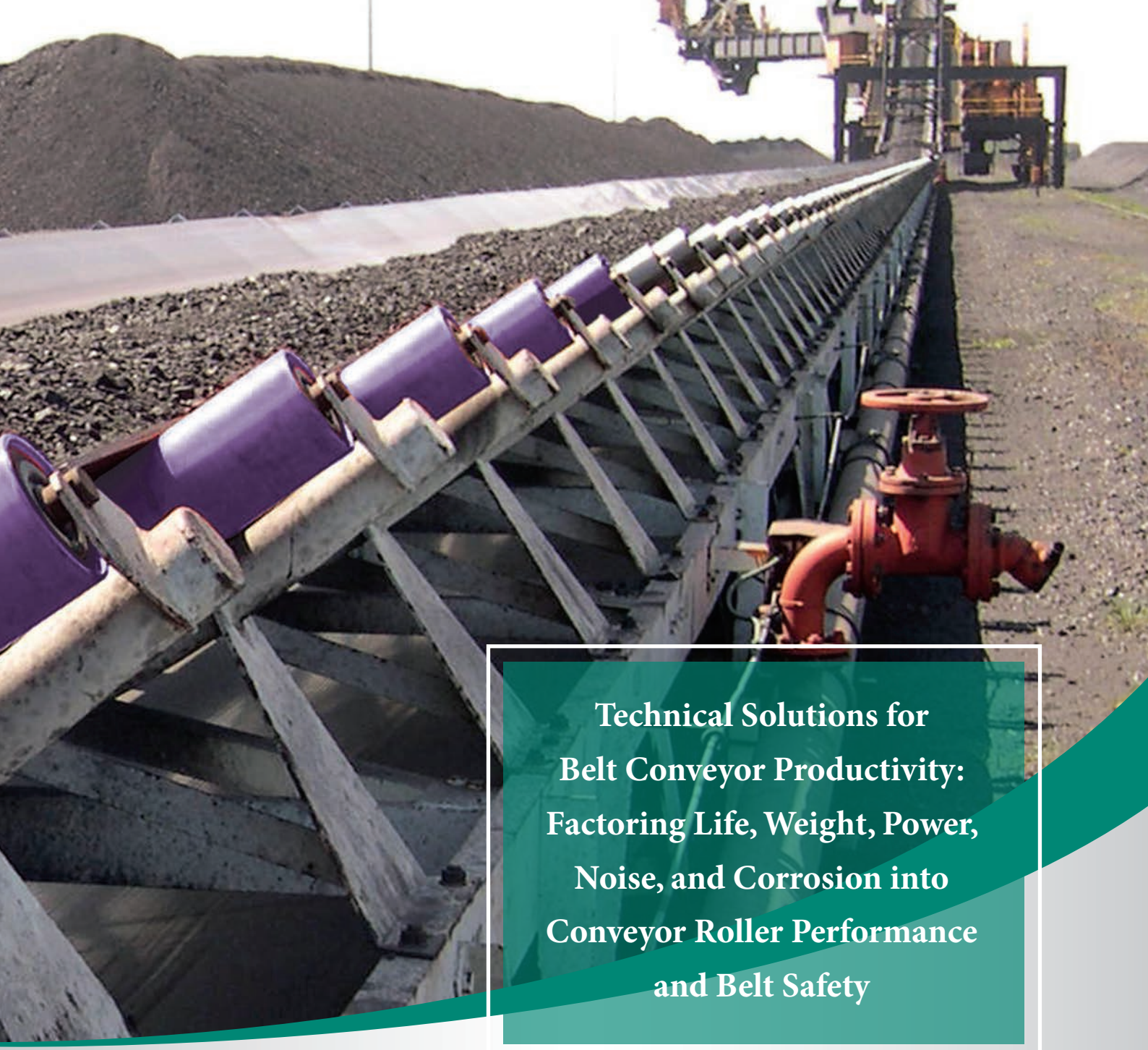

Technical Solutions for Belt Conveyor Productivity: Factoring Life, Weight, Power, Noise, and Corrosion into Conveyor Roller Performance and Belt Safety

When an operation is working at full speed, trying to move product or fulfill orders, the last thing it needs to worry about is the performance and reliability of its belt conveyor rollers. Belt rollers greatly impact the productivity of the system, and that means they should be carefully selected and matched to each application for maximum longevity and performance.

When choosing the right roller for your application, you will want to consider your environment, the application in which they will be used, the belt speed, and the size of your material load. These factors, as well as the size of your rollers and the number of rollers you need, should be a good starting point.

This paper touches on what to consider when selecting the right roller for your application: the life and weight of the roll, power consumption, noise generation, and corrosion-resistance. It will also explore how these subjects affect conveyor roller performance and belt conveyor productivity.

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What Affects Conveyor Roller Life?

How long does a roller last?

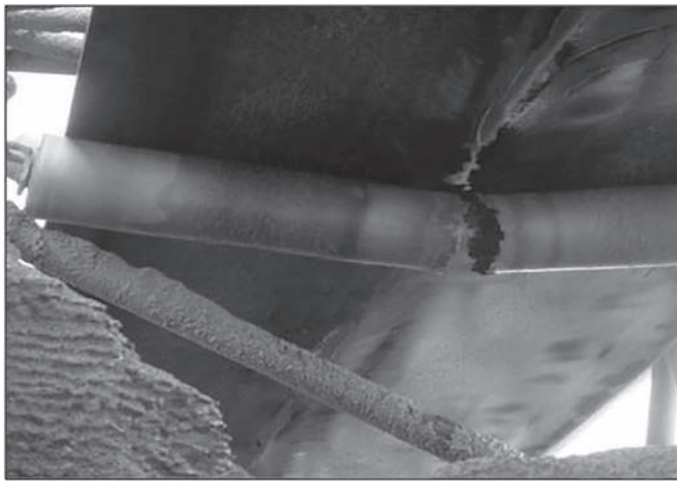
Most rollers are selected on the basis of theoretical bearing life calculations to determine which rollers are recommended based mainly on load and speed. Idler life is determined by many factors, such as seals, bearings, shell thickness, belt speed, lump size/material density, maintenance, environment, temperature, and the idler design that handles the maximum calculated idler load. And while all the variables listed above can affect the life of the roller, the only variable for which laboratory tests have provided standard value is the bearing rating.

In an ideal situation, rollers would last as long as the bearings last. Eventually, the bearings would just wear out, due to metal fatigue. But each application presents environments and characteristics that simply can't be taken into account during laboratory testing. This situation is what is referred to as "design life vs. actual life," or the time the roller is supposed to last based on testing in laboratory conditions versus the time the roller will actually last in day-to-day working conditions.

Modes of roller failure

There are many different causes of roller failure, but the most common are abrasion, corrosion, seal failure, and end design failure. Regular surface wear, or abrasion, from belt contact can limit the roller life. The increasing use of polymers (like engineered Nylon and HDPE) instead of steel can be useful in combating this type of roller failure. And in this case, corrosion is directly related to abrasion in the sense that the more corrosion you have, the more the rate of abrasion accelerates as the surface continues to weaken. Seal design and effectiveness are both key to the success of the bearing and, in turn, to the success of the roller. A seal design that is resistant to moisture and other fines protects the roller from contamination and internal corrosion. It is estimated that 43% of bearing failures come from moisture and other contaminants. One way to prevent this is by opting for a roller with a quality "centrifugal flinger seal." This feature offers up to nine times more centrifugal force, to help "spin out" fines, water, and other contaminants. The design of the flinger seal discourages the entry of contaminants and protects the bearing inside the roller.

End disks may be made of durable materials, but the method used to join the end disk to the core can make an impact on the life of your roller. Every roller has a core and roller end piece(s), and if they come apart, the result can be disastrous for your belt. In the case of steel, the end disk separating from the core can act like a sharp knife, cutting the belt. With many composite rollers, the end disk can work loose, causing premature roller failure.



Centre wear can be so drastic that it cuts your belt like a knife. In a study comparing the abrasion resistance of steel to other common materials in sand slurry testing, all but polypropylene were significantly more resistant than steel.

Roller failure and belt safety

Regardless of the type of roller you install, preventative maintenance is one of the most important parts of roller success. Inspecting the rollers on your line, much like you inspect the other components of your belt conveyor system, is an important task. If a roller seizes or wears through the shell, the conveyor belt can actually be cut. The sharp edges and loose end assemblies that form are commonly known as "smiley faces" and "pizza cutters," causing safety hazards and the potential for a lengthy belt shutdown, not to mention the cost of replacement belting, which is generally the most expensive component on a belt conveyor system.

Verified Solution

CoreTech™ rollers offer the absolute best combination of structural strength coupled with the requirements of mining, which include corrosion resistance, excellent abrasion resistance, and very low surface friction. The process used to join the end disk to the core of CoreTech rollers, sets them apart from the competition. While other composite rollers use "pressed" housings that can gradually pop out from the core, the welded bearing housing on CoreTech rollers make the end the strongest part of the entire roller.

Available in both engineered Nylon and HDPE, CoreTech rollers feature a flinger seal that keeps material from resting in the bearing, causing corrosion or seizing. Allowing the bearing to live its fullest life (or L10 life) means the operator is getting the most for the investment. Field-proven seal design is the key to CoreTech roller life. The centrifugal seal rotates with the roller and creates forces up to 9x gravity.

Factoring Weight into Roller Selection

Is roller weight an issue?

When choosing a roller for your belt conveyor system, compatibility, availability, and assurance of superior performance should certainly be at the top of your list. But what about weight? Should roller weight also factor into your selection process? When making decisions about replacement items for your system, serviceability and ergonomics need to be considered. On the topic of roller weight, some might think a heavier roller has a thicker wall and thus will last longer. As long as you don't have to sacrifice performance, less is definitely more.

- Half of work-related injuries or illnesses in Australia were sustained mostly by lifting, pushing or pulling objects (27%) or by hitting or being hit or cut by an object (25%), according to the Australian Bureau of Statistics.
- Muscular stress (due to manual handling or repetitive movement) accounted for 32% of claims in Australia, according to Safe Work Australia's workers' compensation claims database.
- More than 60% of those who experienced a work-related injury in Australia received some sort of financial assistance, and of those who received financial assistance more than half (59%) received workers' compensation. More than 55% of those who experienced a work-related injury had some time off.

If those three statistics don't convince you that roller weight should be a factor, then consider this ... it often takes only a single reportable injury at your workplace to raise your workers' compensation insurance premiums, lower your productivity, increase your absenteeism, and possibly increase your legal costs fighting an injury suit.

Weight and conveyor rollers

Weight is a safety issue when it comes to your workers. Workers injure themselves in several ways, including lifting cumbersome, heavy rollers. Traditionally, rollers have been constructed from steel; the heavier the application, the heavier the roller. For example, a single 1800 mm roller can weigh up to 45 kg, making the roller difficult to carry and install. And the longer the roller, the more concerns arise about weight and the risk of back injury. Especially on incline conveyors or conveyors not accessible by maintenance vehicles, the weight of a roller can become a major drain on productivity and source of injury risk.

In addition, many workplaces set maximum lifting requirements that limit the weight one person can carry by himself/herself to 25 kg or less. A roller made of lighter materials would require only one individual to lift, carry, and place the roller, while a steel roller of the same size would require two workers. Opting for a polymer-based roller, weighing up to 40% less than steel, is a wise choice. With a lighter option, you not only have less of a chance of a workplace back injury, but increased productivity. Product performance can also be a factor when the rollers are heavier. Routine roller maintenance duties may be neglected because the rollers are large and cumbersome to replace. This situation can affect both safety and productivity as some rollers may be left on the line for too long, resulting in catastrophic belt failure.

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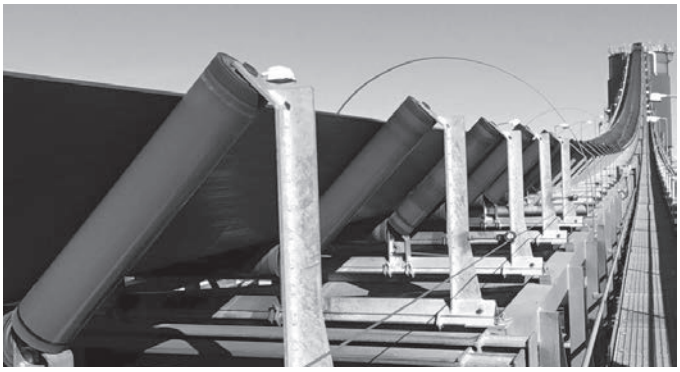
CoreTech™ rollers are approximately 40% lighter than equivalent steel rollers and as the rollers get longer in the larger diameter steel rollers, that weight reduction gets closer to 50%.

Just how light are CoreTech rollers in comparison to steel? We took 152 mm Steel and CoreTech Nylon rollers in several widths and measured them against each other on the scale. While the smallest steel roller (900 mm) was well over the typical one-person lifting limit at 35 kg, the largest nylon roller (2400 mm) weighed in at only 32 kg. As the rollers got longer, the weight difference between steel and nylon increased.



A roller made of lighter materials would require only one individual to lift, carry, and place the roller.

How Roller Selection Affects Power Consumption

What power consumption means to you

It costs money to operate a business – whether you're buying materials, paying employees, or simply moving material. Any time you can save money, it is a victory. Depending on your workload, your conveyor systems may be operating 24/7, so making sure your rollers are running as efficiently as possible can only add dollars to your bottom line. While the power to rotate a single idler roller is small, it accumulates along the length of a conveyor.

Power consumption and breakaway energy

Two factors contribute to the energy consumption required to operate a large number of rollers on a system. The first is breakaway energy — the power required to get the conveyor and all the rollers supporting the belt started. Breakaway energy is a function of the rolling resistance generated by seals and bearings and overcoming the moment of inertia, which is a function of the weight and geometry of the rollers. Conveyor start-up can utilize as much as 13% of available power. Electric motors are typically designed with the ability to operate at peak power, three times as much as their operating rating, specifically to provide the needed energy at start-up.

The power required to get a belt conveyor up and running is largely dependent on the effort (or energy) required to get the system running. The design of the rollers plays a big part in this calculation because of the large number of rollers in the system and the rolling resistance they have in a stationary state.

Two things contribute to rolling resistance. First is the seal design. A roller using a very tight seal to prevent ingress of water and fine materials will have much greater rolling resistance than a roller using a non-contact labyrinth or centrifugal seal. Labyrinth seals rely on a complex path and often a grease chamber to make dirt and water ingress more difficult. Centrifugal seals use the churning effect created by the rotating motion of the roller to constantly move materials away from the bearing to prevent internal corrosion. Using a seal with lower rolling resistance can significantly reduce the energy required to get the roller moving and to keep it moving.

Second is the moment of inertia. Moment of inertia is used to determine how difficult it is to change the motion of a rotating object around an axis. In this case, it is used to determine how difficult is it to get a roller to turn around the shaft. With rollers, this is almost entirely a function of the weight of the shell, since the shaft remains stationary. Rollers made of lightweight materials will have a significantly reduced moment of inertia, which can translate into large savings in the energy required to get the conveyor system running.

As long as the roller does not lack performance in other areas, going with a lightweight material can be a very effective way to significantly reduce energy consumption from belt conveyor systems. Rollers with composite sleeves over a steel core will often weigh nearly as much as a steel roller and will not provide the reduced moment of inertia that can be achieved with a roller made with a full composite shell.

Power consumption and running energy

In addition to requiring enormous amounts of energy to begin rotating, steel rollers also generate substantial friction. Once the belt is moving, significant energy is required to keep the rollers running. This is a function of the friction caused by the bearings and seals, in addition to the "running friction" of the rollers on the belt. Steel rollers tend to have much greater running friction than composite rollers, making them more costly to operate in terms of power consumption.

The best choice for power consumption

When it comes to energy savings, engineered Nylon or HDPE rollers are a smart choice. They can weigh 40-50% less than steel rollers and many designs have lower running friction values, which, depending on the application, can decrease power bills by up to 30% a year. Installing rollers with non-contact seals is also wise if you are looking to save money on power because they require less breakaway energy. However, not all non-contact seals are the same. A centrifugal flinger seal will deter moisture, fines, and other contaminants from entering the inside of the shell while protecting the bearing. Other non-contact seals are packed with grease to create a barrier, which contributes to low breakaway energy and running friction numbers.

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CoreTech™ rollers typically require much less energy to create rotation and maintain a given RPM than standard steel rollers. With no contact points internally or on the shaft, the CoreTech seal does not allow contaminants inside the roller, but still allows free rotation without creating the drag associated with a tight contact seal. The CoreTech seal requires no grease barrier, further reducing breakaway energy and running friction.

To get a grasp of the true effect of seal design and weight on power consumption, CoreTech rollers replaced existing rollers on a belt conveyor in an underground coal mine. The results were staggering. The simple switch from the existing steel rollers to 178mm CoreTech Nylon conveyor rollers projects a ***Power Savings of 11%*** *and an* ***Annual Cost Savings of $48,500****.*

Conveyor Specifications	1926m, relatively flat belt
Belt Width	1800mm
Belt Speed	4.8mps
Belt Load	5512.5 mtph
Idler Specifications	45-degree, 3-roll trough with 10-degree, v-roll return

Noise and Your Rollers

Is noise an issue for your operation

It is surprising how much of the noise from bulk material handling systems is generated by rollers. After all, shouldn't the belt be moving smoothly across the rollers with little noise or friction? In a perfect world, yes, but heavy material loads, friction between the belt and rollers, and splices reverberating over the rollers can affect the sound produced by your conveyor systems. Combine that with the noise that rollers generate due to resonance in the hollow cavity, and your system can get loud enough to be problematic.

Roller noise and your pocketbook

In many countries, local jurisdictions and municipalities have their own laws about noise regulations, and heavy fines can be levied when noise exceeds allowable levels. Depending on where you are located, you may find that certain decibel levels are allowed during the day and lowered at night. If operating near a residential area, these limits are even lower. Work Health and Safety Regulation legislation states that the exposure standard for noise in relation to a person cannot exceed 85dB(A) for excess of eight hours. This level is tightened by many mine sites, in particular sites that are in or near residential areas. The penalties in NSW are (a) in the case of an individual—$6,000, or (b) in the case of a corporate body—$30,000. Violations like that can cut into both profit and production.

Community relations and safety

Even if local ordinances don't regulate the noise coming from your operation, it's important to be a good neighbour to residences and other businesses within the area. Many operations install sound barriers for this exact reason – to combat noise pollution on crushers, blast zones, and impact beds where material is being dropped and transferred. If your operation isn't located near a residential area or within a jurisdiction that has stated noise ordinances, you're safe from a governmental point of view, however, how safe are your workers? Continuous exposure to elevated noise levels can be dangerous for workers in these environments. A single roller may not be dangerous to workers, but the combination of hundreds of rollers and other machinery can add up to hazardous noise levels.

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Operations that generate noise levels above 70 dB may be subject to fines. To see if CoreTech™ rollers could produce a satisfactory noise reduction, an independent head-to-head test was conducted comparing CoreTech rollers to metal rollers at a coal processing plant. According to the findings, noise emissions were lower at the sections fitted with CoreTech rollers than sections fitted with metal rollers. The estimated noise contribution of the CoreTech rollers was +/- 10 dB below the noise contribution of the metal rollers, which means the CoreTech roller emissions were a tenth of the sound energy emission of the metal rollers. The 10 dB decrease will have a significant impact on the surrounding environment, as well as the workers.

How Does Corrosion Affect Rollers?

Why corrosion matters

The rollers on your conveyor system are often an afterthought ... viewed as simply a disposable commodity that is easily replaceable. In fact, rollers are integral system components that can positively or negatively impact your productivity. And that means they should be carefully selected and matched to your application for maximum longevity and performance. If you think about it from a numbers perspective, there are more rollers than any other type of component on a conveyor system. Other than the belt, they usually represent the highest maintenance cost item in the system.

So it's no surprise that a failed or seized roller is no small matter. One of the main causes of premature roller failure is corrosion.

Causes of corrosion

To better understand the causes of roller corrosion, one must understand the different types of corrosion. External corrosion affecting the outside of the roller can be caused by anything from environment to temperature to application. For example, regions near a saltwater coast or applications that feature salt or chemicals can have an effect on the rollers. Corrosion accelerates the process of abrasion, changing the properties of the surface and stripping away layers of roller material.

Internal corrosion is usually caused by moisture and fines making their way inside the roller and either damaging the bearing or causing build-up that seizes the internal components and stops the roller from turning.

Corrosion had a "polishing effect" on this steel roller, weakening the surface so drastically that material wore away at a rapid rate, leaving a shiny surface.

Design and materials contribute to roller success

Since environment, temperature, and the type of material being conveyed can't be changed, many people just write off corrosion as an inevitable occurrence. However that doesn't have to be the case. Both the material the roller is constructed from, as well as the seal design that protects the bearing, can make a huge impact on the life of the roller.

Metal can rust, corrode, and scale. Polymers are more resistant to corrosion than metal. Rollers that match the ratings of steel are now available in polymers such as engineered Nylon and HDPE. These materials are resistant to corrosion from chemicals, salt, and moisture. Steel rollers can fall victim to several environmental factors. When exposed to moisture, nylon actually gains toughness, while virtually eliminating the risk of premature failure due to surface corrosion.

Seal design is also paramount to the success of the roller. Many rollers don't reach their design life because of moisture and contamination reaching the bearing. In fact, statistics show that 43% of bearings fail prematurely for this reason. The best way to ensure the bearing in a conveyor roller lives its full life is to prevent moisture and fines from reaching it. One way to accomplish this is by opting for a roller with a quality "centrifugal flinger seal." This feature offers up to nine times more centrifugal force, to help "spin out" fines, water, and other contaminants. The design of a flinger seal, combined with a rock shield, discourages the entry of contaminants and protects the bearing.

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A major mine conducted a test comparing rollers from 10 different manufacturers. Each manufacturer supplied nine rollers for the test, which were placed on the same conveyor. For 11 months, the mine evaluated the 178 mm, 6,309 bearing rollers, deeming a manufacturer roller a complete test failure if even one roller failed. Only three manufacturers survived the first round with all nine rollers surviving the 11-month test. Three roller samples were collected from each of the three survivors, including CoreTech™ and two steel roller manufacturers. When disassembled, both sets of steel rollers showed noticeable corrosion on the shaft and bearing as well as the outer shell, while the CoreTech rollers showed no signs of dust or moisture ingress. The effectiveness of the CoreTech field-proven seal design was evident by the lack of corrosion and moisture in the inner core.

CoreTech rollers are made with engineered Nylon or HDPE material that is highly corrosion-resistant and sheds material quickly. Combined with a seal that protects against bearing damage, these rollers offer extended wear life and greatly reduce the frequency of roller replacement due to bearing failure and shell wear.

When moisture, acid, salt, or other corrosive materials are present, the CoreTech offering provides an excellent alternative to steel rollers. Since CoreTech rollers provide the same ratings as steel rollers, there is no loss of functional performance, and much longer life can be achieved through the benefits of the latest composite technology. CoreTech HDPE rollers are resistant to all acidic environments.

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