

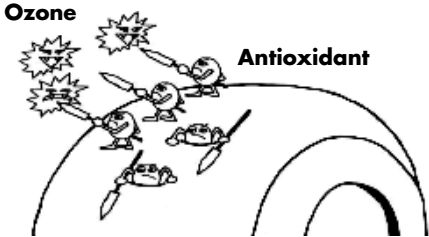
TOYO TIRE TALK

Subject: Rubber Compound ... Antioxidants and Waxes

As is commonly known, rubber is a main constituent of tires. And rubber, regardless whether natural or synthetic, suffers aging like any other substance as a result of usage over a long period. Aging is recognized as deterioration in physical properties. Namely, aged rubber becomes either hardened or softened causing cracking or loss of adhesion. The main causes of rubber aging in tires are Ozone, Heat and Deflection. To protect rubber from aging, Antioxidants and Waxes are generally used in the rubber compounding. Now in this issue of Toyo Tire Talk, we would like to explain about Antioxidants and Waxes.

Functions of Antioxidants and Waxes

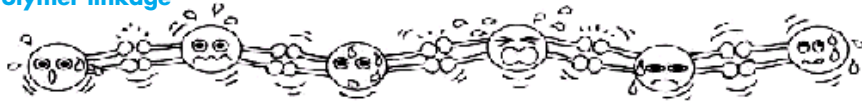
The table below shows how Antioxidants and Waxes work as anti-aging agents in tires.

Cause	Antioxidant	Wax
Ozone	<p>*Antioxidants come out to the surface of the tire where chemical reactions take place with the attacking ozone. Thus ozone is rendered inactive to age rubber.</p>  <p>The diagram illustrates the mechanism of antioxidants. It shows a cross-section of a tire's surface. On the left, several starburst shapes labeled 'Ozone' are shown attacking the surface. Small figures labeled 'Antioxidant' are positioned between the ozone and the tire surface, with some holding swords, indicating they are neutralizing the ozone's attack.</p>	<p>**Waxes migrate to the tire surface and form a thin film covering the surface. Thus the rubber is physically protected from the attack of ozone.</p>
Heat / Deflection	<p>Tire deflection and heat generation in the tire weaken and finally cut the polymer (rubber molecule) linkage which results in aging. Antioxidants in the rubber work to chemically bond with polymers in order to prevent the polymer linkage from being extensively cut. (Please see the drawing on next page.)</p>	<p>Wax has no effect against heat and deflection aging.</p>

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- The polymer linkage is weakened by heat and deflection.

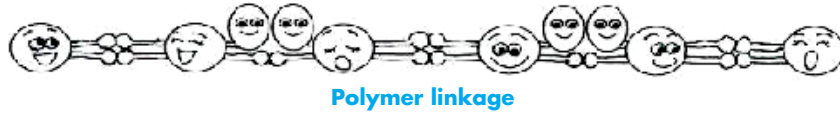
Polymer linkage



- Antioxidants work to chemically bond with the polymer in order to prevent the polymer linkage from being extensively cut.

Antioxidant

Antioxidant



Polymer linkage

*When you find the tire surface "reddish", this means Antioxidants have come out to the surface and effectively fought against ozone.

**When you see the tire with a "whitish" color, this is evidence of a layer of wax protecting the tire from ozone. (However the effectiveness of the wax layer is lost once the tire becomes rolling because the wax layer is broken.)

Type and Property Requirements of Antioxidants

Antioxidant is used in various parts of the tire. The type and requirements vary depending upon the part of the tire where the antioxidant is used.

Required Property \ Tire Part	Heat Resistance	Deflection Resistance	Sun-checking Resistance	Ozone Resistance	Oxidization Resistance
Tread	○	○	○	○	○
Sidewall		○		○	
Carcass	○	○			
Bead	○	○			

Tire Parts where Wax is used

Tread, Sidewall, Rim Strip and Tread Strip

