Keeping coal on the move – in the stockyard and elsewhere

Conveyor belt specialist Leslie David explains how belts that last up to three or four times the norm can dramatically reduce the cost of conveying coal.

Coal may not be 'de rigueur' environmentally but the reality is that it remains a very important source of business within the dry cargo industry. As with the majority of dry cargo products, the most efficient method of transhipping coal is the use of conveyors. However, as any operator who uses conveyors will testify, the conveyor belt itself is invariably the Achilles heel because when a belt fails the costs start mounting, in terms of both belt repairs and replacements as well as the cost of lost throughput. Their durability and the length of their working lifetime has a huge influence on throughput and, ultimately, on profitability.

Apart from very long-distance applications where steelcord belts are used, the most common type of conveyor belts used to carry coal above ground are rubber multi-ply belts. The basic construction has barely changed since 1905 when mining engineer Richard Sutcliffe invented the first rubber conveyor belts for use in underground coalmines.

However, the demand to cut costs has created a downward pressure on the prices and consequently the quality of the conveyor belts themselves. Particularly in recent years, the Covid pandemic and now the Russia–Ukraine conflict have caused the unprecedented inflation of the cost of raw materials used to manufacture conveyor belts, a great many of which are derived from oil. This shift in the market has widened the already open door to manufacturers located outside of Europe who were already supplying very substantial volumes within the European market. As the prices of European-made conveyor belts have been forced to increase, it has created a natural but extremely risky temptation to seek lower-priced alternatives.

Shorter working lives

The ensuing downward trend in prices has been mirrored by a marked downward trend in the average working life of the conveyor belts themselves. Conveyor belts that carry coal should reasonably be expected to run for many years because coal is not particularly abrasive or destructive. Sadly, such longevity is now a very rare occurrence. Nowadays, it seems that the majority of coal-carrying belts often only last for a couple of years before they have to be replaced. In some cases it can be only a matter of months. There are two basic reasons why conveyor belts have to be replaced prematurely. The most common is when the covers of the belt are simply worn down, cut and gouged by the materials they are conveying.

Wear and tear

Wear and tear takes place over time but the actual length of time mostly depends on the durability of the belt covers. The biggest cause of rapid belt cover wear is simply because the manufacturer has used low-grade rubber that has an inadequate resistance to wear. Put another way, the rubber compound has been produced with 'economy' (low selling price) as the first priority rather than using a formula engineered to provide a high level of wear resistance and longer operational lifetime. In a typical belt, rubber constitutes at least 70% of the material mass so it is the prime target for cost cutting.

Manufacturers may claim that their

The biggest single cause of rapid cover wear is poor quality rubber that has insufficient wear resistance.

rubber meets the required standards for abrasion resistance (maximum volume loss in cubic millimeters under ISO 4649/DIN 53516 test conditions). However, in reality, the wear resistance may only be borderline or, as is regularly found during laboratory testing, totally inadequate. One example I came across recently was a belt with an abrasion resistance of 264mm³. The manufacturer had actually sold the belt on the basis that it was a DIN W specification, which is the highest abrasion standard and demands a maximum loss of surface rubber of no more than 90mm³. This meant that the belt had a level of wear resistance* that was more than three times less than it should have been.

Not just abrasion

It is important to bear in mind that the ability of a belt cover to withstand wear is not due to its 'abrasion resistance' alone because much also depends on the cover rubber's overall strength and its resistance to cut and tear propagation. If that is low then a small, seemingly insignificant area of damage in the cover can easily increase in size due to the continuous material loading and the relentless flexing around the drums and pulleys. In time, this damage will spread and link up with another area of damage. Consequently, small pieces of damaged rubber are effectively cut out from the surface rather than being simply worn thinner.

Unfortunately, apart from Dunlop in the Netherlands, which is the only exception that I am aware of, the technical datasheets provided by manufacturers and traders that contain data relating to such things as abrasion resistance almost invariably only show generic information such as the minimum standard demanded by a specific test. The data therefore does NOT reflect the actual performance achieved during the test or even a level of performance that the buyer might reasonably expect.

** When comparing abrasion resistance data it is important to remember that higher figures represent a greater loss of surface rubber under testing. This means that there is a lower resistance to abrasion. Conversely, the lower the figure the better the wear resistance.*

Abrasive wear testing

The test method for abrasion (ISO 4649/DIN 53516) is actually quite simple. Abrasion resistance is measured by moving a test piece of rubber across the surface of an abrasive sheet mounted on a revolving drum. It is expressed as volume loss in cubic millimeters, for instance 150mm³.

Wear on the top cover is primarily caused by the abrasive action of the materials being carried, especially at the loading point or 'station' where the belt is exposed to impact by the bulk material and at the discharge point where the material is effectively 'accelerated' by the belt surface. However, there are other factors that add to the abrasive wear inflicted on belt surfaces. These include belt cleaning systems with scrapers that are poorly set up and also poor quality idlers, again that may be poorly aligned and/or poorly maintained. Short belts (below 50 metres) usually wear at a faster rate because they pass the loading and discharge points more frequently compared to longer belts. For this reason, the quality of abrasion resistance needed for belts fitted to short conveyors is even more crucial than normal.

Although the thickness of the cover is an important consideration, the actual wear-resistant properties of the rubber are much more important. If increasing the cover thickness in order to compensate for premature wear is being considered then that is a sure sign that the quality of abrasion resistance is inadequate. Good quality rubber will also have superior tear strength (measured as either N/mm² or MPa) or, in other words, have the physical ability to resist tear propagation.

The wear resistance of rubber is a combination of overall strength, resistance to abrasion and resistance to cut and tear propagation.

The invisible enemy - how ozone & ultra violet light contribute to rapid wear

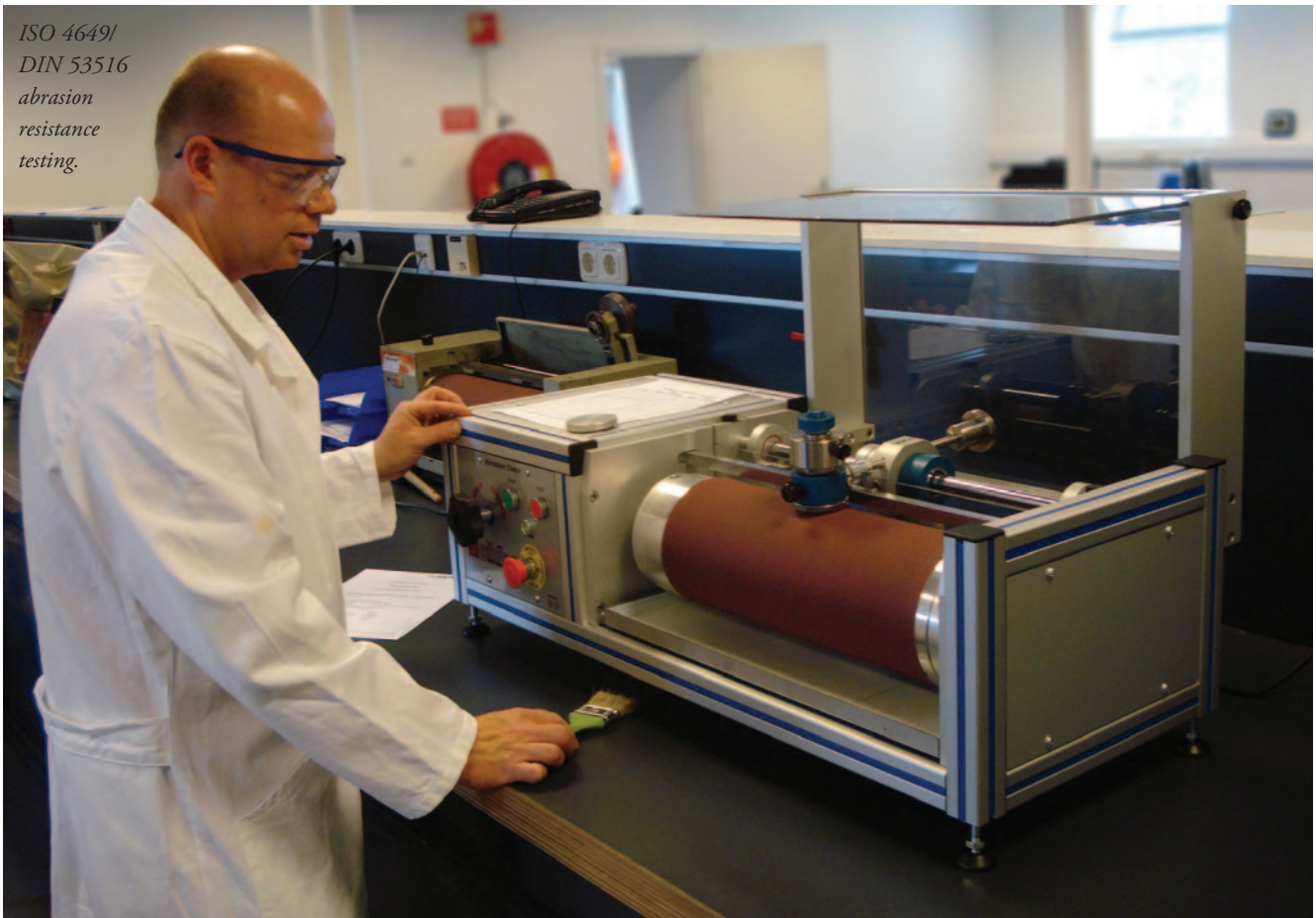
The surface wear caused by the abrasive action of coal sliding on and off the conveyor belt is significantly accelerated if the rubber is not fully resistant to the damaging effects of ozone and ultra violet light. This is because ozone becomes a pollutant at ground level. Ozone concentrations are notably higher in coastal areas so ports and terminals are especially vulnerable.

Exposure to ozone, which is of course unavoidable, increases the acidity of carbon black surfaces and causes reactions to take place within the molecular structure of the rubber. This is known as oxidative ageing and has several consequences such as surface cracking and a marked decrease in the tensile strength of the rubber. The dynamic stress caused by the belt travelling around pulleys and drums under tension greatly accelerates the formation of the cracks. The cracks also create a pollution hazard because coal dust enters the cracks and is then shaken out of the underside of the belt on the return run.

Likewise, ultraviolet light from sunlight and artificial (fluorescent) lighting also accelerates deterioration. This is because it produces photochemical reactions that promote the oxidation of the surface of the rubber resulting in a loss in mechanical strength. In both cases, this kind of degradation causes the covers of belts to wear out even faster than they should.

There is absolutely no question that ALL rubber conveyor belts should be fully resistant to the effects of ozone and ultra violet light. The reality is that to have any realistic chance of providing a cost-effective operational life, every rubber conveyor belt needs to be fully resistant.

This resistance can only be achieved by the use of UV stabilizers, anti-ozonates, and anti-oxidants within the rubber compound. Sadly, laboratory testing consistently confirms that the use of these essential ingredients is an exception rather than the rule, almost certainly due to the cost. My advice is to always make ozone & UV resistance a required part of the specification when selecting any rubber conveyor belt.



ISO 4649/ DIN 53516 abrasion resistance testing.

Rip and tear

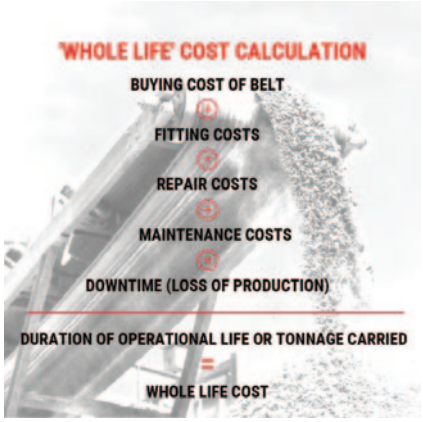
Moving coal is not always as straightforward as it may first appear because coal can contain some very nasty surprises. This is because a tremendous amount of pollution in the form of foreign objects can occur during transportation from the coalface to the conveyor. Lengths of rail track, pieces of mechanical equipment of every description, pickaxes — the list is almost endless.

As a result, a significant proportion of conveyor belts in ports and terminals have to be replaced prematurely due to accidental damage rather than wear and tear. Even the thickest conveyor belts can easily be ripped apart over their entire length in a matter of minutes under the right kind of circumstances. Consequently, instead of looking for higher quality belts that are more capable of handing the demands, many operators choose what they see as the cheaper option, which is to fit low grade, 'sacrificial' imported belts and accept the fact that they will have to be repaired and replaced at much more frequent intervals.

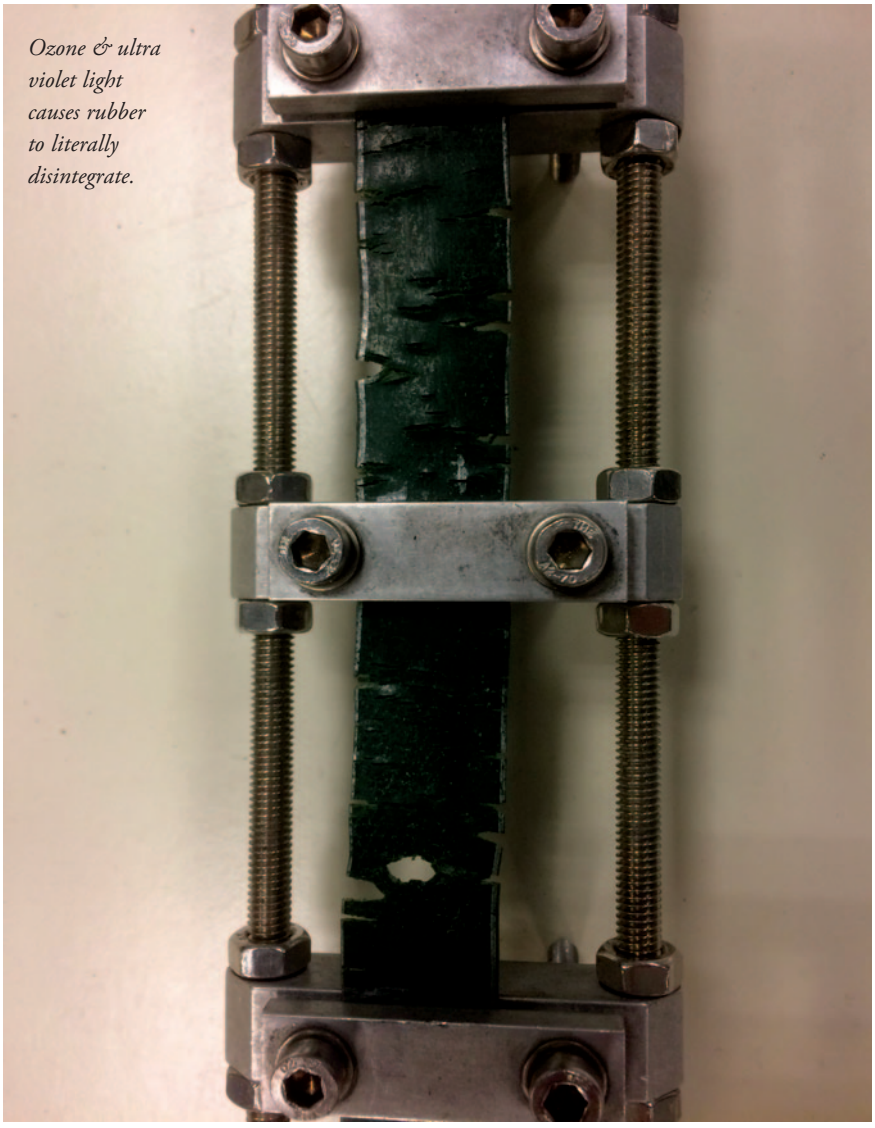
However, when you add together the cost of repeated repairs, the fitting costs and the lost production to the cost of replacement belt after replacement belt, sacrificial belts simply do not make economic sense.

Problem solving belts

On conveyors where accidental damage seems to be a regular occurrence the answer may well lie in the use of a specialist 'problem solver' belt. Such belts have highly durable rubber covers and damage resistant carcasses and will run and run, even under the most demanding conditions. One example is the Dunlop Ultra X, which has three or four times the rip resistance compared to conventional multi-ply belts. Usually such belts come with a high price tag but the Ultra X belt seems to be surprisingly price competitive.



Sacrificial belts rarely make economic sense.



Ozone & ultra violet light causes rubber to literally disintegrate.

Playing the long game

There can be no doubt that price will always be a consideration when buying conveyor belts. However, I would argue that cost is far more important than price. As the old adage goes, "price is what you pay but cost is what you spend". As with all products, when price competition intensifies, the first thing to suffer is the quality and cost effectiveness of the product. Conveyor belts, especially those being used to convey coal, can and should be lasting substantially longer than they are but levels of expectation seem to have dropped in recent years. As I mentioned earlier, coal is not a particularly aggressive material to transport. Ironically, this may be a cause of complacency when buying belts to carry it. Even more ironically in my opinion, especially when it comes to conveyor belts, price levels are usually an excellent indicator of the levels of performance and operational lifetime that the buyer can reasonably expect. Playing the long game by using the 'lowest lifetime cost' approach is undoubtedly the best way to dramatically reduce the cost of conveying coal.

About the author

After spending 23 years in logistics management, Leslie David has specialized in conveyor belting for over 15 years. During that time, he has become one of the most published authors on conveyor belt technology in the world.