Leslie David, Conveying Expert

Tightening the belt

Factors to look out for to reduce conveyor belt expenditure...

Above: After spending 23 years in logistics management, Leslie David has specialised in conveyor belting for over 13 years. During that time, he has written numerous technical guidance bulletins and is one of the most published authors on conveyor belt technology in Europe.

Below: Conveyors in the cement sector take a beating. Cheap ones may be appealing but won't last the course.

Conveyors continue to be the most effective method of moving bulk materials in the cement industry. The conveyor belts themselves are often the most vulnerable component and their durability, reliability and cost are critical factors in both productivity and cost management.

The technology used to manufacture conveyor belts has advanced enormously in recent years. Today's users should expect belts to provide operational lifetimes at least 2-3 times longer than those seen even 5-10 years ago. However, most operators continue to replace belts far more frequently than they should need to. Here, conveyor belt specialist Leslie David provides an insight into how taking a slightly more technical approach can significantly reduce the costs of replacing conveyor belts.

Evaluating the *true* cost

Before we talk about the technical aspects of conveyor belts and how to get the best value, let us first deal with the issue of price. Although sales people will maintain that making a choice based on price rather than the quality of the product is not the best way to make a decision, the fact remains that conveyor belts are costly items: price *does* come into it. Also, whether they admit it or not, buyers will almost invariably have price as a major, if not *the* major factor selection criterion. However, in the case of complex components like conveyor belts, knowing its price is not an accurate measure of its value.

The economic value of a conveyor belt can only be properly established (or estimated in advance) by calculating the 'whole life' cost. This is simply done by adding the price paid to other known associated costs such as fitting, repairs and maintenance. The total is then divided by either its actual (or anticipated) operational lifetime in weeks, months, years or operational hours or, alternatively, by the tonnage carried. In my experience it is surprisingly rare to find a conveyor operator that makes such calculations. Some do not even seem to keep date records of when belts are replaced.

Over the years I have often shaken my head in disbelief when I see buyers of conveyor belts that are convinced they are getting a good deal because the price is significantly lower than other offers. Many completely ignore the fact that they will most probably have to use two or three of these 'super value' belts when in reality a single, good quality belt would cost considerably less in real terms.

What is 'quality'?

Almost every salesperson in the world uses the word 'quality' to describe the products they are selling. When it comes to conveyor belts, how can 'quality' be defined and how can it be evaluated? What is 'quality'?

Industrial conveyor belts may simply look like lengths of thick black rubber but the truth is they are surprisingly complex. Perhaps the question I am most often asked is *'How can there be such huge differences in price between one belt supplier/manufacturer and another for belts of apparently the exact same specification?'* The answer lies in the cost make-up of producing a conveyor belt.

There can never be a fixed formula due to the wide variety of individual belt specifications, but the influence of raw material costs on the selling price is hugely significant. As a general 'rule of thumb', raw materials represent some 70% of the cost of producing a conveyor belt. General overheads make up no more than around 10%. Thanks to the high level of automation, the labour cost element is very low. You would not expect to see more than three or four people manning a typical production line. This fact certainly shoots down the usual assumption that low prices of belts imported from Asia are only lower because their labour costs are much lower than in developed markets.

When faced with a huge difference in price and the fact that raw materials make up the vast bulk of the total manufacturing cost, it is perfectly reasonable to conclude that materials of a lower quality have been used. The pressure to keep costs to an absolute minimum also means that recycled rubber of highly questionable origin may well have been used in the mix. Another cost-saving method is to use cheap 'bulking' fillers to replace part of the rubber polymers in the rubber compound.

Fortunately, the tell-tale signs to look for when evaluating the quality of a conveyor belt can be broken down to its two main constituent parts - the carcass and the covers that protect the carcass.

The carcass

By far the most commonly used type of conveyor belts are those with a multiple layer of reinforcing fabric (usually polyester/nylon) carcass construction known as 'multi-ply' belts. The top and bottom of the carcass is covered by an outer protective layer of rubber. It is the carcass that provides the inherent characteristics of a conveyor belt such as its tensile strength and elongation (elasticity or 'stretch' under tension). Although they may be the same basic specification, there are often huge differences in the actual quality of the fabric plies between one belt and the next.

Nowadays it is unusual to find a fabric that has inadequate tensile strength, so simply comparing tensile strength data will not help. In lower quality (lower cost) fabrics, although the amount of material used in the longitudinal strands of the fabric may be adequate, the amount of transversal weft material is kept to an absolute minimum in order to reduce cost. Although the required tensile strength is achieved, rip and tear resistance is reduced and elongation (stretch) is low. Low elongation may sound good in principle but if the elongation is too low then this can cause problems with transition distances, as well as a general inability to accommodate the contours of the conveyor and its drums and pulleys. Ultimately, this leads to the premature failure of the belt.

Not what they seem

A method of cost cutting that is now becoming worryingly common is the use of totally polyester (EE) fabric plies in a carcass that is declared as having an EP carcass (polyester/nylon mix) construction. The whole basis of using a mix of polyester and nylon fabric is that it has the best balance of mechanical properties that allow a conveyor belt to run straight and true, to trough, to flex round pulleys and drums, stretch, have the optimum transversal rigidity, longitudinal strength and much more besides. As I said earlier, conveyor belts are surprisingly complex components.

Above: What is a 'quality' conveyor belt?

The use of totally polyester (EE) fabric compromises a whole range of essential mechanical properties. The biggest danger is that a polyester weft can cause low transverse elasticity, which reduces both the troughability and impact-resistance of the belt. This consequently causes tracking issues. In addition, less weft in the belt can also reduce rip resistance, fastener strength and the belt's ability to handle small pulley sizes. The seriousness of the detrimental physical effects for the end-user are huge. One test that I witnessed recently revealed that the tensile strength of the carcass was more than 20% lower than the specified minimum.

The simple reason for this deception is that EE fabric costs some 30% less than EP fabric. In itself this may not seem like a great deal, but the fabric plies are a major cost component in any multi-ply conveyor belt. This means that cheaper fabric is a big help when trying to achieve the perception of a lower 'like-for-like' price. As far as the manufacturer using these underhand tactics is concerned, they can 'sleep easy' in the knowledge that it is highly unlikely that the end-user will have the kind of laboratory tests carried out that would ever reveal the deception.

The covers

It is the rubber used for the outer covers that provides the manufacturer with the single biggest opportunity to economise. There are many different types of rubber compound used for rubber multi-ply belts simply by virtue of the fact that belts have to deal with a multitude of different (and often combined) demands, including abrasion, heat, oil, ozone, fire and much more. These cover compounds are

Above: Severe wear caused by heat damage that has been accelerated by UV exposure.

commonly referred to and known as 'cover grades' or 'cover qualities.'

Most of the rubber used in conveyor belting is synthetic. Literally hundreds of different chemical components and substances are needed to create these synthetic rubber compounds that, once vulcanised, are able to meet the specific physical performance and safety requirements. There are three basic aspects that most determine the quality of performance of all the belts used within the cement industry. These are wear (abrasion) resistance; heat resistance and the hugely important but much under-valued resistance to ozone and UV light.

'Abrasion-resistant' is the most commonly used type of cover grade and it is the actual level of abrasion (wear) resistance of any rubber cover that will almost certainly have the greatest influence on the length of the operational lifetime of a conveyor belt before it needs to be replaced.

There are two internationally-recognised sets of standards for abrasion, EN ISO 14890 (H, D and L) and DIN 22102 (Y, W and X). In Europe it is the longer-established DIN standards that are most commonly used. Generally speaking, DIN Y (ISO 14890 L) relates to 'normal' service conditions and is normally the standard most used in the cement industry. DIN X (ISO 14890 H) and DIN W (ISO 14890 D) are usually reserved for when extra resistance to impact, cutting and gouging is required or where especially high levels of resistance to abrasive wear are needed.

Abrasive wear testing

Abrasion resistance (ISO 4649 / DIN 53516) is measured by moving a test piece of rubber across the surface of an abrasive sheet mounted on a revolving drum. It is expressed as volume loss in cubic millimetres, for instance 150mm^3. The most important thing to remember when comparing abrasion test results (or promises) is that higher figures represent a greater loss of surface rubber, which means that there is a lower resistance to abrasion. The lower the figure, the better the wear resistance.

Comparing one offer from another is made very difficult by virtue of the fact that (with only one exception that I know of) the technical datasheets provided by manufacturers and traders almost invariably only show the minimum requirement of a particular test method or quality standard rather than the actual performance that the belt being offered would be expected to achieve.

Wear on the top cover is primarily caused by the abrasive action of the materials being carried, especially at the loading point or 'station' where the belt is exposed to impact by the bulk material and where the material is effectively 'accelerated' by the belt surface. Short belts (<50m) usually wear at a faster rate because they pass the loading points more frequently compared to longer belts. For this reason, the quality of abrasion resistance needed for shorter length belts is even more crucial than usual. Although the thickness of the cover is an important consideration, the actual wear-resistant properties of the rubber are much more important than the thickness. If it is felt necessary to increase the cover thickness in an effort to compensate for premature wear then that is a sure sign that the abrasion resistance is inadequate.

Handling the heat!

Belts that can resist high temperatures are widely used in the cement industry, Of all the demands placed on industrial conveyor belts, heat is widely regarded as the most unforgiving and damaging. High temperature materials and working environments cause an acceleration of the ageing process of the rubber that causes it to harden and crack.

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. If the core temperature of the carcass becomes too high then the belt will quite literally start to fall apart. This is commonly referred to as 'de-lamination'.

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 conveyor belt 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.

ISO 4195 testing

To provide the most accurate measurement of heat resistance, 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 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, at least one manufacturer (Dunlop) also carries out testing at 175°C.

There are three key factors to consider when choosing a heat-resistant belt. The most critical considerations are the actual temperature range of the materials being carried; the level of ambient temperatures of enclosed running environments and the length of the conveyor. All of these factors have a major influence on the speed of the ageing process. Success or failure will depend on two factors; having accurate temperature data to give to potential belt suppliers and, ultimately, the heat resistance qualities of the belt they supply.

Ozone and UV resistance

There is absolutely no question that *all* rubber conveyor belts should be fully resistant to the damaging effects of ozone and UV light. This is because ozone becomes a pollutant at ground level. Exposure increases the acidity of carbon black surfaces and causes reactions to take place within the molecular structure of the rubber. This has several consequences, such as surface cracking and a marked decrease in the tensile strength of the rubber. Likewise, UV light from sunlight and artificial (fluorescent) lighting also accelerates deterioration. This is because it produces photochemical reactions that promote the oxidation of the surface of the rubber. This results in a loss of mechanical strength. In both cases, this kind of degradation causes the covers of the belt to wear out even faster than normal.

Rubber belts that are not fully resistant to ozone and UV can start to show signs of degradation even before they have been fitted to a conveyor simply by being exposed to the open air and daylight. Sadly, despite its crucial importance in terms of operational lifetime, ozone and UV resistance is very rarely, if ever, mentioned by traders or manufacturers. This is almost certainly because the anti-ozonants that need to be used during the mixing process of the rubber compounds are relatively costly. Building that 'avoidable' cost in would immediately make the belt less competitive on up-front price. My advice is to always make ozone and UV resistance a required part of the specification when selecting any rubber conveyor belt.

Don't accept the inevitable

When belts frequently have to be replaced after only a short period of time there is often the temptation to accept the 'inevitable' and fit 'economy' belts. But there is a lot more to conveyor belts than meets the eye. Good quality, longer lasting belts do cost more to produce but they will almost certainly run two or three times longer before they will need to be replaced. That initial price difference of 30-40% then becomes very insignificant indeed, as well as being a lot less hassle in the long run! After all, the quality of a belt and the materials used to produce it is best reflected by its price!