Total discharge: clean belt, clear chute

Dan Marshall, Martin Engineering, offers recommendations on the best practices that can help operators avoid common inefficiencies at their discharge zone.

Suggesting the 'total discharge' of cargo from a conveyor belt in any bulk handling application is enough to make operators and maintenance staff chuckle. In the dirty and punishing atmosphere of cement production, there are no absolutes. Spillage, carryback, chute clogging, and fugitive dust emissions obstruct walkways, foul rolling components, cause unscheduled downtime, and degrade air quality, but they do not have to. Manufacturers of innovative equipment solutions are always striving to improve workplace safety and production efficiency by eliminating as many of the causes of downtime as possible.

Following the installation of modern belt cleaning technology, cement plant operators realise that the volume of material entering the transfer chute grows

exponentially, rather than piling around the discharge zone. This greater volume leads to blockages in the transfer chute followed by downtime to unclog it. However, designers can take a holistic approach and engineer an efficient discharge transfer point with components that work together. This approach strives to make equipment last between scheduled closures, improves safety by

Figure 1. Discharge from the belt no longer needs to be a dirty and dusty process.

Figure 2. Sand spillage reaching up to the discharge point on a stacker conveyor.

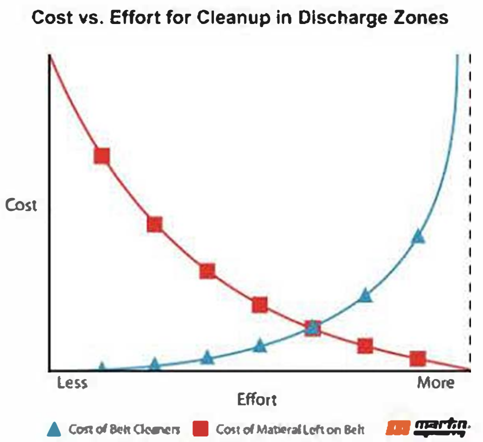

Figure 3. The cost of cleanup and improved safety justify the expense of a well-designed discharge solution.

minimising maintenance, and addresses the causes of inefficiency.

Signs of inefficiency at a discharge zone

The discharge zone starts at the last troughed idler before the conveyor belt flattens and encounters the head pulley. Cargo falls from the conveyor into a transfer 'drop' chute that can lead to several places including another conveyor, a storage silo/pile, a transport vehicle, etc. The primary cleaner is located after the discharge stream to clear any adhered material caused by the weight or characteristics of the cargo (moisture, cohesion, heat, etc.). A secondary cleaner clears dust and fines from divots and cracks in the belt. Material cleared from the secondary cleaner is generally directed to a sloped surface connected to the transfer chute.

Obvious signs of discharge inefficiency are spillage, carryback, chute clogging, and dust. Alone, each can lead to a workplace safety violation, together they result in unscheduled downtime and increased operating costs. From an operational standpoint, three of the most expensive consequences are workplace injuries, belt damage from friction, and fouled equipment replacement.

Spillage and safety

Primary cleaners or 'scrapers' can fail in several ways, causing adhered coarse aggregate and caked fines to pass by the blade and spill around the discharge area. This fugitive material can build up quickly and encapsulate the belt, fouling rolling components and causing the belt to ride on top of the coarse pile, leading to serious belt damage and increased belt temperatures from friction.

Fugitive material spills into walkways, obstructs access for maintenance, and creates trip and fall hazards. When coarse grit fouls rollers it causes them to freeze, leading to friction and high-heat damage to the vulnerable return side of the belt, lowering the equipment's life. To avoid belt fires and dust explosions, seized idlers/rollers should be maintained and changed right away, which makes clear access to the system imperative.

Cleaning spillages can be costly, divert staff from other essential duties, and become a workplace safety issue if workers are clearing material around a running belt (Figure 3). What may seem like a routine job in the beginning, clearing spillage by either shovelling it back into the cargo stream or into bins, requires more labour as time goes on and the problem worsens. Clearing material using machinery (front loaders, industrial vacuums, etc.) can result in accidental contact with the stringer or supports, potentially leading to belt mistracking.

Mistracking can be a major cause of spillage, not just along the belt path, but at the discharge point as well. The blade is centred on the head pulley, but if the belt is not, adhered material becomes spillage.

Recommendation

Install a belt tracker a distance of 3 – 4 times the width of the belt prior to the head pulley as the trough angle flattens to ensure the belt hits the head pulley in the centre.

Figure 4. Innovative new cleaner designs require less monitoring and no tensioning.

Figure 5. The V-plow diverts fugitive carryback to either side of the system, ensuring tail pulley health.

Figure 6. The direction of the cannon shot matches the stream trajectory to encourage constant flow.

Over-/under-tensioning and/or extending blade changes for too long can also cause spillage. Over-tensioning causes rapid wear on the belt/splice and lower blade life. Under-tensioning allows material to pass without being removed. Allowing primary cleaners to wear excessively can result in pull-through, where the force of the belt causes the blade to face the opposite direction and, in some cases, break off.

Recommendation

Enter a service agreement with the blade manufacturer to regularly monitor, tension, and change the blades as needed. Consider installing a modern assembly that allows workers to slide units from the stringer for fast and easy one-person blade changes. There is also the option of using an innovative cleaner technology with 4 times the lifespan of the normal primary blade and needs no tensioning over the course the blade's use (Figure 4).

Reducing carryback

Anything that clings onto the return side of the belt and travels with it is considered carryback, which seriously damages a system. Not only is it a major source of fugitive dust and fines, but it can migrate easily into return rollers and takeup pulleys, fouling the bearings, mechanical drives, and the face of the roller. The grit grinds down roller bearings and can lead to excessive friction heat, causing them to become misshapen and seize up.

Like spillage, carryback can migrate to the non-carrying underside of the belt. These chunks travel all the way to the tail pulley. The intense pressure between the pulley and the belt causes the hard, sharp mass to damage the vulnerable side of the belt and the pulley face, cycling over and over, delivering more damage as it does so. Along with shortening the life of the belt, dust and fines fill these blemishes and foul the pulley face.

When a roller or pulley face becomes fouled, it is caked with abrasive grit that degrades and damages the belting over time. In some cases, fouling causes slippage which can disrupt the smooth operation of the belt and promote mistracking.

Recommendation

If there is adequate space, install secondary and tertiary cleaners to ensure that the belt is totally clean on the return. To improve safety, consider units that allow a single worker to pull them away from the stringer for faster external servicing. Consider a diagonal or V-shaped plow placed underneath the loading zone right before the tail pulley that rides on the underside of the belt removing any loose travelling material (Figure 5). For more effective cleaning and reduced friction damage, consider a plow with torsion arms rather than one held in place by chains. Install belt trackers or crown rollers along the upper and lower belt paths to ensure alignment.

Safely addressing bulk handling clogs

A clogged transfer chute or hopper is one of the most dangerous situations in bulk handling. Untrained and uncertified (enclosed chute entry certification) personnel should never enter a clogged chute or bin under any circumstances. A sudden discharge can be deadly as unknown voids engulf and crush a worker. Material adhered vertically to the sides can loosen and send a sheet of debris falling on anyone occupying the vessel.

Buildup points in chutes include:

- Rockboxes – Shelves, even if they are sloped, can experience buildup.
- Exit gates or doors – As these help to control flow, they are also prone to clogging.
- Sloped points – Under the secondary cleaner, chute grades, or located at choke points.
- Metal surface grain – The metal grain of chute plating should match the flow of cargo.
- Exposed surfaces – Surfaces where moisture can collect and cause buildup.
- Damaged surfaces – Surfaces that have scratching, denting, creasing, or divots.

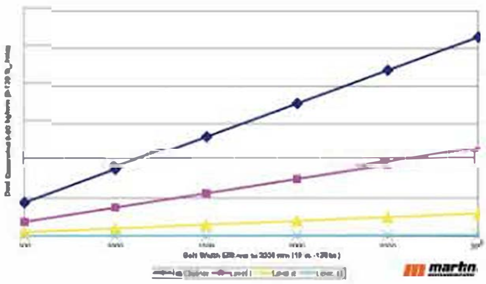

Figure 7. Potential dust generated at discharge zone.

Figure 8. The roller is encapsulated by spillage at the discharge zone.

Figure 9. Cleaning the belt of dust and fines with a few telltale streaks on the belt denoting carryback.

Misguided practices for addressing buildup include banging on the sides of the hopper with a mallet or to loosen the obstruction by poking at it from below. In some operations, clogs are so frequent that spots for pounding are marked and mallets are left in the area for convenience. This is hazardous because it reduces the structural integrity of the vessel or chute, causing it to buckle. Ripple damage from pounding can create a situation where it is easier for material to build up, shortening periods between clogs and leading to more unscheduled downtime. Poking from below is even more dangerous, since a sudden discharge sends tons of material in a surge that will injure anyone in the vicinity and break the equipment below.

Recommendation

Air cannons strategically installed around the chute have nozzles pointed in the direction of the material flow. Powerful shots of air are distributed across the surface inside the vessel, dislodging material and preventing buildup. The air cannons are supported by vibration units that ensure gates and narrow spouts on hoppers and chutes retain proper flow before bridging starts. In many cases, vibration alone can handle most dry material flow but changes in humidity raising the stickiness of cargo and chute surfaces, along with fluctuations in production volumes, are much better handled by air cannons (Figure 6).

Discharge dust

Emissions at the discharge zone can be found billowing out of the chute against the direction of the cargo stream or exiting the sides and bottom as it loosens from the belt's return side. Dust has become a highly regulated workplace and environmental concern which can lead to stiff fines and, potentially forced downtime if high volumes of respirable crystalline silica (RCS) are detected. RCS is found in nearly every substance pulled from the earth, but is prevalent in limestone, coal, clay, etc. Regulators measure fugitive particulate matter (PM) at the size of <10 μm in volumes of >50 μg/m³ over an 8 hour time-weighted average (TWA). This is the volume and size determined to cause serious chronic lung issues in workers and it does not just apply to RCS, this is the case with any PM.

Dust emissions returning from the chute can be caused by uncontrolled airflow at the exit point. The emissions can also be caused by hitting rock boxes meant to slow the flow of material or an unobstructed impact causing turbulence.

Dust from carryback permeates the area and spreads emissions down the entire length of the belt return. If the belt reaches into a tower or is exposed to the outdoors, this can cause dust to be carried long distances on air currents into nearby communities leading to possible violations.

Studies have shown that dust can be controlled by adequate cleaning at the discharge using levels 1 – 3. One is a primary cleaner, two a secondary cleaner, and level three a tertiary cleaner (Figure 7).

Recommendation

By reconfiguring the chute's exit into a sloping scoop, material can be slowed and loaded onto the next belt in a controlled and centred manner with less turbulence. Air cannons installed along the chute are pointed with the material stream and can help direct air flow.

Case study: carryback in a Ukrainian cement plant

A cement plant located in Western Ukraine was experiencing extensive carryback on conveyors carrying slag. Due to the abrasive material's particle shape and small size, it easily passed under the cleaner blade and remained on the return side of the belt, allowing it to drop along the belt path. Fugitive material built up on floors and encapsulated rolling components, causing excessive downtime for maintenance and cleaning (Figure 8).

After testing numerous primary and secondary cleaners from several suppliers, operators found none of the cleaners adequately cleaned the belt. Increased operational costs for labour and replacement parts inspired managers to seek alternatives.

Technicians from Martin Engineering Europe inspected the system and recommended the installation of a CleanScrape® Cleaner. Designed to be installed diagonally across the discharge pulley, the blade forms a three-dimensional curve with an extremely low contact pressure between belt and cleaner. The blade is comprised of a matrix of tungsten carbide scrapers and is tensioned against the belt by stringers, typically resulting in the removal of as much as 95% of difficult material. Engineered for belt widths up to 120 in. (up to 3000 mm), speeds up to 1500 fpm (7.5 m/s), and pulley diameters of up to 78 in. (2000 mm), the blade delivers double the life of most standard blades (Figure 9).

Following the installation, the results were immediately apparent. To fully clear the fines stuck in the cracks and divots of the belt, managers also installed a Martin® SQC2S™ secondary cleaner for more complete cleaning. "Once we made the proper adjustments and finished the full installation, we are very happy with the result," said an operator close to the project.

The company is now budgeting to equip several more belts with CleanScrape Cleaner blades.

Conclusion

Modern cement plants are changing and growing every day because the demand for raw and processed materials for construction and manufacturing keep rising.

Production increases can change throughput volumes and belt speeds, which have a direct effect on spillage, carryback, clogging, and dust.

Retroactively installing equipment that improves both safety and efficiency should be a priority for any operator. Although the initial capital investment might be slightly higher, the return on investment (ROI) and benefits are not just in fewer injuries, but reduced labour costs for maintenance, less equipment replacements, greater compliance, and a lower cost of operation overall. ■

About the author

Daniel Marshall received his Bachelor of Science degree in Mechanical Engineering from Northern Arizona University. 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 a leading expert in this area. A prolific writer, Dan has published over two dozen articles covering various topics for the belt conveyor industry; he has presented at more than fifteen conferences and is sought after for his expertise and advice. He was also one of the principal authors of Martin's FOUNDATIONS™ The Practical Resource for Cleaner, Safer, and More Productive Dust & Material Control, Fourth Edition, widely used as one of the main learning textbooks for conveyor operation and maintenance.