ADVANCES IN FLAME RETARDANT BELTING AND THE FUTURE

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1. INTRODUCTION

Flame retardant belting has been in general use for decades since this stipulation was enforced by the National Coal Board (NCB) when conveyors in industrial coal mining were first used.

Advances in the technology of flame retardant belts has resulted in improved product performance and safer products. Ongoing research and development will most definitely continue this trend.

2. PURPOSE

This paper highlights several improvements that have emerged in flame retardant belting over the past few years, and also comments on likely future developments.

3. HISTORY OF FLAME RETARDANT BELTING

There is a pronounced difference between 'Flame Resistant' and 'Flame Retardant' belting. Flame resistant implies that the object will not burn, whereas flame retardant implies that the object can burn but will retard the flame propagation.

Flame retardant belting is designed to self-extinguish if the flame source is removed. In order for any object to burn it needs a fuel source and oxygen.

First Generation Belts (1905)

The first generation belts were manufactured from cotton carcasses soaked with PVC paste. During the burning process of polyvinyl chlorine (PVC) belting, chlorine gas is emitted which starves the flames of oxygen preventing further burning and thus the belt automatically self-extinguishes.

Second Generation Belts (1950)

The cotton carcass in first generation belts absorbed moisture easily resulting in reduced belt strength as the cotton rotted. Synthetic fibers such as polyester and nylon were then introduced to overcome this problem. This enabled manufacturers to construct much stronger belts which made possible much longer belt installations. The flame retardant properties were still obtained through the use of PVC as the saturate.

Unfortunately PVC also releases highly toxic fumes in large quantities coupled with high smoke densities. Examples of the toxic gasses are NO, CO, CO_2, HCl and SO_2

There are still, however, many mines that use this type of belting, mainly due to the low associated cost.

Third Generation Belts (1980)

Multi-ply rubber covered belts were developed and introduced in the 1980s. The rubber contained high levels of chlorinated paraffin that was used to starve the fire of oxygen. These belts also released highly toxic fumes in large quantities associated with high smoke densities.

GAS DETECTED	CONCENTRATION FOR 100g OF MATERIAL BURNED (ppm)	TOXICITY INDEX
Carbon Dioxide	227 272	2.271
Carbon Monoxide	6 818	1.704
Nitrogen Oxide	182	0.727
TOTAL TOXICITY INDEX		**4.703**

Table 1. Test results on a typical third generation rubber sample

The toxicity index is calculated from the summation of the ratios of these concentrations to the concentrations causing fatality to an individual after a 30-minute exposure time. Gases and their fatality limits as defined in UK Naval Engineering Standard NES 713 are shown in Table 2.

Gas Type	Gas Concentration (ppm)	Gas Type	Gas Concentration (ppm)
Carbon Dioxide	100 000	Nitrous Oxides	250
Carbon Monoxide	4 000	Hydrogen Cyanide	150
Formaldehyde	500	Acrylonitrile	400
Hydrogen Fluoride	100	Ammonia	750
Hydrogen Chloride	500	Sulphur Dioxide	400
Hydrogen Bromide	150	Hydrogen Sulphide	750
Phenol	250	Phosgene	25

Table 2. Gases and their fatality limits

Fourth Generation Belts (1992)

The introduction of the ‘Gallery Test’ forced manufacturers to increase the flame resistance of belts. The Gallery Test simulates a belt burning underground in a confined space with an air draft. This is a fairly severe test and generation one to three belts did not comply. As a consequence, belt manufacturers reduced the potential fuel sources usually added to the rubber, and also examined the type of rubber used. This resulted in an increase in the belt cost but a much safer belt.

Unfortunately, highly toxic fumes and high smoke density remained a problem. Earlier versions of flame retardant belting specifications focused purely on the self-extinguishing properties of the belt and not the toxicity levels or smoke density generated by a burning belt.

Fifth Generation Belts

Most of the rubber belts currently supplied, excluding PVC belts, incorporate non-halogenated products to achieve the required self-extinguishing properties. Basically, a mixture of chemicals are added to the rubber, which during the combustion process, release water which extinguishes the fire. Chlorine was thus eliminated from the rubber formulation and toxicity reduced.

These modifications were still, regrettably, insufficient in lowering the remaining high levels of toxic fumes coupled with high smoke density during combustion.

4. THE LATEST GENERATION OF FIRE RETARDANT BELTING

To date, the focus of all the conveyor belt specifications have been on the 'flame'. There are no regulations or guidelines for the smoke density or gas toxic levels.

The belt evaluation laboratory test (B.E.L.T.) also known as the 'Gallery Test' does not measure or control the smoke properties.

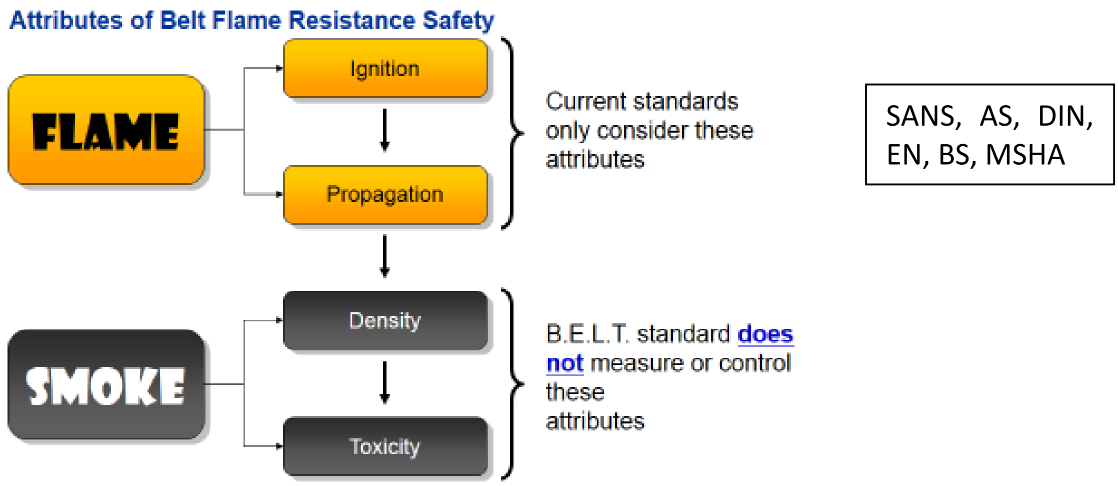

Figure 1. Attributes of belt flame resistant safety

Conveyor belt manufacturers have now developed flame retardant belting with a much lower toxicity and also drastically reduced smoke density. The charts below illustrate the reduction in the toxic gas levels and also the improved drop in smoke density.

Toxic Gases from Belts – BSS 7239 (Boeing Safety Standard)

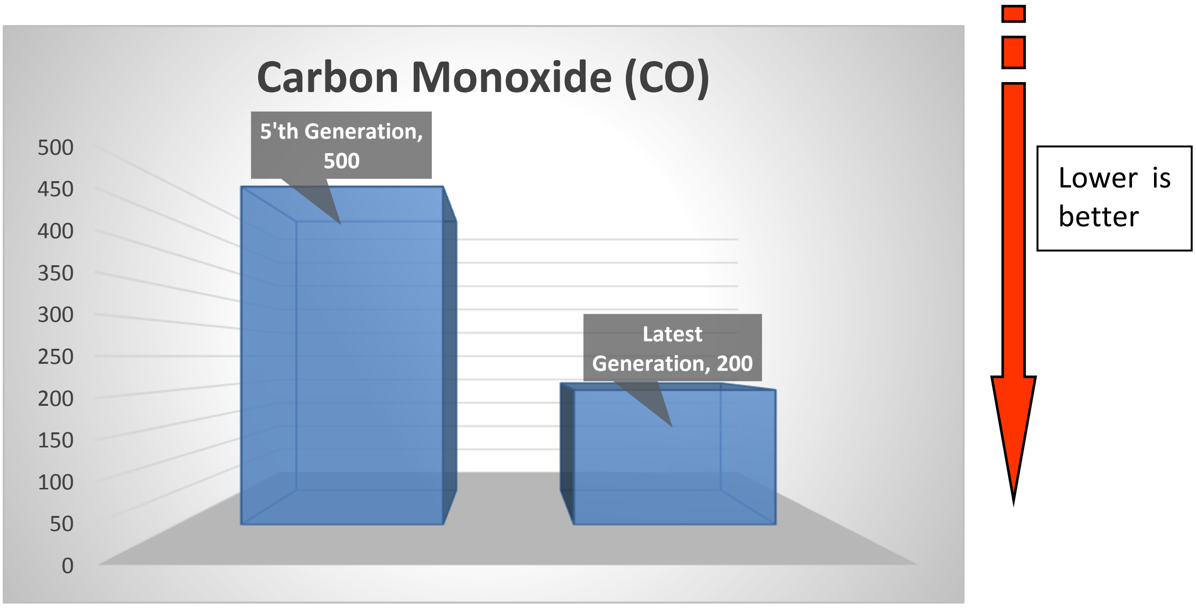

Figure 2. The Carbon Monoxide (CO) levels reduced by 60%

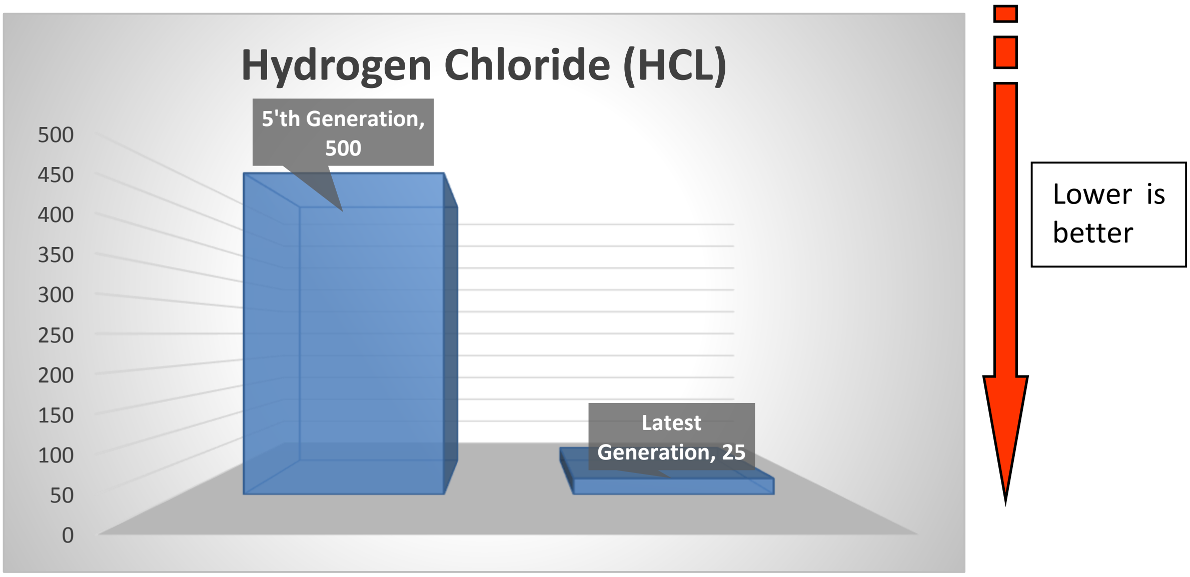

Figure 3. The Hydrogen Chloride (HCL) levels have reduced dramatically to almost zero

Smoke Density when tested to ASTM E662 (after 4 minutes flaming)

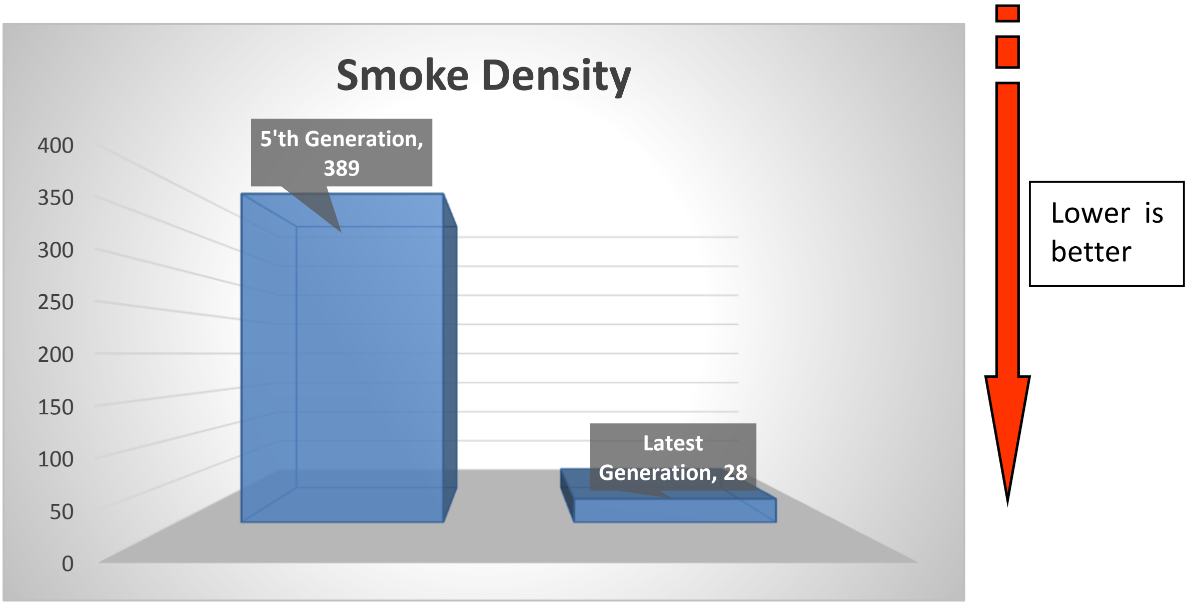

Figure 4. The smoke density levels have reduced dramatically

5. CONCLUSION

Generation two, three, four and five belts are all currently used in South Africa. All of the above complied with the requirements of SANS 971 up until the latest revision of 2013 where changes were introduced to reduce the belt flame propagation properties in line with the best global specifications.

Without sacrificing on belt performance, the latest generation of flame retardant belts will ensure a much safer environment compared to older generation belts. The major reduction in toxic gas levels coupled with the improved drop in optical density will most definitely result in a safer environment in the event of a fire starting.

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ABOUT THE AUTHOR

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Ben-Piet obtained his B.Sc. degree in 1994 at the University of Port Elizabeth. The following year he completed his B.Sc. Honours in polymer chemistry at the University of Port Elizabeth.

In 1996, Ben-Piet started his journey into the wonderful world of rubber, where 17 years later, he still finds himself. On his path he has been a rubber compounder, laboratory technician, quality manager and technical manager.

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