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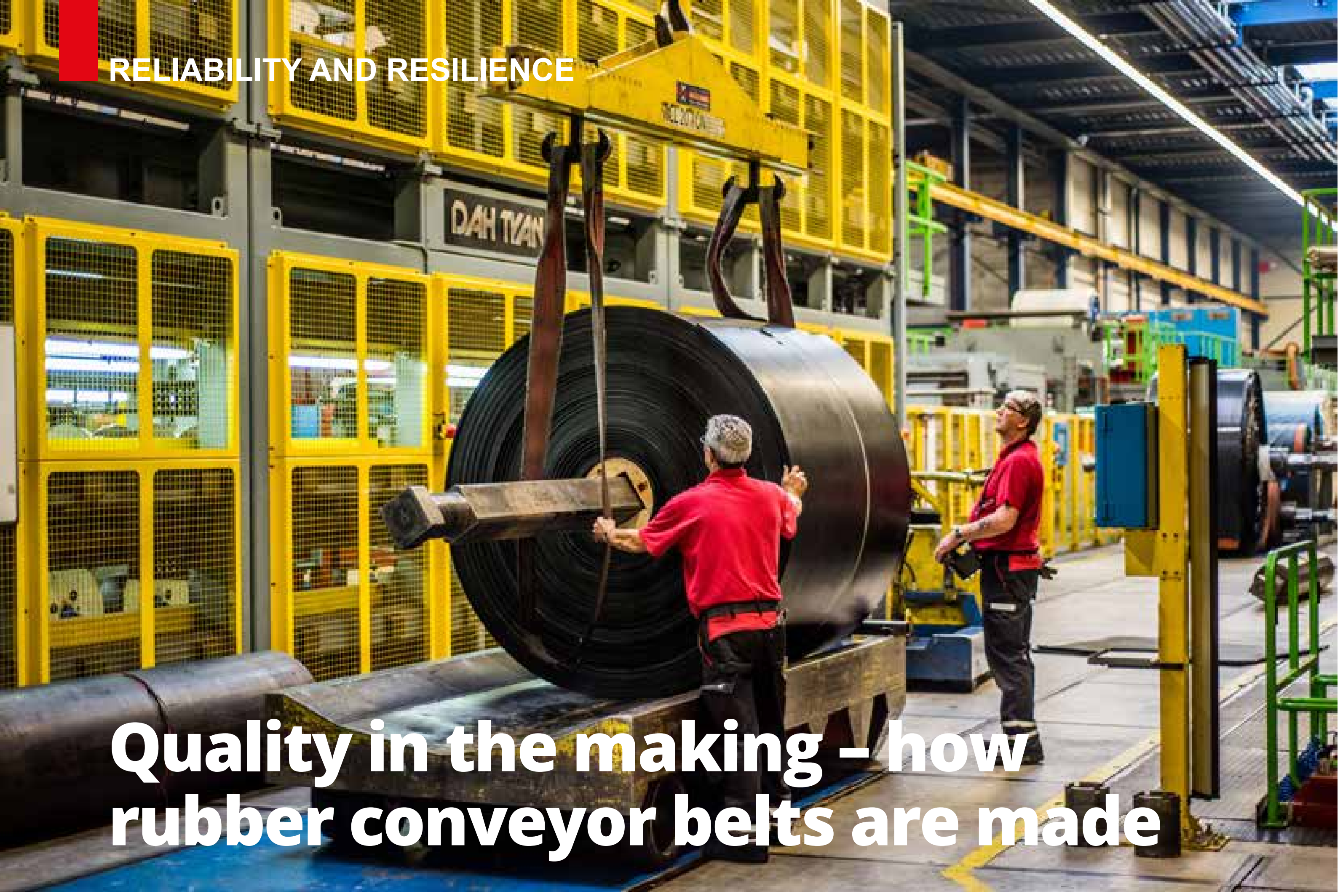
MINING & QUARRY WORLD



Quality in the making – how rubber conveyor belts are made

Conveyor belts play a crucial role in the mining and quarrying industry. They are a complex and costly component where reliability and resilience are essential if unplanned stoppages are to be kept to a minimum. Despite this, there is a surprising lack of knowledge about how they are made and how they are engineered to cope with the demands placed on them. Here, conveyor belt specialist Leslie David pays a visit to Fenner Dunlop Conveyor Belting in The Netherlands to provide an interesting insight into the core process involved in the making of rubber multi-ply conveyor belts.

IT'S ALL ABOUT THE RUBBER

In the majority of cases, it is the quality of the rubber outer covers that will have the greatest influence on the performance and operational lifetime of a conveyor belt. Some belts need to be able to resist the impact of heavy rocks, others have to cope with the ravages of sharp, abrasive materials while others have to operate in environments that can literally rip a belt from end to end in the blink of an eye. Fire resistance, of course, can also be another factor in our industry. Very often, belts need to handle a combination of these factors. The rubber covers for each belt therefore need to be made using very specific recipes.

Somewhat worryingly in my opinion, it is becoming increasingly common for manufacturers to outsource the manufacturing of their rubber. Although it helps to reduce the cost, the downsides of outsourcing are considerable. Apart from making quality control and consistency of performance virtually unmanageable, outsourcing makes it equally impossible to ensure compliance with European safety and environmental regulations. In Dunlop, they believe that the only way to truly control the quality of the end product is to carry out every step of the production process in-house. This includes the manufacturing of their own rubber compounds. The vast majority of rubber used to make conveyor belts is synthetic, the most common being Styrene Butadiene Rubber (SBR). This is because synthetic rubber is far more adaptable than natural rubber and can be more precisely engineered to cope with the many combinations of operational demands.

Each rubber compound consists of a complex 'cocktail' involving a huge range of different chemical components, polymers and other essential ingredients. This includes the vital UV stabilizers, anti-ozonates and antioxidants needed to create a resistance to premature ageing of the rubber caused by exposure to ozone and ultra violet light, which every rubber compound should have but some 90% lack due to 'economy' reasons.

Quality begins at home. Dunlop carry out every step of the production process in-house.

MIXING - MAKING THE RUBBER COMPOUND

The process starts by the hand selection of the raw materials according to a computerised formula specific to the required specification of rubber. The various ingredients are carefully weighed and measured along with oils and carbon black, which is one of the most essential polymers used in any black rubber compound. These are added automatically to form the base mixture. The batch of mixed rubber compound is then heated and mixed coarsely. After a calculated time, the mixture is dropped onto a rolling mill and then further kneaded until a soft, pliable consistency is achieved.

The rubber mixture is kneaded into a soft, pliable consistency.

When complete, the rubber is hung like 'drapes' to cool down. A soap-like solution is applied to prevent the surfaces from sticking to one another. In Dunlop, each batch of rubber is labelled and a sample is sent to the laboratory for testing. In Dunlop, each batch of rubber is labelled and a sample is sent to the laboratory. This is a crucial stage in the quality control process because every batch has to be tested and approved before it can be released for further processing. This helps to ensure a consistent quality so that each specification of rubber performs exactly as it is designed to do.

Each rubber compound is a complex 'cocktail' of chemical components, polymers and other essential ingredients.

SAFE TO HANDLE?

To make some rubber compounds it is unavoidable that chemicals that may be extremely dangerous in their own right have to be used. Fortunately, in Europe, strong regulations are in place to protect humans and the environment in the form of REACH (Registration, Evaluation and Authorisation of Chemical substances) regulation EC 1907/2006.

These regulations stipulate that all European manufacturers are legally obliged to comply with the regulations relating to chemicals, preparations and substances used to create finished products. This includes registering the use of any "substance of very high concern" (SVHC) listed within the regulations with European Chemical Agency headquarters in Helsinki. Sadly, many European manufacturers have chosen to ignore these legal requirements, either completely or at least partially, again because of the impact on production costs. Of even more concern are those manufacturers located outside of EU member states and the UK because they are not subject to EU regulation concerning the use of hazardous chemicals

The fabric inner plies and thin layers of rubber (skim) are compressed together to create the belt carcass.

or the use of Persistent Organic Pollutants (POPs). Needless to say, every Fenner Dunlop belt is fully REACH compliant as well as being ozone and ultraviolet resistant.

THE CALENDERING PROCESS

The next stage is the calendering process. It is at this point that the belt begins to take on its durable form as layers of inner fabric (for multi-ply belts) or steel cords in the case

Temperatures and pressure levels of the vulcanizing press need to be accurate and uniform.

The vulcanization process must always be continually monitored.

of steelcord belts, are mated with the raw unvulcanised material. The rubber is introduced from what is called 'the nip' where it is spread as a film onto the rolling mill. The fabric plies, most commonly a mix of Polyester warp and Polyamide weft (EP), are then fed through the nip, where the rubber is compressed directly onto it.

Some fabrics are calendered with one or two sides of rubber, allowing the additional strengthening layers to be added. The strength of the level of adhesion (bond) between the various layers of plies and between the plies and the covers is extremely important and is measured according to the ISO 252 test method. This literally involves pulling the layers apart and measuring the force required in Newtons per millimetre. Adhesion levels that are too high can be very problematic when creating a splice joint to make the belt ‘endless’. On the other hand, if the adhesion is insufficient then the layers of the belt can become separated over time. This phenomenon is known as ‘delamination’.

The layering process can happen several times depending on the number of plies required by the belt specification and the thickness of the outer covers of the belt. Once the specified grade thickness is achieved, the belt moves forward onto the stationary vulcanization presses.

VULCANIZATION

Vulcanization is the chemical process in which the belt is pulled under tension into a press. The rubber compound is typically heated with sulphur; accelerator and activator at a temperature of between 140–160°C and pressures up to 20 bar are applied. Pressure is exerted on the surfaces of the press in contact with the outer covers of the belt using hydraulic rams. Both the temperature of the press plates and the level of pressure need to be extremely accurate and uniform throughout the entire area of the press surfaces otherwise imperfections and inconsistencies can occur.

The actual scientific process involves the formation of cross-links between long rubber molecules in order to achieve improved elasticity, resilience, tensile strength, viscosity and hardness. It is therefore a crucial part of the production process. The duration of the vulcanisation process depends on the thickness of the belt and the type of rubber. Although highly automated, the vulcanization process stills needs to be closely monitored by experienced personnel.

FINAL CHECKING

The manufactured belt finally moves onto quality control where every metre is thoroughly inspected before being approved for transportation to the shipping and storage areas. Even at this stage, final quality control procedures are in place because random samples of completed belt are subjected to further arduous testing in the Dunlop laboratory.

THE CONVEYOR BELTS OF THE FUTURE

The process I have described relates to ‘multi-ply’ conveyor belts that have multiple layers of inner fabric. Although multi-ply belts are the most commonly used type, Fenner Dunlop believe that the future lies with super-strength single and dual-ply belts. The single-ply version, known as Ultra X, has been developed in conjunction with their colleagues in North America and made using a unique fabric that the company invented and manufacture in-house. It is so advanced it can withstand the kind of punishment that would destroy a conventional belt. Although the production process is essentially the same, single-ply and dual-ply constructions help to maximise production efficiency and consumes less energy because there are fewer calender runs. Having no rubber skim between the plies also helps to create a thinner, lighter but remarkably stronger carcass.

These factors also have a significant bearing on environmental impact and sustainability, which is clearly genuinely important to the company. Apart from a more efficient production process, single and dual-ply belts use less rubber and a corresponding reduction in the amount of chemicals and additives used to create that rubber. Yet another important environmental benefit is the dramatic reduction in the amount of non-biodegradable nylon and polyester used compared to the multiple layers found in a conventional multi-ply belt.

NOT EVERY CONVEYOR BELT IS CREATED EQUAL

Although the basic production process involved in the manufacture of conveyor belts is ostensibly used by all manufacturers, the fact remains that there are huge variations between one manufacturer and another in terms of quality, performance and product longevity. Such differences are particularly noticeable when comparing belting made in Europe and imported belt from Southeast Asia, where all the evidence points to top quality European-made belts being able to provide up to four or five times longer operational life compared to their Asian counterparts. Yet again, there is a strong environmental impact motive because the stated philosophy in Fenner Dunlop is to only make belts that provide the longest possible working life. This surely makes them the only belt manufacturer who actually wants their customers to use less conveyor belt!

There can be no denying that the quality standards applied during the production process are hugely important. However, any production process is only as good as the raw materials that are used within that process. Raw materials constitute up to 70% of the ultimate cost of a belt. Low grade, unregulated raw materials cost appreciably less, which is the biggest single reason why some manufacturers can offer prices as much as 50% lower than their competitors.

No matter what price you pay, it is how long your conveyor belts last before they need to be replaced that really dictates how much they cost. The reduction in expenditure over time and increases in productivity achieved by investing in well-made, premium quality conveyor belts will invariably compensate for the higher buying price many times over. As the old saying goes, “Price is what you pay but cost is what you spend”.

Tested to destruction- made to perfection. Every Dunlop belt undergoes thorough final inspection and testing before being approved for use.

Single-ply – thinner, lighter, stronger with less environmental impact.

ABOUT THE AUTHOR

Leslie David

After spending 23 years in logistics management, Leslie David has specialised in conveyor belting for over 17 years. During that time, he has become one of the most published authors on conveyor belt technology in the world.