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MASTERING DUST CONTROL

Jerad Heitzler, Martin Engineering, USA, discusses the best practices for controlling dust at conveyor transfer points.

Whether from a silo, hopper, or another conveyor, when dry bulk material is dropped onto a moving conveyor belt, dust emissions are inevitable, right? Not necessarily.

The moving belt, even when empty, pulls air through the enclosure in the direction it is moving. When the material hits the belt, the impact causes the cargo to splash, particulates to become airborne, and the subsequent air turbulence forces the dust emissions towards the nearest opening. Without a sealed environment that controls airflow, the poor air quality creates a serious workplace safety hazard.

Dust emissions do not just create a harmful environment for those working in the area. Abrasive particulates make their way into exposed machine parts and rolling components, causing them to wear quicker, seize, and require replacement sooner. Dust clogs air intakes of nearby equipment and vehicles, raising the amount of downtime and maintenance. Particulates can cover walkways, stairs, and control units and obscure signage. There are also serious environmental concerns and increased complaints from nearby communities that trigger inspections from authorities.

Over the years, the US Occupational Safety and Health Administration (OSHA) and the US Mine Safety and Health Administration (MSHA) have targeted efforts to improve air quality through greater scrutiny followed by steep fines. Regardless of operators' opinions of these measures, they have successfully helped to reduce the number of illnesses and chronic lung diseases associated with fugitive dust emissions.

Often at issue is many operators' lack of understanding of the underlying causes of dust. Most solutions focus on dust suppression and collection, but decades of field study and experience have shown that, to control air quality at transfer points, it is more beneficial to address the root causes by taking a holistic view of the function and design of the material transfer process.

Elements of a transfer chute

A transfer chute should have several key components that mitigate material spillage and dust, allow the cargo to settle on the belt's centre, and facilitate the settling of dust either back into the cargo flow or into a dust collection mechanism. These components include cradles, wearliners, skirting, raised enclosures, and strategically placed dust curtains.

Some manufacturers offer modular transfer chute enclosures that can be quickly and economically retrofitted for changes in production during scheduled downtime. Extending the transfer chute enclosure provides more space for the turbulent air and dust to settle. Externally facing wearliners and skirting allow easy access for significantly safer maintenance. Although the normal lock-out/tag-out procedures are required, external servicing eliminates the need for chute entry and drastically reduces the amount of downtime.

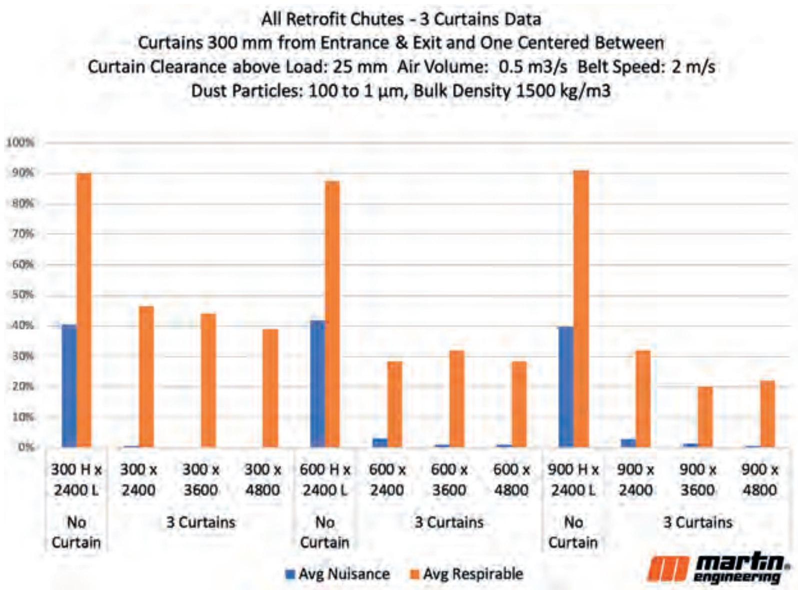

Figure 1. The percentage reduction in dust in three chutes differentiated by chute height and width.

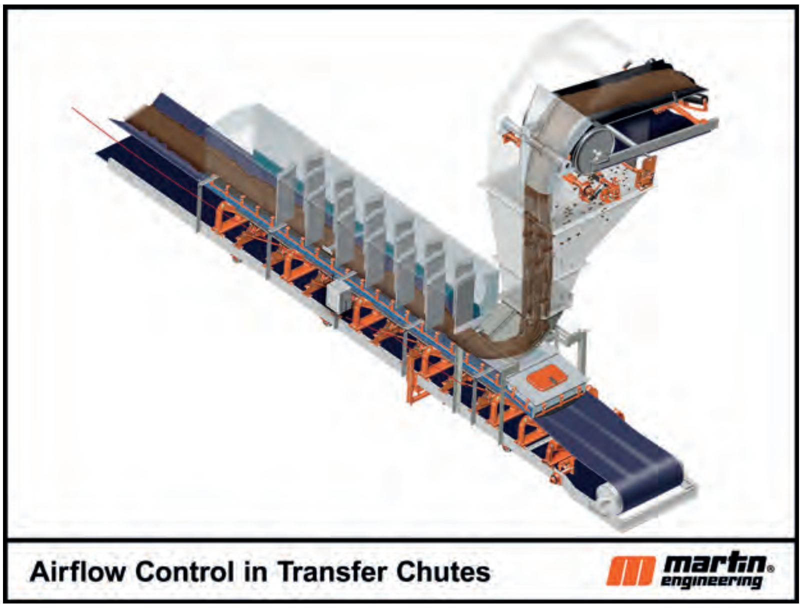

Figure 2. The centred spoon loading design and dust curtain system helps control turbulence and airflow.

Nuisance vs respirable dust

If you can see the particulates floating in the air, they are not small enough to be respirable, meaning they do not surpass the body's natural defences and enter deep into the lung, which can cause serious damage and health issues. Nuisance particulate matter (PM) smaller than 200 µm (micrometres in diameter) – roughly the size of normal household dust – is light enough to remain airborne on ambient air currents. It settles on every surface and causes serious abrasion in rolling and mechanical components.

When PM reaches 100 µm – approximately the size of a cross section of a human hair – it becomes invisible to the naked eye. At 10 µm or smaller, the particulate is considered 'respirable'. These particulates have become highly regulated, having been linked to chronic lung diseases some workers experience later in life, which has drastically lowered the mortality rate.

The chute design can have a significant impact on the volume of particulate matter emitted during conveyor transfers. Chutes that are properly sealed and retrofitted with three curtain zones incrementally slow the airflow and allow dust to settle. Field tests show a drastic reduction in emissions of both nuisance and respirable dust (Figure 1).

Identifying the root causes of dust

Many operators have the misperception that, in the inherently dirty business of mining, processing, and handling bulk materials, dust control is a futile battle that can never be overcome. This is particularly true when experienced maintenance staff gaze baffled at a transfer point engulfed in dust that provides no clue as to the source of the emissions.

Air flow through the transfer point is achieved by adjusting the loading angle and the proper placement of dust curtains. With a centred and sloped or spoon-shaped loading configuration, the cargo is eased onto the belt with less impact (and associated belt damage), no splashing, reduced air turbulence, and less shifting leading to potential mistracking. Proper placement of curtains creates zones where air is slowed, allowing dust to settle back into the cargo stream or be sequestered into dust collection systems (Figure 2).

Material degradation increases small fines in two ways. As raw material is processed through crushers or mills, it is reduced in size and dust becomes more prevalent. Degradation can also be caused by the impact of material upon transfer, resulting in it breaking apart.

Poor transfer point design for current production expectations is perhaps the largest cause of dust. Conveyor systems are generally built for the production demand at the time of construction and leave little room for change. Increases in production require either a greater volume of conveyed material or higher belt speeds. Often, they result in both. If the system is not graded for these expectations, dust becomes the bellwether for a host of other issues, such as reduced workplace safety, increased spillage, more frequent equipment breakdowns, and excessive downtime.

Best practices for belt conveyor dust control

- Avoid belt sag: Support the belt the entire length of the chute wall (the skirtboard) so it does not sag away from skirting. The pressure from air turbulence is enough to push dust and fines out of these gaps, causing excessive dust and spillage.
- Wearliners increase the conveyor system's life: Modern chute design raises the height of the chute, providing more room for dust settling in the stilling zone and also room to place the external wearliner. Without it, the rubber skirting takes the force of abrasive bulk material, which lowers the equipment's life and requires premature replacement.
- Install belt skirting to seal the environment: Single skirting should be cut to the belt's trough angle for a tighter seal and mounted externally for easy and safe adjustment. Self-adjusting skirting has spring-driven latches that offer slight downward pressure for reduced maintenance. Dual skirting offers a single skirt with a rubber flap that provides a second layer of sealing and protection from spillage and emissions.
- Seal before adding dust collection devices: 'Passive dust control' uses engineered design solutions, such as

controlled loading, wearliners, skirting, curtains, and modular enclosures first. When there are length restrictions for chutes to allow an extended stilling/settling zone, dust bags and mechanical air cleaners are highly effective.

Figure 3. Mechanical air cleaners are low maintenance and improve the air quality around the system.

Figure 4. A cradle and idler system ensure a smooth and sealed belt path through the length of the chute.

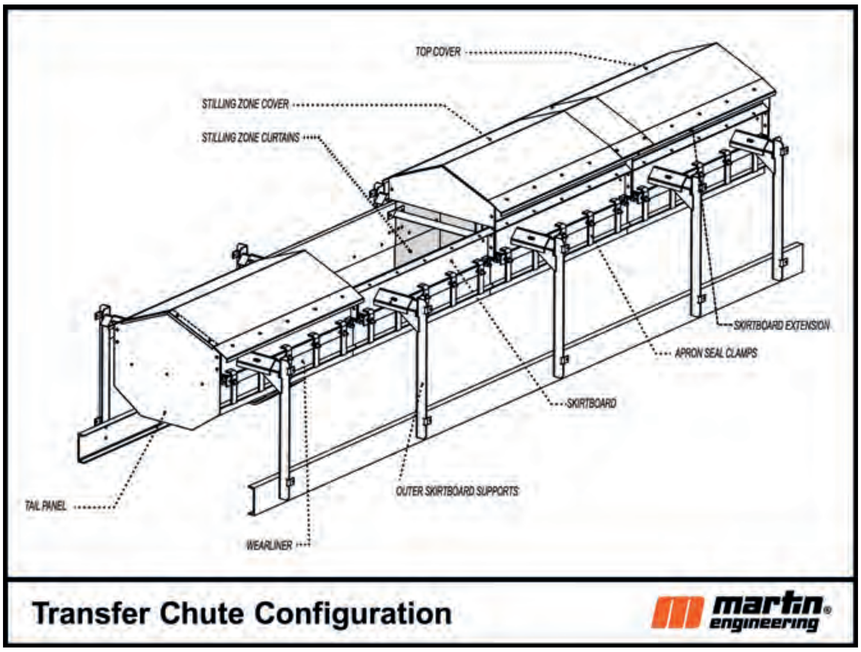

Figure 5. A well-designed transfer chute prevents fugitive material and ensures cargo is centred and settled.

They use the airflow to direct dust towards the mechanism and once the conveyor system stops, that collected dust is deposited back onto the belt. However, they can require more maintenance and monitoring, so sealing first will better control the cost of operation.

- Slow the exiting air velocity: A flow of air is still going to be prevalent exiting the system, but the key is slowing it to under 200 fpm (1 m/s), enough to reduce emissions. Adding a tail panel and curtains is essential to this, however, only adding them at the ends does not accomplish the proper stilling environment required. Strategic placement is the key to slowing exiting air velocity.

Case study: Coal mine in Jining City, Shandong Province, China

A coal mine in east China with production of approximately 1 million tpy was experiencing dust and spillage from one of its main conveyors. Excessive fugitive dust lowered the air quality, clogged equipment, and had the potential to affect workers' health. Belt misalignment caused by frozen idlers resulted in piles of spillage that required clean up, increased labour costs, and reduced system efficiency. Operators attempted to build a settling zone in-house, but it was found to be ineffective and dangerous to maintain.

The Martin Engineering team created a transfer point system that effectively settled the load and centred it on the belt in a sealed environment. Martin Engineering technicians installed a Martin® Impact Cradle, Martin Slider Cradle, and Martin ApronSeal™ Skirting, as well as a Martin Tracker™ to maintain proper belt alignment. Designed for heavy, high impact loads, the transfer point features low friction polyurethane bars and rubber skirts that retain a tight seal on the belt, reducing spillage and dust emissions.

The customer reports a drastic reduction in fugitive dust and spillage, resulting in fewer equipment breakdowns, better air quality, and increased production, with less product loss. Operators say that they are "very satisfied" with the products and service Martin provided and will continue a positive working relationship.

Conclusion

Improving workplace air quality seems like a daunting task, but eliminating it increases compliance and raises staff morale and safety. Of course, conveyor transfer points are not the only source of dust. However, as one of the most prevalent generators of particulate emissions in any bulk handling operation, it is an excellent place to start. By following best practices using modern and well-designed retrofitted components, operators can tackle dust by a process of elimination. Once large emission sources are addressed, it is easier to identify dust from other parts of the operation, with the ultimate goal of a clean and efficient operation with high worker morale and an exemplary record of safety. GMR