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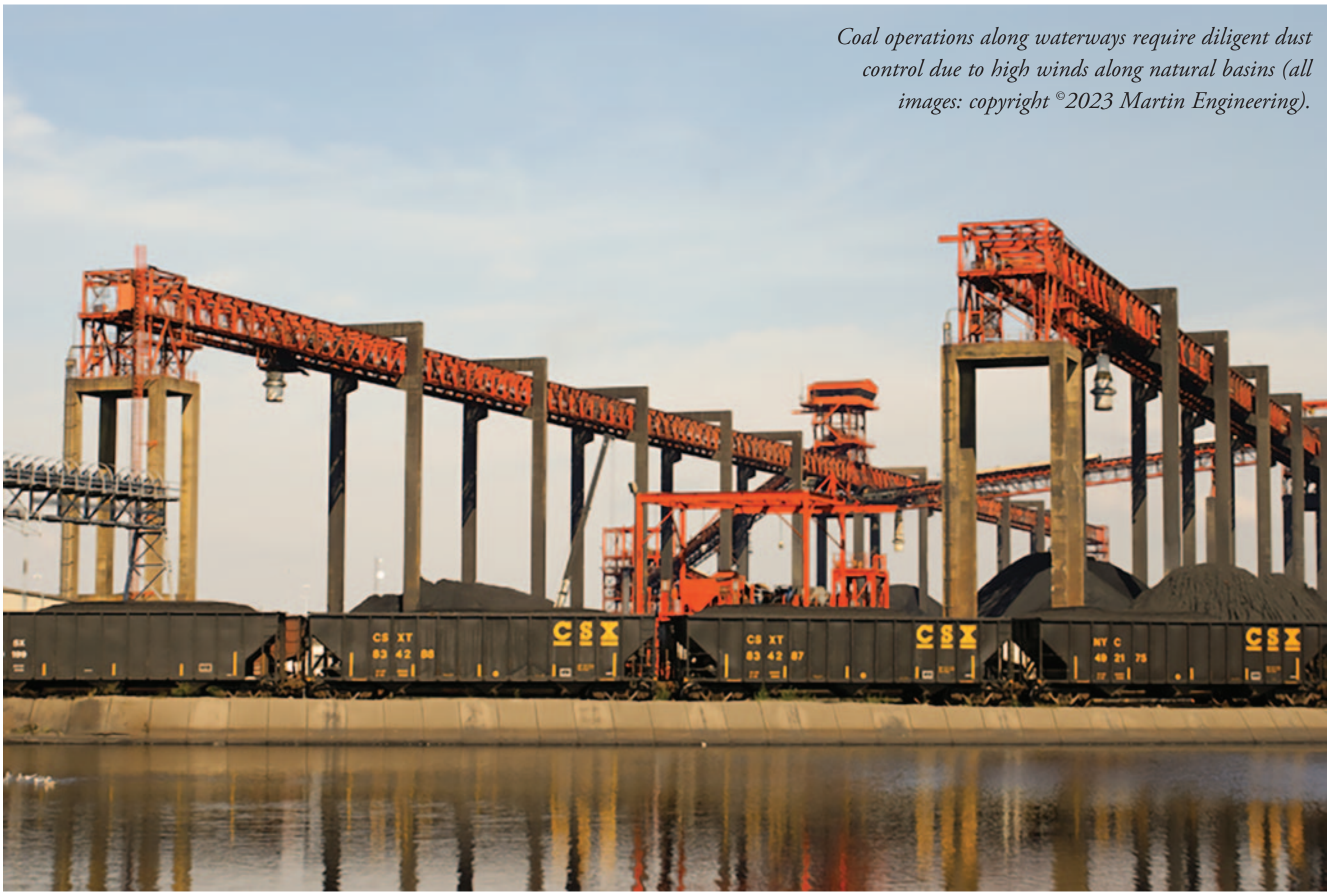
Loading the barge: coal terminals control dust at the source



Coal operations along waterways require diligent dust control due to high winds along natural basins (all images: copyright ©2023 Martin Engineering).

Coal terminals face an uphill battle since coal dust is more highly scrutinized and regulated compared to other bulk handling operations, *writes R. Todd Swinderman, President Emeritus/ Martin Engineering*. Loading barges for transport down waterways can be difficult since they are commonly natural basins which concentrate and amplify winds. Bays offer some respite, but loading structures can be several stories high, exposing conveyors to ambient air currents that can carry emissions long distances. Controlling emissions is made that much more problematic by the fact that coal is hydrophobic, causing it to resist clumping commonly associated with water-based dust control methods without the aid of expensive surfactants. This makes containment of dust at the point of transfer a more appealing approach.

Along with worker safety, controlling dust is sensible from an operational aspect as airborne particulates can foul rolling

Coal conveying, storage, and processing are all activities that generate dust.

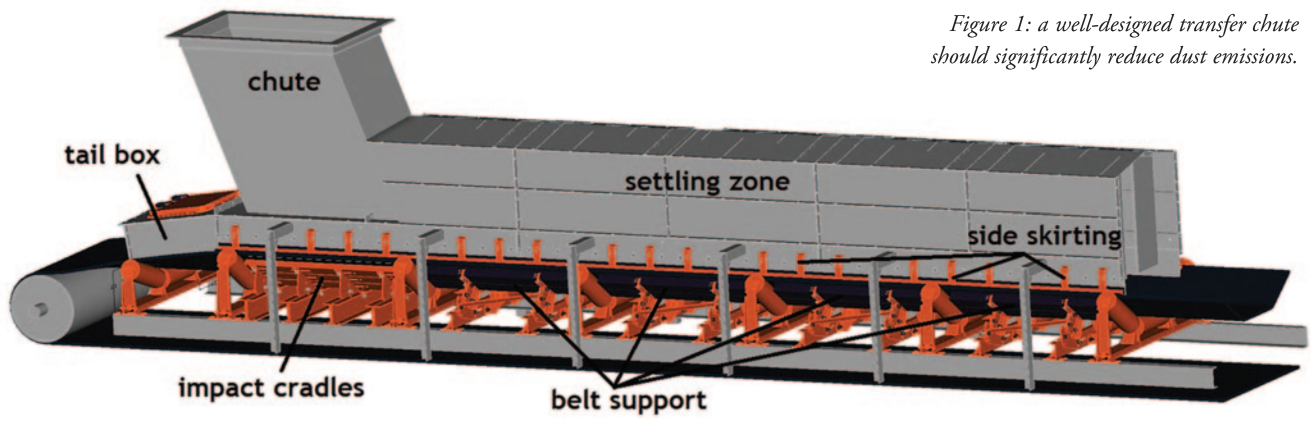


Figure 1: a well-designed transfer chute should significantly reduce dust emissions.

Impact cradles can reduce damage and prolong belt life over standard impact idlers.

components, machinery, and equipment air intakes requiring extra parts and labour for cleaning and maintenance. All of these factors unnecessarily raise the cost of operation when there are methods and technologies designed to control and suppress dust emissions before they become airborne and cause these risks.

While obvious that one way to reduce coal dust emissions is to reduce the amount of dust created in processing, it isn't always practical or easy to accomplish. There are many dust sources that must be managed depending on the haulage and storage methods. Most of the dust contained in bulk materials is either from crushing or grinding to reduce material size or from transferring materials to other conveyors or a stockpile.

Conveyor dust strategies

Conveyors are a major source of dust emissions, but they can also aid in reducing fugitive dust. For example, in pit crushing and overland conveying in a surface coal mine, there is reduced total site dust generation compared to truck haulage. Coal is easily windswept and in some cases may require an enclosed conveyor belt system such as a fold belt, pipe conveyor, or air-supported conveyor.

When the haulage involves a conveyor belt, dust generation is a function of the loading and discharge as well as how it is managed. Closed conveyors are very useful for preventing contamination and protecting the cargo from the elements, but they still have to be opened and closed for loading and discharge. Passive dust reduction strategies include: [Fig.1 above.]

- **Shorter or directed drops:** transfer chutes over loading zones that decrease the impact of cargo on the belt below reduce the amount of turbulence within the loading zone, lowering the amount of dust released.
- **Managing the flow:** although rock boxes can work, they can also be prone to clogging, so experienced engineers recommend a sloping system that slows material to minimize impact and induced air, as well as loads in the centre of the belt for less shifting and improved belt training.
- **Preventing belt sag between idlers:** the belt can dip slightly between idlers, creating gaps between the belt and skirting, causing the release of dust and fines in the loading zone. Using an impact cradle with shock-absorbent polyurethane bars reduces impact strain on the belt and creates an even belt plane with no gaps between the skirting and belt. Cradles can extend along the entire length of the stilling zone.
- **Fully enclosed transfers:** by completely enclosing the loading and settling zone, dust is contained. Items like dust curtains and dust bags can then be added to control airflow and capture dust.

Enclosed conveyors with external double skirting and internal curtains drastically reduce dust emissions.

Lower belt speeds

There are many suggestions for belt speeds

Uncontrolled drops into stockpiles can spread dust for long distances.

based on the properties of the bulk material. ANSI/CEMA 550-2003 Classification and Definitions of Bulk Materials lists miscellaneous properties of bulk materials that would contribute to a decision to use a lower belt speed and may be windswept as part of its classification code system include:

- B-1 Aeration-Fluidity;
- B-6 Degradable-Size Breakdown;
- B-8 Dusty; and
- B-20 Very Light and Fluffy.

With lower belt speeds, the belt width has to increase to convey the same tonnes per hour creating a capital cost vs operating cost dilemma. Many sources suggest belt speeds of 2m/s (394fpm) or less for reducing dust generation.

If a conveyor is being designed for an extended lifetime, then it is worth the effort to closely compare the capital savings from a higher-speed belt to the long-term costs of maintenance, cleanup, and safety. There are clear relationships between increased cleanliness, fewer safety incidents, and more reliable production so the tradeoffs should be examined closely. *Foundations™ for Conveyor Safety* — a comprehensive textbook for safe conveyor operation written by Martin Engineering — provides a detailed methodology and data sources for including direct and indirect costs in the financial analysis in section six.

Coal dust and belt tension

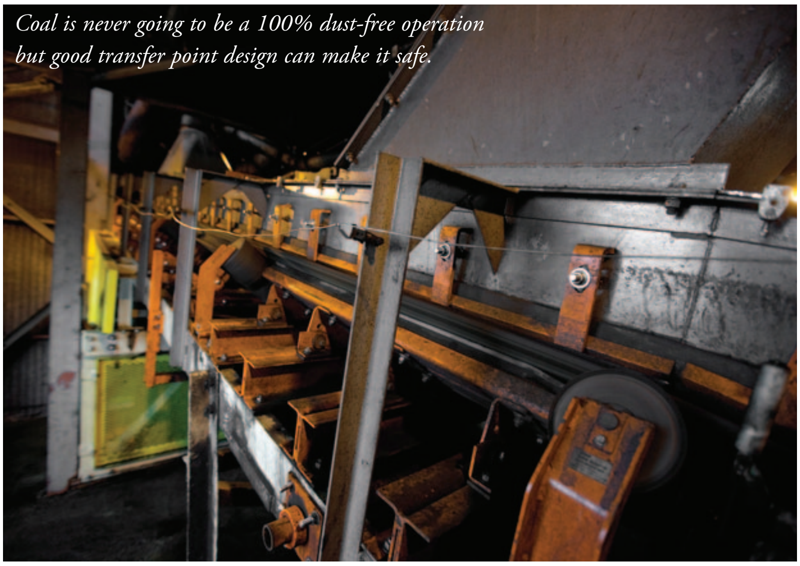
Similarly, at a critical speed, the bulk material loses contact with the belt at the idler and is launched into the air, falling back onto the belt at a slightly lower speed than the belt. This splashing action opens the profile, creating induced air flows that can release dust, creating turbulence, impact, and degradation as the material lands and returns back up to belt speed. Keeping the belt sag to 1% between idlers is a frequent specification. Usually, the concerns in conveyor design from these belt sag phenomena are the added belt tensions required to overcome the frictional losses.

Often overlooked in a dust reduction strategy are design choices that can minimize dust creation from the undulations of the bulk material on the belt as it is transported. Managing belt tension so the sag between idlers is minimized reduces the effects of material trampling and splash. Material trampling is the particle-to-particle movement created by the change in the bulk material profile as it goes over the idlers. Trampling and splash can be a source of dust generation given the large number of times the cargo passes over idlers every hour. The higher the belt tension, the lower the trampling loss.

Coal storage

Controlling dust at the storage location is another challenge. Large stockpiles are impractical to enclose in buildings and are often stacked out and reclaimed by machinery that generates additional fines. Open stockpiles are subject to the weather where some bulk materials degrade upon exposure to the atmosphere and some materials will revert to a solid state when exposed to humidity or rain. Those materials that can be wetted often use water sprays to reduce windblown dust. Other strategies include wind fences and compacting the pile.

Discharge onto the pile is a source of dust release as the material flows from the delivery equipment, often a conveyor, onto the pile. Cascading or telescoping chutes can be used to reduce the release of dust in these cases. If the material is easily broken, the drop height from discharge to the pile or between cascade shelves can create additional dust from impact degradation. One unexpected source of dust emissions can be the site layout. For example, if a slope conveyor going from the stockpile into a storage bin or building is orientated in line with the prevailing winds in a high wind locale, the wind flowing up the conveyor will overwhelm dust control strategies by creating positive pressure throughout the conveyor enclosures.



Coal is never going to be a 100% dust-free operation but good transfer point design can make it safe.

Best practices: enclose the system

If the material stream can be constrained so that it does not open up when discharged, the amount of air induced into the transfer point is reduced. As the material particles spread out, it creates a low-pressure area in the spaces which induces airflow into the transfer point.

The amount of dust that can become airborne is directly proportional to the volume and speed of the airflow through the transfer point. If the openings in the chute work are restricted to the practical minimum, the inward airflow is restricted. A useful dust control strategy is to capture the material shortly after discharge and keep the stream coalesced as tightly as possible to reduce induced air.

There are a number of Discrete Element Modelling (DEM) software programmes specifically designed for the design of material flow through chutes and there are specialty chute manufacturers that specialize in these techniques. These chutes work best with materials of consistent size and adhesive and cohesive properties like coal. Wear on the chute surfaces may be accelerated but this can be offset with a maintenance-friendly design for quick and easy change out of wear surfaces.

Conclusion

Much emphasis is placed on planning the coal terminal to maximize profitability but little attention is placed during the initial feasibility studies on how the layout can affect dust creation and emissions. Conveyor transfer points have a history of being drafted rather than designed. Design tools are now readily available to address these critical details. How the conveyor is operated and maintained also has a significant effect on dust generation and release.

About the author

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 at the forefront of bulk material handling for more than 75 years, continuously developing new solutions to make high-volume conveyors cleaner, safer and more productive. 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, Malaysia, 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.