The invisible conveyor belt destroyers

Conveyor systems are major components of the average bulk material stockyard, and it is important that they are safeguarded against damage. This article addresses how ozone and ultra violet is dramatically shortening the working life of conveyor belts

There are an awful lot of things that damage conveyor belts. The constant abrasive action of material being loaded at speed onto the belt and then being accelerated across its surface at the discharge point; the hammering the belt surface and its carcass takes as aggressive materials (often sharp and heavy) are being dropped onto it; the ripping and tearing that occurs when rocks or foreign objects become trapped; the softening and distortion of the rubber caused by oils and resins; the hardening and premature ageing of the rubber caused by heat. The list goes on and on.

All of these factors are, of course, very well known to operators of conveyors. The fact that conveyor belts can be engineered to significantly limit the amount of damage each of these factors can cause is also pretty common knowledge. However, what is definitely not common knowledge within the world of industrial conveyor belts is that there are also two other 'invisible' and inescapable factors that cause very serious damage on a daily basis. And all the while they are rapidly shortening the operational life of your conveyor belts. Those factors are ozone and ultra violet light.

If you type "The effects of ozone on rubber conveyor belts" into your search engine then only one belt manufacturer's name seems to appear — Dunlop Conveyor Belting in the Netherlands. Here, Dunlop's Les Williams explains what causes this little known phenomenon, its vastly underrated consequences and how to avoid them.

From protector to destroyer

Ozone occurs naturally in the upper atmosphere, where it is formed continuously by the action of solar ultraviolet radiation on molecular oxygen. At high altitude, ozone acts as a protective shield by absorbing harmful ultraviolet rays. Wind currents carry ozone to the atmosphere at the Earth's surface.

At low altitude, ozone becomes a pollutant. Ground level or 'bad' ozone is not emitted directly into the air, but is created by the photolysis of nitrogen dioxide from automobile exhaust and industrial discharges. The effects are known as ozonolysis.

Splice joints are prone to stress concentrations.

The variability of weather, airflow patterns, seasonal changes, motor vehicle and industrial emissions, geographical and climatic conditions such as higher altitudes and coastal areas mean that ozone concentrations (and therefore the level of exposure) can differ greatly from one location to another. That said, ground level ozone pollution is an ever-present fact of life that must never be under-estimated.

Even tiny traces of ozone in the air will attack the molecular structure in rubber. It also increases the acidity of carbon black surfaces with natural rubber, polybutadiene, styrene-butadiene rubber and nitrile rubber being the most sensitive to degradation. This can have several consequences such as surface cracking and a marked decrease in the tensile strength of the rubber.

Ozonolysis

Ozonolysis is the reaction that occurs between the molecular structure (double bonds) and ozone:

The immediate result is formation of an ozonide, which then decomposes rapidly so that the double bond molecule is split. The critical step in the breakdown of molecular chains is when polymers are attacked. The strength of polymers depends on the chain molecular weight or degree of polymerization. The longer the chain length, the greater the mechanical strengths including the highly important tensile strength. By splitting the chain, the molecular weight drops rapidly. There comes a point when it has little strength whatsoever and a crack forms. Further attacks occur in the freshly exposed cracks which continue to steadily grow until they complete a 'circuit' and the product separates or fails.

A partner in crime

To make matters worse, 'bad' ozone has a partner in crime that also has a seriously detrimental effect on rubber. Ultraviolet light from sunlight and fluorescent lighting accelerates rubber deterioration because it produces photochemical reactions that promote the oxidation of the rubber surface resulting in a loss in mechanical strength. This is known as 'UV degradation'.

Somewhat ironically, the rapid decline in the ozone layer in the upper atmosphere over the past several decades is allowing an increasing level of UV radiation to reach the earth's surface. Continuous exposure is a more serious problem than intermittent exposure, since attack is dependent on the extent of the exposure. As you would expect, the problem is exacerbated in sunnier, hot climates but even in the most moderate of environments, the problem is nonetheless ever-present.

Hidden effects

Ozone cracks form in rubber that is under tension. However, the critical strain needed is only very small. Even a belt that is not fitted on a conveyor has a certain amount of intrinsic tension. The cracks are always oriented at right angles to the strain axis. Ozone attack will occur at the points where the strain is greatest and the rubber is flexing in use. Splice joints are particularly prone to stress concentrations.

At first glance, fine cracks in the surface rubber may not seem to be a major problem but over a period of time the rubber becomes increasingly brittle. Transversal cracks deepen under the

repeated stress of passing over the pulleys and drums. As mentioned earlier, the ozone continues to attack so the cracks steadily grow until catastrophic failure occurs. Again, surface cracking may not initially seem to be a cause of concern but there are often other potential risks such as scrapers catching on the cracks and tearing off parts of the cover. Re-splicing can also become more and more difficult as the adhesion properties of the rubber diminish.

Yet another 'hidden' problem is that moisture seeps into the cracks. This then penetrates down to the actual carcass of the belt. In multi-ply belts, the fibres of the weft strands of the plies expand as they absorb the moisture, which in turn causes sections of the carcass to contract (shorten) as the weft strands pull on the warp strands of the ply. This can often result in tracking problems that are difficult to pinpoint and which no amount of steering idler adjustment can compensate for.

There can also be significant environmental and health and safety consequences, especially when the belt is being used to carry materials such as cement, coal or grain because fine particles of dust penetrate the cracks. This dust is then discharged (shaken out) on the return (underside) run of the belt.

Ozone damage accelerates damage caused by heat.

Magnifying other causes of damage

Apart from the damage caused in their own right, the cracking of the rubber covers by ozone and UV exposure also play a major role in magnifying other causes of damage. As the rubber covers become more brittle and lose strength they also lose the ability to resist abrasive wear. Oil-resistant belts also suffer because the cracked surface allows the oil to penetrate much more quickly and deeply leading to increased swelling and belt distortion. In heat-resistant belts, the cracks allow heat to penetrate the carcass more easily. An increase of only 10°C in the core temperature of the belt carcass can reduce the life of the belt by as much as 50%.

Excluding accidental mechanical damage, unless they are being used to transport extremely aggressive materials modern-day conveyor belts should be expected to last

for many years. However, conveyor operators continue to replace belts months and years before they should have to, completely unaware that the need to replace has almost certainly been accelerated by the effects of ozone & ultra violet.

New technology

Several years ago, we were amongst the very first in the world to make use of new technology that enabled the effects of ozone to be tested and measured. We invested in the very latest ozone testing equipment for their research and development laboratory. Mandatory testing to EN/ISO 1431 international standards was introduced for all Dunlop belting products and comparison tests also applied to samples of belts made by other manufacturers.

As a direct result, special anti-oxidant additives that act as highly efficient anti-ozonants were introduced into all Dunlop rubber compound recipes to provide protection against the damaging effects of ozone and ultra violet, thereby further extending the working life of our belts.

EN/ISO 1431 testing

To scientifically measure resistance to ozone in accordance with the EN/ISO 1431 test method, samples are placed under tension (20% elongation) inside the ozone testing cabinet and exposed to highly concentrated levels of ozone for a period up to 96 hours. Every sample is closely examined for evidence of cracking at two-hourly intervals and the results carefully measured and recorded.

Because of the sheer size of industrial conveyor belts, it is common practice amongst manufacturers and distributors to store rolls of belting in open-air storage yards. Belts can often be held in stock for long periods, sometimes for several years, before they are eventually despatched to their final destination and ultimately put to use. During that time they are vulnerable to the effects of ozone and UV radiation. A number of conveyor belt users have reported that surface cracking was apparent at the time of delivery.

Test samples are checked for cracks every two hours for 96 hours. It is vital to ensure that belts are resistant to ozone and UV.

Some rubber literally disinte-grates.

No hiding place.

The importance of having conveyor belts that are resistant to ozone and ultra violet can no longer be ignored by those that use them. Unless conveyor operators start insisting on ozone and UV resistance then belt manufacturers and suppliers will continue to ignore the issue. You will hardly ever find a belt manufacturer or supplier that even mentions ozone and UV. Please be my guest and check it out for yourself. This is because the special additives (anti-ozonants) required to create the necessary resistance cost money and at the same time help to appreciably extend the operating life of the belts they are supplying.

It may sound cynical but the reality is that it is not really in the best interests of belt manufacturers (or traders and service companies for that matter) for conveyor belts to run and run and run, particularly if they are trying to compete on price, which is pretty much the usual approach. This is especially so when you consider that a huge proportion of belting is directly or indirectly imported from Asia. We have hardly ever tested a competitor's belt (and never an Asian import belt as far as I know) that has survived the EN/ISO 1431 test specific conditions without cracking. In many cases the rubber literally disintegrates.

For all buyers of rubber conveyor belts there must now be two absolute pre-requisites when choosing any type of belt. Firstly, regardless of type, the rubber covers must always have good resistance to wear (abrasion) and, just as importantly, they must be fully resistant to the effects of ozone and ultra violet. Without these all-important properties the belt will not provide genuine value for money because it will need to be replaced far sooner than necessary.

My advice is to always insist on certification provided by the actual manufacturer that confirms that the belt you are ordering is fully resistant to ozone and ultra violet as in accordance with the EN/ISO 1431 test method.

ISO 1431. Lateral cracking. The effects of ozone on rubber.