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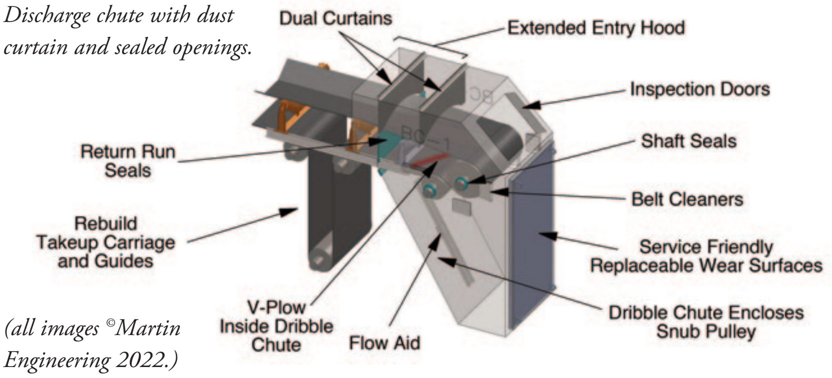
Dust control in fertilizer production with Martin Engineering

In response to global shortages, fertilizer producers are stepping up production, contributing to higher conveyor speeds and greater volumes of cargo, causing more dust within manufacturing facilities, *writes R. Todd Swinderman, P.E., CEO Emeritus, Martin Engineering*. For the most part, these facilities are enclosed to prevent odour and dust from affecting surrounding communities, but most workplace safety regulators closely monitor workplace conditions relating indoor air quality.

Some components of fertilizers can produce microscopic dust particles that are invisible to the naked eye which, over long-term exposure, can lead to chronic medical conditions, and thus are highly regulated. Dust can also clog bearings and other mechanical components, requiring more cleaning, maintenance and replacement parts. With this in mind, many fertilizer producers have improved workplace air quality by retrofitting conveyors to better seal the systems and thoroughly clean the belts.

Discharge chute with dust curtain and sealed openings.



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Many conveyors, many recipes

The manufacturing process for organic fertilizer differs from plant to plant, but most high-volume producers employ a multi-stage system with a throughput driven by conveyors. Many operators generate various mixes of fertilizers by adding precise measurements of different ingredients at specific intervals in the production cycle. Conveying and processing any dry bulk material runs the risk of dust emissions, but many of the hazardous ingredients found in fertilizer need to be ground to a fine powder before incorporation. This lighter, smaller particle size makes the additives more prone to becoming airborne.

Dusty particulate material (PM) can be as small as 2.5 microns (μ) and easily becomes airborne with agitation. At this size, the particles are invisible and small enough to bypass the body's natural defences, penetrating deep into the lungs. Workplace regulators often test for PM10 and PM2.5 using personal testing devices carried by workers throughout their shifts.

Fertilizer dust can lead to violations because it contains regulated substances. There's no disputing that fine powder phosphorus dust is toxic to humans and animals, causing serious long-term health issues.[1] Potash is less hazardous, but low dust levels of crystalline silica still appear during testing, which can violate OSHA air quality regulations.

Once a violation is identified, regulators have a number of options. They can set a deadline to solve the problem, issue fines, recommend a medical assessment of the entire staff, or even order a shutdown until the issue is resolved.

Sealing a fertilizer conveyor system

Enclosing the system to contain fugitive dust depends on controlling air flow and ensuring there are as few openings as possible. Two areas to focus on are the discharge and receiving chutes.

Sealing the discharge zone

A sealing system that is maintained with no gaps between the belt and skirting is critical to controlling airflow, dust and spillage. Because the process is continuous, the discharging material acts like a fan pulling air into the enclosure. As air is induced into the transfer chute, particles separate, leaving the head pulley and flowing onto the receiving chute.

Installing curtains or barriers where the belt enters the discharge chute and sealing gaps in the chute reduce the open areas where air is drawn in. This air must discharge through the exit of the skirtboard enclosure. The skirtboard enclosure should be designed tall and long enough with intermediate curtains that cause dust to recirculate and agglomerate or collect on the curtains.

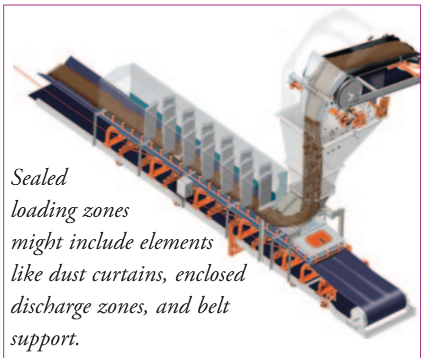
Induced air flow is proportional to the throughput, particle size and drop distance, so minimizing the free fall of material in the discharge chute — while still allowing adequate space for belt cleaning — is important. Where air flow is greater than what can be controlled passively, provisions for active dust collection should be included in the design.

Sealing the loading zone

- Regardless of how many belts are discharging onto a single 'main belt', the receiving system should be *enclosed with sealed chutes*. After the last feed belt, the enclosure should be long enough to give dust and fines time to settle, called the 'settling zone.'
- Although fertilizer isn't a particularly heavy material, *the belt support system* should be able to absorb the impact of the heaviest cargo to protect the belt.
- *Closely spaced idlers or cradles with support bars* help avoid sags in the belt that allow gaps where fines can escape, while easing material disruption.
- *Externally adjustable or self-adjusting skirting* traps fine particles in the enclosure and adapts to fluctuations in the belt plane.
- *Easily serviced wear liners* can be changed from outside the chute

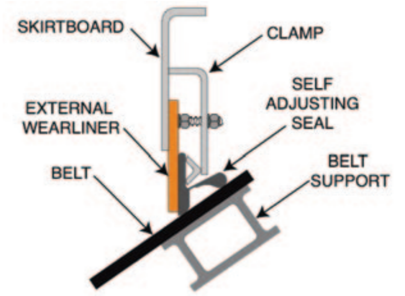
$$\text{Heubach Dustiness Index (g/g min)} = \frac{\text{Dust Collector Filter (g)}}{\text{Mass or test sample (g) x Test Period (min)}} \times 100$$

Equation: Heubach Dustiness index to measure the amount of dust in a dust monitor.



Sealed loading zones might include elements like dust curtains, enclosed discharge zones, and belt support.

A belt support system improves the belt seal and protects the belt during loading.



External wear liner and dual self-adjusting seal with belt support.

without confined space entry.

- *Dust curtains* strategically placed throughout the enclosure control airflow and help settle dust.
- *Dust bags or mounted air cleaners* collect tiny, highly active particles when induced air flow is too great to be controlled in the enclosure.
- Inclined belts are common in fertilizer production. A *sealed tail box* protects the tail pulley from the backflow of fines, dust and spillage.
- *An exit curtain set back slightly from the end of the chute* is required to help prevent fugitive dust from escaping at the settling zone and prevent 'popcorn' spillage caused by the exit curtain.

Conveyor belts found in fertilizer production

As the belt passes over the head pulley, material generally does not discharge completely due to static, flaws in the belt's surface, ambient humidity and adherent qualities of the cargo. Whatever is not discharged or removed with a belt cleaner is carried back along the belt's return and is one of the main causes of fugitive dust. This carryback not only throws off the proportions of carefully weighed additives, but also results in lost product as material drops from the belt along the entire length of the system.

Due to the type of belting commonly found in fertilizer production, dust emissions from carryback are especially problematic. Since the cargo is relatively light, producers rarely use expensive heavy-duty belting, instead choosing more cost-effective polyvinyl chloride (PVC). Antistatic rubber belts are available with flat top surfaces, but PVC belts are often seen as a lower priced option without considering the cleaning, maintenance and safety costs of dust. This cheaper PVC belt tends to have tiny depressions caused by shrinkage of the PVC into the top layer of the solid woven belt carcass. The belt face resembles a hammered metal surface, with fines getting trapped in the dimples and not falling off during the return by gravity. A primary belt cleaner installed on the discharge pulley will remove heavy build-up, but this does not address the particles captured in a dimpled or damaged belt surface which is a main source of dust on the return run.

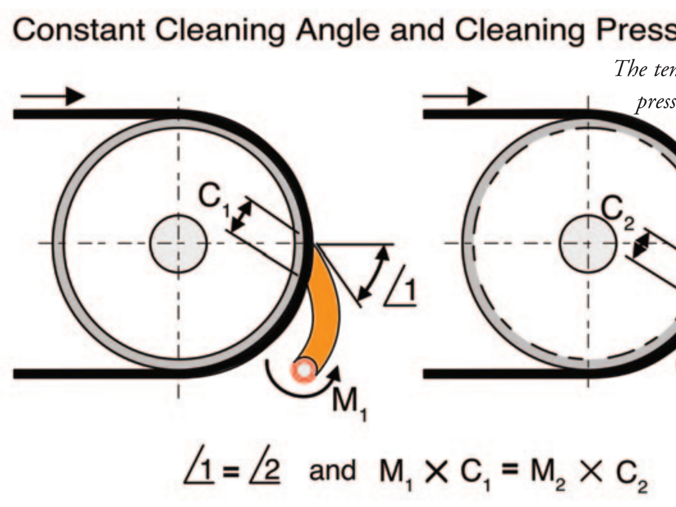
The fertilizer production process can also have several inclined conveyors fitted with ribbed, flighted, grooved or chevron belts. These ridges can resemble wheel

A long, sealed enclosure with cradles, idlers, external skirting and dust curtains.

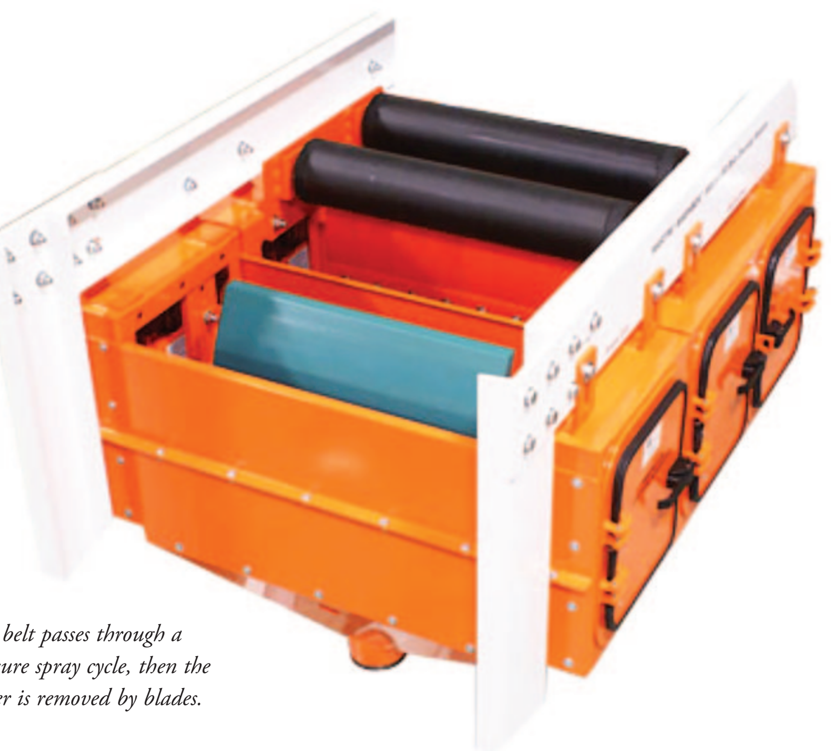
tracks or tyre treads which the cargo attaches to as it is pulled upward. Textured belting is impossible to clean effectively using a standard belt cleaning system designed for flat belts, so maintenance tends to leave the belt uncleaned. As carryback piles underneath the system, workers typically shovel it back into the material flow, which adds more labor to the cost of operation and exposes the workers to potential injuries.

Belt cleaning in fertilizer production

Because of the tendency of the fertilizer to accumulate static charges, all components in the system — including belt cleaners and chutes — must be grounded to reduce



The tensioner puts enough pressure on the blade to clean the belt but easily pass over splices.



The belt passes through a pressure spray cycle, then the water is removed by blades.

dislodged dust from re-attaching to the belt surface. Primary cleaners are most effective on a flat (non-crowned) head pulley, and if crowned pulleys are used, segmented precleaner blades are recommended. High quality polyurethane blades can be shaped in a curved 'constant angle and pressure' (CARP) design to ensure that a consistent wear surface and pressure are applied to the belt throughout the life of the blade.

The tiny depressions in PVC belting can also sequester material beneath the belt's surface plane, allowing it to bypass primary cleaner blades. To mitigate this, a specialized mechanically grounded and static dissipating rotating brush cleaner has bristles that can remove trapped dust and fines. The brush is also well suited for the removal of fines and residue from ribbed, flighted, grooved or chevron conveyor belts. The fine polypropylene bristles are rotated using a one or two-horsepower motor (depending on belt width) to dislodge trapped material. Enclosed discharge zones should be designed to fully encase brush cleaners, since the rotating brushes can release dust from dry cargo. The brush cleaner will create generated air and its use may require a mechanical dust collection system. Air cleaners inserted above the discharge enclosure are preferred.

An alternative to brush cleaners is the 'wash box'. The typical configuration is one or two high pressure spray bars for applying water, followed by two or three secondary belt cleaners, all contained within the wash box housing. The final blade is generally designed for removing water so that the belt leaves the box relatively dry, and most of the water is drained at the base of the unit. In the case of ridged belting, an internal rotating brush cleaner can be used in place of secondary blades.

Dust collection systems

When evaluating strategies to control dust in fertilizer manufacturing, some plants may assume that a central collection system is the best or only option, largely because the equipment is widely available. But the cost of these systems is high, and they require significant ongoing maintenance, leading managers to assume that the cost of dust control is going to be prohibitive. In comparison, the mechanical solutions outlined above typically require minimal investment, and there are also highly-effective options that don't require massive central collection systems with a cost to match.

Two common pieces of filtration equipment are dust bags and integrated air cleaners. Installed above the conveyor loading zone, dust bags collect particles without energy consumption. In a well-sealed chute with properly controlled airflow, the air is directed through the upper openings, where dust agglomerates in the fine mesh bag.

Once full, a short stoppage in the system allows the bag to relax and the collected dust falls safely onto the belt. Some fertilizer ingredients can emit combustible dust so static-dissipating bags and proper grounding are recommended.

Air cleaners are individual mechanical collectors that use a reverse air pulse in the collection chamber to return dust to the main cargo stream. With low power consumption and easy maintenance , some operators have found air cleaners offer a good return on investment over the long term.

Conclusion

The current fertilizer shortage has exposed the fragility of the global supply chain, but workplace safety does not need to take a back seat to production. Managers of production facilities are generally aware of air quality issues, but with only a moderate increase in production, operators are often surprised by the dramatic increase in dust emissions these modest changes can produce.

Retrofitting equipment that improves both production and working conditions results in avoidance of dust-related violations, less unscheduled downtime and a lower cost of labour for clean-up. This reduces the total cost of operation and offers a greater long-term return on investment, and most importantly, results in a safer workplace.

Several dust bags can be utilized, depending on the number of loading zones or dust volume on a belt.

Mechanical air cleaners are low maintenance and improve the air quality around the system.

References

[1] Environmental Protection Agency (EPA). "Phosphorus", EPA, 7723-14-0, Sept. 2016.

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About the author

R. Todd Swinderman.

R. Todd Swinderman, P.E. /CEO Emeritus/ Martin Engineering, earned his B.S. from the University of Illinois, joining Martin Engineering's Conveyor Products division in 1979 and subsequently serving as V.P. and General Manager, President, CEO and Chief Technology Officer. Swinderman has authored dozens of articles and papers, presenting at conferences and customer facilities around the world and holding more than 140 active patents. He has served as President of the Conveyor Equipment Manufacturers' Association and is a member of the ASME B20 committee on conveyor safety. Swinderman retired from Martin Engineering to establish his own engineering firm, currently serving the company as an independent consultant.

About Martin Engineering

Martin Engineering has been a global innovator in the bulk material handling industry for more than 75 years, developing new solutions to common problems and participating in industry organizations to improve safety and productivity. The company's series of *Foundations* books is an internationally recognized resource for safety, maintenance and operations training — with more than 22,000 print copies in circulation around the world. The 500+ page reference books are available in several languages and have been downloaded thousands of times as free PDFs from the Martin website. Martin Engineering products, sales, service and training are available from 17 factory-owned facilities worldwide, with wholly-owned business units in Australia, Brazil, China, Colombia, France, Germany, India, Indonesia, Italy, Mexico, Peru, Spain, South Africa, Turkey, the USA and UK. The firm employs more than 1,000 people, approximately 400 of whom hold advanced degrees.