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FEATURES

- Global Feedstuffs Trades
- Bulker Services
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Controlling conveyor belt carryback: cost vs. payback

'Carryback' is defined as the material that fails to unload from a conveyor belt, adhering to the belt and typically falling off at some point other than the intended discharge point, *writes R. Todd Swinderman, P.E., CEO Emeritus, Martin Engineering*. The effectiveness of mechanically scraping carryback from a conveyor belt is important in the cement industry, because the consequences of not cleaning the belt are significant. Carryback is one of the main sources of fugitive materials, estimated to account for 85% of all maintenance issues. Accumulations from dirty belts can stop production and require frequent cleaning, which exposes workers to muscular-skeletal injuries and respiratory diseases. The fines that adhere to the belt also degrade the life of components, and a dirty belt as it travels over return idlers releases dust into the environment.

Belt cleaners

It can be shown practically and theoretically that a conveyor belt cannot be cleaned 100%, because the surface of the belt and the blades are not without imperfections or damage. However, this doesn't mean operators shouldn't take a proactive approach to keeping the belt clean. Virtually every technique and combination imaginable has been tried for cleaning conveyor belts handling bulk solids, including piano wires, high pressure water spays, brushes, vibration and even very small head pulleys to fling carryback from the belt. Most industries have gravitated to basic mechanical scraping with a metal or elastomeric blade for flat rubber or PVC belting as the best combination of effectiveness, ease of maintenance and low belt wear to yield the lowest cost of ownership.

Belt cleaning is a process, and the effectiveness varies day to day with changing conditions and the number and type of cleaners applied, as well as the maintenance they receive. Keeping the material in the process is always better than letting it accumulate on components and build up under the conveyor. Whether the cargo is valuable or not, it makes sense to keep as much of it in the process as possible. Without effective belt cleaning, experience has shown that as much as 3% of the total cargo can be lost due to spillage, dust and carryback. World-class operators can average less than 0.1% fugitive material loss, reducing direct operating costs. The exposure to hazards and injuries is also reduced when less cleanup is required, saving significant — but seldom considered — indirect costs. The key to consistent cleaning effectiveness is to control the process through proper selection, installation, inspection and maintenance of the belt cleaning system and establish a safe cleanup routine and schedule.

The use of multiple mechanical scrapers on a belt has been accepted for quite some time as an effective cleaning approach. In some applications, the amount of carryback that can be tolerated is very small, due to fire and explosion hazards when compared to that which is acceptable in rock quarries, for example. The real question is: how much carryback per hour can the system tolerate and still function safely until the next scheduled maintenance? In most operations, multiple cleaners are required to reduce the carryback to a safe, acceptable level while limiting manual cleanup to weekly or even monthly tasks.

Effectiveness vs. efficiency

The undulating action of the loaded belt passing over idlers tends to cause fines and moisture to migrate and compact on the surface of the belt. Quarrying and processing create a large volume of fine particles, many of them just a few microns in diameter, which makes belt cleaning difficult. The carryback that adheres to the belt through a combination of adhesion and electrostatic forces — depending upon the characteristics of the bulk material and the moisture content — is measured in grams per square metre of dry weight material on the carrying side.

The amount of carryback that clings to the belt can range from a few grams to a few kilograms per square metre. The level of belt cleaning required is a function of the operational schedule and method of collecting and disposing of the carryback that is cleaned from the belt or dislodged by return idlers and collects outside of the conveyor discharge chute. Depending upon the length of the conveyor, the amount of residual carryback that falls along the return or becomes airborne dust after cleaning ranges from 25% for short belts to 75% for longer belts.

When discussing the efficiency of a belt cleaner, it's meaningless to talk about *efficiency* without stating the initial level of carryback. When considering the beginning and ending levels of carryback as a measure of improvement, *effectiveness* is a better term. Some guidelines do exist. The U.S. Bureau of Mines states that an average of 100g/m^2 of carryback is a reasonable level of performance for belt cleaning. At this level, the belt may have visible streaks of discolouration or wet bands but not create excessive buildup on components or piles on the ground.

A typical manual shovelling rate is one tonne per hour or less, depending upon access and disposal methods. At 100g/m^2 a 1,200mm (48-inch) belt travelling 2m/s and operating 24/7 would create a cleanup workload of about seven tonnes per day. If the conveyor is elevated from the surface at the tail greater than what most standards establish as the minimum clearance of 300mm (12 inches), cleanup schedules should be manageable.

CEMA[i] standard 576 is a rating system based on belt and bulk material conditions and level of desired cleaning for specifying belt cleaner performance. The standard

Figure 1: Typical carryback cleanup labour requirement calculation

Belt Width 1200 mm, Belt Speed 2.0 m/s, Hours of Operation 24/7, Carryback Level 100 g/m^2

Carryback (C_b) = Belt surface to be cleaned × Hours of Operation × Carryback Level × % Falling From Belt

Assuming dirty width of the belt is 0.8 m, 50% falling to the ground and converting to calculate tons per day:

C_b = 0.8 m × 2.0 m/s × 24 h/d × 3600 s/h × 100 g/m^2 ÷ (1000 g/kg × 1000 kg/t) × 50% = 6.9 tons per 24 hours day

Shoveling at 1.0 t/h, 6.9 tones equals one cleanup laborer one shift a day or 6 laborers, one 8-hour shift a week

Cleaning with mobile equipment can significantly reduce the time required over manual shoveling uses belt attributes and material characteristics to develop its ratings, using CEMA Standard 550 to assign values for the material categories. The factors include the conveyor speed, belt width and splices, as well as the material's abrasiveness and moisture content. Each is scored individually and then totalled to arrive at the class rating for the application. The final score is divided into five application ('Class') levels that should be considered when cleaners are being selected. Appropriate cleaners should have a rating that meets or exceeds the calculated application class score.

Carryback level determines the cleanup schedule. In reality, a typical belt cleaner loses effectiveness over time due to lack of inspection, cleaning and maintenance. On systems with average or poor maintenance, effectiveness values are more in the range of 40–60%, thus the need for multiple cleaners. Regular cleaning of the blades or the use of water sprays can improve these values by ~15%[ii].

Cleaning location

CEMA has established nomenclature for the location of belt cleaners. Unfortunately, designers often focus on the lowest installed cost of the structure around the head and snub pulleys in an effort to reduce prices, without allowing enough space for optimum cleaner installation. Incorrect mounting location from the face of the belt is another common cause of poor cleaner performance, which introduces significant long-term costs that can be mitigated with cleaner-friendly structural arrangements. Access to cleaners restricted by structure or drive components reduces the ability to inspect, clean and service belt cleaners and therefore also contributes to reduced cleaning effectiveness.

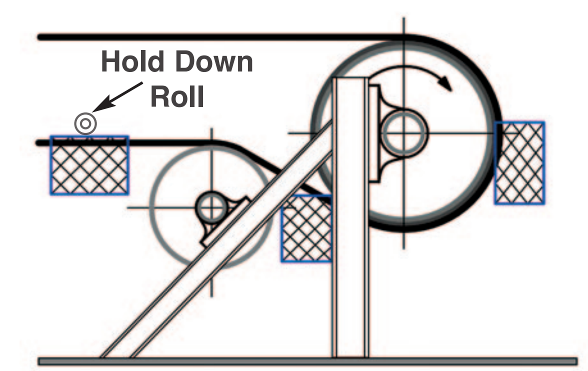

Figure 2: CEMA belt cleaning positions and a belt cleaner-friendly structure

Figure 2 shows the clear areas needed on a discharge chute for installation of belt cleaners in the optimum positions. The installations should be at an ergonomic height above the work platform to encourage proper inspection and service. Consideration in the design stage for locating cleaners in the optimum locations will lead to more effective inspections, maintenance and belt cleaner performance. A large enough discharge pulley (>600m Ø [24in]) can often accommodate two precleaners, which is desirable since the cleaned carryback will flow with the main stream of cargo and reduce or eliminate the issue of build-up on a dribble chute.

Belt cleaners can be placed anywhere along the return run of the belt, as long as

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i Conveyor Equipment Manufacturers Association, www.cemanet.org, Belt Conveyors for Bulk Materials, 7th edition.

ii Water as a means of Spillage Control in Coal Handling Facilities, J.H. Planner, Institution of Engineers Australia 1990 International Coal Engineering Conference.

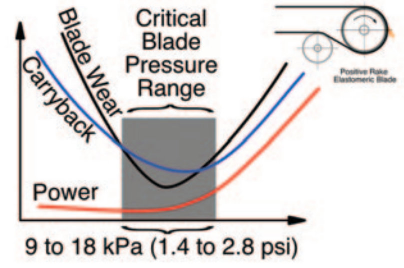


Figure 3: Elastomeric primary blade pressure at a positive rake.

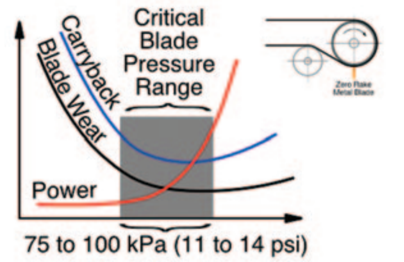
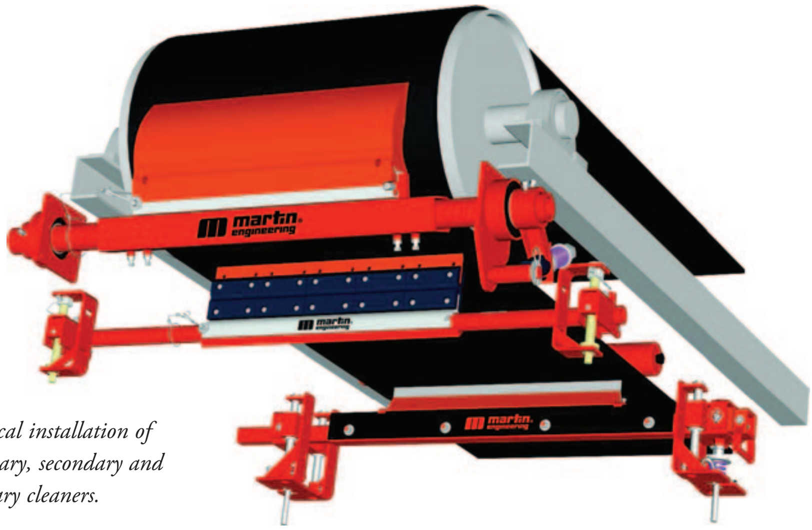


Figure 4: Metal secondary blade pressure at zero rake angle.



Typical installation of primary, secondary and tertiary cleaners.

the belt is supported in some fashion. Since it's desirable for the carryback cleaned from the belt to be returned to the main material flow, most belt cleaners are installed inside the discharge chute. Cleaning on the head pulley — labelled the 'primary cleaning position' — is preferred. Cleaning the dirty side of the belt before it reaches a snub, bend pulley or return idlers is considered less desirable, requiring a dribble chute for cleaners in the secondary position.

The secondary position is complicated by another fact: the nature of carryback is such that it can adhere to vertical surfaces and not flow down a sloped dribble chute. A tertiary position is sometimes required for critical applications such as conveying over wetlands. In such cases, the tertiary cleaners are often enclosed in a spray box and the effluent directed to a settling basin. Most cleaners, when located more than a few cm (inches) from where the belt leaves the discharge pulley, require a backup or hold down roll to maintain stable blade-to-belt contact and control belt flap (vibration).

Cleaning pressure & blade wear

There have been several studies that indicate optimum cleaning pressures for primary and secondary belt cleaners[iii]. [iv]Without enough cleaning pressure, the blade cannot stay in contact with the belt, resulting in poor carryback removal effectiveness and increased blade and belt wear. With too much cleaning pressure, the cleaning performance declines due to deflection of the elastomeric blade or metal blade indentation into the rubber belt. Power consumption also increases dramatically with excessive cleaning pressure.

Figures 3 and 4 show the optimum range of cleaning pressures for different cleaner designs and blade materials. Keeping a belt cleaner properly tensioned is critical for maximum effectiveness and lowest cost of ownership. The cleaning pressure usually varies over time, based on the maintenance department's attention or lack thereof. Some manufacturers have begun to offer automatic tensioners and wear indicators which maintain the optimum cleaning pressure and alert operators when blades are worn.

Final thoughts

Many belt cleaner systems are installed and forgotten. A survey of technicians indicates that about 25% of all belts have cleaners installed, and of that percentage only about 25% are properly maintained. While the initial cleaning results may be significantly better than the previous performance, lack of inspection and maintenance results in accepting a gradually lower level of effectiveness, higher operating cost and an increased exposure to the hazards associated with cleaning up carryback.

Effective belt cleaning starts in the design stage, with adequate space for cleaners and well-positioned work platforms for ergonomic inspection and maintenance access. Service-friendly designs improve production and prolong the life of equipment. If the cleaners are located in the optimum positions and easy to access, it is more likely that regular inspection, cleaning and maintenance will be performed, resulting in optimum results.

Proper selection, installation, inspection and maintenance of conveyor belt cleaners can provide an immediate return on investment simply from reduced cleanup labour. Further, effective belt cleaning produces often-overlooked savings from reducing wear on belts and components, minimizing worker exposure to the hazards of cleaning around a conveyor and maintenance in hard-to-access locations.

Automatic tensioner maintains optimum cleaning pressure without operator intervention.

iii Findings from a Study of Belt Cleaner Blades and Belting, R. Todd Swinderman, Martin Engineering internal document, 2018

iv RI 9221 Basic Parameters of Conveyor Belt Cleaning, C.A. Rhoades, T.L. Hebble, S.G. Grannes, Bureau of Mines, United States Department of the Interior, 1989