A GUIDE TO FIRE RESISTANT CONVEYOR BELTS

Ron van Oijen, Fenner Dunlop, Netherlands, provides essential guidance on fire resistant conveyor belts – a complex and extremely important subject.

If a conveyor belt that is specified as being fire resistant catches fire and then proves not to be sufficiently resistant, then the consequences can be truly catastrophic. Despite this, an increasing number of mines, of virtually every size and description, are yielding under the pressure to cut costs, including the fire resistant conveyor belts they buy. On the other hand, in a desperate bid to win orders, more and more conveyor belt manufacturers and suppliers seem willing to create a false sense of security by using exaggerated, and sometimes downright false, claims of compliance.

Anecdotal as well as scientific evidence gained from laboratory testing seems to indicate that even some of the biggest mine operators are running conveyor belts that are not nearly as fire resistant as they are claimed to be.

Above and below

The fire resistance standards and test methods applied to conveyor belts fall into two basic, but quite distinct, sets of categories – belts that operate above ground, and belts that operate below ground. As one might expect, although both are equally important in regard to human safety, standards and test methods for belts used below ground are subject to a more stringent level of testing and certification.

For this reason, coal handling belts used underground usually have a mono-ply, solid-woven carcass construction with PVC or rubber covers, commonly referred to by the term 'solid-woven.' On the other hand, the most commonly used belts operated above ground have rubber outer covers reinforced by multiple inner layers of synthetic fabrics or, in some cases, steel cords.

Figure 1. All coal-carrying belts should at least be EN 12882 Category 1 (anti-static conforming to EN ISO 284 international standards).

Figure 2. Category 4A entails EN12881-1 method A, C, or D, in addition to EN ISO 340 testing.

Figure 3. EN ISO 340 testing.

Above ground and general service applications

In environments where coal dust is present, it is essential that the conveyor belt cannot create static electricity that could ignite the atmosphere. Belts need to be able to allow static electricity to pass through the metal frame of the conveyor structure down to earth, rather than allow static to build up. The safest approach is for all belts to meet EN 12882 Category 1, which simply demands that the belt is anti-static and conforms to EN ISO 284 international standards. This means that it meets the primary requirement for use in ATEX 114 (Directive 2014/34/EU) classified zones if necessary.

No conveyor belt is totally fireproof

The first and most important thing to bear in mind is that, though rubber can be engineered to resist fire, rubber conveyor belts cannot be made totally fireproof. The fabrics used in the carcass of the belt are most commonly polyester and/or nylon, which have no resistance to fire. In other words, when exposed to a naked flame that is sufficient to ignite it, every belt will burn.

Rather than fire resistant, 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. Once the fire-resistant rubber has been vulcanised and is ignited, it emits gases that effectively suffocate (extinguish) the fire by starving the flames of oxygen.

Different recipes, or 'cocktails,' of rubber compound are necessary depending on the level (standard) of fire resistance required. However, the chemical additives are very costly, so if low grade or insufficient quantities of the additives are used in an effort to keep the selling price artificially low, then the ability to self-extinguish will be slower and less effective than it could and should be. The time it takes for a belt to self-extinguish is enormously important. Firstly, conveyors are frighteningly effective when it comes to conveying fire. Secondly, burning rubber and synthetic fabrics release a dangerous, thick, acrid smoke that contains cyanide, carbon monoxide, sulfur dioxide, and products of butadiene and styrene. Smoke emissions must therefore be kept to an absolute minimum, which means that the time it takes for the flames to self-extinguish is critical.

Fire resistance standards for above ground applications

For the majority of coal handling 'open air' applications, EN 12882 Category 2A (K grade) or Category 2B (S grade) levels of fire resistance would be perfectly adequate. Deciding between Category 2A and Category 2B largely depends on the abrasive characteristics of the coal being conveyed.

Category 2A is usually suitable, but if the type of coal is prone to be more abrasive and tends to wear the top cover more rapidly, then the safest option is to choose Category 2B.

In enclosed environments such as buildings and covered conveyors, the risk to life is heightened because of the dangerous smoke referred to earlier. For this reason, EN 12882 Category 4A is usually the best choice because it involves a more severe fire test according to EN12881-1 method A, C, or D, in addition to EN ISO 340 testing.

It is inadvisable to rely on water sprinkler systems as rubber conveyor belts that have inadequate fire resistance properties will ignite (and reignite) too easily and will continue to burn. Hence, water sprinklers can have only a limited effect.

The basis of most fire resistance tests for general and above ground belting is EN ISO 340 and is included within the classifications of EN 12882 on electrical and flammability safety requirements. These standards make the distinction between fire resistance with outer covers intact, which is Category 2A (or often referred to as K grade), and fire resistance with and without covers, which is Category 2B (or often referred to as S grade). The relevance of 'with and without covers' is primarily because the layers of rubber between the synthetic plies protect the most flammable part of the belt (the inner carcass), and which can actually be the path for flames to propagate. The rubber skim material therefore needs to be as equally fire resistant as the outer covers. Worryingly, manufacturers who want to minimise costs to achieve a more competitive price often use rubber skims that have inadequate resistance to fire.

EN ISO 340 tests involve exposing six individual samples of belt to a naked flame causing them to burn. The source of the flame is then removed and the combustion time (duration of flame) of the test piece is recorded. A current of air is then applied to the test piece for a specified time after the removal of the flame. The flame should not re-ignite.

The time it takes for the belt sample to self-extinguish after the flame has been removed is measured. The duration of continued burning (visible flame) should be less than 15 sec. for each sample with a maximum cumulative duration of 45 sec. for each group of six tests. This means that the average allowable time per sample is 7.5 sec. This factor is of paramount importance because it determines the distance that the fire can be effectively carried by a moving belt.

Even if a manufacturer states that their belt has passed the EN ISO 340 test, caution should still be exercised. A typical conveyor belt can easily travel more than 40 m within the 15 sec. that is allowable for a belt sample to pass the test, which is a potentially very dangerous distance. For this reason, Fenner Dunlop in the Netherlands applies an average

Figure 4. PVC solid woven belts have superior self-extinguishing properties compared to rubber belts.

Figure 5. Drum friction testing – the belt must break before it reaches a temperature of 325°C.

maximum time limit of only 1 sec., which is more than six times faster than the required standard, and decidedly safer as a consequence.

Underground and extreme risk environments

Conveyors used underground, or in particularly hazardous environments where there is a high risk of fire and/or explosion, most commonly use PVC Solid-Woven belts rather than rubber multi-ply. Solid woven belts have a mono-ply solid-woven carcass utilising a combination of interlocked nylon or polyester yarns and nylon or nylon/cotton yarns, which is impregnated with PVC and then protected by PVC or nitrile rubber covers.

PVC has far superior self-extinguishing properties compared to rubber due to the abundance of chlorine in its formulation. However, additives are also used to create a sufficiently enhanced level of resistance to both fire and the potentially excessive heat caused by seized drive pulleys and drums. Fenner Dunlop were the first to develop PVC Solid-Woven belting following demands by the UK Government in the aftermath of the Cresswell Mine fire, which caused the death of 80 miners in the 1950s.

The fire was caused by torn strips of rubber belting from a damaged running belt that collected in the transfer point. The frictional heat build-up of these against the running belt/pulley started the fire. The ensuing introduction of the drum friction test, and the use of PVC Solid-Woven belting are widely recognised as being the most important contributions to mine fire safety in the last 80 years.

In Europe, the Fire Safety Standard applied to the majority of belting used underground is EN 14973: 2015 (conveyor belts for use in underground installations – Electrical and Flammability Safety Requirements). The various class levels are:

- **A:** General use, only hazard is limited access and means of escape.
- **B1:** As class A, but potentially flammable atmosphere. No secondary safety devices.
- **B2:** As class A, but potentially flammable atmosphere. With secondary safety devices.
- **C1:** As class B1, plus combustible dust or material conveyed. No secondary devices.
- **C2:** As class B1, plus combustible dust or material conveyed and additional fuel sources. With secondary safety devices.

Class C1 is the strictest safety standard. Compliance means that the belt must be safe to use in explosive environments without the need for secondary safety devices to be installed on the conveyor (for example, temperature sensors on drums, slip detection and sprinklers, etc). This is primarily due to strict drum friction test limits whereby the belt must break before it reaches a temperature of 325°C. This temperature is significant because it is the ignition temperature of coal dust.

Drum friction tests, which must be carried out and certificated by independent test organisations, demand that there must be no evidence of flame or glow during or after the test. This is only achievable by using a PVC belt because the thermoplastic melts/breaks before it reaches 325°C. The Fenner Dunlop maximum average is around 260 – 270°C, depending on belt type. This drum friction test, combined with the strict flame, fire propagation, and anti-static test limits required to meet the EN 14973 Class C1 standard, ensures that the belt is the safest possible for use in hazardous environments.

Not worth the risk

The urge to minimise costs has probably never been greater than it is today. That temptation applies equally to both manufacturer and end-user. However, the stark reality is that the quality of performance, longevity, and, in this case, the ability to truly resist fire, is always reflected in the price. Regardless of financial pressures, a decision not to buy premium grade fire resistant conveyor belts can never be justified.