COOKED TO PERFECTION?

Conveyor belt specialist, Leslie David, explains what happens when heat and rubber come together and why some heat resistant conveyor belts are able to provide longer working lifetimes than most would think possible.

The cement industry is by far the biggest consumer of heat resistant conveyor belting. Other than fire, it is hard to think of anything more damaging to rubber than extremely high temperatures, which is why conveyor belts in cement plants all over the world are being replaced with frightening regularity. This article will look at what happens when heat and rubber come together and why some heat resistant conveyor belts are able to provide longer working lifetimes than previously thought possible.

A destructive combination

High temperature materials and working environments create a combination of highly destructive forces for rubber conveyor belts. First and foremost, heat causes a rapid acceleration in the ageing process of the rubber, which causes it to harden and crack. High temperatures also have a seriously detrimental effect on the inner carcass of the belt because it damages the adhesion between the covers on the top and bottom of the carcass and between the inner plies contained within it. The result, known as 'de-lamination', is that the layers of the belt literally detach from one another.

As rubber becomes harder and less elastic, its tensile strength and elongation (stretch) can be reduced by as much as 80%. This effectively destroys the operational strength and flexibility of the belt including a serious weakening of the splice joints. At the same time, the surfaces of the belt begin to wear much faster than they would under normal circumstances because the resistance to abrasive wear diminishes by as much as 40% or more. In short, exposure to high temperature materials and working environments can shorten the life expectancy of a rubber conveyor belt like no other.

A sadly common misconception is that all heat resistant conveyor belts of a stated specification will provide a roughly similar performance and operational lifetime. Although in reality nothing could be further from the truth, the selection of heat resistant belts continues to be primarily driven by up-front price rather than whole life cost.

An increase as little as 10°C in core temperature can cause a belt to fall apart.

Dual role

The heat resistant properties of the rubber have to perform a dual role. Firstly, the rubber has to maintain its own integrity by not hardening, cracking or losing its tensile strength, elongation and wear resistance. At the same time, it must also be able to prevent as much heat as possible from penetrating the carcass. Protecting the carcass is key because if the core temperature becomes too high, then the bond between the covers and fabric layers can separate (delaminate) and the belt will quite literally begin to fall apart.

An increase as little as 10°C in core temperature can reduce the life of the belt by as much as 50%. The only way to limit the effects and slow down the degradation is to use very highly engineered rubber that has been specially designed to cope with the temperatures that the belt is required to endure. Cutting corners and cutting costs when making the rubber compound is the equivalent of cutting the life expectancy of the belt.

Heat resistant rubber – a complex cocktail

The vast majority of rubber used to make heat resistant conveyor belts is synthetic. This is because synthetic (man-made) rubber is far more adaptable than natural rubber and can be more precisely engineered to cope with the many different, often combined sets of physical demands placed on conveyor belts. Each different rubber compound consists of a complex 'cocktail' involving a huge range of different chemical components, polymers and other essential substances. In the case of heat resistance, the rubber not only needs to protect itself and the belt carcass, it also needs to have good wear resistance, tensile strength and durability. In addition, the rubber needs to be fully resistant to the damaging effects caused by ground level ozone and natural exposure to ultra violet light which, very much like high temperatures, causes surface cracking and a marked decrease in the tensile strength of the rubber. This is why *any* rubber conveyor belt for any purpose is ultimately only as good as the quality of the rubber used to make it. Consequently, it is also the reason why some heat resistant belts seem to run and run without problem while others literally crack up and fall apart in a matter of weeks or months. Finally, and equally importantly, the rubber should also conform to European REACH regulations so that the end-product is safe to handle.

Delamination – the layers of the belt detach themselves.

The best of both worlds – Dunlop Betahete exceeds ISO 4195 class T150 requirements and has an average abrasion resistance that is better than DIN X (ISO 14890 'H').

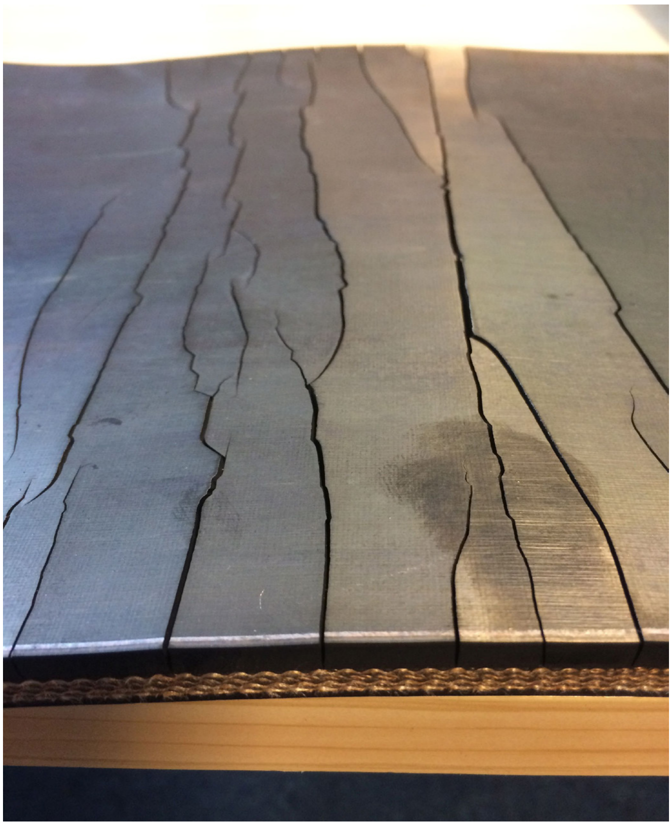
Appearances can be deceptive

Especially when it comes to conveyor belting, appearances can be very deceptive. Visually, all heat resistant belts with the same basic specifications, such as number of plies, will appear to be identical. Expecting that the heat resistant qualities, overall performance and working lifetime will also be roughly the same is therefore not an unreasonable assumption. However, the quality of the rubber will have the biggest bearing on the performance and cost-effectiveness of the belt. The rubber used for conveyor belts usually constitutes at least 70% of the material mass and is therefore the single biggest element of cost when manufacturing a conveyor belt. Consequently, for manufacturers who want to compete for business based on price rather than operational longevity, rubber is their biggest opportunity to minimise costs. This is precisely why the alarm bells should start to ring if there is a significant difference between the prices being quoted for belts of apparently the same specification. The reason why the price of one belt can be 30% or 40% lower compared to another seemingly identical one is because there is a direct correlation between the price and the quality of the rubber. There is a very old saying, but it remains true to this day: "you only get what you pay for."

The art of deception

Three of the most common methods used by less scrupulous manufacturers (especially those outside of the EU) to minimise the cost of the rubber includes the use of recycled rubber, often of highly questionable origin. A second deception is the use of cheap 'bulking' fillers such as chalk to replace part of the rubber polymers in the rubber compound.

Some 20% of synthetic rubber compounds consist of carbon black, which means that it has a notable impact on the overall cost of making a conveyor belt. Good quality carbon black is an expensive commodity because it is created by a process of burning oil in a strictly controlled, low oxygen environment. To create a much cheaper, albeit lower grade form of carbon black, the practice of burning used rubber car tyres is becoming increasingly commonplace. However, burning used car tyres means that any oils and greases and other undesirable elements contained within this 'regenerated' material will have a detrimental effect on the physical



Cracking evidence – not all heat resistant belts perform the same.

Lower prices often mean lower quality rubber and shorter belt lifetimes.

Avoid overloading – uncovered belt surface area allows heat to escape.

properties of the rubber compared to good quality carbon black.

ISO 4195 testing

To provide the most accurate measurement of heat resistance, accelerated ageing tests are carried out by placing rubber samples in high temperature ovens for a period of 7 days. Literally speaking, the rubber is 'cooked'. The reduction in mechanical properties such as tensile strength, elongation etc are then measured. The three 'classes' of ageing within ISO 4195 are: Class 1 (100°C), Class 2 (125°C) and Class 3 (150°C). In order to maximise temperature resistance qualities, manufacturers like Dunlop also carry out testing at 175°C.

Making a choice

There are three key factors to consider when choosing a heat resistant belt. The 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 up to 200°C. Providing potential suppliers with accurate temperature data relating to the actual conveyor application is extremely important.

The next consideration is the type and nature of the materials being conveyed. Materials with fine particles such as cement usually cause a greater concentration of heat on the belt surface due to the lack of air circulation between the particles. By comparison, even though the temperature of the material can be extremely high, the larger sized particles of coarse materials such as clinker allow a better circulation of air.

Bearing this in mind, the actual loading of the belt is an important consideration because if too much of the belt surface is covered by material there may be insufficient uncovered surface to allow the heat in the belt carcass to dissipate. This means that heat can build up within the covers and within the core of the carcass. This problem is even more applicable to conveyors that have a relatively short (less than 50 m) centre-distance length because the shorter the conveyor, then the less time there is for the belt to cool down on the return (underside) run. The running speed of the belt should also be taken into consideration.

Any belt will generally wear faster on a short conveyor simply because it passes the loading and unloading stations (where materials are accelerated across the belt surface) more frequently than longer belts, so having a heat resistant belt with good abrasion resistance is even more important than usual. The combination of very hot, abrasive materials being conveyed at speed on a short conveyor is the toughest one of all and many heat resistant belts often last only a few weeks or months before having to be replaced. If this occurs, it should not be simply accepted as an inevitable consequence of a tough working environment. The fact is that there are heat resistant belts available that are capable of lasting two or three times (or more) longer than might be expected.

Heat and wear resistant – the best of both?

Apart from not being able to literally 'handle the heat', another common problem with heat resistant belts is that they tend to wear out much more rapidly than straightforward abrasion resistant belts. The reason for this is that the special chemicals and polymers used to create the heat resistance properties usually also have a very negative effect on the rubber's ability to resist abrasive wear. This is a double-edged sword because as the covers become thinner, then the level of protection they provide for the inner carcass is steadily reduced. This invariably results in belts having to be replaced at unacceptably frequent intervals.

Fortunately, this costly shortcoming is not evident in all heat resistant belts on the market. For example, Dunlop Conveyor Belting in The Netherlands claims to have overcome this problem many years ago. The Dunlop Betahete ISO 4195 class T150 is designed to handle materials at continuous temperatures up to 160°C and peak temperatures as high as 180°C. At the same time, Betahete possesses an impressive resistance to wear with an average abrasion resistance of 112 mm^3, which is even better than the requirement of 120 mm^3 applicable to DIN X (ISO 14890 'H').

Checking the data

When deciding on which type of heat resistant belt to order, it is always important to try and be as specific as possible when making requests for quotations from manufacturers and suppliers. It is important to always request technical datasheets. However, be aware that with only one exception that the author is aware of, virtually all manufacturers only provide technical datasheets that show (claim) the minimum required standards rather than the standards that the belt they deliver can be expected to achieve. In many cases technical datasheets can be very misleading because the impressive looking reference numbers shown on them often only refer to the test methods used rather than the actual performance achieved during that testing. There can often be a very big difference between what is promised and what is actually delivered to site.

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Keep it moving

Even the very best heat resistant belts can easily be damaged beyond repair if a conveyor belt loaded with hot material is allowed to stop, even for a relatively short period, because heat is allowed to build up and penetrate through to the core of the carcass. In fact it is one of the most common causes of failure and arguments over warranty. 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.

Never give up

Cement plant engineers should never accept that belts can only ever be expected to last a short period of time. There is no such thing as a 'sacrificial' belt. By going for genuine quality and working on the basis of lowest lifetime cost rather than lowest price, it is possible to save a lot of trouble, stress and money at the same time. ■

About the author

After spending 23 years in logistics management, Leslie David has specialised in conveyor belting for over 14 years. During that time, he has written numerous technical guidance features and papers and has become one of the most published authors on conveyor belt technology in Europe.