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FUGITIVE MATERIAL:

A preventable enemy of bulk conveying

Todd Swinderman, Emeritus/Martin Engineering, USA, examines how fugitive material can be managed in order to improve safety in the workplace and dramatically reduce the cost of operation.

Most conveyors have some amount of material loss from spillage, leakage, dust and carryback emissions, collectively called fugitive materials. The loss can range from 3% of the cargo for poorly operated and maintained systems to less than 0.1% for world-class operations. The lost material manifests itself as degraded component life, resulting in workers being exposed to hazards and reduced product quality. While fugitive materials cannot be totally eliminated from bulk material handling conveyors, the problem can be managed.

The root causes are often obvious, but rarely addressed. Rather, the standard approach is to treat the symptoms. The symptoms of a failure to control fugitive materials include:

- Unplanned downtime.
- Excessive cleaning costs.
- Regulatory actions.
- Poor public relations.
- Safety incidents.

Addressing these symptoms with workable long-term root cause solutions will improve availability, housekeeping, safety, and company cash flow.

Types of fugitive material

The nature of fugitive material problems from any conveyor is indicated by the location and particle sizes of the accumulations. Fugitive materials are generally categorised into: spillage, leakage, dust, and carryback.

Spillage

Spillage is cargo that escapes the belt, accumulating on either side of the conveyor and characterised by a range of particle sizes similar to the cargo. Piles of spillage can accumulate quite rapidly and can occur intermittently from plugged chutes, overloaded belts and mistracking, or continuously from poorly designed or inadequately maintained transfer points. Inclined loading zones can also have material roll backward, causing spillage out the back of the transfer point.

Leakage

Leakage of bulk material can happen from worn skirtboard wear liners and seals or gaps in chutes and hoppers. Leakage tends to slowly accumulate in piles of small, mostly uniform particles created by the dimensions of the leak. Leakage frequently falls from overhead and collects on top of transfer points and equipment below, so its source may not be obvious.

Dust

Dust is the fine particles, usually less than the diameter of a human hair, that are created during processing and the degrading action as the bulk material moves through a conveyor system. Fine airborne dust is emitted at locations where the cargo becomes airborne and is emitted from open inspection doors, missing covers, worn skirtboard seals, and the exit of transfers. Because dust particles are very small, when dry they are easily dispersed by wind and blanket wide areas, but the sources are often visually obvious. In processing involving hot materials, the fumes given off often saturate dust particles and cause them to build up inside chutes and on equipment.

Carryback

Carryback is fine material that sticks to the belt surface or becomes lodged in the cracks and crevices of the carrying side of the belt. Carryback material collects on components that the carrying side of the belt touches and eventually dries out, dropping beneath the system along the return path. Carryback accumulations tend to range from pyramid shaped piles of dry dust particles to puddles of muck. In severe cases, large chips of material form thick layers of buildup on return rollers and are thrown off of return rollers as they dry and break up.

Issues created by design

Bulk material handling projects are often capital projects because of the significant cost and the expected life of the equipment. Control of fugitive material requires attention to detail in the design stage that is often not considered.

Figure 1. Spillage from transfer point causing slip, trip, and fall hazard.

Figure 2. Crusher dust containing silica.

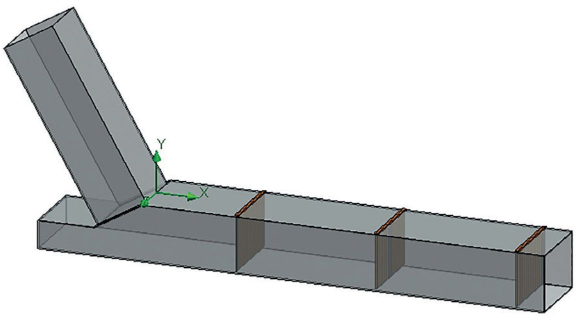

Figure 3. Transfer point designed for fugitive material control, with three dust curtains maintained close to the cargo.

This is as a result of the additional design time (capital cost) required and the perception that fugitive material control costs are hard to quantify, and therefore hard to justify design improvements.

In new projects, careful thought must be given to capacity calculations, the angle of incline, transfer point design, and access for cleaning and maintenance. To improve fugitive material control, it is advisable to derate the capacity to 80 – 90% of the theoretical capacity and use slower belt speeds. A common spillage problem is created during rainy periods when the angle of incline is appropriate for dry cargo, but not for wet material. Loading at less than a 5˚ angle and reducing the angle of incline will reduce flooding and material rollback at the tail.

Designing a skirtboard enclosure that is longer and taller, with the proper number and placement of dust curtains, will help control dust emissions. Designing access for cleaning and maintenance can shorten downtime for these activities by 33%, and can significantly reduce exposure to hazards that can result in safety incidents. If future capacity increases are likely, they should be planned for in the initial design. In most cases, adding 10% to the design time of a project will allow for these details to be designed into the project, with little impact on the overall equipment cost, but a huge return on the investment over time.

Quite often existing conveyor systems are 'upgraded' to increase capacity or handle alternate bulk materials. An upgrade is often actually a downgrade, because control of increased fugitive emissions was not considered in the upgrade plans and short cuts taken in the original design have left minimal space for changes. A common 'upgrade' is to increase the speed of the belt. Fugitive material problems are roughly proportional to the speed of the conveyor (or tonnage), so if the belt speed is doubled, the fugitive material problem and costs may also double. In addition, an upgrade often results in less capacity, rather than more, because of changed material trajectories resulting in chute plugging and increased wear, both requiring increased downtime or reduced throughput to keep running.

Issues created by fugitive material

Because of the large number of variables in handling bulk materials – both in the bulk materials themselves and in the condition of the conveyors – it is physically, financially, and statistically impossible to reduce fugitive emissions to zero over a long period of time. Accumulations of fugitive materials are often an indication of an underlying culture of 'production first'. In this environment, frequent cleaning is an accepted necessity to keep production running.

Many safety incidents occur during cleaning and many fatalities have occurred trying to clean with the conveyor operating: piles of spillage on waking surfaces present slip, trip, and fall hazards; accumulations of carryback and buildup that falls when cleaning a chute, or spillage of cargo from overhead conveyors, can increase the risk of blunt trauma or crushing hazards; safety incidents range from minor first aid to lost-time cases; a common lost-time event is a muscular skeletal injury manifested as a back or shoulder injury. These sprains and strains are often hard to diagnose and on average result in a multi-week recovery. Control of fugitive materials to the point where cleaning is seen as a periodic housekeeping task rather than a daily production-enabling strategy should be the goal.

The need to clean to keep running is one obvious cause of unplanned downtime. Another less obvious productivity thief is the large role fugitive materials play in reducing equipment life, which leads to more frequent outages for maintenance than necessary. Idler bearings are particularly susceptible to contamination from dust. Material escaping under the wear liners and skirtboard seals leads to shorter belt life, due to belt grooving under the seals. The belt (because of its total mass) and idlers (because of their numbers) are expensive and time consuming to replace.

There are additional hidden costs that are often overlooked when justifying improvements to control fugitive materials. Working in a dusty atmosphere reduces worker productivity, in some studies as much as 20%, if respirators must be worn. The leading cause of death in industry is from disease, not accident. Respiratory illness from exposure to even nuisance dust often leads to workers being put on long-term disability, increasing worker compensation costs. A dirty operation also attracts the attention of regulators and neighbours. A reputation as a dirty place to work reduces the pool of employees who are willing to work in such an environment, and those already employed often suffer from low morale.

Fugitive materials are often a root cause of catastrophic events. Many dusts present fire and explosion risks, in addition to health and safety concerns. The destructive power of dust explosions is well documented in industries such as coal mining, grain processing, and sugar production. Static discharge into a dusty atmosphere is a common cause of many of these fires and explosions. What is often harder to detect is the chain of events that led up to a conveyor belt fire. In many cases, a frozen idler bearing is the heat source that ignites the grease, in turn causing the belt to catch fire. In other cases, mistracking belts caused by spillage or carryback built up on pulleys creates friction between the belt and structure that can actually cut steel beams in two, or create enough heat to become an ignition source. Friction is another common root cause of major incidents.

Detecting and measuring fugitive materials

Indirectly, safety switches and conveyor parameter sensors create data outputs from problems created by fugitive materials, and thus can provide some measurement or indication of problems to come. In many operations, acceptable fugitive material control performance means keeping the emissions to a level that allows cleaning or maintenance during scheduled routine production outages or maintenance time. Through good design techniques, well trained operators and predictive maintenance practices, most conveyor systems can go weeks without a need to shut down just for cleaning, without causing a safety problem or significant production loss.

The application of indicators – such as belt wander switches, zero speed switches, and plugged chute detectors – has been practiced for as long as there have been conveyors. These devices are often purposely defeated due to false trips or other signals that interrupt production. The bulk material handling industry is starting to adapt sensor technology to the rigors of bulk material handling to better monitor conveyor performance and provide proactive warnings of problems that are developing. For example, wireless technology can gather data from numerous sensors without the need for hard wiring, and fibre optics are being used to detect heat rise in idler bearings. Many conveyor components that were simply considered 'dumb' brute force devices, such as belt cleaners, are now being remotely monitored and controlled to improve cleaning effectiveness and provide indications of malfunction.

Figure 4. Buildup causes belt mistracking, which leads to belt and structural damage and a potential safety incident.

Figure 5. Damaged idler roll shell because bearings failed from fugitive materials penetrating the bearing seal.

Figure 6. Coal carryback accumulation causes bearing failure, which can lead to a belt fire.

In new designs, case study data can be used to estimate the potential size of the fugitive material problem and costs associated with not addressing the issues. With existing operations, the information needed to justify improvements may at first seem difficult to quantify. In reality, as few as five independent observations of the problem can provide facts that represent the problem with a reliability of over 90%.[1] While some company data or information may not be kept or readily available, there are many resources completing the picture of the costs of fugitive materials and the benefits to be derived from implementing controls.[2]

Measuring the amount of fugitive materials can be as easy as laying a tarp under the transfer point or conveyor return run and weighing the accumulations over a period of days. The same observation and measurement techniques can be used to judge the success or failure of mitigation efforts. There are even ways to empirically judge the extent of the problems and determine whether or not the changes are having the desired effects.[3]

Conclusion

Because the problem of fugitive material has been around since conveyors first came into use, in the minds of many operators, fugitive material is merely a sign that the plant is producing – i.e. 'We're making money, so there's dust and spillage.' However, fugitive material leads to major issues that can and should be addressed.

Managing fugitive material is a more economically and operationally sound choice than merely chalking it up as 'the cost of doing business'. The effect that spillage, dust, and carryback have on an operation is a tangible reminder of unnecessary inefficiency. By working with experts, installing modern solutions to age-old conveyor problems and practicing state of the art maintenance, operators can significantly improve safety in the workplace and dramatically reduce the cost of operation.

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