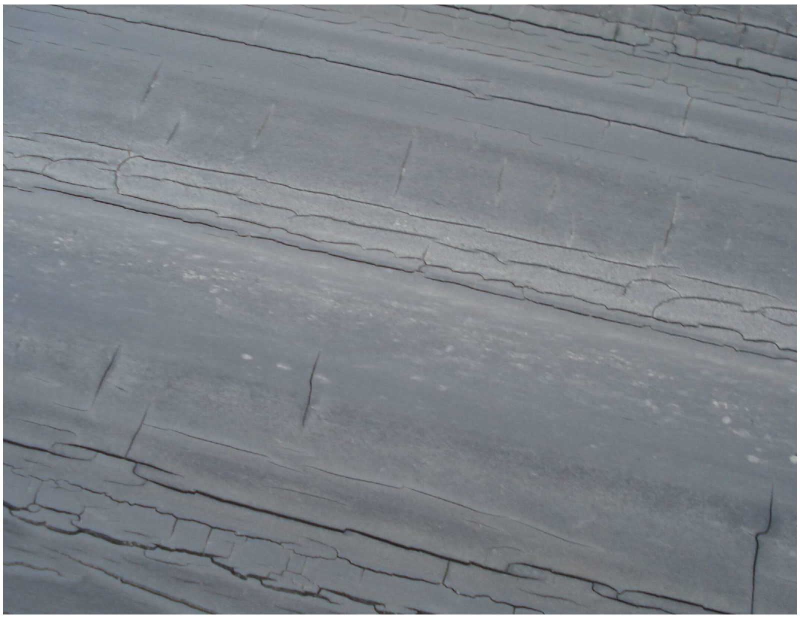
# HANDLING THE HEAT

**Dr Michiel Eijpe, Dunlop Conveyer Belting,** provides a guide to heat-resistant conveyor belts.

## Introduction

Of all the demands placed on conveyor belts, heat is without question the most unforgiving and damaging. High-temperature materials and working environments cause a rapid acceleration in the ageing process. This results in a hardening and cracking of the rubber covers. High temperatures also have a very destructive effect on the actual carcass of the belt because it damages the adhesion between the covers on the top and bottom



Cooked to perfection.

The result of poor heat-resistant rubber

of a stated specification must all be pretty much the same, providing a similar performance and operational lifetime. In reality, nothing could be further from the truth.

Conveyor belts that can genuinely cope with the heat, as well as providing a long operational lifetime, are available. This article explains the technical mumbo jumbo and provides a buyers insight into what to look for.

## High temperatures, low prices?

A well-made, good-quality, heat-resistant belt will easily out-perform and out-last economy versions many times over. The initial price per meter will be higher, because some 80% of the cost of a conveyor is in the quality of the materials used to make it. However, the truly important thing is that the cost over the lifetime of the product will ultimately be dramatically less because one good-quality, heat-resistant will out-last two or three economy belts.

## All about the rubber!

Sales and marketing people constantly use the word 'quality', but very rarely explain what it means technically. In other words: how it will benefit the customer? As a conveyor belt engineer, the first thing that this author would say when describing quality is that it is all about the rubber! The rubber covers on the top and bottom of the belt act as the barrier between the heat source and the carcass. The carcass (usually layers of polyester and nylon fabric) is bonded together by thin layers of rubber. The effectiveness of heat-resistant rubber covers is the most crucial factor in determining how long the working life of the belt will be.

If the temperature of the carcass becomes too high, then the bond between the fabric layers of the belt will, quite literally, separate. This is known as delamination. Delamination also occurs between the covers and the carcass. When operating at high temperatures, an increase of as little as 10°C in the core temperature of the belt carcass can reduce the life of the belt by as much as 40% or more. The only way to limit the effects and slow degradation is to use a very high-quality rubber that has been specially engineered using a complex mix of polymers, chemicals, and additives. It is important to bear in mind that, in order to provide

of the carcass, as well as between the inner plies contained within the carcass. The layers of the belt literally detach themselves. This is known as delamination.

As rubber becomes harder and less elastic the tensile strength and elongation (stretch) can fall by as much as 80%, effectively destroying its overall operational strength and flexibility, as well as seriously weakening the splice joints. At the same time, the rubber's ability to resist abrasion decreases to the extent that the wear life of the belt can be shortened by as much as 40% or more.

With so much that can go wrong, it is even more surprising that decisions on buying heat-resistant belt are still usually based on the lowest selling price. This is due to the common (and very mistaken) belief that heat-resistant conveyor belts

Heat-resistant belts usually have less resistance to abrasion.

The heat build-up in enclosed environments is far higher than conventional conveyors.

the longest possible working life, the rubber not only needs to withstand heat but also other demands, such as wear (abrasion), cutting, ozone, and ultra violet.

## How are belts tested for heat resistance?

To provide the most accurate measurement of heat resistance (and therefore anticipated working life), accelerated ageing tests are conducted by placing rubber samples in high-temperature ovens for a period of seven days. The reduction in mechanical properties is then measured. The three classes of aging within ISO 4195 are: Class 1 (100°C), Class 2 (125°C), and Class 3 (150°C). In order to include more extreme temperature-resistance qualities, Dunlop also carries out testing at 175°.

## Making your choice: what to consider

There are three key factors to consider when choosing a hea-resistant belt. The first and most critical consideration is the actual temperature range of the materials being carried on that conveyor. The temperature limits that a belt can withstand are viewed in two ways: the maximum *continuous* temperature of the conveyed material and the maximum *temporary* peak temperature. The two main classifications of heat resistance recognised in the market are T150, which relates to a maximum continuous temperature of 150°C, and T200, which is for more extreme heat conditions of up to 200°C. Success or failure will depend on having accurate temperature data to give to potential belt suppliers.

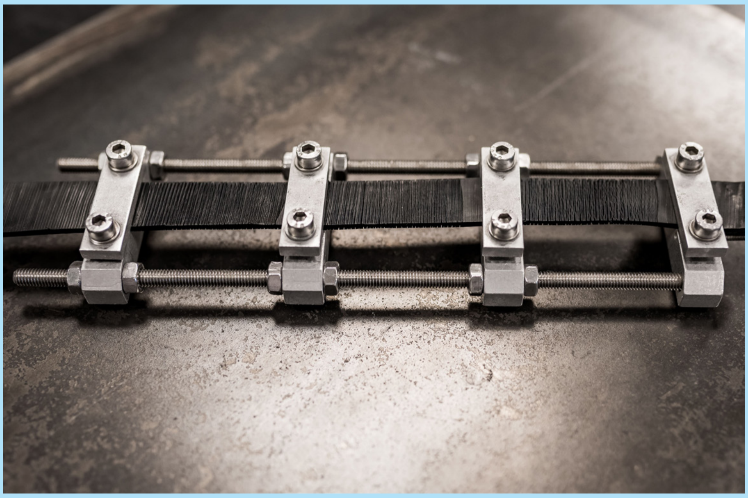
The third factor is the length (and running speed) of the conveyor because the shorter the conveyor then the less time there is for the belt to cool down on the return (underside) run. Belts generally wear faster on short conveyors, so having a heat-resistant belt with good abrasion resistance is even more important than usual. Very hot, abrasive materials being carried at speed on a short conveyor is the worst possible

**Ozone & UV resistance**

Apart from being able to resist heat, all above-ground conveyor belts, without exception, also need to have first-class resistance to the effects of ozone and sunlight (UV).

At high altitude, ozone acts as a protective shield, but at ground level it is a pollutant. Its effects on rubber are known as ozonolysis. Search for 'the effects of ozonolysis on rubber' on the internet will yield the information that tiny traces of ozone in the air will attack double bonds in rubber chains, with natural rubber, polybutadiene, styrene-butadiene rubber and nitrile rubber being most sensitive to degradation.

Exposure to ozone increases the acidity of carbon black surfaces and causes reactions to take place within the molecular structure of the rubber. This can have several consequences, such as a surface cracking, a marked decrease in the tensile strength of the rubber and consequently a much shorter belt life. The same applies to exposure to UV light (including fluorescent light) and is referred to as UV degradation.



Ozone test sample.

Apart from the damage caused in their own right, the cracking of the rubber covers by ozone and UV exposure also plays a major role in magnifying other causes of damage. The cracks allow heat to penetrate the carcass more easily. At the same time, as the rubber becomes more brittle and loses strength, it also loses the ability to resist wear.

Even more significant are the environmental and health and safety consequences because the dust particles penetrate the cracks in the belt surface and are then discharged (shaken out) on the return (underside) run of the belt. Yet few belt manufacturers mention ozone and UV, because it requires expensive special additives in the compound to create the resistance. To ensure UV and oxone resistance, insist on a certification confirming that the belt has successfully passed the EN/ISO 1431 test.

combination. In conveyor belting it is the 'perfect storm', and belts often last only a few weeks or months before having to be replaced. However, do not simply accept the situation because there are belts available that will provide at least double the lifetime.

## Heat and wear resistant?

The biggest downside to heat-resistant rubber is that the treatments used to create the heat resistance can also have a very negative effect on the rubber's ability to resist abrasion. As the covers protecting the carcass become thinner, the level of heat protection is gradually reduced. This invariably results in belts having to be replaced at much more frequent intervals than necessary.

Dunlop's traditional strategy has always been to maximise the working life of belts. Longest possible life is therefore the golden rule for all of the company's belts. For heat-resistant belting, Dunlop has developed rubber cover compounds that possess a combination of both heat and wear resistant qualities. This results in a much longer operational lifespan. For example, ISO 4195 laboratory testing has shown that following continuous exposure to 150° for seven days, Dunlop Deltahete retains its original (pre-test) resistance to abrasion.

When deciding on which type of heat-resistant belt to order, buyers are recommended to be very specific in their requests for quotations from manufacturers and suppliers. Always request technical datasheets; however, be aware that most manufacturers only provide technical datasheets that show the *minimum* required standards, rather than the actual standards that their belt can be expected to achieve. There can be a very big difference: the belt delivered to site may well not be up to the required standard.

## The weakest link

The splice joint is always the weakest point in any belt – and this is especially so when it comes to heat-resistant belts. The build up of heat in the splice joint area will cause the joint to delaminate. The golden rule is to always use splice materials that are designed for the specific belt quality (cover grade), preferably supplied by the company that manufactured the belt. It is essential that the heat-resistance properties of the splice materials are as good as the actual belt covers.

## The ultimate test?

The ultimate test of heat-resistant belting is usually bucket elevator systems because the heat build up in enclosed environments is far higher than conventional conveyor systems. Bucket elevator belts need to operate under high tensile loads and be able to withstand material temperatures as high as 130°C. Conventional textile-reinforced belts cannot withstand this kind of treatment and will stretch permanently. Ideally, bucket elevator belts should be steel reinforced.

Failure of a bucket elevator belt can be catastrophic, both in terms of physical risk, as well as downtime. As always, the price of the belt invariably reflects the quality, so whenever safety is involved, short-term cost savings should never be a consideration.

## Keep it moving

Apart from an insufficient resistance to heat, the most common cause of failure in heat-resistant belts comes when a belt loaded with hot material is allowed to become static. This allows the heat to penetrate through to the carcass. Even the very best heat-resistant belts can be easily damaged beyond repair, if a loaded conveyor is allowed to stop.

Unless it is for emergency safety reasons, the loading feed to the conveyor should be stopped first and the belt allowed to fully discharge its load before being stopped. It is important to make sure that belts are not overloaded, so that there is sufficient 'unloaded' space on either side of the belt surface to allow some of the heat to escape via the cooler outer edges.

## Do not give up

My final message to all cement plant engineers would be this: never accept that your belts only last short periods of time. There is no such thing as a sacrificial belt. Opting for genuine quality and working on the basis of lowest lifetime cost rather than lowest short-term price will avoid trouble and stress and save your company a lot of money at the same time.

## About the author

Dr Michiel Eijpe is Technical Director of Dunlop Conveyor Belting in the Netherlands. A former University Lecturer, he has worked in the conveyor belt industry for over 20 years. Dr Eijpe has a Phd in fibre-reinforced polymer composites and is a leading light in the development of high-performance conveyor belting and conveyor belt manufacturing technology.