Conveying biomass – a guide to belt selection

Conveyor belts carrying biomass have to operate in highly explosive, combustible environments. They therefore need to be completely anti-static and self-extinguish as quickly as possible if ignited. They must also be highly resistant to the potentially damaging oils and resins that biomass contains. As if that is not enough, they are under constant attack by ground level ozone pollution and ultraviolet radiation. They need to be reliable and provide an operational life that is as long as possible in order to be economic and above all else, they must be as safe as possible in every respect.

Netherlands-based Dunlop Conveyor Belting has been one of the most prominent and well-respected manufacturers of high-performance conveyor belting in the world for over 50 years. Who better to ask, therefore, for some expert advice and guidance? As part of this month's focus on handling biomass, *Rob van Oijen*, Dunlop's manager of application engineering provides an easy-to-follow guide to selecting belts for conveying biomass.


Biomass dust can be prone to self-ignition.

Five-point checklist

Biomass can consist 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. Within this multitude of different organisms are a variety of elements that can have a very detrimental effect on rubber and consequently a major influence on the operational lifetime of a conveyor belt. Most importantly of all, they can also create significant safety issues. There are five essential characteristics to consider when selecting conveyor belts to convey biomass and the first two both involve safety.

1. Risk of explosion (anti-static properties)

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 be ignited by static electricity created by abrasion within the conveyor system because the source only requires ignition energy as low as 17mJ for the ultimate ignition to take place. 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).

There should be no more than 35 grams of dust in a cubic metre of air (lower explosive limit) in the atmosphere immediately surrounding a biomass conveyor. Strict conformity to Directive 94/9/EC (applicable to potentially explosive atmospheres of zones 20, 21 and 22 where combustible dust is present) should therefore be a pre-requisite. 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 300MΩ. It is important to bear in mind that it is not possible to obtain an ATEX certificate for a conveyor belt itself because belts are classified as a component and not as a system. ATEX certification only applies to the whole conveyor system.

CHECK POINT: *When sourcing conveyor belts for use in ATEX regulated areas it is very important to ask the supplier for a copy of a certificate provided by an appropriate independent testing authority such as the German Institute Dekra Exam GmBH.*

2. Fire safety. Choosing the correct standard of fire resistance

The basis of most tests for belting used in normal industrial applications is EN/ISO 340. This standard makes the distinction between fire resistance with covers (K) and fire resistance with or without covers (S). The relevance of 'with or without covers' is that wear reduces the amount of fire-resistant rubber that protects the flammable carcass.


ISO 340 fire testing.

Class 4A entails EN12881-1 method A, C or D in addition to EN/ISO 340 testing.

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. A current of air is then applied to the test piece for a specified time after the removal of the flame. The time it takes for the belt sample to self-extinguish after the flame has been removed is then 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 test samples. This determines how far a moving belt can carry a fire.

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.

For the majority of biomass handling applications, EN 12882 Class 2A (K grade) or Class 2B (S grade) levels of fire resistance would be perfectly adequate. Class 2A demands that the belt is able to pass the ISO 340 test with the covers intact on the belt samples whereas Class 2B requires that the belt is also able to pass the test with the top and bottom cover rubber removed. Both Class 2A and 2B must fulfill the anti-static requirements of ISO 284.

Because of the increased risk of self-ignition when biomass becomes damp, the use of covered conveyors is becoming increasingly commonplace. The risk to human life is heightened in enclosed environments because burning rubber and other synthetic materials such as polyester and nylon release a dark, thick smoke that contains cyanide, carbon monoxide, sulphur dioxide, and products of butadiene and styrene.

For this reason, EN 12882 Class 4A is usually the best choice for conveyors operating in closed or covered conditions because it involves a more severe fire test according to EN12881-1 method A, C or D in addition to EN/ISO 340 testing.

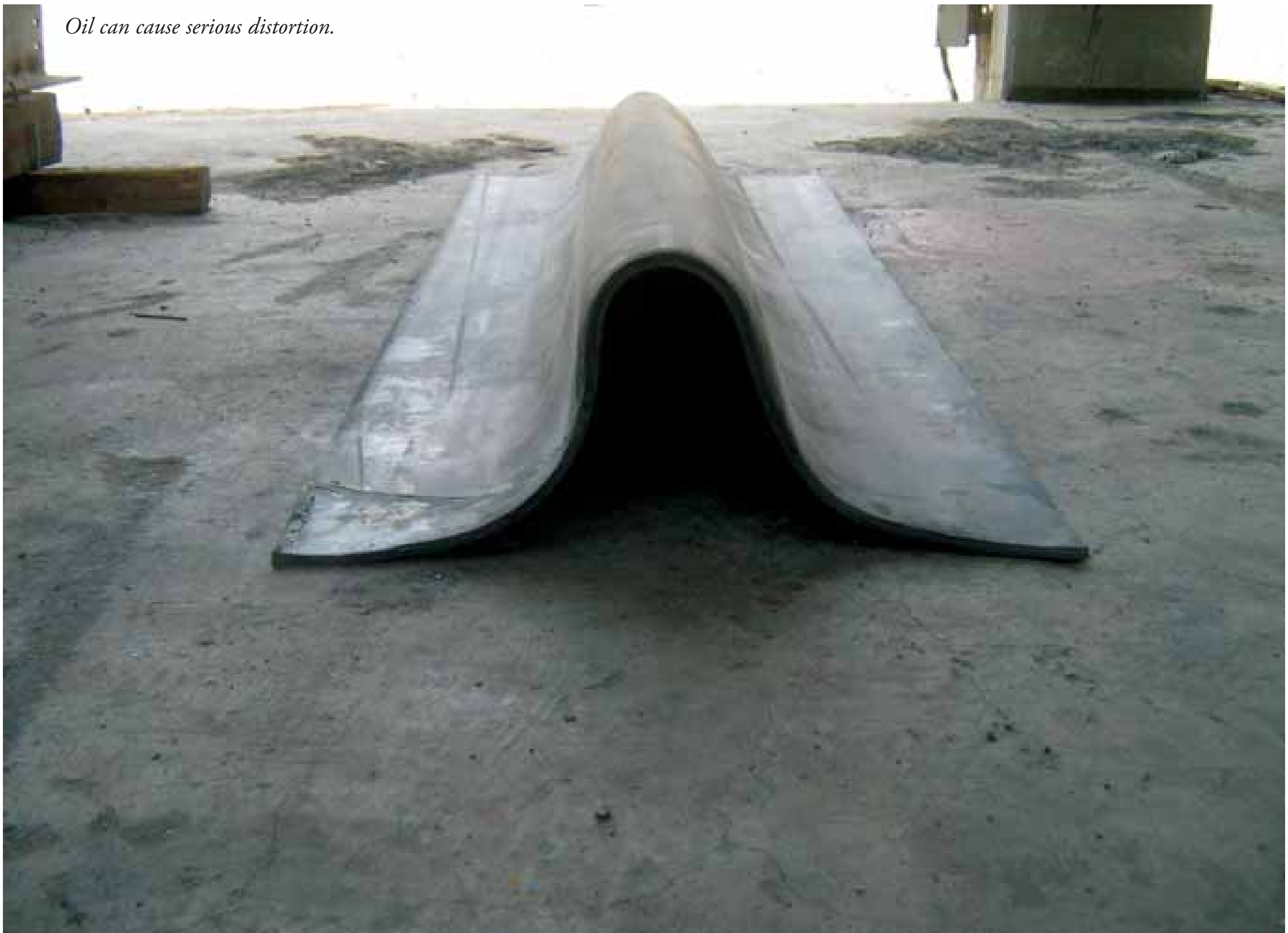
CHECK POINT: *Even if a manufacturer states that its fire-resistant belt meets the requested EN 12882 level of fire resistance, it is advisable to insist on certification and, if available, details of the typical self-extinguishing timings achieved during ISO 340 testing. A conveyor belt can easily spread a fire more than 40 metres within 15 seconds.*

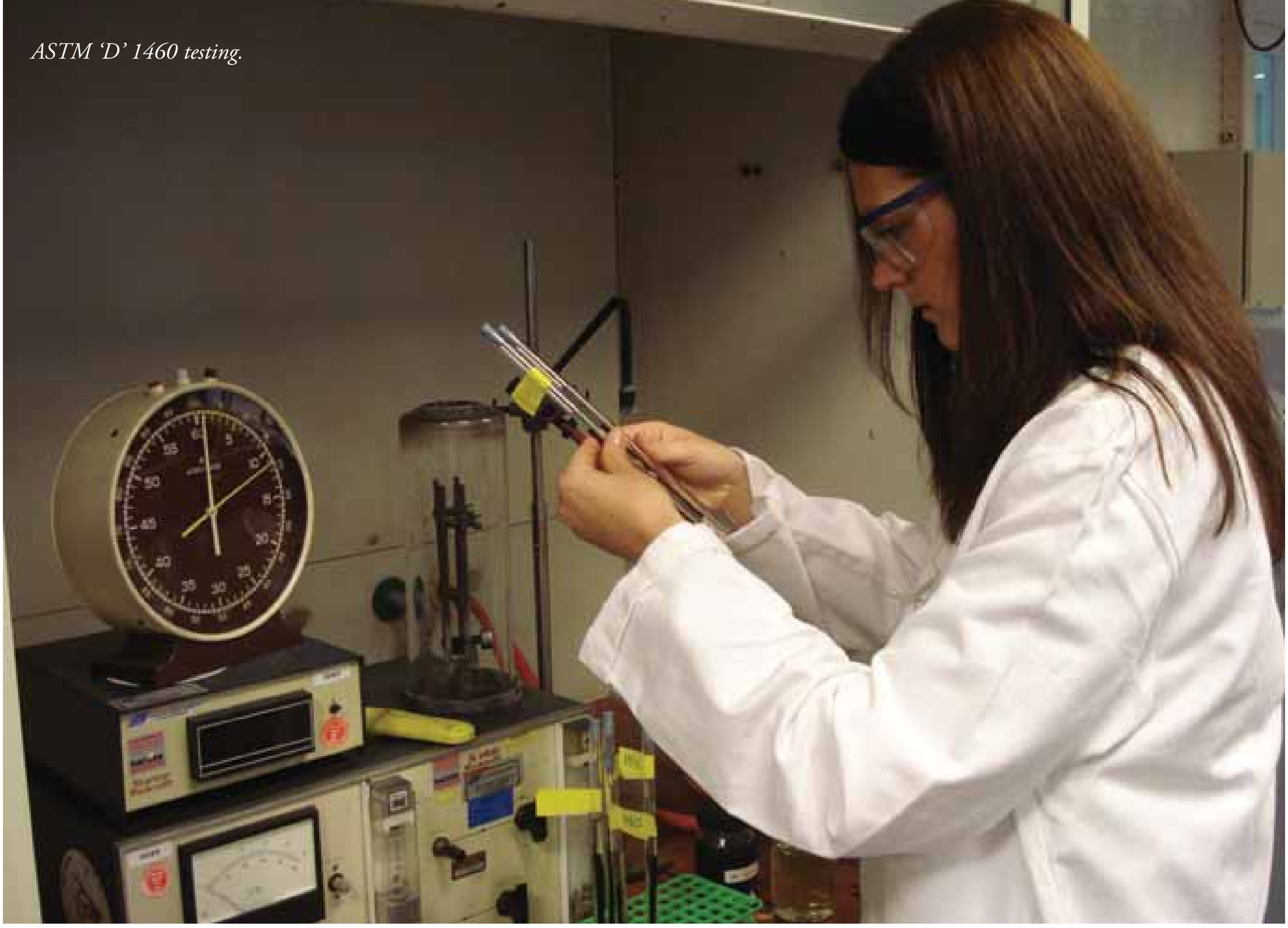
3. Resistance to oils and resins

Biomass, especially the wood and wood waste content, can contain vegetable oils and resins that have a very detrimental effect on the performance and life expectancy of a conveyor belt. When the oils and resins penetrate rubber it causes it to swell and distort, resulting in serious tracking and steering problems as well as premature wear. Over time, belts that have a poor level of resistance to oil can literally fold themselves into a pipe shape.

The oils, resins, fats and greases that have these damaging effects can be divided into two distinct sources — mineral and vegetable/animal. The level of oil and resin present depends very much on the type (origin) of the wood used to create the biomass. For most wood from Scandinavia for example, good resistance to oil is essential 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 I would recommend the use of conveyor belts that have a combined resistance to fire and oil.

Oil can cause serious distortion.

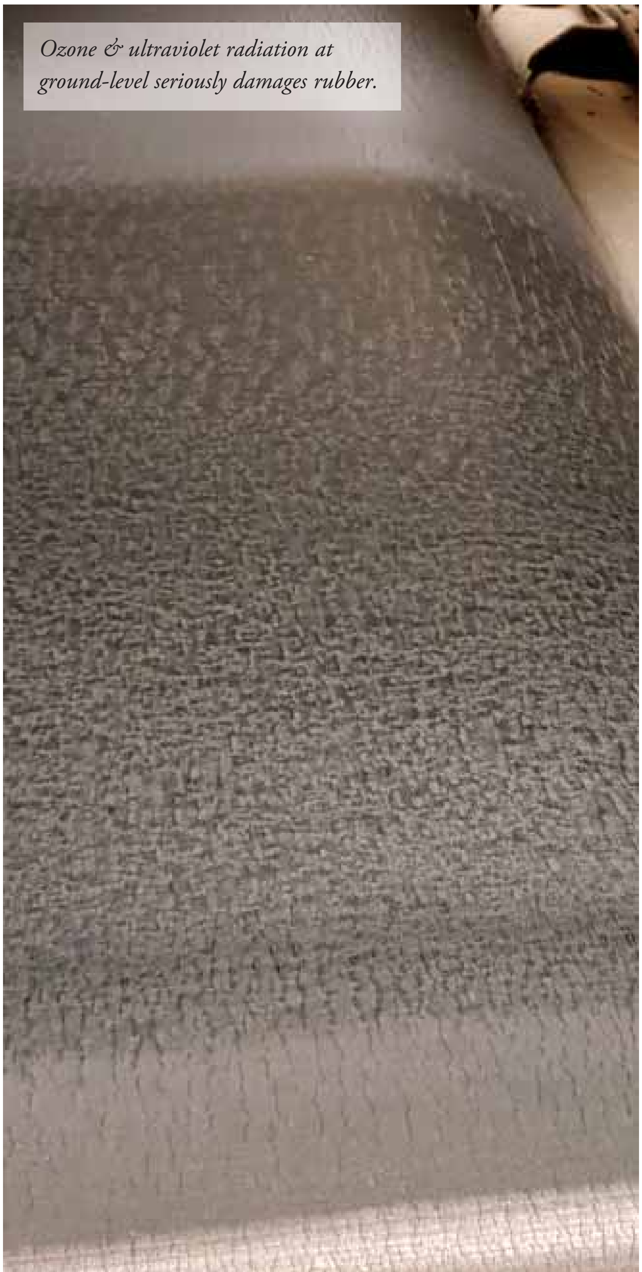




ASTM 'D' 1460 testing.

<u>Oil resistance — test methods</u>

There are two recognized test methods, both of which involve almost identical test procedures. These are ISO 1817 and the comparable, slightly less elaborate but very stringent American ASTM 'D' 1460. Rather surprisingly, ISO or DIN international performance standards for oil & grease resistance do not yet exist. Manufacturers are therefore at liberty to use whichever test conditions they deem most suitable to them. However, there is a sting in the tail concerning the matter of test methods.



Ozone & ultraviolet radiation at ground-level seriously damages rubber.

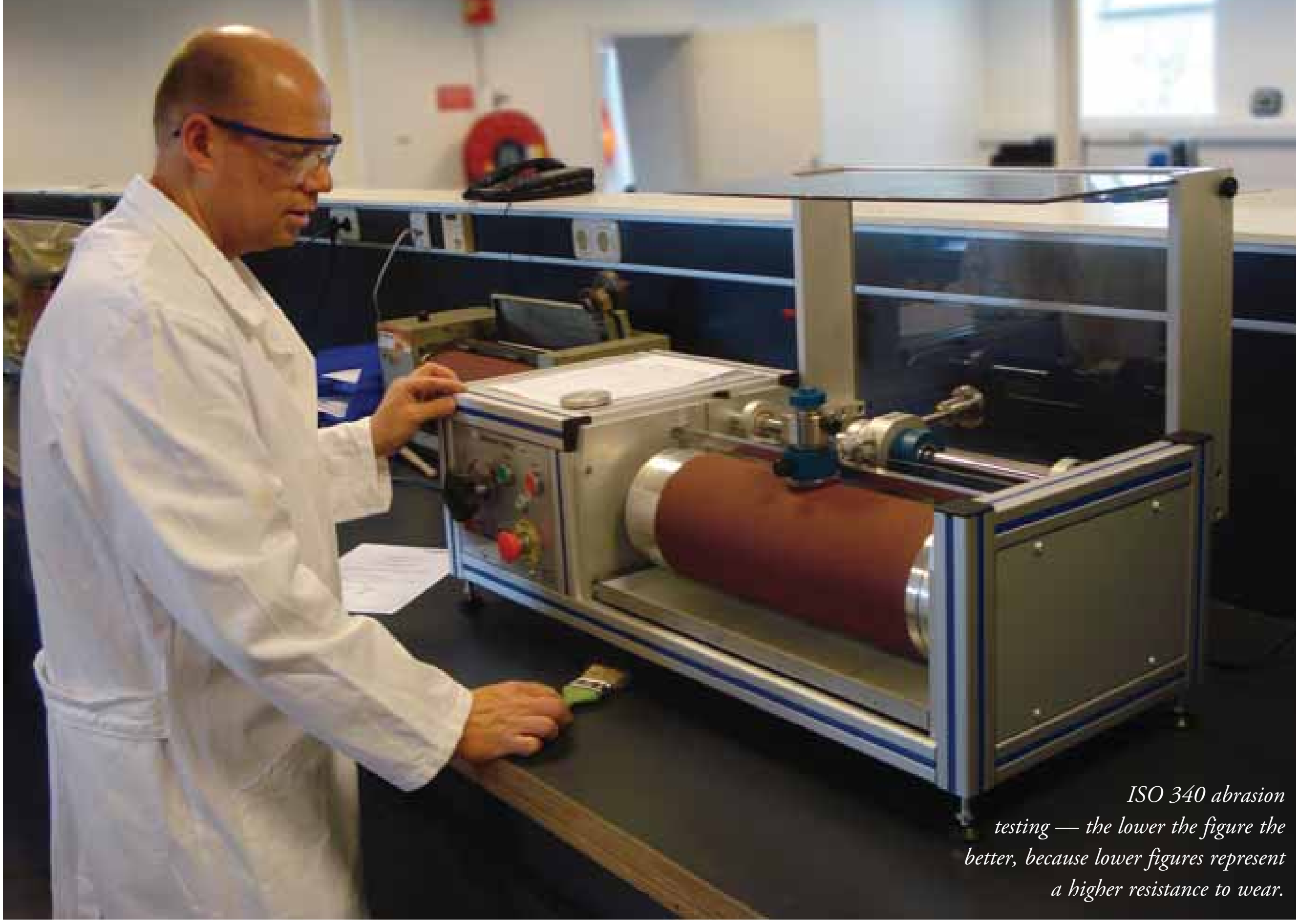
<u>DIN 22102 G. Not what it seems.</u>

Some of the biggest manufacturers of belting in the world, primarily those in Asia, and even some in Europe, use the DIN reference number 22102 G when referring to oil-resistant belting. This can be very misleading because the letter 'G' is simply used to denote oil- (or grease-) resistant belting. In reality, there are no firm requirements, test methods or limits specific to oil-resistant belting associated with DIN 22102 G. This is a classic example of how simply showing a test method reference number is designed to create a false sense of security but is essentially meaningless in respect to actual performance.

CHECK POINT: *Always insist on belts that have been tested according to either ISO 1817 or ASTM 'D' 1460 and review actual test conditions on a like for like basis.*

4. Ozone & UV resistance

The fourth essential criteria for selecting a conveyor belt to carry biomass is the ability to resist the damaging effects of ground-level ozone and UV rays. 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



ISO 340 abrasion testing — the lower the figure the better, because lower figures represent a higher resistance to wear.

exhaust and industrial discharges. The effects are known as ozonolysis.

Even tiny traces of ozone in the air will attack the molecular structure in rubber. It also increases the acidity of carbon black surfaces with natural rubber, polybutadiene, styrene-butadiene rubber and nitrile rubber being the most sensitive to degradation. This can have several consequences such as surface cracking and a marked decrease in the tensile strength of the rubber.

Belts that operate in coastal areas are especially prone to surface cracking. This 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. This is especially so 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. There are also hidden long-term effects such as moisture (including oils and resins) which seeps into the cracks and penetrate through the belt covers down to the carcass of the belt, causing it to distort.

To make matters worse, 'bad' ozone has a partner in crime that also seriously damages rubber. The 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 causes chemical reactions to take place within rubber that accelerate deterioration because it produces photochemical reactions that promote the oxidation of the surface of the rubber resulting in a loss in mechanical strength.

CHECK POINT: *Ozone & UV resistance should be an essential requirement when selecting any rubber conveyor belt. Make sure that the belt you choose has been successfully tested according to ISO 1431.*

5. Wear resistance

Conveyor belts are a very significant investment so apart from the essential features I have already detailed, I would definitely include wear resistance as part of the selection criteria because it does have a very significant influence on the 'whole life cost' of any conveyor belt. This is especially so when it comes to belts that convey biomass because 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 straightforward abrasion-resistant belting.

Although very few and far between, one or two European manufacturers have proved that it is possible to have the best of both worlds by designing fire- and oil-resistant rubber compounds that also have extremely good resistance to abrasion. Sadly, however, this is very much an exception to the rule.

CHECK POINT: *Always request technical datasheets before placing an order and in particular look at the level of abrasion resistance shown. To provide an adequate wear life on conveyors carrying biomass I would expect an absolute maximum abrasion figure of 200 mm³. It is important to remember that for abrasion, the lower the figure the better because lower figures represent a higher resistance to wear.*

About the author.

Rob van Oijen is Manager Application Engineering for Dunlop Conveyor Belting in The Netherlands. He has specialized in conveyors for over 14 years, supporting businesses throughout Europe, Africa, the Middle East and South America.

Rob van Oijen.