BEWARE OF THE WEAR EFFECT

Jan Willems, Conveyor Belt Expert, outlines why distinct types of coal cause different kinds of wear and pose varying levels of fire risk.

A common generalisation is that coal does not have a particularly aggressive wear effect on rubber conveyor belts; a view shared by most in the conveyor belt industry. Consequently, insufficient attention and investment is often paid to the



type and quality of rubber conveyor belts needed to handle it. Generalisations also seem to exist regarding fire safety and the level of risk posed by coal. In both cases, the reality is that the level of wear and the level of fire risk very much depend on the type of coal being conveyed.

Wear and tear

Different types of coal vary significantly in how damaging to rubber they are. Each has distinctive wear damage mechanisms including surface abrasion, cutting, gouging, and chemical degradation. The abrasiveness of coal is largely determined not by the carbon itself, but by the hard impurities and mineral matter trapped within the coal, specifically quartz and pyrite, which can both be harder than steel and therefore cause the most aggressive wear. Another factor is particle size and particle shape because they affect how coal interacts with equipment, with angular and coarse particles causing greater abrasion than rounded or finer ones.

Coal with a higher ash content typically displays a higher Abrasivity Index, as more ash generally corresponds to a higher concentration of abrasive minerals. 'Excluded' minerals (dust) that are released and exposed during handling, especially the pulverisation process, cause significantly more abrasive damage than 'included' minerals that remain locked safely inside the carbon matrix.



Figure 1. The abrasiveness of coal is largely determined by the impurities and mineral matter trapped within it.



Figure 2. Lowest lifetime cost. Experience shows that premium quality belts may outlast as many as three or more 'competitively priced' imported belts.

Coal rank (anthracite vs bituminous)

Although higher-ranking coals such as anthracite are harder, coal rank alone is not a reliable indicator of abrasiveness. Lower-rank coals, such as bituminous and lignite, can cause equal or greater wear depending on their mineral content. Coal rank is the measure of the degree of organic metamorphism of a coal, ranging from low-rank peat to high-rank meta-anthracite. However, no single parameter can be used throughout the entire rank range.

Belt surface wear

Belt surface wear is caused by fine, abrasive particles that scour the belt cover, especially at the loading and unloading stations when the particles are effectively accelerated across the belt surface.

It is important to bear in mind that the ability of a belt cover to withstand wear is not due to its 'abrasion resistance' alone, because much also depends on the rubber overall strength of the rubber and its resistance to cutting and gouging. When sharp lumps of hard coal such as anthracite strike the belt surface they puncture and slice into the rubber surface. On low-grade rubber, this is often barely visible at first but the damage quickly spreads and links up with other areas of damage, cutting out small pieces of rubber from the surface rather than just wearing it thinner.

Scraper wear

Scraper wear occurs when highly abrasive coal fines become trapped under belt cleaners and scrapers, acting like sandpaper, scoring grooves in the centre of the belt. Chemical degradation of the conveyor belt is caused by high-sulfur bitumous coal that creates acidic runoff when under moist and oxidising conditions. This chemically attacks the rubber compound, causing it to harden, crack, or soften – depending on the composition of the rubber. This is even more pronounced in belts with low grade rubber that is not resistant to the effects of ground level ozone (O_3) and ultraviolet light. Finally, tracking issues can also be influenced by coal type. For example, lignite

typically has a low level of physical abrasion due to its relative softness but high moisture and clay content cause material buildup, leading to belt tracking issues and edge wear.

Summary

There can be no argument that the quality and durability of the rubber covers determines the rate of wear damage. Imported belts can be as much as 50% lower in price compared to premium quality brands in Europe, such as Netherlands-based Fenner Dunlop. However, field surveys and repeated laboratory testing consistently confirm that their belts will outlast as many as three or more 'competitively priced' imported belts, which can compensate for the difference in price.

Different coal types = different fire risks

Different types of coal also have vastly different levels of fire risk, primarily driven by their propensity for spontaneous combustion during storage and transport. Contrary to logical expectation, lower-rank coals (e.g. lignite and sub-bituminous) often present a higher risk of spontaneous combustion, and therefore pose a significantly higher immediate fire risk than higher quality coals (e.g. bituminous and anthracite). This is because lower-rank coals have less fixed carbon and are highly chemically reactive. They absorb oxygen rapidly at ambient temperatures, initiating an exothermic (heat-generating) oxidation reaction that can quickly accelerate into an open fire.

Low-rank coals also contain high inherent moisture and volatile matter. When stored in large stockpiles, the evaporation and condensation of this internal moisture can also trigger an exothermic chemical response while softer coals create dust more easily, causing an enormous cumulative surface area for oxygen interaction, while simultaneously acting as an insulation blanket that traps heat. Finally, the presence of iron pyrites (FeS_2) significantly amplifies fire hazards. Pyrite oxidises rapidly in the presence of air and moisture, releasing a large amount of localised heat that serves as an ignition trigger for the surrounding coal.

A brief guide to fire resistant belts

The basic definition of fire-resistant belting is that it will not continue to burn without an external fire source. The ability to 'resist' fire is achieved by using special chemicals and additives within the rubber compound to prevent ignition and consequently burning. Once vulcanised rubber has been ignited it emits gases that effectively suffocate (extinguish) the fire by starving the flames of oxygen.

EN 12882 Category 1

EN 12882 is the most basic classification and demands that the belt is anti-static (limited electrical resistance). This means that the belt meets the primary requirement for use in risk areas that contain coal dust.



Figure 3. Coals such as lignite pose a significantly higher fire risk.



Figure 4. ISO 340 measures the time taken to self-extinguish.



Figure 5. If the type of coal varies then the safest option is Class 2B.



Figure 6. Class 4A involves a more severe fire test according to EN 12881-1 method A, C, or D.

EN 12882 Class 2A and Class 2B

The basis of most tests within EN 12882 for belting fire resistance is EN ISO 340, which measures the amount of time that a sample of belt takes to self-extinguish when the source of ignition is removed. These standards make the distinction between fire resistance with covers, which is Class 2A (also referred to as K grade) and fire resistance with and without covers, which is Class 2B (also referred to as S grade). The relevance of 'with and without covers' is primarily because the rubber skim layers between the synthetic plies protect the most flammable part of the belt. The rubber skim material therefore needs to be as equally fire resistant as the outer covers. Unfortunately, manufacturers who want to achieve a more competitive price often use rubber that is not sufficiently fire resistant.

For the majority of coal handling 'open air' applications, EN 12882 Class 2A (K grade) or Class 2B (S grade) levels of fire resistance would be perfectly adequate. The best way to decide between Class 2A and Class 2B is to consider the type of coal being carried. If the type is unknown or unpredictable then the safest option is to choose Class 2B.

EN 12882 Class 4A

Class 4A involves a more severe fire test according to EN 12881-1 method A, C, or D in addition to EN ISO 340 testing. This increased level of fire safety is necessary when conveying coal with a particularly high level of flammable dust that can be ignited by static electricity because under certain conditions the source only requires ignition energy as low as 17 mJ for ignition to take place.

Although the use of covered conveyors minimises this risk, the risk to human life is heightened in enclosed environments because burning rubber belts release thick toxic smoke that contains cyanide, carbon monoxide, sulfur dioxide, and products of butadiene and styrene. EN 12882 Class 4A is therefore usually also the best choice for conveyors operating in closed or covered conditions.