Handling the biomass boom

The growing pressure to reduce CO_2 emissions has seen an enormous growth in the transshipment of biomass, *writes Les Williams of Dunlop*. With the Kyoto Protocol and the EU's continuing objective to reduce its member's states' carbon footprints, more and more countries are making the push towards biofuel. In fact, the EU wants to achieve 63% of heat generation by biomass by 2020. Just 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 1.5mt (million tonnes) per annum to 6mt by 2020. At the same time, there continues to be a parallel decline in the volume of coal transshipment. As Bob Dylan famously sang, "the times they are a – changing."

For a great many reasons, conveyor systems previously used to carry coal or other cargo such as iron ore cannot simply be used to carry biomass. Adapting existing conveyor systems and building new ones entails enormous investment and very expensive lessons are already being learnt. Here we discuss the impact of handling the biomass boom and its ramifications concerning conveyor systems, maintenance, safety and the critical importance of conveyor belt technology.

What is biomass?

Biomass is used to meet a variety of energy needs, including generating electricity, heating homes, fuelling vehicles and providing process heat for industrial facilities. To the uninitiated, a commonly held belief is that biomass is simply compressed wood waste that is formed into pellets. Not unsurprisingly, it is not nearly as simple as that. Biomass can be made up of a combination of several different resources. Apart from wood and wood waste (of which there are several types), 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, ports often receive shipments that contain a mixture of different biomass pellets.

This multitude of different organisms plus other characteristics of biomass provide a wide range of challenges and demands in terms of safety, maintenance and efficiency. These challenges certainly apply to the conveyor belts used to carry biomass. Apart from the usual considerations of adequate tensile strength, tear strength, elongation and cross-rigidity, there are four essential characteristics that biomass-carrying belts must have, all of which have a direct or at least important influence on safety.

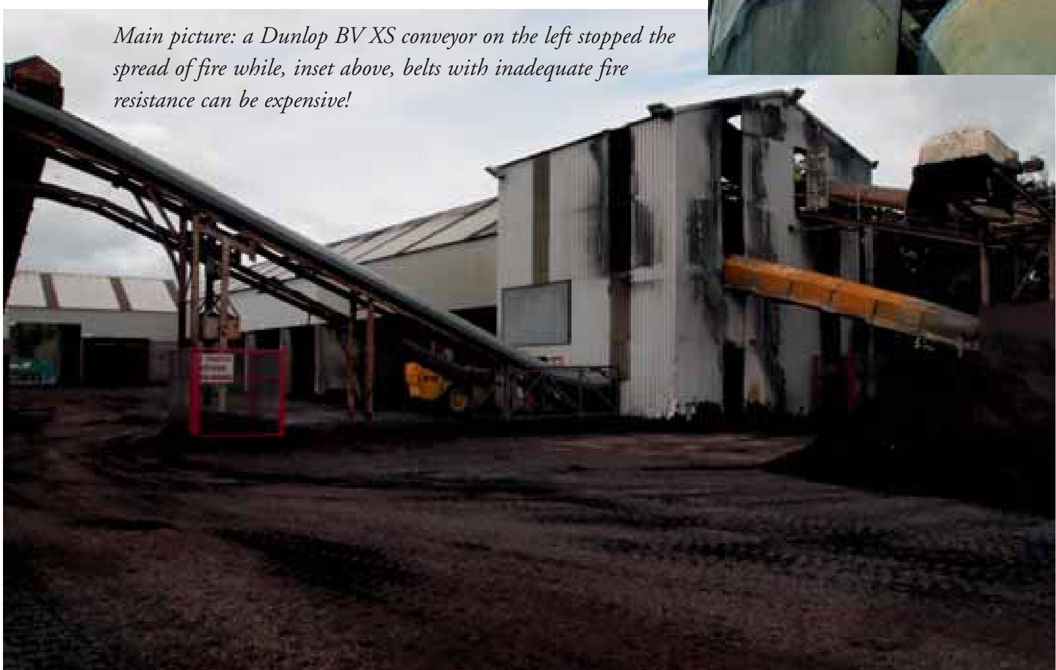
Risk of explosion

One of the biggest issues is dust emission. 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 be ignited even by abrasion created within a conveyor system because the source only requires ignition energy as low as 17mJ for the ultimate ignition. This is one of the major factors in biomass dust explosion prevention. Biomass dust can also be highly prone to self-ignition, especially if the material 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).

In the atmosphere immediately surrounding a biomass conveyor, there should be no more than 35 grammes of dust in a cubic metre of air. Put into perspective, that is approximately the volume of a small tube of popular children's sweets. This means that conveyor design including dust extraction systems and chutes take on a much greater importance. Strict conformity to Directive 94/9/EC (also known as 'ATEX 95' or 'the ATEX Equipment Directive') applicable to potentially explosive atmospheres of zones 20, 21 and 22 where combustible dust is present should be a pre-requisite.

Dust build-up 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 DIN EN 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. The key ingredient in conveyor belt rubber is carbon black, which acts as an electrical conductor. It is widely accepted that premium grade belts will contain an optimum level of high quality carbon black whereas belting designed to compete in the lower price range end of the market



Main picture: a Dunlop BV XS conveyor on the left stopped the spread of fire while, inset above, belts with inadequate fire resistance can be expensive!

will almost invariably contain less carbon black, often with 'fillers' used as a substitute to keep prices to a minimum.

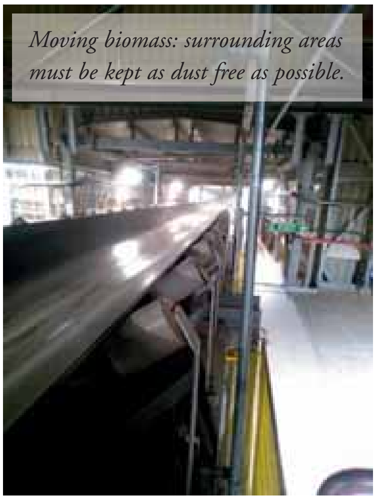
It is strongly recommended that the belt supplier be asked to provide certification issued by an independent expert body for explosion protection such as DEKRA in Germany, which is the organization that is used by Dunlop Conveyor Belting.

Ozone & UV resistance

Ozone occurs naturally in the upper atmosphere. At high altitude, ozone acts as a protective shield by absorbing harmful ultraviolet rays. However, at low altitude, the ozone itself is a pollutant. Coastal areas and inner cities have particularly high levels of ozone pollution. Exposure to ozone increases the acidity of carbon black surfaces and causes reactions to take place within the molecular structure of the rubber. This can have several consequences such as a surface cracking and a decrease in the tensile strength of the rubber.

Belts that do not operate under shelter are especially prone to surface cracking, which can be extremely detrimental in terms of the performance of the belt and its working life. 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.

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. Again, surface cracking may not initially seem to be a cause of concern but there are often 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.



Moving biomass: surrounding areas must be kept as dust free as possible.

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 they produce photochemical reactions in rubber that promote the oxidation of the surface of the rubber resulting in a loss in mechanical strength.

EN/ISO 1431 international standards

Dunlop Conveyor Belting was amongst the very first to introduce mandatory testing to EN/ISO 1431 international standards. As a direct result, special anti-oxidant additives that act as highly efficient anti-ozonants were introduced into all of its rubber compound recipes to provide protection against the damaging effects of ozone and ultra violet.
Customers should always insist that their belt supplier provides written verification that their belts undergo stringent conditional testing according to EN/ISO 1431 and are 100% resistant to the effects of ozone and UV. At Dunlop, the pass criteria is that the rubber sample does not show any signs of cracking after 96 hours (@ 20°C, 50pphm and 20% strain) inside the ozone cabinet.

ASTM D 1460 oil resistance testing.

Fire safety

Anecdotal as well as factual evidence gained from laboratory testing certainly indicates that some of Europe's biggest users of conveyor belts, including some major ports, may be 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 be considered.

The first and most important thing to bear in mind is that conveyor belts cannot be totally fire proof. The fabrics used in the carcass of the belt most commonly contain polyester and nylon. These materials have little or no resistance to fire. In other words, every belt will burn when it is exposed to a naked flame that is sufficient to ignite the belt. Using special additives and chemicals, the rubber used in the top and bottom covers that protect the carcass of the belt and the rubber skim between the fabric plies of the carcass can be engineered to resist fire but the complete structure of the belt cannot be made fire proof. In truth, the 'fire resistance' properties of a conveyor belt are actually its ability to self-extinguish.

How long will the belt continue to burn?

EN/ISO 340 testing involves 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 seconds for each sample with a maximum cumulative duration of 45 seconds for each group of six tests. Fire can be carried along a moving belt with disastrous results so the time factor is of paramount importance because it determines how long the rubber will continue to burn before it self-extinguishes. The effects of fire being literally 'conveyed' to adjoining buildings can be seen in some of the photographs.

Even if a manufacturer states that their belt has passed the ISO 340 test, the buyer should still exercise caution. A typical conveyor belt can easily travel more than 40 metres within the 15 seconds sufficient for a belt sample to pass the test. But even ten seconds would still allow the belt to carry flames over a potentially dangerous distance. For this reason, the required time limit standard in Dunlop is an average of no more than one second, ideally even less. Buyers of fire-resistant belt are therefore recommended to ask to see copies of the manufacturer's test results.

EN/ISO 12882 fire resistance specifications make the distinction between fire resistance with covers ('K' grade) and fire resistance with or without covers ('S' grade). Given the highly flammable nature of biomass, in terms of actual fire resistance, Dunlop recommends that 'S' grade (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, Dunlop recommends DIN 22109 part 4, which is Class 4A of EN 12882.

Optimizing safety and economy

The relevance of 'with or without covers' within EN/ISO 12882 (Class 2A and 2B) is that as belt covers wear during their operational life the amount of fire resistant rubber protecting the flammable carcass reduces. 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 rubber usually wears faster and, as it wears, then the level of fire resistance reduces accordingly.

However, the rubber compound technicians at Dunlop have proved that it is possible to have the best of both worlds by developing fire- (and oil-) resistant rubber compounds that 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 wear life. Unfortunately, laboratory tests have consistently revealed 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 both safety and value for money reasons, buyers should always request technical datasheets before placing an order because they include data on the level of abrasion (wear) resistance. (NB: for abrasion, higher figures represent less resistance to wear.)

The effects of oil on rubber

Oil (including fat and grease) resistance can be divided into two sources — mineral and vegetable & animal. 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. Rather surprisingly, ISO or DIN international standards for oil and grease resistance do not yet exist. Dunlop applies the American ASTM 'D' 1460 standard, generally regarded as being the most demanding standard of its kind in the world.

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 essential. This is generally valid for non-pine wood such as poplar and birch. If the origin of the wood used for the biomass can be from variable sources then Dunlop would recommend the use of conveyor belts that have a combined resistance to fire and oil.

As a general rule, belts carrying biomass in open conditions should at least have a fire-resistant standard 'S' grade (EN 12882 Class 2B) combined with a good standard of oil resistance. For these conditions, Dunlop recommends its BVM-S. Belts operating in closed conditions should be EN 12882 Class 4A fire resistant. Here, Dunlop recommends its BV-VT, which is both Class 4A fire resistant and oil resistant (ASTM 'D' 1460).

Perfect storms demand a perfect solution

To summarize, conveyor belts carrying biomass have to face the perfect storm; they operate in highly explosive, combustible environments. They need to be completely anti-static and self-extinguish as quickly as possible if ignited. They convey materials that contain potentially damaging materials in terms of oils and resins. They are under constant attack by the elements including ozone pollution and ultra violet. 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 and you need to be as sure as you can be that what the manufacture promises you is actually delivered. When it comes to carrying biomass, belts that are not of the highest standard are a very dangerous and expensive liability indeed.