mechanical conveyor does not need a cyclone or filter to separate the product from the air.

Furthermore, the air carrying the material is not expelled at the outlet. The material is separated from the air that carries it, and the unloaded air current is directed down the return section →

This vacuum conveyor provides good product flow rates and low maintenance costs.

of the tube. It is therefore retained in the tube circuit. Typical maximum rates of throughput are oats 40 tn/hr; milk powder (26% fat) 20 tn/hr; and granulated sugar 80 tn/hr. If installed vertically, the throughput of the aero-mechanical is unaffected, and material can be lifted at the above-stated rates of throughput to 20 or 25m.

Throughput of the flexible screw conveyor, on the other hand, will diminish the steeper the angle at which it operates. The extent of this depends on the nature of the material. The problem is caused by fallback of material back through the center of the spiral, which can be checked by the provision of a central core or tube. Single flexible screw conveyors of 6 to 8m in length can then be used in the vertical.

An aero-mechanical conveyor should always be started empty and stream fed. In some cases, a controlled feed device, such as a screw or flexible screw conveyor, will have to be used. Maintenance needs are moderate to high. The rope must be tensioned occasionally. Rope life depends on conveyor length, the number of starts and stops, solids loading, and whether routine inspection and tensioning are properly performed.

Vacuuming Conveyor

A pneumatic conveyor uses air to convey materials through an enclosed pipeline. It provides a solution for any user requiring a system that is easy to route, has few moving parts, is dust-tight in operation, and completely empties the system of product with minimum residue. Most systems are derivatives of three basic technologies →

employing some common equipment in terms of filtration, pipeline fittings, blowers, or compressors.

Vacuum conveying is made under negative pressure, but its use is usually restricted to throughputs of around 10 tn/hr over 50m. The motive air force is provided by either a roots pump or side-channel high-efficiency fan sited at the receiving end of the system. Air-powered venturi systems are also used for low-capacity conveying. However, despite their comparative low capital cost, they can prove more expensive to run.

Vacuum systems are regularly used to transfer material from bag dump units, open containers, drums, silos, and big bag dischargers where longer transfer distances and excellent route flexibility is required. Variants of all the above types of conveyor can be produced in mobile forms for processors who require transfer of materials at several locations.

Wherever materials need to be transferred, vacuum conveying offers distinct advantages in terms of good product flow rates and low maintenance costs.

The main advantage for this type of conveyor is the fact that the product will only come into contact with air throughout the conveying line. Coupled with their dust-free operation and easy-to-clean features, this makes them particularly suitable for transferring food and pharmaceutical materials where the most rigid standards in hygiene and containment need to be met and maintained. The product range for these materials is virtually unlimited and is used for salt, sugar, flour, starch, spices, yeast granules, glucose, talc, and paracetamol. Other industries include the chemical, plastics, water, and minerals. ■

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How to Determine the Best PNEUMATIC Conveying Method for Handling BLENDED POWDERS

By Steven Wicklund, Tetra Pak Inc.

Pneumatic conveying methods provide sanitary conveying options for sensitive powders and achieve distances mechanical conveying systems cannot. However, homogeneity issues can arise in blended powders that are transported using the wrong pneumatic conveying system. Such issues can be costly endeavors resulting in scrapped product, downtime, and concerns around brand standards and reputation. This column will discuss the two main categories of pneumatic conveying systems: Dense and dilute (also known as lean) phase and highlight dense as the best option for blended powders.

Pneumatic conveying systems work by generating a gas flow (generally air) in a pipe combined with a pressure difference between the pickup and receiving points. Product moves from a point of higher pressure to a point of lower pressure.

Dilute Phase Conveying Methods

In a dilute phase conveying system, product is dropped into a continuous stream of air that is generated either by a blower at the front end (pressure) or back end (vacuum) of the process where typical air velocities can range from 3,000 to 7,000 ft/min. Dilute phase conveying is an excellent way to move robust powders, but not so much for fragile, instantized, or blended powders. With the high conveying velocities, fragile or instantized products are broken down. When dropping a blended product into a fast-moving airstream, the first thing the product does is separate based on particle size, shape, and density. You will lose the homogeneity you worked so hard to achieve.

Dense Phase Conveying Methods

A dense phase system moves slugs of powder through the convey line separated by cushions of air where typical convey velocities will range from 150 to 2,500 ft/min. These slower convey velocities, as well as the higher concentration of powders, makes it less likely for fragile powders to be broken down or blended powders to de-mix. A dense phase conveying system can be set up to meet almost any production requirement remembering that the goal of this system is to move the product as slowly as possible, without plugging the lines and keeping up with required production. A dense phase system can be set up to run either as a batch system or continuous, depending on the production requirements, and can achieve rates up to 20 tn/hr.

Dense phase conveying can further be subdivided into a pressure system where compressed air is used to pressurize a transporter vessel to push the powder, or a vacuum system where a vacuum pump is used to draw a vacuum on the receiving vessel and pull the powder. A pressure-dense phase system can move powder up to 325 ft with an elevation increase of over 75 ft, and a vacuum dense phase system can move powder over 160 ft with an elevation increase of 60 ft.

When the production requirements are outside the limitations of a dense phase system, semi-dense phase conveying is a good alternative. By adding a little more air, hence moving the product a bit faster, the overall distance (horizontal and vertical) can be increased without overly affecting the product's integrity or homogeneity.

When developing a powder blending system, it is important to not only spend effort on the design of the blending process, but on the post-blending handling process. It is advisable to for producers to test their chosen solution in a pilot plant to confirm the breakage rate, de-mixing, and other important characteristics. Test centers specialized in powder handling solutions let producers simulate any kind of powder handling process to test the system on sensitive products and validate line performance. This extra effort will go a long way because the wrong powder handling process can easily negate the efforts to develop your blending system. ■

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