Too hot to handle?

The high temperatures experienced when transporting clinker in cement plants place special demands on conveyor belts and carcasses. To minimise costly repairs and plant shutdowns, a guide to selecting a heat-resistant conveyor belt is presented below, taking into account the key factors for consideration.

■ *by **Dr Michiel Eijpe**, Dunlop Conveyor Belting, The Netherlands*

Of all the demands placed on conveyor belts operating in the cement industry, heat is widely regarded as the most unforgiving and damaging. High-temperature materials and working environments cause an accelerated aging process that results in a hardening and cracking of the rubber covers. Heat also has a very destructive effect on the carcass of the belt because it damages the adhesion between the covers on the top and bottom of the carcass, and also between the inner plies contained within the carcass. This is commonly referred to as 'delamination'.

As rubber becomes harder and less elastic, the tensile strength and elongation (stretch) can fall by as much as 80 per cent, effectively destroying its overall operational strength and flexibility as well as seriously weakening the splice joints. At the same time, resistance to abrasion (wear) can decrease by 40 per cent or more.

With so many potential issues, it is even more surprising that decisions on buying heat-resistant belts are still often based on the lowest selling price. This is due to the common but mistaken belief that all heat-resistant conveyor belts of a stated specification will give a similar performance and operational lifetime.

High temperatures, low prices?

'Low-price' heat-resistant conveyor belts are priced as such because the materials and processes used to make them are the lowest-cost (and therefore, lowest-quality) options.

Some 80 per cent of the cost of making a conveyor belt is the materials. A well-made, good-quality heat-resistant belt will easily outperform and outlast 'economy' versions several times over.

The initial price per metre may be higher, but the eventual cost will ultimately be many times lower.

Heat is widely recognised as the most unforgiving and damaging factor in conveyor belt life

It's 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 consists of layers of fabric (usually polyester and nylon), bonded together by thin layers of rubber. The effectiveness of the heat-resistant rubber covers is the most crucial factor that determines the length of the belt's working life.

If the core temperature of the carcass becomes too high then the belt will start to fall apart. This 'delamination' process also occurs between the covers and the carcass. 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 per cent. The only way to prevent this is to use high-quality, specifically-developed rubber containing a mix of polymers and chemicals that can withstand the heat.

ISO 4195 heat resistance testing

To provide the most accurate measurement of heat resistance (and therefore, anticipated working life) accelerated aging 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)
- Class 3 (150˚C).

To include more extreme temperature resistance qualities, Dunlop testing is also carried out at 175˚C.

Key selection factors

There are three key factors to consider when choosing a heat-resistant belt.

1. Temperature range of materials being carried

The first and most critical consideration is the actual temperature range of the materials being carried on the conveyor. The temperature limits that a belt can withstand are viewed in two ways: the maximum continuous


High temperatures cause an accelerated aging of the belt's rubber material

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. Success or failure will depend on having accurate temperature data to give to potential belt suppliers.

2. Type and nature of materials being carried

The second factor relates to the type and nature of the materials being carried. Materials with fine particles such as cement often 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 for better air circulation. The actual loading of the belt needs to be considered in conjunction with the type of material because if too much of the belt surface is covered by material there may be insufficient uncovered belt surface to allow the heat in the belt carcass to dissipate.

3. Length and running speed of conveyor

The third factor is the length (and running speed) of the conveyor. The shorter the conveyor, the less time there is for the belt to cool down on the return (underside) run. Short conveyors also cause the belt to wear faster so a heat-resistant belt with good abrasion resistance is more important than normal. Very hot, abrasive materials being carried at speed on a short conveyor is the worst possible combination. Effectively, it is 'the perfect storm'. In such cases, belts often last only a few weeks or months before having to be replaced. However, this situation should not be accepted because there are belts available that will provide at least double the lifetime.

Heat- and wear-resistant?

The biggest 'disadvantage' to rubber that has a high heat resistance is that the treatments used to create the heat resistance have a very negative effect on the rubber's ability to resist abrasion. Therefore, they invariably need to be replaced at much more frequent intervals because of wear compared to standard rubber belting. At Dunlop this dilemma has been solved by developing rubber cover compounds that have a virtually unique 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˚C for seven days, the Dunlop Deltahete retains its original (pretest) resistance to abrasion.

When deciding on which type of heat-resistant belt to order, Dunlop advises buyers to be very specific when making requests for quotations from manufacturers and suppliers and to always ask for technical datasheets. However, even these can often show only the minimum required standards rather than the standards that the belt can be expected to achieve. The actual 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 heat build-up in the splice joint area will cause the joint to come apart (delaminate).

The golden rule applicable to all splice joints is that the splice materials used to make the joint should be identical to the


Keeping the load moving can help to overcome issues with insufficient heat dissipation

Quality conveyor belts suited to the materials they carry provide longer lifetimes and less downtime for repairs

Hot clinker transport

To transport hot clinker, a cement plant in Spain had used heat-resistance belts from a number of different suppliers over the years but had found these belts only lasted about 4-5 months before they required replacement.

These very short average belt lifetimes resulted in considerable cost to the cement producer and a different solution was needed. Taking into consideration the characteristics of the clinker, which has a continuous material temperature of around 150˚C, Dunlop recommended 500/3 5+2 Deltahete.

The introduction of the Deltahete conveyor belt has considerably improved average conveyor belt life. Some 19 months after installation, the belt remains in good condition, lasting already more than three times than the previous belts.

rubber used in the belt cover. 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 can often be found in elevators because the heat build-up in enclosed environments is far higher than in conventional conveyor systems. 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, elevator belts should be steel-reinforced.

Failure of an elevator belt can be catastrophic, both in terms of physical risk and production downtime. As the price of the belt invariably reflects the quality, 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 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 ensure that belts are not overloaded so that there is sufficient 'unloaded' room on either side of the belt surface to allow some of the heat to escape via the cooler outer edges.

Dunlop solutions

Dunlop engineers have developed rubber compounds that can handle even the most extreme conditions. For example, the company's '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. Betahete has a high wear resistance with an average abrasion resistance of $96mm^3$, higher than ISO 14890 'D', the highest ISO abrasion standard.

For belts that need to be resistant to oil as well as heat, Dunlop's BV GT is heat resistant (up to 150˚C continuous with peaks up to 170˚C) combined with the highest level of oil resistance. It is also resistant to fire (ISO 340), abrasion and ozone.

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 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 therefore is effectively 'Class 4', although this category does not yet exist within the ISO 4195 classifications for heat resistance.

If cement plants select conveyor belts in terms of quality and lowest lifetime cost rather than lowest short-term price, significant cost savings can be made. ■

"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."