DRY BULK®

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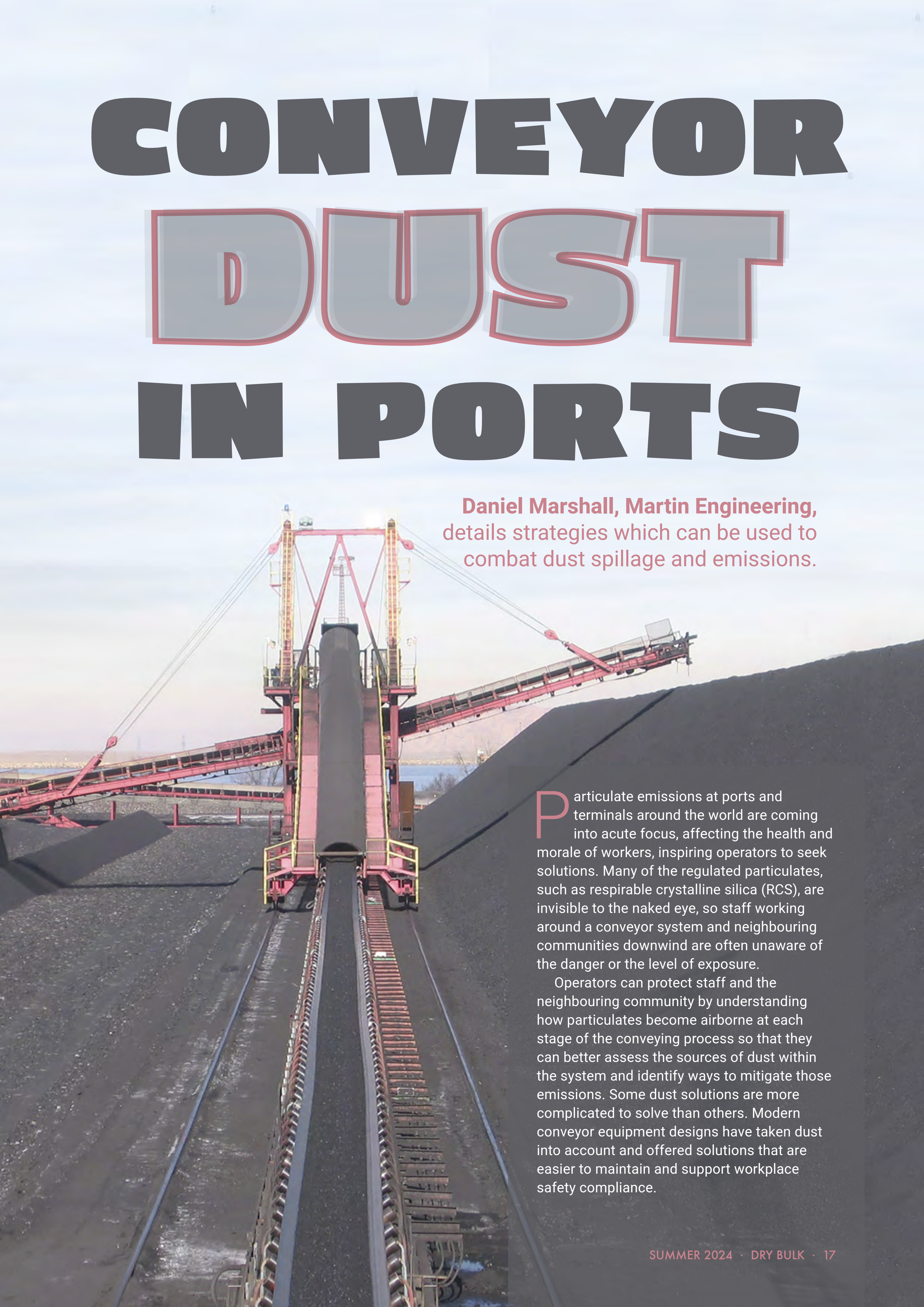
CONVEYOR DUST IN PORTS



Daniel Marshall, Martin Engineering, details strategies which can be used to combat dust spillage and emissions.

Particulate emissions at ports and terminals around the world are coming into acute focus, affecting the health and morale of workers, inspiring operators to seek solutions. Many of the regulated particulates, such as respirable crystalline silica (RCS), are invisible to the naked eye, so staff working around a conveyor system and neighbouring communities downwind are often unaware of the danger or the level of exposure.

Operators can protect staff and the neighbouring community by understanding how particulates become airborne at each stage of the conveying process so that they can better assess the sources of dust within the system and identify ways to mitigate those emissions. Some dust solutions are more complicated to solve than others. Modern conveyor equipment designs have taken dust into account and offered solutions that are easier to maintain and support workplace safety compliance.

Specs on dust specks

In the US, inspectors from the Occupational Safety and Health Administration (OSHA) and the Mining Safety and Health Administration (MSHA) equip trained workers with personal dust monitors that they wear throughout their shift. The small machines collect particulates from the air to measure RCS, heavy metals, and other regulated substances. The filters capture particulate matter (PM) smaller than 10 µm in size. In the case of RCS, the regulated measurement must be less than 50 µg in weight over an eight hour time-weighted average (TWA), i.e., a single shift.

For perspective, PM smaller than 200 µm, roughly the size of sand dust, is light enough to remain airborne on ambient air currents. 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' meaning it can surpass the body's natural defences and enter deep into the lung causing serious damage and health issues.

Figure 1. Port terminals of coal or petcoke with exposed stacker conveyors can be especially vulnerable to dust emissions.

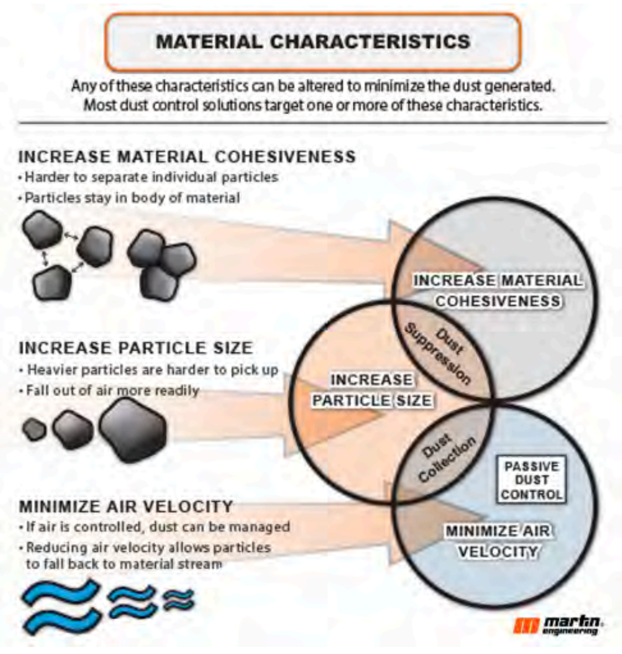


Figure 2. Dust suppression can be engineered control methods like enclosed transfer points. Dust collection includes dust bags or mechanical air cleaners.

Once measured, inspectors usually order violators to address the detrimental air quality. Personal protective equipment (PPE) such as respirators can be the answer in the short-term, but for the long-term, regulators recommend that operators address the problem using 'engineering controls'. These are equipment solutions that prevent emissions, reducing or eliminating the need for PPE. The reason for this is that PPE usage can be hard to monitor throughout a shift, PPE is often inadequately maintained, and the internal safety policy commonly lapses as time goes on since respirators can be challenging to wear day in and day out throughout entire shifts.

Relevant international standards include:

- Australia – AS2895-2004 Workplace Atmospheres – Method for Sampling and Gravimetric Determination of Respirable Dust and AS3640 – 1989 Workplace atmospheres – method for sampling and gravimetric determination of inhalable dust.
- Canada – Alberta's Occupational Health and Safety Code (2009) Part 36 (Mining) Section 601 (1)(2), 742 (1 – 5); Section 743 (1.1). Health, Safety and Reclamation Code for Mines in British Columbia (6.24.2); Province of Quebec's Regulation respecting occupational health and safety in mines (98).
- EU – DIN EN 620 Continuous handling equipment and systems – Safety and EMC requirements for fixed belt conveyors for bulk materials (5.5); EN 1127-1:1997; DIN EN 620 Annex A.
- South Africa – SANS 1929 (2011) Ambient air quality – Limits for common pollutant; National Environmental Management: Air Quality Act, 2004 National Dust Control Regulations (4.2)(6.2 a-f).
- US – OSHA 29 CFR 1910.22; CFR 29 1910.307 Hazardous (classified) locations; CFR 29 1910.1200 Hazard communication; CFR 29 1910.269 Electric power generation, transmission and Distribution; CFR 29 1910.272 Grain handling facilities. MSHA 30 CFR Section 56.5001 and 57.5001.

Conveyor dust emissions in ports

The volume of conveyor dust emissions is dependent on the conditions and the application. Operators and designers should first know the material characteristics and how they change as they pass through the processing and conveying system. This can be a challenge for smaller general purpose ports, since it is commonplace to handle many different types of materials, whereas terminals, for the most part, are designated for a specific type of material transfer and have the mechanisms in place to remain compliant.

Year-round weather conditions can create dust, especially during dry seasons, which pull humidity out of the air, thus increasing emissions. Prevailing winds or changes in wind patterns can also suddenly transform a dust-free operation into one with several violations.

Conveyor dust emissions are also derived from many sources including transition points, material impact, and cargo disruption:

- Dust at the transition happens when material falls to the belt, hitting the sides of the chute or rock boxes on the way down. As it falls, material not contained by a drop chute (such as onto a stockpile) separates, exposing the entire stream to ambient air currents which allow emissions.
- Dust on impact happens when material lands on the belt with no controls such as a rock box or curved drop chute. Depending on the height, weight, and density of the material, the impact on the belt causes air turbulence and shifting which leads to airborne emissions.
- Dust from disruption happens along the conveyor path, often between idlers where the belt slumps. This causes the cargo to shift and bounce slightly along the belt path, disrupting material, and creating dust emissions.

Loading the belt

Loading zone design has shifted over the past decade in response to the need for dust reduction and greater efficiency and is an excellent example of an engineering control strategy. Rather than feature transitions from conveyor to conveyor, or storage container to conveyor that are straight drops from height, chutes now direct and control material flow using spoon designs. These designs ensure that material is loaded in the centre of the belt with little impact. This reduces dust, spillage, mis-tracking, and belt damage commonly associated with conveyor transitions.

The impact of material on the belt can cause a splashing effect and produce air turbulence that seeks exit points from the chute through gaps between the skirt and the belt created by the slump between impact idlers. These rollers also tend to break under long-term pressure, causing them to seize. Accordingly, another innovation has been developed which replaces impact idlers with a bed of steel angles lined by energy-absorbing impact bars with a top layer of low friction, ultra-high molecular weight (UHMW) polymer or polyurethane. The bar design helps the skirtboard sealing systems consisting of a wear liner and skirting to retain a consistent seal at the loading point to reduce the amount of spillage and dust emissions.

Eliminating moving parts and the requisite lubrication of rolling components drastically reduces the amount of maintenance and improves safety by promoting a tight seal between the skirting and the bar. Some manufacturers have even developed designs that mount the cradles on rails, allowing slide-out removal to reduce maintenance time and improve safety.

Dust during transport

After the cargo has been loaded, the stilling and settling zones of the transfer enclosure should be properly designed to have a sealed environment that controls airflow with negligible dust emissions. This design should include closely set idlers or idlers that transition between cradles. Another important element is continuous external skirting in single strips that run the length of the enclosure on either side. Inside the enclosure, strategically placed dust curtains should slow airflow enough for particulates to settle back into the cargo stream. Dust bags and compact mechanical air cleaners, when installed on the enclosure, will also capture dust and ensure a dust-free exit from the enclosure.

Once the material has left the enclosure, wind can be an issue so many operators cover exposed conveyors. However, this does not control dust emissions from material shifting, disruption over idlers, or mis-tracking. These actions can cause spillage and allows dust to fall along the length of the conveyor. Installing tracking devices along the belt path helps reduce spillage from mis-tracking even if cargo shifts.

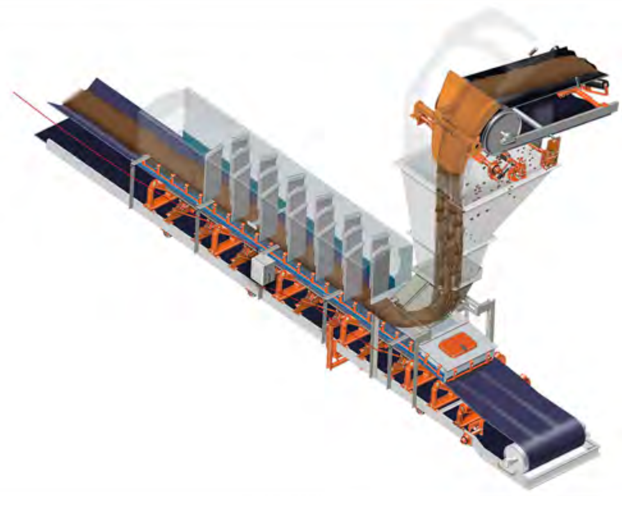


Figure 3. Enclosed conveyor transfer point – controlled material flow with dust curtains helps to dramatically minimise dust emissions in the loading zone.

Figure 4. Belt tracking keeps loads centred and minimises dust from spillage and disruption.

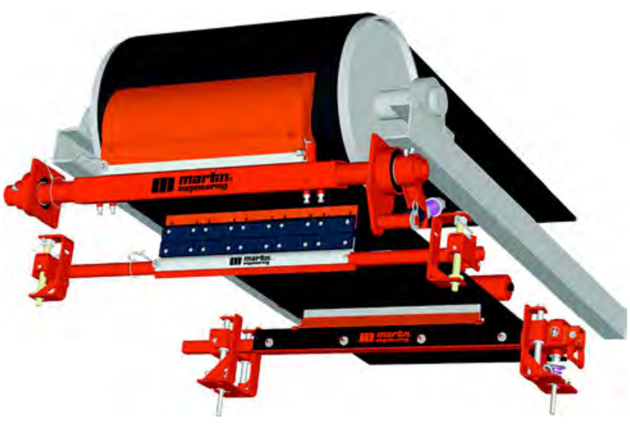


Figure 5. Primary, secondary, and tertiary bladed systems ensure dust from carryback is mitigated.

Dust at the discharge zone

More often than not, the conveyor discharges down an open shaft with a dead drop into the transfer chute leading to another conveyor, into a hopper or silo, or directly onto a storage pile. When the material leaves the belt, it separates, exposing the entire materials stream which allows smaller particulates to become airborne. Stacker conveyors and tripper conveyors are especially prone to this and often utilise a misting ring or a specially designed sock to control the stream.

However, material often hits the back of the transfer chute or impacts on rock boxes which can result in dust blowing back up the chute. Enclosing the discharge zone and controlling the impact of material using a spoon design helps mitigate blowback. Also, adding air cannons helps direct cargo and airflow, as well as prevent unscheduled downtime from build-up and blockages within the chute.

Dust on the return

Conveyor belts across all bulk handling sectors take a tremendous amount of punishment and the single most expensive piece of equipment on the conveyor system is the belting. No matter how careful the upkeep, the belt will eventually start to show divots and cracks. The weight of the cargo can cause dry material to stick to the surface and dust and fines collect in the flaws. If not properly cleaned, the adhered material will not be discharged with the cargo flow and remain on the belt as carryback, spilling fines and emitting dust along the return path of the system.

Primary cleaners remove the most abrasive and hardest material left on the belt after discharge. Mounted at the head pulley on a tensioned assembly and the engineered polyurethane construction, many blades are in a curved configuration that allows the blade tip to fit snuggly against the belt and wear evenly throughout the blade's life with only minor adjustments to the tensioner. One primary cleaner design requires no tensioning at all after initial installation. It features a matrix of tungsten carbide scrapers installed diagonally to form a three dimensional curve around the head pulley and typically delivers up to four times the service life of urethane cleaners without ever needing re-tensioning.

Secondary and tertiary cleaners are located immediately after the belt leaves the head pulley to address dust and fines that escape the primary cleaner. Generally equipped with spring or air tensioners that easily adjust to fluctuations in the belt, secondary and tertiary cleaners dislodge dusty carryback, adding it back into the cargo flow.

Case study – Transnet Port Terminal, Richards Bay, South Africa

Transnet Port Terminal at Richards Bay, one of South Africa's largest ports, was experiencing excessive spillage at eight of its conveyor discharge zones. While transporting raw materials such as magnetite, chrome, coal, chloride, and zircon on 1350 mm and 1500 mm

Figure 6. Spillage at the Transnet Port Terminal was pervasive, requiring regular clean-up which raised the cost of operation.

Figure 7. The low-profile CleanScrape primary cleaner takes up less space than standard cleaners.

(54 – 60 in.) belts, fines were adhering to the belt and carryback spilled along the belt path. This caused excessive dust emissions and allowed material to pile underneath the system and spill out into walkways. In addition to product loss, workers would have to be pulled from other duties to clean up under and around the system. Several different brands of primary and secondary cleaners were installed in an attempt to mitigate the problem, but they were unsuccessful. To reduce the cost of operation, remain compliant with workplace air quality standards, and improve safety, managers sought a solution.

Invited to inspect the system and resolve the dust and spillage issue, technicians from Martin Engineering South Africa performed a detailed Walk the Belt™ inspection to determine the best course of action. Due to the varying nature of the material, technicians replaced the existing cleaner with a CleanScrape primary cleaner.

Installed diagonally across the discharge pulley to form a three-dimensional curve, the design uses a matrix of tungsten carbide scrapers to dislodge material. The cleaner was tensioned once upon installation, requiring no further adjustment. With four times the equipment life of other cleaners, the CleanScrape reduced carryback and delivered improved performance, reducing the cost of operation.

Operators have reported that spillage along the length of the belt has been drastically reduced and no longer piles up around the conveyor structure, resulting in considerably less dust. The material discharge efficiency has improved production and reduced maintenance requirements, giving operators more control over labour costs, while reducing the need to perform potentially hazardous cleaning near the moving conveyor.

Not a forgone conclusion

The prevailing impression that bulk handling is inherently dusty is an old idea that regulators are trying to reverse. By identifying causes of dust emissions and retrofitting modern equipment, operators find that they can control emissions at the source and increase efficiency. Designers and engineers of high-quality conveyor accessories are constantly striving to innovate, adding ways for operators to reduce employee interactions with equipment, significantly lower dust emissions, improve workplace safety, and remain compliant. DB

About the author

Daniel Marshall received his Bachelor of Science degree in Mechanical Engineering from Northern Arizona University, US.

With nearly 20 years at Martin Engineering, Dan has been instrumental in the development and promotion of multiple belt conveyor products. He is widely known for his work in dust suppression and considered an expert in this area.