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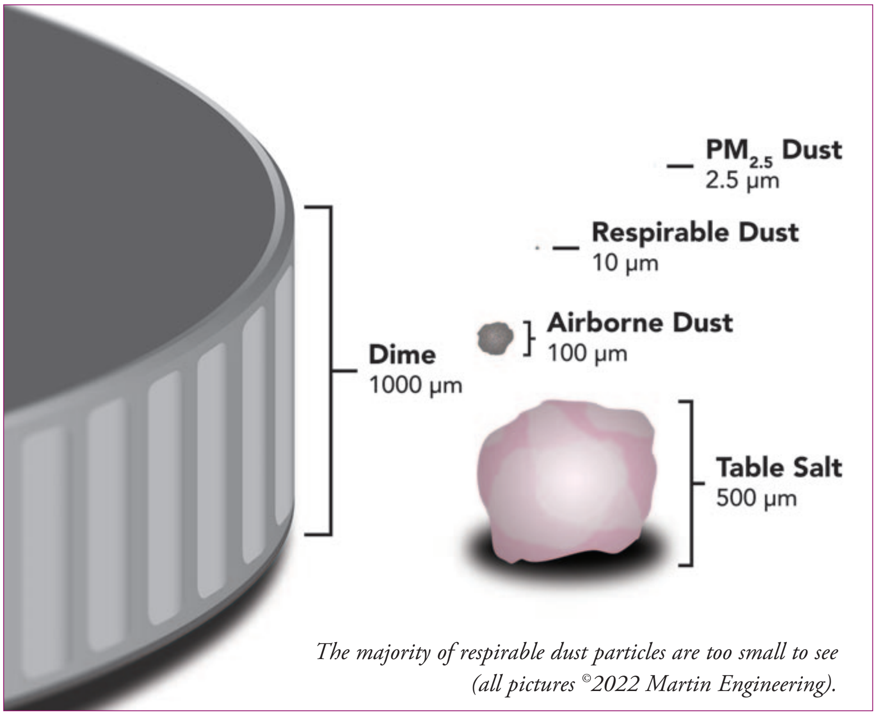
Dust management for conveyors in coal operations

Fugitive dust on conveying systems is an ongoing issue faced by mines, transfer stations and utilities transporting, processing or burning coal, *writes Mark Strebel, Division Manager, Martin Engineering*. Effective dust control has become an increasingly important challenge, with raised awareness and tighter regulatory standards motivating operations to employ efficient, cost-effective methods of particle management.

Depending on the source and ambient conditions, airborne dust can contribute to a number of concerns, including potential health or safety hazards, environmental issues, regulatory challenges, explosion risks, higher equipment maintenance costs and poor community relations. Dust inhaled by workers or members of the surrounding community can also irritate bronchial airways and exacerbate existing lung conditions.

Operationally, significant amounts of dust can lead to more frequent maintenance and faster equipment wear, raising costs. Complaints about fugitive dust from local residents and businesses can affect community relationships and endanger future operating permits. Further, cleaning can place staff in the vicinity of moving conveyors and other process equipment, resulting in a higher risk of injury.

Because of the varying types and diversity of dust control methods, coal handlers should consider evaluating causes, problem areas, dust generating processes and potential cargo management techniques to arrive at the optimum approach for their operation.



The majority of respirable dust particles are too small to see (all pictures ©2022 Martin Engineering).

What is 'dust'?

Categorized as either respirable or inhalable according to particle size, dry, solid dust particles range from about 1 to 100 microns (µm) in diameter. According to the EPA, inhalable dust particles (about 10µm) are typically caught by the nose, throat or upper respiratory tract. In contrast, respirable dust particles (under 10µm) can penetrate beyond the body's natural cleaning mechanisms (cilia and mucous membranes) deep into the lungs and can be retained.

Sources of dust in bulk handling

Virtually any activity that disturbs bulk material is likely to generate dust. Composed primarily of smaller, lighter particles, coal dust can create huge volumes of airborne material if left uncontrolled. Bulk conveying operations and trucks or railcars dumping loads of raw material often struggle to manage this fugitive material, as well as any activity involving heavy loading equipment.

Because they move large amounts of material at high speeds, conveyors can be a complex source of fugitive material. Transfer points composed of drop chutes, impact points and conveyor enclosures are notorious dust sources unless properly designed, installed and sealed. In fact, with today's larger, faster conveyor systems, virtually the entire belt path can be a contributor to the release of dust.

Loading / unloading points can present significant dust control challenges.

Containment, prevention or suppression?

Due to the significant number of complicated variables, which are constantly altered by changes in environment and materials, coal handlers implement a variety of process designs and plant layouts. Dust conditions and the methods of control are affected by production techniques and technologies, system options and equipment choices, and differences in conveyor design and construction.

Dust management efforts are generally based on one or more approaches, with many operations using a combination of methods to achieve maximum effectiveness:

- Contain the material and reduce, eliminate or control the air to let the

Containment can be improved by enclosing the settling zone to slow the air velocity and return dust to the cargo flow.

dust settle out

- Prevent the particles from becoming airborne by increasing their mass
- Collect, clean or suppress the airborne dust from the air

Material containment

Containment is the foundation of most good dust prevention processes and should be the first option considered. Keeping particles within the flow of the material prevents spillage and airborne dust from being released and requiring cleanup.

By controlling the drop height of the material, a less turbulent transition is created. Ideally optimized in the design stage of the conveyor system, structural drop height modifications on existing systems include additions such as hoods, spoons, deflector plates and rock boxes. These reduce the distance of the fall and the impact on the receiving belt.

Impact beds improve control over the material by flattening the impact zone of the conveyor and absorbing some of the drop force. Slider beds flatten the belt through the settling zone, allowing raised chute walls with external wear liners located on the outside of the chute for installing and servicing without confined space entry. Wear liners close to the belt will ensure that the load remains on the conveyor.

Skirt seals (also known as apron seals) can be installed along the belt edge in order to confine air and small particles to the transfer point enclosure. For extremely abrasive materials or high belt speeds, engineers have developed new skirt seal designs that extend performance and durability using standard two-inch (50mm) or massive three-inch (75mm) thick construction. Innovative swing arms enable its use on reversing belts as it rides gently on the belt, self-adjusting to maintain effective sealing, even as the belt path fluctuates and the sealing strip wears.

Dust bags filter outgoing air to minimize fugitive material, while reducing positive air pressure.

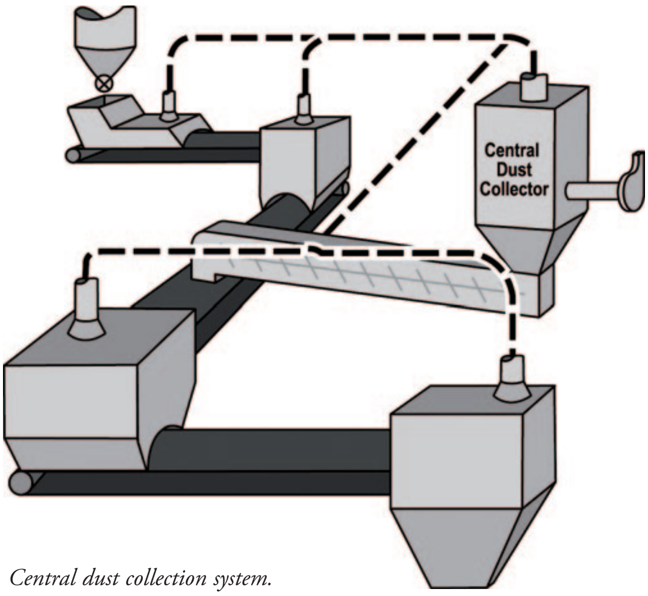
Prevention: controlling air flow

Minimizing the height difference and providing material containment also assist in controlling the air flow within the transfer point. The flow of air entering and exiting the transfer point can be mitigated by avoiding drastic changes in material speed or trajectory.

Engineered flow chutes accomplish this by loading material in the same direction and speed as the receiving belt and confining the material stream, minimizing the disturbance in the material flow. The hood, located at the discharge of the loading conveyor, reduces the expansion of the material stream and deflects it downward. The spoon, located at the entry of the receiving conveyor, provides a curved loading chute that delivers a smooth transfer in order to allow the material to slide down to the receiving conveyor or vessel. Depending on design requirements, engineered flow chutes can prove to be cost-prohibitive, as changes in the material, moisture content or the quantity conveyed can all affect their efficiency. Properly installed kicker plates are an alternate means of reducing the force and redirecting the flow of material in some applications.

Good containment design with effective air flow control features an adequate dust settling zone of sufficient dimensions, with a belt that has been flattened and sealed to prevent material and air from escaping. Allowing the air to slow and the dust to settle requires an enclosure large enough for the air to expand and lose velocity. The height and width of the settling zone should offer the area necessary to decrease the air velocity to less than 200ft/sec in order to minimize any dust pickup, with a chute long enough to allow time for the settling process to take effect. To improve the effectiveness of the containment, one or more dust curtains can be installed near the chute exit, with narrower curtains added intermittently within the stilling zone to create a circuitous path for the air to follow.

Dust bags provide a method of relieving positive air pressure within the system,



Central dust collection system.

while also filtering the dust and minimizing its escape. Often attached with a simple circular clamp to the rim of a port in the enclosure, the dust is captured inside, creating a filter cake. They are generally designed to collapse when the conveyor isn't running, allowing filtered material to drop back onto the belt.

When necessary, air-cleaning systems (active control), like the central dust collector can also be used to filter the air and trap airborne particles. Installed in a central location and connected to the individual collection points by means of sealed ductwork, this type of filtration system would handle the dust extracted from the entire conveying system, collecting it for disposal or feeding it back into the process.

Central collectors utilize a blower to produce negative pressure, drawing air through the filter media. The blower is sized to manage the required airflow, while overcoming losses due to pressure drop across the system, including pressure losses in the ducts between the collector and the pickup points.

Although widely used in the past, central dust collection systems have several undesirable attributes, including:

- build-up of material in the ducts causing operational and safety issues;
- potential explosion hazards from accumulated combustible material;
- large capital investments & high power usage;
- challenging maintenance issues, such as system-wide airflow balancing;
- manual maintenance may be required if material is not returned to the cargo flow; and
- the need to periodically empty the containment vessel of collected dust.

A better alternative is the integrated air cleaner. Containing only the blower and required filter media, these units are designed to collect dust at the source by employing a series of smaller, independently operating units that pull air from the settling zone with a blower sized to remove the excess air from the enclosure. Unlike central systems, particles are not stored for disposal. Instead they are trapped in the filter media, agglomerated into a filter cake, then discharged back into the material stream using a pulse cleaning system, which sends a short burst of air sent back through the filter to dislodge accumulated material. No ducting means less of a pressure drop, reducing overall power requirements and operating costs.

Chemical additives

Some technologies such as spray bars aimed at large-scale saturation using plain water may not be sufficient to effectively control the dust. To further enhance particle control, chemical formulations have been engineered to improve results.

Many dust control products offer some combination of wetting agents, binding agents and/or crusting agents to improve performance. Additives enhance the ability of the water droplet to combine with material particles, thus increasing the mass of the particles. Dust control additives also promote particle cohesion to improve the longevity of those bonds.

Modular elements configured to best suit the specific operating conditions and requirements of the individual process are important to manage the cost of operation. Water and dust control products should both be applied with variable flow in order to maintain chemical to water ratios, while delivering independent control at multiple application points. To protect operations from liquid spills or equipment damage due to system faults, the dust control products should also contain fail-safe mechanisms.

Integrated air cleaners are small, independently operating units at each dust generation point.

The most common and least expensive dust prevention technique is moisture addition.

Conclusions

Every coal conveying system has its own individual characteristics. Users should examine the features, construction and trouble points of individual systems, without making general assumptions that could lead to unsatisfactory results.

Dust management should be an integral part of the material handling system, optimized to prevent dust by:

- ❖ applying containment in the right places;
- ❖ applying controlled amounts of moisture to improve agglomeration; and
- ❖ utilizing air cleaners when moisture is not an option or excess air is present.

Major changes in moisture or alterations in the process or equipment (increasing belt speed or cargo volume) can have dramatic consequences on the dust management of a coal handling system. Even minor changes in environment such as a change in the atmospheric humidity can impact the performance of a material handling system.

However, if an existing material handling system successfully manages dust and spillage upon installation, it should continue to work as long as the conditions stay relatively consistent and the equipment does not suffer wear or abuse that alters its performance.

Some suppliers will engineer customizable dust control systems using application-specific components.