Les Williams, Dunlop Conveyor Belting, the Netherlands, discusses a number of commonly held misconceptions surrounding the fire safety of conveyors and why these views are inaccurate.

SEPARATING FACT FROM FICTION

Fire-resistant conveyor belting has been around since the 1950s when Fenner Dunlop was the first to pioneer its development. This came about following a request by the UK government in the aftermath of the Cresswell mine fire, in which 80 miners tragically died as a result of a fire caused by a stalled belt at a transfer point.

Fenner Dunlop operates belt manufacturing plants and laboratories in the Netherlands, where the company produces rubber multi-ply belting primarily for use above ground and in the UK, where they specialise in solid-woven belting for use below ground.

Since those times, conveyor belt technology and fire safety standards as a whole have developed enormously. However, this progress often causes misunderstanding and confusion amongst conveyor belt operators. Although the first priority is to avoid opting for a belt specification that provides an inadequate, and therefore dangerous level of fire protection, it is also important to avoid overkill by specifying a fire-resistant standard that is unnecessarily high.

In order to separate fact from fiction, this article will attempt to decipher the technical jargon surrounding conveyor belt fire safety, and explain what belt operators really need to know starting with belts for use above ground.

Fireproof conveyor belts?

The first and most common misconception is that rubber conveyor belts can be fireproof. The fact is that no

Figure 1. Coal conveyor fire.

Figure 2. DIN 22881 -1 testing.

conveyor belt can be totally fireproof. Rubber itself is flammable and the fabrics used in the carcass of rubber multi-ply belts most commonly contain polyester and nylon, which have little or no resistance to fire. In other words, every rubber multi-ply belt will burn when it is exposed to a naked flame that is sufficient to ignite the belt.

The two most frequently used phrases or descriptions relating to fire safety that are used for conveyor belts are 'fire-retardant' and, most commonly of all, 'fire-resistant'. In truth, however, 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 actually happens when the rubber is ignited is that the gases created by the additives are emitted, which effectively starves the flames of oxygen, thereby extinguishing the fire.

If poor quality or insufficient amounts of the additives are used in the rubber compound (usually as a cost-saving measure) then the ability for the belt to self-extinguish will be slower and much less effective than it should be. As will be explained in more detail later, the time it takes for the belt to self-extinguish is crucial as the conveyor is performing its function, which is to convey at speed; only this time, it is conveying fire. This means that literally every second counts.

Who sets the standards?

The most widely accepted standards for all types of conveyor belt are those used in Europe. This article only refers to European Norms (EN) standards maintained by the Committee European de Normalization (CEN) and the International Organization for Standardization (ISO) test methods. The ISO is an independent, non-governmental organisation. The organisation is the world's largest developer of voluntary international standards and comprises the quality standards organisations of 168 member countries.

Fire resistance standards for conveyor belts vary between different countries. However, members of the CEN are obliged to implement EN standards as their national standards without modifications and have to withdraw any of their own national standards that may conflict. Countries that are not members of CEN have their own standards, which in many cases are found to be significantly inferior.

When assessing quality credentials, it is essential to differentiate between what is simply an approved method of conducting a particular test and the actual standards attained during that test. The fact that a belt has been tested according to a certain method (for example, ISO 4649 for abrasion resistance) means very little.

What is important is the standard (minimum acceptable level of performance) that was actually achieved during the testing. In other words, was the performance standard met? In the case of abrasion resistance testing (ISO 4649), the performance would be measured against the performance standards set within ISO 14890.

Finally, it should always be borne in mind that in some cases fire test certification may only relate to a sample of belting that the manufacturer produced specifically for test certification purposes. In reality, the actual belt delivered to the site may well not be up to the required standard.

Above ground and general service applications

One of the most difficult challenges for users of conveyor belts (for both above and below ground) is establishing the correct level or standard of fire resistance. EN 12882 is the European standard for safety requirements for conveyor belts for general purpose and above ground use where rubber belts reinforced by single or multiple layers of textile fabrics (multi-ply) or steelcord reinforcement are the most commonly used types. There is a separate standard (EN 14973) for belts for use below ground, which will be discussed later.

Although there are numerous safety classifications and international standards and many different tests used to measure the self-extinguishing properties of conveyor belts, the basis of most tests for this type of belting is EN/ISO 340. This test standard makes the distinction between fire resistance (self-extinguishing properties) purely with covers attached (EN 12882 Class 2A), and fire resistance with and without covers (EN 12882 Class 2B).

The relevance of testing without covers is that the amount of fire-resistant rubber protecting the flammable nylon/polyester carcass is steadily reduced by wear over the belt's operating lifetime. In both grades, the rubber skim that bonds the fabric layers of the carcass together also needs to be fire-resistant. In the case of Class 2B grade (fire-resistant without covers), the rubber skim should be thicker than the skim used for Class 2A grade belts. The easiest way to tell if a Class 2B grade belt has the required thicker rubber skims is to obtain technical data sheets from the manufacturer for both grades and compare the carcass thickness figures.

Figure 3. Fire simulation test method EN 12881-1 Method C.

Figure 4. ISO 340 testing.

Above ground fire-resistant belts – what standard do I need?

The EN 12882 contains five categories. The most basic fire safety requirement for belts for use above ground is EN 12882 Category 1, which demands that the electrical conductivity of the belt must fulfill the requirements of ISO 284.

Next comes the aforementioned EN 12882 Class 2A and 2B, which would be perfectly adequate for the vast majority of belts being used in the open air. The best way to decide between Class 2A and Class 2B grade is to consider the material being carried. For moderately abrasive materials then, Class 2A is usually perfectly adequate. However, if the material being conveyed is quite coarse and abrasive and tends to wear the top cover more rapidly, then Class 2B is the safest option.

Classes 3A and 3B are identical to 2A and 2B but have a drum friction test added. Classes 3A and 3B would be appropriate when blocked/seized drums and drive pulleys are a potential hazard because there is no safety system in place to detect belt slippage or identify that rotation has stopped.

Class 4A is usually the best choice for conveyors operating above ground in closed or covered conditions. Class 4A involves a more severe fire test (EN12881-1 A, or C or D) in addition to the requirements of Class 2B. Class 4B includes a drum friction test (Method B1) whereas Class 5A has an intensified drum friction test (Method B2). The demands of the B2 drum friction testing escalate through Classes 5B and 5C.

Thanks to improved conveyor technology, drum rotation detection sensors are now commonplace and easy to fit. Most are designed to automatically stop the conveyor if a problem is identified. These systems are usually referred to as 'secondary safety devices', along with other safety equipment, such as sprinkler systems. Generally speaking, this means that for above ground use, drum rotation detection sensors effectively eliminate the need for compliance with Class 3A/B, 4B and 5A/B/C drum friction test standards.

EN/ISO 340 testing

EN/ISO 340 tests involve exposing six individual samples of a 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 reignite.

The time it takes for the belt sample to self-extinguish after the source of ignition (flame) has been removed is then measured. The duration of continued burning (visible flame) should be less than 15 sec. for each sample with an absolute maximum cumulative duration of 45 sec. for each group of six samples. The time it takes for the test pieces to self-extinguish (duration of continued burning) is of paramount importance because it effectively determines the distance over which the flames would be carried along a moving belt. The effects of fire being literally 'conveyed' to adjoining buildings can be seen in Figure 5.

Even if a manufacturer states that their fire-resistant belt has passed the ISO 340 test, the buyer should still exercise caution. A typical conveyor belt can easily travel more than 40 m during the 15 sec. that is permitted to pass the test, which is a potentially very dangerous distance for a blazing belt. For this reason, Dunlop applies a self-imposed time limit standard of no more than one second, ideally less. Buyers of fire-resistant belts are therefore recommended to ask for copies of the test results.

Fire-resistant rubber wears faster

The ability of rubber to resist the natural effects of surface wear caused by abrasion and the usual financial considerations relating to 'lifetime cost' has far more significance when it comes to fire-resistant belting. This is because the amount of protection given to the flammable carcass by the rubber covers decreases as the covers become thinner.

Historically, fire-resistant rubber has always worn faster compared to rubber that is simply abrasion-resistant. This is because the ingredients used to create fire-resistant rubber compound have an adverse effect on its ability to resist wear. Whether we like it or not, from a cost point of view it means that fire-resistant belting usually needs to be replaced at much more frequent intervals.

However, the rubber compound technicians at Dunlop have created an exception to the rule by developing rubber that not only has first class fire-resistant properties, but also exceptionally good resistance to wear. This means that the ability to resist (self-extinguish) fire is retained for longer, thereby prolonging the economic lifetime of the belt. A word of caution however, because extensive laboratory testing has proved that this is very much an exception within the conveyor belt industry. The question of having a belt that can resist both fire and wear is another important reason why buyers should request technical datasheets that include the level of abrasion resistance of the rubber before placing an order.

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. Although rubber EpP belts are sometimes used, the type of belting most commonly

Figure 5. A blazing belt spreads fire very quickly.

Figure 6. A PVC solid woven belt undergoing drum friction testing.

used in underground environments is Solid-Woven with PVC or rubber covers. These belts usually 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, nitrile or chloroprene rubber covers.

PVC is inherently a self-extinguishing, fire-retardant material due to the abundance of chlorine in its formulation. However, additives such as zinc stannate, hydroxystannate zinc and antimony white have to be used to create a sufficiently enhanced level of resistance to both fire and the potentially excessive heat caused by seized drive pulleys and drums.

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. The various class levels within EN 14973 are:

- A: general use, only hazard being 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 are arguably the single biggest difference in the safety classifications (standards) between belting used above ground and belting used below ground. If certification is required then these tests must be carried out by an independent test organisation. The test standards demand that there should 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. Depending on belt type, the Fenner Dunlop maximum average is around 260 - 270˚C.

This drum friction test, combined with the strict flame, fire propagation and the anti-static test limits required to meet the EN 14973 class C1 standard, ensures that the belt is the safest possible for use in very hazardous environments. The highest possible standard achievable for textile-reinforced rubber belts is C2.

Do all belts used in ATEX-classified zones need to be fire-retardant?

A fairly common misconception is that all belts used in ATEX-classified zones must be flame-retardant, but actually this is not the case. What is true is that the electrical conductivity (dischargeability) of all fire-resistant belts must fulfill the requirements of ISO 284.

For environments where coal dust, gas or other potentially combustible materials are involved, 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.

For the uninitiated, ATEX regulations apply to industrial environments where there is a risk of explosion because dust or gas is present in the atmosphere. When sourcing conveyor belts for use in ATEX regulated areas it is very important to ask potential suppliers for a copy of a certificate provided by an appropriate independent testing authority, such as the German Institute Dekra Exam GmbH.

It is important to note that one cannot get an ATEX certificate for a conveyor belt as belts are classified as a component. ATEX certification only applies to the whole conveyor.

Dunlop decided some time ago that the safest approach was for all of its belts to be anti-static and to conform to the EN/ISO 284 international standards. This meant that they could all be used in ATEX 95 (94/9/EC Directive) classified zones. Interestingly, a belt with good anti-static properties can often be a significant indication of the quality of the rubber used on the belt. All (black) rubber belts contain carbon black, which is a costly but crucial ingredient needed to achieve good mechanical properties.

Don’t play with fire

Fire safety should be the first priority of any operation in order to preserve human life. It is also a somewhat cold but nonetheless true fact of life that fire safety protection is needed in order to mitigate the financial and economic impact that a fire can have on production. You cannot put a price on fire safety, so although manufacturers and suppliers may be willing to provide test certificates, such certification should never simply serve as documentary evidence that could be used to exonerate management from blame in the event of a conveyor belt fire.

All managers involved in the operation of conveyor belts share a duty of care to their fellow employees. It is encumbent upon those managers to do as much as they possibly can to ensure that the belts they purchase provide sufficient protection in relation to the level of risk, and that the claims of the manufacturers and suppliers are genuine and proven. So, to avoid playing with fire, it is always wise to order at least two or three extra metres of belt and then have it tested by an accredited testing authority or laboratory. It could prove to be a lifesaver. WC