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White Paper

Belts for Conveying Biomass – The Safety and critical Importance of Conveyor Belt Technology

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For a great many reasons, the conveyor belts used to convey coal or other bulk materials are highly unlikely to be suitable for carrying biomass. Sadly some very expensive lessons are already being learnt. Here Les Williams of Dunlop Conveyor Belting discusses the essential and very specific characteristics that biomass-carrying belts must have in order to perform safely and efficiently.

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The growing pressure to reduce CO_2 emissions has seen an enormous growth in the transhipment of biomass. With the Kyoto Protocol and the EU's continuing intention to reduce carbon footprints of its member states, more and more

countries are making the push towards biofuel. In fact the EU is determined to achieve 63% of heat generation by biomass by 2020. In the Port of Amsterdam alone, the boom in biomass volumes means that the port could see handling of biomass products rise from its current 1.5 million tonnes per annum to 6 million tonnes by 2020. At the same time, there continues to be a parallel decline in the volume of coal transhipment.

What is Biomass?

To the uninitiated, a commonly held belief is that biomass is simply compressed wood waste that is formed into pellets. Actually, it is not nearly as simple as that because biomass can be made up of a combination of several different resources. Apart from the several different types of wood and wood waste (more will be explained later), biomass can include agricultural crops and their waste by-products, municipal solid waste, animal wastes, waste from food processing and even aquatic plants and algae. Nowadays, bulk terminals often receive shipments that contain a mixture of different biomass pellets.

It is this multitude of different organisms plus other characteristics of biomass that provides such a wide range of challenges to conveyor belt manufacturers and those who operate the conveyors that carry it. Apart from the usual considerations of adequate tensile strength, tear strength, elongation and cross-rigidity, the type of rubber compound used on the belt covers must be able to cope with the differing demands created by different forms of biomass. There are four essential characteristics that biomass-carrying belts must have.

Risk of Explosion (Anti-Static Properties)

Safety should always be the first priority and one of the biggest issues concerning belts that carry biomass is dust emission and the prevention of biomass dust explosion. In the production process of biomass wood pellets, wood chip and similar renewable resources, the materials are continually broken down. This results in high levels of combustible dust. The dry flammable dust found in biomass can easily be ignited by static electricity created by abrasion within the conveyor system. In fact the energy required to create ignition is as low as 17mJ. Worse still, biomass dust can also be highly prone to self-ignition, especially if it has become damp. A chemical reaction can take place that causes self-heating and what is referred to as “off-gassing” (carbon dioxide, carbon monoxide and methane emissions).

There should be no more than 35 grammes of dust in a cubic meter of air (lower explosive limit) in the atmosphere immediately surrounding a conveyor carrying biomass. Put into perspective, that is approximately the volume of a small tube of popular brand of children’s sweets. This means that conveyor design including dust extraction systems and chutes takes on far greater importance. Strict conformity to Directive 2014/34/EU should be a pre-requisite. This is also known as 'ATEX 95' or 'the ATEX Equipment Directive' and is applicable to potentially explosive atmospheres of zones 20, 21 and 22 where combustible dust is present.

The build-up of dust has to be kept to an absolute minimum, which means almost constant cleaning. When carrying out any form of maintenance or repair, the dust must be completely removed within several meters of the working area to prevent the possibility of ignition. From a conveyor belt point of view, it is absolutely essential that the electrostatic dischargeability (anti-static) properties of the conveyor belt cover rubber (according to ISO 284 test methods) do not exceed the maximum resistance value of 300 MΩ.

Despite the claims of some manufacturers, not all rubber belts are sufficiently anti-static. 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 bear in mind that it is not possible to obtain an ATEX certificate for a conveyor belt because belts are classified as a component. ATEX certification only applies to the whole conveyor.

Fire Safety (Self-Extinguishing Properties)

Factual evidence (gained from extensive laboratory testing) as well as anecdotal evidence certainly indicates that some of Europe’s biggest users of conveyor belts, including some major ports, are using belts that are not as resistant to fire as they are claimed to be. Only the best quality fire resistant belting for conveyors carrying biomass should ever be considered.

The important thing to remember about fire proof rubber conveyor belts is that they do not exist. By their very nature, rubber and the fabric inner ply material (usually polyester & nylon) used to make conveyor belts is combustible. They will burn – end of story. The two descriptions used by conveyor belt manufacturers are “fire retardant” and, most commonly, “fire resistant”. However, in truth, a more accurate description would be “self-extinguishing”. This is because the ability of a 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 it emits gases that effectively starve the source of the flames of oxygen, thereby extinguishing the fire.

If poor quality and/or insufficient amounts of the additives are used in the rubber compound then the ability to self-extinguish is slower and less effective. The time it takes for the belt to self-extinguish is enormously important because the conveyor is doing what it is meant to do, which is to convey at speed; only this time it is conveying fire. This means that literally every second counts.

There are numerous safety classifications and international standards for which there are many different tests used to measure the self-extinguishing properties of conveyor belts. The basis of virtually all fire testing for belting used in the cargo industry is ISO 340.

ISO 340 Testing

The ISO 340 test standard makes the distinction between fire resistance with covers, which is grade EN 12882 Class 2A and fire resistance ‘with or without covers, which is grade EN 12882 Class 2B. The relevance of “with or without covers” is that as the belt cover wears during its operational life it becomes thinner so the amount of fire resistant rubber protecting the flammable carcass reduces.

EN/ISO 340 Laboratory Fire Test

The actual tests involve exposing 6 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 each belt sample to self-extinguish after the flame has been removed is precisely measured. This is the crucial aspect of the test because the duration of continued burning (visible flame) should be less than 15 seconds for

each sample. The absolute maximum cumulative duration for each group of six sample pieces is 45 seconds. In other words, an average duration of less than 7.5 seconds per test sample. As has already been mentioned, this factor is of paramount importance because it effectively determines how far the fire can be carried by a moving belt. The effects of fire being literally ‘conveyed’ to adjoining buildings can be seen in the photograph.

Every second counts. Conveyors carry fire at an alarming rate.

Even if a manufacturer states that their fire resistant/fire retardant belt has passed the ISO 340 test, the buyer should still exercise caution. A typical conveyor belt can easily travel more than 20 meters within the 7.5 seconds average allowed to pass the test so this would still allow the belt to carry flames over a potentially dangerous distance. Dunlop Conveyor Belting in the Netherlands are widely recognised as the inventors of fire resistance rubber conveyor belts and it is interesting to note that their self-imposed time limit standard for a sample to self-extinguish is less than one second. It is always a wise move to ask to see copies of the test results before placing an order.

Given the highly flammable nature of biomass, in terms of actual fire resistance, it is recommended that EN 12882 Class 2B be regarded as the minimum standard. For conveyors that are in enclosed areas a higher level of fire resistance is needed. Here, DIN 22109 part 4, which is Class 4A of EN 12882, is the recommended standard.

Resistance to Oils and Resins

Biomass, especially the wood and wood waste content, can contain vegetable oils and resins that can have a very detrimental effect on the performance and life

expectancy of a conveyor belt. Over time the oils and resins penetrate the rubber causing it to swell and distort, resulting in serious running problems.

Oil (including fat and grease) resistance can be divided into two sources – mineral and vegetable & animal. Rather surprisingly, ISO or DIN international standards for oil & grease resistance do not yet exist. As a consequence, the American ASTM ‘D’ 1460 test method is generally regarded as being the most demanding test of its kind in the world.

Belt samples following oil test.

The level of oil and resin present depends very much on the type (origin) of the wood itself. For most wood from Scandinavia, good resistance to oil is necessary as these trees are mostly pine trees, which have high turpentine content. In South-European countries and in Latin America, Eucalyptus trees are commonly used. The wood from these trees contains little or no turpentine so oil resistance is not so important. If the origin of the wood used for the biomass can be from variable (or unknown) sources then we would recommend the use of conveyor belts that have a combined resistance to both fire and oil.

Optimising Safety and Economy

The ingredients used to create a fire-resistant (self-extinguishing) and oil resistant rubber compound almost invariably have an adverse effect on the wear-resistance of the rubber. In plain speak, fire resistant and oil resistant rubber usually wears significantly faster than belting designed purely to be resistant to abrasion.

However, it is possible to have the best of both worlds. One such example is Dunlop who have developed fire (and oil) resistant rubber compounds that also

have extremely good resistance to abrasion. This means that the belt retains its resistance to fire for much longer while at the same time considerably extending its operational lifetime. Sadly, laboratory tests consistently reveal that this is very much an exception to the rule within the conveyor belt industry.

Fire resistant conveyor belts are a very significant investment so for reasons of both safety and value for money, buyers should always request technical datasheets before placing an order because they include data on the level of abrasion (wear) resistance. It is important to remember that for abrasion, lower figures represent better resistance to wear.

Ozone & UV Resistance

The fourth essential characteristic of belting used to carry biomass (indeed for all types of rubber conveyor belt) is ozone and UV resistance. Ozone (O_3) occurs naturally in the upper atmosphere, where it is formed continuously by the action of solar ultraviolet radiation on molecular oxygen (O_2). At high altitude, ozone acts as a protective shield by absorbing harmful ultraviolet rays. Wind currents carry O_3 to the atmosphere at the Earth’s surface. At low altitude, ozone becomes a pollutant. Ground level or "bad" ozone is not emitted directly into the air, but is created by the photolysis of nitrogen dioxide (NO_2) from automobile exhaust and industrial discharges. The effects are known as ozonolysis.

Ground level ozone pollution is an ever-present fact of life that should never be under-estimated, especially in ports because coastal areas invariably have a much higher level of ozone pollution. Even tiny traces of ozone in the air will attack the molecular structure in rubber. It also increases the acidity of carbon black surfaces. Natural rubber, polybutadiene, styrene-butadiene rubber and nitrile rubber are the most sensitive to this kind of degradation, which can have seriously detrimental effects on the belt including surface cracking and a marked decrease in the tensile strength of the rubber.

Even more significant are the environmental and health and safety consequences, especially when carrying biomass because the dust particles penetrate the surface cracks and are then discharged (shaken out) on the return (underside) run of the belt thereby increasing pollution and the risk of explosion.

At first glance, fine cracks in the surface rubber may not seem to be a major problem but over a period of time the rubber becomes increasingly brittle. Transversal cracks deepen under the repeated stress of passing over the pulleys and drums and, if the conveyor has a relatively short transition distance,

longitudinal cracks can also begin to appear. There are also hidden long-term effects. One of those hidden effects is that moisture (as well as oils and resins from the wood waste) seep into the cracks and penetrate through the belt covers down to the carcass of the belt. The belt starts to distort and all sorts of difficult, expensive problems ensue.

To make matters worse, ‘bad’ ozone has a partner in crime that also has a seriously detrimental effect on rubber. Ultraviolet radiation causes chemical reactions to take place within rubber and the rapid decline in the ozone layer in the upper atmosphere over the past several decades is allowing an increasing level of UV radiation to reach the earth’s surface. Ultraviolet light from sunlight and fluorescent lighting accelerates deterioration because it produces photochemical reactions that promote the oxidation of the surface of the rubber resulting in a loss in mechanical strength.

ISO 1431 international Standards

Preventing the problems caused by ozone and UV is surprisingly easy using special anti-oxidant additives within the rubber compound during mixing that act as highly efficient anti-ozonants. The test used to measure resistance to the effects of ozone is ISO 1431, which involves placing samples under tension inside an ozone cabinet (50 pphm, strain 20%) for 96 hours. The pass criteria is that there should be no signs of cracking when the test is completed.

ISO 1431. Lateral cracking. The effects of ozone on rubber.

Unfortunately for the users of conveyor belts, most belt manufacturers completely ignore the issue of ozone and UV resistance because the protective additives cost money making their belts less price competitive. Would-be purchasers therefore need to always insist that the belt supplier provides written verification that their belts successfully undergo testing according to EN/ISO 1431 and at which conditions the test is performed.

Perfect Storms demand a perfect Solution

Conveyor belts carrying biomass really do have to face the perfect storm. Firstly; they operate in highly explosive, combustible environments so they need to be completely anti-static and able to self-extinguish as quickly as possible if ignited. Secondly, they convey materials that contain potentially damaging materials in terms of oils and resins. Thirdly, they are under constant attack by the elements including ozone pollution and ultra violet. In short, they have to be safe, reliable and provide an operational life that is as long as possible in order to be economic.

Such belts are, of course, available but you need to be absolutely sure of their providence. You also need to be as sure as you can be that what the manufacture has promised will actually be delivered. When it comes to carrying biomass, belts that are not of the highest standard are a very dangerous and expensive liability indeed.