Handling the heat: The search for longer lasting heat resistant conveyor belts*)

Of all the demands placed on conveyor belts within the cement industry, heat is without doubt the most unforgiving. There are several different damaging effects caused by high temperature materials and working environments. First and foremost, heat causes a rapid acceleration in the ageing process of the rubber (❱ Fig. 1). 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 of the carcass and the adhesion between the inner plies contained within the carcass. The layers of the belt literally detach themselves and this is referred to as 'de-lamination' (❱ Fig. 2).

As rubber becomes harder and less elastic the tensile strength and elongation (stretch) can be reduced by as much as 80 %. This effectively destroys the overall operational strength and flexibility of the belt as well as seriously weakening the splice joints. At the same time, the surface covers of the belt begin to wear down rapidly because resistance to abrasive wear diminishes by as much as 40 % or more. In a nutshell, exposure to high temperature materials and working environments creates a perfect storm that can shorten the life expectancy of a rubber conveyor belt like nothing else.

This makes it even more surprising that decisions on buying a heat resistant belt are still usually based on the lowest price. This is due to the common misconception that all heat resistant conveyor belts of a stated specification will provide a roughly similar performance and operational lifetime. In reality, nothing could be further from the truth.

The heat resistant rubber covers on the top and bottom of the belt act as the barrier between the heat source and the carcass, which usually consists of layers of polyester and nylon fabric bonded together by thin layers of rubber. The heat resistant properties of the covers need to be good enough to do two things – maintain their own integrity by not hardening, cracking or losing their tensile strength, elongation and wear resistance while at the same time preventing as much heat as possible from penetrating the carcass. Protecting the carcass is absolutely essential because if the core temperature becomes too high then the bond between the covers and fabric layers will 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 % (❱ Fig. 3). 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 levels of 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

Virtually all 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 during their working lifetime. 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 effects of ozone and ultra violet light and should also conform to European REACH regulations so that the end-product is safe to handle. 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.

Especially when it comes to conveyor belting, appearances can be very deceptive. Visually, all heat resistant belts look virtually identical. The basic specifications such as tensile strength and number of plies may also be identical. Therefore, it should not be unreasonable to expect that the heat

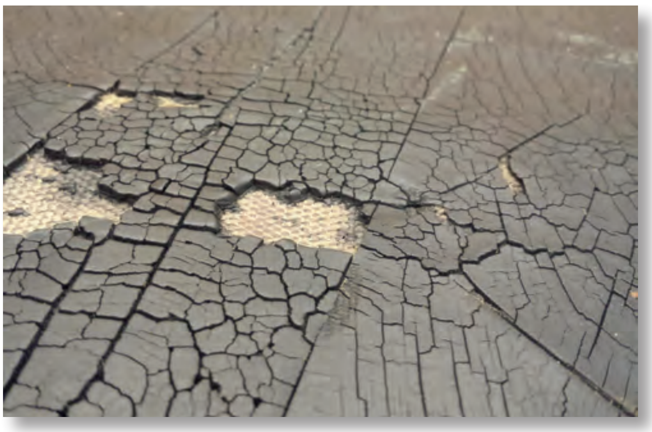

Figure 1: A heat stressed conveyor belt surface

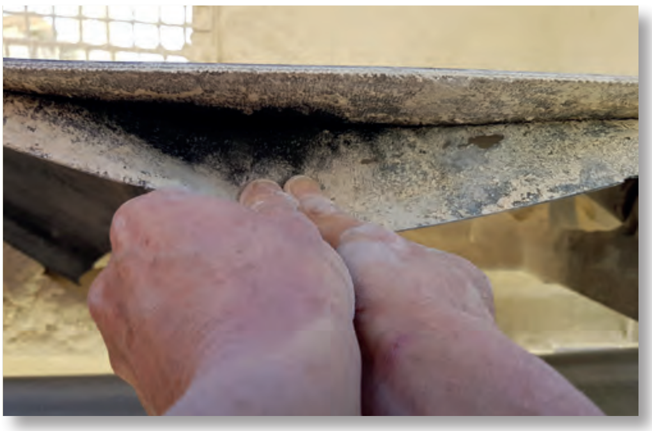

Figure 2: Delamination – the layers of the belt detach themselves

*) Experiences of L. Williams, Dunlop Conveyor Belting, Netherlands

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Figure 3: An increase as little as 10 °C in core temperature can cause a belt to fall apart

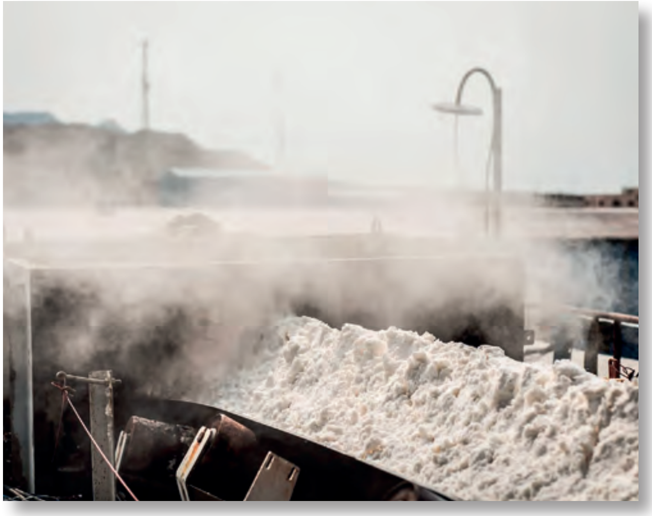

Figure 4: Avoid overloading – uncovered belt surface area allows heat in the belt to escape

resistant qualities, overall performance and working lifetime will be roughly the same. Don't be fooled. 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, in the highly price-competitive conveyor belt market, for manufacturers who want to compete for business based on price rather than performance and operational longevity, rubber is the single 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. The reason why the price of one belt is 30 or 40 % (or more) lower compared to one of a seemingly identical specification is because ultimately, there is a direct correlation between the price and the quality of the rubber. There is no doubt that the quality of the rubber will have the biggest bearing on the performance and cost-effectiveness of the belt.

The tricks of the trade

The two most common methods used by some manufacturers (especially those outside of the EU) to minimize the cost of the rubber are the use of recycled rubber (often of highly questionable origin) and the use of cheap 'bulking' fillers such as chalk to replace part of the rubber polymers in the rubber compound. Another practice is the burning of used rubber car tyres to create a cheap form of carbon black. Some 20 % of synthetic rubber compound consists of carbon black so it has a notable impact on the overall cost of making a conveyor belt. Good quality carbon black is quite costly because it is created by a process of burning oil in a strictly controlled, low oxygen environment. But burning used car tyres means that any oils and greases and other undesirable elements contained within 'regenerated' materials will have a detrimental effect on the physical properties of the rubber compared to good quality carbon black.

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. 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, Dunlop also tests at 175 °C.

The three key factors for choice

There are three key factors to consider when choosing a heat 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 recognized 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. Success or failure will depend on having accurate temperature data to give to potential belt suppliers.

The type and nature of the materials being conveyed is the next consideration. 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. In the case of coarse materials such as clinker, although the temperature of the material can be extremely high, larger sized particles allow a better circulation of air. The actual loading (➧ Fig. 4) of the belt also needs to be carefully considered 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.

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. Any belt will generally wear faster on a short conveyor so having a heat resistant belt with good abrasion resistance is even more important than usual. Very hot, abrasive materials that are being conveyed at speed on a short conveyor is the toughest combination of all and many heat resistant belts often last only a few weeks or months before having to be replaced. But there are heat resistant belts available that are capable of lasting two or three times (or more) longer.

Heat AND wear resistance?

Apart from not being able to literally 'handle the heat', another extremely common negative associated with heat resistant rubber is that the treatments used to create heat resistance properties usually also have a very negative effect on the rubber's ability to resist abrasive wear. Heat resistant belt covers usually wear far more rapidly than non-heat resistant covers. This is a double-edged sword because as the covers become thinner the level of heat protection they provide for the carcass is steadily reduced. This invariably results in belts having to be replaced at much more frequent intervals.

Therefore Dunlop has developed heat resistant rubber cover compounds that possess an almost unique combination of both heat and wear resistant qualities. For example, the 'basic' heat resistant cover, Betahete, consistently exceeds the requirements demanded by ISO 4195 class T150. Betahete is a high performance heat and wear resistant cover designed for materials at continuous temperatures up to 160 °C and peak temperatures as high as 180 °C. It has an amazingly high resistance to wear with an average abrasion resistance of 112 mm³, which is even better than DIN X (ISO 14890 'H'). This results in a much longer operational lifespan.

For more extreme temperatures and demanding heavy-duty service conditions such as cement plants where very hot and abrasive materials are conveyed Dunlop Deltahete is recommended. Deltahete is designed to withstand maximum continuous temperature of the conveyed material as high as 200 °C and extreme peak temperatures as high as 400 °C. It exceeds the highest requirements of Class 3 and is therefore effectively Class 4, although this category does not yet exist within the ISO 4195 classifications for heat resistance. The search for longer lasting heat resistant conveyor belts really is not difficult at all.

For belts that need to be resistant to oil as well as heat, Dunlop's BV GT could well be the solution. It is heat resistant (up to150 °C continuous with peaks up to 170 °C) combined with the highest level of oil resistance. It is even fire resistant (EN 12882 Class 2A) and, as with all Dunlop rubber compounds, it has excellent abrasion resistance and is fully resistant to ozone and ultraviolet.

Data checking and some useful hints

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. In many cases technical data sheets can be very misleading because the impressive looking reference numbers often only refer to the test methods used rather than the actual performance achieved under such testing. There can often be a very big difference between what had been promised and what is actually delivered to site.

Apart from an insufficient resistance to heat, the most common cause of failure in heat resistant belts is 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 easily be 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 over-loaded so that there is always sufficient 'unloaded' space on either side of the belt surface to allow some of the heat to escape via the cooler outer edges.

The final message to all cement plant engineers is, never to accept that belts can only ever be expected to last a short period of time. ◂