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FEATURES

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The world's leading and only monthly magazine for the dry bulk industry

DCi

The SENNEBOGEN 860 E-series impresses with ranges of up to 23m and a load capacity of up to 6.9 t. Whether handling piece goods or bulk goods,it has a high materials handling capacity, with proven low energy costs and operating costs that have even been further reduced, thanks to the Green Hybrid energy recovery system. With the Skylift 900 the operator cab can be adjusted over a height of 9.5m. The proven SENNEBOGEN modular concept offers extensive superstructure variants. From mobile undercarriage to crawler and rail undercarriage, extending to sophisticated gantry and pylon solutions for special applications, all can be can be individually implemented.

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SENNEBOGEN 860 E-Series with Green Hybrid Energy Recovery and Skylift cab elevation

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ENGINEERING & EQUIPMENT

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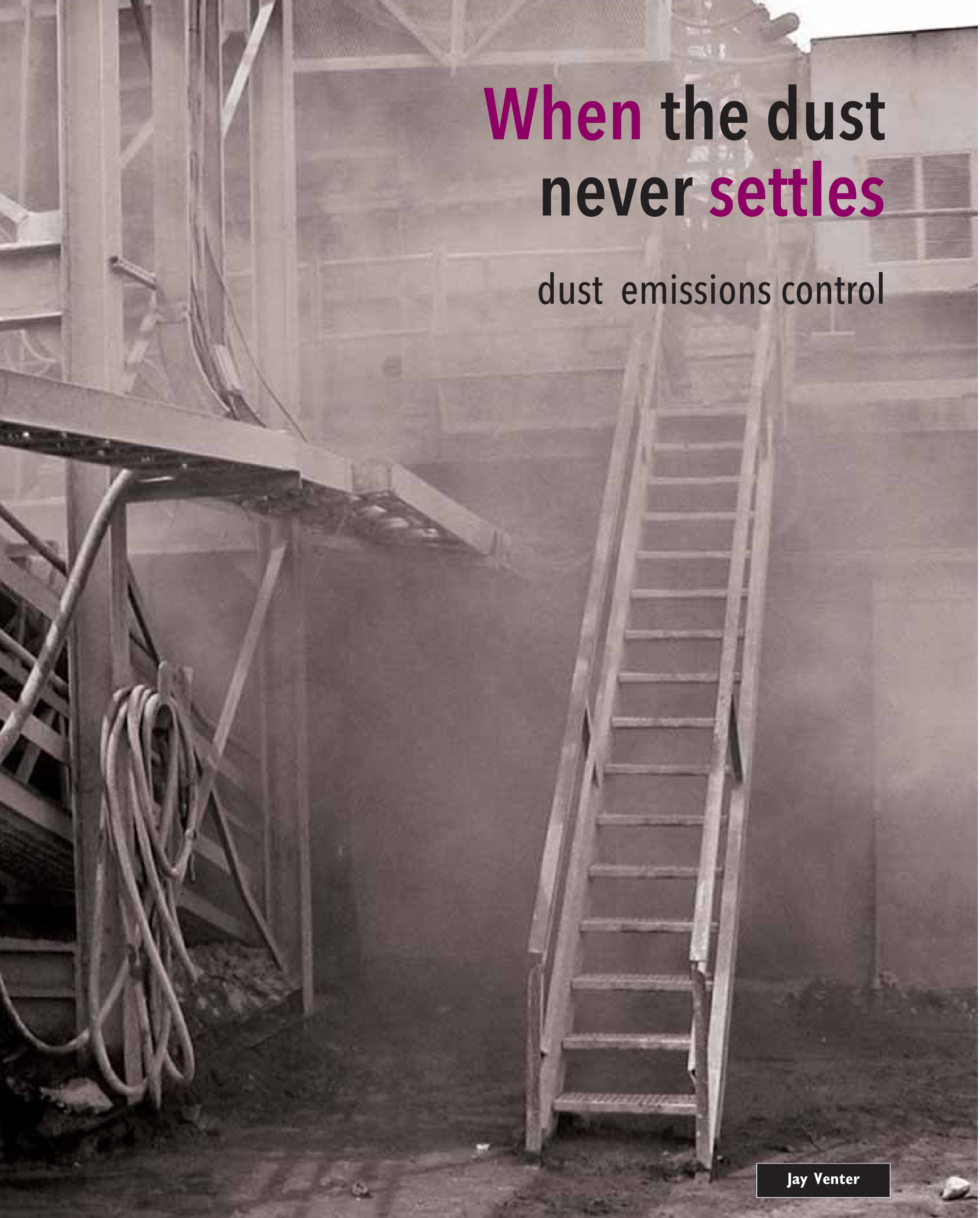
When the dust never settles

dust emissions control



Dust problem at belt conveyor.

Jay Venter

The problem with dust

A common refrain regarding dust management at conveyor transfer points goes something like this: "That's just the way it is. There's always been dust. And the control system has never worked properly," *writes Reiner Fertig, Business Development Manager for Conveyor Products, Martin Engineering GmbH.*

In fact, the causes of dust generation are complex: volumes, particle sizes and behaviour of the emitted dust depend on many factors. Accurate dust measurements are difficult and often costly, as the emissions are diffuse, so it may be impossible to draw any direct conclusions regarding individual emission sources. Plant operators often rely on a visual impression to decide where the dust problem lies. The tendency is then to try out different things and see what effect they have.

- Unfortunately, guidelines for a systematic approach are generally lacking. To find an effective solution, it's necessary to know the causes and the desired objectives to be achieved, but also to define what the primary problems of dust emission are in each case, based on the specific operating conditions of the individual application:

- employee health & safety issues;
- exceeding limits for individual dust fractions (total dust/PM10/PM2.5); and
- increased operating costs from reduced component life, product loss or increased cleaning requirements.

Dust generation on conveyors

Fine bulk solid particles can be stirred up as a result of the relative air speed of bulk conveyors. Especially critical are particle sizes around 10–100µm, as they become airborne easily and can travel long distances. A noticeable effect occurs at around 2m/s relative speed; at 4m/s, even larger mineral particles are energized. In addition, bulk solids residue sticks to the conveyor belt and is partly transferred to other components, such as idlers, pulleys, support beams, etc. As a result of drying and vibration, particles are liberated, causing the formation of small particle sizes.

In the field, other factors can have an adverse effect on the volume of emitted dust. Among them are transfer points that are not fully enclosed, enclosures which are damaged or have openings, ineffective sealing against the belt or a belt that sags below the seal. Further, wind effects, thermal changes, humidity and vibration can all influence dust generation. As the material flows through transfer points, considerable quantities of energy are converted in the flow. As a result, lumps and large bulk solids particles are pulverized, constantly forming more fine particles that can find their way into the air.


A properly-sealed transfer point.


Influence of fall height on dust generation.


Discharge area with seal between carrying and return sides of the belt.

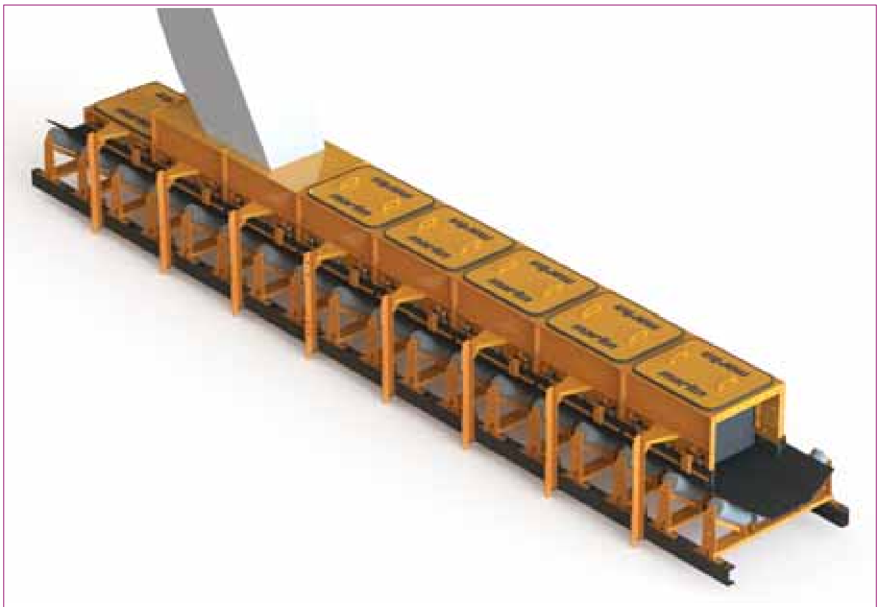
Dust generation at transfer points

Bulk solids fan out during free fall, i.e. the individual particles distance themselves from each other, resulting in the formation of spaces between them. The interspaces fill with air and the particle sizes segregate, as fine dust swirls up more strongly and breaks away from the actual flow of bulk solids, causing the generation of airborne dust.

The air between the bulk solids particles is displaced as soon as the flow of bulk solid hits the conveyor belt and takes small particles with it — another source of dust.

Passive measures

There are various individual measures with which existing equipment can be retrofitted to reduce dust generation, including support cradles, wear liners and belt sealing. In most cases, little or no structural change is necessary at the transfer points. They are therefore low-cost measures that make a considerable contribution to dust reduction and are


Modular settling zones offer a versatile solution to suit a wide variety of applications.

Settling zone with wear liner, apron seal & dust curtain.

Support cradles help flatten the belt path for effective sealing.

usually the precursor to the expedient implementation of further measures. Passive measures should be implemented as the first priority.

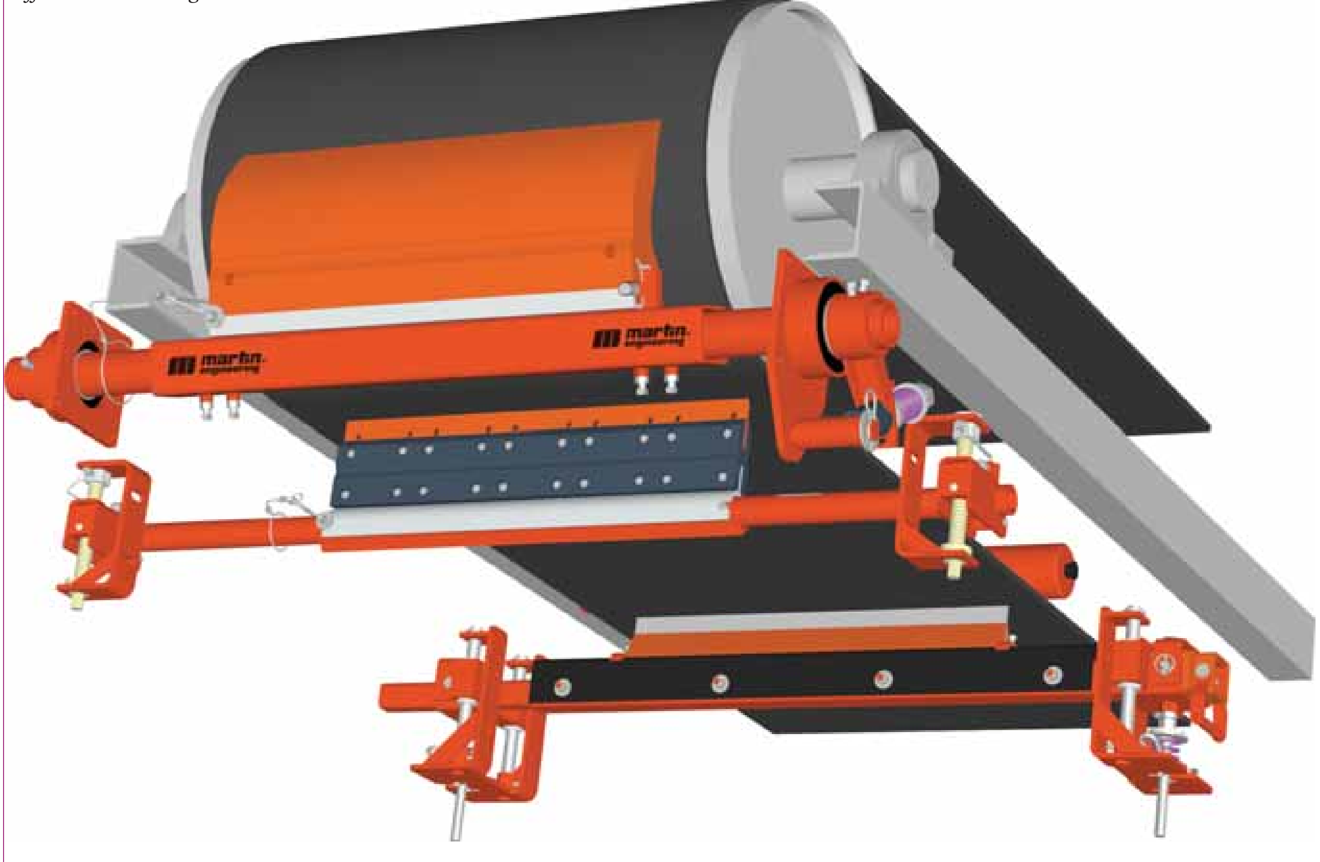
The transfer points on many existing systems are not fully enclosed. Full enclosures help restrict the air flow and locally limit the dust emissions, and are a natural precondition for belt sealing to be installed.

The conveyor belt should be effectively sealed against the fixed components at the transfer points and settling zones. Side seals are available in different designs, and multicomponent systems provide the most effective dust barrier. The load-carrying and return sides of the discharging belt should also be sealed against the enclosure. The objective is to minimize open area through which air can be drawn in.

On the carrying side of the belt, ideally only the form of the bulk solids contour should be left open on the belt, and the return belt should be completely sealed. Generally, the lower the volume of air that can be drawn into the transfer point, the lower the dust emission at the outlet of the chute and the more readily economical containment measures can be employed.

Transfer points can be prone to spillage as the conveyed material lands on the receiving conveyor. Once the belt leaves the impact area, it can sag while the material is still settling. This compromises the skirt seal, allowing dust and fines to escape, while creating pinch points where material can get caught and gouge the belt.

When discharged from a height, coarse material and fines can both cause considerable impact force. Without proper impact absorption and distribution, all of that force is exerted on the belt, *Effective belt cleaning is essential to dust control.*



essentially crushing it against a rigid surface underneath. But impact beds absorb the energy, so the belt doesn't have to. They also create a flat edge for the apron seal, to prevent spillage and fugitive dust.

Settling zones

The tunnel-like enclosures after the loading point of a belt conveyor can be equipped with dust curtains to fulfil two purposes: they generate flow resistance for the movement of air and therefore reduce the air flow. They also give coarser dust particles a greater opportunity to settle before they leave the settling zone.

The dimensions of the settling zones should be generous to maximize the dwell time of the air and therefore the dust particles. They should be oriented to the design of the transfer point, the properties of the bulk solids and the parameters of the belt conveyor. The air flow velocity serves as a guide for the height of the settling zone. Within the settling zone, this should be lower than the belt speed and ideally be <1.5m/s (300fpm). The length is geared to the belt speed and dust particle sizes that are intended to settle in the zone.

Belt cleaning

As described above, bulk solids particles can stick to the conveyor belt and also become deposited on other components. If the particles dry out or are exposed to vibrations, they can become loose and be discharged as very fine dust. The more effectively the belt is cleaned, the more it reduces this effect. Very efficient belt cleaning systems are available for this purpose. To clean residual bulk solids out of grooves or chevrons in the belt surface, brush cleaners and belt washers can be used.

The single most common problem with belt cleaning systems (and one of the easiest to rectify) is proper maintenance and tensioning. There is a tendency to set-and-forget in many operations, as long as a belt cleaner doesn't have an overt failure. But regularly scheduled assessments of the entire conveyor system by professionally trained technicians can identify and address the most prevalent issues to optimize performance and manage fugitive material. Some manufacturers are even putting QR code labels on the system's wear components, allowing technicians to quickly enter performance data and track system info via smart phone app, recording details about the application, bulk material, operating environment, service life and condition of conveyor components.

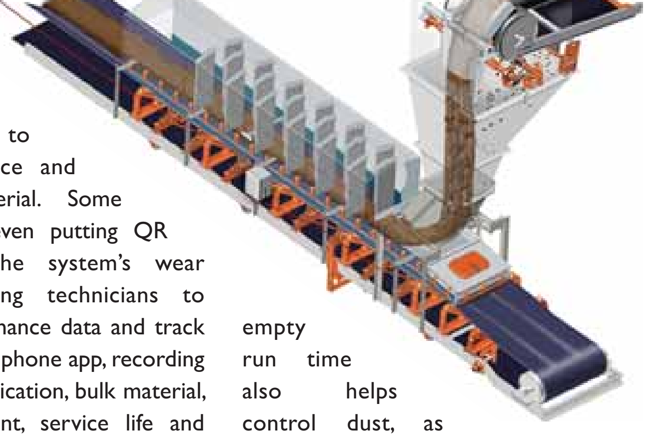
System modifications

There are a number of other changes that can be made to minimize dust emissions.

For example, dust bags may be installed, which are basically filter elements fitted onto the settling zones. They use the positive air pressure from the chute as the driving force for filtration and reduce the local overpressure around the loading point.

On some systems, it may be possible to reduce the belt speed, which helps reduce the swirling effects of the turbulent air flow and lower the air speed through the transfer point and settling zone. Avoiding empty run time also helps control dust, as

A well-engineered chute confines the load, depositing material with minimal impact.



emissions are generally at their lowest when the belt is operated at or near its capacity. When empty run time is required, unnecessary wear to the belt and cleaners can be minimized by automated systems that will sense an empty belt and automatically back the blade away from the belt until the load resumes.

Belt sagging can be a significant problem on some systems, particularly with heavy loads. Operators may choose to reduce the distance between rollers to minimize the issue, or they may elect to add support cradles to create a flat, stable surface that can be effectively sealed against dust emissions.

Even with good belt cleaning, some residue of bulk solids can stick to the conveyor belt, idlers and pulleys. Minimizing the vibrations to which the components are exposed helps reduce the number of particles liberated as dust. Vibrations in the conveyor belt can be reduced by varying the belt tension, reducing idler spacing or adding support cradles.

Structural Changes

Making structural changes to an existing transfer point can be a difficult enterprise, but some manufacturers have designed modular systems with components that can be mixed and matched to suit virtually any conveyor design. An effective flow chute employs special geometries that capture and concentrate the material stream as it travels through. Every design should be tailored to suit the specific material characteristics and conveyor systems of the individual customer, rather than using stock products and attempting to make them work. A properly designed chute provides the dual benefits of minimizing aeration and preventing buildup within the chute, particularly important when dealing with combustible materials.

The top of the chute minimizes expansion of the material stream, directing it downward, while the receiving section at the bottom provides a curved loading surface for a smooth line of descent, consistently feeding the material at a specific speed and direction to match that of the receiving belt and minimize impact in the loading zone.

The goal is to confine the load and reduce air entrainment, while directing the moving material onto the receiving belt with minimal impact. Successful designs reduce spillage, abrasion, dust and premature belt wear. This control also helps ensure that material is center-loaded on the belt, avoiding mistracking and fugitive material.

Conclusions

These are just a few of the technologies gaining the forefront in the effort to better control dust. Until recently, the engineering of belt conveyors to carry bulk materials hadn't changed much in the last half-century, despite the fact that virtually every requirement for safety, regulatory compliance and production performance has been raised during that time. Even with powerful software and modelling techniques to help design conveyor systems, the basic approach remained much the same. Most conveyor systems were designed by matching capacity requirements with the most economical construction cost, while still adhering to codes and safety regulations.

But no two bulk materials are the same, no matter what type or classification they are. Similarly, every conveying system will have its own individual characteristics. It is important for users to examine the features, construction and trouble points of their systems as unique entities, without making assumptions that could lead to unsatisfactory results. The causes of dust formation are complex, and successful solutions often consist of a combination of several individual measures. Enlisting the help of a trained and experienced equipment/service provider with a proven reputation can be of significant benefit in analysing dust issues and determining the most cost-effective solutions. The entire conveyor system should be regularly inspected and maintained to minimize dust, maintenance costs and downtime.