CONVEYING ADVICE

Rob van Oijen, Dunlop Conveyor Belting, The Netherlands, explains how rubber compounds are able to stand up to the challenges of the fertilizer industry.

The demands placed on conveyor belts are high and varied in the fertilizer industry. Oils, chemicals, and high temperature materials such as potash can have seriously damaging effects on rubber. Fortunately, the development of highly sophisticated rubber compounds, particularly in recent years, now means that rubber belts should provide a working life that is considerably longer than they have ever achieved before. Currently, unless there has been some kind of problem, many operators tend to continue to buy the same type of belt that was originally specified by the OEM without seriously questioning whether the level of repairs, overall performance, and longevity can be significantly bettered.

Challenges

Rubber conveyor belts have two constituent parts – an inner carcass covered by a protective layer of rubber on either side known as the cover. However, for a

conveyor belt to fulfil its purpose, there can be no doubt that the qualities and characteristics of the rubber covers ultimately have the biggest influence on performance, safety, and longevity of use. These qualities or 'cover grades' are effectively a list of what conditions the rubber belt needs to be able to withstand operational demands. Although the most common categories are resistance to abrasion, heat, oil, chemicals, and fire, it is common to see the need for rubber compounds that have a combination of these qualities.

Figure 1. Serious distortion – the effect of oil on rubber.

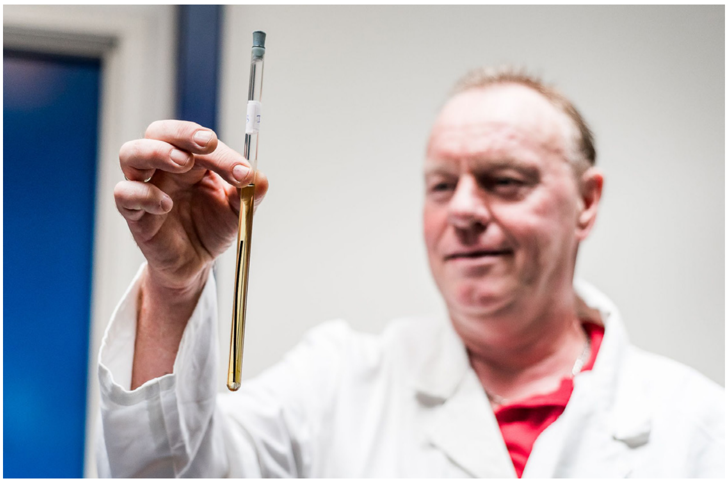

Figure 2. There are two distinct sources of oils that damage rubber – mineral and vegetable/animal.

Figure 3. Delamination - the belt falls apart.

Abrasion resistance

Insufficient resistance to abrasion is one of the biggest reasons why belts need to be replaced much sooner than they should be. When conveying materials with a continuous ambient temperature of less than 80°C that do not contain oils or chemicals, then a straightforward abrasion-resistant compound should suffice. The two most commonly referenced standards for fabric reinforced belting are the international ISO 14890 (with abrasion resistant classes H, D, and L) and German DIN 22102 (with abrasion resistant classes Y, W, and X). In Europe, the longer-established DIN 22102 standard is still very often used although both are almost identical. The DIN grade 'Y' (or ISO 14890 closest equivalent grade 'L'), is usually suitable for 'normal' service conditions. When comparing figures relating to abrasion resistance, it is important to remember that lower figures represent a higher level of resistance against abrasive wear.

Oil resistance

When oil of any kind penetrates rubber it causes it to soften, swell and distort. Although this can be a fairly gradual process, it leads to all kinds of serious problems.

The first is a dramatic decrease in the ability of the rubber to withstand abrasive wear. As the rubber continues to soften, it also steadily loses its tensile strength, while at the same time becoming much more prone to ripping and tearing. The next stage is that the rubber begins to swell and distort. This causes steering and handling problems, along with a serious reduction in the elongation at break (the amount of stretch before the belt snaps).

There are two distinct sources of oils that damage rubber – mineral and vegetable/animal oil, and each has its own particular effects, however most conveyor belt manufacturers only offer one oil resistant rubber cover. This is often referred to as 'MOR' (medium oil resistance). In order to provide the best possible protection against the differing effects of each category, it is often the case that at least two different oil resistant rubber compounds are required, rather than a single 'one compound suits all' approach.

In general, Dunlop ROM is a SBR/nitrile based compound and is recommended for vegetable-based oils while Dunlop ROS has a much higher level of nitrile designed to resist the effects of mineral oils, and some of the more demanding vegetable oil applications, such as crushed soya beans and palm kernels, as well as other aggressive chemicals.

Fertilizer materials such as phosphates and urea that do not contain oil still require oil resistant rubber covers if they are treated with an oil-based coating to prevent the granules sticking together. Experience has also shown that when urea folmaldehyde (UF) is used as an anti-caking and de-dusting agent, rubber covers that are resistant to mineral oil, such as Dunlop ROS, seem to perform better than abrasion resistant rubber.

Oil resistance test methods

There are two recognised test methods. These are ISO 1817 and the comparable, less elaborate but very stringent, American ASTM 'D' 1460, which is the test method that is used at Dunlop. Rather surprisingly, ISO or DIN international performance standards for oil resistance do not yet exist. This means that in the absence of actual performance standards, manufacturers and traders can safely claim that the belt they are supplying is sufficiently oil resistant for its intended use. It is always best practice to ask for precise details of the oil resistance test methods that the manufacturer has used to support their claim. However, there is a sting in the tail concerning the matter of test methods.

Figure 4. Avoid overloading – uncovered belt surface area allows heat to escape.

Figure 5. Some conveyor belts are not nearly as resistant to fire as the operators may like to believe.

Figure 6. Class 4A is usually the best choice for conveyors operating in closed or covered conditions.

All is not what it seems

Some of the biggest manufacturers of belting in the world, especially those in Asia, use the DIN reference number 22102 G when referring to oil resistant belting. This is misleading as there are no firm requirements, test methods, or limits specific to oil resistant belting associated with DIN 22102 G. The letter 'G' is simply used to denote oil (or grease) resistant belting and is not an indication of the actual resistance level. This is an example of how simply indicating a test method reference on the supporting technical datasheet is designed to give the end user a false sense of security even though, in truth, it does not reflect actual performance.

Handling the heat

High temperature materials and working environments create a combination of highly destructive forces on rubber conveyor belts. First and foremost, heat causes a rapid acceleration in the ageing process of the rubber, causing it to harden and crack. Tensile strength and elongation (stretch) can be reduced by as much as 80%, effectively destroying the operational strength and flexibility of the belt and seriously weakening splice joints. At the same time, the covers of the belt can wear much faster than they would under normal circumstances because the resistance to abrasive wear diminishes considerably.

The heat resistant properties of the rubber need 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 while at the same time, preventing as much heat as possible from penetrating the carcass. This 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 begin to fall apart. An increase as small as 10°C in core temperature can reduce the life of the belt by as much as 50%. This is because for every ten degree increase in temperature, the rate of oxidation increases by a factor of eight. The only way to limit the effects and slow down the degradation is to use belts that have good quality rubber components and have been specially engineered to cope with high material temperatures over prolonged periods.

Making your 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 the 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. The next consideration is the type and nature of the materials being conveyed. Materials with fine particles usually cause a greater concentration of heat on the belt surface due to the lack of air circulation between the particles, whereas the larger size 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, as 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.

Fire safety

Conveyors are a very efficient method for conveying materials, but in the right conditions, they are just as effective in conveying fire. The subject of fire resistant conveyor belts is complex; the following is therefore intended as a general guidance.

No conveyor belt is fire proof

The first thing to bear in mind is that rubber conveyor belts can never be totally fire proof, as rubber is flammable. Secondly, the fabrics used in the carcass of multi-ply belts are almost invariably polyester and nylon, which have virtually no resistance to fire. Consequently, every belt will burn when exposed to a naked flame that is sufficiently energised to cause it to ignite.

The two most frequently used descriptions relating to fire safety used for conveyor belts are 'fire retardant' and, most commonly of all, 'fire resistant.' In truth, a better and more accurate description would be 'self-extinguishing.' This is because the ability of a rubber conveyor belt to 'resist' fire is achieved by adding special chemicals and additives to the rubber compound during the mixing process. What happens is that when the rubber compound has been vulcanised and is ignited, it emits gases that effectively extinguish the fire by starving the flames of oxygen.

There are two sets of categories relating to the fire resistance of conveyor belts – one for 'general purpose' belts (mostly for applications that are above ground) and one for belts used underground. Each category contains several levels of fire resistance. Deciding on the correct level of fire resistance needed for a specific application or environment is of crucial importance. The golden rule is that when there is doubt, then it is best to consult the experts.

Establishing the correct level or standard of fire resistance needed for conveyors operating in the open air is relatively straightforward. EN 12882 is the standard for safety requirements for conveyor belts for general-purpose use. The most basic safety requirement is EN 12882 Category 1, which simply demands that the belt is anti-static and conforms to EN ISO 284 international standards and is also the primary demand for use in specific ATEX 95 (94/9/EC Directive) classified zones. This is especially important in environments where potentially combustible materials such as ammonium nitrate are being conveyed. It is essential that the conveyor belt cannot create static electricity that could ignite the atmosphere. Belts need to allow static electricity to pass through the metal frame of the conveyor structure down to earth rather than allow the static to build up.

For the vast majority of applications, EN 12882 Class 2A or Class 2B levels of fire resistance are perfectly adequate. These standards make the distinction between fire resistance with covers, which is Class 2A ('K' grade) and fire resistance with or without covers, which is Class 2B ('S' grade). The relevance of 'with or without covers' is that surface wear gradually reduces the amount of fire resistant rubber that protects the internal flammable carcass. For conveyors operating above ground in closed or covered conditions, Class 4A, which involves a more severe fire test (EN12881-1 method A, C, or D), is usually the best choice.

Underground and extreme risk environments

Belts that are used underground or in particularly hazardous environments, where there is a high risk of fire and/or explosion, are subject to the most stringent testing and certification. In Europe, the Fire Safety Standard applied to the majority of belting used underground is EN 14973 (conveyor belts for use in underground installations – electrical and flammability safety requirements). Although rubber EP, EpP, or steelcord belts are also used, the type of belting most commonly used in underground environments is solid-woven belting with PVC or rubber covers.

A combination of qualities

Within the fertilizer industry, there are probably more operations that involve multiple combinations of abrasion, oil, chemical, heat, and fire than in any other industry. Fortunately, unique rubber compounds are now available that are proven not only to withstand multiple demands but also provide promising levels of life expectancy. For example, Dunlop BV GT is heat resistant ISO 4195 Class T1 and able to carry hot materials at continuous temperatures up to 150°C and peak temperatures of up to 170°C. The material is oil and chemical resistant to ASTM 'D' 1460 testing and is abrasion resistant comparable to DIN 'X' and ISO 'H' levels and fire resistant to EN 12882 Class 2A and 2B standards. Dunlop BV VT is designed specifically for the transportation of wet sulfur. It is also flame-retardant according to the ISO 340 and MSHA 2G, moderately oil resistant, and acid resistant.

Quality always wins

Many in the conveyor belt industry would like to believe that there is not much difference in choosing between one belt manufacturer and another. However, good quality conveyor belts made using top quality rubber that perform as they should, will always prove cheaper in the long run. WF