Bulk Solids Innovation Center
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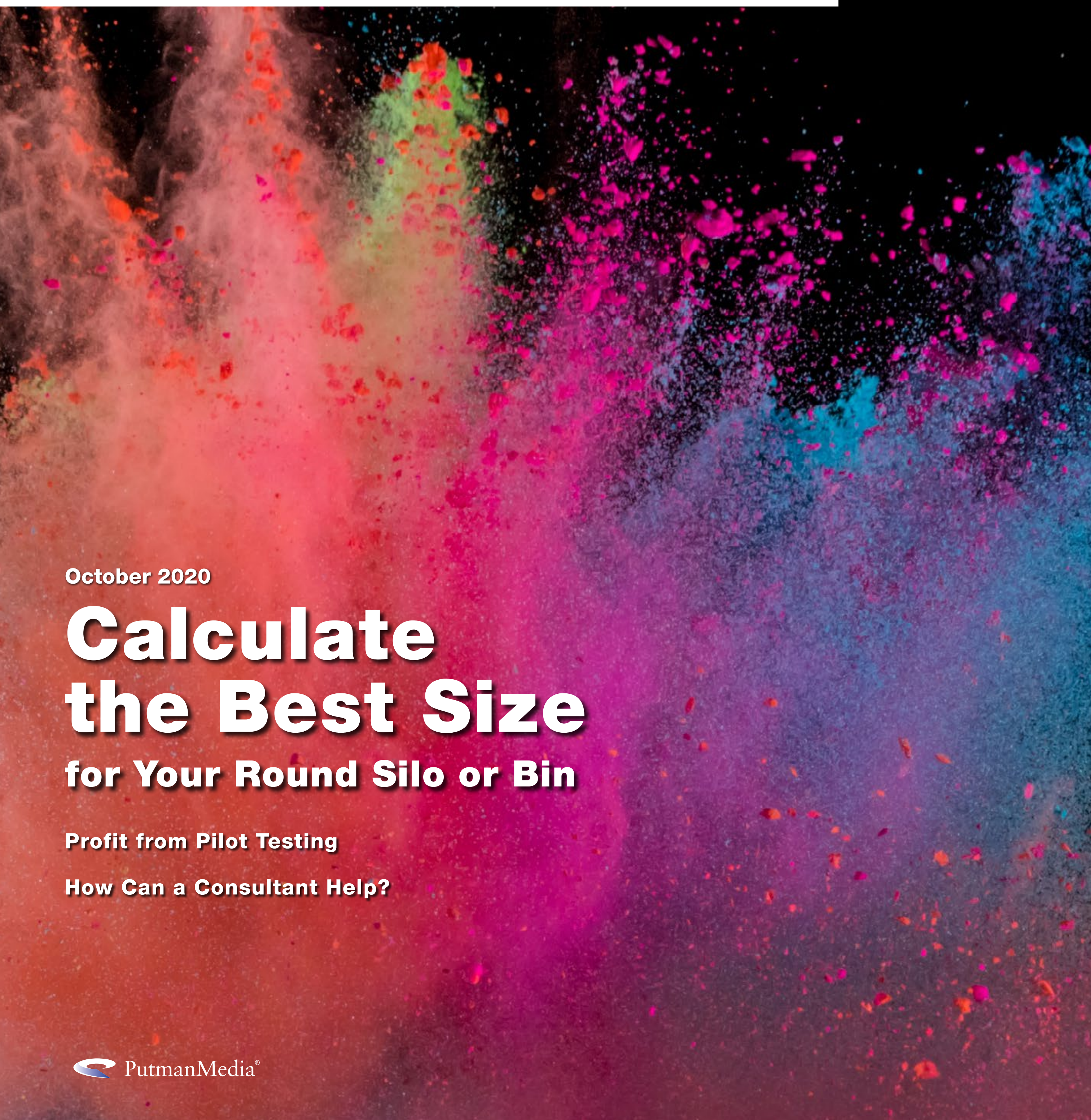
CHEMICAL PROCESSING



October 2020

Calculate the Best Size for Your Round Silo or Bin

Profit from Pilot Testing

How Can a Consultant Help?

PutmanMedia®

Bulk Solids Innovation Center Journal

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Calculate the Best Size of Your Round Silo or Bin

4-step procedure helps you determine your bulk solids storage vessel dimensions

By Todd Smith, KSU-Bulk Solids Innovation Center

Silos and bins are some of the most common pieces of equipment in any plant that produces or uses bulk solid materials. Determining the proper size is not difficult, but it requires some calculations. Figure 1 shows basic nomenclature and equations.

DESIGN PROCEDURE

Like many engineering projects, determining the best size for your silo or bin is a set of compromises. Most process designers would like as much storage capacity as possible, but this should be balanced with other constraints such as budget and available head height or floor space.

Furthermore, vessels that are too large cost more than necessary and

Nomenclature:

r = radius

d = diameter

h = height

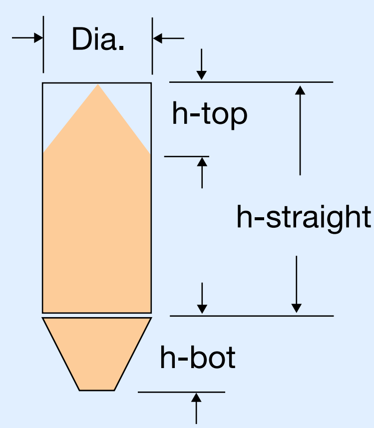
Relevant Equations:

Area of a Circle = $\pi r^2 = \frac{\pi d^2}{4}$

Volume of a Cylinder = area x height = $\pi r^2 h$

Volume of a Cone = $\pi r^2 h/3$

Height of a Cone = r tan(angle)



BASIC DETAILS

Figure 1. Hopper geometry is fairly straightforward.

WATCH FOR ADDITIONAL SIZING TIPS

Over the next several issues, the BSIC Journal will provide a set of practical methods for sizing equipment and processes. Future articles will focus on sizing rectangular storage bins, bin vent filters, cyclones, air ducting and receivers with tangential inlets.

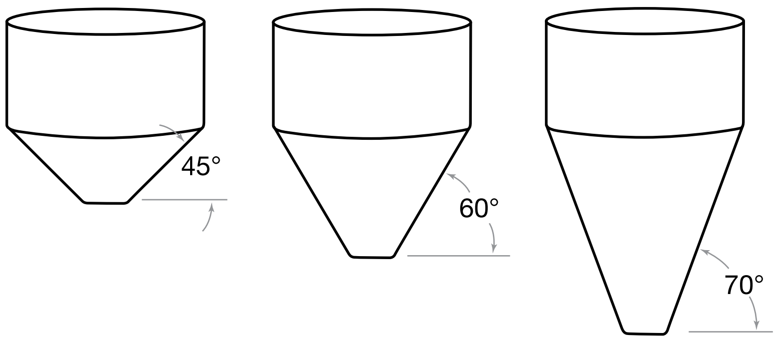
hold excess inventory, which is bad for the company's finances. They also can cause process issues such as stagnant material that doesn't flow well if it sets too long in a bin.

These four steps help you calculate the best silo or bin size.

Step 1. Determine the vessel's desired volume. This often is set by process variables, such as the amount of material that will be consumed in one batch or the amount required for one hour in a continuous process.

Silo sizes often are determined by the type of incoming container. For example, if the incoming truckload is 50,000 lb, then many plants will want a silo that is at least 1.5 times that amount, i.e., 75,000 lb, so that another truck can be unloaded as soon as the amount of material remaining in the silo gets down to 25,000 lb or less.

Step 2. Choose the silo or bin's diameter. This can be based on available plant space or by looking at similar applications. Silo diameters often are determined by the largest diameter that can be transported down a highway.



COMMON HOPPER ANGLES

Figure 2. A material's flowability, available space, and equipment cost factor into choosing the desired hopper angle.

Most states require an oversize load permit if the load exceeds 8.5 ft in width, and most have additional requirements such as escort vehicles if the load exceeds 10 or 12 ft in width. Therefore, most welded silos are 8, 10 or 12 ft in diameter.

Step 3: Set the cone's hopper angle. Shallower angles, such as 45° from horizontal, cost less than steeper angles, such as 60°, because the silo will hold more volume in a given height. As such, 60° is the most common hopper angle, and it works well enough to achieve funnel flow for many materials (Figure 1).

For a few very free-flowing materials such as some plastic pellets, a 60° cone will achieve mass flow, whereas a 45° cone will achieve reliable funnel flow. A steeper angle, say 70°, will induce better flow, but it requires much more height and therefore costs more to hold the same amount of material.

To determine the hopper angle reliably, look at examples of what has worked well in the past, but only if the material and environment will be identical. In other cases, it is best to send materials to a testing agency so that the proper dimensions can be calculated from the material properties.

Step 4. Determine the material's angle of repose. This is the angle (from horizontal) the material forms as it flows into a pile at the top of the vessel. (This is depicted at the top of the of figure 1 in this article, and the height of the angle of repose is depicted by "h-top".) A common angle of repose is 35° from horizontal, but fluidizable and very free-flowing materials will have a lower angle. Poorly flowing materials will have a steeper angle of repose. You can measure it by pouring a pile of material and then measuring the angle. This is a routine measurement for your material testing provider.

Angle of repose is important because it will cause a void space at the top of the vessel that must be accommodated in the bin or silo design. If you forget about angle of repose, then the vessel can fill up to the top opening before you reach the desired amount of material. Angle of repose also is good to know when deciding where to place the high level switches in your silo or bin.

EXAMPLE CALCULATIONS FOR CHOOSING A SILO (BASED ON STEPS 1–4)

Desired silo capacity = 75,000 lb. Based on example bulk density of 35 lb/cu ft, the desired Volume = 75,000 lb ÷ 35 lb/cu ft = 2143 cu ft

Diameter = 10 ft.   r = 5 ft

Hopper angle = 60° from horizontal

Material angle of repose = 35° from horizontal

Calculation #1: Find the height and volume of the bottom cone.

h-bot = 5 * tan(60degrees) = 8.66 ft

Volume of bottom cone = $\pi * 5^2 * 8.66/3$ = 227 cu ft

Calculation #2: Calculate the height and volume of the top cone of material, formed by the angle of repose.

h-top = 5 * tan(35°) = 3.5 ft

Volume of material in top cone = $\pi * 5^2 * 3.5/3$ = 92 cu ft

Calculation #3: Determine the volume and height of material that will be held in the cylinder.

Volume in cylinder = Desired volume – volume in bottom cone – volume in top cone = 2143 – 227 – 92 = 1824 cu ft

Height of material in the cylinder = Volume ÷ Area = 1824 / ($\pi * 5^2$) = 23.2 ft

Final Calculations: Determine the Minimum Sidewall Height = Height of material in cylinder + h-top = 23.2 + 3.5 = 26.7 ft

Determine Total Height = Sidewall Height + Cone Height = 26.7 + 8.66 = 35.4 ft

Note: If you would like a copy of a spreadsheet that performs these calculations, contact the author, and he will send it to you. The spreadsheet includes features such as calculating your vessel's weight allowing for the size of the bottom discharge opening.

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Solids Handling: Surmount Sticky Situations

A properly designed fluid-bed dryer can handle sticky solids | By Tom Blackwood, Contributing Editor

"Almost all fine solids, when wet, are sticky. "

"Don't put them in a fluid bed." I often hear this comment about sticky solids from plant operators and engineers because they've had many bad experiences with fluid beds. They end up spending countless hours cleaning out a plugged distributor, opening a discharge chute or banging on the vessel to get the solids to flow. They say the solids are too sticky to fluidize. Let's face it: sticky solids need special attention. But first, we must identify the source of the stickiness.

Almost all fine solids, when wet, are sticky. Many others clump due to a variety of factors including stickiness (see: "Clamp Down on Clumping"). Only a few of those factors come into play in the operation of a fluid bed; the leading issue is the solvent, usually water. In my mind, melting of the particulate solids is the only legitimate excuse for plugging a fluid bed. So, what are the real causes of pluggage and how can you prevent them? The problem mainly arises on the fluidizing plate, screen or grid. The failure often stems from poor dispersion of the solids, lack of enough bed depth, low velocity through the grid and spacing the holes in the grid too far apart, as the following examples show:

• In one dryer project, a centrifuge had been placed above the dryer to eliminate the need for a screw feeder. Unfortunately, if the centrifuge was over-fed, slurry dropped onto the dryer grid. The grid had tuyeres designed for a catalytic cracker instead of a dryer. These were replaced with a more-robust design while retaining the tuyere spacing. The increase in velocity and horizontal gas flow tolerated the occasional centrifuge upsets, which were reduced by better instrumentation. The benefits of the new grid design didn't stop there. The dryer product had a more-uniform moisture content, partially due to the greater heat transfer to the solids. Later, thanks to the change in grid

design, the plant was able to raise the capacity of the dryer.

• On a second project, the plant engineers were painfully aware of the stickiness of their product; it plugged up the centrifuge discharge on a regular basis. Also, the moisture content was higher than normally encountered in a fluid bed. The solution was to install a high-speed mill above the dryer even though the solids already were finer than the mill could produce. It dispersed the solids over the bed without attriting the particles. The fluid bed was split into zones, with the first very deep. This design allowed the particles to flash off the free moisture and eliminate the normally sticky surface. The deep bed required more pressure drop across the grid to ensure uniform distribution of the solids and to keep them off the grid. In addition, the higher pressure-drop requirement called for smaller grid holes that were spaced closer together to avoid hot spots.

• Another project involved a dryer suffering excessive entrainment after a recent product change presented a finer material to it. The corporate health and safety group had mandated a minimum velocity through the fluid bed of 3 ft/s for this product — due to frequent fires in the dryer when the velocity was below 3 ft/s, even though the solids could be fluidized easily at 1 ft/s. I replaced the grid with one that had the same pressure drop at 1 ft/s as the old one had at 3 ft/s. The lower velocity in the bed reduced the entrainment while the higher velocity through the grid kept the solids from sticking to the grid and burning. It also improved the heat transfer and evaporation rate, enabling the dryer to maintain the same production rate despite the lower fluidization velocity.

Almost all fine solids, when wet, are sticky.

The secret to putting particulate solids into a fluid bed successfully (which means getting them out in one piece) is close attention to dispersion of the solids, good bed depth, and careful design of the fluidization grid. It's amazing how many other good things happen when you properly put sticky solids into a fluidized bed.

TOM BLACKWOOD is a *Chemical Processing* contributing editor. You can email him at TBlackwood@putman.net

How can a consultant help?

When Should I Hire a Technical Consultant?

Understand the types of services that outside experts offer

By Kevin Solofra, KSU Bulk Solids Innovation Center

Throughout our standard work endeavors, we all inevitably are exposed to new projects and new assignments. After we get over the initial feelings of "I have such a full plate, I can't possibly work on anything else," we settle down and start to determine what needs to be done for the new assignment. Sometimes, we realize we cannot handle the new assignment alone and need to consider bringing in external consulting support.

Unfortunately, a single employee usually cannot make this decision. Company support is needed approve external consulting services. The stakeholders will require a solid understanding of why you need the additional support and what the consultants can and will do for the company.

DEFINE THE DESIRED OUTCOME

Any new project or assignment requires a well-defined problem statement and outcome. Moving forward without them usually leads to confusion, with different parties expecting for different results.

We may need to ask for support in creating this definition as a verification step that everyone agrees on the endpoint and that the outcome is feasible. To this end, the external consulting support can be a key stakeholder in helping to develop the project statement and, more specifically, the project endpoint definition.

TYPES OF CONSULTING SERVICES

When it comes to understanding what external consulting services can offer, the generic response is "Information along the lines of professional or experienced advice and guidance as well as actionable solutions." This does not do justice to the full spectrum of services that a consultant can provide.

Testing Services. The most simplistic type of support is testing services. These are lab-scale tests with equipment that can be too expensive for a company to justify based on their infrequent use or that requires specialized knowledge that is not consistent with standard business needs. Tests such as true particle density or particle size distribution fall within this category.

Turnkey Solutions. On the other end of the spectrum are complex deliverables such as turnkey solutions to a project or problem. Deliverables are in no way limited to the simple and complex ends of the spectrum — there is a full array in between.

Training. Direct solutions also are available such as training. Training can be provided on topics of expertise or can be customized to address a company's specific process or onsite equipment. This is beneficial in that internal personnel can retain the knowledge, but the consulting provider usually

is available as a sounding board when needed.

Troubleshooting. Consulting services can include troubleshooting a process or equipment issue. Everyone has hit a dead end in attempting to address and fix an issue. Having additional sets of experienced eyes looking at an issue can give a faster resolution, and a different perspective can lead to a new plan of attack. During this process, the consulting support also can be a sounding board for ideas and discussions without any direct work on a process. This allows experts to share ideas which, in the end, likely will be beneficial to all parties.

Equipment Verification. Another area of consulting support is process or equipment verification. This should start at the beginning of a project with process design and equipment selection. Designing equipment appropriate to the task at hand will make everything easier and more successful in the long run. Beyond the designing, some consulting services can pretest the equipment for a proof of concept and determination of appropriate process parameters once installed in the plant. This type of full hands-on consulting service is not provided by every consultant, but most still should be able to help to design equipment, bring it online and assist with debugging onsite if requested.

MAKING YOUR CASE

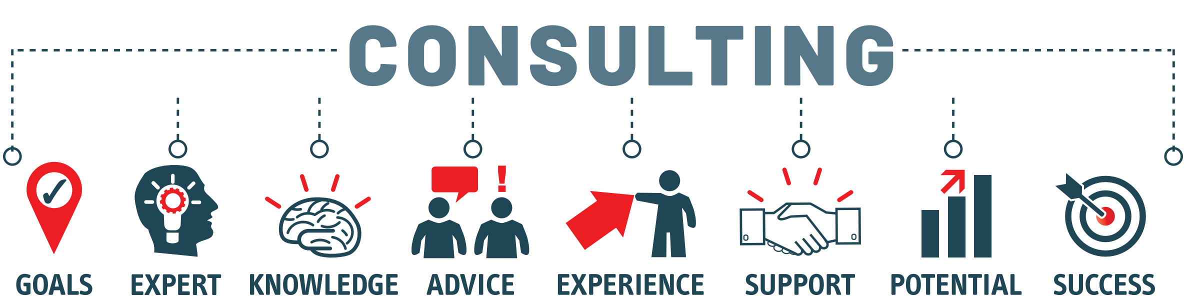
Considering the variation in what consultants can supply, the next questions are "Why would someone use a consultant, and how do I sell the idea to my boss?"

To dig into this topic, we first must consider who is initiating contact with the consultant. Two types of people usually are making this contact: the project owner, a role a process engineer or technician usually fills, or the project sponsor, usually someone in management who assigns actions and projects to other engineers or technicians.

Lack of Topic Expertise. A project owner and project sponsor share some reasons for wanting additional consulting help. One of the most common is the lack of topic expertise. While some may realize it sooner than others, most workers eventually will be challenged enough that they run out of expertise or relevant experience.

Knowledge Gap. Running out of talent or knowledge is not a bad thing; that is partially why consulting services exist to begin with. Project owners and sponsors need to remember they are responsible for making sure the project is completed and not necessarily for personally performing every step along the way.

Recognizing a knowledge gap can open a door for employees to learn, which can add to their effectiveness on future projects. Consulting services are perfect for helping to fill this gap. They already have the topical expertise and can guide you through both the learning and the doing stages of a project.



Priority and Timeline. While not synonymous, priority and timeline often are a pair — more specifically, a high priority and a short timeline. These two concerns can come into play when immediate solutions are required to address current negative impacts on the business. Priority and timelines also come into play for new equipment introductions to meet a larger-scale company timeline, perhaps for a new product introduction or increased throughput needs for increased orders.

Regardless of the reason, when you're pressed in these areas, bringing in expertise from an external consultant can help to relieve the stress by shortening timelines. External consultants usually will be able to juggle their own priorities to assist you in meeting necessary timelines when you are in a pinch.

Project Owners. Project owners with a full plate can look to consultants to help them to keep their heads above water. While this can be indicative of other concerns, it is a valid reason to seek external help. The other end of the spectrum is the dead-end effect, in which project owner feel they have left no stone unturned. This can lead to the sounding board-type support from a consultant.

Project Sponsors. Project sponsors share some similarities with project owners, but from a slightly higher vantage point. Project sponsors may realize they have no remaining resources. As with project owners, all their time is filled.

Instead of piling it onto a project owner, a sponsor may decide to bring in outside support. If communicated properly, a direct report may feel appreciated and understood as opposed to untrusted or unable to execute the project. This also can eliminate the need for overworked reports to admit to their supervisor that they cannot do the project. Early and collaborative conversations between the parties can eliminate any potential morale and performance pitfalls.

KNOW YOUR WHY

Sometimes a project's definition leads to different reasons for pursing external support. Some projects may require specific test equipment that is not available. Others may request specific facilities, such as power or airflow, that are not readily available but would be part of the installation when the project is complete. Still others may require verification before they can be incorporated into a full production line. While not personnel-dependent, they still require a knowledgeable consultant with access to specific equipment and large lab space to help ensure success.

The next time you are tasked with a new project, be sure to consider whether an external consultant could increase your ability to execute the project successfully. Keep in mind that your desired outcomes will be the same as the consultant's, which can lead to a great partnership in approaching an array of projects.

Regardless of the underlying motivation, consultants are ready and willing to support any project from simple lab-scale tests up to and including full-scale production verification runs. More specifically, if your projects are in the arena of powder and bulk solids storage, flow, conveying, product formulation, equipment testing or particulate air filtration, be sure to contact the personnel at the Bulk Solids Innovation Center. With capabilities from benchtop testing all the way through full-scale verification and proof testing of equipment, the BSIC has the necessary resources to begin a successful consulting partnership.

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Evaluate Secondary Dust Explosion Hazards

Examine potential risks and process characteristics when selecting an explosion isolation system | By Jeramy Slaunwhite, Rembe Inc.

Dust explosion hazards must be assessed and managed when handling most bulk solids and powders. Where a combustible dust cloud is suspended in sufficient concentration within a confinement, a credible ignition source is likely to initiate a deflagration. Without protection, the internal pressure development can accumulate quickly, causing catastrophic, explosive rupture of the vessel or structure. Careful consideration and diligence must be applied to ensure reliable protection systems are in place to prevent both explosions and the effects of a deflagration.

Explosion protection systems such as deflagration relief vents and chemical suppression systems are necessary to prevent explosions; however, a comprehensive explosion protection safety system also must include effective means to isolate the extending effects of a deflagration.

These effects include an impulse pressure wave traveling at nearly the speed of sound (~343 m/s), a turbulent flame front traveling initially in the order of 2-8 m/s and a mass of unburnt dust propagated by the pressure wave. As the initial flame front catches up to the unburnt dust cloud, a traveling fireball ensues until the fuel is consumed.

DEFLAGRATIONS

Deflagrations typically are chaotic chemical reactions that can be approximated analytically but are challenging to predict completely. Through actual incidents, experimentation and numerical modeling, one absolute is that deflagrations will propagate through open paths.

Any course with an opening large enough for flame passage with an oxygenated atmosphere is susceptible to deflagration propagation. Certain characteristics have been shown to reduce the likelihood of flame propagation such as dense-phase conveying and small-diameter pipes; however, flame propagation tests have been conducted confirming flame propagation through piping as small as 27 mm in diameter over 12 m (Ref. NFPA 654-2020 A9.7.2.1).

Most process equipment handling combustible dust is not isolated completely from other equipment or process areas. Air intakes, aspiration hoods and open discharges are expulsion paths for deflagration pressure waves and propagating fireballs. A deflagration pressure pulse can disrupt dust layers in plant areas with inadequate housekeeping, resulting in a suspended dust cloud and associated secondary deflagration.

Historically, secondary deflagrations and explosions tend to be larger and more catastrophic, especially when building compartments become involved. Open deflagration paths near occupied areas can result in hazardous pressure and fireball expulsion to nearby operators and personnel.

Material infeed/transfer pipes, chutes and ducts create interconnections to upstream equipment where outfeed and discharge paths connect the primary vessel to downstream equipment. A nonisolated deflagration can propagate through process interconnections to create a secondary explosion in any unobstructed direction. An initially unconfined flame front will accelerate to multiple times the initial velocity when confined in a pipe or duct for instance.

Accelerating combustion in a

confined volume leads to increasing internal pressure, which is referred to as pressure piling. With sufficient fuel, oxygen and distance, a propagating deflagration can accelerate to supersonic velocity resulting in a transition from deflagration to detonation velocities with extreme pressure effects. Both pressure piling and especially detonation can cause deformation and catastrophic rupture of pipes, ducts and vessels.

Secondary deflagrations in interconnected vessels can be more violent and energetic than the primary precursor. The pressure wave from the primary deflagration can cause a precompression of the atmosphere in an interconnected vessel. This phenomenon is similar to a piston combustion engine resulting in a higher energy combustion reaction. Greater initial pressure in the primary vessel from pressure development or a large volume ratio to the secondary vessel can produce a significant precompression with secondary deflagration pressure effects exceeding standard protection calculations.

The effects and hazards associated with secondary and propagating deflagrations are managed through engineered and tested deflagration isolation systems. Explosion protection system design and application guidelines are published in NFPA 69 — Standard on Explosion Prevention Systems — 2019 Publication. The NFPA 69 recommendations are widely accepted as minimum required industry best practice and enforced by the Occupational Safety and Health Administration (OSHA) in the U.S.

Isolation systems are either passive or active response systems and must be evaluated carefully for reliability and compatibility with the specific equipment, material and requirements of NFPA 69. Active systems consist of event monitoring sensors (typically pressure or infrared spark/fire energy optical sensors), an electronic controller and actuated isolation devices.

Common active deflagration isolation device examples are fast-acting mechanical knife gate valves, actuated float valves, inline pinch valves and chemical inert powder injection. Upon detection of a positive signal from the sensor, the protection system controller commands the isolation device to actuate, all within several milliseconds. All active isolation devices employ a method of stored energy for rapid deployment upon command.

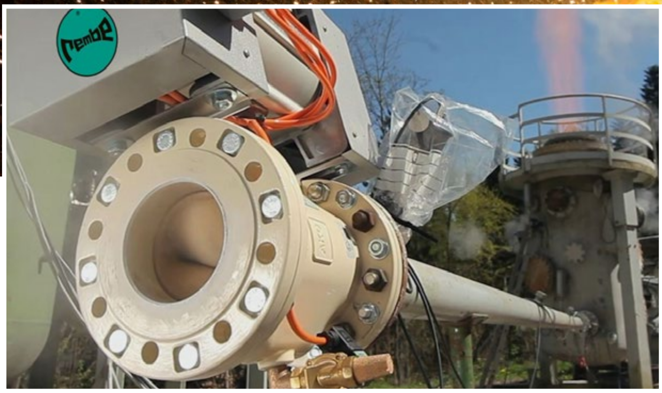
Passive deflagration methods provide either an inherent barrier to deflagration propagation or an actuated mechanical barrier under the passive influence of the initial deflagration pressure wave. Passive isolation methods include inline float or flap valves, material chokes, rotary valves, inline flame arrestors and flame front diverters. Inline flame arrestors typically are applied to vapor deflagration hazards and are not suitable for solid material conveying.

A summary of characteristics and considerations for each isolation device type follows, including application suitability and limitations.

ACTIVE ISOLATION SYSTEMS

Fast-Acting Mechanical Valve. Fast-acting mechanical valves are heavy-duty knife gate valves with an integral stored energy actuator such as compressed air or a gas-charged cartridge. They are used in conjunction with a sensor and controller and must be tested and certified for the application.

The valves are fully open during normal operation and as such are compatible with most flow and material applications, including abrasive, sticky and hygienic considerations. They can be installed in any orientation and provide bidirectional isolation. These valves generally are available up to 16 in. in diameter and comparatively are high in cost but certified for high explosive



ACTUATED PINCH VALVE SYSTEM

Figure 1. The Rembe EXKOP QV is an actuated pinch valve system. These valves work well for high material loading applications.

energy dusts. Once actuated, most designs will require an inspection and some degree of refurbishment (Ref. NFPA 69 – 2019 11.2.2).

Inline Actuated Float Valve. Inline actuated float valves consist of an internal poppet that seals upstream from a deflagration upon detection, command and compressed-gas actuation. These valves are sized for small- and medium-diameter applications with high-pressure resistance strength and corresponding high mass. As the sealing poppet rests in the air-material stream, it is limited to very small dust loading and not recommended for abrasive or sticky materials (Ref. NFPA 69 – 2019 11.2.3).

Actuated Pinch Valve. Actuated pinch valves (Figure 1) provide bidirectional isolation capabilities with normally open full-bore rubber sleeves that contract rapidly from released compressed air upon controller activation. Pinch valves are suitable for high material loading applications; however, the standard or food-grade rubber sleeve is susceptible to wear from abrasive materials.

The valves are medium-high in cost but can easily and immediately be reset following actuation (Ref. NFPA 69 – 2019 11.2.4).

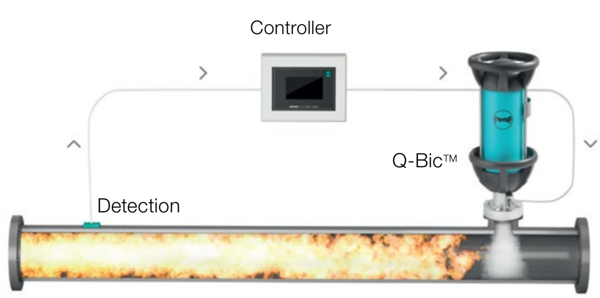
Chemical Barrier. Pressurized canisters of an inert powder, typically sodium bicarbonate, are mounted to the pipe or duct at the manufacturer-designated location. Deflagration detection by pressure or optical sensor triggers a rapid discharge of the suppressant into the protected volume. By flooding the deflagration path, the oxygenated atmosphere is displaced and diluted such that incoming flame front combustion cannot be sustained.

Chemical barrier systems (Figure 2) are suitable for all flow and material applications in a range of line sizes and geometries. The systems often are hygienic and noncontaminating until activated when the suppressant is released into the protected process. Like all isolation systems, chemical barrier systems must be specifically tested, certified, installed and maintained according to the manufacturer specifications.

Maintenance inspections, often quarterly, are more onerous than other isolation systems and must be followed strictly to ensure reliability. Refurbishment postactivation includes bottle recharge and replacement and technician commissioning. Application considerations must be designed and reviewed thoroughly to ensure coverage and prevent expensive and laborious false activations (Ref. NFPA 69 – 2019 11.2.1).

PASSIVE ISOLATION SYSTEMS

Passive Float Valves. Inline passive float valves can provide unidirectional or bidirectional deflagration isolation. Similar to actuated float valves, the internal inline



CHEMICAL BARRIER SYSTEM

Figure 2. This diagram demonstrates how a chemical barrier is activated and floods the deflagration path when deflagration is detected.

PASSIVE FLAP VALVE

Figure 3. These flap valves are suitable for up to medium dust loading, Use with abrasive or sticky materials is not recommended because of performance reliability reasons.

poppet seals to block flame passage although by passive actuation from the deflagration pressure wave.

The instream poppet and sealing faces make these valves unsuitable for sticky, abrasive and medium or high dust loading applications. Robustly designed, passive float valves can handle high deflagration pressures and easily can be reset following activation (Ref. NFPA 69 – 2019 12.2.2).

Passive Flap Valves. Deflagration isolation flap valves originated as process flow dampers on aspiration inlet lines and act similarly to piping check valves. An internal pivoting flap is forced closed under air flow reversal from the deflagration pressure wave (Figure 3).

Flap valves must be designed, tested and certified for specific material and system geometry applications, including installation location, piping, protected vessel volume and system fan location (Ref. NFPA 69 – 2019 12.2.3.3). The valves can tolerate up to medium dust loading and are relatively low cost and maintenance. Abrasive or sticky material may cause performance reliability concerns. Various fabrication materials can allow for elevated temperature applications; however, the design function is not inherently compatible with hygienic processes.

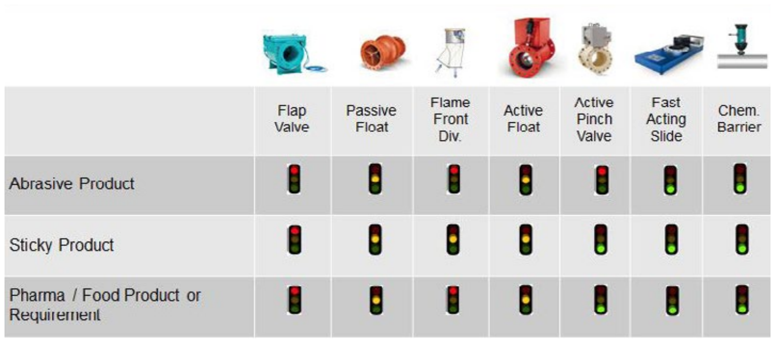
Rotary Valves. Multi-vaned rotary air lock valves can provide effective deflagration isolation on bin and hopper discharges to prevent a hazardous fireball bottom blow-through. To qualify and function as effective and reliable isolation, rotary valves must be designed to meet specific standards and tested accordingly (Ref. NFPA 69 – 2019 12.2.4.1). Close clearance metal tip vanes allow rotation in the housing to permit material transfer but resist deflagration flame flow. Rotary valves must be interlocked to stop upon activation of a deflagration protection system to prevent transferring burning material through the hopper.

Material Choke. In the absence of a suitable rotary valve on a hopper discharge, a material choke can provide a barrier to the passage of deflagration flames. A material choke consists of a minimum defined column of bulk solid material above the hopper discharge. The material can be supported by a discharge flow control device such as a nonisolating rotary valve or auger, for example, with feedback from an internal level sensor to maintain a minimum required material level.

Another means of choked isolation is through a double dump valve arrangement that sequences stacked sealing valves, typically butterfly, so that an intermediate column of material is discharged while maintaining a barrier above. It is recommended that valves be confirmed for material and deflagration pressure tolerance before application.

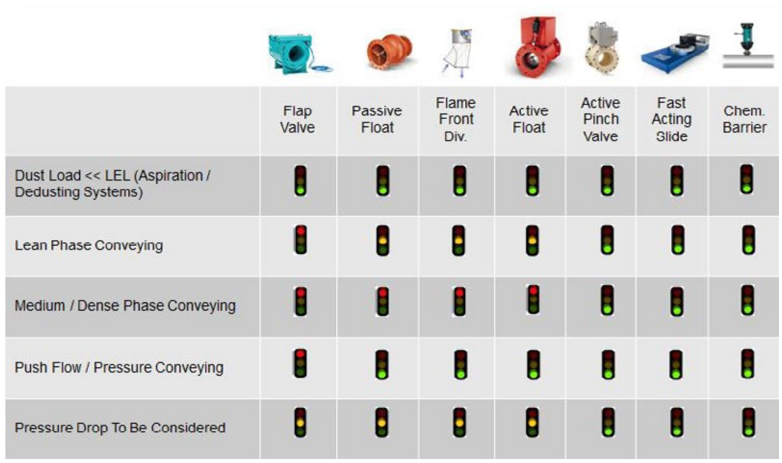
Flame Front Diverter. A flame front diverter operates per its namesake by diverting the deflagration flame front away from the upstream path. This is accomplished by an integral piping arrangement forcing the direction of flow to change direction nearly 180°. Accompanied with a rupture panel, an incoming deflagration flame front is unlikely to make a sharp direction change and is intended to discharge to the exterior.

Flame front diverters are applicable only for exterior installations in safe areas and are not recommended for sticky or abrasive materials that could cause flowability problems through an abrupt direction change.



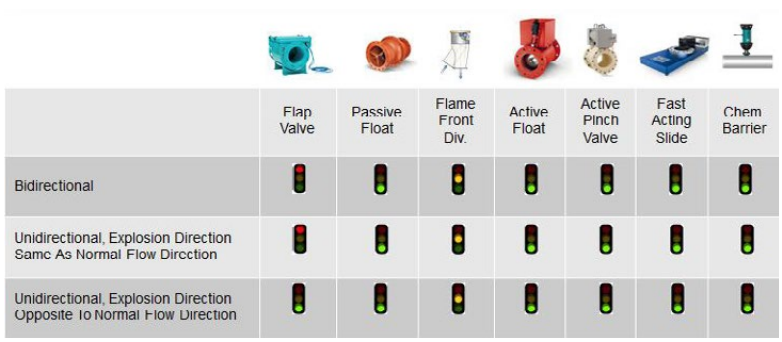
SELECTION BY PRODUCT CHARACTERISTICS

Figure 4. Product Characteristic Comparison



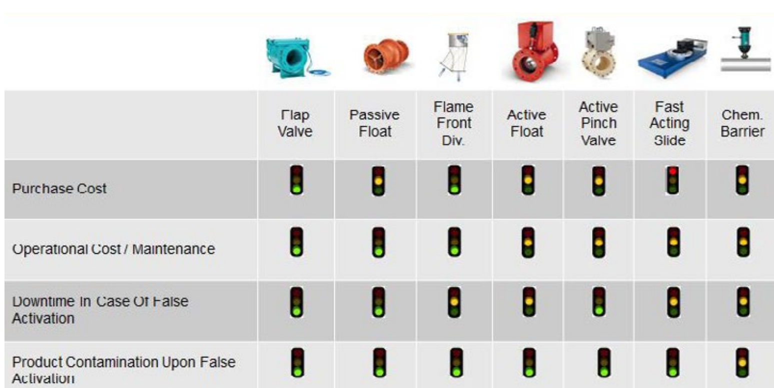
SELECTION BY DUST LOAD

Figure 5. DUST LOAD COMPARISON



SELECTION BY EXPLOSION DIRECTION

Figure 6. Explosion Uni/Bi-Directional Comparison



SELECTION BY COST/BENEFIT

Figure 7. Cost/Benefit Comparison

These diverters can be effective at preventing damage due to pressure piling by relievingthe deflagration pressure through the rupture vent; however, where there is no physical barrier, there is no certainty that burning material is prevented from traveling upstream. As such, flame front diverters are not permitted on their own where complete isolation is required (Ref. NFPA 69 – 2019 12.2.1.5. (1)). Where limiting pressure piling in ducting is the primary objective, deflagration vents also can be applied to ducts to limit overpressurization. Any upstream equipment also must be protected as flames still may propagate.

The following comparative tables allow for an at-a-glance comparison of available isolation system types:.

Explosion isolation systems are critical safety devices that require testing, certification, maintenance and careful application and selection to ensure the secondary effects of a deflagration are managed reliably. Unidentified misapplication or deficiencies can compromise isolation system performance and give a false sense of explosion protection security resulting in possible harm, damage and costs.

JERAMY SLAUNWHITE is an explosion safety consultant at Rembe Inc. He can be reached at jeramy.slaunwhite@rembe.us

Plant Banishes Blend Binding

Tests reveal an unexpected issue

By Kevin Solofra, KSU Bulk Solids Innovation Center

The Bulks Solids Innovation Center gets a number of interesting and unique projects. We would like to share some of these that encompass issues and challenges that many companies experience.

THE PROBLEM

A leading bulk supplier of natural products was producing a new formulation for nutritional supplement encapsulation. It encountered an issue in which the conveyed blend of material was binding up the equipment to the point of extensive downtime and considerable repair costs, neither of which was acceptable nor anticipated with the material.

The supplier was able to perform internal testing to isolate the root cause to a single material in the mix. Without the ability to eliminate this material from the formulation, the company attempted to modify its process parameters within acceptable ranges and saw improvements but was not able to eliminate the failures. The apparent issue was the propensity of blends with this ingredient to seize up in the conveying portion of the process, so the company contacted the Bulk Solids Innovation Center Staff for help and support.

GAINING AN UNDERSTANDING

As the company knew the problem material, it would have been easy to focus solely on that material. However, working with a mixture of multiple powders normally is not straightforward, and this case was no exception. While a material may behave one way on its own, it can behave differently when in proximity of other materials. The ratios of one powder to another also can impact this synergistic effect drastically.

To that end, the customer's internal testing with the ability and willingness to readily share its results gave us a

jump start on understanding the issues, eliminating the need for some upfront routine/basic testing. Through conversations with the customer, we were able to gather further details and agree upon on a testing protocol designed to help isolate the properties of the questionable material and the full blend.

THE PROCESS

The initial material testing focused on the flow characteristics of the individual powder and the blend. A standard powder flow test as well as a wall friction test against stainless steel was performed. While the results showed the materials to be in the cohesive to very cohesive category, neither material had noticeable issues with flowability in real-life application. There was some expectation by all parties involved that the particular material of interest would be much more resistant to flow.

Working with a mixture of multiple powders normally is not straightforward.

In preparation for further testing, visual observations were made of the culprit material forming agglomerates merely by rolling over on itself in a small plastic bag. So, while the powder flowed well, it also was able to coalesce quickly into ¼-in.-size and larger agglomerates on its own.

This observation lead to a sidetrack test of weight consolidation. Without much surprise based on the observation, the weight consolidation test resulted in large chunks of material. However, they were easily reduced back to a powder with minimal physical effort. This eliminated flow properties and particle cohesion

A final set of testing was planned for the moisture content. The moisture for each sample was well within the acceptable range for the product, but some hardening of the material was noted in the sample cups. This again led to another sidetrack test of the material with moisture and heat.

The dissolution of the materials in water was tested, along with the analysis of the residue after further drying. These tests showed that once dissolved, the material would cure, almost like a glue, as the moisture was driven off. This type of adhesion helps to explain why a material would be binding in the equipment and supports why it would have appeared to be a straightforward conveying problem.

RESULTS AND RECOMMENDATIONS

In discussing the results with the customer, the recommendations revolved around moisture control and reduction along with reducing temperatures to limit driving off any moisture in the powder blend. Neither of these was immediately obvious in the early stages of problem analysis, showing the diversity of problems faced in the world of bulk solids.

An open mind and a keen eye are needed when investigating problems related to bulk solids to be able to dig and find root causes. They go along with accepting course adjustments as quickly as results can suggest making sure we are always moving to solutions and not just following a plan.

KEVIN SOLOFRA is laboratory manager for the Bulk Solids Innovation Center. He can be reached at solofra@k-state.edu.

Profit From Pilot Testing

Consider outsourcing to handle bulk solids issues

By Raju Dandu, KSU-Bulk Solids Innovation Center

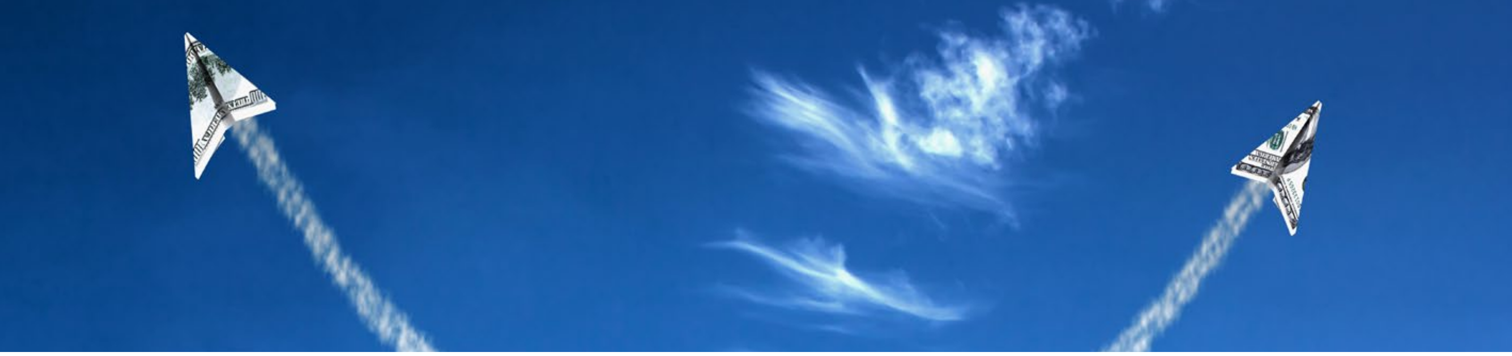
The need for and importance of pilot testing in bulk solids storage, handling and conveying cannot be underestimated. Handling bulk solids involves solving a complex and wicked problem that cannot be addressed using only experience and existing broad-based knowledge; it needs continuous attention because storage and conveying issues can't be resolved completely.

Powders and bulk solids behavior is complex due to variations in physical properties such as particle size and distribution as well as particle shape — for example, sugar, plastic pellets, food, chemicals and pharmaceutical powders. Further, materials often are susceptible to variations in properties due to environmental factors such as temperature, relative humidity and moisture content that can cause caking, agglomeration, cohesiveness and levels compaction.

Bulk solids property changes in every aspect of conveying and storage. For example, a friable material will degrade during dilute-phase pneumatic conveying because of high-velocity air, and highly cohesive material compacts during storage and forms caking. These properties determine the material flow characteristics in the bin, hopper, chute, feeder and pneumatic/mechanical conveying systems. They also are essential in designing pneumatic conveying systems.

Pneumatic conveying systems are becoming the preferred technology to convey powders and bulk solids. The majority of processing industries — food, chemicals, plastics and minerals — require powder or bulk solids handling or storage systems or equipment. Materials conveying performance is critical in specifying, designing or retrofitting a conveying technology to avoid flowability problems.

This performance includes evaluating important conveying characteristics such as pickup velocity, pressure drop, inlet airflow rate (ICFM), solid-load ratio and can velocity at filter. Across the bulk solids industry, manufacturers, developers and operators of pneumatic conveying systems, products and components need to ensure that the bulk solids pneumatic conveying systems are up to their intended tasks. No matter how you design and build a system, there always will be a few bumps along the way when operating it when material properties or operating conditions change, causing flow problems leading to inadequate performance.



Further, in today's challenging and complex marketplace, businesses need to step up to meet end user requirements. This may involve spending millions of dollars to improve existing systems as well as developing new systems and equipment. This is an investment for any company, but small and medium-size companies tend to be more price-sensitive. The solution to achieving peace of mind and taking the best step forward is, above all, through pilot testing.

Whether you are specifying, designing or improving a poorly run conveying system, conducting pilot tests and having a thorough understanding of flow properties and conveying characteristics will result in avoiding material flow problems and costly mistakes and increasing sustainable, reliable and smooth operations. In addition, it provides a better foundation for the correct system design, equipment selection and efficient processes. Moreover, pilot testing will ensure you know your system or the system you need and identify the key properties to operate your system efficiently, protecting your company's investment. This article will cover what pilot testing is, why it's important, what the key considerations are and what to look for in a pilot plant facility.

WHY TO PILOT TEST

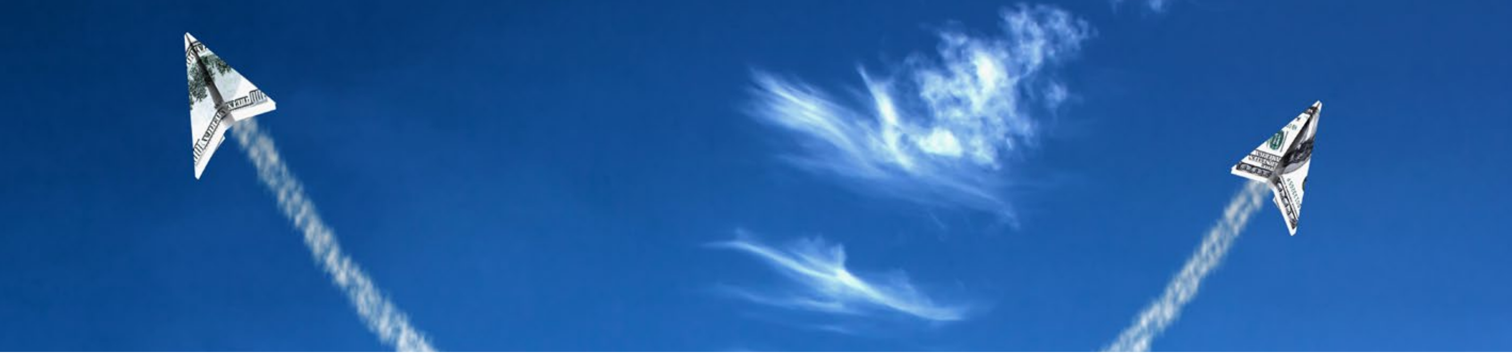
Acquired knowledge of bulk solids handling mostly is empirical, meaning it is gathered based on experience and limited experiments. The main problem with this knowledge is it applies only to a particular material and its environmental conditions and may not work for similar or other material because of variations in material properties.

Powders and bulk solids behavior is complex due to variations in physical properties.

Most empirical and science-based knowledge is protected within the industry's intellectual property rights. Most of these industries are original equipment manufacturers (OEMs). Even these OEMs or industry experts will not make a decision on material conveying characteristics without testing the material for its characteristics. The science of full-scale material handling is totally different from bench scale testing. The successfully identified flow property based on the bench scale may not work in full scale if the characteristics change. It would be hard to determine the property in full-scale.

From an economic perspective, pilot testing becomes necessary when companies are more price-sensitive, have limited budgets or are under pressure to control costs. Traditionally, large companies have been well-equipped with their own in-house pilot test facilities. In-house pilot testing requires significant time, resources and capacity. However, some companies are not able to manage resources in terms of systems, equipment and expertise to support in-house pneumatic conveying systems testing.

In addition, the pilot test facility, state-of-the-art instrumentation, data collection, air filtration systems, dust control systems and explosion-proof installations require more



expensive equipment. The facility must be suitable for testing and development of applied research work and be able to convey test demonstrations to potential customers. The facility also can be used for education and training.

Ultimately the pilot test facility will set the basis for specifying, improving or designing a large-scale conveying system. Further, the personnel running the system must be well-trained, with years of experience. The knowledge and experience necessary to run and maintain these test facilities seldom are available in the powder and bulk solids industry.

CENTER OFFERS EXTENSIVE CAPABILITIES.

Opening five years ago, Kansas State University Bulk Solids Innovation Center (BSIC) is the only university facility and staff in North America dedicated to helping industrial companies with education, consulting, testing services and research related to powder and bulk solids. With 13,000 sq ft, the facility includes six laboratory rooms with test bench equipment for measurement and characterization of material properties, while providing additional room for client research projects.

BSIC features a full-scale bay with a variety of equipment for testing and studying hopper flow, chutes, conveying, filtering, flow aids, blending, separating and the like. The facility is filled with state-of-the-art equipment and instrumentation. The center's full-scale pilot test facility features 3-, 4-, and 6-in. pneumatic conveying lines capable of conveying up to 920 ft horizontally and 65 ft vertically.

TO PILOT TEST OR NOT?

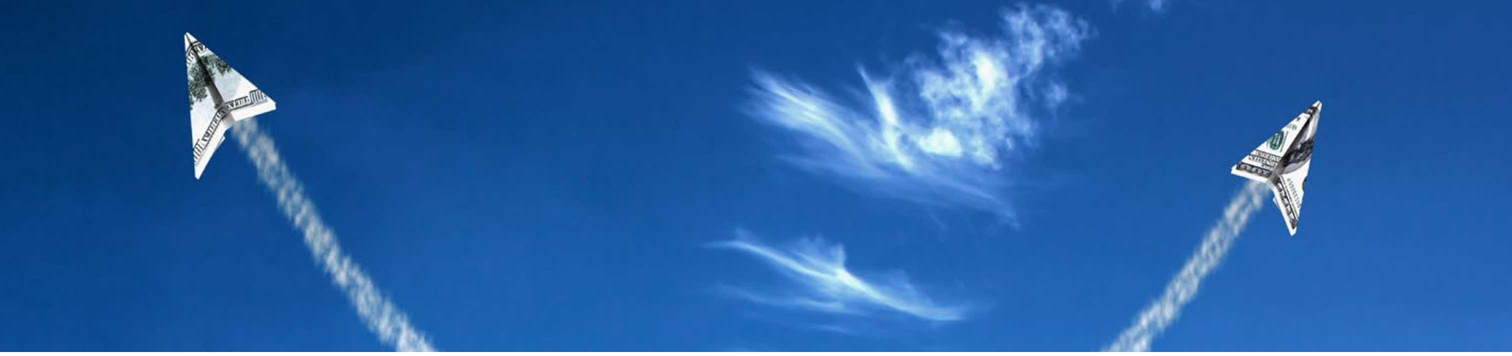
Several in the powder and bulk solids industry contemplate this question every year. Most of us often face the need for an existing plant to increase output or production, optimize conveying conditions and modify or replace plant equipment, and we realize that system is not capable of rated duty. The industry doesn't always have the luxury of halting production in a conveying plant running near capacity for experimental runs with simple modifications to address the issues or test new products or processes. That's what makes a pilot plant so important.

For new powder or bulk solid conveying, pilot testing is a way to assess commercial run viability and offers a place to see how variations in material properties impact material flow and conveying parameters. It also is a place to experiment with new equipment and processes. Other reasons to pilot test are to:

- Validate and verify expected operating conditions, results and relationships
- Test and validate the benefit of proposed solutions
- Understand expected variation in the conveying process
- Reduce the risk of failure by limiting resource use
- Improve the ability to better predict cost savings from a proposed solution
- Quickly deliver a version of a solution to a particular segment
- Validate the measurement system

WHAT IS PILOT TESTING?

In the bulk solids industry, pilot testing is the evaluation of conveying systems and equipment for a limited time and at a limited scale under real-time operating conditions to understand systems performance and determine the design and operating conditions. It



essentially is a practice run, a test similar to using a flight simulator before you fly a jumbo jet. Pilot testing usually is done to compare different processes, operating conditions, systems or equipment to determine which will work best for handling a specific powder or bulk solid.

Pilot testing also is done for a specific conveying technology to determine the system or equipment design parameters for full installation. Further, existing processes and operations can be simulated using pilot test facilities to assess the impact of material conveying or troubleshoot problems without interrupting main plant operations.

A pilot testing facility includes a precommercial pneumatic conveying system with new conveying technology. It should be unique in that it operates in an integrated fashion, such that it should be capable of both dilute- and dense-phase conveying with high material flow rates. Finally, it is beneficial to use a facility that is flexible and modular in providing test capabilities.

KEY CONSIDERATIONS

Pilot plant testing helps customers to mitigate risks and plan for business success. Before initiating a pilot test, assess the need and the amount of risk to the business. When planning to conduct pilot testing, the following items should be considered:

1. Identify the facility and its capabilities to conduct pilot testing.
2. Discuss your timing, anticipated project scope and financial requirements.
3. Develop a work scope statement.
4. Collect data and performance of the current method of conveying under various conditions, including seasonal changes and operating conditions.
5. Look at alternatives and technologies being considered, including where they have been used and the performance at those locations.
6. Determine the need for bench testing that would aid in the design of the pilot test.
7. Know the schematics and design data of the actual processes proposed for the pilot testing. The design data sheets should include but not be limited to the physical dimensions, material physical properties and expected flow rates.
8. Determine specific operational and performance characteristics.
9. Decide on the specific test methodology, if required.
10. Be aware of requirements of a written report.

FINAL THOUGHTS

In today's challenging and complex marketplace and from an economic perspective, outsourcing pilot testing becomes necessary when companies need to control costs and operate in a cost-effective way. Owning and maintaining equipment to measure physical properties and determine conveying characteristics of powders and bulk solids is expensive. The trend for outsourcing pilot testing is growing. Ultimately, the decision to test depends on the project timeline, cost constraints and business needs. The upfront pilot testing will lower the project risk. If the project risk is low, peace of mind and benefits offered are plentiful and difficult to ignore and will outweigh the risk.

RAJU DANDU is the Director of the KSU-Bulk Solids Innovation Center. He can be reached at rdandu@k-state.edu.

Consider Pneumatic Conveying to Divert Dry Material

Payoffs include system flexibility and increased safety

By Kevin R. Peterson, Vortex Global

Pneumatic conveying is a process by which powders or granulated solids are transferred from a source to a destination using air as a conveying method. Conveying material pneumatically offers numerous benefits:

- *Fewer moving parts than a mechanical conveying system*. Pneumatic conveyors typically require less maintenance and are safer for operators and maintenance personnel. Additionally, they take up less space than mechanical systems and can move material at higher speeds.
- *Material is transported through an enclosed pipeline.* The risk of material leaking to atmosphere to create maintenance, health or safety issues is minimal.
- *Flexibility*. Pneumatic systems can be designed to fit around existing equipment and can offer multiple destination points and longer conveying distances.

Before choosing pneumatic conveying, keep these considerations in mind:

- *Cost*. Pneumatic systems require more energy to supply the proper conveying line pressure.
- *Dust collection*. A dust collection system is required to separate the material conveyed from the air stream at the destination.
- *Type of material.* Not all material conveys well pneumatically. Material that is larger sized, sticky or combustible are not good candidates.

DIVERTERS — BASIC PRINCIPLES

Valves for diverting material flow within a pneumatic conveying system are available in many configurations and modifications.

Diverters are designed to divert (one source to multiple destinations) or converge (multiple sources to one destination) bulk solid materials that are conveyed pneumatically in high-cycle applications. They are available in a variety of sizes, materials of construction and actuator type. They handle differential pressures and vacuums up to 15 psig (1 barg), depending on the diverter's diameter size.

When sourcing diverters, some important features to look for are:

- "live loaded," which refers to wear compensating, hard polymer pressure plates that are used to seal material and conveying line pressure that are positioned out of the material flow stream;

- a shimming system for in line maintenance of the pressure plates; and
- a diverter that can be shifted on a flowing column of material ("shifted on the fly") to redirect the conveyance of material to selected destinations without the need to stop conveyance before diversion.

DIVERTER TYPES

Several types of diverters are available to meet various application needs.

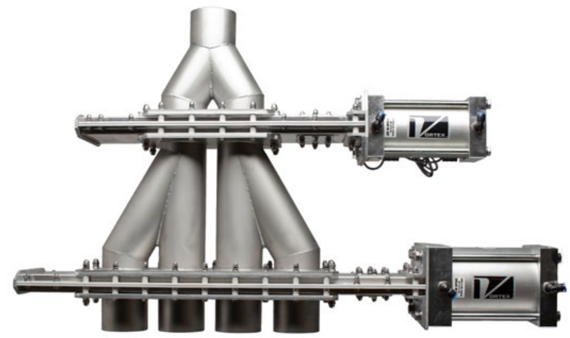
Wye Line Diverter — two, three and four way. Wye line diverters (Figure 1) are built in two-, three- and four-way configurations. When used as a diverter, material enters one source and exits to either two, three or four different destinations. Wye lines also can be used to converge material, where material enters two, three or four different sources and exits to one destination.

Flex Tube Diverter – two and three way. Flex tube diverters (Figure 2) are built to incorporate a flexible hose made of natural rubber with steel wire helix or stainless steel. The hose establishes an unobstructed, through port within the diverter. This style of diverter is chosen for certain types of products or when cross-contamination of different materials may be an issue.

The flex tube typically is not shifted on the fly, making it an excellent choice for applications in which different material grades or colors cannot be mixed or odd-sized material, such as film or paper strips, is being transported.

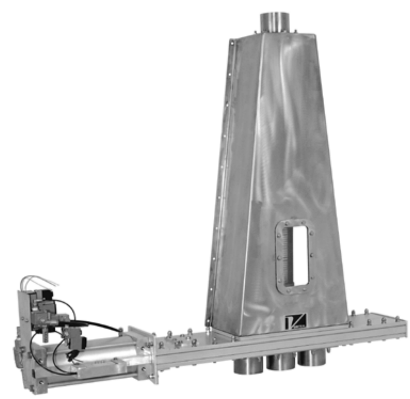
Multi-Port Diverter. Multi-port diverters (Figure 3) use a combination of two-, three- and four-way wye line diverters or two- and three-way flex tube diverters to address customer needs when a diverter is required to transport material from multiple sources to multiple destinations.

Normally the rerouting is accomplished using multiple flexible hoses (hose manifold system) that have to be



WYE LINE DIVERTER

Figure 1. Depending on the configuration, material enters one source and can exit to multiple destinations. In also can converge material in the same fashion.

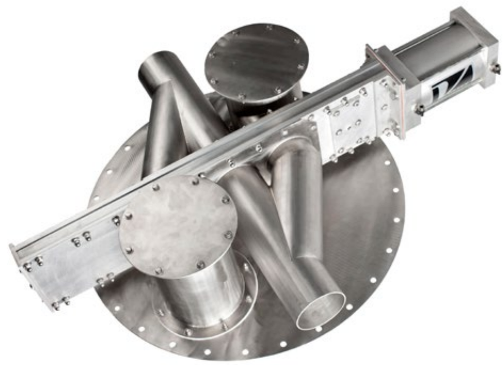


FLEX TUBE DIVERTER

Figure 2. This type of diverter is an excellent choice to avoid cross-contamination or materials mixing.

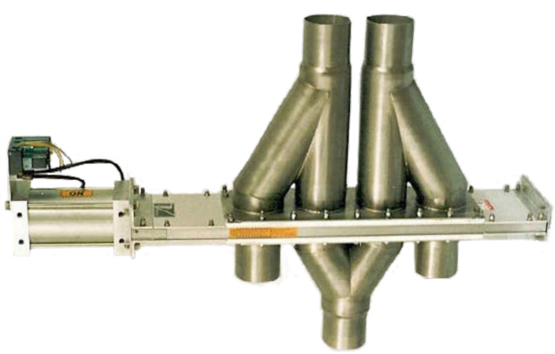
MULTI-PORT DIVERTER

Figure 3. A hybrid of wye line and flex tube diverters, the multi-port diverter transports materials from multiple sources to multiple destinations.



FILL PASS DIVERTER

Figure 4. These stackable diverters are used to deliver dissimilar materials to bins through independent conveying lines.



CROSS-OVER DIVERTER

Figure 5. A cross-over diverter also is used to route material from multiple sources to multiple destinations but with additional flexibility.

moved manually and individually connected to reroute material. The process is labor-intensive, the hoses take up precious production floor space, and rerouting mistakes often happen. The multi-port diverter offers an automated way to confirm and reroute material.

Fill Pass Diverter. Fill pass diverters (Figure 4) are used when transporting material to one or more bins or silos being fed by a closed-loop pneumatic conveying system. Bins within the system are fed individually. These diverters are stackable, allowing dissimilar material to be delivered to bins through independent conveying lines

Cross-Over Diverter. Cross-over diverters (Figure 5) allow additional flexibility in routing material from multiple sources to multiple destinations. In this application, material can be conveyed from source A to either of destinations C or D. Material can be conveyed from source B to either of destinations C or D. Material can be conveyed from A to C and from B to D at the same time. Material can be conveyed from A to D and from B to C at the same time. Imagine the possibilities!

AVAILABLE MODIFICATIONS

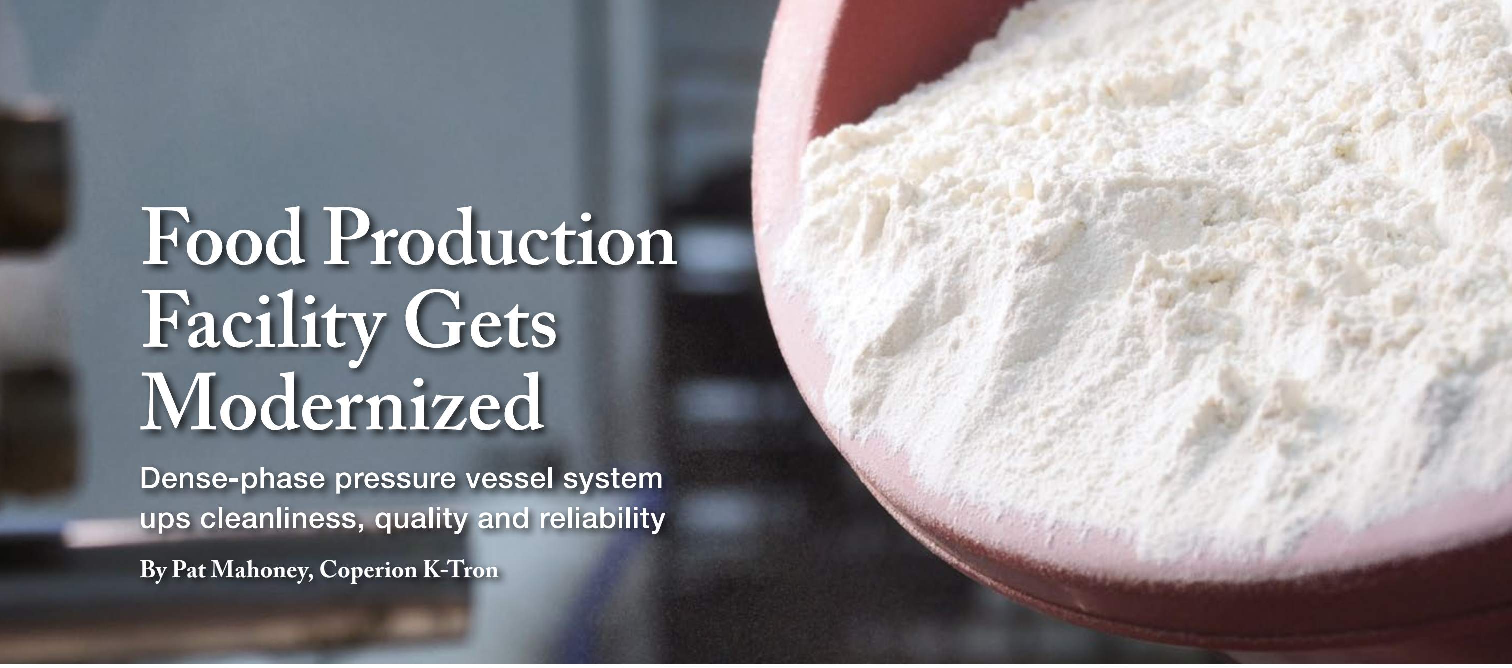
It is important to work with a manufacturer that offers numerous modifications to make sure the proper diverter, correctly modified, will be successful for each specific customer application. Modifications may be made to address material handled (size, type, reactivity and abrasiveness), conveying line size, conveying line connections, inlet or outlet offset angles, environmental temperatures, indoor or outdoor diverter placements, body-frame or weldment materials of construction, pressure plate material, load seal material options, type of drive/actuator, switches for blade position confirmation and compliance ratings and certifications.

Because of the complexity of so many variables to consider in choosing a properly modified diverter for a pneumatic conveying system, customers are encouraged to contact the manufacturer or a manufacturer's representative for experienced assistance in selecting the right diverter for each specific application.

IS PNEUMATIC CONVEYING THE RIGHT CHOICE?

Whether contemplating installation of a new pneumatic conveying line or needing to address problems in an existing line in which the diverter is not working as efficiently as it should be, industry help is available to assist production managers, maintenance supervisors or system engineers with correct valving for any specific project.

KEVIN R. PETERSON is the director of business development for Vortex Global. He can be reached at kevinp@vortexglobal.com.



Food Production Facility Gets Modernized

Dense-phase pressure vessel system ups cleanliness, quality and reliability

By Pat Mahoney, Coperion K-Tron

Established in 1946, Salina, Kansas-based Repco has provided the enrichment industry with ideas, services and products such as flour oxidation and maturing services, vitamin and mineral premixes, micro-ingredient dispensing systems and on-site field servicing. The division of the company that produces vitamin and mineral premix products decided to look into options for modernizing an outdated mechanical transfer system. The decade-old bucket elevator system that transferred the premixes from mixer to packaging was causing housekeeping and segregation issues, not to mention large amounts of product being lost during clean-out.

Repco contacted Coperion K-Tron to look into pneumatic conveying solutions that would clean up the process and ensure the finished blended product did not segregate during transfer to the packaging system. This process started with full-scale testing of blended materials at the Bulk Solids Innovation Center (BSIC), where Coperion K-Tron's test lab resides in partnership with Kansas State University. After witnessing the full-scale tests of multiple blended premixes, Repco was convinced to go with Coperion K-Tron for the project because of its demonstrated ability to convey the blended products without segregation consistently and reliably.

APPLICATION AND PROCESS DETAILS

The material handling system Coperion K-Tron provided includes an Omniveyor dense-phase pressure conveying system (Figure 1) complete with pressure vessel, programmable logic controller (PLC), piping, diverter valve, specially designed hopper lids and modular cartridge bin vents. During testing at the BSIC,

OMNIVEYOR SYSTEM

Figure 1. The Omniveyor system includes an all-encompassing control system provided by Coperion K-Tron. Here, the pressure vessel is receiving material from the mixer above.

Coperion K-Tron determined the ideal method of conveying to ensure a constant and reliable blend was to use a dense-phase pressure vessel pneumatic conveying system.

The first portion of this system transfers the finished product — a blend of vitamins and minerals — from an existing mixer into the pressure vessel below. From the pressure vessel, the material is transported through the convey line where a WZK diverter valve then directs the material into one of two holding tanks before packaging.

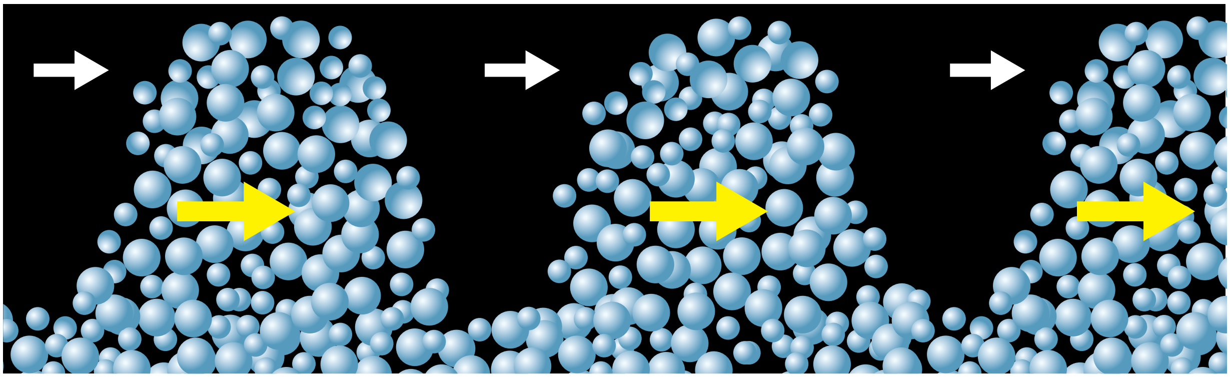
To confirm an entire batch makes it all the way through the system, the holding hopper above the mixer, the dense-phase conveyor and the destination hoppers are mounted on load cells with weights communicated back to the plantwide control system.

The bucket elevator system was causing housekeeping and segregation issues, and large product losses.

DENSE-PHASE PRESSURE VESSEL PNEUMATIC CONVEYING

The key component in the Omniveyor system is the pressure vessel, which allows the system to operate in a dense-phase conveying mode. Dense-phase pressure vessel systems use high air pressure, above 1 bar (g) [15 psi (g)], and low air volume as the motive force to convey powder or granular bulk solid materials through a pipeline at low velocity. The low velocity makes this type of conveying especially suitable for premixed materials; materials with high bulk density; and materials that are abrasive, friable or tend to segregate.

The dense-phase system uses a pressure vessel that is filled via



CONVEY LINE SLUGS

Figure 2. This illustration represents the slugs within the convey line once the material leaves the pressure vessel all the way to the destination receiver hoppers.

TWO-WAY DIVERTER VALVE

Figure 3. Coperion WZK two-way diverter valve directs material to one of two hoppers equipped with Coperion K-Tron modular cartridge bin vents.

gravity from the blender above until a high level control switch is activated. At this point, the pressure vessel's inlet and vent valves are closed, and material is conveyed in low-velocity slugs to one of two destination receiver vessels (Figure 2). The conveying cycle will continue until the receiver vessel signals that no additional material is required.

Communication between the Repco PLC and the Coperion K-Tron PLC ensures that the mixer outlet valve is open and the pressure vessel is filled. In addition, the automation system allows transfer of the blended product to the proper receiving vessel, utilizing control of an inline WZK diverter valve to direct the correct path of the material slugs.

RETROFITTING EXISTING HOPPERS

In addition to providing the Omniveyor dense-phase system, the existing destination receiver lids were replaced so that Coperion K-Tron modular cartridge bin vents (MCBV) could be installed. Four MCBVs are installed on both destination hoppers to filter the displaced air properly as material is conveyed into the hoppers.

This modification reduces product waste greatly by eliminating the product carryover that previously was experienced when venting the hoppers using a central dust collector. Coperion K-Tron's MCBVs use lower headroom than traditional bin vents while still maintaining high filtration efficiency. In addition, the easy-clean and easy-access design make them ideal for quick changeovers to different products and recipe formulations.

A SUCCESSFUL PARTNERSHIP

Repco's continued focus on product quality and partnership with Coperion K-Tron has resulted in a state-of-the-art dense-phase system that has allowed it to improve plant cleanliness, product quality and system reliability with full process automation.

Travis Schubert, VP of Operations at Repco, says "Replacing our old mechanical system — which proved to be a wasteful, sanitation nightmare — with the Coperion K-Tron dense-phase system has made our facility cleaner and run much more efficiently, while improving the quality of our finished products due to zero segregation of the materials during transfer."

PAT MAHONEY is systems process engineering manager at Coperion K-Tron. Pat can be reached at pmahoney@coperionktron.com.

Take a Pictorial Tour of the Kansas State University – Bulk Solids Innovation Center

See the equipment and facilities the center offers

CENTER INCLUDES:

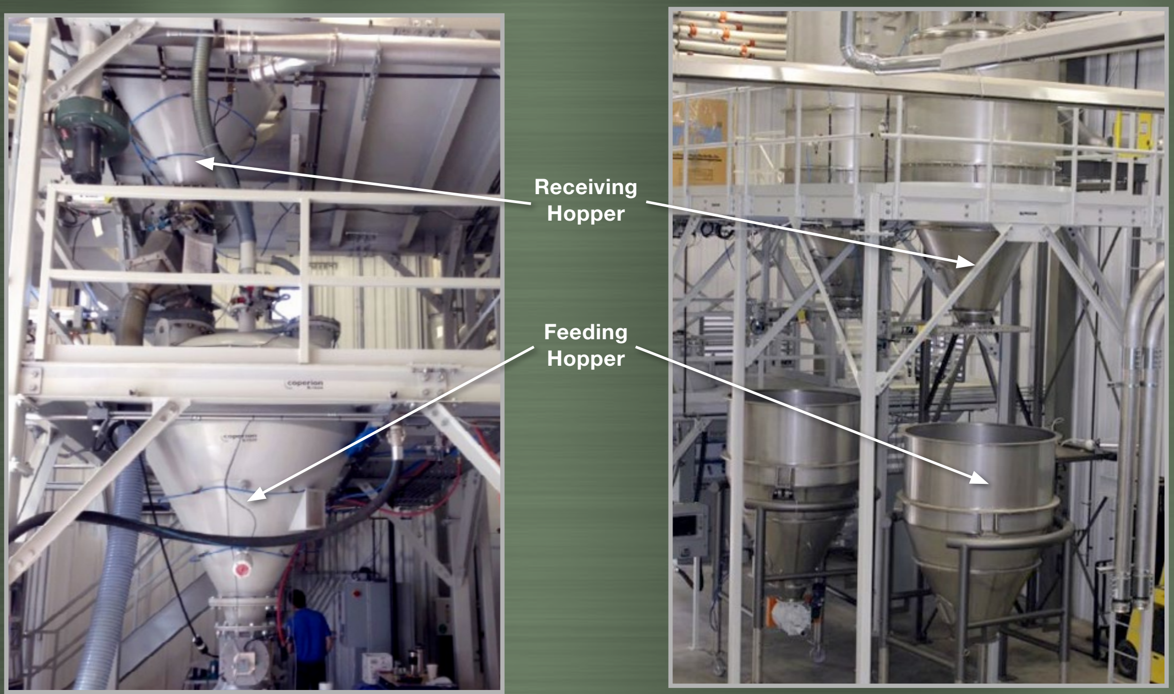
- Two-Story 13,000 ft2 (1,208 m2) Building
- Research Areas - Six Laboratories for university and Industry Sponsored Research
- Training/Education, Conference, and Lecture Rooms
- Material Properties Test Lab - Bulk solid and partiicle properties can be evaluated and modeled in a test bench environment. Includes a full range of lab instruments.
- Full Scale Bulk Solids Test Bay - Full Scale Systems include: Vacuum and Pressure Dilute Phase, Vacuum Sequencing, Vacuum and Pressure Vessel Dense Phase, Rotary Value Dense Phase, Batch Weighing, Silo Zone Bender, Gravity Flow, Air Filtration, Feeding, .Mixing and Silo Storage
- University Researchers, Doctoral Candidates and Students
- Continuing Educati:on and University Level Courses about Bulk Solids

PANORAMIC VIEW OF FULL-SCALE BAY

K-State BSIC has full-scale equipment to assist industry with equipment testing, scale-ups, troubleshooting, and research.

BINS FOR GRAVITY FLOW & STORAGE

The Center has several sizes of bins, with variable discharge geometries and flow aids, to determine which method is best for achieving reliable flow.

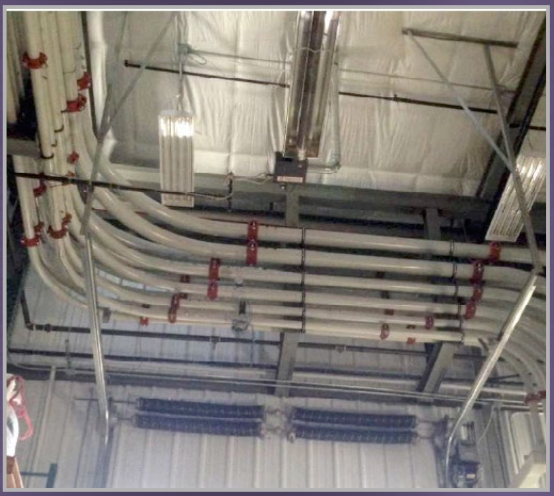


CONVEYING SYSTEMS

Conveying systems include Dense and Dilute Phase Pneumatic Conveying, Vacuum Sequencing, and Mechanical Conveyors.

DIFFERENT TYPES OF FEEDERS

Many types of Feeders are in use at BSIC.



CONVEYING LINES

Distances up to 950 ft horizontal and 65 ft vertical can be accommodated.

PARTICULATE AIR FILTRATION

A large number of separators are available, including Dust Collectors, Bin Vent Filters, Filter Receivers, and Cyclones. This photo shows our full-size Silo with its multiple Bin Vent Filters, next to the large Dust Collector.

MOTIVE AIR

We have plenty of air: 6 blower packages, 3 air compressors, numerous fans, and side-channel blowers. We have a heat exchanger to make sure we aren't always full of hot air.

MOTOR CONTROL

Our sophisticated motor control center includes real-time current measurement for each motor.

SOPHISTICATED INSTRUMENTATION AND SENSORS

Key data is recorded and graphed via our data acquisition system.

CONTROLS

All systems are controlled by PLC's, in automatic or manual mode for easy control. Numerous HMI panels provide human/machine interface with the controls.

CUSTOM EQUIPMENT

BSIC has the capability to build, install, and evaluate custom equipment for your project needs.

SEE ALL OUR CAPABILITIES AT: HTTPS://BULK-SOLIDS.K-STATE.EDU

The Puzzler

Offer your inputs on a problem that started after switching suppliers

In each of the *BSIC Journal* editions, there will be a little puzzle related to various aspects of working with bulk solids. The BSIC staff would like to hear everyone's thoughts on the situations presented. To get things started, some answers will be presented, but we would like to hear your other options or even just why you picked one provided. As a thank you for taking the time to participate, there will be drawings for prizes ranging from BSIC paraphernalia all the way up to free registration to a BSIC short course. All submitted answers will be summarized for presentation in the next edition. Good luck and we are looking forward to hearing from you!!!

CONVEYING CONUNDRUM

There are always several different directions from which to approach a situation like this, and many of them can be efficient and successful. In general, while it is always a good idea to double-check a system for obvious issues, equipment operators never should be ignored as critical information sources. Additionally, once a root cause is identified, longer-term solutions such as PMs and material specifications can be updated accordingly in an effort to prevent reoccurrences.

SUPPLY STORY

One of your suppliers has contacted you about a potential cost savings it can offer on one of your raw materials. The supplier has been good, without any issues to date. The proposal is to change the delivery from pallets of 50-lb bags to 2000-lb super sacks of "the same" material for a 10% cost savings. Currently, your process unloads 20 bags of material into a small hopper each day spread across multiple shifts. From there, it is transported pneumatically to a storage hopper where the materials awaits utilization in the process. How would you begin your approach to this situation?

1. Tell the supplier, "No changes will be accepted as everything is fine the way it is."
2. Immediately accept the new material because there is a big push for cost savings.
3. Verify the new material still meets specifications in quantities used
4. Review the unloading and transport equipment for handling larger volumes.
5. Contact your supervisor or accounting and tell them what a good negotiator you are for cost savings.

6. Pull in plant support for details on handling, storage and unloading of large bulk bags.
7. Ignore the offer and let the supplier find someone else in the company to contact.
8. Ask the supplier for larger discount to make the efforts worth your while.
9. Ask the operators performing the unloading operation for input and thoughts.
10. Contact BSIC for support in understanding differences in material properties, conveying and storage, safety and financial payback estimates.

PLEASE SUBMIT YOUR RESPONSE TO BSIC@K-STATE.EDU

While a full explanation for answers is not required, anyone with a full response will be entered into a drawing for free registration to a Bulk Solids Innovation Center Short Course. The lucky winner will be selected at random from full submissions. Additional winners will be selected at random from all submission as well. Please submit your response to bsic@k-state.edu and put Supply Story in the subject.

KANSAS STATE UNIVERSITY | Bulk Solids Innovation Center

The Kansas State University Bulk Solids Innovation Center is a university-level research facility and the only one of its kind in North America. Our mission is to provide solutions that enhance productivity, research, product testing and education related to bulk solids storage, flow and conveying.

bulk-solids.k-state.edu

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