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Coal dust at the source

MARTIN ENGINEERING BREAKS DOWN SOME OF THE MANY ASPECTS OF EFFECTIVELY CONTROLLING COAL DUST.

There is little doubt that coal dust operations are more highly scrutinised and regulated than other areas of bulk material handling – and with good reason.

Coal operations come with well-known associated risks to workers' health, as well as the relatively high danger of explosions.

The fact coal production is increasing in Australia means progressively more workers are involved, further emphasising the focus on safety.

Controlling dust makes sense from an operational aspect, as it can foul rolling components, machinery and equipment air intakes, requiring extra parts and labour for cleaning and maintenance.

These factors increase the cost of operation when there are methods and technologies designed to control and suppress dust emissions before they become airborne.

While minimising the amount of dust created in processing is a seemingly obvious way to reduce coal dust emissions, it isn't always practical or easy to accomplish. There are many dust sources that have to be managed depending on the extraction, haulage, and storage methods. Most of the dust contained in bulk materials is from crushing or grinding to reduce particle size, and from transfers in the production process.

The hydrophobic properties of coal also make it harder to control dust emissions using water without the addition of expensive surfactant additives.

SURFACE VERSUS UNDERGROUND

Dust is difficult to control in surface operations because the processes take place in the open air and the fracturing of the in-situ material creates dust.

The bulk material is typically loaded into haul trucks at the point of extraction and taken to a conveyor transfer point or a crusher. As the material is dumped and crushed, the most effective dust control is water or, if the addition of water to the material is a problem, foam.

Water is not as effective as foam but is often preferred due to the cost of foaming chemicals. There are some residual effects of water, but they are usually short-lived.

In underground extraction, water is often used at the face and conveyor transfer points to control dust. When water cannot be used, methods such as in mining salts, ventilation and modular dust collection are options.

CONVEYORS

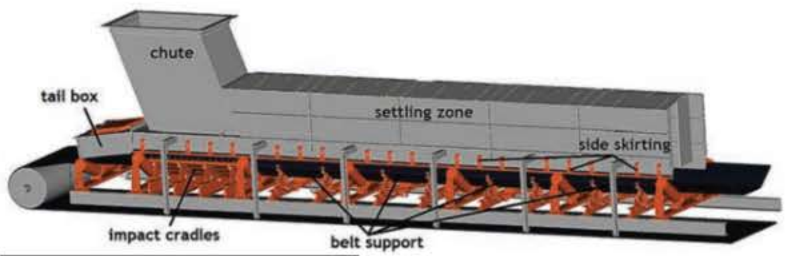
Conveyors are a major source of dust emissions, but they can also aid in reducing fugitive dust.

For example, in the case of 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.

Some common passive dust reduction strategies:

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



A well-designed transfer chute should significantly reduce dust emissions.

- 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 – experienced engineers recommend a sloping system that slows material to minimise 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 – 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.
- 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.

LOWER BELT SPEEDS

There are many suggestions for belt speeds 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:

- B-1 aeration-fluidity
- B-6 degradable-size breakdown
- B-8 dusty
- B-20 very light and fluffy

With lower speeds, the belt width has to increase to convey the same tonnes per hour, creating a dilemma of capital cost versus operating cost. Many sources suggest belt speeds of 2m per second or less for reducing dust generation.

If a conveyor is being designed for an extended life, it is worth comparing the capital savings from a higher-speed belt to the long-term costs of maintenance, clean-up and safety.

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.

COAL DUST AND BELT TENSION

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. It also creates turbulence, impact and degradation as the material lands and returns back up to belt speed.

Keeping the belt sag to one per cent between idlers is a frequent specification.

The concerns in conveyor design from these belt sag phenomena are most often the added belt tensions required to overcome the frictional losses.

Often overlooked in a dust reduction strategy are design choices that can minimise dust creation from the undulations of the material as it is transported on the belt.

Managing belt tension so the sag between idlers is minimised 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 represents another challenge.

Large stockpiles are impractical to enclose inside buildings and are often stacked out and reclaimed by machinery that generates additional fines. Open stockpiles are subject to the weather, often degrading upon exposure to the atmosphere, and some materials will revert to a solid state when exposed to rain or humidity.

Enclosed conveyors reduce exposure to wind with fewer dust emissions leaving the site.


Uncontrolled drops into stockpiles can spread dust for long distances.

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, but 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.

Site layout can be an unexpected source of dust emissions. 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 location, the wind flowing up the conveyor will overwhelm dust-control strategies by creating positive pressure throughout the conveyor enclosures.

BEST PRACTICES: ENCLOSE THE SYSTEM

If the material stream can be constrained so it doesn't 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 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.

A number of discrete element modelling software programs are specifically created for the design of material flow through chutes, and some specialty chute manufacturers specialise 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.

Australian mining companies often emphasise planning the mine to maximise profitability without paying enough attention 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, but design tools are now readily available to address these critical details.

Addressing particulate emissions early with modern techniques and equipment allows operators to formulate a detailed dust plan and create a safe and efficient operation.

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